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**THE RESULTS OF TAGGING EXPERIMENTS WITH TENCH,
TINCA TINCA (LINNAEUS, 1758), IN LAKES KISAJNO AND TAJTY**

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W JEZIORZE KISAJNO I TAJTY**

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5821 specimens of tench were tagged in 1971–1972. The fishes were caught in shallow lakes of fairly high tench yields, and released to shallow parts of the complex of Głaz Mazurian Lakes. 25.7% of the tench tagged in 1971 were caught in 1971–1974, and 17% of the tench tagged in 1972 were caught in 1973–1974. Analysis was made of tench migrations in the lake complex. Annual length increments were determined and the relationship between growth rate and body length. An attempt was made to determine the effectiveness of tench transplantations.

INTRODUCTION

In most cases commercial tench catches from natural waters originate from shallow lakes, of mean depth > 1.5 to 2 m, and maximal depth > 6 m, characterized by water transparency of 1.5–2.0 m (Anvand 1965, Bryliński 1977, Szmid 1974, materials of the Inland Fisheries Institute).

Such lakes are usually called pike – tench lakes, and they are characterized also by

considerable yields of pike, crucian carp, roach, rudd, bream, perch and eel. Tench in these lake inhabits underwater meadows and parts with muddy bottom. In bigger, deeper lakes tench usually is found in the littoral zone, in which the habitat conditions are of the same character (Anvand 1965, Strzyżewska 1974, Szmida 1974). It is generally accepted that tench does not undertake spawning or trophic migrations, as spawning and feeding grounds of this species are found in shallow areas, among aquatic vegetation (Anvand 1965, Schminke 1934, Strzyżewska 1979, Szmida 1974). According to Anvand (1979) and Schminke (1934) too dense tench population or lack of hiding places may induce migration of some fishes in search of new feeding grounds and aquatic plants. Vostradowska (1974) analysed the results of tench tagging in Lipno reservoir (Czechoslovakia) and found that this species formed dense populations on spawning grounds and larvae habitats. When tagged tench was released on spawning grounds 65% of the released fishes were caught in this area, and 88% in the zone up to 3 km from the release point. Nevertheless, single specimens were caught as far as 30 km from the release area. This authoress obtained similar results with tagged bream in the same reservoir.

Tench exploitation in Polish freshwater lakes consists of catches carried out mostly with trap nets set during the spawning season. This procedure affects the results of natural spawning (Bryliński 1977, Waluś 1958, materials of the IFI). According to Strzyżewska (1979) maximal tench catches in the Vistula Lagoon are obtained during spawning season, from June till July (during blue-green algae bloom). It seems that major tench catches in fresh waters are carried out during prespawning and spawning season. According to Kaj et al. (1964), and Brylińska and Długosz (1976) tench spawning takes place at water temperature of 19–20°C, this being usually in June. Since the spawning is of a multi-batch character, it can extend till mid-August.

In Poland in order to improve the effects of natural spawning, and to increase tench catches from inland waters, tench is stocked into natural waters. The stocking material usually consists of tench yearlings reared in ponds. Transplantation of tench yearlings from one lake to another is also a common procedure. Analysis of fishery management in 1960–1970 (Bryliński 1977, materials of the IFI) revealed that stocking with tench yearlings or tench transplantations were a common practice in 303 lakes out of 397 lakes under study.

Unnumerous literature dealing with tench biology and ecology in natural waters, considerable economic value of this species, and lack of knowledge on tench migrations and on the effectiveness of stocking, induced us to undertake tagging experiments and to analyse the results. At the same time, our studies were aimed at determining the effectiveness of tench transplantations and finding out whether the species migrates from the places of release. In case tench undertook such migrations also beyond the spawning period it might be possible to carry out tench catches with trap nets in other periods as well.

MATERIAL AND METHOD

Studies were carried out in 1971 and 1972. Tench from small, rich lakes (Skarż, Wojsak, Sieroż – Tab. 1) was tagged and transferred to shallow parts of the complex of Great Mazurian Lakes (Fig. 1). Origin of the material, dates of transplantations and numbers of tagged tench are presented in Table 2. 5831 fishes were tagged altogether in 1971 and 1972, in this 2804 males and 3017 females. Tagging base was set at an island Maliniak, on Lake Kisajno. Fishes delivered to this base were placed in cages submerged close to the island shore, in which they remained until the next day; all weak fishes were discarded. Fishes were tagged with numbered plastic tags, 12 x 4 mm. Tags were attached in front of the dorsal fin, with a monel wire. In 1971 red tags were used, and in 1972 – white ones. Tag numbers were registered together with data on fish sex and body length (*longitudo corporis*). For some fishes also body weight was recorded. Fishes were kept in cages for another 24 hours after tagging. All dead fishes were removed. The material was then transported in boats filled with water to the selected stations of release (Fig. 1, Tab. 3).

Catches of fishes were carried out in subsequent years with trap nets since April till July and with seines since July till April. For all recovered fishes the following parameters were recorded: date of catch, tag number, sex, body length (*longitudo corporis*), place of catch and body weight. Then the recovered fishes were released again. All the data obtained from fishermen were verified and eliminated in case of some discrepancies with the initial data. Since 1973 all recovered fishes were delivered to local fish farm where the above mentioned parameters were recorded and, additionally, scale samples were collected. The observations revealed that some fishes lost their tags; a number of fishes had wires left in the body but no tag. Percentage of fishes with lost tags increased along with time, and amounted on the average to from 2 to 5% for the whole period. Recaptured fishes did not show any negative signs of tagging and the places where the wire was passed were well healed.

