Partial primary moult in first-spring/summer Common Sandpipers *Actitis hypoleucos*

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This note is intended to draw the attention of wader catchers to the need for careful examination of the primaries of Common Sandpipers *Actitis hypoleucos*, and other waders, for partial primary wing moult. This is thought to be a diagnostic feature of waders in their first spring and summer (Tree 1974).

While members of the Tay Ringing Group were mist-netting in Angus, Scotland, during early May 1980, a Common Sandpiper died accidentally. This bird was examined and measured, noted as an adult, and then stored frozen until it was skinned, 'sexed', and the gut contents removed for analysis. Only during skinning did we notice that the outer primaries were fresh and unworn in comparison to the faded and abraded inner primaries. The moult on both wings was uniform, with the five outer primaries having been replaced, i.e. a moult score of $0^5 5^5$ (Figure 1). In addition, the tenth secondary and first tertial had been replaced. The contrast between the old and new feathers in the primaries was easy to see, but was less obvious in the secondaries and especially the tertials, as occurs also with Semipalmated Sandpipers *Calidris pusilla* that have partial moult (Gratto & Morrison 1981).

Prater *et al.* (1977) state that in first-winter Common Sandpipers in the tropics and southern hemisphere "a small percentage moult outer primaries only". However, after examining the original sources, we feel that Prater *et al.* have greatly under-estimated the occurrence of partial moult in first-year birds. In Kenya, first-winter birds renew most of their flight feathers between January and March. The moult usually proceeds outwards from the fourth or fifth primary, and the old inner feathers are often retained (Pearson 1974). Similarly, in Zimbabwe, first-year Common Sandpipers replace the outer five to seven primaries between December and April (Tree 1974). It thus seems normal for first-spring/summer Common Sandpipers wintering in east and southern Africa to show a contrast between new outer and old inner primaries. There is no information for birds wintering further north. However, there may be differences in moult strategy between wintering areas, since 3 of 23 juvenile Common Sandpipers caught during autumn in Morocco had well-advanced primary moult (Pienkowski *et al.* 1976). These birds were moulting normally, and so may have completed a full primary moult during their first winter (M.W. Pienkowski, pers. comm.).

Do first-summer Common Sandpipers regularly return to the breeding grounds? Holland *et al.* (1982) recorded four birds, ringed as chicks, which bred successfully during their first summer. Delayed recruitment in this population was considered unlikely. The bird from Angus (Figure 1) was a male, and its testis size suggested that it was capable of breeding. During the 1982 breeding season, 3 (19%) of 16 Common Sandpipers that we caught in Glen Lethnot, Angus, showed partial primary moult, their moult patterns being $0^4 5^6$, $0^5 0^5$, and $0^6 5^4$. So some Common Sandpipers do return to breed in their first summer, and at least some have partial primary moult.

We can find no other reports of Common Sandpipers showing partial primary moult on the breeding grounds, or on spring or autumn passage. However, it seems probable that it is a feature that is being missed by ringers. For example, Brown (1973) mentioned no examples of partial primary moult amongst 200 adult Common Sandpipers mainly from Britain that had been examined for moult. Also the bird we examined would have been released as an adult, if it had not died. We feel that with more vigilance, ringers will find partial primary moult to be common in first-year Common Sandpipers on the breeding grounds, Indeed, partial primary moult may be widespread amongst first-year waders, since it has been found also in Curlew Sandpipers *Calidris ferruginea*, Ruffs *Philomachus pugnax*, Marsh Sandpipers *Tringa stagnatilis*, Greenshanks *Tringa nebularia* and Wood Sandpipers *Tringa glareola* wintering in Zimbabwe (Tree 1974). In Hardangervidda, Norway, in June 1982, members of the Joint Tay/Grampian Expedition nest-trapped a female Ruff showing partial primary moult ($0^7 5^3$), and a Dotterel *Charadrius morinellus* with a primary moult pattern of $0^7 5^2 0^1$ on both wings. All the old feathers on this latter bird appeared the same age.

