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PARENTAL BODY WEIGHT AND PROGENY PERFORMANCE IN RAINBOW TROUT (*Oncorhynchus mykiss* Wall.)

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A B S T R A C T. The influence of parental body weight on the progeny growth up to the market size was analysed in rainbow trout. The only one and highly significant correlation was observed between female size and amount of eggs (r=0.8). Male size had no influence on the progeny growth. Basing on these results no particular strategy for selecting spawners in mass selection can be recomended.

Key words: RAINBOW TROUT, GROWTH, MASS SELECTION

NTRODUCTION

Publications on the genetic parameters of rainbow trout populations have reported low to moderate values of heritabilities for body weight and length (Aulstad *et al.* 1972, Kincaid *et al.* 1977, Refstie 1980, Gunnes & Gjedrem 1981, Crandell & Gall 1993, and others) as well as their dependence on environmental factors (Życzynski *et al.* 1995).

Low values of h^2 as observed in a Polish rainbow trout population (Życzynski *et al.* 1995) predict low correlations between the genotype and phenotype of individuals. Under these circumstances a genetic improvement of growth rate through mass selection would be almost impossible. Nevertheless, there is still a tradition of choosing the biggest (better looking) spawners for reproduction.

In the present paper we attempt to trace the influence of parental body weight on the production results of their progeny. For this experiment rainbow trout from a selective breeding programme performed at the Inland Fisheries Institute, Salmonid Research Laboratory in Rutki (Dobosz et al. 1992) were used.

MATERIALS AND METHODS

The three years old parental fish within each sex were divided into three groups according to body size (L=large, M=medium, S=small) before stripping (table 1).

Pairing was done in every possible combination of these categories resulting in nine groups of progeny families (table 2). To introduce a maximum number of fish into the parental generation, and to prevent any unintentional loss of representativness, each family was created by random mating one male to two females, and by repeating each parental combination several times. The total number of progeny families amounted to 78. The numbers of progeny families within each combination are given in table 2.

Weight of green eggs in each family was recorded. Each family was incubated and reared separately until tagging in autumn. After hatching and first feeding, the number of families was reduced to 60 basing on the survival rate. Then 500 fry of each family were placed in $4m^2$ tanks. They were reared under commercial conditions. Daily food ration was calculated for the whole stock of the experimental fish. Dead fish were recorded. In autumn the amount of families was culled to 52 (the families with the lowest survival were rejected), and the amount of fish within each family was reduced to 180 properly shaped ones. Out of these, 80 were tagged individually with

TABLE 1

Mean body weights (g) of parental fish in the selected categories

Category	Males	Females
Large	904.3	1062.1
Medium	630.4	839.0
Small	403.1	651.1

TABLE 2

Pairing scheme of the different size categories and designation of the progeny families

Females	Males			Maternal groups
	large	medium	small	
Large	LL (9)	LM (10)	LS (9)	L*
Medium	ML (10)	MM (12)	MS (11)	M*
Small	SL (6)	SM (5)	SS (6)	S*
Paternal groups	*L	*M	*S	

PIT tags (September), and the remaining 100 with traditional (Carlin´s type) group tags (November). The PIT tagged fish remained in Rutki; they were mixed and stocked into three ponds for normal rearing until market size. The traditionally tagged fish were transported to a commercial farm (Bytów) and reared in one pond up to the market size. At the end of the experiment the fish in both rearing sites were weighed and the families identified. Additionally, the amount of precocious males (PM) in PIT tagged fish families was recorded. Thus, the fish growth was analysed in two periods: the first from the begining of feeding till tagging, and the second from tagging untill the fish obtained market size.

The data were analysed statistically by calculating coefficients of correlation and regression between the chosen traits and using ANOVA according to the following models:

model I. for the first period from feeding fry till tagging:

$$y_{ijk} = m + a_i + b_j + ab_{ij} + e_{ijk}$$

where:
m is the overall mean,
a_i is the effect of i-th size category of dame,
b_j is the effect of j-th size category of sire,
ab_{ij} is the effect of dame size * sire size interaction,
e_{ijk} stands for random error.

model II. for the second period from tagging till market size:

$$y_{ijkl} = m + a_i + b_j + c_k + ab_{ij} + ac_{ik} + bc_{jk} + e_{ijkl}$$

where:
a_i is the effect of i-th farm,
b_j is effect of size category of dame,
c_k is the effect of k-th size category of sire,
ab_{ij} is the effect of farm * dame size interaction,
ac_{ik} is the effect of farm * sire size interaction,
bc_{jk} is the effect of dame size * sire size interaction,
e_{ijkl} is the random error.