DESCRIPTION OF THE ENVIRONMENT

Shallow parts of the complex of Great Mazurian Lakes (into which tench was released) were lakes Kisajno and Tajty. Lake Kisajno has the area of 1896 ha, average depth 8.4 m and maximal depth 25.0 m. It is a part of Lake Mamry Północne. It is connected with other lakes of the complex (Doba, Labab, Dargin) with a wide straits (about 2000 m). Hence, the division into separate lakes is more a tradition than reality. Bottom of Lake Kisajno is overgrown in 33.9% with aquatic vegetation, in this submerged plants occupy 24.5%. Tench can find favourable food conditions there. Lake Kisajno can be divided into two, morphometrically different parts:

I. North part, beginning at the height of Dębowa island and reaching wide straits (almost 2 km wide) connecting the lake with other lakes of the complex of Mamry

Table 1

Limnological and fishery characteristics of lakes under study

Lake	Water surface area		Depth (m)		Fish catches in kg/ha (for 1970–1977)					
	in ha	in this % overgrown with submer- ged vegeta- tion	max.	mean	total	in this		roach	carp	pike
						tench	crucian carp			
Skarż	55.0*)	96.4	3.0	—	97.5	9.1	8.8	12.3	47.4	6.3
Wojsak	47.8*)	58.1	1.5	—	60.6	16.6	0.9	21.1	—	3.4
Siercz	63.5*)	96.9	2.0	—	17.7	8.1	1.3	1.6	—	4.0
Kisajno	1896.0*)	24.5	25.0	8.4	36.9	0.8	(0.02)	19.1	—	2.9
Tajty	240.7**)	11.7	34.0	7.6	38.8	0.8	0.1	16.4	—	3.4

*) according to lake management programmes of the Inland Fisheries Institute

**) lake morphology according to Kondracki (1953), submerged vegetation according to Kocół (1953)

Table 2

Origin and numbers of tench tagged in 1971 and 1972
(l.c. – average body length in cm, W – average body weight in g, n – numbers)

Year	Date of tagging	Lake	n	In this			
				♀♀		♂♂	
				n	l. c.	n	l. c.
1971	9–16.06	Skarż, Wojsak	1060	534	20.4	526	19.9
	2–8.07	Siercz, Kwidzyńskie	740	339	20.6	401	20.1
	8.07	Skarż	232	125	20.0	107	19.2
	19.07	Siercz, Kwidzyńskie	339	145	20.2	194	19.6
	30.07	Siercz, Kwidzyńskie	224	129	20.0	95	19.0
	9.06 – – 30.07	Total W ($\Sigma 503.87$ kg)	2595	1272	20.2	1323	19.5
1972	8–12.06	Wojsak	438	226	17.7	212	18.3
	21.06	Wojsak	166	86	17.6	80	17.9
	29.06	Dgał Wielki	62	41	20.4	21	20.8
	7.07	Skarż	247	129	21.1	118	21.9
	10–15.07	Kinort	66	43	19.5	23	20.3
	15–31.07	Wojsak, Skarż	1677	920	18.0	757	18.7
	3–11.08	Wojsak, Skarż	570	300	18.5	270	19.0
	8.06 – – 11.08	Total W ($\Sigma 605.87$ kg)	3226	1745	18.9	1481	19.6
1971–1972			5821	3017	19.6	2804	19.6

Table 3

Stations of release of tagged tench in lakes Kisajno
and Tajty in 1971 and 1972

Year	Station no	Numbers(n)		
			♀♀	♂♂
1971	1	251	84	167
	3	230	127	103
	6	269	91	178
	7	197	110	87
	9	441	257	184
	10	68	41	27
	11	199	116	83
	12	97	49	48
	13	232	125	107
	14	611	272	339
	Σ	2595	1272	1323
1972	1	300	151	149
	2	109	36	73
	3	229	126	103
	4	121	65	56
	5	438	226	212
	6	330	187	143
	7	228	127	101
	8	149	84	65
	9	310	162	148
	10	172	102	70
	11	181	102	79
	13	247	129	118
	14	412	248	164
	Σ	3226	1745	1481

No – station numbers are given on the map (Fig. 1) and in the following tables

Północne. There are no islands in this part, and the shore line is relatively weakly developed. The littoral zone is also undifferentiated and rather narrow. Open waters of this part are subjected to strong northern and southern winds. Tench does not find here many suitable places for feeding and spawning, contrarily to the other part of the lake. This part will be referred to as the first region. Tench was released in this part on stations 1 to 4 (Tab. 3, Fig. 1).

II. South part is characterized by a well developed shore line. It contains several islands, and the littoral zone predominates in the lake area. The effect of winds is very weak in this part due to many islands overgrown with forests. Tench in this part can find many places suitable for feeding and spawning. South part of the lake will be referred to as the second region. Tench was released in this part on stations 5 to 13 (Tab. 3, Fig. 1).

South-east part of Lake Kisajno is connected with Lake Tajty by a narrow channel (Channel Mamry-Tajty). Lake Tajty has the area of 241.3 ha, maximal depth of 34 m, average depth of 7.6 m. This lake will be referred to as the third region. It is an elongated water body, situated along a latitude. Bottom of this lake is overgrown in 24.6% with aquatic vegetation, in this 11.6% by submerged plants. Relatively lower percentage of area overgrown with plants results in the fact that there are less places suitable as tench habitats in this lake. Release station no 14 was situated in this lake (Tab. 3, Fig. 1).

Commercial fish catches in lakes Kisajno and Tajty are predominated by roach (*Rutilus rutilus* L.), bream (*Abramis brama* L.) and pike (*Esox lucius* L.). Tench catches do not exceed 1 kg/ha (Tab. 1). From April till July tench is caught with fyke nets, and small size specimens (tench „S” of body weight from 0.25 to 0.5 kg), constituting 40.6–47.7% (Fig. 2). During winter and summer seine catches bigger specimens are mostly caught (tench „D”, over 0.5 kg in weight), so that percentage of S tench decreases to 1.5–25.0%. Percentage of small (S) sized tench in total tench catches varied in particular years from 20.6 to 45.6% of the annual catch (Tab. 4). The highest percentage of tench S was noted in 1972, and the lowest in 1974. Trend of tench S catches in different seasons was similar during the period under study.

