Northwest Atlantic Fisheries Organization

**Serial No. N4714** **NAFO SCR Doc. 02/93**

**SCIENTIFIC COUNCIL MEETING – SEPTEMBER 2002**

# Feeding and Food Consumption by the Barents Sea Skates

(Elasmobranch Fisheries – Poster)

by

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## Abstract

Stomach content data were used to study spatial, seasonal and interannual dynamics of feeding of the thorny skate *Raja radiata*. Data on food composition for other Barents Sea skates ( Northern skate – *R. hyperborea,* Round skate – *R. fyllae,* Blue skate – *R. batis*, Spinytail skate- *R. spinicauda*, Long-nosed skate – *R. oxyrhynchus* and Sail ray - *R. lintea*) are presented. The diet of thorny skate of different age is analysed. Food consumption by thorny skate is assessed with a special focus on the consumption of commercial species.

## Introduction

The Barents Sea is inhabited by seven skate species (Dolgov, 2000). However, the biology and feeding of most of them still remain largely unknown. Except for a few papers on feeding of thorny and round skates (Zenkevich and Brotskaya, 1931; Antipova and Nikiforova, 1983; Berestovsky, 1989; Dolgov, 1997), data on feeding of other skates are virtually unavailable.

This paper summarizes data on feeding of the six Barents Sea skate species registered in catches in the recent decade in order to specify their diet and estimate the effects of their predation on commercial stocks.

## Materials and Methods

The number, length and weight of each prey species occurring in skate stomachs were identified and the biological parameters of predator (length, weight, sex, stomach fullness) were defined. Prey species were classified to the smallest identifiable taxon.

A total of 2 192 stomachs of thorny skate, 85 of round skate, 48 of northern skate, 39 of blue skate, 14 of spinytail skate and 5 of sail ray were examined.

Percentage by weight (m) (% of the food bolus) and frequency of occurrence (f) (% of feeding fish) were used as feeding indices.

Food consumption in the entire Barents Sea was calculated by quarter and by 5 cm age groups. Daily ration of all age groups in all quarters was taken as 0.80% of the body weight (Berestovsky, 1989). The abundance of length groups was calculated as mean abundance of this group based on the trawl survey data for 1994-2001 and was assumed to be the same over the year (Dolgov, 1997; Dolgov *et al*., 2002).

Approximate consumption by other skates was calculated using averaged data on food composition and total stock biomass (Dolgov *et al*., 2000). Mean daily ration was taken as 1% of the body weight.

## Results

Food composition

*Thorny skate*

The diet of thorny skate consisted primarily of fish and large shellfish (shrimps and crabs). Of more than 18 fish species, young cod (12.5% by weight) and capelin (6.1% by weight) prevailed. Bottom shellfish were presented mainly by northern shrimp (9.5% by weight). Fisheries waste (digestive tract, gonads etc.), which also played an important role in the diet of skates, occurred in 12% of stomachs and made up to 35% by weight.

The importance of small food items (*Gammaridea*, *Euphausiidae* and *Polychaeta)* reduced with an increase in skate length, with a simultaneously increasing role of large crustaceans and fish (Fig. 1). The diet of skates of 31-35 cm length and larger consisted mainly of fish and large decapods.

We did not find any clear regularities in the seasonal dynamics of food composition of thorny skate over the period of investigations (Fig. 2).

*Round skate*

Round skate fed mainly on bottom benthos, especially *Polychaeta* (31% by weight) and *Gammaridae* (14% by weight) (Table 1). The diet of this species consisted primarily of northern shrimp (26% by weight) and fisheries waste (10% by weight). Fish, mostly capelin and young cod, occurred in small quantities.

Small individuals of below 35 cm length consumed exclusively benthos (*Polychaeta* and *Gammaridae*), and only those of 36-40 cm length and larger started to feed on bigger prey (Fig. 3). In the feeding of the largest skates of 51-55 cm length the portion of small benthic organisms remained high, though it did not exceed 30-40%.

*Northern skate*

The diet of this skate was dominated by fish (ca. 90% by weight) (Table 1), including herring, capelin and redfish. The portion of northern shrimp was also rather high (8.3% by weight), while that of fisheries waste did not exceed 2%.

