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**GROWTH OF TAGGED RAINBOW TROUT (*SALMO GAIRDNERI* RICH.)
RELEASED TO THE BALTIC SEA**

**WZROST ZNAKOWANYCH PSTRĄGÓW TĘCZOWYCH (*SALMO GAIRDNERI* RICH.)
WSIEDLONYCH DO BAŁTYKU**

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On the basis of 2436 tag returns (10.3%) from 23624 one- and two-years old rainbow trout released into the Gulf of Gdańsk and the Vistula mouth, calculations were made of the fish growth. After the first year rainbow trout released at the age of one year attained 43.8 cm and 1048.8 g, while those released at the age of two years reached 48.7 cm and 1408.7 g. After the second year the respective values amounted to 59.8 cm and 2631.6 g, and 62.4 cm and 3251 g.

INTRODUCTION

Range of distribution of rainbow trout in the world is very wide (Mac Crimmon 1971, 1972). The species is found in a variety of environments, streams, rivers, lakes and seas, and its growth rate is highly differentiated, from very slow in the Estibere Stream (Dumas 1976) to very rapid in case of the fishes migrating from the rivers to the sea (Maher and Larkin 1954, Shapovalov and Taft 1954, Hallock et al. 1961, Gilbreath et al. 1976). The objective of this study was to determine length and body weight of rainbow trout released into the Baltic Sea.

Table 1

Tagging experiments with rainbow trout released into the Gulf of Gdańsk
and the Vistula mouth

No* of the experiment	Released						Recaptured**	
	Date	Place	Age	Average length cm	Range of length cm	Number of fish	Number of fish	%
2-9	1964-1972	Gulf of Gdańsk, Gdańsk	1	17.9	13-21	9571	686	7.2
10-16	1967-1972	Gulf of Gdańsk Gdańsk	2	23.2	14-49	6756	1062	15.7
17-20	1965-1968	Vistula mouth, Świbno	1	18.4	13-24	6133	523	8.5
21	1966	Gulf od Gdańsk Jastarnia	1	18.5	17-20	1164	165	14.2
Total:						23624	2436	10.3

* No. of experiment and detail data are presented in the paper Bartel (198).

** As recaptured fish are included only "older" fish, caught after July in the first year after the release.

MATERIAL AND METHOD

In 1964–1972 23.624 one- and two-year old tagged rainbow trouts were released into the Gulf of Gdańsk at Gdańsk and the Vistula mouth at Świbno (Fig. 1, Tab. 1). The fishes were tagged with silver and celluloid tags (Bartel 1985, in print). The returns amounted to 2436, i.e. to 10.3% (Tab. 1).

Fig. 1. Sites of releasing tagged rainbow trout (see the arrows)

Tag returns were very low in some experiments, so in order to determine the fish growth it was decided to analyse overall data in two age groups, i.e. the fishes released as one- and as two-years old. It was assumed that the fishes did not grow since November till March, so that average length and weight for this period corresponded to the fish size in successive years of life.

RESULTS

Fishes released at the age of one year reached average length of 43.8 cm and weight of 1042.8 g in winter of the first year after the release. The respective values for two-years old trout were 48.7 cm and 1408.7 g.

In winter of the second year after the release average fish length in the first group amounted to 59.8 cm and weight to 2631.6 g, and in the second group to 62.4 cm and 3215.9 g. Number of tags returned with an information on fish length and weight was very low in winter of the third year (7 tags). The calculated average values amounted to 62.4 cm and 3060 g for the first group, and 69.5 cm and 3033.3 g for the second group (Fig. 2 and 3).

Considerable differences in the fish growth were observed in the first and the second year after the release. For instance, fishes released at the age of one year attained in

Fig. 2. Growth of rainbow trout length in the sea. Fish released at the age of one and two years. 1 – average monthly lengths of caught rainbow trouts, released at the age of one year, 2 – average monthly lengths of caught rainbow trouts, released at the age of two years, 3 – average length of rainbow trout during winter (November – March); fishes released at the age of one year, 4 – average length of rainbow trout during winter (November – March); fishes released at the age of two years.

winter of the first year from 35 to 68 cm, while those released at the age of two years – from 36 to 70 cm. Weight of the fishes ranged from 500 to 3500 g in the first group, and from 1200 to 4600 g in the second. In winter of the second year, length and weight of rainbow trout varied between 45 and 73 cm, and 1200 and 4600 g for the younger fishes, and between 43 and 74 cm and 1100 and 6000 g for the older ones.

