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Conference paper

CORRELATIONS AMONG LINEAR TYPE TRAITS IN THE BELGIAN BLUE BREED

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Summary

Records on 23814 Belgian Blue cows classified for 20 lincar type traits were analysed to estimate heritabilities and genetic correlations. Heritability estimates were ranging from 0.02 for one leg trait (shoulder joint) to 0.44 for stature. Traits corresponding to muscular development had heritabilitty estimates ranging from 0.25 to 0,41; traits related to skeletal conformation had heritabilities from 0.11 to 0.36 while the leg traits had heritabilities ranging from 0.02 to 0.22.

Distinct sets of closely related traits could be identified 1°)-traits in relation to vertical and longitudinal growth (height and length) 2°)-traits related to lateral growth (chest and pelvis widths) 3°)-traits characterizing muscular development (shoulder, top, thighs) 4°)-other traits of skeletal conformation such as the shape of the rib, the slope of the rump and the tail set.

Better muscling was associated with a slightly smaller height, with wider chest and pelvis, with a round rib, a sloping rump, a prominent tail and finer bone. The grade for General Appearance was especially correlated with muscular development, with and other traits of skeletal conformation.

Introduction

Genetic specialization (dairy or beef) has obvious repercussions on conformation. The extreme dairy type shown by the Jersey or the Holstein is so much different from the extreme beef type exemplified by the Belgian Blue. Not only the muscular development but also the skeletal conformation are implied. But variations in body shape still persist within these biological types. The introduction of linear type traits to describe conformation characteristics enabled 1°) the estimation of their heritabilities, of the genetic and phenotypic correlations among them and with production and functionality traits 2°) sire evaluation for type traits. The inheritance of linear type traits was studied in performance-tested Belgian Blue bulls as well as their correlations with production traits (Hanset et al., 1998).

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The object of this work was to estimate the genetic parameters (heritabilities and correlations) of the twenty linear type traits of registered cows of the Belgian Blue Cattle breed.

Material and methods

Data consisted of linear type records for 23814 registered cows of all ages belonging to the Belgian Blue breed classified between April 1994 and March 1996. 787 sires had at least 5 daughters and 185 sires at least 20 daughters. Each record contained information on 19 traits linearly scored on a scale of 1 to 50 and on a grade for General Appearance recorded on a scale of 1 to 20. Height at withers was firstly measured then converted into a linear score as follows: the deviation of the measured height from the expected height given the age (norm for height) is multiplied by 2.5 then added to 25, with limits of 1 and 50. A detailed description of the Belgian Blue linear scoring scheme is given elsewhere (Hanset, 1995). Summary descriptions and abbreviations used are given in Table l.

Multiple- trait derivative- free restricted maximum likelihood (MTDFREML) estimates of genetic (co) variance components were calculated (Boldman and Van Vleck, 1991, Boldman et al., 1993). The model of analysis was a sire model (sire, sire of sire, maternal grandsire of sire) with as fixed factors: herd x date x classifier, condition, nr of last calving. The number of animals in A^{-1} was 5928. In the single trait analyses (heritabilities), there were 7476 equations and of course twice as much in the two trait analyses (correlations) carried out with variance components held constant.

Results and discussion

Phenotypic means, standard deviations, coefficients of variation and heritability estimates of the type traits are given in Table 1. Apart from the grade for general appearance, for the other traits with a scale of 1 to 50 to represent the breed range, one expects means and standard deviations approximating 25.5 and 8.23 respectively. Means were generally above expectation and it was mainly true for the scores concerning body and pelvis lenghts.

On the other hand traits with score 25 as the anatomical norm (shoulder joint, top line, fore-and rear legs hocks) had means near the expectation. As could be anticipated, these traits had the smallest standard deviations, the height having the largest. Nevertheless, apparentty, there is a tendency among the classifiers to restrict scoring to a part of the range. The same observation was made in dairy cattle even in the case of a scale of 1 to 9 (Meyer et al. 1987).

