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Winter Food of the Baltic Herring (Clupea harengus L.)

by

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Abstract

The stomachs of 42% or 63% respectivly, of the Baltic herrings caught in the Eckernförde Bight in Jan./Feb. and on the Oderbank off the Pommeranian coast in mid November contained food remains. In juvenile herrings of the Eckernförde Bight copepods and plaice eggs were the dominant food items. In fishes > 16 cm gobiids (Pomatoschistus minutus) were most important. An average of 91% of all stomach contents in the samples of the Oderbank herrings consisted of gobiids.

Introduction

In winter, feeding activity of herring is very limited (Hardy 1924, Jespersen 1928, Savage 1931, Nikolayev 1951). Dementieva (1955), in her study of herring of the eastern Baltic found no feeding for a period of up to four months in the years 1952 to 1955. According to Blaxter and Holliday (1958) herring does not feed at temperatures below 4°C in captivity. Both Farin et al. (1957) and Kamshilow and Garasimow (1960) observed feeding at temperatures of 1°C or less.

In general the number of relevant studies on herring in winter is very limited. It seemed worthwhile to investigate whether or not herring of the western Baltic feeds in winter when zooplankton production is low.

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Material and methods

Most of the material comes from the Eckernförde Bight in the Belt Sea (Fig.1). From 22 Jan. to 19 Feb. 1976, 12 hauls each of one hour, were made using a herring bottom trawl with a vertical opening of up to five meters, towed by R.V. "Alkor" or R.V. "Hermann Wattenberg".The water depth was about 20 m and the bottom temperature ranged from 1°C to 3°C. All samples were taken between 7 a.m. and 5 p.m. local time, i.e. in day-light. Altogether about 1000 herring were caught. 571 were dissected for their stomach contents. Most of the herring were juvenile or in the maturity stage III or IV. The few more mature fishes of stage V (Heincke-Scale) were not included in the study. The herrings were sorted into 2 cm length groups (total length measured to the cm below). The fore gut consisting of oesophagus, stomach and pylorus was preserved in 15% formalin for later analysis.

The state of filling of the stomach was roughly classified into 6 stages: 0 = empty, 1 = small remains, 2 = half filled, 3 = three quarters filled, 4 = full, 5 = stomach expanded. The contents of the fore part of the digestive tract will subsequently referred to as stomach contents. It was analysed for its composition by taxa and measured for its dry weight. In addition to the samples taken in Eckernförde Bight by research vessels, some further herring were caught by pair trawlers on the Oderbank off the Pommeranian coast. The bottom trawl works at 12 m depth and has a vertical opening of up to 10 m. The herring caught by this method might have been well above the sea bed, even more than the fishes taken in the Eckernförde Bight. Two samples were taken between 10 and 11 a.m., three samples around 3.30 p.m. and one in the late afternoon at 7.30 p.m.. Since each haul lasted several hours, only live herring were analysed, as only for these fish the time of catching can be estimated. Unfortunately no temperature measurements were taken while fishing, but the usual temperature at this time of the year is about 9°C. 273 herrings were analysed. The commercial trawl did not catch herring smaller than 18 cm.

Results

a) Eckernförde Herring

Of the 571 herrings of the Eckernförde Bight, 240 specimens (42%) had food in their stomachs. The percentage of fish with food remains seemed to be lower in large fishes than in smaller ones (Tab.2). However, the variation between hauls and size groups is quite considerable. The average degree of filling was similar in all size groups of fish with food, and there is no indication that large specimens tend to have fewer but much larger meals. When grouping the material to the hour of capture, two major peaks are found in the percentage of feeding fish: around noon and sun set. This pattern is the same in smaller (18 cm) and larger fish (Fig.1). The average stage of filling rises slowly during the course of the day from 7 a.m. until 3 p.m. and drops afterwards, particulary with smaller fishes in the evening (Fig.3). The high percentage of fish with food in the stomach at a time of decreasing filling states might indicate small meals for a number of herring which do not feed during the day. On average 80% of the stomach contents were easy to identify. The composition of food taken by the various size groups of herring was quite different as shown in Fig.3 where the food items are given according to the dry weight, and in Tab.3 which lists presence, and relative abundance of food. In juvenile herring of 12 - 14 cm (there were no fishes of 14 - 16 cm in the sample) fish eggs and copepods were the major part of the food. Often a fish contained only one kind of food.

