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THE PROBLEM OF THE CORRELATION BETWEEN EGG NUMBER AND EGG SIZE IN FAYOUMI FLOCK

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In a Fayoumi flock the phenotypic, genetic and environmental correlations between egg number and egg size were estimated using variance and covariance technique. The experiments have been carried out in two different seasons. In the first, one set of 15 males was used, while in the second, two shifts of 48 males were practiced. Thus the data of the second experiment was considered in the analysis as, from one population and as from two different populations.

To provide more reliable estimates, egg number and egg size were measured in different ways and at different ages and the data were adjusted before analysis to their hatch means, in order to remove some of the environmental effects.

One might conclude from the correlation analysis that, in this Fayoumi flock, a genetically controlled superiority in egg number, was generally associated with a reduced egg weight at least till the third month production, whereas the environmental effects which increase one of these characters tend to decrease the other at the same time. This is true even when the genetic correlation is positive or insignificant. Notice must be taken to the evidence which indicating that the genetic correlations between egg number and egg weight at later measurements in the laying season, have a tendency to be positive. This suggests that, in this flock, selection for egg number might not affect egg size in opposite direction at later stage of production or vice-versa. Furthermore, this flock is characterised by the considerable positive genetic condition involved among some measurements which have not been found in many other flocks.

The relationship between egg number and egg size is important to the breeder, as it concerns the most economic factors determining egg production. Early workers have reported that, in general, an antogonistic correlraion does usually exist between these two traits when examined on a phenotypic base, (*e.g.* Atwood, 1923 ; Hays, 1930, 1944*a*). However, Marble (1930) reported that egg size was reduced at both extremes of egg production. He obtained maximum egg weight from birds producing at or near the average level for the production, but found significant negative correlation between egg weight and annual egg production for those birds above the average level. Blyth (1952) suggested that poor layers with low intensity of production might show a positive correlation with egg weight, while poor layers with a high rate of lay over periods separated by long pauses would show a negative correlation. This interpretation is an amplification of that put forward by Marble (1930).

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Knox (1934), Jeffrey (1941), and Ragab and Assem (1953), on the Fayoumis, were not able to show any signiffcant phenotypic association between egg number and egg size. Jeffrey (1941) concluded that rate of egg production had less effect on egg size than environmental temperature in his flock.

In view of quantitative genetics the phenotypic correlation depends upon both the genetic and the environmental correlation. The genetic correlation is the most interesting to the breeders as he wishes to know how the genotypes for a certain trait will be affected when selection is practised upon other trait. The phenotypic corrlation can give a misleading impression as its size may be primarly controlled by the environmental correlations.

Furthermore, there is no much agreement, regarding the magnitude and sign of the genetic correlation, between recent workers using different flocks, or even between estimates in a single flock using different measurements of egg number and egg size.

Negative genetic correlation has been reported by Watt (1954) being —.43, by Jerome *et al.* (1956) being —.25 and by Abplanalp (1957) being —.38, —.47. On the other hand, positive genetic correlation was estimated by Hogsett and Nordskog (1958) being .10 using variance components and by Hicks (1958) being .53, when the environment what twht so-called "substandard".

In this study these correlations between egg number and egg size have been estimated in a Fayoumi flock.

Material and Methods

The data were taken from two experiments in two different seasons (1957/58, 1958/59). In the first season 15 males were taken at random from a Fayoumi flock at Fayoum Poultry Experimental Station. Each male was put in a breeding pen with 12 females, which were also randomly taken from the same flock, to produce the next generation. 4976 chicks were produced and each one was pedigreed to sire ands dam. At housing time 800 pullets were taken at random and were put under trapping for egg number and egg size In the second season 48 males were taken in two shifts and were put in 24. breeding pens, each contained 12 females. Progeny were available only from 14 males in the first shift, and from the 24 males in the second shift. 5021 pedigree chicks were produced and 1005 pullets were available for trapping.

Ten hatches were taken each season and hatching season was from 7/12/1956 to 16/3/57 and from 30/1/58 to 22/4/1958 respectively.

1. *Description of the samples analysed*

One lsample (A) was teken from the first season for statistical analysis It comprised 350 birds which had complete record for the trits analysed and is, therefore, essentially a "survivors" sample, although some surviors will have been omitted because some measurements required for these birds was not available.