Fig. 2. Percentage of tench D (big – a) and S (small – b) in commercial tench catches in Lakes Kisajno and Tajty in 1971 – 1974

Table 4

Share of tench S (small) in commercial tench catches „W” (in kg)
in lakes Kisajno and Tajty in 1971 – 1974

Year	Months											
		III	IV	V	VI	VII	VIII	IX	X	XI	XII	Σ
1971	W	–	484	1469	1330	137	122	810	221	112	–	3285
	% S	–	60.7	51.6	52.3	52.6	22.1	20.4	100	2.7	–	38.4
1972	W	–	116	516	1018	111	108	191	102	21	10	2193
	% S	–	51.7	56.4	50.2	41.4	13.0	35.6	3.9	14.3	20.9	45.6
1973	W	1	103	422	1050	266	167	326	151			2485
	% S		52.4	44.8	35.5	59.0	–	0.6	2.0			31.3
1974	W	3	180	281	465	308	65	100	126	97	–	1625
	% S	33.3	24.4	29.5	25.8	19.2	18.5	11.0	1.6	3.1		20.6

RESULTS OF STUDIES AND DISCUSSION

2595 fishes were tagged in 1971 and released at various stations in lakes Kisajno and Tajty. 668 specimens were recaptured in 1971–1974 (25.7%, Tab. 5, 6). 3226 fishes were tagged in 1972. From among these, 547 specimens were recaptured in 1973–1974, i.e. 17%. Higher number of recaptures obtained from 1971 tagging resulted from longer period of catches. In 1971 fish catches commenced in summer-autumn period, and the whole study lasted for 4 years, i.e. 1971–1974. For fishes tagged in 1972 the study period was only 2 years (1973–1974). Comparing the recaptures obtained during similar periods, viz. 1972–1973 for tagging of 1971, and 1973–1974 for tagging of 1972, it appeared that the difference was 3.6% only. This difference can be connected with lower commercial tench catches in 1974 compared to the preceeding years (Tab. 3). Recaptures of fishes released at 14 stations (Tab. 5) were very differentiated, and constituted from 1.7 to 71.0% of total recaptures. Percentage of tag returns in two years of studies (1971 and 1972) was not the same for the same stations. This could have been caused by different intensiveness of catches in particular years and stations, as well as by different natural mortalities and tag losses in particular portions of the released fishes.

There are almost no data in the literature on tench tagging. Consequently, Table 6 contains data on tagging of other cyprinids in inland waters, which serve as comparison. This way it is possible to roughly estimate which species is subjected to the highest fishing mortality. As regards tench tagging only Vostradovska (1974) described tagging of 901 fishes in dam reservoir Lipno (Czechoslovakia). Tag return was 7.21% after 4 years of studies. 15.2% of all recaptured fishes were those with tags attached with a monel wire, and only 6% were tags attached with steelon thread. Similarly as in case of our studies (Tab. 5), also in Vostradovska's study recaptures of males were slightly higher (54%). Our results suggest that recapture rates of tench released to lakes Kisajno and Tajty were slightly higher than in case of the study by Vostradovska in Lipno reservoir for fishes with tags attached with monel wire. Comparison of our results with data on returns of other tagged cyprinids in Polish inland waters suggests that fishing mortality in case of tench is higher than for roach, being more or less similar as for various populations of bream and vimba (*Vimba, vimba* L.).

Analysing the data on recapture of fishes released into natural water bodies attention should also be given to the fact that the results depend on many factors which cannot be totally eliminated, such as fishery exploitation, angling etc. These factors sometimes result in erratic estimation of the results. Draw-backs of fish tagging procedure were pointed out by many authors and summarized by Beverton and Holt (1956). Vostradovska (1974) pointed to the fact that the results depended also on the type of material used for attaching the tag. In practice not only the material, but also the place where the tag is attached is significant, and may contribute to their loosing, and thus result in underestimation of the fishing mortality (Backiel 1964, Brylińska and Bryliński 1970, Vostradovska 1969, Wilkońska 1967). The results depend also on fish sex, condition and body size. Season, water temperature during tagging, duration of

Table 5

Number of recaptured tench on particular stations
in lakes Kisajno and Tajty in 1971 and 1972

On station	Taged in									
	1971						1972			
	n	recaptures in years (in %)					n	recaptures in years (in %)		
		1971	1972	1973	1974	total		1973	1974	total
Region I										
1	251	0,4	1.2	0.8		3.6	300	20.0	1.7	21.7
2							109	39.5	4.6	44.1
3	230		1.3	0.4		1.7	229	2.6	0.5	3.1
4							121	5.8	1.6	7.4
Region II										
5							438	3.9		3.9
6	269	13.7	51.7	5.6		71.0	330	29.7	2.1	31.8
7	197	3.1	21.3	10.2	2.0	36.6	228	18.4	4.4	22.8
8							149	2.0	0.7	2.7
9	441	7.9	30.4	1.4		39.7	310	32.6	2.9	35.5
10	68	2.9	38.2	1.5	2.9	45.5	172	8.7	1.7	10.4
11	199	2.0	6.5	3.0		11.5	181	16.0		16.0
12	97		3.1			3.1				
13	232	4.7	19.8	2.2		26.7	247	22.7	0.8	23.5
Region III										
14	611	5.1	9.2	2.3		16.6	412	6.1		6.1
Total										
0	1323	5.4	18.2	2.6	0.1	26.3	1481	16.8	1.7	18.5
0	1272	4.4	17.6	2.8	0.3	25.1	1745	14.5	1.1	15.6
Σ n %	2595	$\frac{127}{4.9}$	$\frac{465}{17.8}$	$\frac{70}{2.7}$	$\frac{6}{0.2}$	$\frac{668}{25.7}$	3226	$\frac{502}{15.6}$	$\frac{45}{1.4}$	$\frac{547}{17.0}$
Σ n %			$\frac{535}{20.6}$					$\frac{547}{17.0}$		

Table 6

Comparison of the results on cyprinid tagging
in inland waters of Poland and Czechoslovakia

