The relationship between conformations of dams and daughters in Czech Holsteins

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ABSTRACT: The relationship between type traits in Holstein cows over generations was analysed. The analysed data set included a total of 12 157 dam-daughter pairs with linear scores of 14 type traits including a final score and general characteristics of type. Significant relationships existed between linear type traits in dams and their daughters. Pearson correlation coefficients ranged from $r = 0.20$ to $r = 0.63$ except the rump angle. A negative correlation ($r = -0.02$) was found for this trait. A similar tendency resulted from the analysis of the relationship between values of general characteristics and the final type score.

Keywords: Holstein cattle; cows; linear type score; correlation

The development of the dairy industry in European countries is strongly influenced by the current milk market regulation. This brings not only a new look at the evaluation of animal efficiency but also new requirements for breeding programmes. The objective of these programmes is to maximize the overall herd profit. The basic method of achieving this goal is the development a healthy cow capable to produce high quantities of quality milk and characterised by very good reproduction parameters. As a consequence, research in the area of cattle breeding is more and more aimed at identifying new selection criteria which would contribute to the genetic improvement of economically important traits with low inheritance. One of the possible solutions is to use indirect selection for these characteristics through selection for animal type traits. The heritability of these traits is sufficiently high for efficient selection (De Groot et al., 2002; Dechow et al., 2003; Tsuruta et al., 2005).

The relationship between type traits and economically important characteristics has been studied by many authors. Neuenschwander et al. (2005) conducted a genetic analysis of relationships between increased production, longevity, and type. Longevity and its enhancement are associated with economic benefits (Essl, 1998). Some authors involved in this research area also use other terms to express longevity such as productive life or stayability. It is not possible to perceive the longevity of cows as the sole breeding goal because it yields only some benefits in connection with highly efficient and quality production of animals. The relationship between type and longevity has been analysed by a number of authors. Schneider et al. (2003) found that non-linear relationships between type traits and longevity existed and that the traits describing the udder, feet and legs and hooves strongly influenced stayability of animals. Similarly, Sewalem et al. (2004) confirmed that the length of herd life was particularly associated with udder, foot and leg and hoof traits. A close correlation also exists between herd life and the final type score of animals. Positive relationships between udder traits, longevity, and production traits of cows were also reported by Strapák et al. (2005). It is evident that improved type traits can positively influence the functional longevity of cows and thus the economic efficiency of the herd.

Most countries have implemented genetic evaluation for both production and functional traits

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(Mark, 2004). Especially type, health, fertility, and other economically important traits are considered as functional traits. Their importance is reflected in the development of selection indexes. Including type traits in selection indexes for Holstein cattle was also reported by Miglior et al. (2005) and Šafus et al. (2005).

Improving the type of cows represents one of the possibilities for increasing the economic efficiency of dairy herds. The efficiency of selection for type traits is also based on the relationship of these selection criteria between generations of dams and daughters. The objective of the present study was to analyse this relationship.

MATERIAL AND METHODS

A total of 12 157 dam-daughter pairs with linear scores of 14 type traits and final type scores were included in the analysis. Linear type classifications were performed after the first parturition, and the data obtained from the central database of linear type classifications of Holstein cattle were used for the analysis.

The following type traits were scored in accordance with the methodology:

Trait	1 point	9 points
angularity	lacks angularity	very angular
stature	short	tall
chest width	narrow	wide
body depth	shallow	deep
rump angle	high pins	extreme slope
rump width	narrow	wide
rear legs side view	straight	sickled
foot angle	very low	very steep
fore udder attachment	weak	strong
rear udder height	low	high
central ligament	indistinct	deep
udder depth	deep	shallow
front teat placement	wide	narrow
teat length	short	long

In addition, 5 general characteristics were evaluated and the final score was determined. Dairy character, body capacity, rump, feet and legs, and udder were scored within the range of 50 to 100 points. Based on these results the final type score of cows was determined according to the following relative weights of different characteristics:

General characteristic	Weight in (%)
dairy character	20
body capacity	20
rump	10
feet and legs	10
udder	40

Statistical analyses including of variance component estimation (Rasch and Mašata, 2006) were performed using the multifactorial analysis of variance and the procedures CORR and GLM of the statistical programme SAS (SAS Institute Inc., 2001). The following mixed model was chosen:

$$Y_{ijk} = \mu + HYS_i + B_j + bv_k + b\alpha_1 + e_{ijklm}$$

where: μ = mean value
HYS_i = fixed effect of herd, year, and season of the first parturition
B_j = random effect of sire
bv_k = linear regression for days in lactation at type scoring
$b\alpha_1$ = linear regression for age at the first calving
e_{ijklm} = residual error

The comparison of relationships between types of Holstein dams and daughters was conducted on the basis of Pearson correlation coefficients (r).

RESULTS AND DISCUSSION

The relationships between body measurements of Holstein dams and their daughters are given in Table 1. The highest correlations were found in height at sacrum (r = 0.47) and chest girth (r = 0.51). Height at sacrum corresponds with height at withers (r = 0.51), but to obtain more objective relationships between the height measurements of dams and daughters, height at sacrum appears to be more stable.