*Blue skate*

The dominating food item in the diet of this species was fish, in particular, young cod and haddock, redfish and long rough dab. Fish made up ca. 70% by weight (Table 1). One of the stomachs contained a young round skate of 17 cm length. Fisheries waste was another important food source (25% by weight).

*Spinytail skate*

The diet of this skate was dominated by fish - haddock, redfish and long rough dab. The portion of fish was 90% by weight (Table 1). One of the stomachs contained a round skate of 26 cm length.

*Sail ray*

Data on feeding of this species were very sparse (Table 1). In the stomachs of two young individuals of 22-28 cm length caught on the Fugløy Bank (mean fullness indices of 28.1-62.2‰) only gammarids were found. Food composition of larger individuals was more varied. The stomach of a 72 cm male (mean fullness indices of 140.0‰) caught at the Nordkyn Bank contained 9 northern shrimp of 2.5-11 cm length, 4 *Sabinea septemcarinata* of 4-6 cm length, 1 *Munida* sp. of 2.5 cm carapace length and the remainings of *Ophiura*. The stomach of a 94 cm female (mean fullness indices of 661.6‰) caught in the same area contained mainly fisheries waste. Additionally, it contained one northern shrimp of 10 cm length and one Norway pout of 18 cm length.

Length composition of prey

The length of consumed prey depended on predator length. The length of small prey, in particular northern shrimp, was similar in the stomachs of all skate species, ranging from 1 to 12-13 cm (Fig. 4). The same was noted in small fish, for instance capelin, the length of which allowed the consumption by all skate species on reaching 16-20 cm length. The length of capelin in stomachs ranged from 6 to 17 cm (Fig. 5). In larger fish, consumption selectivity by

size was observed in different skate species. Maximum length of young cod and redfish in the stomachs of thorny skate did not exceed, respectively, 29 and 21 cm, while in blue skate, their length reached, respectively, 40 and 25 cm (Fig. 4). The length of flatfish (long rough dab) cm in the stomachs of thorny skate was not over 19 cm (Fig. 5) and reached 35 cm in those of blue skate.

FOOD CONSUMPTION

Mean annual biomass of food consumed by thorny skate in 1994-2000 was ca. 150 thousand tons, whereof ca. 73 thousand tons were made up of commercial fishes and invertebrates (Table 2). Major food items were shrimp and cod – 31 and 16 thousand tons, respectively.

Possible consumption by other skates was much lower and varied from 2 thousand tons in spinytail skate to 12 thousand tons in northern skate (Table 3). Total food consumption by all skate species did not exceed 31 thousand tons, whereof ca. 18 thousand tons were made up by commercial species.

## Discussion

The obtained data on food composition and length of prey in skate stomachs confirm the known regularities of feeding of this species, both in the Barents Sea (Zenkevich and Brotskaya, 1931; Antipova and Nikiforova, 1983; Berestovsky, 1989) and in the rest of the North Atlantic (Templeman, 1982; Pedersen, 1995; Bjelland *et al*., 2000; Skjæraasen and Bergstad, 2000). Young skates are typical benthos-eaters, while larger ones change to feeding on various decapods and fishes. Round skate, which is considered as a typical benthos-eater (Berestovsky, 1989), can feed on young cod in addition to capelin. Other skates are largely piscivorous species, which is also confirmed by a few data from other North Atlantic areas (Andriyashev, 1954; Stehmann and Bürkel, 1984; Bjelland *et al*., 2000). Scarcity of data does not allow any conclusions regarding sail ray. Many skate species in the Barents Sea fed rather actively on fisheries waste. This fact can point to the deficiency of food supply or, conversely, to its importance as an additional food source.

Of the six skate species, a major part of food is, obviously, consumed by thorny skate, which makes up 95.8% by abundance and 91.8% by biomass of the Barents Sea skates (Dolgov *et al*., 2002). The total biomass of commercial species consumed by skates is rather high (above 90 thousand tons). However, the biomass of each particular species is not so great, with the exception of northern shrimp and young cod. Additionally, the total biomass of food consumed by skates, as compared to consumption by other Barents Sea fishes, is not high and does not exceed 5-7% of consumption by cod. However, it should be noted that skates feed largely on young fish and their predation may have a certain impact on the recruitment to commercial stocks of fish and invertebrates.