The biggest specimens, 85 cm and 58 cm long (from one-year old trouts) were caught in July of the third year, in September of the second year, and November of the fourth year after the release, and the heaviest ones, of 7300 g, 6550 g and 6300 g were caught in November of the fourth and October of the third year after the release.

As regards two-year old fishes, the biggest specimens, 92 cm and 77 cm long, were caught respectively in April and November of the third year, and the heaviest, of 9000 g and 6700 g were caught in November of the fifth and April of the third year after the release.

Fig. 3. Comparison of rainbow trout weight increments in the sea. Fishes released at the age of one and two years, together with two-year old sea trout: 1 – average monthly weights of rainbow trouts, released at the age of one years. 2 – average monthly weights of rainbow trouts, released at the age of two years, 3 – average weight of rainbow trout during winter (November – March); fishes released at the age of one year, 4 – average weight of rainbow trout during winter (November – March); fishes released at the age of two years, 5 – average weight of Vistula sea trout during winter (Backiel, Bartel 1967), 6 – average weight of lake trout in the sea during winter (Backiel, Bartel 1967).

DISCUSSION

As a result of the introductions, rainbow trout inhabits at present all continents, with the exception of Antarctica. In some places the species has acclimated and formed natural populations, in other it has to be reproduced artificially (Mac Crimmon 1971, 1972). Rainbow trout occurs in streams and rivers, lakes, dam reservoirs, and sea waters. Different environmental conditions are reflected in considerable variability of rainbow trout growth (Tab. 2 and 3). The smallest fishes were found in rivers and streams, in some lakes and dam reservoirs, while much bigger ones — in some Canadian lakes (Perhope, Knouff, Kooteney, Simcoe) and an American dam reservoir Mc Conaughy. Steelhead trout which spent some of its life in the sea seems to attain the biggest size (Tab. 2 and 3).

Growth in length and weight of tagged rainbow trout in the Baltic Sea was noticeably better than in Canadian streams and lakes, in an Austrian Lake Piburg, and in dam reservoirs of the USA and Czechoslovakia. On the other hand, it was similar or worse than in case of steelhead trout from American and Canadian rivers. One- and two-years old trouts attained average length of 43.8 cm and 59.8 cm, and 48.7 cm and 64.4 cm respectively in the first and second year of life in the Baltic Sea, being bigger than the fishes from North Pacific. In the third year, however, the latter attained bigger size (Tab. 2 and 3).

Rainbow trout living for one or two years in the Sacramento River, and two-year old fishes in Nottawasaga, grew slower in respective years of ocean life than those released into the Baltic Sea (Tab. 2). On the other hand, one- and two-years old steelhead trout from the Chillwack River was characterized by more rapid growth in consecutive years of sea life than the fishes released into the Baltic Sea, the only exception being two-years old ones after the first year of ocean life (Tab. 2). Similarly, migratory rainbow trout from the rivers Alsea, Snake and Babine was heavier than trout in the Baltic Sea (Tab. 3).

Differences in growth rate of particular groups of rainbow trout in the Baltic Sea were negligible. Mayer (1939) found that the fishes attained length of from 32 to 44 cm, and weight of 440–1000 g during 7 months, while Trzebiatowski (1979) stated that one-year old tagged rainbow trout reached in the sea 42.7 cm and up to 1 kg on the average, and two-years old — 63.3 cm and almost 2 kg. Rainbow trout released into the Gulf of Gdańsk and the Vistula mouth grew slower than the Vistula sea trout, but better than lake trout released into the sea at the same places (Fig. 3).

Length increment during the first year of sea life was almost similar for one- and two-years old rainbow trout, and amounted to 25.7 and 25.5 cm respectively, although length of fishes at the moment of their release differed, amounting respectively to 18.1 and 23.2 cm. Hence, it can be stated that size and age of the released fishes were of no significance for fish growth in the sea. The same was observed for migratory rainbow trout (Maher and Larkin 1954, Sutherland 1973) and sea trout (Sych 1967, Pałka 1977).

