Nomograms for estimating the stage of incubation of wader eggs in the field

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Introduction

Ornithologists sometimes want to know when the eggs in a nest found during incubation were laid, and when they will hatch. A commonly-used method for the estimation of stage of incubation is to combine the weight (W), length (L) and breadth (B) of the eggs in an index of specific gravity (W/LB^2) which declines with increasing incubation time because of water loss. In this note I describe formulae for calculating dates to hatching (D) from W/LB^2 for four wader species, and a simple method of estimating D in the field if you have left your micro-computer or programmable calculator at home.

Methods

Eggs of Common Snipe *Gallinago gallinago*, Redshank *Tringa totanus*, Black-tailed Godwit *Limosa limosa* and Lapwing *Vanellus vanellus* were weighed to 0.1 g with a 50 g Pesola spring balance and measured to 0.1 mm with dial calipers when the nests were first found. Nests were then checked at 5–7 day intervals. I considered that I knew the date of hatching of a clutch in the following circumstances:

a. if the nest was found during laying, the eggs were assumed to have been measured 24 (Redshank and Godwit), 19 (Snipe) or 28 (Lapwing) incubation days before hatching,
b. if star-like cracks caused by the hatching chicks were seen, the eggs were assumed to have hatched two days later,
c. if holes in the shell or exposed membrane caused by hatching chicks were seen, the eggs were assumed to have hatched next day,
d. if chicks were found in the nest, they were assumed to have hatched on that day.

Once eggs have started to hatch they lose weight rapidly so clutches at this stage were excluded from analysis.

Analysis

The mean W/LB2 for a clutch was positively correlated with D to a similar extent in all four species (Table 1). The Redshank data were collected by three independent teams of observers on a saltmarsh, on a coastal grazing marsh and on inland water meadows in south-eastern England. Slopes and intercepts of linear regressions fitted separately to date from the three sources were closely similar and analysis of covariance revealed no evidence of differences (slopes $F_{(2,42)} = 0.23$; intercepts $F_{(2,44)} = 0.09$).

Formulae for estimating D from W/LB2 were obtained in two ways:

1. W/LB^2 was regressed on D and the linear regression equation rearranged to predict D.
2. D was regressed on W/LB^2 to give the estimation formula directly.

My statistics books tell me that I should use method (2) to predict D. However, when the nest-ageing errors from method 2 were plotted against D I found that there was a significant trend for estimates made early in incubation to be too short and those made later to be too long. There was no such trend for method 1, which I therefore preferred. Table 1 shows the formulae derived by method (1), the standard deviations of nest-ageing errors and the mean absolute errors.

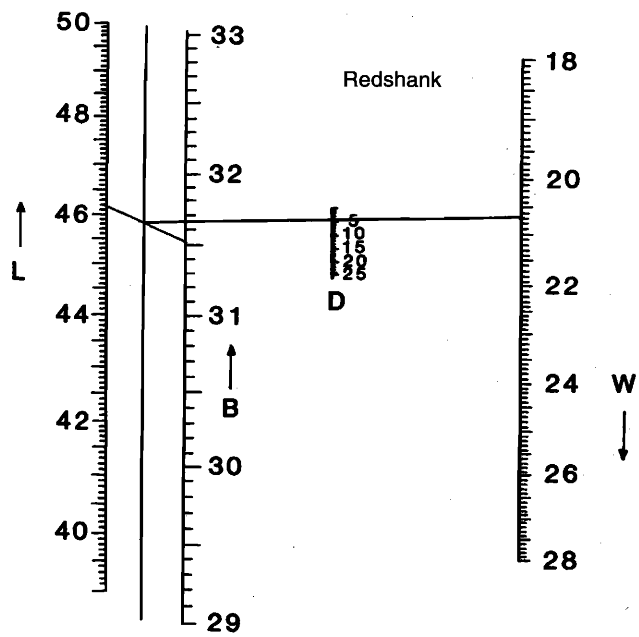

Figure 1. Using the nomogram.
1. Mark the lengths, breadths and weights (L, B and W) on the three scales of the nomogram;
2. estimate by eye and mark the median or average values for L, B and W;
3. join median L to median B by a straight line. Where that line crosses the unmarked axis, mark the point and join it to the median W;
4. read off on the small scale (D), where this lines crosses it, the number of days to hatching.

