13 Egypt. J Anim. Prod., Vol. 28, No. 2, pp. 131-146 (1991).

# Genetic and Phenotypic Associations of Milk Traits with Age at Calving and with Length of Open Period, Dry Period and Lactation

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DATA on three Austrian Fleckvieh breed associations in Lower Austria, Upper Austria and Tirol regions were collected in the period from 1976 through 1982. The material consisted of 130039 female records for the first four lactations. Interval traits analyzed were age at first calving (AFC), age at second calving (ASC), days-open period (DO), days dry period (DP) and lactation length (LP), while the productive traits were 100- and 305-day lactation milk traits (kg milk, kg fat and fat %).

There was no systematic change in the estimates of heritability and genetic and phenotypic variances for interval traits studied over the first four lactations. Heritability estimates for interval measures in the different parities were generally very low ranging between 0.04 and 0.10, except for age at calving (0.37 to 0.39). Estimates of genetic correlations ranged between 0.32 to 0.44 and 0.37 to 0.47 for age at calving with DO and LP, respectively. High genetic and phenotypic relationships were observed between DO and LP (0.55 to 0.75) while negative correlations between DP and LP were obtained, of the order of - 0.2. Genetic correlations between DO or LP and 100- and 305-day milk and fat yields were mainly positive and of the order 0.3 to 0.5 according to the order of parity while negative estimates were found between all interval traits and fat% . In most cases , negative genetic correlations were detected between DP and all milk traits in 100- and 305-day lactation.

Phenotpic correlations were higher with 305-day lactation than with 100-day lactation, indicating the possibility of an effect of pregnancy. Phenotypic correlations between yield traits (milk and fat ) in both 100- and 305-day lactation and interval traits were positive and relatively low in different lactation while negative estimates with DP were observed . Fat% in different lactations were phenotypically negatively correlated with interval traits studied .

**Key Words :** Dairy cattle , milk traits , interval traits , genetic aspects .

In most studies on interval traits (*e.g.* days open , dry period , lactation length .... etc) in dairy cattle carried out on AI data involving large numbers of animals , very low heritability estimates between 0 and 5% have been reported (Maijala , 1978 ; Janson , 1980b; Janson and Andreson 1980 ; Schneeberger and Hagger , 1986) , though in a few reports , heritability estimates were somewhat higher , near 10% (Hansen , 1979 ; Bar-Anan *et al.*, 1979 ; Berger *et al.*, 1981) . Efficiency of selection for improved fertility can be seriously impaired if there is an antagonistic genetic relationship between milk and fertility . Some results from field data indicate the existence of such an antagonism (*e.g.* Maijala , 1976 ; kragelund *et al.*, 1979 ; Olds *et al.*, 1979 ; Van Arendonk *et al.*, 1987) .

During the last years , much attention has been directed towards traits other than production traits in dairy cattle breeding programmes . To make a correct evaluation for fertility and other interval traits of dairy cattle in Austria and in order to improve existing breeding plans it is essential to have a knowledge of the genetic relationships between such traits and milk production traits . The main objective of the present study was , therefore , to estimate the genetic parameters for some interval traits to be used in an evaluation of the consequences of different selection strategies . Special attention was paid to the estimation of genetic and phenotypic correlations between interval traits and milk traits at 100- and 305-day of lactation .

## Material and Methods

Data on productive and reproductive performance of Fleckvieh cows were obtained from the official Federation of Austrian Cattle Breeders (ZAR) on three Fleckvieh breed associations in Lower Austria (LA) , Upper Austria (UP) and Tirol region (TR). The records used were those of first calvers and older cows calved in seven consecutive years from 1976 to 1982 . The material consisted of reproductive and productive performance of 130039 females . All records were 305 day or less completed lactations . Data were available on 20600, 48638 , 34579 and 26222 daughters representing 1001, 3063 , 2548 and 2215 sires in the 1st, 2nd, 3rd and 4th lactations , respectively . In LA all records were from first calvers and older cows (from 2nd through 4th lactations ), while those from UA and TR were only older cows (from 2nd through 4th lactations ).