The correlations between linearly described type traits of dams and daughters are presented in Table 2. Pearson correlation coefficients for the same linear type traits scored in dams and daughters were generally medium-high to high with the exception of the rump angle. Their values were r = 0.47 for angularity, r = 0.63 for stature, r = 0.45 for chest width, r = 0.36 for body depth, r = 0.36 for rump width, r = 0.41 for rear legs set, and r = 0.51 for

Table 1. Pearson correlation coefficients (*r*) between body measures of dams and daughters

Trait rank in dams	Body measure	Rank of daughter traits/*r*		
		1	2	3
1	height at withers	0.47	0.37	0.34
2	height at sacrum	0.51	0.63	0.36
3	chest girth	0.42	0.35	0.51

Table 2. Pearson correlation coefficients (*r*) between linear traits of dams and daughters

Trait rank in dams	Trait	Rank of daughter traits/*r*							
		1	2	3	4	5	6	7	8
1	angularity	0.47	0.24	0.06	0.12	–0.21	–0.01	0.05	0.03
2	stature	0.45	0.63	0.44	0.47	0.10	0.32	–0.07	0.31
3	chest width	0.31	0.39	0.45	0.41	0.15	0.18	–0.10	0.28
4	body depth	0.32	0.37	0.35	0.36	0.16	0.21	–0.11	0.26
5	rump angle	–0.20	–0.18	–0.19	0.27	–0.02	–0.11	–0.29	–0.21
6	rump width	0.14	0.25	0.15	0.20	0.16	0.36	–0.19	0.11
7	rear legs set	–0.04	–0.06	–0.09	–0.11	–0.22	–0.16	0.41	–0.12
8	foot angle	0.17	0.22	0.21	0.20	–0.05	0.05	–0.08	0.51

foot angle. The angularity of dams is more closely positively correlated with the stature of daughters (r = 0.24) and negatively correlated with the rump angle of daughters (r = –0.21). Significant relationships between the stature of dams and type traits of daughters existed in angularity (r = 0.44), chest width (r = 0.44), body depth (r = 0.41), rump width (r = 0.32), and foot angle (r = 0.31). The foot angle of daughters was positively correlated with the chest width and body depth of dams (r = 0.28 and r = 0.26, respectively). Vollema and Groen (1997) reported a negative genetic correlation between the rear legs set and longevity r_g = –0.17. Tsuruta et al. (2005) found the following genetic correlations between longevity and type traits: r_g = –0.12 for stature, r_g = –0.26 for body depth, r_g = –0.19 for rump width, r_g = –0.09 for rear legs set, and r_g = 0.15 for foot angle. It appears that there is a possibility of influencing the productive life of daughters by efficient selection.

Udder conformation traits are even more important for the longevity of cows. Positive genetic correlations between longevity and linear udder traits reported by Vollema and Groen (1997) were r_g = 0.56 for udder depth and r_g = 0.34 for the central ligament. In the study of Tsuruta et al. (2005), genetic correlations between longevity and udder traits were r_g = 0.31 for fore udder attachment, r_g = 0.19 for rear udder height, and r_g = 0.38 for udder depth. The relationships between linear udder traits of dams and daughters are given in Table 3. The lowest correlation was found for the central

Table 3. Pearson correlation coefficients (*r*) between linear udder traits of dams and daughters

Trait rank in dams	Trait	Rank of daughter traits/*r*					
		1	2	3	4	5	6
1	fore udder attachment	0.36	0.32	0.05	0.01	0.04	0.18
2	rear udder attachment	0.29	0.44	0.17	–0.04	0.10	0.00
3	central ligament	0.10	0.17	0.20	0.01	0.10	–0.10
4	udder depth	0.22	–0.08	0.29	0.40	0.33	–0.12
5	front teat placement	0.13	0.06	0.15	0.14	0.36	0.01
6	teat length	0.04	0.00	–0.25	–0.10	–0.13	0.41

Table 4. Pearson correlation coefficients (*r*) between general type characteristics of dams and daughters

Trait rank in dams	Characteristic	Rank of daughter traits/*r*					
		1	2	3	4	5	6
1	dairy character	0.43	0.44	0.08	0.11	0.42	0.44
2	body capacity	0.45	0.51	0.22	0.15	0.35	0.45
3	rump	0.25	0.19	0.40	0.42	0.29	0.34
4	feet and legs	0.10	0.08	0.17	0.34	0.27	0.23
5	udder	0.31	0.32	0.11	0.18	0.50	0.41
6	final scoring	0.45	0.46	0.21	0.26	0.54	0.53

ligament (r = 0.20). The correlations for other traits were r = 0.44 for rear udder height, r = 0.41 for teat length, r = 0.40 for udder depth, and r = 0.36 for fore udder attachment and front teat placement. Positive correlations existed between the fore udder attachment of dams and the rear udder height (r = 0.32) and teat length (r = 0.18) of daughters. Significant relationships were also found between the udder depth of dams and the central ligament (r = 0.29) and front teat placement (r = 0.33).

The relationships between different general characteristics and the final score of dams and daughters are given in Table 4. All correlations were medium-high and ranged from r = 0.34 to r = 0.53. Vollema and Groen (1997) estimated relatively high genetic correlations between these characteristics and the longevity of cows: r_g = 0.39 for feet and legs, r_g = 0.82 for udder, and r_g = 0.62 for the final type score. Zwald et al. (2005) acknowledged the possibility of improving the final score of type by means of efficiently performed selection.

The results given in Table 4 show that type traits of daughters were most closely correlated with the final type score of dams. Correlation coefficients ranged from r = 0.21 for the rump to r = 0.54 for the udder of daughters. The results indicate a very good opportunity to use an efficient selection between generations of animals. Its objective has to be the improvement of economically important type traits and particularly those traits related to the extension of cow productive life.

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