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TABLE 1. Food composition of skates species in the Barents Sea.

| Food item | Raja radiata | | Raja fyllae | | Raja hyperborea | | Raja batis | | Raja spinicauda | | Raja lintea | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % m | % f | % m | % f | % m | % f | % m | % f | % m | % f | % m | % f |
| Polychaeta | 4.25 | 21.4 | 31.24 | 61.2 | 0.39 | 4.2 | 0.16 | 5.1 | 0.48 | 28.6 | | |
| Cephalopoda | 1.29 | 0.14 | 5.56 | 1.2 | | | 0.60 | 2.6 | | | | |
| Gammaridea | 2.10 | 16.9 | 14.22 | 54.1 | | | 0.06 | 10.3 | 1.25 | 42.8 | 0.17 | 50.0 |
| Euphausiidae | 1.31 | 9.6 | 1.23 | 10.6 | | | 0.08 | 10.3 | | | | |
| Pandalus borealis | 9.50 | 20.9 | 26.95 | 21.2 | 8.31 | 20.8 | 2.43 | 33.3 | 3.54 | 28.6 | 7.92 | 50.0 |
| Other decapods | 7.79 | 10.9 | 4.19 | 10.7 | 0.98 | 8.4 | 0.32 | 20.6 | 1.25 | 21.4 | 2.27 | 50.0 |
| Echinodermata | 0.16 | 0.04 | 0.35 | 1.2 | | | | | | | 0.04 | 0.25 |
| Raja spp. | 0.20 | 0.1 | | | | | 0.27 | 2.6 | 1.04 | 7.1 | | |
| Herring | 0.32 | 0.7 | | | 20.33 | 4.2 | | | | | | |
| Capelin | 6.12 | 7.0 | 2.97 | 1.2 | 20.66 | 25.0 | | | | | | |
| Polar cod | 0.91 | 0.6 | | | | | | | | | | |
| Cod | 12.53 | 4.6 | 1.85 | 1.2 | | | 12.25 | 12.8 | | | | |
| Haddock | 0.83 | 0.3 | | | | | 13.58 | 2.6 | 17.13 | 7.1 | | |
| Blue whiting | 0.05 | 0.1 | | | | | | | | | | |
| Norway pout | | | | | | | | | | | 13.47 | 25.0 |
| Redfish | 1.14 | 0.4 | | | 8.13 | 2.1 | 32.18 | 28.2 | 70.02 | 14.3 | | |
| Long rough dab | 2.16 | 2.0 | | | | | 2.96 | 2.6 | 0.17 | 7.1 | | |
| Other fish | 7.63 | | 0.21 | 1.2 | 37.04 | 12.5 | 9.73 | 28.3 | 3.03 | 21.4 | | |
| Other food | 6.02 | | 0.58 | 1.2 | 2.29 | 8.3 | | | 0.21 | 7.1 | | |
| Fisheries waste | 35.69 | 12.3 | 10.66 | 3.5 | 1.87 | 4.2 | 25.38 | 25.6 | 1.88 | 7.1 | 76.12 | 25.0 |
| Number of stomachs | 2192 | | 85 | | 48 | | 39 | | 14 | | 5 | |
| % of empty stomachs | 24.6 | | 11.8 | | 27.1 | | 10.3 | | 0 | | 20.0 | |
| Mean fullness ball | 1.5 | | 1.9 | | 1.3 | | 1.8 | | 2.4 | | 2.5 | |
| Mean fullness index | 301.26 | | 130.52 | | 205.66 | | 231.18 | | 104.08 | | 222.99 | |