Copepods - almost exclusively Temora longicornis - were found in more than 90% of the juvenile herring (< 16 cm) with identifiable stomach contents. Fish eggs were next in presence and abundance; they were found in 18% of these fish. As far as the fish eggs could be identified they belonged exclusively to plaice (Pleuronectes platessa). Mysids and chaetognaths were the other food items of importance to most of the juvenile herring smaller than 16 cm. The size group of 16 - 18 cm (still mainly juvenile) shows a greater diversity in its food. Polychaetes - mainly of the genus Nereis and Pectinaria - were found in considerable presence and abundance in this size group while they were almost

missing in smaller fish and were relatively rare in larger fish. Still more important are the gobiids, which contributed more than 40% of the total food. More than 80% of the gobiids were digested beyond the level where an identification of the species was possible. The identifiable specimens were Pomatoschistus minutus, with the exception of two specimens of Aphia minuta. The gobiids ranged in size from 2.1 cm to 6.4 cm with the majority around 3.1 cm. In adult herring (> 18 cm) gobiids make up more than three quarters of the total food mass. Diastylis rathkei is the only other food item of any importance. It seems that gobiids are mainly eaten in the evening. At least at this time adult herring tend to have the most food in their stomachs.

b) Oderbank herring

The samples from the Oderbank consisted on the average of larger fish than from the Eckernförde Bight. The feeding rate was higher, but decreased with body size. Of the total of 273 herrings analysed at Oderbank 100 were empty. The percentage of feeding fish was around 75% in fish below 22 cm, around 63% between 22 to 28 cm, and below 50% in the few fishes > 28 cm. In all sizes the percentage of feeding fish was higher than in the Eckernförde Bight (Fig.4). No differences was found in the amount and composition of food between the samples taken in the morning, afternoon or evening.

The composition of food is rather similar to that found in the Eckernförde Bight. Gobiids were found in 66% of the feeding herring. The other contained small amounts of other food, mainly decapod crustaceans and their larvae. Copepods played a minor role. The various food items were found in the following number of stomachs (given in percent of feeding herring):

Gobiids	66 %
Crangon	5 %
Decapod larvae	5 %
Amphipoda	2 %
Copepoda	1 %

The overwhelming importance of gobiids in winter food of the Oderbank herring becomes even more obvious when considering various

food items by their share of the total food: 91% (Fig.5). Here Pomatoschistus minutus and again two Aphia minuta were identified. The rest of the fish were digested but also seemed to consist of gobiids.
Among the copepods Temora longicornis was identified. Amphipods seem to consist of Gammarus salinus, mysids of Mysis mixta and Praunus flexuosus. No identification was possible for decapod larvae and polychaetes.

Concluding remarks

Although very limited in scale, the present study leads to an interesting conclusion: Baltic herring is more actively feeding in late autumn and in winter than previously expected. The food consumption might even be sufficient to cover the basic and locomotory metabolism at the given low temperature, without drawing on the fat reserves, which might mainly be used for gonad development. Our figures do not suggest that in winter the average daily ration reaches one complete filling per day. Possibly some herring are rather active feeders while the food intake of others is low or non-existent over considerable periods. The ecological value of any figure of average daily ration in winter is therefore limited.
Nevertheless, Lohmeyer (1977) attempts to estimate the average total food intake of herring in our samples, in spite of the inadequacies of the present data and particulary the lack of continous sampling over day and night. The maximum amount of food in the unexpanded stomach (filling stage 4) increased with body weight of the Eckernförde herring as follows:

fish length	dry weight
12 - 14 cm	45 mg
16 - 18 cm	86 mg
18 - 20 cm	289 mg
20 - 22 cm	227 mg
22 - 24 cm	404 mg
24 - 26 cm	-
26 - 28 cm	694 mg

When averaging total food intake, Lohmeyer estimates that the total amount of food taken within a period of four days is simi-