TABLE 1. - MEANS, STANDARD DEVIATIONS, COEFFIENTS OF VARIATION AND HERITABILITY ETIMATES FOR TYPE TRAITS

Traits	1	50	Abbrev	Mean	s. d.	c. v.	h^2
Height	small	tall	HE	28.78	8.78	30.52	0.44
Length	short	long	LE	38.09	2.72	7.15	0.31
Chest width	narrow	wide	CW	31.46	4.53	14.39	0.13
Pelvis width	narrow	wide	PW	35.62	2.99	8.39	0.33
Shoulder muscling	hardly muscled	well-muscled	ShM	33.37	3.69	11.07	0.25
Top muscling	hardly muscled	wel-muscled	ToM	30.87	5.32	17.23	0.30
Rib shape	flat	round	RI	27.94	5.84	20.91	0.25
Skin	thick	thin	SK	30.41	5.73	18.84	0.30
Rump	horizontal	sloping	RU	27.45	5.73	20.89	0.36
Pelvis length	short	long	PL	37.27	2.68	7.18	0.18
Tail set	deep	prominent	TS	29.84	6.73	22.56	0.25
Thigs side v.	straight	round	ThS	34.64	3.65	10.54	0.41
Thigs rear v.	straight	round	ThR	34.20	3.51	10.25	0.36
Bone	thick	fine	BO	31.89	4.86	15.25	0.16
Shoulder joint	prominent	well-attaced	ShJ	24.70	1.57	6.36	0.02
Top line	concave	convex	TL	25.17	2.00	7.94	0.18
For legs	open	knock-kneed	FL	26.80	2.17	8.10	0.06
Rear legs	open	cow-hocked	RL	25.97	2.09	8.05	0.10
Hocks	straight	bent	HO	27.56	3.83	13.88	0.22
Gen app. (1 to 20)	poor	excellent	Ga	14.28	1.60	11.19	0.38

Heritability estimates range from 0.02 (shoulder joint) to 0.44 (stature). Traits associated with muscular development (ShM, ToM, ThS and ThR) had heritabitity estimates ranging from 0.25 to 0.41 traits associated with skeletal conformation (CW, PW, RI, RU and TS) from 0.11 to 0.36 and traits in relation to the set of legs (ShJ, TL, FL, RL and HO) from 0.02 to 0.22.

Correlations among type traits, both phenotypic and genetic, are given in Table 2. The genetic correlations are systematically larger than the phenotypic correlations. Each trait has its own pattern of genetic correlations as illustrated for four of them in Fig. 1 to 4. Scts of inter- related traits were discernible: 1°)- three traits in relation to vertical and longitudinal growth (HE, LE and PL) had average correlations of: 0.38 (r_p) and 0.67 (r_g) 2°) two traits related to lateral growth (CW and PW) correlations of: 0.38 (r_p) and 0.58 (r_g) 3°) four traits associated with muscular development (ShM, ToM, ThS and ThR) correlations of : 0.55 (r_p) and 0.75 (r_g) 4°)- three other traits of skeletal conformation (RI, RU and TS) correlations of: 0.21 (r_p) and 0.28 (r_g).

