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Elżbieta PIMPICKA

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FECUNDITY OF TENCH (*TINCA TINCA* L.) FEMALES IN LAKE DRWĘCKIE

PŁODNOŚĆ SAMIC LINA (*TINCA TINCA* L.) W JEZIORZE DRWĘCKIM

Chair of Zoology, Academy of Agriculture and Technology, Olsztyn

Absolute and relative fecundity was estimated for 136 tench females in Lake Drwęckie as well as the dependence between absolute fecundity and fish body weight and length, as also between ovary weight and fish age. Absolute fecundity amounted to from 18.4 to 416.1 thousand eggs, and relative fecundity from 85.7 to 543.9 thousand eggs per 1000 g of fish body weight. Most strict correlation was observed between absolute fecundity and ovary weight, and – succesively – body weight, body length and female age. Linear relation was found between absolute fecundity and ovary and body weight, whereas power relation was noted between absolute fecundity and fish length and age.

INTRODUCTION

Fecundity represents one of the parameters which must be known to carry out proper fisheries management. Most papers dealing with this problem give tench fecundity in body length or weight classes (Kaj et al. 1964, Monić 1953, Morawska 1981, Moroz 1968, Papadopol 1970, Papadopol and Weinberger 1971, Rosa 1958, Skóra 1964, Zubenko 1973, 1975, Żukov 1965). Only the papers by Brylińska et al. (1979) and Pimpicka (1981) discussed the relationship between absolute fecundity of tench and selected individual parameters.

The objective of the work was to determine fecundity of tench females in Lake Drwęckie and to study the dependencies between absolute fecundity and such individual parameters as: fish body weight and length, ovary weight and fish age.

The work constituted a part of studies on the fecundity of tench females in Lake Drwęckie (Pimpicka 1986, 1990).

MATERIALS AND METHODS

Fish for studies were collected using electrofishing and trap nets (fyke nets and combined pound nets) set during commercial fishing by the State Fish Farm Ostróda.

Samples were collected in the prespawning period, in June 1978 and May and June 1979.

Preliminary studies (Pimpicka 1986) revealed that the two samples collected in 1978 can be treated jointly as sample I+II, while the samples from 1979 were analysed separately as sample III and IV. General characteristics of the fish used in the analyses are presented in Tab. 1.

Table 1

General characteristic on the material collected in Drwęckie Lake

Data	Symbol of sample	Number of fish	Range		
			body length (lc) in cm	body weight (W) in g	age (A) in years
7–9.VI.78 16.VI.78	I II	47 28	21.0–36.0 21.1–36.0	262–1330 250–1130	3+ – 7+ 3+ – 7+
	I + II	75	21.0–36.0	250–1330	3+ – 7+
24.V.79 5.VI.79	III IV	12 49	21.3–34.5 20.6–34.1	238–860 250–1110	4+ – 7+ 4+ – 8+
	III + IV	61	20.6–34.5	238–1110	4+ – 8+
Total		136	20.6–36.0	238–1330	3+ – 8+

Fishes with ovaries in stages IV to V of development according to the scale by Sakun and Buckaja(1968), were measured determining body length (lc) up to 0.5 cm, weighed determining total body weight (W), weight of gutted fish (Wo) and weight of the ovaries (Ow) up to 0.1 g. Age (A) was determined by scale reading. Scales were collected above the lateral line, just below the base of the dorsal fin.

Absolute fecundity (Fa) i.e. number of eggs present in the ovaries just prior to spawning, was determined using dry weight method (Brylińska and Bryliński 1972).

Relative fecundity (Fr) was calculated dividing absolute fecundity (Fa) by the weight of gutted fish (Wo); it expressed number of eggs per 1000 g of body weight.

