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*Embryonic Mortality in Families of Chicken Selected
for Skeletal Deformities*

Zamieralność w okresie embrionalnym w rodzinach kur selekcyonowanych
na rozwojowe wady kręgosłupa

Skeletal abnormalities in chicken associated with development and gristle metabolism such as scoliosis that leads to spondylolisthesis in acute form or dyschondroplasia of long bone base and articular cartilage of vertebral bodies (1, 2), are regarded as anomalies of the growth stage of birds. However, the increase of acute scoliosis cases and deformation of joints during hatching hens rearing among families selected for high level of embryonic thoracic vertebra anomalies (4). In order to learn more about the etiology of embryonic skeletal deformations, estimation of the effect of that abnormality type on survival, seems to be important.

The purpose of the study was to estimate the mortality of hen embryos in families selected for embryonic deformations of a skeleton regarded as reaction correlated to selection.

MATERIAL AND METHODS

The material for examinations were Rhode Island Red (RIR) and Sussex (Sx) chickens from Kossów chicken farm of the Institute of Genetics and Animal Breeding of the Polish Academy of Science, Jastrzębiec. Birds were maintained in no-windows building, with automatic fodder and water carriers, and were controlled as regarding the hygienic conditions. The full-dose layers mash DJ was applied to chickens.

The mortality of embryos in reproductive hatchings was analyzed in families selected for low or high level of embryonic scoliosis (ESC). In each of the five consecutive generations, RIR and Sx birds

evaluated on a basis of ESC among full siblings that died in the final period of laying and hatching, were mated within groups separated from the flock in the previous generation. One group consisted of the birds from families free from skeletal deformations (L), the second group – families with acute thoracic vertebrae deformations (H). The selection flocks consisted of 2-3 cocks and 6.5 hens per one cock, on the average.

The mated birds were maintained in individual cages and inseminated weekly. The individual hatchings were made once a week at 3-4 sets in a generation.

Results estimation was done on the basis of accumulated correlated response being a sum of mean phenotypic index values for hatchings in selected groups (H and L) starting from the generation before the experiment (G_0) till the last one (G_5). Moreover, separately for each group and for the whole flock, correlated response was evaluated (3, 7). Inbred coefficients (F_x) were calculated for every bird and generation.

Difference significance between mean hatching indices and correlated responses levels for groups H and L were verified using χ^2 -test. Software SAS was applied for statistical calculations (6).

RESULTS AND DISCUSSION

In total, during five seasons, 2682 RIR and 1810 Sx eggs were hatched individually. The hatching performance of the experimental RIR and Sx hens are presented in Table 1. In general, those results were poor (about 50% of hatching from RIR and about 65% from Sx eggs) and no matter what the selection direction

Table 1. Joint hatching (%) results (seasons 1994 to 1998) in groups divergently selected and unselected for embryo skeleton deformities in RIR and Sx breeds

Selected groups	RIR		Sx		Not selected form ESC	
	L	H	L	H	RIR	Sx
Not of eggs	921	1107	650	787	16834	15465
Fertility	80,7	81,9	89,4	88,3	89,1	90,0
Dead embryos (I period)	3,6	6,5*	1,9	4,5	2,2	1,6
Dead embryos (II period)	3,2	5,1	2,4	6,2	2,9	2,6
Unhatched	24,6	29,7*	17,2	17,6	16,8	14,6
Total losses in hatching	33,0	42,5*	24,4	30,6	23,5	20,3
Hatch from set eggs	53,1	47,2*	67,9	65,3	68,2	71,7*

* $P \leq 0,05$.

was, they were lower than in flocks without selection for ESC. Hatching results were significantly affected by relatively low insemination and high percentage of non-hatched chicks (up to 42.5% for RIR and 30.6% for Sx). Other reasons for losses were: embryonic mortality during the period just before hatching, and during hatching, and deformed chicks. Independently of the breed, lower laying indices

Table 2. Responses (%) for embryonic scoliosis (ESC) and correlated responses for hatching results of five generations to two-way selection (low -L and high -H frequency of ESC) and inbreeding as accumulated deviations G₅ from G₀ generations

Breed		RIR			Sx		
Family Groups	generation numbers	L	H	H-L	L	H	H-L
Deformation of ESC	G ₀	5,3			5,9		
	response G ₅ -G ₀	-4,1	22,7*	26,8	-2,6	13,6*	16,2
Dead embryos	G ₀	7,9			6,2		
	response G ₅ -G ₀	-2,5	19,6*	22,1	5,8	9,6	3,8
Total losses in hatching (from fertile eggs)	G ₀	36,3			27,2		
	response G ₅ -G ₀	-22,8	23,8*	46,6	3,5	7,3	3,8
Hatch from set eggs	G ₀	54,7			89,6		
	response G ₅ -G ₀	29,5	-23,1*	52,6	-20,3	-21,1	-0,8
Inbreeding coefficient	G ₀	0			0		
	G ₅ -G ₀	20,9	14,2*	6,7	14,4	11,0	-3,4

*P ≤ 0,05.

were found for groups selected for low level of ESC. In RIR hens, mean level of total losses due to inseminated eggs (TL) being the sum of died, non-hatched embryos and deformed chicks, was significantly lower (by about 10%) in families L than in H, but in Sx breed, those differences were statistically insignificant.