Heifers were inseminated when they reached an average 320 kg body weight , while cows were inseminated during the first heat period after the 60th days post - partum . All services were by artificial insemination (AI) using deep-frozen semen with the restriction of avoiding full-sib , half - sib and sire-daughter matings . Other details of the breeding policy and management followed were described by hartmann *et al.* (1986) . The interval traits studied were age at first calving (AFC) , age at 2nd calving (ASC) , days-open period (DO) , days - dry period (DP) , length of lactation period (LP) while the productive traits were 100-day milk yield (100 dMY) , 100-day fat yield (100dFY) , 305-day milk yield (305dMY) , 305-day fat yield (305dFY) , 100-day fat% (100dF%) and 305-day fat% (305dF%) . Only sires with at least two daughters (paternal half sisters) were included in the analyses . For each herd, one daughter per sire was represented randomly and therefore the herd effect was partly eliminated as discribed by Harvgrove *et al.*, (1981). .Harvey's (1977) Mixed Model Computer program was utilized in analyzing the data.

Data of lst lactation in LA were analyzed using the following mixed model:

$$Y_{jklm} = u + S_j + A_k + M_l + (AM)_{kl} + e_{jklm} \qquad (1)$$

where Yjklm denotes the observation on the jklmth lactation ; $\mu$ = the overall mean common to all observations; $S_j$ = the random effect of jth sire; $A_k$ = the fixed effect of the kth year of calving; $M_l$ = the fixed effect of the lth month of calving; $(AM)_{kl}$ = the effect of the Two-factorsinteraction between year and month of calving, and $e_{jklm}$ = a random error element of the jklmth observation assumed to be independently and randomly distributed (0.02 e).

Data of the 2nd through the 4th lactations obtained from LA, UA and TR were analyzed by adopting the model :

$$Y_{ijklm} = \mu + B_i + S_{ij} + A_k + M_l + (AM)_{kl} + e_{ijklm} \qquad (2)$$

where all terms are explanined in the previously described mixed model, except $B_i$ = the fixed effect of the ith breed association, and $S_{ij}$ = the random effect of the j th sire nested within ith breed association. Confounding between breed association and sire is thus avoided since the analyses were carried out within breed association.

Estimates of the effects of sires (in model 1) or sires within breed associations (in model 2) and remainder components of variance and covaiance were computed according to method III of Henderson (1953). Paternal half-sib analyses of variance and covariance were performed to obtain the estimates of heritability and correlations. Standard errors of heritability estimates were calculated according to the method derived by Swiger *et al.* (1964). Estimates of genetic (with standard errors) and phenotypic correlation were obtained by computing techniques described by the LSML76 program of Harvey (1977).

## Results and Discussion

*Means and Variation*

Means and standard deviations and coefficients of variation (CV) of interval traits studied in different parities are given in Table 1. In general, means of DO and LP slightly increased from the 1st to 4th lactation, while those of DP had no definite trend (Table 1). However, means reported here fall within the range of estimates obtained on Fleckvieh cattle in Austria (e.g. Essl, 1984; Hartmann *et al*., 1986). The results showed that variation in DO and DP were relatively high as compared with that of other traits studied.

**TABLE 1 . Means , standard deviations (SD) and coefficients of variation + (CV) of interval traits in the first four lactations of Fleck vieh cattle .**

| Trait | No. of records | Mean | SD | CV,% |
|---|---|---|---|---|
| Ist Lactation | | | | |
| AFC (months ) | 20600 | 29.3 | 3.8 | 12.7 |
| DO (days ) | 20600 | 98.4 | 67.4 | 68.3 |
| DP (days ) | 20600 | 51.1 | 29.1 | 56.9 |
| LP (days ) | 20600 | 336.3 | 62.9 | 18.6 |
| 2nd Lactation | | | | |
| ASC (months ) | 48638 | 42.5 | 4.1 | 9.6 |
| DO | 48638 | 98.4 | 64.2 | 65.2 |
| DP | 48638 | 52.5 | 28.5 | 54.1 |
| LP | 48638 | 335.9 | 58.4 | 17.3 |
| 3rd Lactation | | | | |
| DO | 34579 | 99.1 | 64.4 | 64.8 |
| DP | 34579 | 52.0 | 29.1 | 55.7 |
| LP | 34579 | 338.6 | 58.4 | 17.2 |
| 4th Lactation | | | | |
| DO | 26222 | 99.7 | 65.1 | 65.1 |
| DP | 26222 | 51.4 | 29.6 | 57.4 |
| LP | 26222 | 340.4 | 58.1 | 17.0 |

+Coefficients of variation computed as the residual s.d. divided by the overall least-squares means of a given trait.