Absolute fecundity (Fa) was treated as a dependent variable; it was analysed in relation to the following independent variables: body length (lc), body weight (W),

ovary weight (Ow), and fish age (A). In order to determine the relationship between absolute fecundity and these selected parameters, coefficients of linear correlation (r) were calculated. Their significance was analysed on absolute and logarithmic data. Moreover, coefficients of linar regression were calculated for the function $y = ax+b$, as well as for power function $y = bx^a$, the latter being transformed to a logarithmic form $\log y = b \log x + \log a$, where: $y = Fa$, x – parameters under study (lc, W, Ow, A). Graphs of the dependencies were made basing on power functions in the logarithmic form.

RESULTS AND DISCUSSION

Results related to average absolute and relative fecundity and individual parameters under study are given in Tab. 2a, b, c for particular length classes of tench females. It appears that in both spawning seasons, females taking part in the reproduction were in body length classes 21.2–35.4 cm, and weighed from 238.0 to 1126.0 g. They were aged 3 to 7 years.

As the fish grew (both in length and weight) and became older, weight of the ovaries increased 3 to 13-fold, while average absolute fecundity increased 3 to 10-fold.

Tench stock in Lake Drwęckie was characterized by considerable differences of absolute fecundity. In 1978 it amounted from 30.3 to 318.8 thousand eggs (Tab. 2a) and in 1979 it was from 18.4 to 416.1 thousand eggs (Tab. 2b, c).

Absolute fecundity of tench females from Lake Drwęckie was compared with the data from other water bodies. The respective graph in body length classes is presented in Fig. 1.

Absolute fecundity of tench females from Lake Drwęckie was low, being similar to that in Lake Patryki (Pimpicka 1981) but slightly higher than in Goczałkowice Dam Reservoir (Skóra 1964). Tench females from the lakes of Chełmińsko-Dobrzyński Lakeland were characterized by slightly higher fecundity, and so were females from Mazurian lakes (Brylińska et al. 1979). The highest fecundity was found for tench females in waters of the Danube River delta (Moroz 1968, Papadopol and Weinberger 1971). This is most probably due to higher and more stable temperature in these waters. As shown by Morawska (1981) temperature had a decisive effect on tench fecundity. Brylińska et al. (1979) showed also that tench population in the Danube delta was characterized by higher growth rate (in terms of weight) than in Polish waters, and this favoured higher fecundity.

Relative fecundity of tench females collected in 1978 was from 105.0 to 543.9 (Tab. 2a), and in 1979 from 85.7 to 513.8 (Tab. 2b and c) thousand eggs per 1000 g of body weight. On the average, in both reproductive seasons about 211.0–259.0 eggs were layed per 1000 g of tench weight.

Table 2a

Average value ($\bar{x}$), standard deviation (s), coefficient of mutability (v) of the investigated individual features of tench in Drwęckie Lake collected in 1978 (sample I + II) in body length classes

individual features \ body length classes	n	20.1–22.0	22.1–24.0	24.1–26.0	26.1–28.0	28.1–30.0	30.1–32.0	32.1–34.0	34.1–36.0	Total	Range
		5	6	19	18	10	6	6	5	75	
Absolute fecundity (Fa)	$\bar{x}$	42.6	84.4	83.8	110.1	149.5	157.0	163.1	219.6	117.4	30.3–318.8
	s	13.9	17.9	38.8	50.7	52.4	25.4	34.4	67.4	60.0	
	v	32.5	21.2	46.3	46.1	35.0	16.2	21.1	30.7	51.1	
Relative fecundity (Fr)	$\bar{x}$	184.2	273.5	235.1	267.1	291.5	259.0	222.6	235.9	251.0	105.0–543.9
	s	63.1	54.8	93.7	109.3	77.6	62.0	56.7	64.6	86.6	
	v	34.3	20.1	39.9	40.9	26.6	23.9	25.4	27.4	34.5	
Body length (lc)	$\bar{x}$	21.9	23.7	25.0	26.8	29.1	31.1	33.0	35.4	27.0	21.0–36.0
	s	0.11	0.30	0.60	0.57	0.60	0.77	0.40	0.75	3.73	
	v	0.54	1.28	2.39	2.12	2.07	2.48	1.23	2.11	13.59	
Ovary weight (Ow)	$\bar{x}$	19.5	37.3	40.8	51.5	70.8	69.3	73.6	104.7	54.8	12.2–143.2
	s	6.0	7.3	20.7	23.1	25.4	19.1	16.8	31.1	28.6	
	v	30.6	19.7	50.7	44.9	35.9	27.6	22.8	29.7	52.2	
Body weight (W)	$\bar{x}$	270.4	372.2	421.9	496.7	622.5	796.3	880.0	1126.0	566.0	250.0–1330.0
	s	18.5	37.6	59.6	57.2	87.7	90.5	82.0	149.4	232.9	
	v	6.8	10.1	14.1	11.5	14.1	11.4	9.3	13.3	41.1	
Age (A)	$\bar{x}$	3.0	3.8	4.1	4.7	5.5	6.0	6.0	7.0	5.0	3.0–7.0
	s		0.4	0.6	0.6	0.7	0.0	0.0	0.0	1.14	
	v		10.7	15.3	12.2	12.9	0.0	0.0	0.0	23.69	