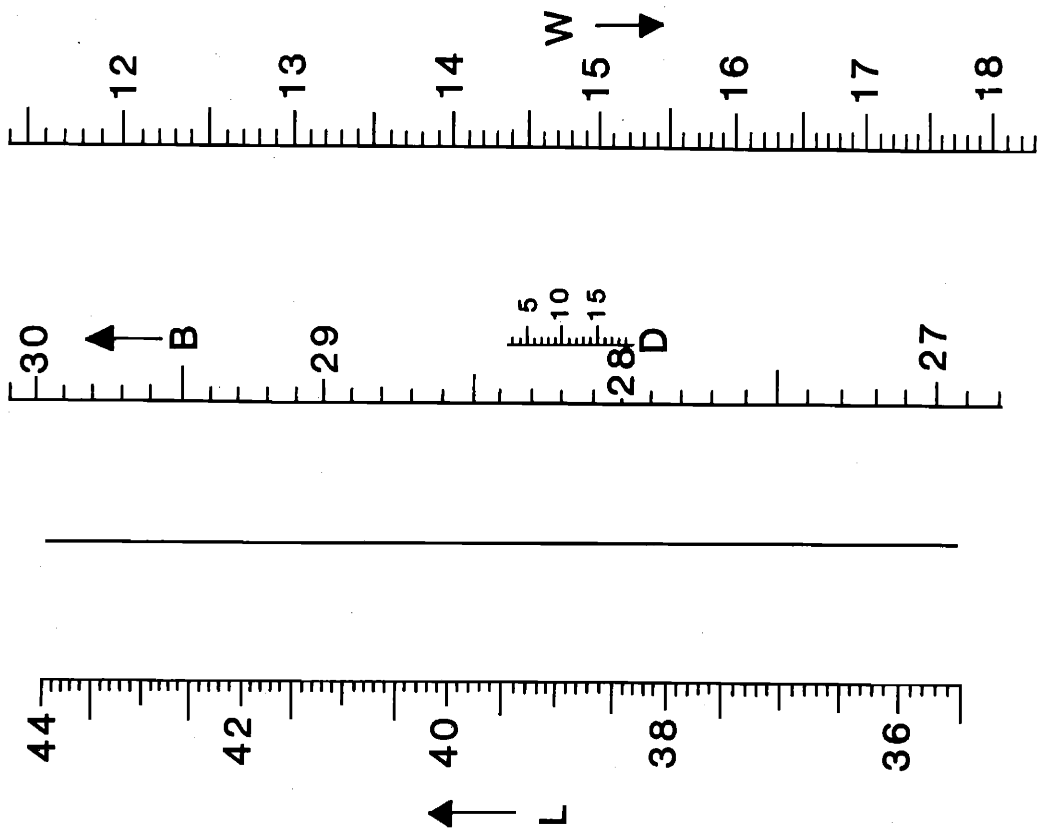

Figure 3. Snipe

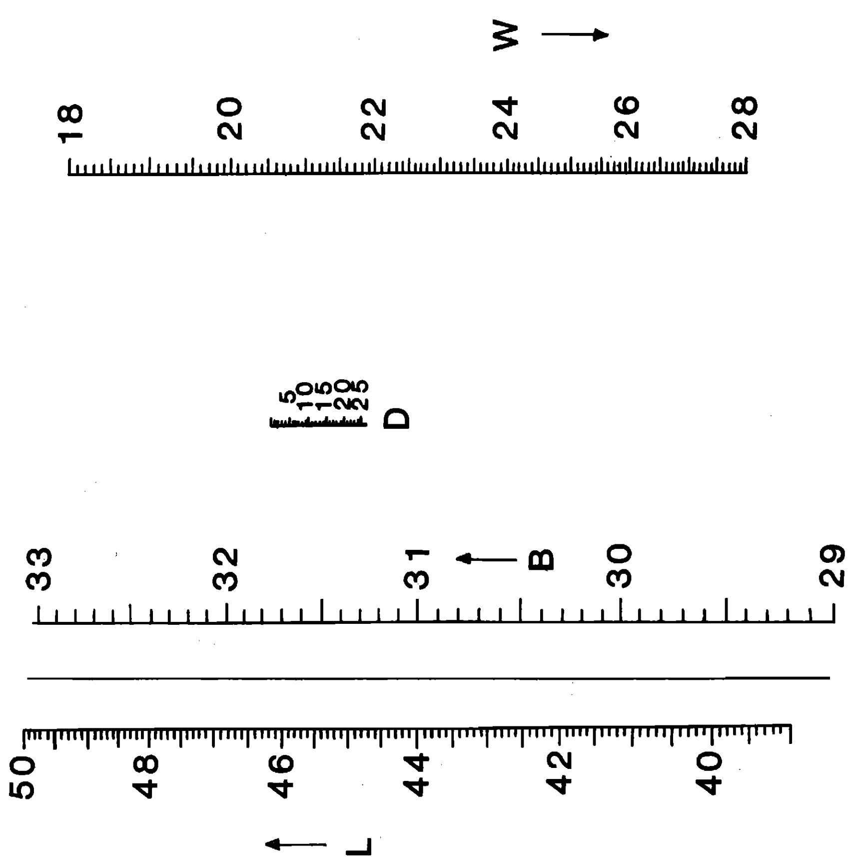

Figure 2. Redshank

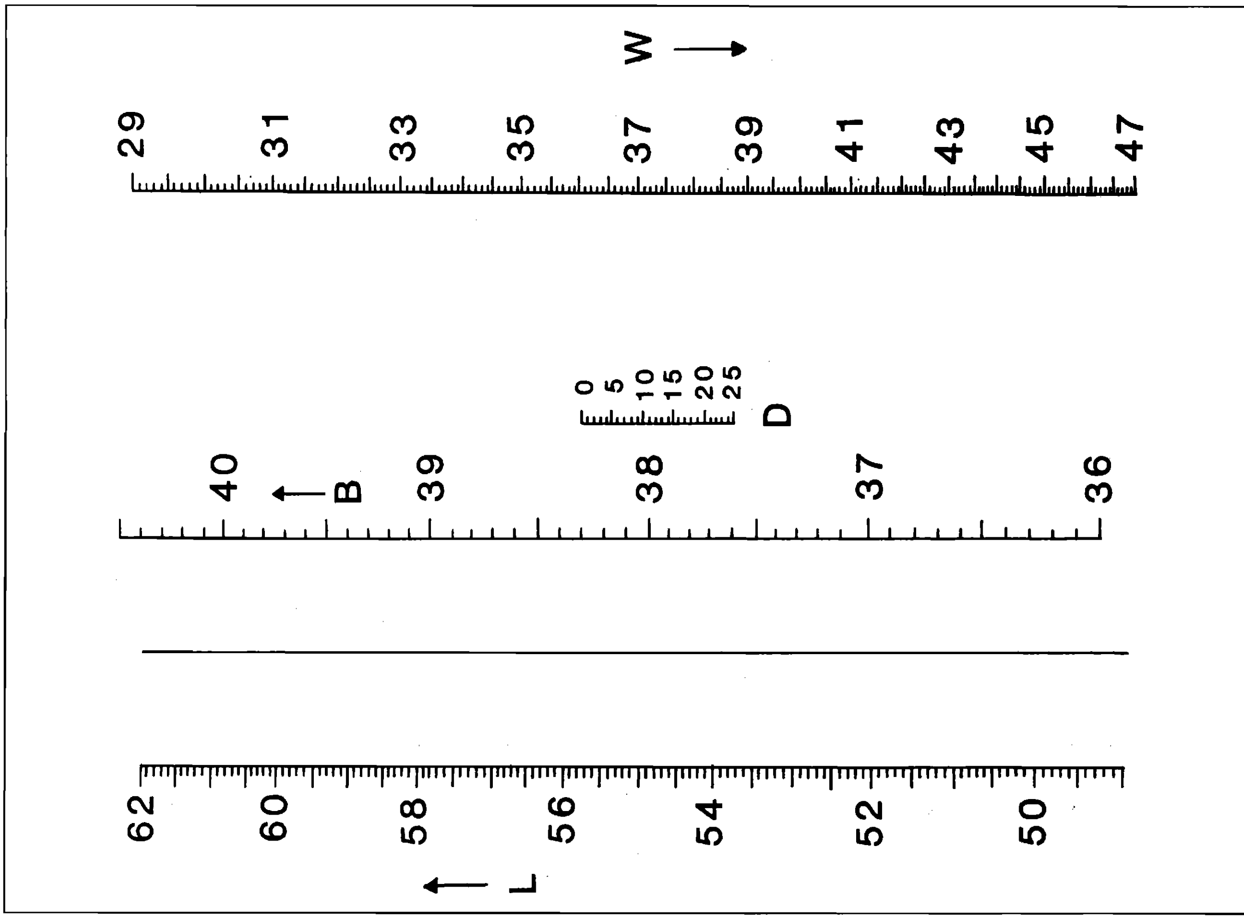

Figure 5. Black-tailed Godwit

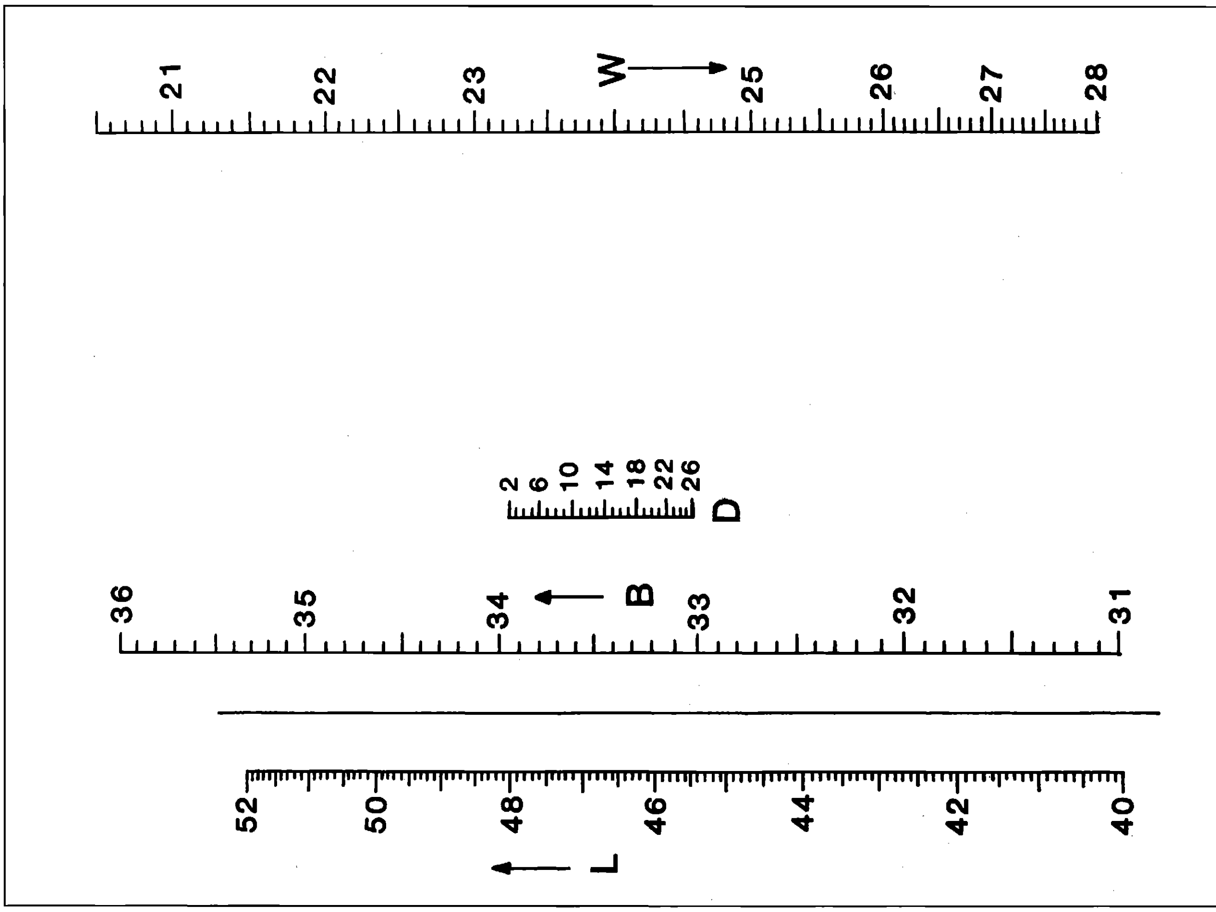

Figure 4. Lapwing

Table 1. Formulae for estimating days to hatching (D) from W/LB^2 measurements (in g and mm).

Species	Formula	r	Error S.D. (days)	Mean error (days)	N (nests)
Common Snipe	$D = 325945\ W/LB^2 - 145$	0.821	3.23	2.54	82
Redshank	$D = 446508\ W/LB^2 - 197$	0.821	3.92	3.13	48
Black-tailed Godwit	$D = 382819\ W/LB^2 - 165$	0.829	4.18	3.24	8
Lapwing	$D = 321337\ W/LB^2 - 133$	0.924	3.21	2.18	25

Nomograms

Simple nomograms are diagrams for carrying out addition and subtraction. They are drawn in such a way that joining values on two