TABLE 2. - GENETIC (BELOW DIAGONAL) AND PHENOTYPIC (ABOVE DIAGONAL) CORRELATIONS AMONG TYPE TRAITS

Traits	HE	LE	CW	PW	ShM	ToM	RI	SK	RU	PL	TS	ThS	ThR	BO	ShJ	TL	FL	RL	HO	GA
Height		0.39	-0.04	0.13	-0.03	-0.08	-0.04	-0.09	0.04	0.26	-0.02	-0.01	-0.03	-0.08	-0.01	0.09	-0.01	0.03	-0.04	-0.01
Length	0.55		0.09	0.32	0.11	0.01	0.03	-0.06	0.04	0.49	0.01	0.13	0.12	0.03	-0.04	0.06	-0.02	0.02	0.04	0.12
Chestwidth	-0.09	0.12		0.38	0.49	0.37	0.19	0.01	0.11	0.12	0.10	0.35	0.40	0.01	-0.02	-0.01	-0.04	-0.05	0.02	0.39
Pelviswidth	0.20	0.53	0.58		0.44	0.38	0.17	-0.03	0.09	0.33	0.08	0.45	0.57	-0.09	-0.02	-0.02	-0.02	0.00	-0.01	0.47
Shouldermus	-0.03	0.12	0.77	0.71		0.50	0.31	0.00	0.22	0.19	0.13	0.51	0.55	0.02	-0.01	-0.03	-0.01	-0.06	0.01	0.56
Topmuscling	-0.15	-0.15	0.46	0.43	0.72		0.26	0.01	0.13	0.09	0.11	0.42	0.46	0.00	0.02	-0.06	-0.01	-0.06	-0.03	0.47
Ribshape	-0.07	0.10	0.43	0.41	0.64	0.59		0.05	0.18	0.13	0.20	0.28	0.29	0.13	-0.01	-0.05	0.01	-0.05	-0.04	0.36
Skin	-0.10	-0.06	0.05	-0.02	-0.01	0.10	0.12		0.00	-0.05	0.03	0.01	0.01	0.11	-0.01	-0.03	0.01	-0.01	-0.01	0.02
Rump	0.05	-0.06	0.17	-0.02	0.29	0.17	0.23	-0.07		0.18	0.25	0.50	0.38	0.11	-0.01	0.06	0.02	-0.03	0.01	0.48
Pelvislenght	0.54	0.91	0.14	0.62	0.25	-0.11	0.08	-0.03	0.17		0.03	0.27	0.24	-0.05	-0.04	0.10	-0.01	0.01	0.06	0.24
Tailset	0.05	0.00	-0.04	-0.02	0.16	0.18	0.26	0.08	0.34	0.01		0.21	0.18	0.04	-0.02	0.03	0.01	-0.06	-0.06	0.26
Thigs side	-0.06	0.12	0.50	0.50	0.78	0.55	0.55	0.04	0.71	0.34	0.27		0.84	0.10	-0.02	0.03	-0.01	-0.08	-0.01	0.78
Thigs rear	-0.05	0.12	0.62	0.68	0.88	0.61	0.62	0.06	0.59	0.33	0.19	0.95		0.07	-0.01	0.01	-0.02	-0.07	-0.01	0.78
Bone	-0.17	-0.06	0.04	-0.30	0.04	0.17	0.26	0.16	0.31	-0.23	0.22	0.28	0.16		0.01	0.04	-0.01	-0.01	0.01	0.12
Shoulderjoint	-0.14	-0.50	-0.08	-0.19	-0.05	-0.07	0.16	-0.02	0.02	-0.47	0.43	-0.12	-0.17	-0.04		0.01	-0.04	0.01	-0.03	0.01
Topline	0.26	0.32	0.04	0.12	-0.02	-0.19	-0.15	-0.22	0.02	0.45	-0.18	-0.07	-0.06	-0.13	-0.55		0.00	0.03	0.01	0.02
Forelegs	0.12	-0.10	-0.19	0.15	0.16	0.07	0.15	0.21	0.13	-0.15	0.03	0.17	0.13	0.03	0.16	-0.03		0.09	-0.05	-0.02
Rearlegs	0.15	0.44	0.07	0.19	-0.12	-0.07	0.07	-0.01	-0.03	0.52	-0.19	-0.09	0.01	0.18	-0.33	0.46	-0.25		0.04	-0.08
Hoks	-0.06	0.25	0.08	0.13	0.10	-0.01	-0.13	-0.18	0.02	0.24	-0.11	0.02	0.03	0.01	-0.10	0.19	-0.21	0.10		-0.02
Gener. app.	-0.01	0.09	0.54	0.53	0.85	0.58	0.67	0.11	0.68	0.28	0.32	0.97	0.98	0.31	-0.02	0.03	0.20	-0.06	0.00	

Better muscular development was associated with a slightly smaller height (-0.04 for r_p and 0.07 for r_g), with more pronounced lateral growth (0.43 for r_p and 0.58 for r_g), with a rounder rib (0.28 for r_p and 0.60 for r_g) with a more sloping rump (0.41 for r_p and 0.44 for r_g), with a more prominent tail set (0.17 for r_p and 0.20 for r_g) and with finer bone (0.0.5 fot r_p and 0.16 for r_g). (see Fig. 1, 2 and 3).