Average volue ($\bar{x}$), standard deviation (s), coefficient of mutability (v) of the investigated individual features of tench in Drwęckie Lake collected in 1979 (sample III) in body length classes

individual features \ body length classes	n	20.1–22.0	22.1–24.0	24.1–26.0	26.1–28.0	28.1–30.0	30.1–32.0	32.1–34.0	34.1–36.0	Total	Range
		1	1	1	1	–	3	4	1	12	
Absolute fecundity (Fa)	$\bar{x}$	32.9	130.5	68.6	33.9	–	166.1	197.3	132.2	140.5	32.9–217.2
	s	–	–	–	–	–	29.7	28.2	–	65.6	
	v	–	–	–	–	–	17.9	14.3	–	46.7	
Relative fecundity (Fr)	$\bar{x}$	168.8	511.6	209.2	99.8	–	245.1	300.9	178.6	259.0	99.8–511.6
	s	–	–	–	–	–	49.2	41.2	–	100.1	
	v	–	–	–	–	–	20.1	13.7	–	40.9	
Body length (lc)	$\bar{x}$	21.3	22.3	25.1	26.2	–	31.4	32.7	34.5	30.3	21.3–34.5
	s	–	–	–	–	–	0.5	0.3	–	4.5	
	v	–	–	–	–	–	1.6	1.0	–	13.6	
Ovary weight (Ow)	$\bar{x}$	12.4	40.0	23.2	12.6	–	40.7	47.3	39.6	36.6	12.4–54.6
	s	–	–	–	–	–	3.1	10.3	–	14.2	
	v	–	–	–	–	–	7.7	21.8	–	38.7	
Body weight (W)	$\bar{x}$	238.0	290.0	392.0	392.0	–	783.3	786.3	860.0	639.0	238.0–860.0
	s	–	–	–	–	–	23.1	44.2	–	235.4	
	v	–	–	–	–	–	2.9	5.6	–	36.8	
Age (A)	$\bar{x}$	4.0	4.0	4.0	5.0	–	6.3	5.8	7.0	6.0	4.0–7.0
	s	–	–	–	–	–	0.6	0.5	–	1.1	
	v	–	–	–	–	–	9.1	8.7	–	19.8	

Table 2c

Average value ($\bar{x}$), standard deviation (s), coefficient of mutability (v) of the investigated individual features of tench in Drwęckie Lake collected in 1979 (sample IV) in body length classes