The χ^2 test of independence was used to check up whether the culling of families at the beginning of period II could effect the results, and whether the PM were represented proportionally in the progeny groups and, consequently, whether PM influenced the final biomass within the groups.

RESULTS AND DISCUSSION

FIRST PERIOD FROM FEEDING FRY TILL TAGGING

The number of families within groups diminished during the experiment. At the end the most numerous families (23) were observed in group M*, and the least numerous (9) in group S*.

The culling of families characterised by the lowest survival at the time of tagging not dependid of the parent category - as the χ^2 value was not significant (χ^2=0.99).

The correlation coefficients between the average parental body weight in each category and the observed production results of the progeny families are presented in table 3. The female sizes were highly positively correlated with the amount of eggs (r=0.8). A similar correlation was found by Kato (1975) and Gall & Gross (1978). High correlations were also observed for the final amount of fish per family (trait 5) and its final biomass (trait 6) (r=0.8), as well as for the final amount of fish per family (trait 5) and final mean body weight within the families (trait 7) (r=-0.87).

The male size had no significant influence on the chosen traits.

TABLE 3

Correlation coefficients for selected traits till tagging.

Traits	1	2	3	4	5	6	7
1. Female body weight		-0.09	0.80	-0.01	0.18	0.11	-0.12
2. Male body weight			-	-0.02	0.09	-0.01	-0.10
3. Amount of eggs				-0.09	0.18	0.09	-0.21
4. Starting mean weight of 500 fish per family					-0.07	0.05	0.20
5. Final amount of fish per family						0.80	-0.87
6. Final biomass per family							0.48
7. Final mean body weight per family							

TABLE 4

Values of final biomass and final mean body weight (change in % after correction on different final number of fish per family)

Groups	Number	Biomass (g)	Corrected biomass (g)	Mean body weight (g)	Corrected mean body weight (g)
L*	357	7604(-1.16%)	7693	23.32(+2.01%)	22.86
M*	371	7979 (+1.86%)	7833	22.05(-0.59%)	22.18
S*	316	7181(-1.39%)	7282	23.40(-5.72%)	24.82
*L	372	7804(-0.50%)	7843	21.65(-2.21%)	22.14
*M	311	7350(+1.63%)	7232	25.53(+1.88%)	25.06
*S	362	7610(-1.59%)	7733	21.59(-4.55%)	22.62

TABLE 5

ANOVA results (model I) of families´ final mean body weights and biomasses corrected on final number of fish per family.

Effect	df effect	MSS effect	df error	MSS error	F	p-level
Mean body weights						
Dames	2	13.705	50	6.713	2.04	0.14
Sires	2	8.416	50	6.713	1.25	0.29
Dames * Sires	4	5.420	50	6.713	0.81	0.53
Biomasses						
Dames	2	432749.6	50	550568.2	0.79	0.46
Sires	2	213954.0	50	550568.2	0.39	0.68
Dames * Sires	4	598620.8	50	550568.2	1.09	0.37

Even the correction of data on the final number of fish per family, performed to diminish the effect of stocking density on the growth (Dobosz et al 1995) (table 4), did not reveal any significant influence of parental sizes on the analysed traits (table 5).

SECOND PERIOD FROM TAGGING TILL MARKET SIZE FISH

Though the initial body weights of fish proved to correlate positively (but not strongly) with final body weights (figures 1 and 2) showing that fish maintain their superiority over the life cycle, the correlation between their performance and the parental sizes seems to be doubtful again (figures 3 and 4). A lack of distinct correlation is in accordance with the results of Crandall & Gall (1993) who showed very variable correlation both genetic (r=0.19...0.95) and phenotypic (r=0.29...0.94) between body weights at different age. Values were high between continuous age and generally

