

Zygmunt CHEŁKOWSKI, Józef DOMAGAŁA  
Rajmund TRZEBIATOWSKI

Fish biology

**FEEDING OF SEA TROUT (*SALMO TRUTTA* L.) MIGRATING  
UPSTREAM FOR SPAWNING IN LOWER ODER  
RIVER SYSTEM**

**ŻEROWANIE TROCI (*SALMO TRUTTA* L.) WĘDRUJĄCEJ NA TARŁO  
SYSTEMEM DOLNEJ ODRY**

**Institute of Aquaculture and Fishing Techniques,  
Academy of Agriculture, Szczecin**

The paper presents an analysis of the food tracts of sea trout (*Salmo trutta* L.) migrating from the Baltic Sea for spawning to the Gulf of Szczecin and lower Oder River, i.e. to waters of the lower Oder system.

**INTRODUCTION**

Pomerania extends between lower Oder River and the Szczecin Lagoon to the west, lower Vistula River to the east, South-West Baltic to the north, and Toruń-Eberswald pre-valley to the south. According to Dixon (1930), sea trout (*Salmo trutta* L.) from a Pomeranian River Reda grows in the sea, but is still feeds in the river during the upstream migration. However, data on food composition of sea trout during this migration phase are scarce and incomplete. Analysis of the food tract contents of sea trout grown in the Baltic Sea caught in course of upstream spawning migration in the system of lower Oder River fill this gap in our knowledge.

## MATERIAL AND METHODS

Studies were made on sea trout migrating for spawning to the River Oder system. This system embraces lower stretch of the Oder River and its tributaries as well as some small rivers flowing directly to the Szczecin Lagoon: Wołczenica, Wołcza, Gowienica and Ina (Fig. 1) (Chełkowski et al. 1976). Fishermen fishing in the Gulf of Szczecin and lower Oder supply sea trout as well as other fish to a number of purchasing centres. Two of these were selected, in Stołczyn and Kamień Pomorski (Fig. 1). According to Chełkowski et al. (1976, 1976 a, 1977, 1978, 1979, 1980), these two supply to the market most of sea trout caught by fishermen in Polish part of the Szczecin Lagoon and in lower Oder. The purchasing centre in Stołczyn buys fish