In the second season two samples were taken, one comprised 347 pullets and was taken similar to the first season. The other sample comprised 254 birds which were produced in the second shift only in the last four hatches.

The following Table (1) showed the structure of the samples analysed for the two seasons.

TABLE 1

	1957/1958	1957/1958	
		Both shifts	Second shift only
Number of Sires	11	31	20
Number of Dams	88	105	73
Total No. of birds	350	347	254
Average size of Sire Family	31.80	11.20	2.70
Average size of Dam Family	3.98	3.30	3.48
Average dams per sire	8.00	3.39	3.65

2. *Measuring the Traits:*

Egg size: Three measurements were used:

1. M.E.W. = Egg weight at sexual maturity, the average of the first ten consecutive eggs laid.

2. 3.E.W. = Egg weight after three months production, the average weight of ten consecutive eggs when the birds had reached 3 months production.

3. 12.E.W. = Egg weight at 12 months of age and was the average weight of ten consecutive eggs of ten the birds had reached 12 months of age.

Egg number: Six different measures were used.

P_1: Egg number to 50 days.

P_2: Egg number to 250 days. (Production to a specific period after the first egg).

P_3: Egg number to 12 months of age.

P_4: Egg number to 17 months of age (Production to a sepcific age).

P_5: Date when first hatch is 12 months old.

P_6: Date when first hatch is 17 months old.

(Production to a specific date).

It can be noted that the symbols showed at the beginning of each measurement are used in the following tables in the part of "Results and Discussion".

3. *Method of Analysis*

The data were analysed by the Electronic computer in University of London. The computer program was written to carry out a variance and covariance companent analysis in the deviation of individual value from their hatch means. for a population classified in a hierarchical manner. This programme was suggested by Prof. A.E. Maddison for the Poultry Department of Wye Collage. A modified programme was prepared to fit the particular case of the present data in the seconed shift analysis.

The use of deviations from hatch means as a method of removing hatch effects from the data is only one of several methods which may be used (King and Henderson, 1954a ; Skaller, 1954 ; and Abplanalp, 1956). A main vadnatage of using deviations from hatch average in the analysis is to reduce the errors involved in varince and covariance estimtes, besides the fact that this method can be used in selection practice easily as a means of removing hatch variation. The variance and covariance analysis was carried out according to the model of Lerner (1950) ti give sires, dams and combined estimate.

The genetic and environomental correlations ar also estimated as shown by Lerner (1950) in the same model.

The standard errors of the genetic correlations were calculated according to the method described by Robertson (1959).

Results and Discussion

The results of the analysis are shown in Tables (2, 3, 4 and 5). The first two tables include the results of the two experiments in season 1957/58. The third one shows the results of the seond shift analysis, while the last table indicates the pooled results for the two experiments (combining the vairance and covariance components).

It can be seen that the phenotypic correlations in both experiments between the three egg weight mesures and the six egg number mesures are mainly negative, but insignificant with the later egg weight mesurements 3. E.W., exception to ths rule are the phenotypic correlations between egg number to 50 days (P_1) and the three egg weight measures in 1958/59 which are all positive although two of them are insignificant. The phenotypic correlations tend to be smaller for the latter measures of egg number than for the early measures. This is in agreement with Jerome *et al.* (1956) who found that the phenotypic correlations decreased with later measures of egg number. Jerome et al. (1956) also observed that the correlations were small and negative but smaller than deducted in this study. Also Waring *et al.* (1962) estimated small phenotypic correlation fall between limit of Zero and 0.1.

It seems that phenotypic correlations agree in magintude with those obtained by Blayth (1952) and Hale (1961). However, Ragab and Assem (1953) working on the Cairo University Fayoumi flock obtained a small positive phenotypic correlation between mean monthly egg weight and annual egg number.

Overall, the negative phenotypic correlations appear to be larger in 1957/58 than in 1958/59 results. It will be observed also that this same trend is present in the environmental correlations indicating that they in 1957/58 may have differed markedly from those in 1958/59. This, in fact, is true, as more uniform environment was provided in 1958/59 than in 1957/58 and this may have contributed to the difference in the phenotypic correlations.

