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Abstract

Correlations were computed between pairs of first-lactation milk records of unrelated Holstein cows in New York, where the records were made in the same herd and same year-season of freshening, and in the same herd but different year-seasons of freshening. Records were expressed as deviations from herd-mate averages. The average correlation between pairs in the same herd-year-season was .01. The average correlation when the pair of records was made one season apart was .08, and two seasons apart was .06. The pattern of correlations between a pair of records made more than 1 or 2 yr apart appears to be unpredictable.

One objection to the use of records expressed as deviations from herd-mate averages is the automatic covariance between records of cows in the same herd, introduced because these cows have the same herd-mates in common—more if in the same year-season and fewer if the pair of records is several year-seasons apart in time.

The purpose of this study was to examine empirically the seriousness of the automatic covariance between the records of unrelated animals in the same herd, and the same and different year-seasons. This background covariance would also be expected to be present in the covariances between records of relatives in the same herd.

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Materials, Methods, and Results

The data are the same as those used by Van Vleck and Hart (2) and include first-lactation (2×, 305-day, M.E.) milk records of all registered Holstein daughter and dam pairs from the files of the New York Dairy Records Center. These records were expressed as deviations from herd-mate averages (1). For each herd the records of up to two daughters were assigned to each year-season. The year-seasons are shown in Table 1. No cow in any of the 18 year-season classes had the same dam or sire as any other cow in any of the 18 year-season classes for the same herd. This was the only criterion used in deciding the cows were unrelated. Actually, some less-direct relationships probably did exist in most herds. The covariances among the averages of the 18 classes were obtained, as were variances of single observations in each class (the pooled variances of the one or two cows in each class

TABLE 1

Correlations between first-lactation milk records expressed as deviations from herd-mate average for pairs of unrelated cows both freshening in the same herd-year-season class

Season	Variance $(10\ kg)^2$	Herds no.	Pairs no.	Correlation
(1) Dec., 1956–Mar., 1957	8,897	1,580	286	.05
(2) Apr., 1957–July, 1957	10,078	843	122	−.02
(3) Aug., 1957–Nov., 1957	10,687	2,192	552	−.04
(4) Dec., 1957–Mar., 1958	10,573	1,270	216	.07
(5) Apr., 1958–July, 1958	10,555	721	108	.00
(6) Aug., 1958–Nov., 1958	10,374	2,123	567	.01
(7) Dec., 1958–Mar., 1959	10,588	1,350	227	.02
(8) Apr., 1959–July, 1959	11,584	783	129	−.02
(9) Aug., 1959–Nov., 1959	10,381	2,397	711	.05
(10) Dec., 1959–Mar., 1960	11,136	1,576	256	−.00
(11) Apr., 1960–July, 1960	13,597	1,070	200	.06
(12) Aug., 1960–Nov., 1960	11,217	2,967	834	.01
(13) Dec., 1960–Mar., 1961	12,632	1,991	327	−.02
(14) Apr., 1961–July, 1961	13,706	1,136	195	−.08
(15) Aug., 1961–Nov., 1961	13,559	3,373	907	.03
(16) Dec., 1961–Mar., 1962	12,730	1,897	379	.01
(17) Apr., 1962–July, 1962	15,561	1,244	180	.12
(18) Aug., 1962–Nov., 1962	9,915	3,611	1,102	−.04

are shown in Table 1). Covariances were also computed between the pair of cows in the same herd-year-season of freshening. Table 1 contains the number of herds having at least one cow in each year-season and the number of herds in which a pair of cows had records in the same year-season. Correlations were obtained from the pooled variances and covariances. Correlations between pairs in the same year-season are shown in Table 1. Correlations among pairs in different year-seasons are given in Table 2. The numbers below the diagonal in Table 2 give the number of herds having at least one and sometimes two cows in each of the pair of classes in the covariance.

Correlations, having in common the property of being obtained from classes separated by the same number of year-seasons, were pooled by weighting the correlations by the number of herds with pairs included in the covariance. Approximate confidence limits were obtained by use of Fisher's z transformation. These appear in Table 3.

Discussion

Correlations between a pair of cows in the same herd-year-season of freshening averaged .01. The range was between −.08 and .12 for the 18 year-seasons. This value is lower than might be expected, since both cows have nearly the same herd-mates. The reason for the low correlation, however, is due to each cow of the pair being included as a herd-mate of the other. This introduces a relatively large negative term to the covariance between deviations of the cows, counterbalanced by the positive term due to the same herd-mates and the positive term due to not completely eliminating herd-year-season effects when expressing records as deviations.

The higher correlations between a pair of cows in the same herd but in different year-seasons seem to follow an unexplainable pattern. There is no apparent decrease in the size of the correlation as the number of year-seasons between the pair of records increases. The number of pairs included in the more extreme pairing of records is, however, much smaller than for more contemporary pairs.