Water body Species	Autor Comments	Results of tagging			
		released		recaptures	
		n	l. corp.	period of studies in months	%
Kisajno, Tajty <i>Tinca tinca</i> (L.)	own data 1971 monel wire	2595	♀ 20.2 ♂ 19.5	1-48 24	25.7 20.6
	1972 monel wire	3226	♀ 18.9 ♂ 19.6	24	17.0
Lipno (CSRR) <i>Tinca tinca</i> (L.)	Vostradovska (1974) steelon thread monel wire	901	♀ ♂ 10.1 - 30.6	48	6.0 15.0
<i>Abramis brama</i> (L.)	steelon thread monel wire	3460	♀ ♂ 12.1 - 38.0	48	10.0 10.3
Complex Wdzydze <i>Abramis brama</i> (L.)	Brylińska, Bryliński (1970) Bryliński (1970) tagged in spring	1585			12.0
	tagged in autumn	1246			34.1
	infected with <i>Ligula</i>	902			14.2
	strongly infected	269			10.0
	not infected	2841			26.9
	together	4012	♀ ♂ 10.0 - 40.0	1-48	22.9
Jamno, Gardno coastal lakes <i>Abramis brama</i> (L.)	Zawisza (1970) lakes	3085	♀ ♂ 30 - 36	36	7.8-65.5
	sea	1777	♀ ♂ 30 - 36	36	2.7-20.8
Complex Śniardwy <i>Rutilus rutilus</i> (L.)	Wilkońska (1967) during spawning migration	1810			3.5
	in other periods	7210			2.5
	together	9020	♀ ♂ 13 - 25	1-36	
Wiśła <i>Vimba vimba</i> (L.)	Bontemps (1964) during migrations	540	♀ ♂ 26 - 36	12	17.8
	Bontemps (1969 a) during migrations	2459 3004 2960	♀ ♂ 21 - 40.5	12	1 41.7 53.5 51.6
	Bontemps (1969b) on spawning ground	193 351 156		27-28	14.0

manipulations and especially all body injuries (which might result in bacterial invasion or mould) are also important (Brylińska and Bryliński 1970, Bontemps 1969). Error in the estimation can also result from different behaviour of tagged and not tagged fishes (Beverton and Holt 1956). This can be exemplified by different selectivity of the fishing gear for tagged and not tagged fishes, so that tagged fishes can be caught at a higher rate. Reliability of informations obtained from anglers, fishermen etc. is also significant.

Backiel (1964) estimated on the basis of double fish tagging that in the annual cycle 9.5 to 19% of tagged vimba lost tags attached in front of the dorsal fin. Zawisza (1970) found with the same method that 10.8% of bream in coastal lakes lost the tags during 19 months. This author is of the opinion that the mentioned percentage of losses is of no practical importance. Percentage of tag losses for tench in lakes Kisajno and Tajty was not estimated. Nevertheless, it can be assumed that the losses were higher than values given by Zawisza (1970) for bream in coastal lakes and by Backiel (1964) for vimba in the Vistula River, due to the fact that tench inhabits areas densely overgrown with plants, where it is easier to loose tags. It was found that 2–5% of the recaptured fishes had still monel wire in their backs, although the tags were lost. Hence, it can be assumed that percentage of fishes which lost their tags would be closer to the upper limit given by Backiel (1964) for vimba, i.e. 20 or even 30%.

Analysis of tag returns and commercial tench catches carried out at monthly intervals showed that there were considerable differences in the trends noted. These differences allowed for distinguishing two fishing periods. The first embraces spring-summer months (June-July) in which catches are carried out with trap nets – fyke nets. The second embraces summer-autumn months (August – November), when tench is caught with seines (Fig. 2, 3, Tab. 4). Fyke net catches gave the highest yields (in weight) of tench, as also were characterized by the highest returns of tagged fishes. Curves illustrating trend of commercial tench catches (a – Fig. 3) and recapture rate (b – Fig. 3) are not always characterized by the same tendency. In spring the curves were characterized by similar trend, but in autumn recapture of tagged fishes noticeably decreased in relation to commercial tench landings. In order to obtain a more detailed picture of the results weight of commercial tench catch per one recaptured fish was calculated at monthly intervals (Fig. 4). These indices were calculated separately for tench tagged in 1971 (a – Fig. 4) and in 1972 (b – Fig. 4), and presented on graphs. They showed that during the period of fyke net catches, weight of commercial tench catch per one recaptured fish was much lower than in the period of seine catches. These trends in the next year (1 – Fig. 4) after fish release (0 – Fig. 4) were similar both for fishes tagged in 1971 and 1972. In both years of studies there was a slight increase of the weight of commercial catch per one recaptured fish since April till July. In next months the growing trend was more rapid. In the second year of studies (2 – Fig. 4) the results for the two years of studies did not coincide and were of a random character.

The observed differences in increasing ratios between weight of commercial catch per one recaptured tench might have resulted, among others, from different selectivity of trap nets and seines with respect to fish size. During seine catches percentage of tench S in the

Fig. 3. Commercial tench catches in lakes Kisajno and Tajty (C) in 1971 – 1974, and number of recaptures (M in indiv.). Note: vertical lines denote moments of release of tagged fishes

catch decreased noticeably (Fig. 2, Tab. 4). It is also probable that in case of seine catches many small fishes (tench below 0.5 kg) were unnoticed as usually various small fishes were released from the seine bag, and they might have compared some small tagged tench as well. Average values calculated from the data presented in Fig. 4 revealed that in

Fig. 4. Weight of commercial tench catch per one recaptured tench from fishes released to lakes Kisajno and Tajty in 1971 and 1972. (O – in the year of release, 1 – a year after release, 2 – two years after release)

the first year 4.84 kg of tench were caught with trap nets per one recaptured tench (4.72 kg for tench tagged in 1971 and 4.95 kg for tench tagged in 1972), and 35.80 kg with the seine (35.5 kg for tench tagged in 1971, and 36.11 kg for tench tagged in 1972). Analysis of the ratio between weight of commercial tench catches and weight of recaptured tench suggests that the method used was not accurate. This inaccuracy resulted from the method of tagging and collecting the tagged fishes from commercial fish catches. Consequently, conclusions drawn from these studies must be very careful. All the comparisons can be treated as reliable only when the same fishing periods are taken into consideration.