lar to the figures for one complete filling. This is the equivalent of about 1.5% of the dry body weight of the herring (dry weight of herring had been calculated as 22% of fresh weight). The average daily food intake - the calculation includes those with empty stomachs - ranged from 0.35% to 0.70% of the dry body weight.
The figures for the Oderbank herring were different to the Eckernförde Bight herring and ranged from 0.72% to 1.31% of the dry body weight. It was not possible to find a significant trend in food intake in relation to the size of the fish, but it seems that herring of about 22 cm eat slightly more in relation to body weight.
The figures for food consumption per day are considerable lower than the annual averages of Zalchowski et al. (1976) which vary around 1.5% of the body weight for the size group 10 - 25 cm. The difference is not surprising as Lohmeyer's estimates are based on winter data only. The almost exclusive consumption of gobiids by adult herring has not previously been reported in the literature. In March, Hardy (1924) found sand eel up to 10 cm length in more than 90% of feeding North Sea herring. In April and May the percentage of fish feeders drops slightly, while the percentage of fish with stomach contents increases. In July the herring feed entirely on copepods. Older records of sand eel in herring in the North Sea and western Scottish waters are found in papers by Mitchell (1864) and Scott ;1887, 1906). In Danish waters the sandeel seems to play a minor role as herring food. Jespersen (1928) and others give no records about the Baltic proper. It is worth mentioning that on Oderbank cod, taken together with herring, were stuffed with sandeels, while herring were feeding exclusively on gobiids.
Gobiids are supposedly only taken in winter in great quantities when they leave the shallow coastal zone heading for deeper waters. The off-shore migration of gobiids and their consumption by herring is an interesting element of energy transfer from the rich litoral zone into the open parts of the Baltic. The up-take of plaice eggs in considerable numbers by juvenile herring might control recruitment in plaice. However, that seems farfetched without more quantitative data on the amount and daily ration of herring feeding on fish eggs.

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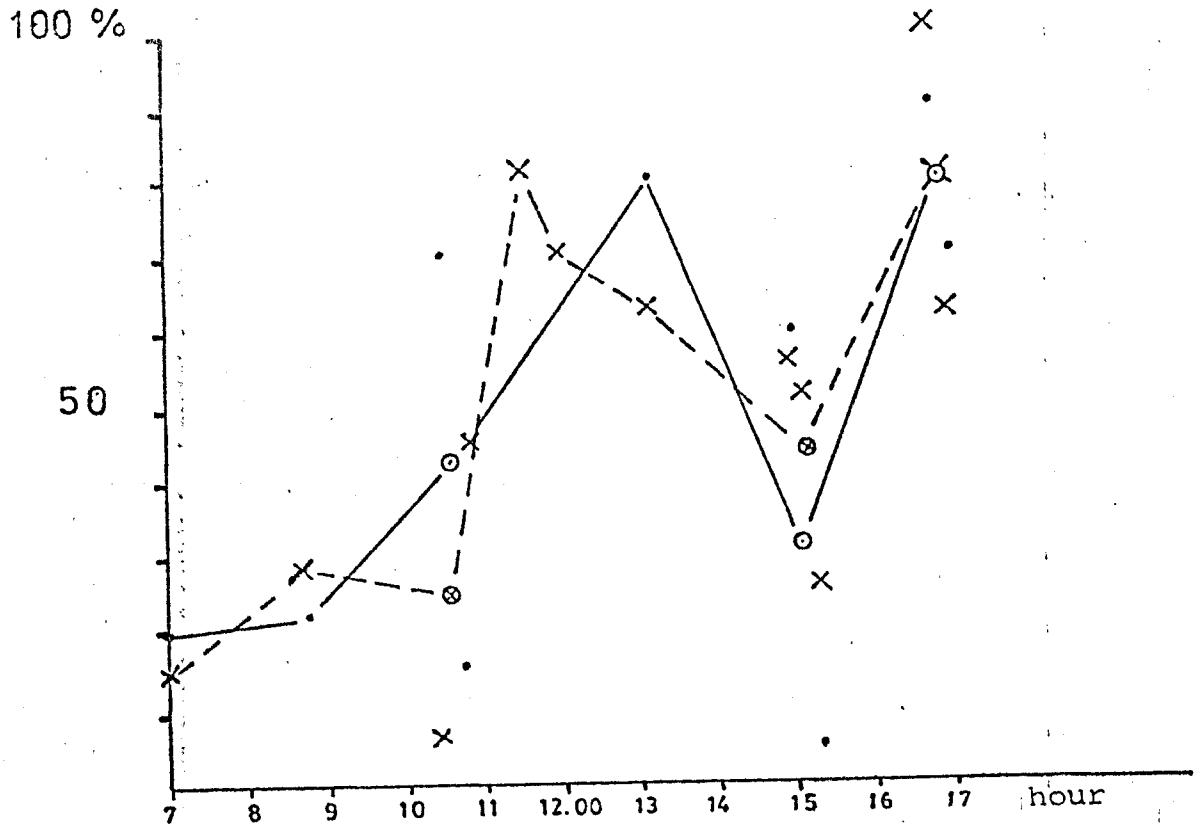