*Non-genetic effects*

For most traits (i.e. interval traits) year and month of calving and their interaction proved to be significant in all parities as shown in Table 2. The magnitude of the effect of year of calving as shown by the size of the F-ratios is larger than that of month of calving for different traits (Table 2). Adjustment for year and month of calving and their interactions, therefore, seems necessary if bull evaluation on female fertility is to be performed on this kind of data.

**TABLE 2. F-ratios for the effects of different factors on interval measures of Fleckvieh cows in the first four lactations.**

| Source | d.f. | Age at calving | DO | DP | LP |
|---|---|---|---|---|---|
| 1st lactation | | | | | |
| Sire | 1000 | 3.1 *** | 1.3 *** | 1.2 *** | 1.3 *** |
| Year of calving (Y) | 3 | 208.5 *** | 13.2 *** | 8.4 *** | 22.4 *** |
| Month of calving (M) | 11 | 19.9 *** | 2.5 ** | 1.9 * | 5.5 *** |
| Y x M | 33 | 1.2 | 2.3 *** | 1.0 | 3.1 *** |
| Remainder mean squares | 19552 | 14 | 4516 | 846 | 3912 |
| 2nd lactation | | | | | |
| Breed association (B)+ | 2 | 28.1 *** | 32.7 *** | 63.2 *** | 14.9 *** |
| Sire within B | 3062 | 2.6 *** | 1.2 *** | 1.2 *** | 1.3 *** |
| Year of calving | 6 | 162.8 *** | 15.5 *** | 25.1 *** | 38.0 *** |
| Month of calving | 11 | 8.6 *** | 1.7 | 11.9 *** | 6.6 *** |
| Y X M | 66 | 1.6 *** | 2.1 *** | 1.5 *** | 2.9 *** |
| Remainder mean squares | 45490 | 17 | 4110 | 807 | 3378 |
| 3rd lactation | | | | | |
| Breed association (B)+ | 2 | | 25.8 *** | 36.8 *** | 8.2 *** |
| Sire within B | 2547 | | 1.3 *** | 1.2 *** | 1.3 *** |
| Year of calving | 5 | | 16.6 *** | 18.3 *** | 24.8 *** |
| Month of calving | 11 | | 3.3 *** | 8.8 *** | 9.0 *** |
| Y X M | 55 | | 3.0 *** | 1.7 *** | 3.4 *** |
| Remainder mean squares | 31958 | | 4121 | 839 | 3372 |
| 4th lactation | | | | | |
| Breed association (B)+ | 2 | | 15.0 *** | 31.6 *** | 14.3 *** |
| Sire within B | 2114 | | 1.2 *** | 1.3 *** | 1.2 *** |
| Year of calving | 5 | | 11.8 *** | 6.3 *** | 17.5 *** |
| Month of calving | 11 | | 2.7 *** | 7.9 *** | 6.8 *** |
| Y X M | 55 | | 2.4 *** | 1.3 * | 3.6 *** |
| Remainder mean squares | 23934 | | 4209 | 1171 | 11876 |

+Effect of breed association tested against sire within breed association and all other effects tested against the remainder mean square.

*Variance Components and heritability estimates*

Results given in Table 2 show that the sire of the cow affected ($P < 0.001$) all traits in different lactations. These findings are similar to those obtained by Janson (1980 b). Sire and remainder components of variance for different traits studied are given in Table 3. However, the proportions of variation (V) for sires and for the error variances were almost the same for the different parities. Strandberg and Dane 11 (1988) came to the same conclusion for days-open period.

The estimates of $h^2$ for age at calving in the 1st and 2nd lactations were very similar (0.39 and 0.37, respectively) , *i.e.* the relative additive genetic variance was almost unchanged from the 1st to the 2nd lactation (Table 3). Heritability for age at calving were the highest estimates amongst the interval traits studied. Therefore, age at 1st or 2nd calving seem to be more efficient as a selection criterion than the other traits (Table 3).

**TABLE 3. Variance component estimates ($\sigma$ 2) and proportions of variation (V) due to random effects and heritability estimates (h 2) and their standard errors (SE) for interval traits in the first four lactations of Fleckvieh cattle.**