body length classes / individual features	n	20.1–22.0	22.1–24.0	24.1–26.0	26.1–28.0	28.1–30.0	30.1–32.0	32.1–34.0	34.1–36.0	Total	Range
		7	13	12	8	7	–	1	1	49	
Absolute fecundity (Fa)	$\bar{x}$	37.5	52.0	68.8	97.4	109.1	–	352.7	416.1	83.2	18.4–416.1
	s	17.8	14.6	21.8	38.0	48.7	–	–	–	72.6	
	v	47.3	28.1	31.8	39.0	44.7	–	–	–	87.4	
Relative fecundity (Fr)	$\bar{x}$	166.4	183.8	193.4	240.0	218.7	–	476.7	513.8	211.0	85.7–513.8
	s	77.1	53.7	64.4	94.4	114.3	–	–	–	97.1	
	v	46.3	29.2	33.3	39.2	52.2	–	–	–	46.1	
Body length (lc)	$\bar{x}$	21.2	23.0	25.0	26.9	29.0	–	33.7	34.1	26.0	20.6–34.1
	s	0.4	0.5	0.4	0.4	0.5	–	–	–	3.1	
	v	1.9	2.4	1.7	1.6	1.7	–	–	–	12.3	
Ovary weight (Ow)	$\bar{x}$	15.7	20.8	29.7	43.3	49.1	–	191.3	208.1	37.3	7.2–208.1
	s	7.9	7.0	12.9	18.1	21.8	–	–	–	38.1	
	v	50.3	33.6	43.5	41.7	44.4	–	–	–	10.2	
Body weight (W)	$\bar{x}$	265.0	331.2	420.0	489.4	607.1	–	1001.0	1110.0	438.0	250–1110.0
	s	15.5	29.4	33.5	23.7	23.4	–	–	–	169.7	
	v	5.9	8.9	8.0	4.8	3.9	–	–	–	38.7	
Age (A)	$\bar{x}$	3.3	3.8	4.2	5.0	5.7	–	7.0	6.0	4.0	3.0–7.0
	s	0.5	0.4	0.6	0	0.5	–	–	–	1.0	
	v	14.9	9.8	13.9	0	8.5	–	–	–	22.2	

