

CHANGES IN FREQUENCIES OF TRANSFERRIN GENES IN CATTLE (1)

Veränderungen in der Frequenz der Transferringene beim Rind

Fréquence des gènes de transferrines chez le bétail

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The polymorphism of blood proteins in cattle may be an indicator of certain physiological and genetical changes occurring in cattle population. ASHTON *et al.* (1), SZAPIRO (10), WHITE *et al.* (12) demonstrated, that cows with the Tf^p/Tf^p genotype were characterised by a greater productivity than those with the Tf^a/Tf^a genotype. ASHTON and FALLON (2) indicated a connection between the transferrin genes and the fertility of cows. Many authors have observed changes in the frequency of the Tf allele, depending on the degree of selection. Thus, for instance, OSTERHOFF (8) demonstrated an increase in the frequency of the Tf^p allele with the age of cows. A similar result was obtained by GELDERMANN (6) as regards the Tf^p2 allele; BUSH (3) recorded, that in the first three lactations he found 5 transferrin phenotypes (*AA*, *AD*, *AE*, *DD* and *DE*), but in cows during the 4 and 5 lactation only three. However, a series of authors have failed to confirm in their works the dependence between the productivity or fertility of cows and the type of transferrins (4, 5, 7).

The present work was undertaken in order to demonstrate the changes occurring in the frequency of Tf alleles and the degree of homozygosity under the influence of the degree of selection.

MATERIAL AND METHODS

Investigations were performed on 2764 head of Black-and-White Lowland cattle, 1416 animals constituted the progeny aged 1 month to 2 years, and the remaining 1348 animals were cows from 2 to 15 years old. The transferrins were separated

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by way of starch gel electrophoresis, according to method described by SMITHIES and HICKMAN (11) and POULIK (9).

RESULTS

The frequency of transferrin alleles in the progeny of cows of different ages is presented in Table 1. A very low frequency of the Tf^E allele can be observed, which is characteristic for Friesian cattle.

The frequency of occurrence of the Tf^E allele in progeny in dependence on the age fluctuates between $q = 0.04$ and $q = 0.06$. In cows, it remains on a more or less constant level ($q = 0.04$), independently of age. Cows 8 and 11 years old ($q = 0.06$) and 7 years old ($q = 0.02$) constitute an exception. The progeny demonstrate differences in the frequency of occurrence of the Tf^A and Tf^D alleles. An increase can be observed in the frequency of the Tf^A allele between the ages of 3 ($q = 0.37$) and 12 months ($q = 0.49$); simultaneously, there occurred a clear decrease in the frequency of the Tf^D allele (from $q_D = 0.59$ to $q_D = 0.49$). Between the 12th and 24th month no decrease in the frequency of allele Tf^A ($q_A = 0.44$) can be observed nor any increase in the frequency of allele Tf^D ($q_D = 0.53$).

When considering the frequency of the Tf^A and Tf^D alleles in relation to the age of cows no clear changes are observed. The frequency of the Tf^A allele in 2 year old cows amounts to $q = 0.50$; then comes a slight decrease in cows 4 years old ($q = 0.43$) followed by a slow increase, so that 9 year old cows demonstrate the same frequency ($q = 0.51$) as 2 year olds. The lowest frequency of occurrence was observed in 10 year old cows ($q = 0.41$) after which (11 years and older) an increase was observed in the frequency of the Tf^A allele ($q = 0.46$).

