and may account for the complex ecological strategies used by resting Ruffs. Situations resembling those in Tuscany are probably those more typical of Italy.

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BODY CONDITION OF PURPLE SANDPIPERS *CALIDRIS MARITIMA* WINTERING IN NORTH-EAST ENGLAND

Nick Davidson

"A little information can go a long way" (Anon)

INTRODUCTION

Most wader species overwintering in Britain and elsewhere in the northern temperate zone store reserves of fat and body protein during winter, usually interpreted as an insurance against food shortage and high energy demands during severe winter weather (*e.g.* Davidson 1981). Reserves of fat generally rise to a peak in midwinter (December-January) before declining to minimum levels in March. Those birds that migrate north to breed then begin to store pre-migratory reserves of varying amounts. These seasonal variations in body condition are most readily seen as variations in total body mass (e.g. Johnson 1985).

Purple Sandpipers winter further north than any other wader, occuring well north of the Arctic Circle in places such as northern Norway (Summers *et al.* 1990). They are close to the southern limit of their wintering range in Britain (Cramp & Simmons 1983) and are unusual amongst the British wader fauna in having no marked midwinter peak in their total mass although mass does increase before migration in spring (Atkinson *et al.* 1981). The inference of this pattern of mass variation is that Purple Sandpipers carry only small fat reserves during winter. Since there have been no published analyses of the body condition of Purple Sandpipers the size of the nutrient reserves represented by body mass at different times of year remains, however, speculation.

This note reports the body condition of an extremely small sample (four birds) of wintering Purple Sandpipers in Britain. Despite its size the sample provides the interesting information on protein reserves and lean mass in relation to body size, and first confirmation that the fat loads in winter are indeed small in comparison to those of other wintering waders.

The birds were adults and collected as accidental casualties of catching operations at St. Mary's Island on the Northumberland coast of north-east England on 20 March 1981, a time when fat loads of waders are generally at their smallest. Carcasses were analysed for fat reserves and protein reserves (represented by the size of the pectoral muscles) using standard techniques (Davidson 1981, Piersma *et al.* 1984).

BODY SIZE

The sample consisted of three males and one female. Bill-lengths (Table 1) of the males were between 24 and 26.5 mm, in the range of the 'short-billed' males identified as Norwegian breeding birds by Atkinson *et al.* (1981). The female was very large, and within the range of the 'long-billed' females breeding in Iceland and possibly Greenland or Canada (Nicoll *et al.* 1988).

BODY CONDITION

Total body mass and body condition are summarised in Table 1. The lipid indices of males ranged between 5.3 and 7.7%, with an average 6.7%. The single female had a similar fat load of 6.0%. These fat loads are similar to the late winter fat levels of most other waders wintering in Britain, which average 5-8% fat (Davidson 1981a,b).

The pectoral muscles form a large part of the

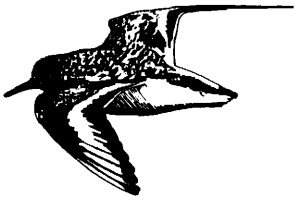

Table 1. Body size and condition of four adult Purple sandpipers[a]. Values are mean±standard deviation.

	male	female
n	3	1
bill-length mm	25.3±1.26	32.5
wing-length mm	125.3±1.53	136
total body mass g	61.1±1.57	83.6
total lean mass g	57.0±1.96	78.6
total lean dry mass g	18.5±0.99	23.6
lipid index %[b]	6.7±1.21	6.0
SMI[c]	0.341±0.014	0.304

[a] birds collected in Northumberland, 20 March 1981.
[b] lipid index = fat mass/total body mass %
[c] Standard Muscle Index (SMI) = pectoral muscle lean dry mass/Standard Muscle Volume. Standard Muscle Volume is calculated from four sternum and coracoid bone measurements (see Piersma *et al.* 1984)

Table 2. Least-squares regressions of measures of body mass (log_{10} g) and bill-length (log_{10} mm) for four Purple Sandpipers collected in Northumberland on 20 March 1981. Values are mean ± standard error.

	coefficient	constant	r^2
A. total body mass	1.090±0.360	0.260±0.516	0.82
B. total lean dry mass	1.110±0.389	0.203±0.557	0.80
C. total lean dry mass	0.889±0.294	0.021±0.421	0.82
D. pectoral muscle mass[a]	0.786±0.326	-0.528±0.407	0.74

[a] lean dry mass of both pectoral muscles

fat-free mass of the Purple Sandpipers: between 19.9-20.7% of the total lean dry mass. The size of the pectoral muscles gives an index of protein reserves, when the size of the skeletal attachment of the muscles is taken into account in the Standard Muscle Index (SMI).