Figure 1. - GENETIC CORRELATIONS BETWEEN HEIGHT AND OTHER TYPE TRAITS

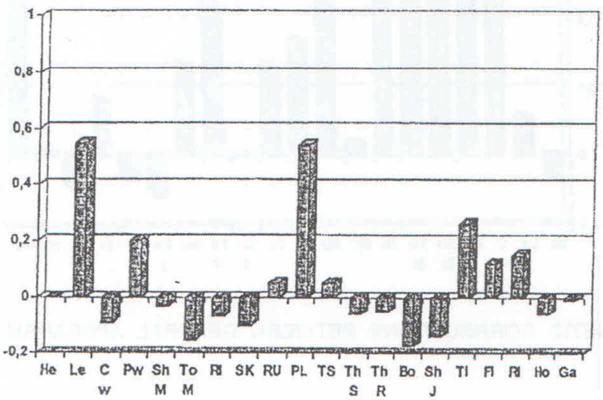
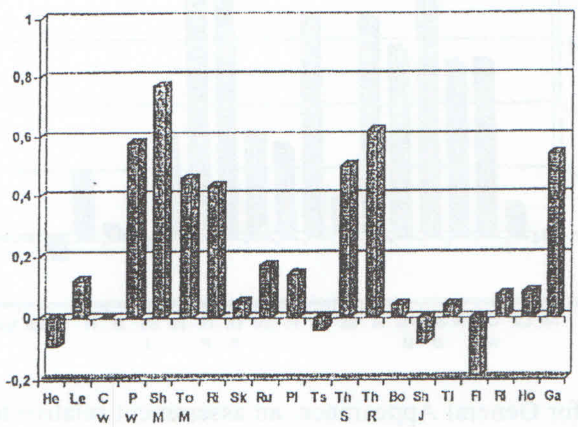


Figure 2. - GENETIC CORRELATIONS BETWEEN CHEST HEIGHT AND OTHER TYPE TRAITS



Taller (and longer) animals had a tendency to have thicker bone (- 0.08 for r_p and 0.11 for r_g) and a more convex top line (0.09 for r_p and 0.26 for r_g). (see Fig. 1).

Figure 3. - GENETIC CORRELATIONS BETWEEN THIGHS SIDE VIEW AND OTHER TYPE TRAITS

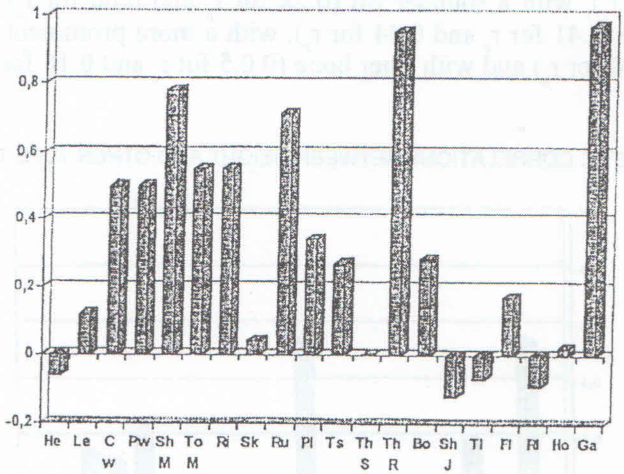
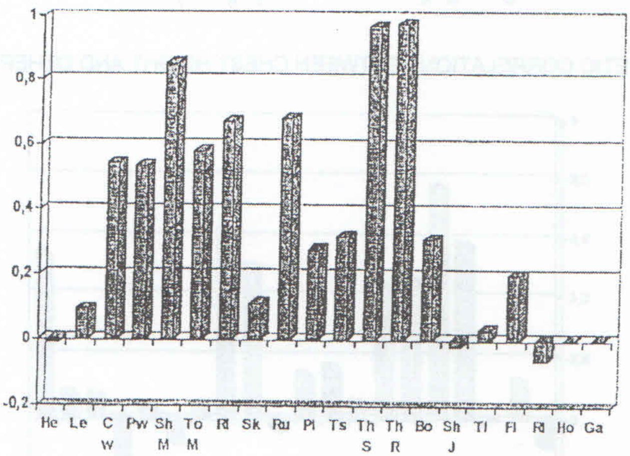


Figure 4. - GENETIC CORRELATIONS BETWEEN GENERAL APPEARANCE AND OTHER TYPE TRAITS



The grade for General Appearance, an assessment relative to an ideal, was correlated with 1°) muscular development (0.65 and 0.84) 2°) skeletal conformation (0.37 and 0.56) 3°) lateral growth (0.43 and 0.53) 4°) pelvis length (0.24 and 0.28) 5°) slender bone (0.12 and 0.31) but was very little influenced by the other traits. (see Fig. 4).The correlations involving leg traits are to be interpreted with caution as the variation of these traits has a biological optimum at score 25 with non- lincarity as a result.