An attempt was made to define some regularities as to the direction and distance of tench migrations. To achieve this, materials from the three distinguished regions were analysed separately (Fig. 1, Tab. 6, 7). These data showed that in the year of fish release most tagged fishes gathered in the same region, and on the same or very close to the release stations. Immediately after tagging tench did not migrate between lakes Tajty and Kisajno, not between the two parts of Lake Tajty. Fishes moved only at a short distance in the middle part of Lake Kisajno (the second region). More distant migrations were observed only for tench released to north part of Lake Kisajno (the first region) from release station no. 1 (Fig. 1). This station was characterized by narrow littoral, subjected

Table 7

Analysis of migrations of tagged tench between particular regions of lakes Kisajno and Tajty in 1971 – 1974

Region of release	Of recapture							
	recaptured totally		in this in region					
			I		II		III	
	in year	n	n	%	n	%	n	%
I	tagged in 1971 n = 481							
	1971	1			1	100.0		
	1972	6	1	16.7	5	83.3		
	1973	3	1	33.3	2	66.7		
II	tagged in 1971 n = 1503							
	1971	95			95	100.0		
	1972	403	2	0.4	390	96.9	11	2.7
	1973	53			50	94.3	3	5.7
	1974	6			6	100.0		
III	tagged in 1971 n = 611							
	1971	31					31	100.0
	1972	56			5	9.0	51	91.0
	1973	14			2	14.2	12	85.8
I	tagged in 1972 n = 759							
	1973	116	5	4.3	110	94.8	1	0.9
	1974	13			13	100.0		
	tagged in 1972 n = 2055							
	1973	361	1	0.3	356	98.6	4	1.1
II	1974	32			32	100.0		
	tagged in 1972 n = 412							
	1973	25			3	12.0	22	88.0

Fig. 5. Direction of migrations of tench tagged in 1971 and released to lakes Kisajno and Tajty to considerable waving. This fact supports the suggestion presented by Anvand (1965) and Schimenz (1934) that tench can undertake distant migrations if there are no hiding places and protection from wave action in the habitat.

In the next year of studies tagged tench was found even at distant places from the release stations. The fishes moved between the two lakes – Kisajno and Tajty (Fig. 5, 6, Tab. 6), although no tagged fishes were found in other lakes of Mamry complex, notwithstanding their connection. Tench released in 1971 into the second region of Lake Kisajno was caught in the subsequent years in Lake Tajty, the percentage of returns

varying from 2.7 to 5.7%. On the other hand, tench released to Lake Tajty moved to south part of Lake Kisajno, the percentage of recaptures being 9–14.2%. Fishes released in 1972 into south and north part of Lake Kisajno were recaptured in Lake Tajty, at the rate of 0.9–1.1%, while those released to Lake Tajty migrated to Lake Kisajno at a rate of 12%. These data suggest that migrations from Lake Tajty to Lake Kisajno took place at a higher rate. As mentioned before, south part of the latter lake is characterized by favourable conditions for tench feeding and reproduction. Sakowicz and Backiel (1961) observed tench migrations in the channel Kisajno-Tajty. These authors found (on the basis of fyke net catches in Lake Kisajno) that tench numbers in the channel were low from April till May, and increased considerably in June and July. Our results also point to tench migrations through the channel. It was also found that the migrations were more distant and more intensive in spring-summer period. This is confirmed by the results of the analysis carried out in July – October 1971 in comparison to the results obtained in the next years (Fig. 5, 6, Tab. 6). This is well documented by data given in Table 8 on tagged tench recaptured twice in the same year, first in Lake Kisajno and then in Lake Tajty or vice versa. These data show that migrations take place in April-June in both directions – from and to Lake Kisajno.

Table 8

Tagged tench recaptured twice in the same year
in Lake Kisajno and then in Lake Tajty or vice versa

Release station	No	Recaptures of tagged tench in the lakes	
		Kisajno month	Tajty month
13	766	IV →	VI
14	2508	VI ←	IV
13	1139	V →	VI
13	1001	IV →	V
13	1133	V →	VI, VI
14	1269	VI ←	IV
14	1311	V ←	IV

Direction of tench movements from particular release stations, in this also of tench recaptured for several times, is presented in Fig. 5 and 6. Analysis of the data collected during tench tagging and recapture revealed that tench migrations were not unequivocal, so that no general conclusions can be drawn. Undoubtful results were obtained only in case of tench released into north part of Lake Kisajno, in places characterized by narrow littoral subjected to waving. Fishes released into this part migrated to the middle, shallow part of the lake. The latter part was characterized by many shallow areas, overgrown with

Fig. 6. Direction of migrations of tench tagged in 1972 and released to lakes Kisajno and Tajty

submerged vegetation, and with numerous islands, protecting the habitat from waving. As regards tench tagged in 1971 and released into the north part of this lake, only 20% of recaptured fishes originated from the same place, while the respective value for tench tagged in 1972 was only 3.9%. All other recaptures of these fishes were obtained from shallow parts of Lake Kisajno (80–90.5%) or from Lake Tajty (0.8%). At the same time negligible number of fishes undertook migration in the opposite direction, from south to north part of Lake Kisajno (0.4% in case of tench tagged in 1971, and 0.3% in case of tench tagged in 1972), and even these remained in areas neighbouring the south part.

The highest rate of recapture was noted for tench released into south part of Lake Kisajno, and most of the fishes were recaptured in the same region (Fig. 3, 4, Tab. 6: 97.1% for 1971 tagging and 98% for 1972 tagging). Migrations of tagged tench between particular stations of the south part of Lake Kisajno were not equally intensive. Tench released to semi-closed parts, surrounded by land (stations 6, 9, 13 – Tab. 9, Fig. 1) remained in place during the first year of studies, or moved at a distance of up to 1 km. Fishes released at stations located among the islands usually migrated at a distance of more than 1 km (Tab. 9, Fig. 1, 3, 4).