Some reasons can be advanced for the relatively high correlations between pairs of records one and two seasons apart. These pairs would have no herd-mates in common, so that the covariance between them is approximately $\sigma_h^2/n_i n_j$; where σ_h^2 is the herd component of variance and n_i and n_j are the numbers of cows in the herd for seasons i and j; i and j are one or two seasons apart. This term increases when

TABLE 2

Correlations[a] among records of unrelated cows in the same herd but different year-seasons of freshening

Season[b]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	......	.14	.03	−.04	.04	.01	−.02	−.13	.13	.05	.27	−.00	.08	−.03	.03	.12	−.03	.10
2	385	......	.02	−.03	−.04	−.08	.19	.02	−.09	.04	.15	−.02	.02	.03	.09	.28	−.02	.07
3	315	442	......	.15	.05	−.02	.12	−.01	.01	.12	−.02	.12	−.01	.08	.09	−.01	.02	.10
4	580	288	703	......	.08	.09	.07	.09	.08	.04	−.03	.06	−.05	−.01	.02	.04	−.09	.08
5	329	225	402	239	......	.00	.09	.09	−.15	.16	−.09	.15	.05	.04	−.15	−.01	.17	−.21
6	804	444	1,089	687	416	......	.08	.12	.02	.05	.13	.06	.04	−.04	−.01	−.02	−.10	.06
7	519	289	666	422	266	694	......	.02	.02	.06	.09	.01	−.03	.02	−.06	.12	.04	−.02
8	309	237	337	232	186	384	279	......	−.10	.07	−.10	.02	.02	.03	.02	.13	−.01	.00
9	684	398	1,003	614	329	1,072	700	435	......	.07	.08	.05	−.02	.12	−.02	−.02	.26	.11
10	510	266	605	405	239	604	542	296	839	......	.21	.12	.08	.14	.12	−.03	.14	.01
11	312	205	416	260	206	393	354	260	527	373	......	.15	.09	.11	.08	.06	.11	.14
12	696	362	984	541	318	1,072	684	398	1,315	841	589	......	.10	.07	.07	.05	−.08	.11
13	509	268	598	417	240	693	533	312	813	604	434	1,091	......	.06	.09	−.09	.04	.01
14	289	164	241	216	188	405	299	235	465	303	302	579	423	......	.10	.12	.16	.11
15	681	377	974	562	365	1,074	676	385	1,284	823	593	1,598	1,031	643	......	.05	.02	.08
16	530	251	615	388	234	693	518	286	849	587	403	935	723	405	1,067	......	.08	.10
17	235	183	367	204	153	370	250	221	476	300	279	535	369	344	639	408	......	.06
18	657	358	920	522	309	967	637	429	1,274	812	643	1,536	1,001	610	1,796	1,110	703	......

[a] Correlations are above the diagonal; the corresponding number of pairs of records in the correlation are given below the diagonal.
[b] The seasons are as defined in Table 1.

TABLE 3
Average correlations among records of unrelated pairs of cows in the same herd and the same and different year-seasons

No. seasons apart	No. pairs	95% Confidence interval on correlation		
		Lower	Correlation	Upper
0	7,298	−.016	.007	.030
1	9,211	.061	.081	.101
2	9,241	.035	.055	.075
3	10,335	.023	.042	.061
4	6,979	.002	.025	.049
5	6,215	.049	.073	.098
6	7,896	−.003	.020	.042
7	5,059	.010	.038	.065
8	4,802	.024	.052	.080
9	5,391	.034	.061	.087
10	3,225	−.030	.004	.039
11	3,108	−.040	−.005	.030
12	3,155	.041	.076	.110
13	1,794	−.082	−.035	.011
14	1,821	.030	.076	.122
15	1,633	.042	.090	.138
16	593	−.054	.027	.107
17	657	.023	.099	.174

either or both n_i and n_j are small. Under New York conditions very few cows freshen in the summer season, whereas about one-half freshen in the fall season. Thus, either n_i or n_j is usually relatively small. On the other hand, herd-mates in one season are likely to be herd-mates in the same season the next year, so that one out of three seasons one year apart would have n_i and n_j both large. A later record of one cow of the pair would likely appear as a herd-mate of the other for seasons about a year apart. This would introduce a negative term to the covariance and reduce the correlation. This pattern appears to hold for about 2 yr, then breaks up with unexplainable increases and decreases in the correlations.

The relatively high correlations between pairs of records two or more years apart do not seem readily explained, unless the increase in the herd size with time is having some influence. The proportion of herd-mates in common would be smaller for pairs of records made many seasons apart than for pairs of records made fewer seasons apart. This would assume that the herd effects at different time periods remain relatively the same. This assumption probably should be questioned.

Originally, the plan was to correct the daughter-dam regression estimates reported by Van Vleck and Hart (2) for these underlying correlations. With this in mind the average time between when the daughter and dam records were made was computed. Table 3 shows the futility of this approach, since the pattern of the correlations is not linear with time. A distribution of the time differences would be needed to calculate the average underlying correlation. For example, daughters and dams made records, on the average, 49 months apart in time or about 12 year-seasons. The correlation for 12 seasons apart is .076, but for the two adjacent seasons, −.005 and −.035. The unweighted average of these is .012, very close to the correlation found by Van Vleck and Hart (2) from comparing the regression of daughter-dam pairs in the same herd with the regression for pairs in different herds. The actual distribution of time differences was not computed, but is likely to extend from 24 months to 10 yr.

Conclusions

There appears to be a negligible correlation between pairs of records expressed as deviations from herd-mate averages made in the same herd-year-season. There is a sizeable correlation between pairs of records made in the same herd but one or two year-seasons apart. The pattern of the correlations between a pair of records made more than 1 or 2 yr apart appears to be unpredictable. The danger of obtaining regressions between deviation records of pairs of related animals, when all pairs of records are exactly the same time apart, is apparent. Sizeable biases would result for some time sequences, whereas in others no bias would result. If the time period between pairs of records is distributed randomly over a relatively short time span, the bias due to herd-mate records may be important. Why this should be for records made four or more years apart in time has no good explanation, since the average turnover in a herd is 25% per year. For records

4 yr apart only about 30% of the herd-mates will be the same.

References

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