In this breed, the transition from the dual- purpose type to the meaty type (DM), corresponding to the fixation of the mh gene, produced animals "with bulging muscles on the shoulder, back and thighs with wide chest and pelvis, rounded rib, hidden hips, fine bones" (Hanset, 1984, 1986, 1991). Obviously, muscular hypertrophy resulting from the action of the mh gene has repercussions on skeletal conformation. The homozygosity for the mh gene was practically achieved during the seventies. Nevertheless, from that time, selection for still better muscling continued and resulted in further improvement.

As shown in this study, within a population of mh/mh animals, a substantial genetic variation is still present regarding muscular and skeletal conformation A "residual" genetic variation is concerned and is due to segregation at unidentified loci. Furthermore, it appeared that, within the breed as it is today, better muscular devetopment, wider chest and pelvis, rounder rib were still associated. In other words, the genes responsible of that residual variation seem to have, as a whole, the same kind of action, both on muscular development and skeletal conformation, as the mh gene.

REFERENCES

1. Boldman, K. G. and L. D. Van Vleck (1991): Deriwative-free restricted maximum likelihood estimation in animal models with a sparse matrix solver. J. Dairy Sci. 74: 4337.
2. Boldman, K.G., L. A. Kriese, L. D. Van Vleck, and S. D. Kachman (1993): A manual for the use of MTDFREML. A set of programs to obtain estimates of variances and covariances. USDA, Clay Center NE.
3. Hanset, R. (1982): Muscular hypertrophy as a racial charracteristic: the case of the Belgian Blue breed. pp. 437-449 in J. W. B. King and F. Ménissier eds. Muscle hypertrophy of gnetic origin and its use to improve beef production. Martinus Nijhoff.
4. Hanset, R. (1986): Double muscling in cattle. pp. 71-80 in C. Smith, J. W. B. King and J. C. Mc Kay eds. Exploiting new technologies in animal breeding. Oxford Science Publications.
5. Hanset, R. (1991): The major gene of muscular hypertrophy in the Belgian Blue cattle breed. pp. 467-478 in J. B. Owen and R. F.E. Axford eds. Breeding for disease resistance in farm animals. CAB Intern.
6. Hanset, R. (1995): The Belgian Blue Linear Scoring Scheme. Belgian Blue Newsletter nr 2:13-20.
7. Hanset, R., F. Famir, F. Boonen, F. and P. Leroy (1998): Inheritance of production and linear type traits in performance-tested Belgian Blue bulls. Proc. 6th W. C. G. A. L. P.- Armidale NSW, Australia.
8. Meyer, K., S. Brotherstone, W. G. Hill, and M. R. Edwards (1987): Inheritance of linear type traits in dairy cattle and corelations with milk production. Anim. Prod. 44:1-10.

KORELACIJE IZMEĐU OSOBINA LINEARNOG TIPA U BELGIJSKOJ PLAVOJ PASMINI

Sažetak

Klasificirani su podaci o 23814 krave "belgijska plava" za 20 osobina linearnog tipa radi procjene heritabiliteta i genetskih koleracija. Procjene heritabiliteta kretale su se od 0.02 za osobinu jedne noge (rameni zglob) do 0.44 za rast. Osobine koje su odgovarale razvoju mišića imale su heritabilitet od 0.25 do 0.41; osobine u vezi konformacije skeleta/kralježnice imale su heritabilitet od 0.11 do 0.36, dok su osobine nogu imale heritabilitet od 0.02 do 0.22.

Moglo se identificirati izrazite skupine usko povezanih osobina: l.osobine u vezi s vertikalnim i longitudinalnim rastom (visina i duljina), 2. osobine u vezi s lateralnim rastom (širina prsa i zdjelice), 3. osobine koje obilježavaju razvoj mišića (rame, gornji dio, bedra), 4. druge osobine konformacije kralježnice kao što su oblik rebra, nagib stražnjeg dijela/trtice, te položaj repa.

Bolje mišićje bilo je u vezi s nešto manjom visinom, širim prsima i zdjelicom, zaobljenim rebrima, spuštenom trticom/stražnjim dijelom, istaknutim repom i nježnijim kostima. Kategorija za opći izgled bila je osobito povezana s razvojem mišića, širinom i drugim osobinama konformacije kralježnice.

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