Pectoral muscles sizes were substantial: between 0.325 and 0.350 SMI in males (average 0.341 SMI - Table 1), and 0.304 in the female. These are rather larger than the winter pectoral muscle size of other *Calidris* sandpipers wintering in Britain, for example

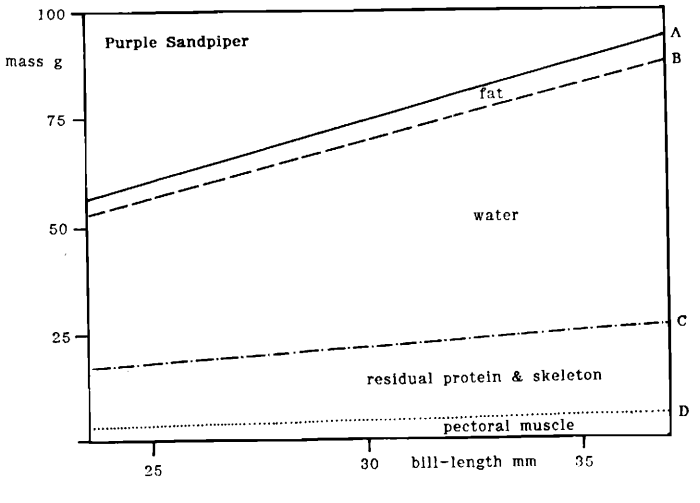

Figure 1. Body composition of Purple sandpipers in relation to body size, as measured by bill-length. Regression formulae for lines A, B, C and D are listed in Table2.

Dunlins 0.273 SMI, Sanderlings 0.270 SMI and Knots 0.286 SMI, but similar to the muscle size of some plovers (Davidson 1981a,b).

Purple Sandpipers wintering in Britain are a heterogeneous population with substantial variation in body size (Atkinson *et al.* 1981, Nicoll *et al.* 1988). It is therefore difficult to apply these condition levels to the total masses reported from ringing studies. Figure 1 provides a very preliminary assessment of the contribution of the various components of body composition to variation in total body mass of birds of different body size in late March. The least-squares regressions on which this figure is based are given in Table 2. Differences in body size as measured by bill-length account for a very substantial part of the mass variations (r^2 = 0.74-0.82) although the very small sample size means that none of these correlations is statistically significant at the 5% level. Nevertheless the trends provide a useful first indication of lean mass and fat levels in relation to body size and the regression for total body mass on bill-length has a similar slope (1.09) to those of much larger samples from Orkney (0.85) and north-east Scotland (0.82) (Summers 1989).

This very limited analysis does confirm that the pattern of steady total mass of Purple Sandpipers in winter is a consequence of the maintenance of only small fat reserves in comparison with other waders in Britain, although this may in part be compensated by the storage of larger protein reserves than in congeners. Although fat loads remain low throughout the winter Purple Sandpipers do undergo premigratory fattening in spring. Atkinson *et al.* (1981) show an increase in total body mass of 18.7% between March and mid-

May (when birds depart for their breeding grounds) in north-east Scotland. Assuming that fat loads in March are the same as the average 6.5% of total body mass in the Northumberland sample and that all the spring increase is fat, fat loads at spring departure would be approximately 21%, certainly sufficent for a flight to breeding grounds in northern Scandinavia or Iceland.

Confirmation of these patterns must, however, await information on the body condition of larger samples than those available to me. If anyone else has undertaken condition analyses of Purple Sandpipers I would be please to hear from them.

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SHOREBIRDS (CHARADRIIFORMES) OF THE PICHAVARAM MANGROVES, TAMIL NADU, INDIA

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INTRODUCTION

Of the different types of coastal wetlands, Mangroves are one of the most productive ecosystems (Parish 1987). Mangroves harbour many invertebrate and vertebrate species, and due to their high productivity and foliage could also provide food and roosting sites to a large number of species of birds. There is an extensive literature on the general importance of coastal wetlands. However, there have been only a few studies on the shorebirds of most Asian countries, although information on the population structure of shorebirds of Eastern Asia and Pacific region is available (Parish & Wells 1984, 1985; Howes *et al.* 1986; Parish *et al.* 1986, 1987). In India, population structure has been investigated by Ali (1981, 1986), Ali & Hussain (1981, 1982), Ali & Sugathan (1985) and Hussain *et al.* (1984). The Pichavaram mangroves, the shorebirds of which are dealt with in the present paper, is among India's notable mangroves, and is especially important as a wintering area for birds. Appreciable number of many species of birds annually migrate from arctic Siberia to wintering grounds in India *en route* passage to Australia.

Location of the study area

The Pichavaram mangroves (11°29'N; 79°49'E) is located on the south east coast of India (Bay of Bengal) near Chidambaram in South Arcot District of Tamil Nadu (Figure 1). This mangrove area also includes 50 islets scattered over an area of 11 000 ha. These islets are separated by intricate waterways, and gullies traversing the wooded portion of the mangroves. Freshwater drains into the canal from the irrigation system of the delta. Some of the islets are vegetated and others unvegetated.

Edaphic character of the mangroves

In these mangroves, the area of waterways comprised of about 40% and forest 50% of the total area. The remaining 10% is sand flats, mud flats and oyster beds (Krishnamurthy & Jeyaseelan 1983).

i) Sand flats

There are three flats each with an area of 1 ha. These flats are located near the sea (Figure 1). They are profusely sandy in nature