| Trait | Sire + | | Remainder | | $h^2$ | SE |
|---|---|---|---|---|---|---|
| | $\sigma^2$ | V | $\sigma^2$ | V | | |
| 1st Lactation | | | | | | |
| AFC | 1.5 | 0.097 | 13.9 | 0.903 | 0.39 | 0.023 |
| DO | 58.5 | 0.013 | 4516.4 | 0.987 | 0.05 | 0.011 |
| DP | 9.1 | 0.011 | 845.9 | 0.989 | 0.04 | 0.011 |
| LP | 59.5 | 0.015 | 3912.3 | 0.985 | 0.06 | 0.011 |
| 2nd Lactation | | | | | | |
| ASC | 1.7 | 0.093 | 16.5 | 0.907 | 0.37 | 0.014 |
| DO | 57.4 | 0.014 | 4111.0 | 0.986 | 0.06 | 0.008 |
| DP | 12.2 | 0.015 | 807.3 | 0.985 | 0.06 | 0.008 |
| LP | 54.5 | 0.016 | 3378.7 | 0.984 | 0.06 | 0.008 |
| 3rd Lactation | | | | | | |
| DO | 76.3 | 0.018 | 4121.1 | 0.982 | 0.07 | 0.010 |
| DP | 13.8 | 0.016 | 839.4 | 0.984 | 0.06 | 0.010 |
| LP | 71.7 | 0.021 | 3371.9 | 0.979 | 0.08 | 0.011 |
| 4th Lactation | | | | | | |
| DO | 72.1 | 0.017 | 4209.1 | 0.983 | 0.07 | 0.012 |
| DP | 21.4 | 0.024 | 871.3 | 0.976 | 0.10 | 0.013 |
| LP | 58.9 | 0.017 | 3334.1 | 0.983 | 0.07 | 0.012 |

+ Contribution of sire to variance of all traits studied was significant ($P < 0.001$) in different lactations.

Estimates of $h^2$ were very low and fairly uniform for interval traits (DO, DP and LP) as shown in Table 3. Different studies showed that only a minor part of the variation in female fertility could be related to systematic factors (Cole and Cupps, 1977). Estimates from the 1st to the 4th lactations ranged between 0.05 - 0.07, 0.04 - 0.10 and

0.05 - 0.08 for DO , DP and LP, respectively. Differences in $h^2$ estimates were generally small and fairly uniform in the different lactations (Table 3) . Since the estimation method used does not give negative estimates there is an inherent bias which may give overestimates of heritabilities when true values are close to zero . However, the reason for the low heritability in this case is not a low genetic variance but rather a high environmental variance. One would therefore expect the inherent bias to be very small. However, the estimates for traits studied fall within the range reported on Fleckvieh or other breeds of dairy cattle (Bar-Anan *et al.*, 1979; Hansen, 1979; Kragelund *et al.*, 1979; Janson and Andreasson, 1980; Seykora and Mcdaniel, 1983; Strandberg and Danell, 1988).

*Correlations between interval traits*

Genetic ($r_G$) and phenotypic ($r_p$) correlations between interval traits are given in Table 4. As expected, positive correlations ( $r_G$ and $r_p$) between AFC and ASC and the other interval measures studied were observed. Higher $r_G$ were generally observed

**TABLE 4. Estimates of genetic correlations with standard errors (below diagonal) and phenotypic correlations (above diagonal) between interval traits of Fleckvieh cattle.**

| Trait | Age at calving | DO | DP | LP |
|---|---|---|---|---|
| Age at calving+ | | | | |
| 1st lactation | | 0.06 | 0.01 | 0.05 |
| 2nd lactation | | 0.09 | 0.01 | 0.10 |
| DO | | | | |
| 1st lactation | 0.32 (±0.085) | | 0.07 | 0.79 |
| 2nd lactation | 0.44 (±0.056) | | 0.20 | 0.76 |
| 3rd lactation | | | 0.23 | 0.74 |
| 4th lactation | | | 0.25 | 0.72 |
| DP | | | | |
| 1st lactation | 0.18 (±0.093) | 0.10 (±0.168) | | -0.17 |
| 2nd lactation | 0.13 (±0.054) | 0.54 (±0.092) | | -0.15 |
| 3rd lactation | | 0.24 (±0.102) | | -0.14 |
| 4th lactation | | 0.38 (±0.104) | | -0.12 |
| LP | | | | |
| 1st lactation | 0.35 (±0.079) | 0.75 (±0.061) | -0.23 (±0.170) | |
| 2nd lactation | 0.47 (±0.051) | 0.60 (±0.057) | -0.26 (±0.120) | |
| 3rd lactation | | 0.63 (±0.054) | -0.21 (±0.108) | |
| 4th lactation | | 0.55 (±0.082) | -0.10 (±0.116) | |

+ Correlations between age at calving and other traits were estimated only for 1st and 2nd lactations.

between age at calving and either DO or LP (0.32 - 0.47) than between age at calving and DP (0.13 - 0.18); a trend which is in good agreement with Baptist and Gravert (1973). On the other hand, estimates of rp are generally weak and similar to those estimates reported by kragelund *et al..* (1979) and Janson (1980a).