TABLE 2. Food consumption by thorny skate in 1994-2000, thousand tons

| | Year | | | | | Mean |
|---|---|---|---|---|---|---|
| | 1994-1996 | 1997 | 1998 | 1999 | 2000 | |
| Euphausiids | 1.82 | 1.66 | 0.88 | 0.51 | 1.10 | 1.19 |
| Hyperiids | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 | 0.01 |
| Shrimp | 12.27 | 10.38 | 28.56 | 40.69 | 67.06 | 31.79 |
| Herring | 0.26 | 0.06 | 0.32 | 1.87 | 0.00 | 0.50 |
| Capelin | 2.99 | 6.23 | 21.12 | 40.09 | 0.00 | 14.09 |
| Polar cod | 2.62 | 0.65 | 1.16 | 4.13 | 7.27 | 3.17 |
| Cod | 15.65 | 33.19 | 15.28 | 18.10 | 0.00 | 16.44 |
| Haddock | 1.26 | 0.00 | 0.59 | 1.97 | 0.00 | 0.76 |
| Redfish | 2.57 | 2.04 | 4.88 | 8.18 | 0.00 | 3.53 |
| Long rough dab | 4.69 | 5.64 | 2.39 | 2.04 | 2.04 | 3.36 |
| Other fish | 12.03 | 15.32 | 3.37 | 4.85 | 30.31 | 13.18 |
| Other food | 109.51 | 90.48 | 87.12 | 43.25 | 57.83 | 77.64 |
| Sum | 165.67 | 165.67 | 165.67 | 165.67 | 165.67 | 165.67 |

TABLE 3. Possible food consumption by other skate species, thousand tons

| Food organisms | Skate species | | | | |
|---|---|---|---|---|---|
| | Round skate | Northern skate | Blue skate | Spinytail skate | Sum |
| Shrimp | 1.38 | 1.06 | 0.27 | 0.08 | 2.79 |
| Herring | | 2.60 | | | 2.60 |
| Capelin | 0.15 | 2.64 | | | 2.79 |
| Cod | 0.09 | | 1.39 | | 1.48 |
| Haddock | | | 1.54 | 0.38 | 1.91 |
| Redfish | | 1.04 | 3.64 | 1.53 | 6.21 |
| Long rough dab | | | 0.33 | | 0.33 |
| Other food | 3.49 | 5.44 | 4.14 | 0.20 | 13.27 |
| Total | 5.11 | 12.78 | 11.32 | 2.19 | 31.39 |

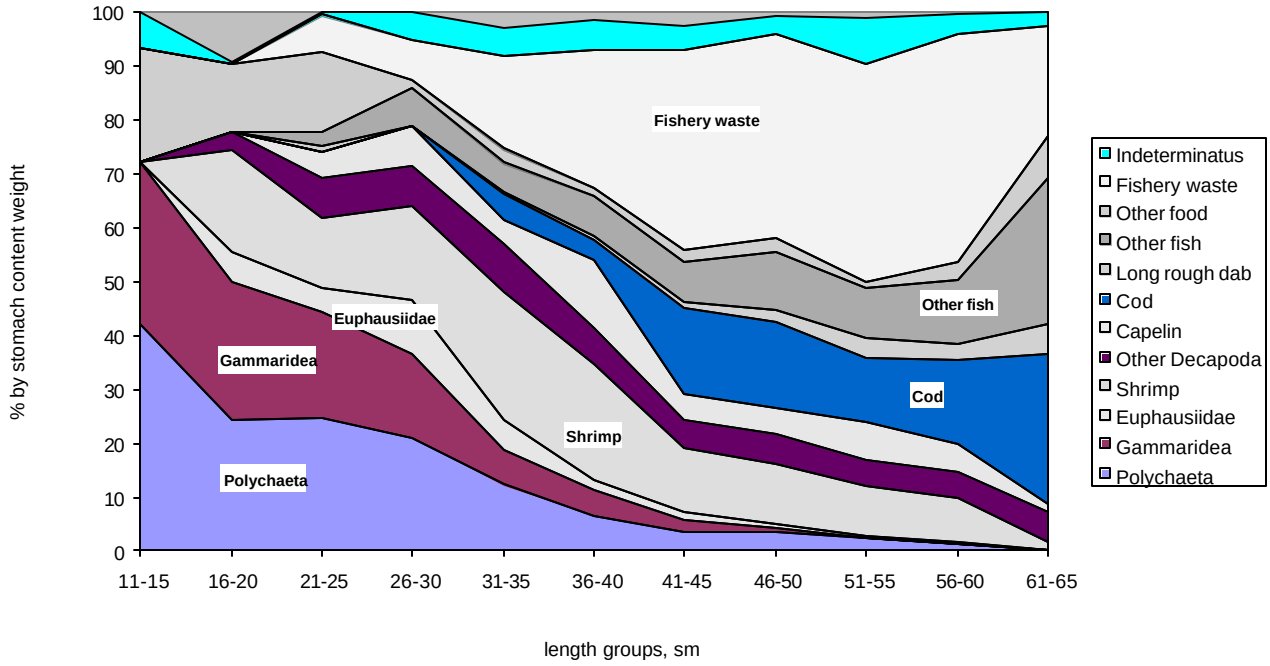


Fig. 1. Diet changes in different length groups of thorny skate.