The genetic correlations in 1957/58 results (Table 2) are negative and large with, few exceptions, for M.E.W. and 3.E.W., and the six measures of egg number. The genetic correlations are, however, positive although generally small between 12.E.W. and the six egg number measurements. Hogsett and Nordskog (1958) obtained a small positive genetic correlation between winter production and March egg weight, and Hicks (1958) obtained a positive genetic correlation (.53) in "substandard" year (less egg number more mortality), when the envirinmental correlation was negative, but in "standard" years the signs were reversed and the estimte was (-.45). Waring *it al.* (1960) did not find negative correlations and showed in their results insignificant positive correlation.

In 1958/59 results, the genetic correlations obtained from the two shifts (Table 3) analysis are again main by negative, though smaller than 1957/58 results for M.E.W. and 3.E.W., and the egg number measures and the genetic correlations between 12.E.W. and the egg number mesures are no longer all positive but are variable in sign and insignificant in magnitude with the exception of that between 12.W.E. and P_1 which is significantly positive However, in the second shift results (Table 4), the genetic correlations between. 12.E.W. and the egg production mesures become again positive. This supports the previous finding in 1957/58 which suggested that negative genetic correlation has not existed, in this flock, between egg number mesurements and egg number measurements and egg size at later stage of egg production. This can perhaps be explained by the fact tht this flock has not been subjected to selection for egg production for long time, thus negative association may not yet have developed in late production season. The tendency of the genetic correlation to be insignificant with 3.E.W. would be explained in view of the same phenomena.

When pooling the two experiments (Table 5) to obtain more precise estimaates, it can be seen that, in general, the negative gentic and phenotypic and correlations have been exited between egg number and egg size weighed at sexual maturity, otherwise, there is no significant negative correlation between egg number and egg size wiehged at later period in the laying season.

Overall the estimates of the genetic correlation, the result does not seem to support the finding of Haggett and Nordskog (1958) and Hicks (1958) in respect of the correlation obtained with M.E.W., but seems to agree with those workers in respect of the correlation obtained obtained with 3.E.W. and

TABLE No. 2.—CORRELATION BETWEEN EGG NUMBER AND EGG SIZE (SURVIVOR) (1957/1958)

Traits	R		M.B.M.				3. E.W.				11 E.W.		
			S	D	S + D		S	D	S + D		S	D	S + D
P_1	P	—.105				—.149				—.030			
	G		—.247	—.298	—.261		—.016	—.140	—.081		.581	1.16	.894
	E		—.095	—.093	—.092		—.162	—.175	—.166		.110	—.292	—.919
P_2	P	—.184				—.157				—.114			
	G		—.181	—	—.188		.020	—	.693		.440	—	0.77
	E		—.180	—.088	—.059		—.189	—.021	—.105		—.284	—.042	—.162
P_3	P	—.459				—.334				—.177			
	G		—.740	—.765	—.705		—.308	—.584	—.460		.276	.136	.192
	E		—.406	—.287	—.351		—.353	—.213	—.289		—.351	—.384	—.364
P_4	P	—.320				—.258				—.113			
	G		—.445	—	—1.03		—.184	—	—.641		.309	—	.139
	E		—.286	—.116	—.201		—.278	—.151	—.211		—.254	—.110	—.179
P_5	P	—.488				—.333				—.118			
	G		—.380	—.636	—.659		—.264	—.503	—.385		.309	.144	.239
	E		—.406	—.413	—.403		—.374	—.949	—.313		—.312	—.327	—.316
P_6	P	—.353				—.255				—.100			
	G		—.613	—3.13	—.759		—.152	—2.01	—.367		.381	.031	.222
	E		—.301	—.169	—.232		—.292	—.159	—.222		—.299	—.148	—.220

P : Phenotypic correlation
G : Genetic correlations
E : Environmental correlation

S : Sires estimates.
D : Dams estimates.
S+D : Combined estimates.

