THE PREDICTION OF HATCHING DATES OF LAPWING CLUTCHES

by Hector Galbraith and Rhys Green

INTRODUCTION

In breeding studies of precocial species where the young leave the nest soon after hatching, and may become difficult to find, it is useful to be able to predict hatching dates from egg measurements. Furness and Furness (1981) developed a technique based on the reduction in egg density resulting from water loss during incubation, and showed that the hatching dates of Great and Arctic Skuas (*Catharacta skua* and *Stercorarius parasiticus*) could be predicted with respective mean errors of only 1.4 and 1.9 days. Again using change in egg density, Green (1984) presented nomograms intended for use in the field to predict the hatching dates of Redshank *Tringa totanus*, Snipe *Gallinago gallinago*, Lapwing *Vanellus vanellus* and Black-tailed Godwit *Limosa lapponica* clutches. He also showed that an index of egg density was similarly related to time to hatching in three widely separated Redshank populations. This note demonstrates, however, that inter-population differences in patterns of egg weight loss may restrict the applicability of Green's Lapwing nomograms.

METHODS

Data were gathered from 3 sites and in 2 different years: Cambridgeshire in 1982 (the data used for the construction of Green's nomogram, with the addition of five reweighings), and 2 separate Stirlingshire populations in 1984. The Cambridgeshire study area lies at sea level and comprised poorly drained meadow land. One Stirlingshire site comprised arable farmland at 15m above sea level whilst the other was an area of poorly drained rough grazing at 180m (hereafter referred to as the arable and rough grazing sites respectively).

Egg lengths and breadths were measured to the nearest 0.1mm using vernier calipers and weights were recorded to the nearest 0.1g using Pesola spring balances (which were regularly calibrated throughout the study period). An index of mean egg density was calculated for each clutch from: (mean weight/mean length × mean breadth (W/LB²)) × 10⁶. Nests were checked at 5-7 day intervals and those with known hatching dates (for criteria see Green (1984)) chosen for analysis.

RESULTS

A regression of mean egg density against days till hatching revealed differences between populations in patterns of weight loss (Figure 1). Covariance analysis showed that, whereas there were no significant differences between the Stirlingshire arable and Cambridgeshire clutches in either slope ($F = 0.224$) or elevation ($F = 2.669$), the Stirlingshire rough grazing clutches differed significantly from both the arable ($F_{slope} = 4.966$, $p<0.05$; $F_{elevation} = 2.878$, n.s.) and the Cambridgeshire clutches ($F_{slope} = 3.847$, $p<0.1$ (n.s.); $F_{elevation} = 8.204$, $p<0.01$).