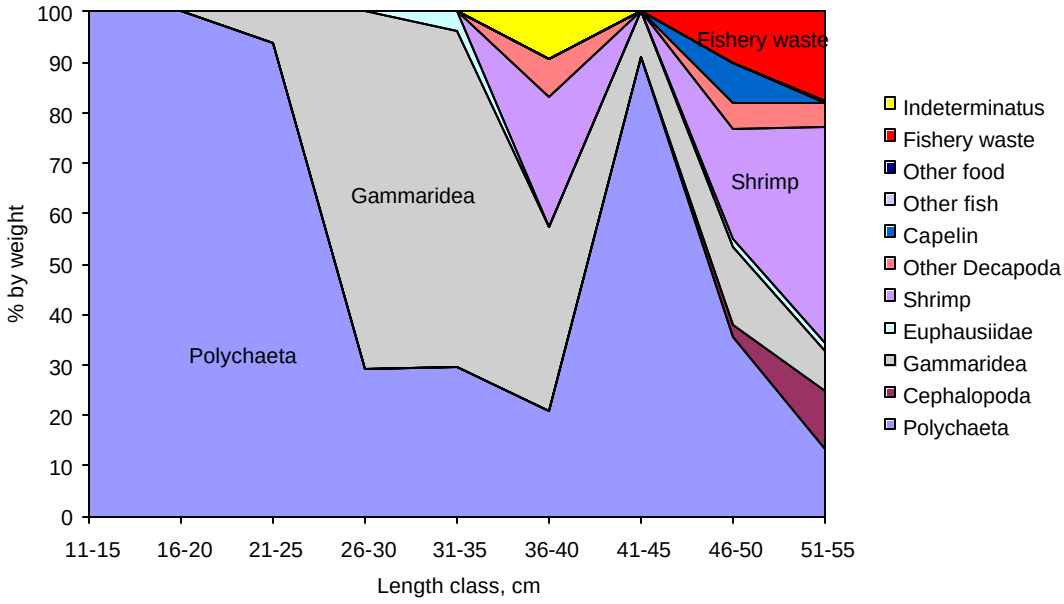


Fig. 2. Diet changes in different length groups of round skate.

