How are distances between grazing cows determined?

M. Shiyomi
Faculty of Science, Ibaraki University, Bunkyo 2-1-1, Mito 310-8521, Japan, Email: shiyomi@ mx.ibaraki.ac.jp

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Introduction Although domestic cows are protected from their natural enemies, they form herds when grazing like their wild forbears did. The herding instinct is used to manage cattle because it is easier to control a herd than separate individuals. This study examined how distances between individual grazing cows are determined.

Materials and methods The coordinates of six Holstein cows in a one-dimensional, fenced grassland of 88 m × 6 m were recorded every 5 minutes (Figure 1a). The cow individuals were numbered A, B, …, F, and distance between two individuals A and B was expressed by A-B or B-A. For each pair of cows, the contribution of each of the five effects was calculated using the sum of squares of data, based on the temporal changes in the distances between individuals.

Model In a grazing herd, complicated interrelationships operate between individuals. We assumed that the distance between any two individuals was based on the following five factors (Figure 1b): the behaviour of the entire herd (measured as the distance between the leftmost and rightmost cows: the herd length effect); repulsive and attractive forces operating directly between two individuals within the herd (direct effect); the effect of third individuals on the distance between two individuals (half-indirect effect); the effect of unconnected pairs on the distance between two individuals (indirect effect); and residual effects that cannot be explained by the other four factors (random/involuntary movement effect). These five factors were analysed using regression analysis.

Results Overall, the random movement effect made the largest contribution (38.8%) to the temporal variation in the distance between two cows, followed by the herd length (25.6%), direct (21.0%), and half-indirect (12.5%) effects. The contribution of the indirect effect was negligible. Contributions of the herd length, direct effects, half-indirect effect and random movement effect between two individuals, measured using sum of squares of temporal variation of distances are shown in Figure 2. The results revealed that one (F) of the six cows was persecuted by the other cows.

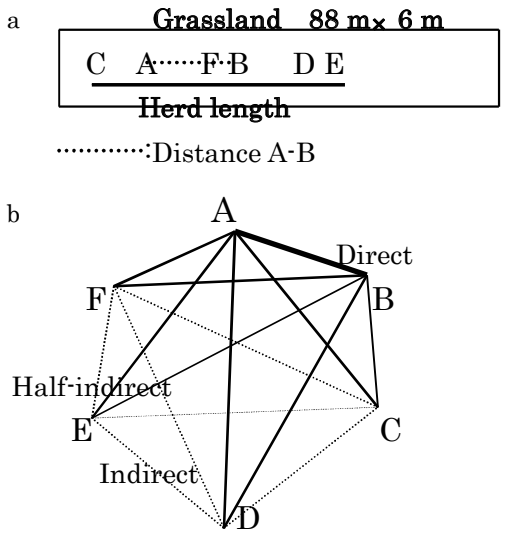

Figure 1 Six cows in a grassland (a), and direct, half-indirect and indirect effects to distance A-B (b)

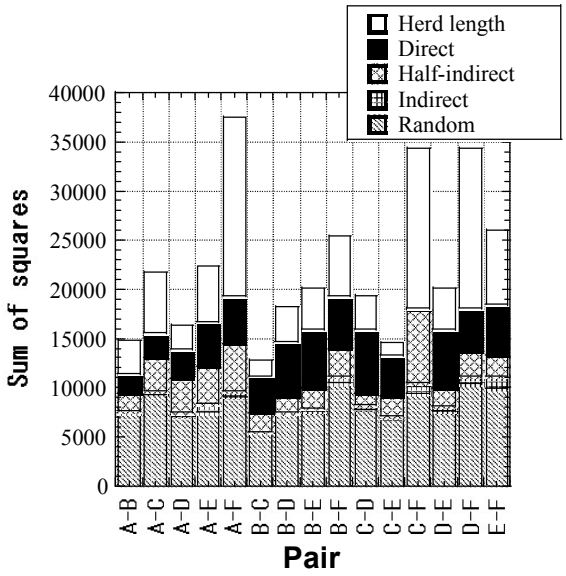

Figure 2 Contributions of the herd length, direct effect, half-indirect effect, indirect effect and random movement effect, measured using sum of squares of temporal variation of distances between two individuals

Conclusions Many mathematical models in crowd formation studies operated on the premise that individuals act like physical particles (*e.g.*, Gueron & Levin, 1993). By contrast, in this study, each individual was supposed to have its own characteristics, although they were not complete.

References

Gueron, S. & Levin S.A. (1993) Self-organization of front patterns in large wildebeest herds. *Journal of Theoretical Biology*, 165, 541-552.