Fig. 1

dial variation in percentage of feeding fish

-------herring < 18 cm
———herring > 18 cm

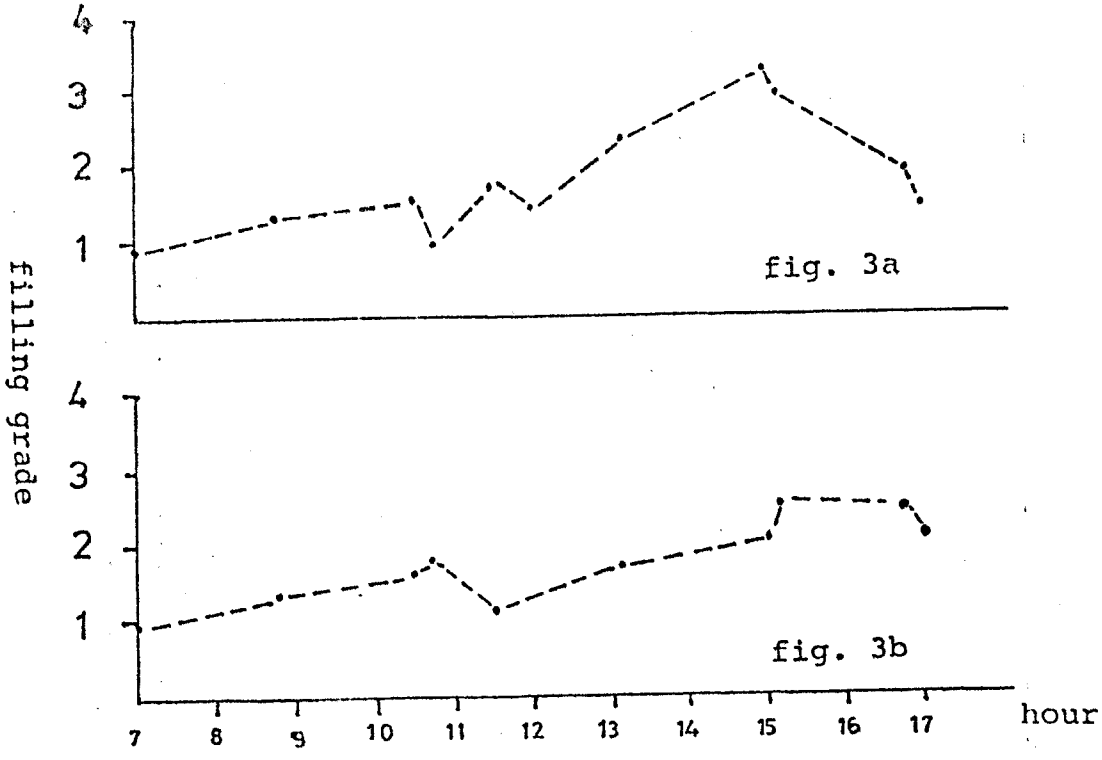
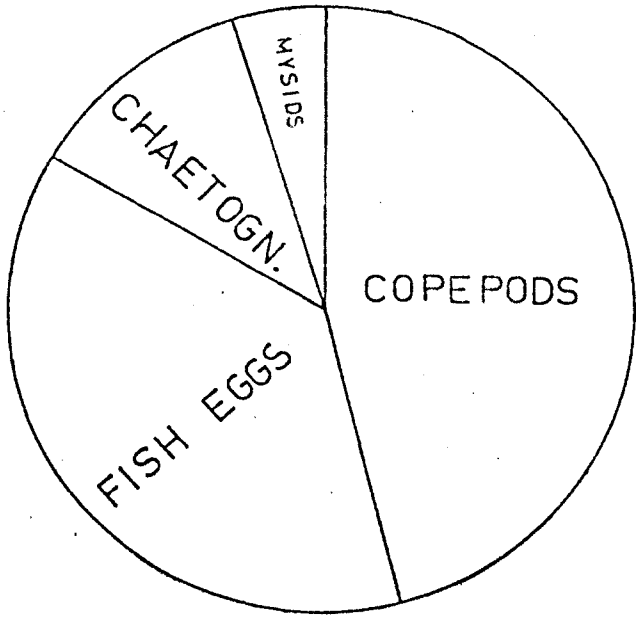