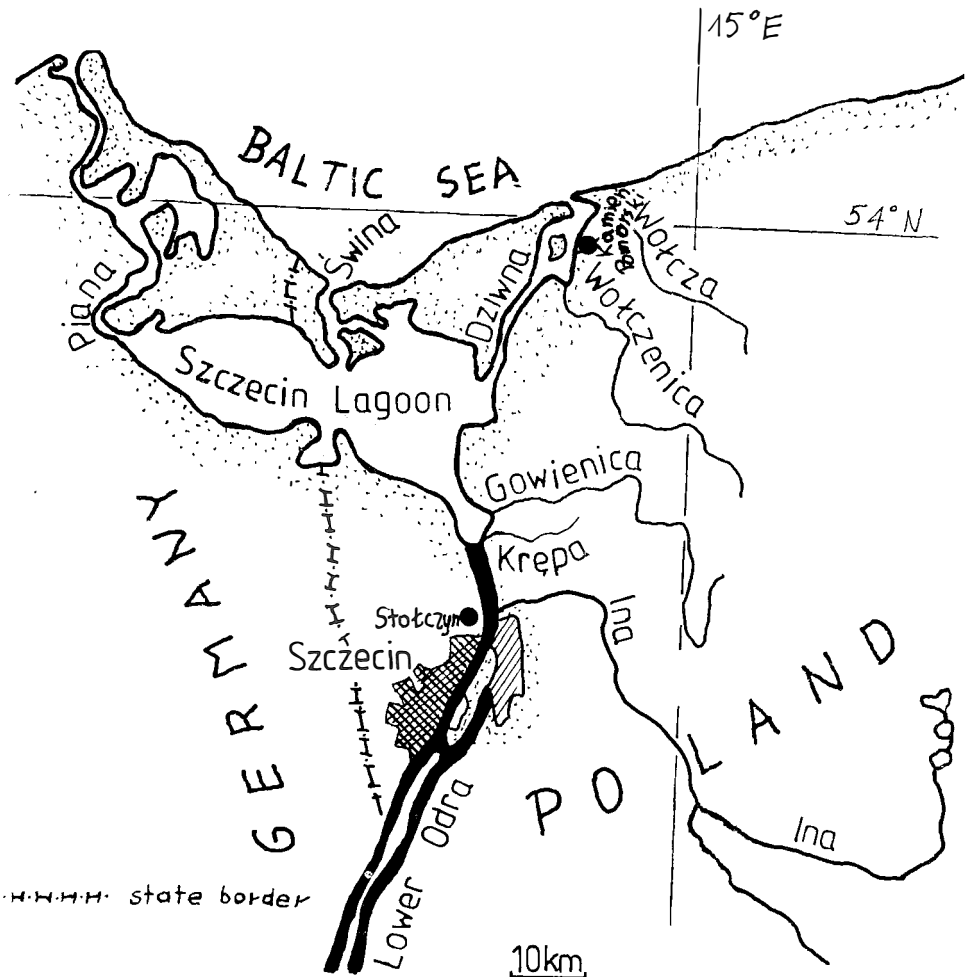


Fig. 1. The lower Oder and Szczecin Lagoon basin

caught in lower Oder. It is 15 km distant (by water course) from the mouth of Oder River, and 53 km from the nearest sea border. The other centre in Kamień Pomorski purchases fish caught in River Dziwna, one of the three rivers of the Oder River system. Fish obtained at this centre originate mainly from the fishing ground of Kamień Lagocn. Kamień Pomorski is distant 9 km (by water route) from the open sea.

Random samples of sea trout were collected in the two centres. Fish species was first identified basing on diagnostic parameters given by various authors (Berg 1948, Schechtel 1925, Chełkowski 1964, 1970). Fish were then gutted and their sex and gonad development determined after Chełkowski (1974), according to an 8-degree scale by Maier. Food tracts were collected. Fish length (*I. caudalis*) was measured up to 1 cm, and nutrition index determined after Chełkowski (1974) according to a 4-degree scale based on the thickness of an abdominal part:

scale degree	description
1.	abdominal part as thick as in fish feeding in the sea
2.	abdominal part still rather thick
3.	abdominal part thin in females, and not so thick in males
4.	abdominal part very thin in females (composed almost entirely of skin) and thin in males

Fresh food tracts were subjected to further examination. Their weight was determined up to 1 g, and the degree of adiposity established according to a 4-degree scale by Chełkowski (1974):

scale degree	description
1.	pyloric processes large, thick, robust, covered with lobes of fat tissue
2.	pyloric processes large, thick, robust, partly covered with lobes of fat tissue
3.	pyloric processes small, soft, with remnants of fat tissue
4.	pyloric processes very small, soft, with no fat tissue

Sea trout in course of spawning migration had gonads in stages 3-5, nutrition index 1-3 and degree of adiposity 1-3. The fishermen supplied also sea trout kelts, but these were discarded. They possessed gonads in stages VIII or VIII/II of development according to Maier's scale, and nutritive index of 4.

Content of the tracts was analysed: its weight was determined up to 1 g, and food composition was established. Consistency and colour of intestine mucus was also

nected. Studies on food composition were carried out in 1982-1984, in the months of more intensive fishing in the Gulf of Szczecin and lower Oder (Chełkowski et. al. 1976). Totally 655 food tracts were analysed. Additionally, weight of gonads up to 1 g was recorded for fish which ingested some food.

Protective size of sea trout in the Gulf of Szczecin and lower Oder is 45 cm, and protective period is from November till 31 January (Anonymous 1964).

In order to characterize the fish under study, the index of nutrition, condition factor of the food tract, and relative gonad weight were determined for each specimen.

Nutrition index (K) was calculated according to Fulton's equation:

$$K = \frac{G \times 100}{L^3}$$

where: G is the weight of gutted fish in g, as proposed by Clark (after Suworow 1948) in contradistinction to total fish weight used by Fulton, and L is the fish length (*l. caudalis*) in cm.

Condition factor of the food tract (P) was calculated after Chełkowski (1974) from the equation:

$$P = \frac{p \times 1000}{L^3}$$

where: p is weight of the food tract in g, and L is the fish length (*l. caudalis*) in cm.

Relative gonad weight (I) was calculated after Chełkowski (1974) from the equation:

$$I = \frac{i \times 100}{G}$$

where: i is gonad weight in g, and G weight of the gutted fish in g.