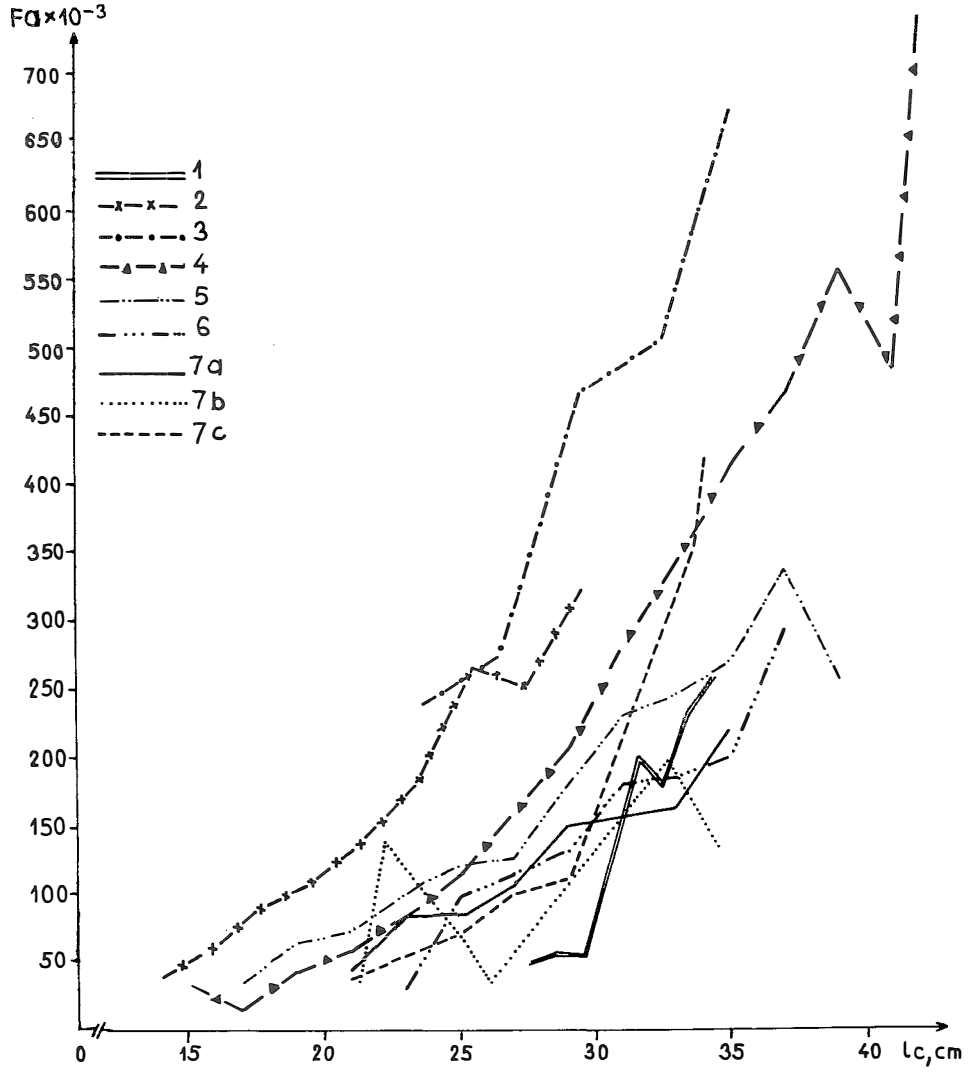

Fig. 1. Absolute fecundity (Fa) of tench in various water bodies in body length class: 1. Goczałkowice Reservoir (Skóra 1964), 2. Danube Delta (Moroz 1968), 3. Danube Delta (Papadopol, Weinberger 1971), 4. Lakes of Mazurian District (Brylińska et al. 1979), 5. Lakes of Chełmno – Dobrzyń District (Brylińska et al. 1979), 6. Lake Patryki (Pimpicka 1981), 7. Lake Drwęckie a) ample i + II 1978, b) sample III 1979, c) sample IV 1979 (resent study)

Table 3

Values of corelation coefficients (r) calculated for the relationship between absolute fecundity (Fa) and investigated the individual features of female tench in Drwęckie Lake)

Year (sample) / Relationship	1978 (I + II)		1979 (III)		1979 (IV)	
	a	b	a	b	a	b
Fa – lc	0.7472**	0.7598**	0.7465**	0.7426**	0.7467**	0.7826**
Fa – W	0.8028**	0.8259**	0.7869**	0.7900**	0.8787**	0.8280**
Fa – O_w	0.9749**	0.9678**	0.9502**	0.9782**	0.9854**	0.9560**
Fa – A	0.7984**	0.8337**	0.5485*	0.5890*	0.5775**	0.5520**
n – 1	74		11		48	

** corelation significant at $p \leq 0.01$
* corelation significant at ≤ 0.05
a – absolute numbers
b – logtransformed numbers

It seems that the trends of changes in the fecundity in relation to the individual features under study were most objective in 1978, this being due to the number of females in particular body length classes (Tab. 2a). It can be assumed on the basis of these results that absolute fecundity of tench females increased with body length and weight, gonad weight, and fish age. On the other hand, relative fecundity was not clearly connected with the mentioned individual features.

Dependencies between absolute fecundity and selected individual features were determined using correlation coefficients (r) which are given in Table 3. Values of these coefficients suggest that in tench population from Lake Drwęckie absolute fecundity depended strictly on: ovary weight (Ow), body weight (W), body length (lc) and fish age (A). Similar relations were found for tench in other waters (Brylińska et al. 1979, Pimpicka 1981, 1986).

Coeficients of the regression equations were calculated (Tab. 4) and the analyses performed of the dependence between absolute fecundity and the parameters under study (Fig. 2, 3, 4, 5); the regressions-were drawn using logarithmic data (Tab. 4).