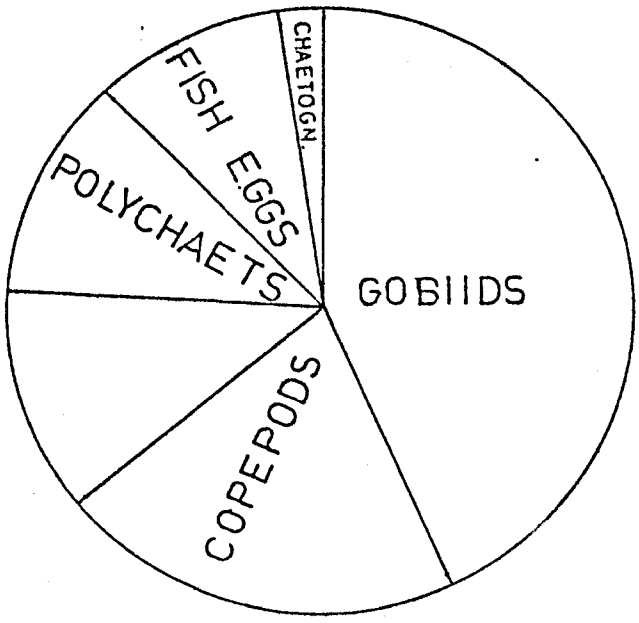
Fig. 2

dial variation of filling grade

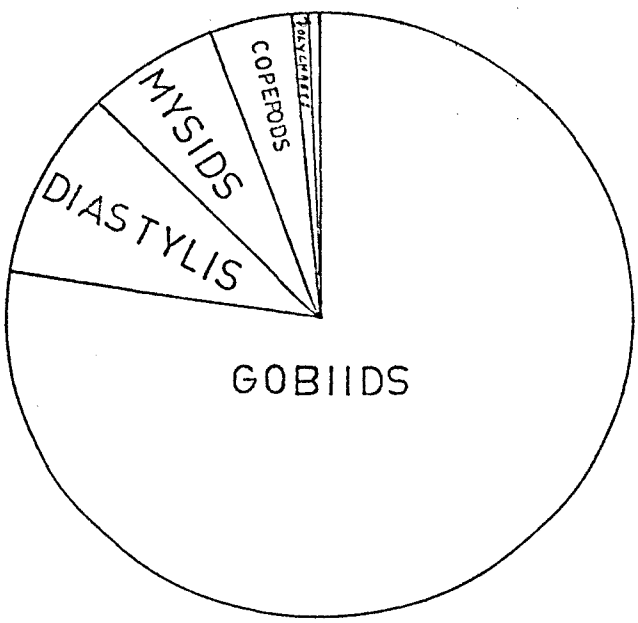
fig. 3a herring 18 cm
fig, 3b herring 18 cm