For the different lactations, DO and LP were positively highly genetically (0. 55 - 0.75) and phenotypically (0.72 - 0.79) correlated as shown in Table 4. Therefore , selection for shorter DO will lead to shorter LP. The correlations between DO and DP were positive, but lower than the corresponding estimates between DO and LP. Negative correlations between DP and LP were of the order of 0- 0.2 observed. Selection for higher LP will therefore lead to shorter DP.

*Phenotypic correlations between intervals and milk traits*

Estimates of $r_P$ between interval traits studied and 100 - day milk traits were between -0.08 to + 0.13 for the different parities (Table 5) while estimates of $r_P$ with 305 - day milk traits were between -0.16 to + 0.29. Negative estimates were generally observed for correlations between DP and most milk traits in both 100 - and 305 - day lactation while positive estimates were observed between DO and yield traits. Also, estimates of $r_P$ between DO and percentage traits were negative.

The estimates in Table 5 show that $r_P$ between milk production during first 100 - days and different interval traits are smaller than corresponding estimates for 305 - day lactation. This is probably due to the influence of gestation on milk production (Smith and Legates, 1962) However, small $r_P$ essentially zero, between 100-day milk production and various interval traits, comparable to those in the present study, have been reported in many studies (*e.g.* Smith and Legates, 1962; Everett *et al..*, 1966; Olds *et al..*, 1979; Janson andAndreason, 1980) while $r_P$ with 305 - day lactation yield were usually somewhat higher, 0.1 to 0.3 (Baptist and Gravert, 1973; Janson and Andreasson, 1980; Seykora and Mcdaniel, 1983; Strandberg and Danell , 1988).

*Possibility of indirect selection for intervals through milk traits*

Estimates of $r_G$ between milk traits and interval measures are given in Table 5. The positive $r_G$ were mainly observed between DO and both 100 - and 305 - day milk and fat yields in the order of 0.3 to 0.5 according to the parity. Also, positive estimates (0.4 to 0.5) were obtained between LP and both milk and fat yield in 100 - and 305 - day lactation. However, negative estimates were mainly observed between all interval traits and fat % . The correlations between DP and all milk traits in 100-and 305-day lactation were also negative in most cases.

**TABLE 5. Estimates of genetic correlation ($r_G$) with standard errors+ and phenotypic correlations ($r_p$) between 100-day and 305-day milk traits and interval-traits in the first four lactations of Fleckvieh cattle.**