## RESULTS

### General characteristic of sea trout under study

Analyses were made of the food tracts obtained from 381 females and 274 males of sea trout caught in lower Oder and Dziwna River (Tab. 1). Fishes were collected in seven consecutive months, since April till October. Stage of gonad development ranged from III to V according to Maier. Number of sea trout obtained in consecutive months and their general characteristic as regards gonad development, fish length, weight of gutted fish, nutrition index (K), condition factor of the food tract (P) are presented in Table 2. It was found that K and P factors, calculated separately for



males and females, increased since April till July, and decreased since August till October. Similar trend was observed for sea trout from Rega River (Chełkowski 1974).

Only 21 food tracts (3.2%) contained food. Other, i.e. 634 (96.8%) were empty (Table 3). Food was ingested by 3.4% of the females and 2.9% of the males. It was also found that the food tracts of fish caught in spring and autumn contained food more frequently than of those caught in summer. As regards the fish caught in spring (April and May), food was found in 7-9.5%, and in those caught in autumn (October) in 4%, while only 1.1-3.3% of the food tracts contained food in summer (July, August, September).

It is interesting to note that ingestion of food by migrating sea trout depended on the place in which the fish were caught. Calculations showed that food was present in 7.6% of the food tracts of sea trout from Dziwna River, and in only 2.8% of fish from the lower Oder.

Food was ingested by fish of all sizes and weight: 59-102 cm and 1.8-8.0 kg as regards females, and 52-80 cm and 1.2-5.8 kg as regards males. Nutrition index (K) of sea trout that ingested food ranged from 0.75 to 1.02 for females, and from 0.85 to 1.2 for males. Condition factor of the food tracts (P) amounted to 0.15-0.63 for females and 0.25-0.71 for males. Gonads of fish with food in their stomachs were in stage III to V of development, at relative gonad weight (I) from 0.46 to 22.0 for females, and 0.11 to 5.61 for males. Intestine content was also analysed. Since April till October the intestines were filled with some mucus of light yellow colour.

Table 3

Frequency of food presence in the tracts of sea trout from lower Odra (a) and Dziwna River (b)

Month	a		b		Total	
	number of fish studied	containing ind.	number of fish studied	containing ind.	number of fish studied	containing ind.
Apr	—	—	43	3	43	3
May	21	2	—	—	21	2
Jun	25	0	—	—	25	—
Jul	20	0	10	1	30	1
Aug	56	1	—	—	56	1
Sep	178	2	—	—	178	2
Oct	302	12	—	—	302	12
Total	602	17	53	4	655	21



### Content of sea trout food tracts

Food of sea trout males and females caught in April and July in Dziwna River was at an advanced stage of digestion. It consisted of herring (*Clupea harengus* L), sprat (*Sprattus sprattus* L) and marine crustaceans (*Crustacea*). This food must have come from the sea which was about 9 km distant from the fishing area.

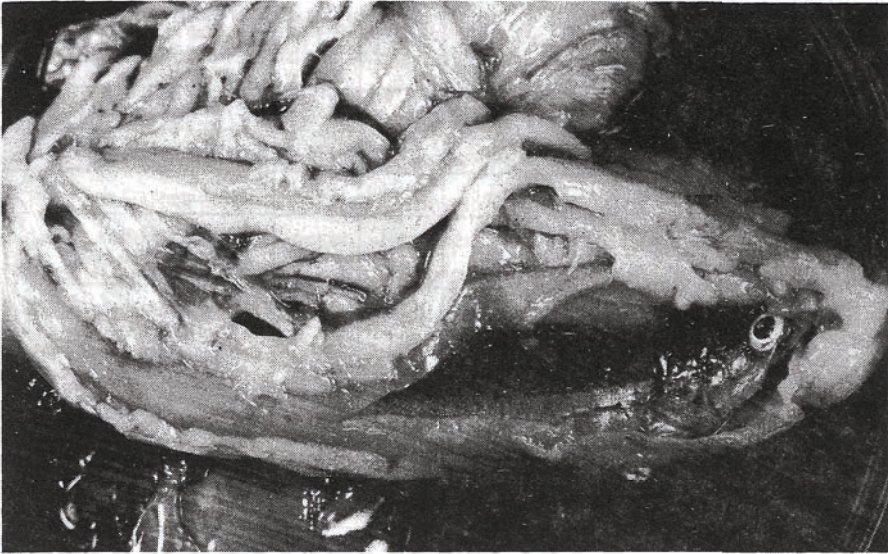


Fig. 2. Food tract of a sea trout with pikeperch in the stomach  
(for more detailed data see Table 4 No. 3)



Fig. 3. Food tract of a sea trout with white bream in the stomach  
(for more detailed data see Table 4 No. 11)