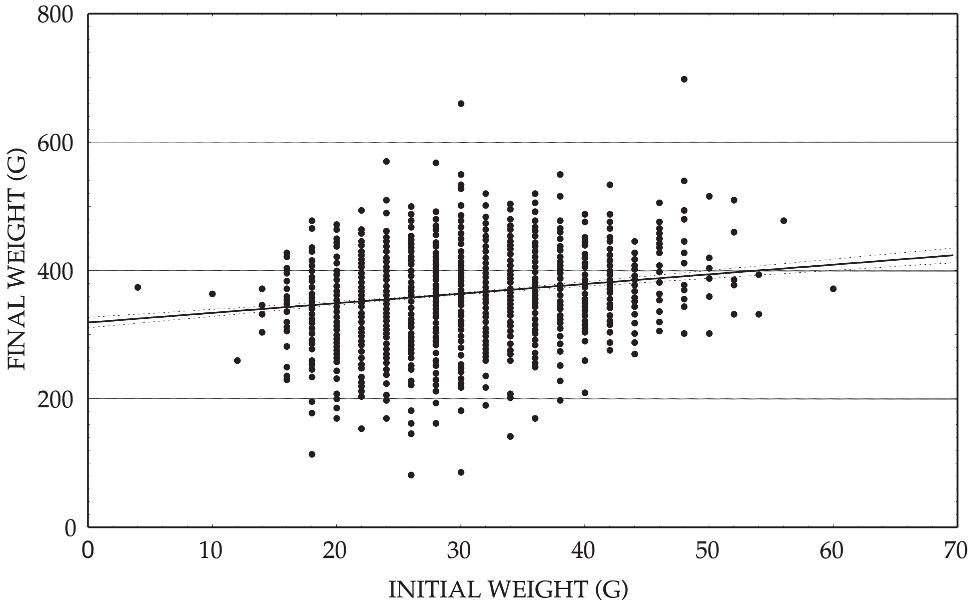

Figure 1. Regression of initial weight on final weight in all fish in Rutki farm. FINAL WEIGHT = 318.89 + 1.506 * INITIAL WEIGHT 3666 cases; r=0.176; p=0.000.

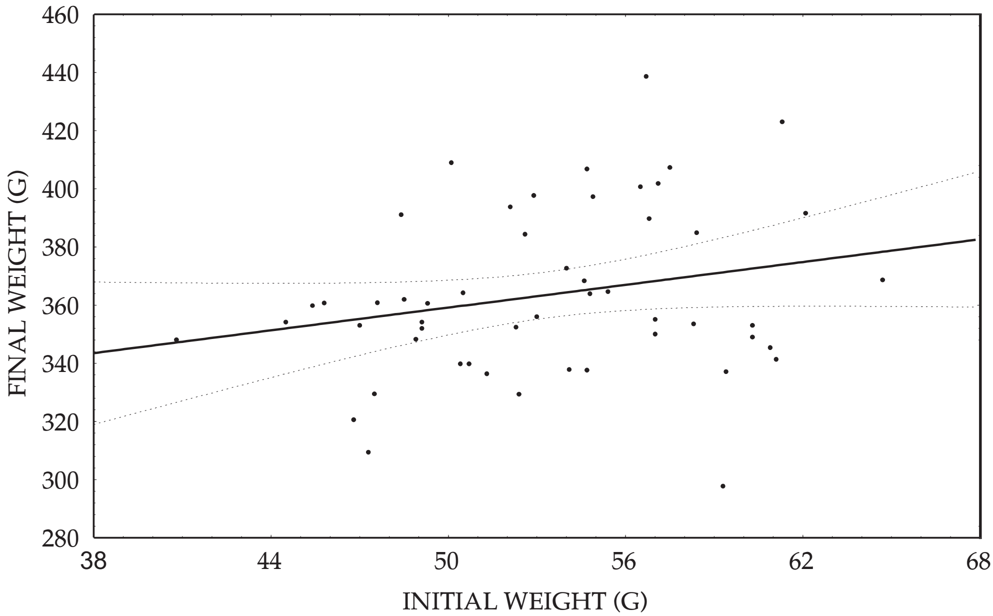

Figure 2. Regression of initial weight on final weight in families in Bytow farm. FINAL WEIGHT = 293.83 + 1.307 * INITIAL WEIGHT 52 cases; r=0.239; p=0.088.