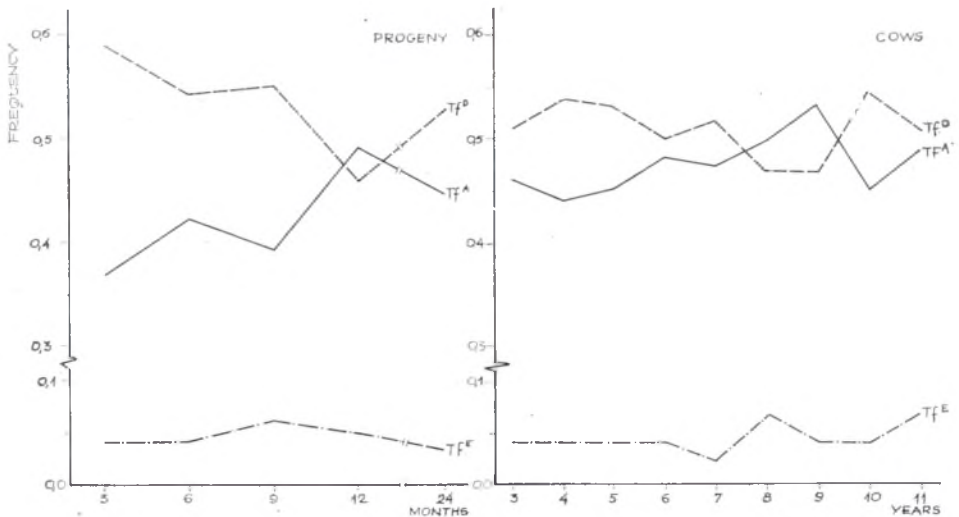


Fig. 1. The frequencies of the transferrin genes in cattle of different ages.

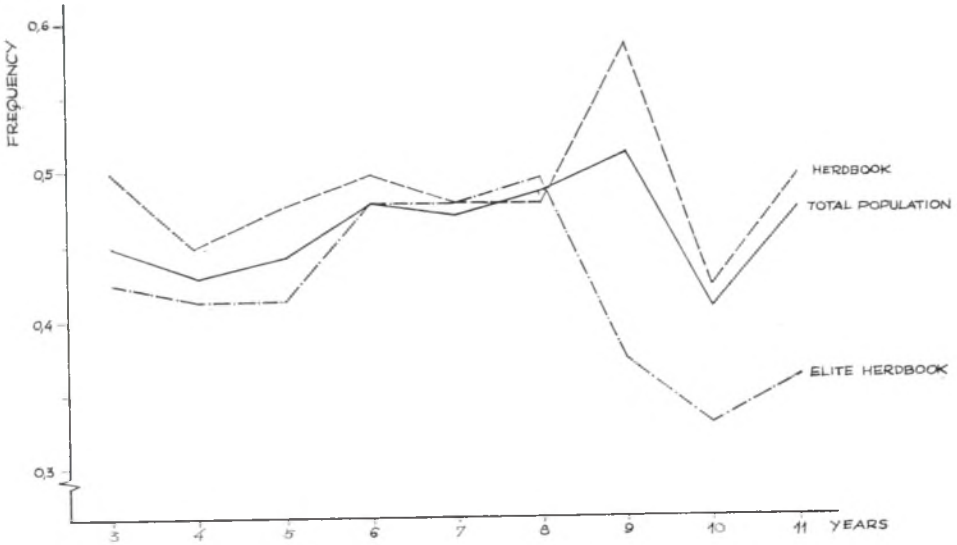


FIG. 2. The effect of selection on the frequency of Tf^A gene in cows from the Herdbook and Elite Herdbook.

