The Value of Identical Twins in Research

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SUMMARY.

A CRITICAL appraisal of ten years of identical twin research shows that they fully merit their now-established place in dairy cow investigations, though some reservations must be made. Their general usefulness was considered under the two broad headings of environmental studies (comparative experiments) and genetic investigations.

The use of twins in comparative experiments, by permitting the elimination of the normally great hereditary variation between individuals, generally leads to considerable economy in the number of experimental animals—though a minimum of about seven twin sets is still desirable. The measurement of the relative value of twins in this respect (compared with ordinary animals) was discussed, and it was shown that calculated twin efficiency values, while providing a simple and useful yardstick, usually overestimate their actual superiority. For short-term growth and production studies other means are available to reduce experimental error. Twins are less useful in comparing a large number of treatments, and high wastage reduces their value in long-term studies.

For genetic investigations it was emphasised that the prime value of identical twin data lies in the assessment of the magnitude of component sources of variation and covariation (genetic and environmental) rather than in the mere derivation of heritability estimates and genetic correlations. The latter may be expected to materially exceed estimates of heritability, and even repeatability, from field data, primarily because of stricter environmental control, and elimination of appreciable interaction effects. In view of the large sampling errors of relevant estimates, a minimum of about twelve twin sets is desirable for satisfactory genetic interpretation. Consideration was given to the problems associated with aberrant observations and in general with selection of data. The time-replication of twin experiments yields most valuable information, generally otherwise unobtainable, on the nature and extent of interactions between heredity on the one hand and environmental factors on the other.

The main conclusions reported were illustrated with analyses of actual identical twin experiments at Ruakura, together with some relevant data from other sources.

Discussion

Dr. WILLIAMS: I am surprised at the great reduction of error variation resulting from covariance methods; could this technique be more widely used in animal experiments? As regards aberrant experimental data, would it be desirable to apply known statistical tests of the significance of outlying observations?

Dr. CARTER: I would emphasise that marked gains in experimental precision from covariance methods can be expected only in relatively short-term studies where animals show similar "persistencies." No, I do not think that any general tests on aberrant observations would be warranted with such limited and usually variable data; the main problem is not to detect significant "outliers" (they usually stand out anyway) but to seek a biological explanation.

Mr. BRUMBY: With inevitably small numbers of twins one observation that is out of line may markedly upset an analysis that is otherwise straightforward and clear-cut. Twins may have a value in animal research which cannot be measured by "efficiency" values. For instance we have been able to show that the yield of an animal induced to lactate by hormone therapy is quite closely related to the normal potential of that same animal for milk production—a valuable observation and one difficult to show without twins. I would join issue with Dr. Carter in regard to the value of uniformity trials. Unless one has a measure of the extent of genotype-environment interaction for a character under given circumstances, estimates of genetic variance from a split twin experiment are of dubious value. The extent of the interaction can only be assessed by running both a uniformity trial and split twin experiment, or a time-replicated split twin trial.

Dr. CARTER: I would contend rather that estimates of genetic variance derived from a treatment experiment would be more generally valid than those from a uniformity trial, in view of the known environmental variation in the national dairy herd. Although in theory a joint uniformity and treatment twin trial would provide a measure of treatment-genotype interaction, in practice sampling errors of the relevant variances would be so high as to render the resulting estimate of dubious value; I would strongly favour the time-replicaction approach.

Dr. STEWART: Could not the large differences between standard heritability estimates from field data, and those from twin experiments be in part explained by inclusion in the latter, but not the former, of non-additive genetic effects? Have you any evidence as to the magnitudes of such effects?

Dr. CARTER: Yes, non-additive genetic effects could contribute to the observed differences in heritability. Comparison of estimated genetic variances from the two sources suggests, however, that such effects are not of major importance.

Mr. McFARLANE: I would like to congratulate the speaker on a notable contribution to an important field of animal research. It seems to me most appropriate that Ruakura, which has perhaps led the world in the experimental use of identical twins, should also be the first to objectively review both the advantages and limitations of such important experimental material.