parallel scales with a straight line gives the required quantity where the line crosses a third scale midway between the first two. If the scales are logarithmic they can be used for multiplication and division. For estimating the stage of incubation I used two overlapping logarithmic nomograms. The first nomogram calculates LB^2 and the second uses this result and W to calculate D. Fig. 1 gives instructions for using the nomograms and Figs 2–5 show nomograms for Snipe, Redshank, Lapwing and Black-tailed Godwit. A copy of the nomograms can be covered with adhesive-backed transparent plastic film and inserted into a field notebook. The diagram can then be marked with a water-soluble overhead projector pen and wiped clean after each use. Nomograms used over 100 times are still in good condition. Estimating D from measurements on nest record cards (four egg clutches) took me an average of 41 second per clutch (range 34–48 N=10) using a nomogram, compared with 40 second per clutch (range 38–42, N=10) using a micro-computer.

A good alternative method for estimating the incubation stage of wader eggs, which can give an instant result in the field, is to judge the degree of flotation of eggs in water in a transparent container (see Paassen *et al.* 1984). This method is accurate and quick in experienced hands, but if eggs are being weighed and measured for other reasons then the use of the W/LB^2 nomogram will probably save time and inconvenience.

Acknowledgements

I am grateful to Steve Carter for redrawing the nomograms.

References

van Paassen, A.G., Veldman, D.H. & Beintema, A.J. 1984. A simple device for determination of incubation stages in eggs. *Wildfowl* 35: 173–175.

The prediction of hatching dates of Lapwing clutches

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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 & 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 was gathered from three sites and in two different years: Cambridgeshire in 1982 (the data used for the construction of Green's nomogram, with the addition of five reweighings), and two 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 15 m above sea level whilst the other was an area of poorly drained rough grazing at 180 m (hereafter referred to as the arable and rough grazing sites respectively).

Egg lengths and breadths were measured to the nearest