As regards tench released to Lake Tajty, recapture rate for the same lake amounted to 93.1% in case of 1971 tagging, and to 88.0% of all recaptures in case of 1972 tagging. The remaining fishes moved to south part of Lake Kisajno. Within Lake Tajty fishes moved from the release place (central part) in two directions. Most recaptures were obtained from the part situated closest to Lake Kisajno. The rest of the fishes was recaptured in the opposite end of Lake Tajty.

An analysis was also made of migrations of fishes which were recaptured at least twice in the same year, in spring months (April-June), during reproduction period (June-July) and after spawning (August-October). It appeared that 31.8% of fishes moved before spawning from the place of first recapture, while only 18.7% left this place in autumn period. During reproduction fishes gathered in place of their first recapture. These data suggest that most intensive migrations of tench take place in spring months. Anvand and Taege (1973) stated that most intensive growth of 3-year-old tench in a 4 ha lake took place in May-June, and then since August till October. Reproduction period (July-August) was characterized by the slowest growth. Hence, it can be stated that most intensive migrations are observed during the period of fast growth, and thus – of intensive feeding. Intensive migrations are also observed prior to spawning.

As mentioned in the methods, increments of body weight and length were also analysed. These data are presented in Table 10 and Fig. 7. Growth in length depended on body size and differed in the two periods of studies. Tench tagged and released in 1971 grew faster compared to fishes tagged and released in 1972. This was probably due to more favourable thermal conditions in 1971.

Comparisons were made between condition of tench released to Lake Kisajno and condition of this fish in its maternal lakes (Skarż, Dgał 2,3,5,6), and after some time of fish stay in Lake Kisajno (1, 4 – Fig. 7). The results showed that fishes transplanted to Lake Kisajno were characterized by equally good condition and growth rate. Annual

Tagged tench in region II of Lakes Kisajno recaptured in subsequent years in the place of release (a),
or in the place of release and places up to 1 km distant (b)

Table 9

Year		Stationslocated in bays									Stations located among islands												Stations with narrow littoral		
of tag- ging	of re- captu- re	6			9			13			7			10			11			12			8		
		n	% a	% b	n	% a	% b	n	% a	% b	n	% a	% b	n	% a	% b	n	% a	% b	n	% a	% b	n	% a	% b
1971	1971	37	86.5	91.2	35	74.1	94.3	11	100	100	6	16.6	16.6	2	0.0	50.0	4	25.0	50.0	—	—	—	—	—	—
	1972	139	69.1	89.2	134	67.9	87.3	46	50.0	55.6	42	23.8	28.5	26	7.6	46.1	13	46.1	46.1	3	0.0	0.0	—	—	—
	1973	15	20.0	20.0	6	50.0	83.3	5	40.0	40.0	20	35.0	35.0	1	0.0	100	6	100	100	—	—	—	—	—	—
	1974	—	—	—	—	—	—	—	—	—	4	50.0	50.0	2	0.0	50.0	—	—	—	—	—	—	—	—	—
1972	1973	98	60.2	95.9	102	62.1	64.8	56	55.2	62.5	43	41.8	48.8	15	6.7	60.0	29	93.2	93.2	—	—	—	3	33.3	100
	1974	7	14.2	57.1	9	55.6	55.0	2	0.0	0.0	10	90.0	90.0	3	0.0	100	—	—	—	—	—	—	1	0.0	0.0

n — total number of fishes recaptured on stations of release

Increments of body length (Δ l. corp.) of tench determine for the period since release in 1971 and 1972 till recapture in 1971–1974,
in length classes

Tabela 10

L. corp. in cm	Year of tagging		Date of catch																			
			1971				1972					1973						1974				
			VIII	IX	X	XI	IV	V	VI	VII	VIII	IX	III	IV	V	VI	VII	VIII	X	IV-V	VI	VII
10.1-15.0	1971	Δ l. c. n											4.5 1	8.0 3	9.0 6	7.5 2			12.5 1	13.5 1		
		Δ̄ l. c.													8.1					13.0		
15.1-20.0	1971	Δ l. c. n	4.6 4	5.3 31	4.3 23	7.0 2	7.1 44	7.4 81	7.6 103	9.0 5		7.5 1		10.0 8	9.8 10	11.2 16	13.5 1		11.0 7	10.0 2		
		Δ̄ l. c.		4.9					7.5						10.9					10.0		
	1972	Δ l. c. n											6.6 5	4.2 28	4.7 97	5.4 123	6.6 14	8.5 2	9.2 4		10.4 37	8.5 20
		Δ̄ l. c.														5.2					9.7	
20.1-25.0	1971	Δ l. c. n	4.5 1	5.2 22	4.5 10	4.1 21	6.7 29	6.0 73	6.9 57	9.4 6	11.5 2			13.0 1	10.6 7	9.5 16	15.2 2		12.3 3		12.4 5	11.2 2
		Δ̄ l. c.		5.3					6.6						10.6						12.1	
	1972	Δ l. c. n												3.9 26	3.8 63	4.6 80	5.3 18	8.8 3			9.1 17	7.8 13
		Δ̄ l. c.														4.4						8.5
25.1-30.0	1971	Δ l. c. n			3.6 1				10.0 1						8.5 1							
		Δ̄ l. c.			3.6				10.0						8.5							
	1972	Δ l. c. n												1.0 1	0.5 1	4.8 4						
		Δ̄ l. c.														3.5						
Δ̄ l. c. (l. corp.) 1971 total			5.1 (24.9)				7.2 (27.0)					10.3 (30.1)						11.8 (31.6)				
1972												4.8 (24.0)						9.3 (28.5)

Fig. 7. Curves of tench condition 1 – tench tagged and released to Lake Kisajno. Fishes originated from Lake Dgał, 2 – tench sample from Lake Dgał before release, 3 – tench from Lake Dgał, 4 – tench tagged and released to Lake Kisajno. Fishes originated from Lake Skarż, 5 – tench sample from Lake Skarż before release, 6 – tench from Lake Skarż