Graphs of power functions expressing the relation between absolute fecundity and ovary weight (Fig. 2) are characterized by the highest coefficient of correlation, almost equal one (Tab. 3). These functions are practically linear, pointing to regular increase of the fecundity with increasing weight of the ovaries. Brylińska et al. (1979) and Pimpicka (1981) also found linear relationships between fecundity and ovary weight in tench from other lakes. The regression line (Fig. 2) suggests that absolute fecundity increased more rapidly in sample III (1979) compared to other samples.

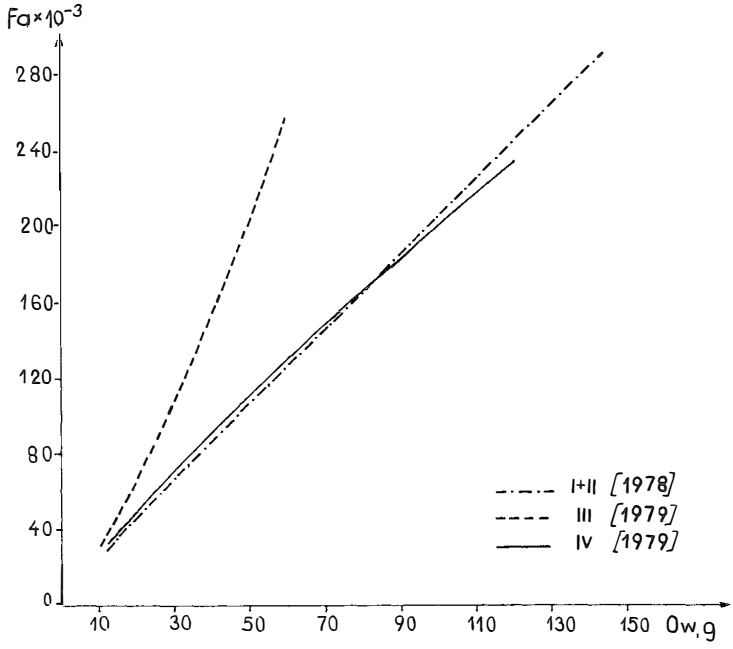

Fig. 2. Relationship between absolute fecundity (Fa) and ovary weight (Ow) of tench females in Drwęckie Lake

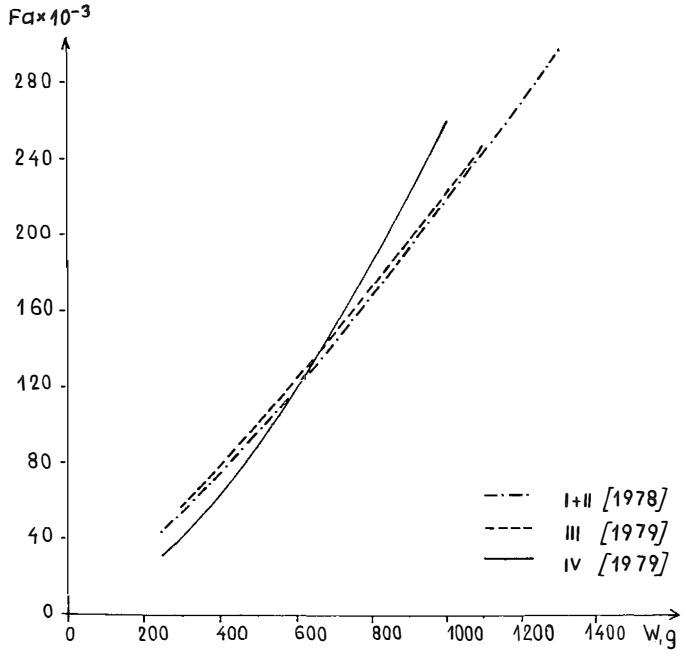

Fig. 3. Relationship between absolute fecundity (Fa) and body weight (W) of tench females in Drwęckie Lake