The biggest fishes caught in the Baltic Sea (length 92 and 77 cm, weight 9000 g and 7300 g) were smaller than the biggest steelhead trout — 114 cm (Hart 1973, cit. after Carl et al. 1959). Scott and Crossman (1973) stated that the biggest trouts of this form attain

Length of rainbow trout (stationary and migratory form) in cm from various water bodies

Table 2

Name of water body Place	Type of water body	Country	Age								Author	Comments
			1	2	3	4	5	6	7	8		
Vrica Stream	stream	CSRS	7.8	14.3	18.8	21.7					Kirka (1962)	1. caud.
Loučna River	river	CSRS	11.8	19.6	26.3	31.8	36.5	42.5	48.4	52.1	Kalal, Napravnik (1972)	
Stěnáva River	stream	CSRS	8.7	15.5	18.0	24.2					Lohniski (1960)	
Estibere Stream	stream	France	6.1	11.8	16.9	21.3	25.0				Dumas (1970)	
Piburg	dam	Austria	8.0	13.5	18.3	22.9	27.5	31.7	35.2	38.0	Kolder (1970)	
Hubenov	reservoir											
	dam	CSRS	10.0	22.7	34.8	39.0	38.8				Leontovyč, Vostradovsky (1978)	stock age 1 +
Paul Lake	lake	Canada B.C.	7.9	23.2	34.7						Larkin, Smith (1953)	1. caud.
Paul Lake	lake	Canada B.C.	7.3	15.9	25.0						Larkin, Smith (1953)	1. caud.
Perhope Lake	lake	Canada B.C.	8.82	31.16	46.80	55.10					Larkin et al (1956)	1. caud.
Knouff Lake	lake	Canada B.C.	9.31	25.51	35.64	44.96					Larkin et al (1956)	1. caud.
Kootenay Lake	lake	Canada B.C.	10.32	26.01	30.33	45.27					Larkin et al (1956)	1. caud.
Lightening Lake	lake	Canada B.C.	8.06	13.64	18.25	19.23					Larkin et al (1956)	1. caud.
Cluculz Lake	lake	Canada B.C.	5.31	14.83	27.5	27.68					Larkin et al (1956)	1. caud.
Pyramid Lake	lake	USA	6.1	13.5	19.1	23.6	29.5	37.6	45.5		Rawson, Elsey (1948)	
Simcoe Lake	lake	Canada Ont.	10.2	19.0	41.9	55.9	66.0	72.4	80.0		Scott, Crossman (1973)	
Okanagan Lake	lake	Canada B.C.	6.5	12.0	29.0	43.5	51.5	59.0	71.0		after MacCrimmon (1956)	1. tot.
											Scott, Crossman (1973)	
											after Clemens et al (1939)	1. tot.
Mc Conaughy	dam											
	reservoir	USA		39.1	52.8	58.4					Van Velson (1974)	1 year in a river
Mc Conaughy	dam											
	reservoir	USA			40.6	50.8	63.0				Van Velson (1974)	2 years in a river
Waddell Creek	sea	USA		39.1	65.1	78.5					Shapovalov, Taft (1954)	1 year in a river
Waddell Creek	sea	USA			46.7	68.0	74.1				Shapovalov, Taft (1954)	2 years in a river
Waddell Creek	sea	USA				55.3	69.5				Shapovalov, Taft (1954)	3 years in a river
North. Pacific	sea	USA		36	57	70	78	79	89	90	Sutherland (1973)	+ 1–5 years in a river
Nottawasaga River	sea	Canada Ont.			46.0	54.6	58.7	59.2			Scott, Crossman (1973)	
Nottawasaga River	sea	Canada Ont.				41.9	58.9	62.0			after Wainio (1962)	2 years in a river
											Scott, Crossman (1973)	
											after Wainio (1962)	3 years in a river
Chilliwack River	sea	Canada B.C.		48.3	70.9	81.0					Maher, Larkin (1954)	1 year in a river
Chilliwack River	sea	Canada B.C.			47.5	69.8	81.0	96.5			Maher, Larkin (1954)	2 years in a river
Chilliwack River	sea	Canada B.C.				47.5	70.1	81.8	85.1		Maher, Larkin (1954)	3 years in a river
Sacramento River	sea	USA	12.2	33.5	52.1*						Hallock et al (1961)	1 year in a river
Sacramento River	sea	USA	9.4	18.0	41.9	59.2*					Hallock et al (1961)	2 years in a river
Snake Lake	ocean	USA		62.0	82.0						Gilbreath et al (1976)	
Gdańsk	pond	Poland		42.7	51	53.3	59.0	65.2			Goryczko (1975)	spawners, autumn strain
Gdańsk	pond	Poland			40.8	46.4	52.9	62.0			Goryczko (1975)	spawners, spring strain
Rumia	pond	Poland				48.8	65.2	72.9	75.1	77.1	Bartel (1971)	1. caud. spawners
Rumia	pond	Poland			52.0	63.9	68.8				Bartel (1971)	1. caud. spawners
Baltic Sea	sea	Poland	18.1	43.8	59.8	62.4					own data	stocking, age 1
Baltic Sea	sea	Poland		23.2	48.7	62.4	69.5				own data	stocking, age 2