Table 11

Assessment of economic effects of tench transplantations
to lakes Kisajno and Tajty

Date of tagging	Weight of released tagged fishes in kg	Date of recapture	Weight of fishes recaptured again in kg	
			a	b
1971	503.87	1972	242.56	315.32
		1973	53.55	69.62
		1974	4.37	13.10
		1972-74	300.47	398.03
1972	605.87	1973	200.80	271.07
		1974	26.10	33.93
		1973-74	226.90	304.97

a — weight of recaptured fishes determined on the basis of recapture rate and growth rate (tab. 4, 10, Fig. 7)

b — weight of recaptured fishes determined taking into account 30% tag losses.

increments of body length and weight, and recapture rate in particular years were used together with total weight of released fishes for an assessment of the economic results of fish transplantation to lakes Kisajno and Tajty. The results are given in Table 11. Total weight of fishes released into both lakes was much higher than the weight of recaptured fishes (a — Tab. 9), even when a correction was made for 30% loss of tags (b — Tab. 9). It seems that better economic results might have been achieved by increasing spawning success through changes in tench exploitation, viz. by a decrease of tench S catches during reproduction period and increase of these catches with seine nets.

SUMMARY

Analysis was made of the results of tench tagging in 1971 and 1972. The fishes were transferred from small, highly productive lakes to shallow parts of the complex of Great Mazurian Lakes. The results suggest that tench is a sedentary species with low predisposition for undertaking distant migrations, provided that environmental conditions for feeding and reproduction are satisfactory. Favourable conditions are represented by littoral areas protected from waving and overgrown with submerged vegetation. In such habitats tench rarely moves, and if so, at a short distance only. More intensive migrations were observed only prior to spawning, and afterwards the fishes returned to their former habitats. However, no typical spawning migrations of tench were observed in cases when the habitat was also characterized by favourable conditions for the reproduction. Transplantations of tench from small lakes, with dense tench population into shallow parts of large lakes are frequently ineffective. It seems that better results can be achieved

by an analysis and proper determination of size composition of tench catches, so that less small tench might be caught during spawning season. Increase of spawning success may be more effective than fish transplantations, the latter being additionally connected with a possibility of transferring fish parasites from one lake to another.

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WYNIKI ZNAKOWANIA LINA TINCA TINCA (L.) W JEZIORZE KISAJNO I TAJTY

Streszczenie

Nieliczne piśmiennictwo dotyczące biologii i ekologii lina w naturalnych zbiornikach wodnych, duża jego wartość gospodarcza, skąpe wiadomości o efektach prowadzonych masowo przerzutach było powodem podjętych badań nad tym gatunkiem ryb. Oznakowania przerzucanego lina z małych zasobnych jezior (Skarż, Wojsak, Siercz tab. 1,2) do wypłyconych części Wielkich Jezior Mazurskich (Kisajno, Tajty rys. 1, tab. 1,3) przeprowadzono w latach 1971 i 1972. Liny oznakowano znaczkami plastikowymi, umocowano drutem monelowym przez płetwę grzbietową. Notowano numery znaczka, płeć długość ciała (*l.corp*), a dla części również masę ciała. Po 24 godzinach przetrzymywania w sadzach wpuszczano do jezior (rys. 1, tab. 3).

Wypłycone części systemu Wielkich Jezior Mazurskich podzielono pod względem morfometrycznym na trzy części o różnych warunkach dla rozrodu i odżywiania się lina (tab. 1, rys. 1). Odłowy znakowanego lina prowadzono łącznie z połowami gospodarczymi, w których przeważa płoć, leszcz, szczupak, a masa lina nie przekracza 1 kg/ha. Asortymentowy skład odłowu lina jest różny dla połowów wiosenno-lętnich prowadzonych narzędziami stawnymi oraz jesiennych prowadzonych narzędziami ciągnionymi, jak i w różnych latach badań (rys. 2, tab. 4).

Oznakowano w roku 1971 – 2595 osobników i odłowiono ponownie w latach 1971 do 1974 – 668 osobników (25,7% tab. 5,6,7). Natomiast z 3226 linów oznakowanych w 1972 roku odłowiono w latach 1973, 1974 – 547 ryb (17%). Zwroty oznakowanych i wpuszczonych na czternastu badanych stanowiskach są bardzo zróżnicowane i stanowią od 1,7 do 71% wpuszczonych ryb (tab. 5). Porównanie wyników badań własnych z danymi dotyczącymi innych ryb karpiowatych oznakowanych w wodach śródlądowych Polski pozwala przypuszczać, iż śmiertelność połowowa lina jest wyższa niż płoci, a zajmuje miejsce między różnymi populacjami leszcza i certy (tab. 6). Analiza zwrotów oznakowanego lina i połowów gospodarczych wskazuje na różne tendencje w dwóch wymienionych okresach połowowych (rys. 2,3,4 tab. 4). Analiza wyników znakowania lina czyniona pod kątem poszukiwania pewnych prawidłowości w kierunkach, jak i odległościach podejmowanych wędrówek dokonano osobno dla trzech wyodrębnionych stref (rys. 1,5,6, tab. 7,8,9), stanowisk do których wpuszczono ryby, linów kilkakrotnie złowionych w tym samym roku badań. Uzyskane wyniki wskazują, że lin jest gatunkiem zasiedlającym o małej predyspozycji do dalszych wędrówek jeżeli napotyka na korzystne warunki żerowiskowe i rozrodcze. Do korzystnych warunków w szczególności należą; dostateczne partie osłoniętego od falowania litoralu porośniętego roślinnością zanurzoną. W granicach takich siedlisk tylko nieliczne osobniki tego gatunku przemieszczają się na nieznaczne odległości. Intensywniejsze wędrówki stwierdzono jedynie w okresie przedrozrodczym, aby po odbytych rozrodzie powrócić do stanu pierwotnego. Nie stwierdzono jednak wyraźnych wędrówek rozrodczych, gdy w strefie bytowania występują dogodne warunki do rozrodu. Istnieją dwa okresy nasilających się przemieszczeń troficznych lina w ciągu roku, na co wskazują wyniki kilkakrotnego połowu tych samych ryb w okresie roku. W miesiącach wiosennych, w których zanotowano, że 31,8% ryb przemieszcza się poza miejsce pierwszego połowu oraz w okresie jesiennym (18,7%). Aąan i Tage (1973) określili, iż w tych miesiącach notowane są również największe przyrosty lina.