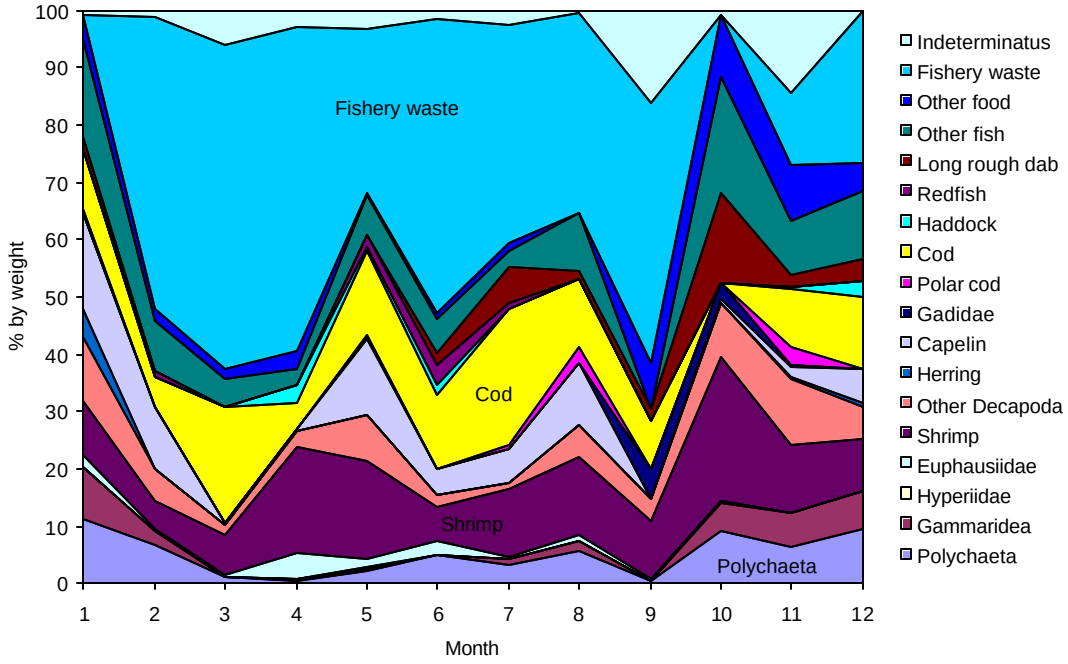


Fig. 3. Seasonal changes in the diet of thorny skate.

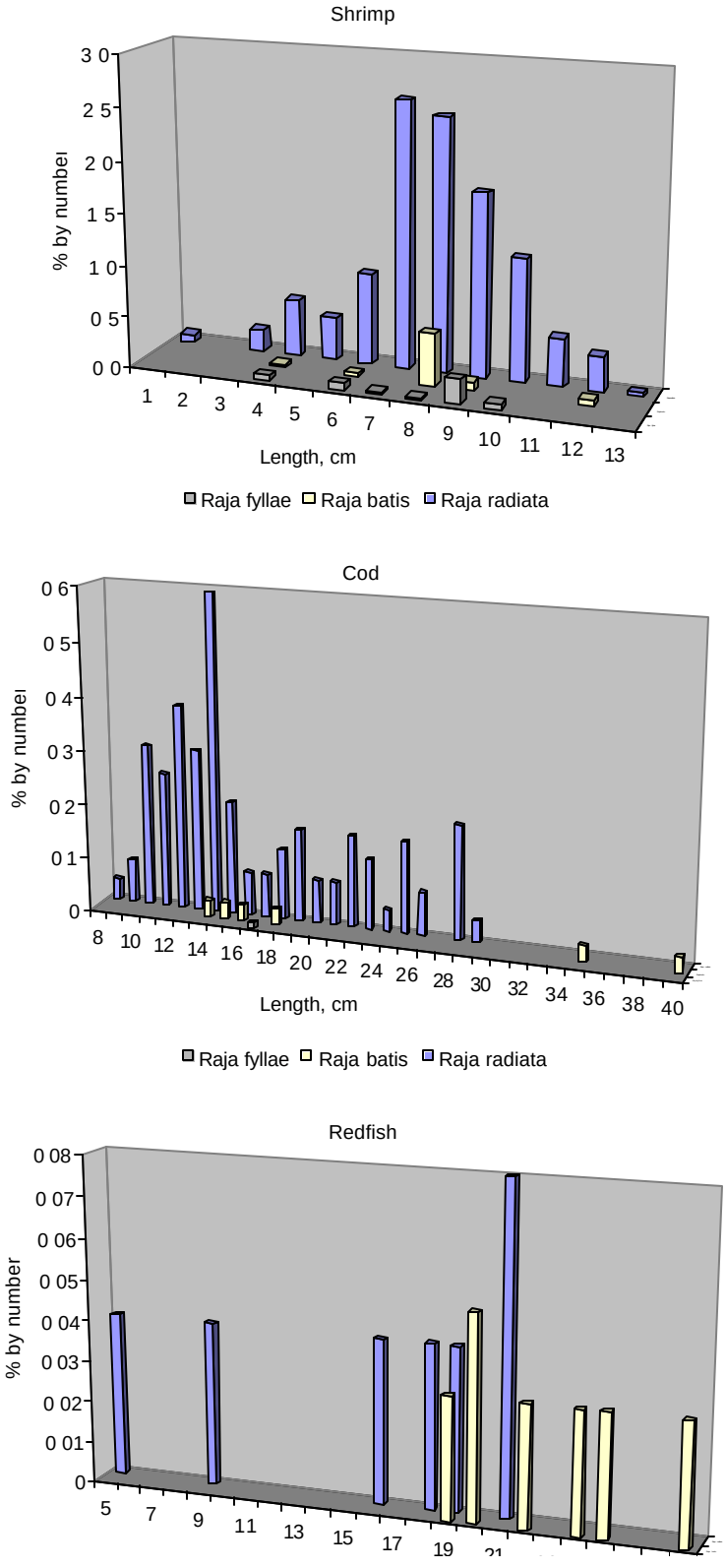


Fig. 4. Length distribution of shrimp, cod and redfish in the stomachs of skates.

