The Auk 114(1):142–143, 1997

Abiotic Factors and Preroosting Behavior of Greylag Geese: Response to Reebs

ALAIN SCHMITT[1]
Konrad-Lorenz-Institut, Austrian Academy of Sciences and Department of Physiology, University of Veterinary Medicine, Vienna, Austria

In a study of the group-living Greylag Goose (*Anser anser*), I tested whether abiotic factors influenced flock synchronization and departure time to night roosts and whether social interactions themselves influenced departure time (Schmitt 1994). I concluded that "abiotic factors determine departure time but do not disturb flock cohesion" (p. 763) and that "none of the variation in departure time is due to variation in social interactions leading to flock synchronization" (p. 762). Reebs (1997), who reviewed my earlier manuscript and made helpful and substantial comments at the time, now reports that many of my conclusions are flawed. Most of his comments are statistical and thus open to debate. I address these comments below.

Reebs' major criticism concerns the correlations that I reported between flock cohesion and departure time (1986: $r = -0.05$; 1987: $r = -0.23$; $P > 0.05$ in both cases; Schmitt 1994:760). Indeed, these data formed much of the support for my conclusions. Reebs recalculated these correlation coefficients based on examination of my figure 3, obtaining r-values of -0.54 ($P < 0.001$) and -0.08 ($P > 0.5$) for 1986 and 1987, respectively. When Reebs compared these values with the numbers that I gave in the text, he noted a large inconsistency. Based on Reebs' (1997) report I recalculated the correlations from my original data and obtained r-values of -0.54 (1986) and -0.04 (1987), which are very similar to the results of Reebs. Thus, the data in my figure 3 are correct, but the correlations given in the text (p. 760), and on which I based my main conclusion, simply are false. I regret these errors and sincerely thank Reebs for bringing them to my attention. The original analyses were performed by a university computing center, and I relied solely on the printouts generated by that agency. The original field notes and the raw data files are in complete agreement, yet the original correlations are incorrect. I cannot determine how these errors originated, but I can say without question that they were completely unintentional.

When I concluded that abiotic factors did not influence group cohesion, I relied on three data sets of different statistical quality that gave slightly contradictory results (i.e. the correlation analyses noted above, a nonparametric ANOVA based on grouped weather data from 1986, and a multiple regression analysis of the 1987 data). I relied most heavily on the correlation coefficients and the 1987 analysis. Reebs identified some potential problems with my multiple regression analysis, including an inappropriate dependency between the variables "illumination decrease" and "departure time." I recalculated the multiple regression as proposed by Reebs (1997). The new analysis shows that the abiotic factors "illumination at sunset" and "day length" account for 43% of the variance in departure time by Greylag Geese, and that group cohesion (i.e. synchronization) does not contribute to variance in departure time (Table 1). I also used "illumination decrease" as a rate, which should reduce the strength of Reebs' interdependency argument. This new variable did not enter into the regression (Table 1). These results support my original conclusion regarding the importance of abiotic factors in determining departure times by geese.

Reebs also noted that I did not perform power analyses. Cohen's (1988) table for r shows that power is high for my sample sizes, however, and at the time I wrote the original paper I was comfortable with my conclusions without having to calculate the power of my tests directly. Reebs is correct in asserting that my original hypothesis should have been tested with a curvilinear regression, or, more precisely, by a quadratic correlation. However, my figure 1 does not suggest any such relationship, a point also noted by Reebs. Nonetheless, I performed quadratic regres-

TABLE 1. Summary of stepwise multiple regression analysis (criteria for entry $P = 0.05$, for removal $P = 0.10$) on departure times of Greylag Geese flocks (1987; $n = 46$).

Variable	R^2 change	Partial correlation	P
Illumination at sunset (LOG[lux])	0.297	−0.54	0.000
Day length	0.136	−0.37	0.006
Temperature at sunset	—[a]	−0.11	0.535
Synchronization of flock	—	−0.14	0.426
Illumination decrease[b]	—	0.28	0.097

[a] Indicates variable did not enter analysis. Total R^2 change was 0.433. Collinearity diagnostics revealed tolerance values >0.95 for all variables (all but "Temperature at sunset" very close to 1).

[b] Difference between values at sunset and at flock departure per unit time.

[1] Present address: Institut für Humanbiologie, Universität Wien, Althanstraße 14, A-1090 Vienna, Austria. E-mail: alain.schmitt@univie.ac.at

sions, and the results provided a poorer fit for each year than did the linear analyses.

I conclude with an interpretation of the correct correlation coefficients between flock cohesion and departure time. Data from the two years yielded contradictory results, one year corroborating (1987) and the other year refuting (1986) my original hypothesis. Reebs (1997) eliminated one point from the 1987 data and obtained a correlation coefficient that also refuted the original hypothesis. I suggest that eliminating one data point, without explanation, is not good statistical practice. Perhaps two or three points should be eliminated, but if so, which ones? Clearly, the problem cannot be resolved without more data that are analyzed with proper statistical practices.

Literature Cited

COHEN, J. 1988. Statistical power analysis for the behavioral sciences, 2nd ed. Lawrence Erlbaum Associates, Hillsdale, New Jersey.

REEBS, S. G. 1997. Abiotic factors and preroosting behavior of Greylag Geese: A comment. Auk 114: 140–141.

SCHMITT, A. 1994. Influence of abiotic factors on preroosting behavior of Greylag Geese (*Anser anser*). Auk 111:759–764.

Received 29 September 1996, accepted 4 October 1996.
Associate Editor: J. S. Marks