herring 12-14 cm



herring 16-18 cm



herring 18-28 cm

Fig. 3

composition of food in three size groups of herring

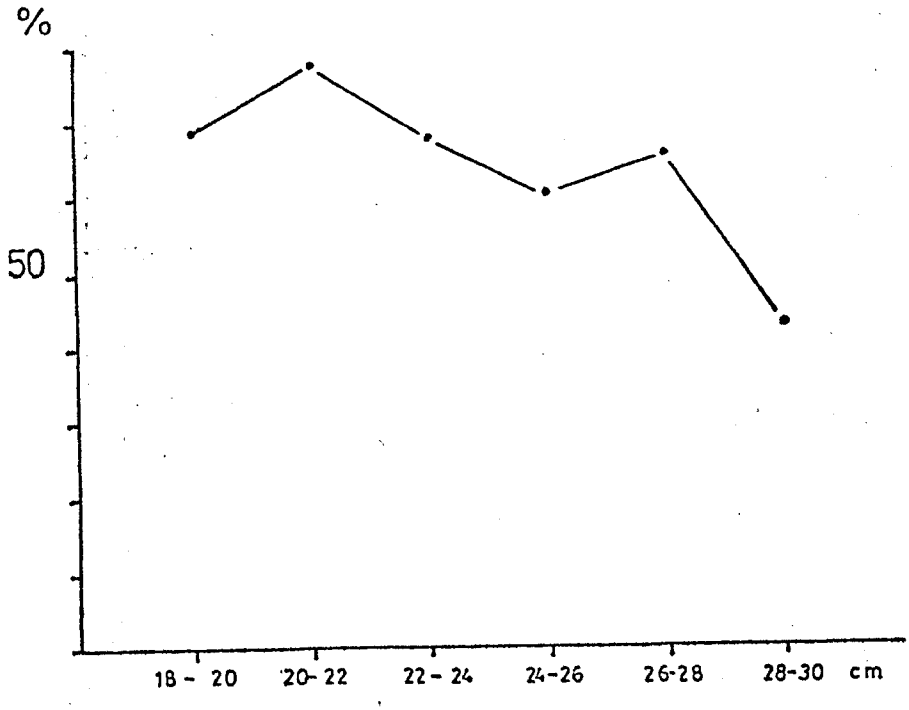


Fig. 4

percentage of feeding Oderbank herring against body length

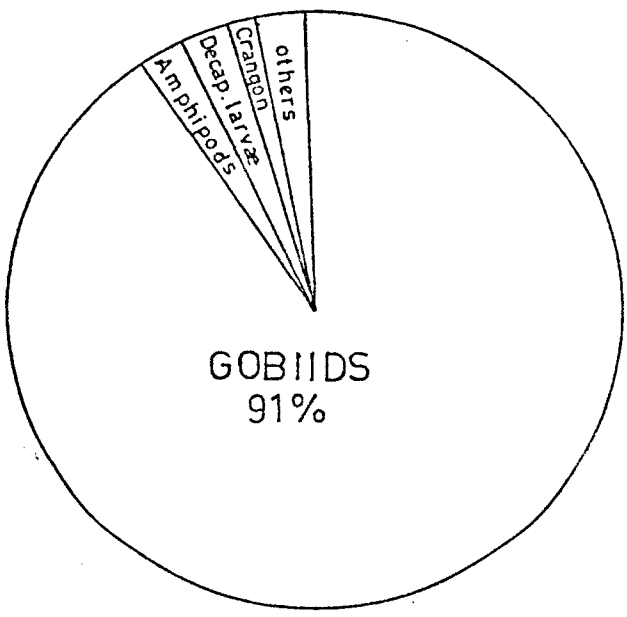


Fig. 5

composition of food in the Oderbank herring

Tab. 1a List of material Eckernförde Bight

(showing the relationship between feeding and non-feeding herring)

DATE HOUR	n	5. 2.76 07.00	n	5. 2.76 08.45	n	5. 2.76 10.30	n	22.1.76 10.40	n	19. 2.76 11.30	n	5. 2.76 12.00	n	19. 2.76 13.10	n	19. 2.76 15.00	n	4. 2.76 15.10	n	2. 2.76 15.20	n	19. 2.76 16.45	n	4. 2.76 17.00	Σ n	DATUM ZEIT	%
		Σ		Σ		Σ		Σ		Σ		Σ		Σ		Σ		Σ		Σ		Σ		Σ		Σ'	
12–14 cm				6:10		4:10						7:10				10:10								6:10		33:50	66
16–18cm		1:5		4:32		3:27		2:12		5:7				17:21		2:12				1:18		9:10				44:144	31
18–20cm		2:10				4:10		9:10		9:10				6:10		10:10		7:10		4:10				5:10		56:90	62
20–22cm				10:40		2:10		6:7		2:3				1:1		4:21		9:30				2:2		11:15		47:129	36
22–24cm				4:10		8:10		16:26												3:10				2:6		33:62	53
24–26cm				6:26		2:3		3:21		2:2						2:3		0:1						2:2		17:58	30
26–28cm		0:3		0:6				4:19								2:3				2:5				2:2		10:38	26
Ratio		3:18		30:124		23:70		40:95		18:22		7:10		24:32		30:59		16:41		10:43		11:12		28:49		240:571	42
%		17 %		24 %		32 %		42 %		82 %		70 %		75 %		51 %		39 %		23 %		91 %		68 %		42 %	

% = percentage of feeding fish

Tab. 1b List of material Oderbank

DATE HOUR	n	18.11.75 10.20	n	15.11.75 10.30	n	15.11.75 15.30	n	14.11.75 15.30	n	18.11.75 15.45	n	14.11.75 19.30			Σ n	
	26	Σ= 29	32	Σ= 56	34	Σ= 61	37	Σ= 53	11	Σ= 18	33	Σ= 51			173	Σ= 273

n = numb. of herring with food remains
Σ = total number of herrings dissected

Tab. 2

percentage of the Eckernförde Bight herring feeding on fish in diff. size groups

herring	% feeding fish
12-14 cm	0 %
16-18 cm	23 %
18-20 cm	62 %
20-22 cm	40 %
22-24 Cm	81 %
24-26 cm	23 %
26-28 cm	50 %

Tab. 3

presence and relative abundance of food items

Gobiids	40 %
Copepods	32 %
Fish eggs	18 %
Polichaets	17 %
Mollusc larvae	5 %
Podon	3 %
Diastylis	2.5 %
Crangon	1.6 %
Appendic.	1.3 %
Amphipods	0.4 %