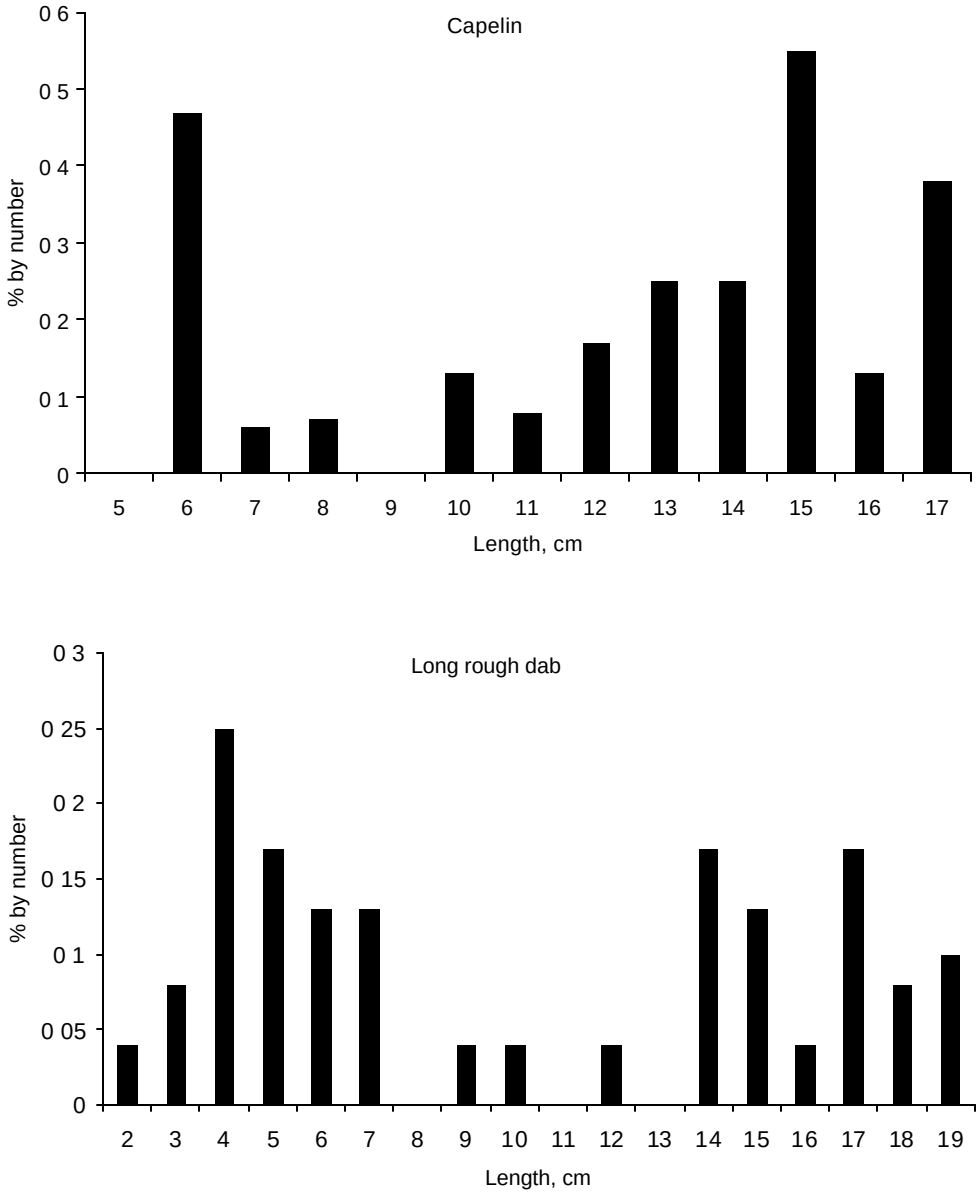


Fig 5. Length distribution of capelin and long rough dab in the stomachs of thorny skate.