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Lipid metabolite levels among pre-migratory Palaearctic songbirds during the wet–dry season transition

The significance of the rate of fat deposition prior to migration has long been recognised, particularly in relation to songbirds preparing to cross the Sahara (Smith 1966, Fry *et al*. 1970). Based on trends in mean weight in pre-migratory populations, I recently speculated that fat deposition proceeds more slowly in dry than in wet season conditions, and that this in turn has a critical influence on the migration patterns of many trans-Saharan migrants (Bell 2006, 2007). The main drawback of these studies is that measures of mean weight in a population are subject to many sources of bias. A more reliable source of evidence would be provided by comparisons based on estimation of individual fattening rates, as indicated by the level of triglyceride in blood plasma (Jenni-Eiermann & Jenni 1994). A small number of blood samples of songbird migrants, taken during the dry-wet season transition period in central Nigeria, provide an opportunity for a preliminary investigation along these lines.

Blood samples were taken from Palaearctic migrants mist-netted in the grounds of the National Veterinary Research Institute on the Jos Plateau in central Nigeria (9°43.7´N, 8°47.1´E), between 25 Mar and 12 Apr 2007. Fat score was also recorded using a standard eight point scale (Bairlein 1995) to assess how far fattening had progressed in each bird. Nets were kept under constant surveillance and the interval between a bird entering the net and the taking of a blood sample (bleed time) recorded. Blood was obtained by brachial venipuncture, and the samples centrifuged at 2000 g for 10 min. Plasma triglyceride was then assayed using an Ultrospec 4000 Spectrophotometer following a standard test procedure (Serum Triglyceride Determination Kit: Sigma Product code TR0100).

Twenty trans-Saharan migrants of six species were sampled during the period 1–5 h after local sunrise, and estimates of plasma triglyceride concentration were obtained from 14 birds of five species. The results show increases in both triglyceride levels and fat score (Fig. 1, Table 1), with a possible accelerating rate of triglyceride level after heavy rain on 3–4 Apr. Bleed time varied between nine and 35 minutes, and triglyceride may have declined with increasing bleed time (Table 1), perhaps due to capture stress or short-term fasting (Guglielmo *et al*. 2002). No significant effect of species or time of day was detectable for either fat or triglyceride (Table 1).

The beginning of the rainy season on the Jos Plateau marks an abrupt transition for resident birds, many of which begin to breed, and for Palaearctic migrants preparing for the trans-Saharan leg of their northern migration. Very little rain falls between October and March, generally broken in early April by heavy thunderstorms over a few days (Smith 1966, Bell 2007). At Vom in 2007, a 10-minute shower on 3 Apr was followed by periods of heavy rain lasting > 1 h on each of the following four days (Fig. 1). Following the first of these heavy showers in the early afternoon of 4 Apr, alate termites emerged in large numbers and many species switched to flycatching, even species ill-suited to this foraging mode, such as African Thrush *Turdus pelios.*

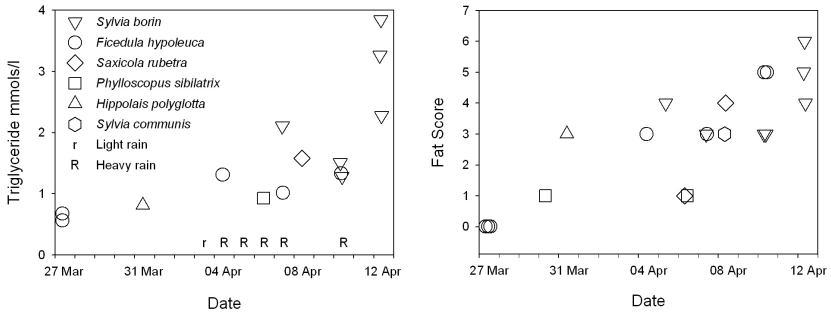

Figure 1. Plasma triglyceride concentrations and fat scores among Palaearctic songbird migrants at Vom, Mar–Apr 2007.