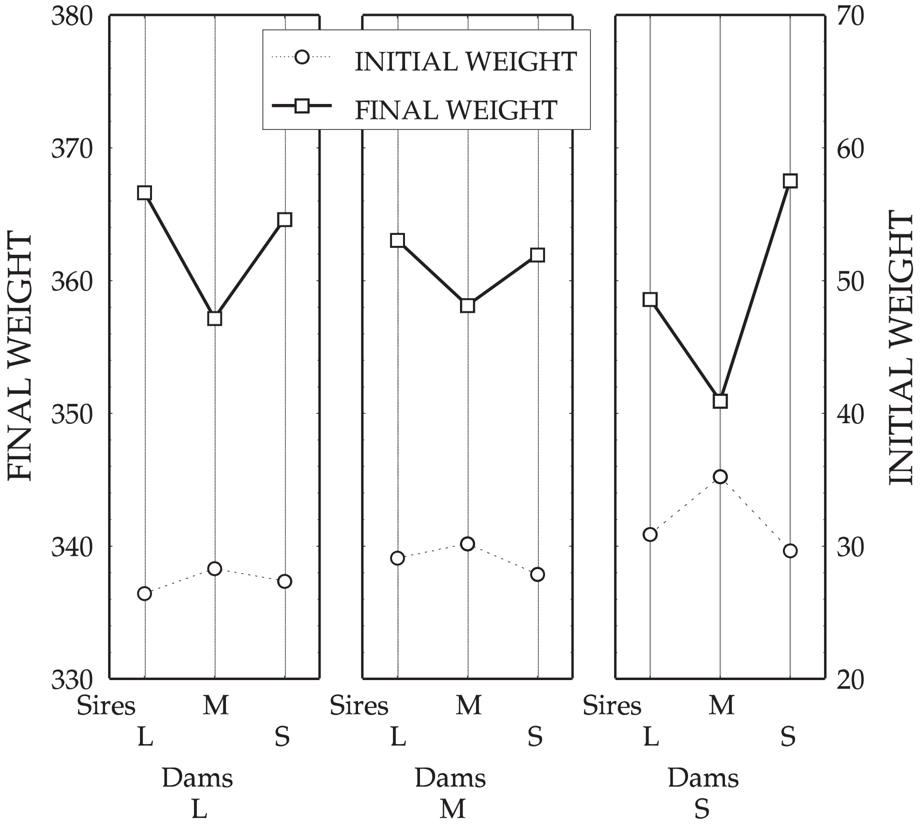

Figure 3. Average initial and final weight in Rutki farm in parental size groups.

decreased as the difference between age increased. Anyway, in our study the wights of progeny from combination L*L was equal to progeny of combination S*S (figure 3).

Significant influence of sires and sire*farm interaction (table 6, figures 3 and 4) is worth noticing, but it could have been of genetic origin, as it were the sires to create the families, and the genotype*environment interaction in this population had been already reported (Życzyński *et al.* 1995).

In Rutki the progeny families of medium size males had the highest initial, but the lowest final mean body weights (figure 3). Usually, a positive correlation between initial weight and final weight, as observed for all experimental fish (figure 1) and families from the production farm (figure 2), is expected. To study this phenomenon analyses were made of the number and weight gain of individually tagged precocious males which could be found in Rutki (table 7). The weight gain of all fish, as well as for