* length of fish in autumn

Table 3

Weight of rainbow trout (stationary and migratory form) in g from various water bodies

Name of water body Place	Type of water body	Country	Age								Author	Remarks
			1	2	3	4	5	6	7	8		
Loučná River	river	CSRS	21.0	103.0	254.0	439.0	672.0	1098.0	1750.0	2050.0	Kalal, Napravnik (1972)	
Estibere Stream	stream	France	2.3	16.4	48.3	96.6	156.3				Dumas (1976)	
Okanagan Lake	lake	Canada B.C.	45.1	136.1	453.6	1360.8	2041.2	3628.8	5443.2		Scott, Crossman (1973)	
											after Clemens et al (1961)	
Buttle Lake	lake	Canada B.C.		158.8	207.0	243.8	277.8				Scott, Crossman (1973)	
											after Mc Mynn, Larkin (1953)	
Pyramid Lake	lake	USA	22.7	42.5	85.1	158.8	320.4	612.4	1077.3		Rawson, Elsey (1948)	
Mc Conaughy	dam reservoir	USA		700.0	1700.0	2400.0					Van Velson (1974)	1 year in a river
Mc Conaughy	dam reservoir	USA			700.0	1500.0	3100.0				Van Velson (1974)	2 years in a river
North Pacific	sea	USA		800.0	2400.0	3400.0	3700.0	5600.0	5100.0	6700.0	Sutherland (1973)	♀ +1–5 years in a rivers
Babine River	sea	Canada B.C.		2300.0*	5200.0*	9200.0*					Sedgwick (1973)	winter run
Alsea River	sea	Canada (Oreg)		1130.0	4080.0						Sedgwick (1973)	summer run
Snake Lake	sea	USA		2400.0	5600.0						Gilbeath et al (1976)	1 year in a river
Sea of Azov	cage	USSR	30–40	800–1000	2000–3000						Romanyceva, Kangur (1979)	
Baltic Sea	cage	USSR	20–30	400–500	800–1500						Romanyceva, Kangur. (1979)	
Baltic Sea	cage	Poland		350	2200	3600					Wiktor (1979)	weight in November
Gdańsk	pond	Poland			947	1405	2099	3093			Goryczko (1975)	spawners, spring strain
Gdańsk	pond	Poland		1160	2054	1933	2778	3980			Goryczko (1975)	spawners, autumn strain
Rumia	pond	Poland					3826.3	5464.0	5247.3	4933.3	Bartel (1971)	spawners
Rumia	pond	Poland			2253.4	4017.1	4550.0				Bartel (1971)	spawners
Baltic Sea	sea	Poland	62.2	1042.8	2631.6	3060.0					own data	stocking, age 1
Baltic Sea	sea	Poland		137.3	1408.7	3215.9	3033.3				own data	stocking, age 2

* fish at the age of 1+, 2+, 3+

122 cm. The heaviest rainbow trouts were caught near Prince Roupert and Bell Island, of 19.5 and 19.1 kg. The biggest trout, of 52.5 pounds (23.9 kg) was caught in Lake Jewel (Hart 1973, after Carl et al. 1959). In Poland, the biggest trout (92 cm and 12.1 kg) was bred in a hatchery of the Polish Anglers Association in Rumia. It was a 6-year old female after spawning (Bartel 1971).