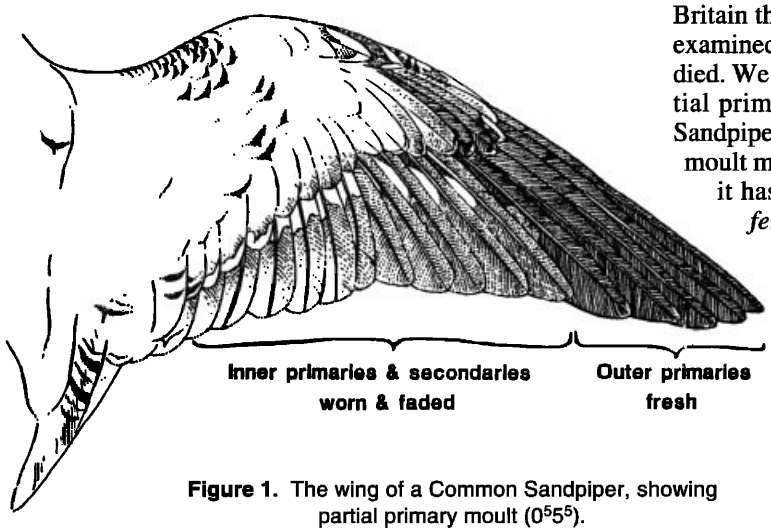

Figure 1. The wing of a Common Sandpiper, showing partial primary moult ($0^5 5^5$).

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Estimating the parameters for primary moult – a new statistical model

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Introduction

It has long been recognized that the regression methods that have been used to estimate the parameters of primary moult are unsatisfactory (see for example Pimm (1976)). Summers *et al.* (1983) compared seven regression methods, most of which have recently been used in the analysis of moult, for estimating the starting date, completion date and duration of moult. Their estimates of starting date varied from 29 June to 31 July (32 days), of completion date from 2 to 24 October (22 days), and of duration from 72 to 109 (37) days for the Redshank *Tringa totanus*. There is obviously a need for a standard and statistically sound method.

Ordinary linear repression

The simplest technique for estimating the parameters of moult (starting and completion dates and duration) is to fit a linear regression of moult score on date, using all birds actively moulting. The reason for the poor performance of linear regression in this case is straightforward. One of the underlying assumptions of least squares regression is that the variance (variability) of the dependent variable (moult score) is the same for all values of the independent variable (date). This assumption is grossly violated, since active primary moult scores lie between 1 and (usually) 49, so that near the commencement and conclusion of moult there is less variability in moult score than during the middle of the moult period (Figure 1). The technical term for lack of constant variance is heteroscedasticity. The regression line runs diagonally across the long axis of the parallelogram that encloses the scatter of points, effectively giving the starting and completion date of the first and last birds respectively in the population, rather than the average bird (Figure 1), (see also Summers *et al.* 1983). Most of the other methods considered by Summers *et al.* (1983) are *ad hoc* attempts that have been devised to overcome heteroscedasticity.

One approach which does apparently eliminate the problem of heteroscedasticity is to reverse the roles of date and moult score, treating moult score as the independent variable and date as the dependent variable (Pimm 1976). This is logically absurd, as there is no sense in which date depends on moult score. The bird-ringer chooses the dates on which to catch birds, and observes the scatter of moult scores in the sample caught on these dates. (Unless birds are caught at

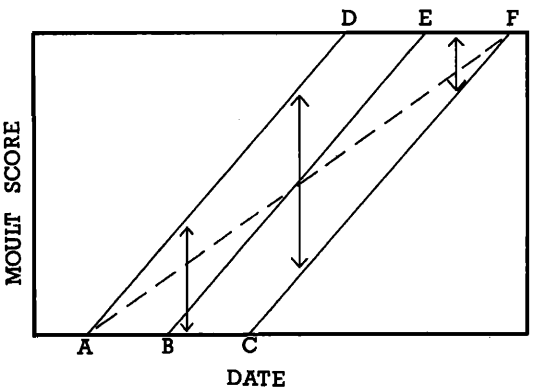

Figure 1. In a plot of moult score against date, the points generally lie within a parallelogram ACFD. The "average bird" is depicted by the line BE. The arrows demonstrate that the variability of moult score is not constant for all dates (see text). Ordinary linear regression gives the dashed line, indicating the starting and completion dates for the first and last birds, respectively, in the population, rather than the average bird.