| Interval Trait | 100-day milk traits | | | | | | 305-day milk traits | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 100dMY | | 100dFY | | 100dF % | | 305dMY | | 305dFY | | 305dF % | |
| | $r_G$ | $r_p$ | $r_G$ | $r_p$ | $r_G$ | $r_p$ | $r_G$ | $r_p$ | $r_G$ | $r_p$ | $r_G$ | $r_p$ |
| Age atcalving | | | | | | | | | | | | |
| 1st lact | - 0.18 (± 0.045) | 0.01 | - 0.26 (± 0.046) | - 0.03 | - 0.29 (± 0.045) | - 0.08 | - 0.15 (± 0.045) | 0.01 | - 0.23 (± 0.045) | - 0.04 | -0.28 (±0.046) | -0.11 |
| 2nd lact | - 0.06 (± 0.032) | 0.07 | 0.06 (± 0.056) | 0.01 | 0.10 ( ± 0.047) | - 0.05 | - 0.02 (± 0.031) | 0.08 | - 0.05 (± 0.031) | 0.06 | -0.07 (± 0.029) | - 0.04 |
| DO | | | | | | | | | | | | |
| 1st lsact. | 0.49 (± 0.084) | 0.09 | 0.45 (± 0.086) | 0.09 | - 0.03 (± 0.100) | 0.01 | 0.49 (± 0.079) | 0.20 | 0.44 (± 0.080 ) | 0.17 | - 0.08 (± 0.087) | - 0.02 |
| 2nd lact. | 0.39 (± 0.059) | 0.10 | 0.21 (± 0.104) | 0.04 | - 0.33 (± 0.090) | - 0.03 | 0.43 (± 0.054) | 0.20 | 0.38 (± 0.055) | 0.18 | - 0.04 (± 0.054) | - 0.02 |
| 3rd lact. | 0.30 (± 0.066) | 0.08 | 0.24 (± 0.222) | 0.01 | - 0.23 (± 0.117) | - 0.04 | 0.39 (± 0.060) | 0.18 | 0.34 (± 0.062) | 0.16 | - 0.05 (± 0.060) | - 0.05 |
| 4th lact. | 0.25 (± 0.085) | 0.09 | - 0.18 (± 0.535) | 0.01 | - 0.32 (± 0.160) | - 0.05 | 0.39 (± 0.077) | 0.18 | 0.33 (± 0.079) | 0.15 | - 0.05 (± 0.072) | - 0.01 |
| DP | | | | | | | | | | | | |
| 1st lact. | - 0.33 (± 0.097) | - 0.08 | - 0.34 (± 0.100) | - 0.07 | - 0.07 (± 0.108) | 0.01 | - 0.45 (± 0.103) | - 0.16 | - 0.46 (± 0.103) | - 0.15 | - 0.10 (± 0.098) | - 0.01 |
| 2nd lact. | - 0.05 (± 0.058) | - 0.02 | - 0.26 (± 0.103) | - 0.01 | - 0.15 (± 0.085) | 0.01 | - 0.25 (± 0.058) | - 0.12 | - 0.29 (± 0.059) | - 0.12 | - 0.14 (± 0.053) | - 0.02 |
| 3rd lact. | 0.20 (± 0.071) | - 0.01 | 0.22 (± 0.232) | - 0.02 | - 0.16 (± 0.121) | - 0.01 | - 0.02 (± 0.068) | - 0.12 | - 0.07 (± 0.069) | - 0.09 | - 0.13 (± 0.064) | - 0.01 |
| 4th lact. | 0.14 (± 0.074) | 0.01 | - 0.72 (± 0.099) | - 0.02 | - 0.33 (± 0.137) | - 0.03 | - 0.02 (± 0.071) | - 0.09 | - 0.01 (± 0.071) | - 0.08 | 0.01 (± 0.062) | 0.01 |
| LP | | | | | | | | | | | | |
| 1st lact. | 0.49 (± 0.076) | 0.13 | 0.46 (± 0.078) | 0.12 | - 0.01 (± 0.054) | 0.01 | 0.57 (± 0.069) | 0.29 | 0.57 (± 0.070) | 0.26 | - 0.01 (± 0.081) | - 0.01 |
| 2nd last. | 0.35 (± 0.055) | 0.11 | 0.27 (± 0.098) | 0.05 | - 0.23 (± 0.084) | - 0.03 | 0.51 (± 0.048) | 0.29 | 0.47 (± 0.049) | 0.26 | - 0.03 (± 0.051) | - 0.02 |
| 3rd lact. | 0.19 (± 0.062) | 0.09 | 0.12 (± 0.202) | 0.01 | - 0.13 (± 0.109) | - 0.04 | 0.38 (± 0.055) | 0.25 | 0.34 (± 0.037) | 0.23 | - 0.01 (± 0.057) | 0.01 |
| 4th lact. | 0.32 (± 0.084) | 0.08 | 0.19 (± 0.537) | 0.01 | - 0.30 (± 0.157) | - 0.04 | 0.45 (± 0.073) | 0.25 | 0.44 (± 0.075) | 0.22 | - 0.12 (± 0.072) | - 0.02 |

.+ Standard errors are given in parantheses adjacent to the estimates of $r_G$.

Positive estimates of $r_G$ between DO and milk production are undesirable for selection for higher milk and fat yields since this leads to an increase in DO. Van Arendonk *et al* . (1987) found even higher $r_G$, 0.6, between DO and milk yield in 1st or 2nd lactations. These $r_G$'s may to some extent be inflated if farmers tend to begin inseminating high producing cowslater than lower producing cows later than lower producing cows. The positive $r_G$ between 305 day milk and fat yields with DO can be explained on the basis of the effect of delayed pregnancy on milk production. Similarly, most of the reviewed studies showed unfavorable $r_G$ between milk traits and interval traits (*e.g*. Everett *et al*.. ,1966 ; Janson and Andreason, 1980); Berger *et al*., 1981., Seykora and Mcdaniel, 1983; Strandberg and Danell, 1988).