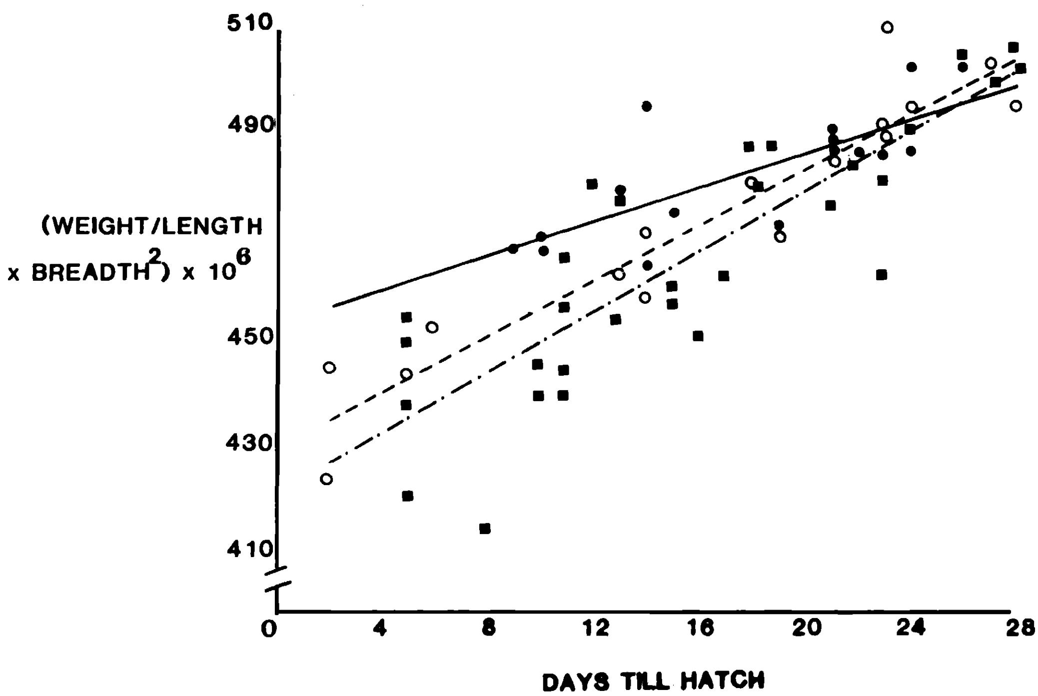

Figure 1. Reduction in mean egg density during incubation. ●—— = Stirlingshire rough grazing clutches (n = 16, $W/LB^2 \times 10^6 = 1.682D + 453.9$); ○ - - - = Stirlingshire arable clutches (n = 16, $W/LB^2 \times 10^6 = 2.634D + 432.0$). ■-·-·= Cambridgeshire clutches (n = 30, $W/LB^2 \times 10^6 = 2.852D + 422.7$) Combining regression equation: n = 62, $W/LB^2 \times 10^6 = 2.670D + 429.5$ where D is days to hatching.

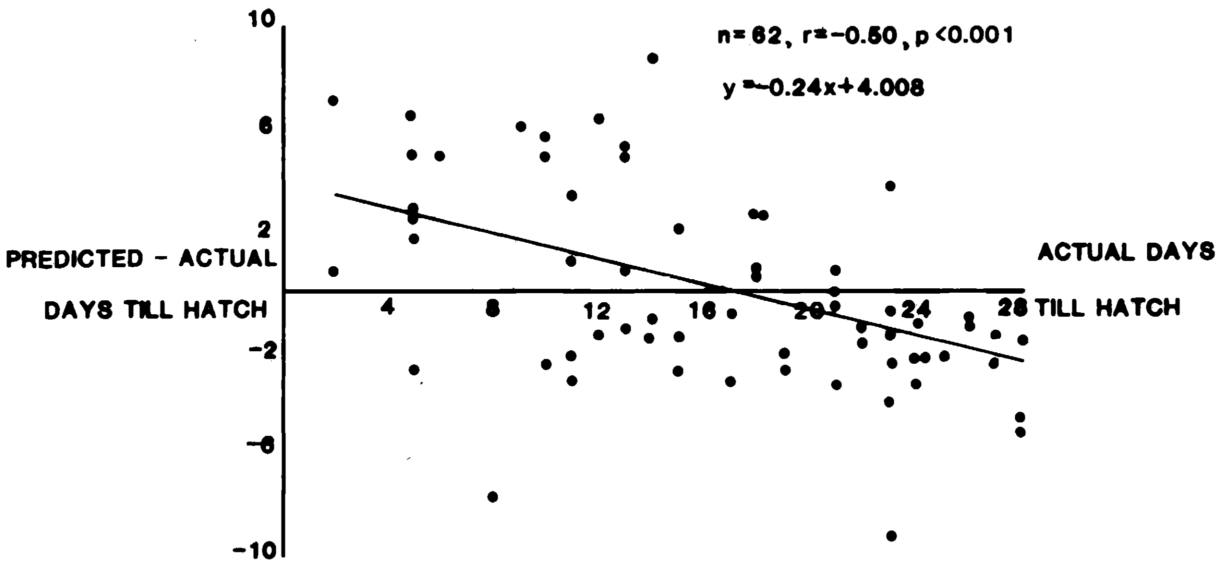

Figure 2. Difference between actual days till hatch and value predicted by regressing days till hatch against $W/LB^2 \times 10^6$.