Efficiency of selection for ESC, expressed as accumulated response to selection and correlated responses of indices of hatching traits are presented in Table 2. In both breeds, the response for five generations of two-directional selection for ESC was efficient (higher in RIR), negative in groups L (-4.1% for RIR, -2.6% for Sx), and positive in H (22.7% and 13.6%, respectively), but differences in relation to response between groups L and H were statistically significant.

For RIR breed, correlated responses of losses indices in hatchings were of similar direction as response to ESC (negative in L and positive in H groups) and converse and significantly different between H and L for hatching from set eggs. However, correlated responses did not significantly differ between L and H groups in Sx breed. The amount of losses in hatchings (in relation to inseminated eggs) significantly increased in H group (by 23.8%) and significantly decreased in group L (by 22.8%) for RIR hens, which was consistent with selection direction. However, for Sx, slight increase of losses both in group H and L (7.3% and 3.5%, respectively) was found.

Figures 1 and 2 present the course of accumulated response of ESC level to two-directional selection and correlated response referring to total losses (TL) in hatchings. In both breeds, response towards the selection was asymmetric, tending

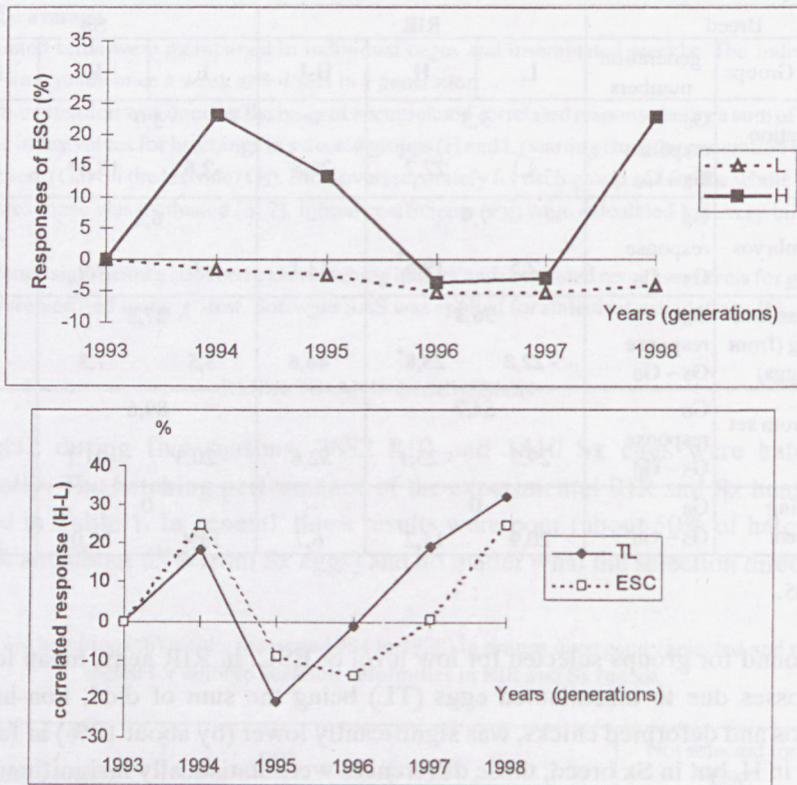


Fig. 1. Responses to divergent selection for ESC and responses and correlated responses of total losses in hatchings, i.e. differences between group H and L in RIR

to reduction in groups L and showing significant ranges in groups H. These ranges could result from the fact that high level of losses caused by acute Gumboro disease (IBA), especially in groups H, took place in the second generation of the rearing experiment. Despite remarkable reduction of families with ESC symptoms (5) due to the disease, the experiment was continued but at lower intensity of selection in the first generation after the disease. Thus, it may be that changes of selection and correlated responses to selection could result from elimination of skeletal deformation carriers, particularly in groups H. It is also possible that inbred increase, mainly in last generations could affect lower indices of hatchings in experimental groups.