## Conclusion and General Considerations

There was no systematic change in heritabilities and genetic or phenotypic variances for different traits studied over the first four lactations. Also, results of the present study and those recently reported in the literature (Schneeberger and Hagger, 1986; Strandberg and Danell, 1988) Show that the $h^2$ of female fertility, as measured in AI, is very low. Thus the major part of variation in fertility traits results from environmental and non-additive genetic variation.

In relation to the level of $h^2$ estimates for different interval traits studied, age at calving seems to be more amenable to selection and thus a means of improving female fertility of dairy cattle, than any other trait. This trait has the advantage over the interval measures, as it can be used for both heifers and cows. Drawing conclusions regarding the efficiency of different measures of female fertility as selection criteria (as measured in Austrian AI recording system) the whole selection programme must be considered. This subject is outside the scope of the present study.

Heritabilities for DO were low, albeit somewhat higher estimates than reported. The heritabilities found, however, do not preclude a possible use of the trait in a progeny testing scheme, especially when considering the large genetic variation in the trait. Here and in some situations, DO also appears to be a measure suitable as a selection criterion, since it is one of the variable parts of the calving interval. The lengthening of this interval may be caused by several factors, *e.g*. the farmer's decision, delayed onset of ovarian activity, silent oestrus or missed oestrus due to weak symptoms (Marion and Gier, 1968; Cole and Cupps, 1977). Poor oestrus detection is one of most important factors, involved in fertility problems. If poor heat expression were found to be the major cause of delayed DO, then direct selection for heat intensity would probably be more efficient than selection on the interval itself.

Age at calving and both DO and LP seem to be related genetically. Also, DO and LP are closely genetically and phenotypically related. Therefore, Shortening the DO would not be a goal in itself. The ultimate goal in selection for better fertility should be to shorten the DO or calving interval parallel with an improvement in conception rate. A major drawback with the interval traits studied as selection criteria is that selection for any one of the intervals requires at least one calving, which may cause biases in breeding values due to selection and also delayed bull evaluation.

Unfavorable correlations between interval traits and milk traits obtained in the present and reviewed studies (*e.g.* Strandberg and Danell, 1988) May have causes other than purely genetic ones. This emphasizes the need for inclusion of some interval traits in the selection criteria. Also, such results must be interpreted with caution. For example, it was shown that DO was influenced to a greater extent by factors on herd level (Janson, 1980 a; Essl, 1984). Thus, if the Austrian farmers were to inseminate high-yielding cows later than moderate or low-producing cows this would automatically produce an antagonistic $r_G$ between milk and fat yields and DO. It is also possible that high-producing cows will be afforded more chances of conceiving than low-producing cows, a management practice which could also create a "false" Jgenetic antagonism. Lack of visible heat later in high-yielding than in low-yielding cows (Marion and Gier, 1968) may be other causes of an antagonistic relation that may at least be partly genetic. A higher incidence of retainned placenta in high - yielding cows (Kragelund *et al.*, 1979) might have the same effect. Accordingly, $r_G$ between production and the interval traits, *e.g.* DO, is subject to these influences. From this point of view, interval measures which included DO can be questioned when investigating the genetic relationship between productive and reproductive performance, at least on field data where it is difficult to asses management practices. For example, when correlating DO with 305 - day lactation yield, one would expect to find an antagonistic relationship due to the depressing effect of pregnancy after about the fifth month of pregnancy.

In conclusion, when evaluating dairy bulls for milk yield by using lactation yield, adjustments should be made for the effect of DO (as cited earlier by the Austrian studies, *e.g.* Essl and Haiger, 1978; Essl, 1984; Soliman, 1984; Soliman and Khalil 1989; Soliman *et al.*, 1989). If such adjustments are not performed, bulls with poor fertility will be favoured in the evaluation for milk yield. The question as to whether there is real genetic antagonism between milk production and fertility in dairy cattle might be difficult to answer without deeper knowledge of the physiological background, such as the hormonal interplay between hormones of reproduction and lactation.

*Acknowledgements* : The authors wish to express sincere thanks to prof. E.S.E. Galal, Department of Animal production, Faculty of Agriculture, Ain Shams University, Cairo, Egypt for his valuable advice, reading and stimulating criticism of this manuscript. We gratefully acknowledge the Official Federation of Austrian Cattle Breeders (ZAR) for supplying the data.