Food present in sea trout stomachs  
(stage of gonads development according to Maier's scale (Gd), fish nutrition index (K), condition factor of the food tract (P), index of gonad development (I) sex; female (f), male (m), slightly digested (sl), almost fresh (al), partly digested (pa), highly digested (hi))

No	Month	Sex	Gd	Length in cm	Weight in kg gutted fish	K	P	I	Description of food fish length in cm and weight in g in brackets
1.	May	f	III	59	2.0	0.97	0.63	0.59	sl, 1 perch (8.9 cm; 7.3 g)
2.	May	f	IV	66	2.7	0.97	0.50	0.46	sl, 1 roach (15.5 cm; 5 g)
3.	Au	f	IV	52	1.7	1.20	0.61	5.61	al, 1 pikeperch (12 cm; 11 g)
4.	Sept	f	IV	92	7.0	0.89	0.15	16.43	sl, 2 roach (10.7 and 6.2 g) and remnants of digested fish
5.	Sep	m	IV	80	5.8	1.13	0.39	3.80	al i roach (10.5 cm, 9.6 g) and 2 white breams (11.7 and 11.4 cm; 17.4 and 12.4 g) i fresh, 1 highly digested
6.	Oct	f	V	62	1.8	0.75	0.31	15.27	al, 1 perch (8.2 cm; 5.6 g)
7.	Oct	f	V	65	2.3	0.83	0.20	13.43	sl, 1 white bream (7.2 cm; 5 g)
8.	Oct	f	V	65	2.3	0.83	0.20	17.45	sl, 1 white bream (7.2 cm; 5 g)
9.	Oct	f	V	70	2.8	0.82	0.30	14.63	1 hite bream (8.5 cm; 7.1 g)
10.	Oct	f	V	70	3.0	0.87	0.21	15.30	pd, 1 white bream (9.1 cm; 7 g)
11.	Oct	f	V	75	3.6	0.85	0.25	22.00	pd, 1 white bream (8.6 cm; 6.4 g) remnants of digested fish
12.	Oct	f	V	76	3.8	0.86	0.27	14.00	remnants of 3 digested fish
13.	Oct	f	V	84	5.3	0.89	0.22	14.53	hi, 1 roach (8 g)
14.	Oct	f	V	102	8.0	0.75	0.15	20.03	sl, 1 roach (8.2 g)
15.	Oct	m	V	52	1.2	0.85	0.29	4.02	2 white bream; 1 slightly digested (9.2 cm; 5.8 g), 1 partly digested
16.	Oct	m	V	56	1.7	0.96	0.46	4.56	remnants of digested fish
17.	Oct	m	V	72	3.2	0.86	0.25	5.41	sl, 1 roach (9.8 cm; 9.2 g)
fish from Dziwna River									
18.	Apr	m	III	60	2.7	1.05	0.65	0.18	remnants of digested marine crustaceans, brown-orange in colour
19.	Apr	m	III	65	2.7	0.98	0.71	0.11	hi, 2 herring and 1 sprat (11 cm)
20.	Apr	m	III	78	5.0	0.92	0.34	0.57	hi, 3 herring (13; 14 and 5 cm, of total weight 80 g)
21.	July	f	IV	75	3.9	1.02	0.54	1.19	sl, 1 roach (9.3 cm; 12.4 g)



Sea trout caught in lower Oder in May-October had only fish in their stomachs. Roach (*Rutilus rutilus* L.) and white bream (*Blicca bjorkna* L.) were the main food items. Perch (*Perca fluviatilis* L.) and pikeperch (*Lucioperca lucioperca* L.) were also found. The two species are very numerous in lower Oder (see Fig. 2 and 3). Fish ingested by sea trout were rather small, within the range 7.2-15.5 cm and 5-40.1 g. Food items in the food tracts were in all stages of digestion; from almost fresh to highly or almost completely digested. Analyses of the food tract content revealed that highly digested items predominated. Some stomachs contained all sorts of food: from freshly ingested to highly digested, while other contained only highly digested food (see analyses of food tract content, Tab. 4, no. 4, 5 and 10). Data showed that stomachs of sea trout in course of spawning migration contained food and that the ingested food was being digested. However, food content was very low compared to sea trout in the sea during their trophic period. Stomachs of sea trout from Dziwna River contained 1-3 fishes weighing 12.4-80 g, and of those from lower Oder 1-3 fishes weighing 5-45.1 g. The highest food weight was found in a fish from Dziwna River; its stomach contained 3 fish weighing 80 g. In case of lower Oder the respective values were 2 fishes weighing 45.1 g.