Palaearctic migrants were relatively scarce prior to the rains, with only six birds entering the mist-nets in 10 days up to and including 4 Apr, but became much more numerous afterwards, with 14 caught in the subsequent eight days (scaled deviance of daily frequency, before vs after rains = 3.93, $P < 0.05$, using Poisson errors and $\log_e$ link). This corresponds with the observations of Smith (1966), who found that species such as Garden Warbler *Sylvia borin*, Pied Flycatcher *Ficedula hypoleuca* and Whinchat *Saxicola rubetra* occurred at Vom in small numbers throughout the winter, but appeared in larger numbers in April each year. It is likely that this annual influx reflects a tendency for birds that pass most of the winter further south to follow the rain front north to fatten for migration on the insect outbreaks that occur when the front reaches areas with a lengthy dry season.

Many of these birds may have already accumulated some fat further south, and the Vom birds with significant fat deposits prior to the rains may conceivably be early arrivals. Whether these birds were local winterers or not, the low triglyceride levels

Table 1. Analysis of covariance of plasma triglyceride concentration and fat score. Triglyceride analysis uses a $\log_e$ link function and gamma errors, fat score normal errors and identity link. All analyses were carried out using Glim (Crawley 1993).

	Triglyceride					Fat Score				
	DF	**SS**	**F**	**P**	**Value**	**DF**	**SS**	**F**	**P**	**Value**
Error	6	0.397				11	12.533			
Species	4	0.186	0.704	0.617		5	6.099	1.071	0.427	
Bleed time (min.)	1	0.428	6.474	0.043	–0.039	1	1.037	0.910	0.361	
Time of day	1	0.0423	0.639	0.844		1	0.414	0.362	0.559	
Date	1	0.526	7.946	0.030	0.053	1	33.44	29.359	0.0002	0.274

exhibited prior to the first rainfall suggests that fat was being accumulated locally at a slow rate, only increasing after the appearance of termites and general increase in insect activity. It could be concluded from this that the beginning of the rains stimulates migrants to begin fattening in earnest. However this would mean that they either fatten at a slower than achievable rate prior to the rains, which is unlikely if the birds are following a time minimisation strategy (Alerstam & Lindström 1990), or that slow fattening reflects constraint by food shortage. After the rains, by contrast, the concentration of plasma triglyceride in Garden Warblers reached levels comparable with pre-migratory birds of the same species fed *ad libitum* in the laboratory (Jenni-Eiermann & Jenni 1994). This also corresponds to the findings of Smith (1966), that weights of migrants at Vom were lower at equivalent dates during a year when rains occurred later than usual.

Ottosson *et al*. (2005) present evidence that Garden Warblers are generally absent from further north in W Africa during the spring migration period, and suggest that they select more wooded areas well south of the desert from which to depart on the trans-Saharan leg of migration. However habitat may be less relevant than food availability in relation to the timing of migration. For species like the Garden Warbler, which have a relatively late spring migration, the latitude reached by the rain front in early April may define both the optimal latitude for pre-migratory fattening, and the northern limit of the wintering range. For earlier departing species and populations, the food glut accompanying the beginning of the wet season in the south of the W African savanna belt occurs too late, and the need to minimize the cost of migration therefore leads to winter occupation and pre-migratory fattening in areas well to the north.

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Low altitude sightings of the Gulf of Guinea Thrush *Turdus olivaceofuscus xanthorhynchus* on Príncipe Island

Príncipe Island, with an area of 139 km^2, lies 220 km from the African coast and 146 km north of São Tomé Island, in the Gulf of Guinea (Fig. 1). Príncipe comprises a flatter region in the north, where the majority of the human population live and agriculture is common, and a more mountainous region in the centre and south of the island, with the highest mountain, Pico do Príncipe, reaching 948 m. Significant areas of primary rainforest remain only in the south, totalling *c.* 50 km^2 (Christy 2001). As one of the Gulf of Guinea islands, Príncipe is part of a globally important area of avian endemism (Jones 1994, Bibby *et al.* 1992, Fishpool & Evans 2001).

The Gulf of Guinea Thrush *Turdus olivaceofuscus* is endemic to São Tomé and Príncipe, with a separate subspecies described for each island. On São Tomé, *T. o. olivaceofuscus* is relatively widespread and common, being present almost wherever there is tree cover, from primary rainforest to urban gardens (Jones & Tye 2006). However, the species has been listed as Near-Threatened (IUCN 2006) as the Príncipe subspecies *T. o. xanthorhynchus* has been recorded on only a handful of occasions, and its status is unclear. One specimen collected in 1901, four in 1928, a photograph in 1997, one or two unpublished reports, and several unsuccessful expeditions to find