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# التلازمات الوراثية والمظهرية لصفات اللبن مع العمر عند الولادة وطول فترات الايام المفتوحة والجفاف والادراد

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استخدمت في هذه الدراسة بيانات ثلاثة جمعيات لماشية الفلاك في النمساوية والتي تم تجميعها خلال الفترة من سنة ١٩٧٦ حتي ١٩٨٢.أجري التحليل الوراثي والمظهري لسجلات تلك الأبقار وذلك لعدد ١٣٠٠٣٩ سجل خلال المواسم الأربعة الأولي من الادرار. كانت صفات الفترات تتمثل في عمر البقرة عند الولادة الأولى والثانية والفترة بين الولادة حتي الاخصاب وطول فترة الجفاف والأدرار في حين كانت الصفات الأنتاجية تتمثل فى محصول اللبن والدهن. ونسبة الدهن عند ١٠٠، ٣٠٥ يوما من الادرار.

ويمكن تلخيص النتائج المتحصل عليها في الاتي:-

١ـ لم يكن هناك تغير منتظم في قيم المكافئ الوراثي والتباينات الوراثية والمظهرية لصفات الفترات المدروسة وذلك خلال المواسم الأربعةمن الادرار .

٢- كانت قيم المكافئ الوراثي لفترات الادرار والجفاف والفترة من الولادة للاخصاب خلال مواسم الادرار الأربعة الاولي منخفضة جدا حيث تراوحت القيم بين ٤.ر. الي ١٠ر. في حين كانت القيم ٣٧ر.، ٣٩ر. لصفة عمر البقرة عند الولادة الاولي والثانية علي الترتيب وهذا يوضح عدم امكانية التحسين الوراثي والمظهري لفترات الادرار والجفاف وللفترة من الولادة للاخصاب وذلك من خلال الانتخاب المباشر لتلك الفترات بينما يمكن تحسين صفة عمر البقرة عند الولادة الاولي والثانية (وبالتالي يمكن تقصير فترة الجيل) من خلال الانتخاب المباشر لتلك الصفة.

٣- تراوحت قيم الارتباط الوراثي بين صفة عمر البقرة عند الولادة والفترة من الولادة للاخصاب من ٣٢ر. الي ٤٤ر. في حين تراوحت القيم من ٣٧ر. الي ٤٧ر. للارتباط الوراثي بين عمر البقرة عند الولادة وطول فترة الادرار.

٤- لوحظ أن هناك علاقات وراثية ومظهرية موجبة وعالية القيمة بين طول فترة الادرار والفترة من الولادة للاخصاب (٥٥ر. الي ٧٥ر.) في حين كانت الارتباطات سالبة وصغيرة القيمة بين طول فترة الادرار والجفاف وبالتالي فان الهدف الأساسي من الانتخاب لتحسين الخصوبة للابقار تتمثل في تقصير الفترة من الولادة للاخصاب أو تقصير الفترة بين الولادتين .

٥- كانت الارتباطات الوراثية بين طول فترة الادرار أو الفترة من الولادة للاخصاب ومحصول اللبن والدهن عند ١٠٠ ، ٣٠٥ يوما من الادرار موجبة وتراوحت بين ٣٠ر. الي ٥٠ر. في حين لوحظ وجود ارتباطات وراثية سالبة بين كل صفات الفترات السابقة الذكر ونسبة الدهن وفي معظم الحالات وجد أن هناك ارتباطات وراثية سالبة بين فترة الجفاف وكل صفات اللبن عند ١٠٠، ٣٠٥ يوما من الادرار. ومن ذلك يمكن القول بأنه يمكن التحسين لفترات التلقيح والادرار والجفاف من خلال الانتخاب غير المباشر لصفات محصول اللبن والدهن .

٦- كانت الارتباطات المظهرية بين صفات الفترات المختلفة وصفات اللبن عند ٣٠٥ يوما من الادرار أعلي من مثيلتها عند ١٠٠ يوما من الادرار مما يشير الي أن محصول اللبن يصاحبه مظهريا ضعف في خصوبة الابقار.

أنظر رقم ٧ خلف الصفحة

٧- كانت الارتباطات المظهرية بين صفات محصول اللبن والدهن (عند ١٠٠، ٣٠٥ يوما من الادرار) وصفات الفترات المختلفة موجبة ومنخفضة القيمة نسبيا وذلك خلال المواسم الأربعة الأولي من الادرار في حين لوحظ وجود قيم سالبة بين فترة الجفاف وصفات محصول اللبن والدهن.

٨- ارتبطت نسبة الدهن ارتباطا مظهريا سالبا بصفات الفترات تحت الدراسة وذلك خلال المواسم الأربعة الأولي من الادرار.