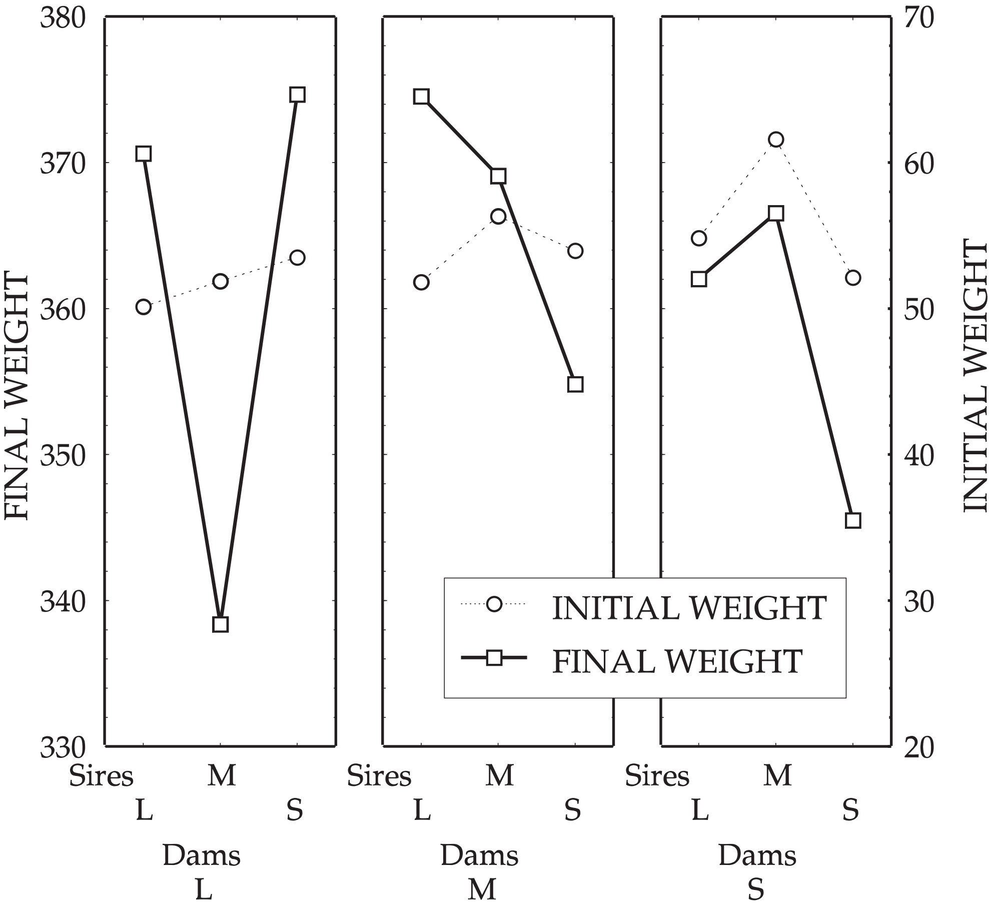

Figure 4. Average initial and final weight in Bytów farm in parental size groups.

TABLE 6

ANOVA results (model II) of final body weight of fish according to parental size categories and sites of fattening

Effect	df effect	MSS effect	df error	MSS error	F	p-level
Farms	1	1801.5	7086	4779.6	0.38	0.539
Dames	2	10964.3	7086	4779.6	2.29	0.100
Sires ***	2	39710.8	7086	4779.6	8.31	0.000
Interaction Farm-Dames	2	8887.6	7086	4779.6	1.86	0.156
Interaction Farm-Sire*	2	18230.5	7086	4779.6	3.81	0.022
Interaction Dames-Sires***	2	41608.6	7086	4779.6	8.71	0.000

TABLE 7

Number and weight gain of all fish and precocious males obtained in Rutki

Sire groups	All fish		Precocious males	
	Number	weight gain (g)	Number	weight gain (g)
*L	1419	334.4a	243	360.8a
*M	1046	324.3b	217	346.9b
*S	1201	336.2c	242	364.0c
F - Value, p-level	10.35 p=0.000		6.85 p=0.001	
p-level (Duncan´s test)	a,b:0.000 b,c:0.000 a,c:0.84		a,b:0.004 b,c:0.003 a,c:0.50	
correlation initial weight-weight gain	0.059		0.067	

PM, was highly significantly lower in progenies of medium sized males (*M). On the other hand, χ^2 test revealed insignificant differences between the observed and the expected amount and weight gains of precocious males in progeny from medium sized males (χ^2 values of 1.45 and 0.019, respectively). Thus, precocious males could not have been the reason for this observation. The problem remains unsolved.

CONCLUSION

Basing on results revealing a lack of correlation between parental size and growth performance of the progeny no particular strategy for choosing spawners in mass selection can be recommended.

Inefficiency of subjective assesments confirms fully the importance of knowledge of genetic parameters (the role of h^2 values), and the advantage of family selection when any breeding success is expected.

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STRESZCZENIE

MASA CIAŁA RODZICÓW A WZROST POTOMSTWA PSTRĄGA TĘCZOWEGO (*Oncorhynchus mykiss* Rich.)

Badano wpływ masy ciała rodziców na wzrost potomstwa do wielkości handlowej. Metodą korelacji analizowano zależności pomiędzy wybranymi cechami rodziców i potomstwa. Jedyną wysoce istotną korelacją okazała się korelacja pomiędzy wielkością samicy a liczbą ziarn ikry (r=0,8). Wielkość samców nie miała wpływu na wzrost potomstwa. W oparciu o otrzymane wyniki nie można zalecić żadnej konkretnej strategii wyboru tarlaków w oparciu o ich masową selekcję. Brak efektywności subiektywnych ocen powszechnie stosowanych w selekcji potwierdza znaczenie znajomości parametrów genetycznych (w tym roli wartości h^2) oraz korzyści wynikających z selekcji rodzinowej.

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