Pobierano pomiary długości i masy ciała niezbędnych dla analizowania przyrostów ciała i kondycji linów przierzucanych w jeziorach macierzystych i w miejscach wpuszczenia. Wyniki wskazują, że liny po przierzuceniu do jeziora Kisajno odznaczały się równie dobrym wzrostem i kondycją (rys. 7, tab. 10). Przyrosty roczne oraz liczebność zwrotów określono dla różnych lat badań, całkowita masa ryb wpuszczonych posłużyła do oszacowania efektu gospodarczego dokonywanych przerzutów do jeziora Kisajno i Tajty (tab. 11). Przerzuty linów z małych jezior do wypłyconych części dużych jezior są zabiegiem nieefektywnym. Wydaje się, że analiza i właściwe ustalenie składu asortymentowego, proporcji sezonowych odłowów mogą zapewnić dobre rezultaty i większy efekt gospodarczy od ryzykownych przerzutów narażających dodatkowo takie populacje na możliwość przenoszenia pasożytów.

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РЕЗУЛЬТАТЫ МАРКИРОВКИ ЛИНЯ – TINCA TINCA (LINNAEUS, 1758) ПО ОЗЁРАМ КИСАЙНО И ТАЙТЫ

Р е з ю м е

Немногочисленная литература на тему биологии и экологии линя по естественным водным бассейнам, большая хозяйственная его ценность, а также скудные информации в области эффективности проводимых в массовом масштабе

перебросок представляют собой основу для исследований этого вида рыбы. В 1971 и 1972 гг. проведено маркировку линя, подвергавшегося перебросам из небольших, богатых рыбой озёр (Скраж, Войсак, Серож, таб. 1-2) в обмеленные участки Больших Мазурских Озёр (Кисайно, Тайты, рис.1, таб. 1-3). Рыбу маркировали пластмассовыми метками, укрепленными проволокой (монельной) у спинного ласта. Записывали: длину тела (1.сogp), пол, у части особей - вес, а также номер метки. Через 24 часа выдерживания в садках, рыбу вводили в озёра (рис.1, таб.3).

На основании морфометрических признаков обмеленные участки системы больших Мазурских Озёр были разделены на 3 части с различавшимися условиями для размножения и питания линя (таб.1, рис.1). Отлов маркированного линя производили совместно с хозяйственными отловами, когда превосходство имеет плотва, лещ и щука, а масса линя составляет обычно до 1 кг/га. Ассортиментный состав отлова линя различался в зависимости от сезона года, а именно для осенне-летнего сезона (отлов с помощью прудового оборудования) и осеннего сезона (оборудование для волочения), а также за отдельные года исследований (рис.2, таб.4).

В 1971 году метку получили 2595 особей, а по отловам в период с 1971 до 1974 гг. получено 668 особей (25,7%, таб. 5,6,7). Тогда как среди маркированных в 1972 г. 3226 линей по уловам проведенным в 1973 и 1974 гг. получено 547 особей (17%). По 14 исследованным участкам возврат вводимой снова, маркированной рыбы значительно различался и составлял с 1,7 до 71% (рис.5). На основании сравнения полученных авторами результатов с данными для карповых рыб, маркированных по континентальным водам Польши установлено, что рыболовная смертность линя выше смертности плотвы. Она занимает место между разными совокупностями леща и сырты (таб.6). Анализ поворотов маркированного линя и хозяйственных отловов показал разные тенденции по исследованным рыболовным сезонам (рис. 2,3,4, таб.4). Анализ результатов метки линя для установления правил в направлении и расстоянии при предпринимаемой рыбой миграции, производили для 3 выделенных зон (рис. 1,5,6, таб. 7,8,9), для мест повторного введения рыбы и для особей отловленных несколько раз на протяжении года исследований. Полученные результаты показали, что линь, имевший хорошие условия для питания и размножения принадлежит к видам местного проживания, с небольшой склонностью к миграции. Хорошими условиями считаются в частности: достаточные участки литорали, укрытые от волнения с покровом погруженной растительности. В пределах таких местообитаний, лишь для незначительного числа особей линя установлено перемещение на небольшом расстоянии. Более интенсивная миграция наблюдается в период предшествующий размножению, но после размножения устанавливается первоначальное состояние. Не установлено однако четкой миграции для размножения, когда в зоне пребывания имелись хорошие условия для размножения. На протяжении года наблюдаются 2 периода более интенсивных трофических миграций у линя, что подтверждают результаты отлова несколько раз тех же особей. В весенний период перемещению вне места первого отлова подвергалось 31,8% рыбы, а осенью - 18,7%. Аваном и Тагэ (1973) для тех же месяцев установлены также самые большие приросты у ли-

Для определения приростов веса и формы особей линя проведено анализ результатов измерений длины и веса у рыбы из переброса по материнским озёрам и по местам введения. Результаты показали, что особи линя перебросенные в озеро Кисайно отличались хорошими ростом и формой (рис.7, таб.10). Годичные приросты, а также числительность поворотов за отдельные года исследований и общий вес вводимой рыбы представляли собой материал для оценки хозяйственной эффективности перебросов в озёра Кисайно и Тайты (таб. 11). Переброся линя из небольших озёр в обмеленные участки больших озёр неэффективны. По мнению авторов, анализ и надлежащее установление ассортиментного состава и пропорций для сезонной рыболовли могут обеспечить хорошие результаты и лучшие хозяйственные эффекты, чем рискованные перебросы, связанные с дополнительной угрозой переноса паразитов этими совокупностями рыбы.

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