TABLE No. 3.—Correlation between egg number and egg size (survivor) (1958/1969)

Traits	R		M.E.M.				3. E.W.				12 E.W.		
			S	D	S + D		S	D	S + D		S	D	S + D
P_1	P	.259				.053				.032			
	G		1.01	.455	.580		—.887	—.045	—.165		—.536	.501	.501
	E		.173	2.47	.236		.194	—.024	.079		—.030	—.107	—.062
P_2	P	—.112				.004				—.077			
	G		—	.160	—.08		—	—.031	—.034		—	.029	—.003
	E		.079	—.102	—.147		.037	.017	.028		—.063	—.220	—.112
P_3	P	—.233				—.059				—.143			
	G		—	.177	—.125		—	.037	.133		—	.091	.063
	E		—.079	—6.735	—.334		—.011	—.176	—.087		—.137	—.335	—.029
P_4	P	—.210				—.042				—.077			
	G		—3.92	.008	—.240		—.569	—.144	—.147		1.378	—.097	—.028
	E		—.001	5.72	—.203		—.007	—.018	—.011		—.002	—.320	—.103
P_5	P	—.309				—.074				—.116			
	G		—6.06	—.032	—3.12		—.188	.646	.133		.262	—.053	—.113
	E		—.181	—5.64	—.379		—.024	—.184	—.103		—.057	—.233	—.125
P_6	P	—.207				—.036				—.084			
	G		—	.007	—.194		—	—.056	—.121		—	.112	.002
	E		—.043	—6.15	—.240		.006	—.041	—.012		—.016	—.399	.127

TABLE No. 4.—CORRELATION BETWEEN EGG NUMBER AND EGG SIZE (SURVIVOR) (SECOND SHIFT) 1958/1959

Traits	R		M.E.M.				S. E.W.				12 E.W.		
			S	D	S + D		S	D	S + D		S	D	S + D
P_1	P	.241				.040				.077			
	G		2.27	.659	1.09		—.138	1.860	.555		1.020	1.01	1.06
	E		.099	.481	.165		.064	—.660	—.004		—.004	—.143	—.060
P_2	P	—.187				—.023				—.062			
	G		—.736	—.087	—.226		.511	—.407	.051		.051	.214	.288
	E		—.093	—.693	—.106		—.141	.050	—.043		—.175	—.337	—.235
P_3	P	—.281				—.031				—.107			
	G		—	—.178	—.378		—	.499	.255		—	.129	.153
	E		—.180	—.912	—.296		—.054	—.143	—.095		—.145	—.360	—.221
P_4	P	—.259				—.040				—.074			
	G		—.877	—.154	—.324		.316	—.416	—.012		.145	.171	.163
	E		—.116	—.874	—.245		—.141	.041	—.050		—.128	—.359	—.212
P_5	P	—.384				—.042				—.088			
	G		—1374	—.314	—.481		.165	.569	.260		—.215	—.070	—.094
	E		.256	—.994	—.368		—.061	—.174	—.113		—.075	—.114	—.089
P_6	P	—.255				—.024				—.080			
	G		—	—.136	—.245		—	—.138	—.112		—	.211	.258
	E		—.197	—.911	—.308		—.123	—.001	—.062		—.157	—.424	—.405

TABLE 5.—CORRELATION BETWEEN EGG NUMBER AND EGG SIZE
(POOLED ESTIMATES 1957/58 AND 1958/59 RESULTS)

Measures†	M.E.W.			3 E.W.			12 E.W.		
	r_p	r_E	r_G	r_p	r_E	r_G	r_p	r_E	r_G
P_1	.068	.037	.415±.097	—.055	—.065	.237±.089	—.065	—.490	.877+.005
P_2	—.186	—.128	—.244±.199	—.090	—.074	—.372±.182	—.083	—.199	.183+.091
P_3	—.370	—.324	—.542±119	—.183	—1.92	—.108±.167	—.142	—.293	.123+.171
P_4	—.290	—.233	—.677±.110	—.149	—.131	—.327±.182	—.092	—.191	.151+.182
P_5	—.436	—.386	—.570±.084	—.179	—.213	—.063±.156	—.103	—.203	.073+.158
P_6	—.304	—.270	—.502±.142	—.140	—.142	—.240±.173	—.090	—.335	.240+.180

† Measures see symbols.
rp phonetypic correlation
rE Environmental correlation
rG Genetie correlation

12.E.W. The significant negative genetic correlation obtained in this study between egg number and egg size at maturity (M.E.W.) agree fairly well with those estimated by Wyatt (1954) and Abplanalp (1957) who reported significant negative genetic correlations between egg number and egg size being -.43 and -.47 respectively.