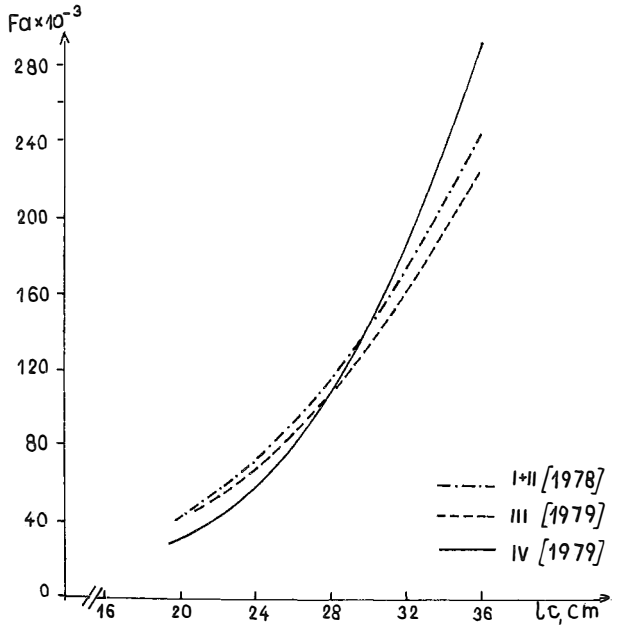

Fig. 4. Relationship between absolute fecundity (Fa) and body length (lc) of tench females in Drwęckie Lake

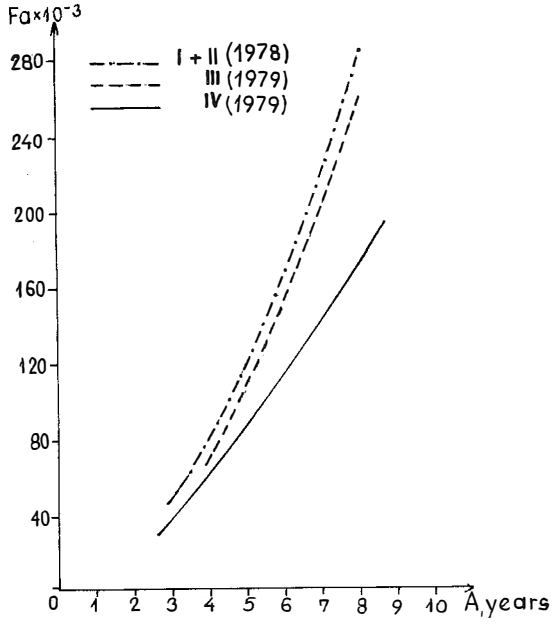

Fig. 5. Relationship between absolute fecundity (Fa) and age (A) of tench females in Drwęckie Lake

Table 4

Coefficient of equation regression calculated for the relationship between absolute fecundity (Fa) and body length (lc), body weight (W), ovary weight (Ow) and age (A) of females in Drwęckie Lake

Relationship	Sample	y = ax + b		log y = b log x = log a	
		a	b	b	log a
Fa – lc	I + II	+12034.9	−212527.5	+3.0847	+0.5872
	III	+10782.3	−177965,8	+3.0150	+0.6606
	IV	+17999.3	−370144.4	+4.0430	−0.8262
Fa – W	I + II	+206.9	+326.3	+1.1738	+1.8176
	III	+218.9	+595.2	+1.1422	+1.9157
	IV	+376.3	−81745.6	+1.5295	+0.8246
Fa – Ow	I + II	+2046.3	+5250.9	+0.9376	+3.4387
	III	+4398.9	−20419.0	+1.2913	+3.1145
	IV	+1881.1	+13077.5	+0.8789	+3.5630
Fa – A	I + II	+41909.9	−84848.0	+ 1.8430	+3.7742
	III	+33083.9	−41489.9	+1.9131	+3.6772
	IV	+42956.9	−106179.4	+1.5313	+3.8555

This was probably due to the fact that when this sample was collected, the oocytes still did not attain full maturity, this being reflected in lower weight of the ovaries, while number of the oocytes was already final and similar to that in other samples.