Although statistically correct, the similarity in slope and difference in elevation obtained in the last resul is misleading because when the lines are plotted (Figure 1) it is obvious that all populations are similar in the value of $(W/LB^2)10^6$ at 28 days from hatching but the clutches from rough grazing lose weight more slowly that the others. The reason for the misleading result of the ANCOVA is that en elevation can be estimated more precisely than a slope from a given body of data.

Figure 1 shows that close to hatching a prediction of hatch date based on the Cambridgeshire data (from which the nomogram in Green (1984) is derived) would give a reasonable estimate for the arable clutches but would overestimate by approximately 8 days for the rough grazing clutches.

A more generally applicable predictor of hatch dates might be obtained by regressing the days till hatch (y axis) against density. This is statistically more valid than rearranging the regression of density on days till hatch. However, when the former is carried out and the deviation from the regression is calculated for each clutch it is found that the predictor is an underestimate in recently completed clutches and an overestimate closer to hatching (Figure 2). When density (y axis) is plotted against days till hatch there is no significant correlation between deviations from the combined regression and days till hatch ($r = -0.03$, $p>0.05$). Density plotted against days till hatch gives, therefore, a more accurate prediction at all stages of incubation. Green (1984) found that this was also the case for Snipe and Redshank.

By manipulating the combined regression equation of density against days till hatch we obtain the predictor equation: days till hatch $= 374532W/LB^2 - 161$ with an overall mean deviation of 3.3 days.

DISCUSSION

It seems that differences exist between populations and that the nomogram in Green (1984) is inadequate for predicting hatching dates in the clutches on rough grazing (except nests found soon after clutch completion). Its general applicability must be questioned.

Van Paassen *et al.* (1984) found that, in the Netherlands, Lapwing eggs attained neutral buoyancy in water (specific gravity 1) eight days after the start of incubation. Assuming an initial specific gravity for Lapwing eggs of 1.059 (Paganelli *et al.* 1974) the day of incubation on which neutral buoyancy is attained can be predicted from the regression given in Figure 1 as: Cambridgeshire 9.7 days, Stirlingshire arable 10.6 days, and Stirlingshire rough grazing 16.5 days.

Hence the results for Stirlingshire rough grazing appear to be markedly different than those from lowland areas. It is worth noting that by applying the same procedure to the data on Black-tailed Godwit clutches in Table 1 of Green (1984) it is predicted that the eggs of this species should attain neutral buoyancy 10.9 days after the start of incubation, which is close to the 11 days reported by Van Paassen *et al.* (1984).

A new nomogram based on the equation $D = 374532W/LB^2 - 161$ is likely to be a more generally applicable predictor of hatching dates than the previously published Lapwing nomogram. Caution should, however, be exercised in its use for two reasons: if inter-population differences in egg weight loss patterns are widespread then there is no assurance that the equation will give unbiased estimates for any given population. Secondly, even if the populations being investigated do conform to the equation, any estimate of days till hatching will be, on average, 3 days out. For this second reason it may be advisable to visit each nest at least 3-4 days before the predicted hatch date and base the timing of further visits on whether or not the eggs show any signs of hatching (eggs which are "starred" will normally hatch within 2-3 days). In this way, precise hatching dates should be obtained for most broods.

Why should the rough grazing clutches lose weight more slowly than the arable or

Cambridgeshire clutches? Possible answers include explanations based on the 160m difference in altitude (with associated differences in climate) or the incubation behaviour of the adults. On 7 occasions during February - late April 1984 air temperatures were recorded to the nearest 1.0°C within 20 minutes of each other at the arable and rough grazing sites. The rough grazing site was, on average, 2.1°C colder (sd=1.463), and it is likely that wind-strengths and rainfall were higher. The possibility of ambient temperature and rainfall affecting egg weight loss was investigated for the Cambridgeshire and Stirlingshire arable sites, from which there were daily temperature and rainfall records. A model in which daily weight loss was a linear function of maximum day temperature and daily rainfall was fitted by least squares but indicated no significant effect of temperature (t^{39} = 0.20) or rainfall (t^{39} = 0.46). Neither was there any significant effect when these two variables were assumed to operate alone. This analysis does not, however, rule out the possible effects of micro-climatic differences in the immediate area of the nest.