The observation that the genetic correlation between egg number and egg size has decreased with the later egg weight in production season, was also found by Thomoson (1960) who obtained -54 and -.26 for the genetic correaltion between annual egg production and egg weight at 10 and 30 weeks production respectively.

Few environmental correlations have been reported in the literature but those presented here are consistently small and mainly negative, thus agreeing in sign with those of Jerome *et al.* (1956) and with those of Waring *et al.* (1962), but contrasting in sign with Abplanalp (1957), Hicks (1958a) and Hale (1961), who calculated these correlations as .25, .21 and .21 respectively.

There is no well marked difference between sire and damé component of covariance. However, in 1957/58 results the sire components are larger than the dam components in the positive sense for the genetic correlation between 12.E.W. and egg number measurements. This does not exist in 1958/59 in the two shifts results but seems to appear to a certain extent in the second shift results. In 1957/58 results sire estimate is also larger than dam estimate, in negative sense, for the genetic correlation between M.E.W. and P_5. The same trend can also be observed in 1958/59 results in both analyses, with a marked difference between sire and dam estimates for the egg weight measure and egg number (P_5). This evidence for disparity between the dam and the sire components of covariance might be explained as sex-linked effect (Warring *et al.*, 1962).

There is also evidence, shown in the tables, that the dam components of covariance are larger than the seize components in some cases. This suggests the presence of maternal effect, as well, which might make the relationship between the two traits and inflating the dam covariance component. It might colud also the sex-linked effect in the analysis. It must be noted however, that sampling errors are generally assumed because the limitation of the data in each experiment, and might explain the inconsistency among the estimates of genetic correlation, from year to year and from measure to measure. Moreover, the assumption underlining the theory of genetic correlatinn must also be tdken into consideratinn (Flaconer, 1960).

Furtheromore, it should be mentioned that mathematical pooling for the results of the different experiments (Table 5) has decreased sampling error due to the limitation of the data and has, in fact, indicated the more relaiable estimates for genetic correlation.

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العلاقة بين عدد البيض ووزنه فى قطيع من الدجاج الفيومى

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الملخص

قدر معامل التلازم الوراثى والبيئى والمظهرى بين صفتى عدد البيض وحجمه فى قطيع من الدجاج الفيومى . وذلك عن طريق تحليل التباين لنتائج تجربتين اخذتا فى موسمين متواليين فى التجربة الأولى أخذ مجموعة واحدة من الديكة عددها ١٥ ووضع مع كل ديك ١٢ انثى للتنسيب وفى التجربة الثانية اخذ مجموعتين من الديكة عددها ٤٨ ديكا .

وللحصول على تقديرات احصائية اقرب الى الصحة لهذه المعايير ، فقد قيمت صفة عدد البيض وصفة حجمه بعدة طرق وفى أعمار مختلفة ، كما ضبطت الأرقام الدالة على الصفة بالنسبة لمتوسط تفريخاتها وذلك لفصل بعض التأثيرات البيئية .

ومن نتائج هذا الحث يتضح ان معامل التلازم الوراثى بين هاتين الصفتين يكون سلبيا فقط مع مقاييس وزن البيض عند النضج الجنسى (ـ ٥٠٧ر ± ١٣١) ، ثم يتلاشى هذا التأثير السلبى بتقدم موسم الانتاج ، من ذلك نرى أن الانتخاب لكثرة عدد البيض فى هذا القطيع من الدجاج الفيومى ليس من الضرورى أن يؤدى الى نقص فى وزنه على مدار السنة الانتاجية ، بل هناك أدلة تشير الى احتمال زيادة فى وزنه فى الأعمار المتأخرة .

فقد وجد فعلا معامل التلازم الوراثى موجبا مع بعض المقاييس ، مما يثبت عدم وجود ارتباط وراثى سلبى بين هاتين الصفتين الا عند النضج الجنسى .

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