Experimental data could also be affected by other factors, such as nutrition or ranges in hatching parameters. To eliminate the environmental factors influence, level of total losses (TL) in hatchings of groups L and H was compared to that index

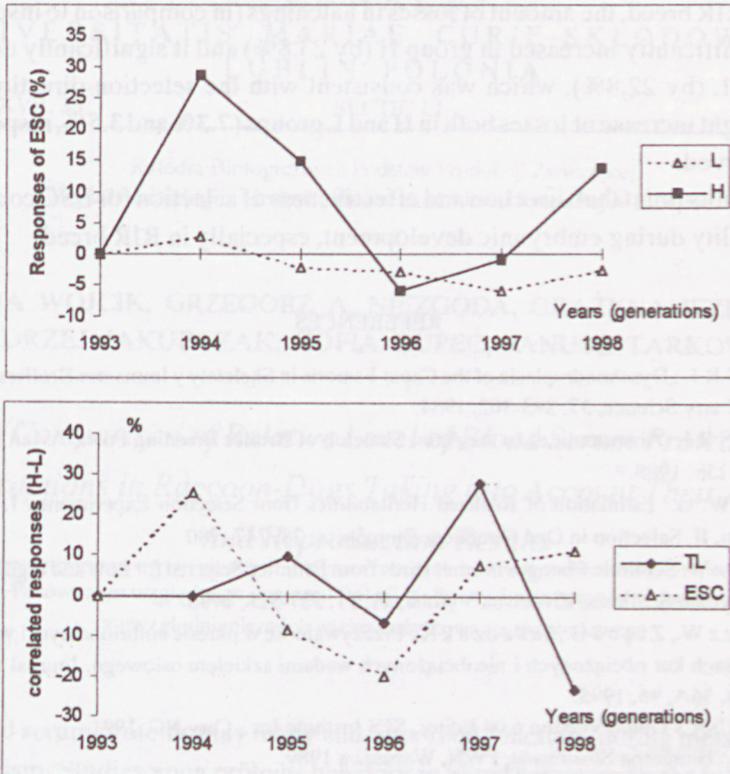


Fig. 2. Responses to divergent selection for ESC and responses and correlated responses of total losses in hatching, i.e. differences between group H and L in Sx

evaluated in the following generations in a flock without selection for ESC. In RIR breed, accumulated differences between the general flock in groups L and H within five years had a similar direction (-16.9% and 51.7%, respectively) as accumulated response evaluated without taking into account the general flock. In Sx breed, higher losses in hatchings took place in groups L rather than H (+7.9% and -7.6%) as compared to the flock without selection. It can confirm that direction and efficiency of selection to ESC had an effect on mortality during embryonic development, especially in RIR.

CONCLUSIONS

1. Response of two-directional selection for embryonic scoliosis (ESC within five generations was effective and negative in groups L (-4.1% for RIR and -2.6% for Sx), and positive in H (22.7% and 13.6%, respectively). No matter the breed, differences between L and H groups were statistically significant.

2. In RIR breed, the amount of losses in hatchings (in comparison to inseminated eggs) significantly increased in group H (by 23.8%) and it significantly decreased in group L (by 22.8%), which was consistent with the selection direction. In Sx breed, slight increase of losses both in H and L groups (7.3% and 3.5%, respectively) was observed.

3. Results point that direction and effectiveness of selection for ESC could affect the mortality during embryonic development, especially in RIR breed.

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STRESZCZENIE

W badaniach przeanalizowano zamieralność zarodków i wylęgowość wyrażoną jako reakcja skorelowana na selekcję rozbieżną na skoliozę zarodkową (ESC) kur ras RIR i Sx, prowadzoną przez pięć pokoleń. Reakcja na ESC była asymetryczna, skuteczniejsza w grupach H selekcyjowanych na wzrost częstości występowania tej cechy, szczególnie w pierwszym oraz dwóch ostatnich pokoleniach. Przeciętne ogólne straty podczas lęgów (TL), liczone w stosunku do jaj zapłodnionych (zamarłe, niewyklute i pisklęta kalekie i słabe), były w rasie RIR istotnie niższe w grupie L, selekcyjowanej na niski poziom ESC, aniżeli w H. Natomiast u Sx różnice między grupami L i H były statystycznie nieistotne. Skorelowane reakcje dla TL u RIR były podobne do reakcji na selekcję na ESC, ujemne w grupie L, a dodatnie w H i wyniosły odpowiednio 22,8 oraz 23,8%. Natomiast skorelowane reakcje dla wylęgowości okazały się ujemne w grupie H i dodatnie w L. U Sx, niezależnie od grupy, skorelowane reakcje były dodatnie dla TL, a ujemne dla wylęgowości. Wyniki badań wskazują na to, że kierunek i intensywność selekcji na skoliozę zarodkową mogły zaciążyć na śmiertelności zarodków i wylęgowości.