Absolute fecundity correlated strictly with body weight. The regression lines for the samples of 1978 and for sample III from 1979 were almost linear (Fig. 3). This means that fecundity of the fish increased regularly with increasing fish weight. On the other hand, the regression line for samle IV in 1979 is slightly concave (Fig. 3). This means that in females in this sample absolute fecundity increased more rapidly than body weight. Linear relation between absolute fecundity anu body weight was found by Brylińska et al. (1979) for tench in several lakes of Mazurian and Chełmińsko-Dobrzyński lakelands, as well as Pimpicka (1981) for tench in Lake Patryki.

The relationship between fecundity and body length was quite different; it was of a noticeably parabolic character (Fig. 4). This suggests that in all samples under study, fecundity increased more rapidly than length of tench females. Similar curvilinear relationship was observed by Pimpicka (1981) for tench in Lake Patryki.

Also the relation between absolute fecundity and tench age is slightly curvilinear (fig. 5). It shows that absolute fecundity of tench females in Lake Drwęckie increased

more rapidly with fish age. On the other hand, Pimpicka (1981) found that the relation was linear for tench from Lake Patryki, and Brylińska et al. (1979) also used straight line to describe this relation.

CONCLUSIONS

1. Absolute fecundity of tench females 20.6–36.0 cm in length and weighing 238.0–1330.0 g ranged in Lake Drwęckie from 18.4 to 416.1 thousand eggs.

2. Significant linear relationships were found between absolute fecundity and individual features as follows (from the most to the least significant): ovary weight, body weight, body length and fish age.

3. Dependencies between absolute fecundiuty and ovary weight and fish body weight were linear, whereas those between absolute fecundity and body length and fish age were parabolic.

4. Relative fecundity of the tench population under study was 85.7 to 543.9 thousand eggs per 1000 g of body weight. On the average, 211–259 thousand eggs could have been spawned in the reproductive season per 1000 g of females weight.

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Translated: Dr. M. Bnińska

Elżbieta PIMPICKA

PŁODNOŚĆ SAMIC LINA, (*TINCA TINCA* L.) W JEZIORZE DRWĘCKIM

STRESZCZENIE

Materiał do badań stanowiło 136 samic lina odłowionych przed rozrodem w 1978 i 1979 r. z Jeziora Drwęckiego (tab. 1). Pobrane samice mierzono określając długość ciała (L), ważono określając masę ciała (W) i masę jajnika (Ow) oraz odczytano z łusek wiek (A). Metodą wagową na sucho określono płodność absolutną (Fa) oraz obliczono płodność względną (Fr) w tys. jaj na 1000 g masy ciała. Płodność absolutną (Fa) jako zmienną zależną analizowano w stosunku do zmiennych niezależnych: długości ciała (lc), masy ciała (W), masy jajnika (Ow) oraz wieku (A).

Płodność absolutna w 1978 roku wynosiła 30,3 do 318,8 tys. jaj, a płodność względna 105,0 do 543,9 tys. jaj. W 1979 roku wystąpiły większe różnice w indywidualnej płodności samic i płodność absolutna wynosiła od 18,4 do 416,1 tys. jaj, a płodność względna 85,7 do 513,8 tys. jaj (tab. 2a, b, c). Otrzymane wyniki płodności absolutnej samioc lina z Jeziora Drwęckiego porównano z danymi z innych zbiorników (rys. 1).

Wartości współczynników korelacji prostej wskazują, że w badanej populacji samic lina istnieją istotne związki proste między płodnością absolutną a masą jajnika, masą ciała, długością ciała i wiekiem (tab. 3). Stwierdzono prostolinijną zależność między płodnością absolutną a masą jajnika (rys. 2) i masą ciała (rys. 3) oraz potęgową zależność między płodnością absolutną a długością ciała (rys. 4) i wiekiem ryb (rys. 4).

Author's address:

Dr. Elżbieta Pimpicka
Akademia Rolniczo-Techniczna
Katedra Zoologii
10-957 Olsztyn-Kortowo
POlska (Poland)

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