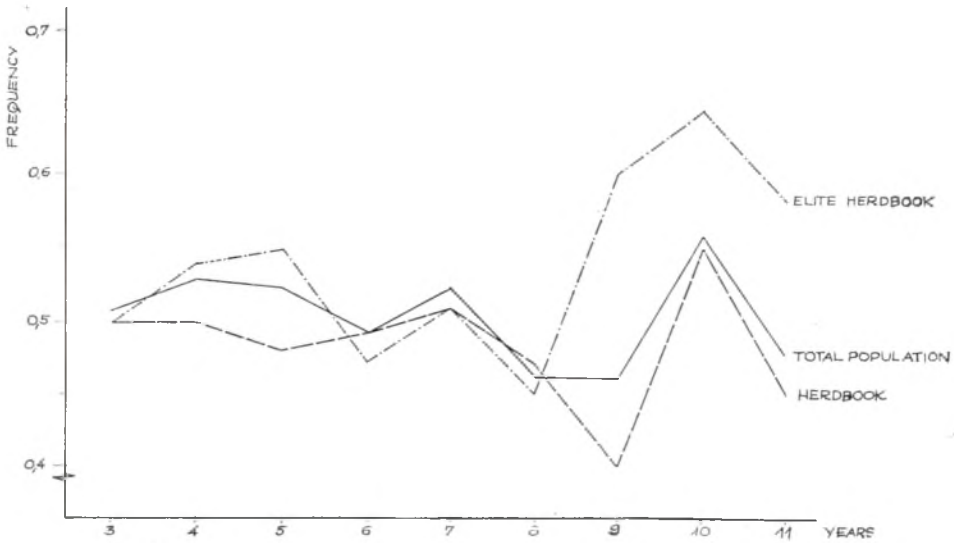


FIG. 3. The effect of selection on the frequency of Tf^B gene in the cows from the Herdbook and Elite Herdbook.

The Tf^D allele demonstrates tendencies contrary to allele Tf^A —an increase at the beginning; next, with the age of cows, a slow decrease of frequency so that cows 8-9 years old have the same frequency ($q = 0.44$) as 2 year olds ($q = 0.45$). The frequency of allele Tf^D in cows of 10 years and older is the reverse of the frequency of the Tf^A allele.

Among the experimental animals, the frequency was investigated of the occurrence of the Tf^A and Tf^D alleles in cows registered in the herdbook and *elite* herdbook (Fig. 2 and 1). Also examined was the change of the frequency of the Tf^A and Tf^D alleles, in relation to the degree of selection. Cows registered in the *elite* herdbook are subjected to a much more severe selection than cows registered in the herdbook. 3 year old cows registered in the *elite* herdbook demonstrated a frequency of the Tf^A allele lower ($q = 0.43$) than cows from the herdbook ($q = 0.50$). In turn, allele Tf^D has in cows from both herdbooks an identical frequency ($q = 0.50$). With age, the difference in the frequency of allele Tf^A decreases, so that for 7 year old cows from both herdbooks it amounts to $q = 0.47$. In turn the difference in the frequency of the Tf^D allele of cows up to 5 years old increases ($q_{elite\ h.} = 0.55$, $q_h = 0.48$); next it decreases and for older cows (up to 8 years old) such differences are very small ($q_{elite\ h.} = 0.45$, $q_h = 0.47$).

A clear difference in the frequency of alleles Tf^A and Tf^D occurs in very old cows—9 years and over. In cows registered in the *elite* herdbook, a decrease can be observed in the frequency of the Tf^A allele and a very clear increase of the Tf^D allele. By contrast, in cows registered in the herdbook big fluctuations can be observed in the frequency of the Tf^A and Tf^D alleles in individual age groups. While the frequency of the Tf^A allele has a tendency to increase, the