Similar analyses for other sites and species would be useful in establishing the extent and causes of inter-population variation.

ACKNOWLEDGEMENTS

This work was carried out while H.G. was in receipt of grants from Glasgow University and the Craignish Conservation Trust and R.G. was employed by the R.S.P.B. We gratefully acknowledge the assistance of these organisations.

REFERENCES

Furness,R.W. and Furness,B.L. 1981. A technique for estimating the hatching dates of eggs of unknown laying date. *Ibis* 123: 98-102.

Green,R. 1984. Nomograms for estimating the stage of incubation of wader eggs in the field. *Wader Study Group Bull.* 42: 36-39.

Paganelli,C.V., Olszowka,A. and AR,A. 1974. The avian egg: surface area, volume and density. *Condor* 76: 319-325.

Paassen,A.G Van, Veldman,D.H. and Beintema,A.J. 1984. A simple device for the determination of incubation stages in eggs. *Wildfowl* 35: 173-178.

H. Galbraith, Zoology Dept., Glasgow University, Glasgow, U.K.
R. Green, RSPB, The Lodge, Sandy, Beds., U.K.

A BIBLIOGRAPHIC NOTE ON WADER PUBLISHING

by Sven Blomqvist

Although the amount of scientific literature has increased considerably during the 20th century (Houghton 1975), there is little documentation on how this increase applies to ornithological literature. In this note, I report on the chronological development of scientific publications in two groups of waders (three genera): *Calidris Limicola* and *Phalaropus*. I also report on a collation of main periodicals where the literature on these birds has been published. The sources of references are two bibliographies on waders recently published by the Ottenby Bird Observatory in Sweden (Blomqvist 1983a, 1983b). The listed references are up to and through 1980. Species covered are those included in the three genera by Voous (1973).

A marked increase during the 1950s, 1960s and 1970s in the number of publications in each group is obvious in Figure 1. The arithmetic means of overall publications per year for each decade have increased by factors of 2.4 between the 1950s and 1960s and by 2.6 between the 1960s and 1970s. Corresponding values for *Phalaropus* are 1.5 and 1.8. The relative increase in the number of *Phalaropus* publications is thus not as high as in *Calidris Limicola*, but still considerable.

The collation of periodicals was compiled by first excluding 100 references to *Calidris Limicola* and 19 to *Phalaropus* from non-periodical books, unpublished university theses and technical reports. The remaining references were listed and ranked in descending order with respect to the total number of papers in each periodical. The 15 journals in which papers occurred most frequently are shown in Table 1. In this table, it can be seen that the majority of papers have appeared in European journals, with with journals from the United Kingdom responsible for more than from any other single nation. This occurs in both *Calidris Limicola* and *Phalaropus*. The 15 journals comprise 45.6% of the total number of papers on *Calidris Limicola* and 50.4% on *Phalaropus*. The rest of the papers are spread through a great number of journals, with no single periodical comprising more than 1.7% of the *Calidris Limicola* papers and 1.1% of the *Phalaropus* articles.

Finally, I have two comments. Firstly, I do not believe that the lower number of publications in 1980 (Fig.1) reflects a representative decrease but rather the difficulty in tracing all new publications. Secondly the frequency of papers (Table 1) has not been weighted to compensate for the influence of differences in journal age, total number of published articles, total number of pages, or more appropriately total text mass, etc.. To do such weightings in a proper and relevant way is a tricky and extremely time consuming task.

I am grateful to Hanna Hill for linguistic corrections to this note.