#### DISCUSSION

Food of grown sea trout from Reda River in the period of upstream migration (undeveloped gonads) consisted of frogs, fishes, earth-worms, marine crustaceans and larvae of aquatic insects (Dixon 1930). Food of sea trout from the Oder River system in course of spawning upstream migration consisted only of fishes and marine crustaceans. No frogs, earth-worms or insect larvae were found.

According to Dixon (1930), food in the stomachs of sea trout (with undeveloped gonads) from Reda River was present since November till May (i.e. 11-5 months before spawning). In fish being at the same phase of upstream migration but caught since April till October, food was present in all months with the exception of June (i.e. 6-1 month before spawning). It should be underlined that also Chełkowski (1974) noted in another Pomeranian river Rega that sea trout commenced upstream spawning migration already in November, i.e. one year before spawning. Sea trout migrating upstream in this river in the period 11-7 months before spawning, i.e. between November and March, had gonads in stage II-III of development according to Maier's scale.

Studies showed that sea trout with gonads at stages II to V of development could and did ingest food in course of upstream spawning migration, the latter lasting for about 11 months. Some analyses of the food tracts of sea trout from Gowienica River (part of the Oder River system) showed that in fish caught at spawning grounds

and during spawning (this takes place in Pomeranian rivers in November and December, Chełkowski 1974, Chrzan 1948 and Dixon 1930) stomachs were empty. Thus, the fish did not feed in this period. Gonads filled the abdominal cavity of this fish (especially in females). Also Żarnecki (1933) did not find food in trout stomachs during spawning in upper Vistula (Dunajec River). On the other hand, trout kelts migrating downstream to the sea did feed<sup>x)</sup>.

## CONCLUSIONS

Analyses of the food tracts of sea trout migrating for spawning upstream in the lower Oder system showed that:

- food was found in 3.2% of the stomachs; 96.8% were empty,
- filling with food was low, i.e. so was the feeding activity of the fish,
- food was present in all months of the studies (April-October) in the stomachs of both males and females which had gonads in stages III, IV and V of development according to Maier's scale,
- food of sea trout caught in lower Oder consisted of small fish, mostly roach and white bream, less frequently perch and pikeperch, of length 7.2-15.5 cm and weight 5.0-40.1 g, while of those caught in Dziwna River of marine crustaceans and fish: herring and sprat, 13-15 cm in length and individual weight of about 26 g.
- the ingested food was digested.

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Translated: Dr M. Bnińska

Zygmunt Chełkowski, Józef Domagała, Rajmund Trzebiatowski

ŻEROWANIE TROCI (*SALMO TRUTTA* L.)  
WĘDRUJĄCEJ NA TARŁO SYSTEMEM DOLNEJ ODRY

STRESZCZENIE

Przeprowadzono analizę 655 przewodów pokarmowych troci (*Salmo trutta* L.) wyrosłych w Morzu Bałtyckim, pozyskanych w trakcie wędrówki tarłowej w Zalewie Szczecińskim i dolnej Odry, a więc w wodach wchodzących w skład systemu dolnej Odry. Stwierdzono, że pokarm wystąpił w 3,2% badanych żołądkach troci, natomiast pozostałe, stanowiące 96,8%, były puste. Wypełnienie żołądków pokarmem było niewielkie, zatem i aktywność pokarmowa była niewielka. Pokarm w żołądkach samic i samców wystąpił w miesiącach prowadzonych badań od kwietnia do października u ryb z gonadami w III, IV i V stopniu rozwoju gonad wg skali Maiera.

Pokarm troci pozyskanych w dolnej Odry składał się z małych ryb, głównie płoci i krąpi, rzadziej z okoni i sandaczy o długości 7.2-15.5 cm i masie 5-40.1 g, natomiast pozyskanych w rzece Dziwnie, stanowiącej jedno z trzech ujść Zalewu Szczecińskiego do morza, składał się ze skorupiaków morskich i małych ryb morskich — śledzi i szprotów o długości 13-15 cm i masie jednostkowej około 26 g. Pobrany pokarm ulegał trawieniu.

Authors' address:

Received: 1989.09.21

Prof. dr Zygmunt Chełkowski, doc. dr Józef Domagała,  
prof. dr Rajmund Trzebiatowski  
Instytut Akwakultury i Techniki Rybackiej  
Akademia Rolnicza  
ul. K. Królewicza 4  
71-550 Szczecin  
Polska (Poland)