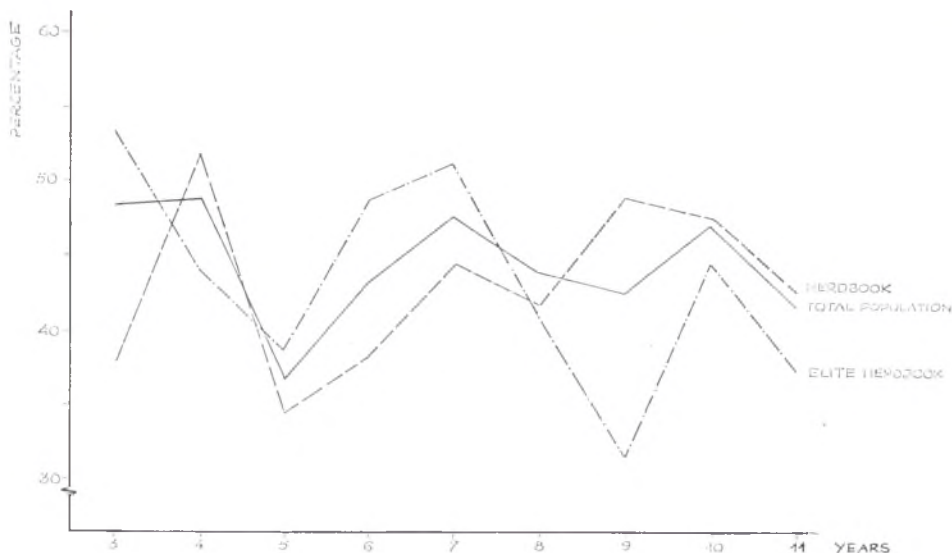


FIG. 4. Degrees of homozygosity in the total population of cows and cows registered in the Herdbook and Elite Herdbook.

allele Tf^p demonstrates rather a decrease in frequency. Comparing the frequency of occurrence of the Tf^a and Tf^p alleles in cows registered in the *elite* herdbook and the herdbook with the frequency of those alleles in the total population of cows, it can be observed that the values for the cows from the herdbook are nearer those for the total population.

In addition to the allele frequency, the degree of homozygosity of the total population was investigated, and also of cows registered in the *elite* herdbook and the herdbook (Fig. 4).

The degree of homozygosity demonstrates very large fluctuations in individual age groups. Thus, for instance, the degree of homozygosity for 3 year old cows registered in the *elite* herdbook, amounted to 53.7 %, for 5 year olds—39.1 %, for 7 year olds—51.1 %, and for 9 year olds only 31.6 %. Similar differences occurred in the cows registered in the herdbook and in the total population. It is difficult to indicate differences between the groups investigated.

In spite of these fluctuations a certain tendency may be seen to decrease the degree of homozygosity with the age of cows registered in the *elite* herdbook.

The results obtained do not demonstrate dependencies between the frequency of the transferrin allele and the effect of selection. These results are not in agreement with the results obtained by OSTERHOFF (8), who demonstrated an increase with age in the frequency of allele Tf^p , or with GELDERMAN'S (6) results, which indicate an increase with age in the $Tf^p/2$ allele and degree of homozygosity.

ZUSAMMENFASSUNG

Das Ziel der vorgelegter Arbeit war die Veränderungen in der Frequenz der Transferinallele und im Homogenitätsgrad beim schwarzbunten Niederungsvieh abhängig vom Alter und der Eintragung ins Herdbuch der untersuchten Tiere zu ermitteln. Insgesamt wurden 2.764 Tiere, darin die Nachkommen im Alter von 1 Monat bis 2 Jahre sowie die Kühe im Alter von 2 bis 15 Jahre untersucht. Die Frequenz der Allele Tf^a , Tf^p und Tf^E sowie der Homogenitätsgrad in den einzelnen Altersklassen wurde ermittelt (Abb. 1, 2, 3 und 4).

Auswertung der Ergebnisse ergab keine Zusammenhänge zwischen der Frequenz der Transferinallele sowie Homogenitätsgrad und dem Selektionseinfluss.

RESUME

Ce travail a pour but de démontrer comment se transforme la fréquence d'allèles transferrins et le degré de homozygose chez le bétail de race pie noir en connection avec l'âge des animaux testés et des notes dans les livres d'élevage.

En général on a testé 2.764 animaux et leur descendants de 1 mois à 2 ans de même que des vaches ayant de 2 à 15 ans. On a fait de recherches sur la fréquence des allèles: Tf^a , Tf^p et Tf^E de même que sur le degré de homozygose sur des animaux d'âge diverse (dessins 1, 2, 3, 4).

Les résultats obtenus ne démontrent aucune dépendance entre la fréquence d'allèles, le degré d'homozygose et la sélection.

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