It can be assumed that size of the fishes calculated from the tagging experiments is underestimated due to fish handling and tag presence, which might have decreased fish ability to move and increased energy costs (Clancy 1963). Power and Shooner (1966) observed that tagged young salmon did not feed normally for the first few days, and did not swim actively until it got accustomed to the tag. Normal behaviour was restored after 4 days. Fish growth was reduced during this period. Also Saunders and Allen (1967) showed that salmon tagged with modified Carlin's tags was characterized by growth inhibition compared to fishes tagged by fin clipping, but in both cases growth was worse than of non-tagged specimens. Even when young salmon was tagged with thread only, growth of some specimens was hampered (Evrópeiceva and Zacepilova 1957).

On the other hand, Mills (1958, cit. by Saunders and Allen 1967) did not observed differences in the growth between tagged and non-tagged fishes. However, tagging is connected with fish handling. As shown by Clancy (1963), steelhead trout subjected to handling similar to the tagging procedure was less able to swim compared to the control fishes. Frequent handling decreased fish growth (Power and Shooner 1966). Wedemeyer (1972) observed an increase of carbohydrate level and disturbance of the osmoregulation process (due to variations of Cl^- and Ca^{++} ion content in the blood plasma) in fishes subjected to frequent handling. However, the symptoms disappeared after 24 hours. Transportation also induces stress. Wedemeyer (1976) observed hyperglycemia and disturbances of the osmoregulation process in rainbow trout 9.2–11.7 cm long, transported at fish density over 8 km/m³. The symptoms disappeared after 12 days and 24 hours respectively. It can be assumed that transportation of the tagged fishes might increase these negative responses.

CONCLUSIONS

Rainbow trout grew better in the Baltic Sea than in ponds, and than sea trout released into the Baltic Sea. On the other hand, it was characterized by slower growth than the Vistula sea trout introduced into the sea. Fishes released at the age of one year attained 2.6 kg on the average after two years of sea life, while those released at the age of two years attained 3.2 kg.

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WZROST ZNAKOWANYCH PSTRĄGÓW TĘCZOWYCH (*SALMO GAIRDNERI* RICH.)
WSIEDLONYCH DO BAŁTYKU

STRESZCZENIE

W latach 1964–1972 wypuszczono do ujścia Wisły i Zatoki Gdańskiej 23.624 jedno- i dwurocznych znakowanych pstrągów tęczowych. Uzyskane 2.436 zwrotów znaczków było podstawą do określenia wzrostu wypuszczonych ryb.

Po pierwszym roku pobytu w morzu pstrągi osiągnęły średnio 43,8 cm i 1042,8 g z jednorocznych i 48,7 cm i 1408,7 g z dwurocznych, a po drugim odpowiednio 59,8 cm i 2631,6 g oraz 62,4 cm i 3215,9 g, po trzecim 62,4 cm i 3060 g oraz 69,5 cm i 3033,3 g. Największy złowiony pstrąg ważył 9 kg.

Р. Бартель

РОСТ МЕЧЕНОЙ РАДУЖНОЙ ФОРЕЛИ
(*SALMO GAIRDNERI* RICH.)
ВЫПУЩЕННОЙ В БАЛТИЙСКОЕ МОРЕ

Резюме

В период с 1964–72 гг. выпущено в устье Вислы и в Гданьский залив 23624 одно и двугодовников меченых радужных форелей. Полученные 2436 возвращенных меток послужили основой для определения роста выпущенных рыб.

После первого года пребывания в море, форели достигли в среднем длины 43,8 см и веса 1042,8 г. – из одногодочников и 48,7 см и 1408,7 г – из двугодовников. А после второго года – соответственно 59,8 см и 2631,6 г и 62,4 см и 3215,9 г. После

третьего года 62,4см и 3060г, а также 69,5см и 3033,3г. Самая большая особь весила 9кг.

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