Habitat use and population density of the endemic bird fauna of São Tomé.

An Expedition Report May 2002

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Introduction

In the first comprehensive analysis of avian biodiversity worldwide, carried out by the then International Council for Bird Preservation (now BirdLife International), the three oceanic islands of the Gulf of Guinea emerged as of global importance. On the basis of their high levels of avian endemism Príncipe, São Tomé and Annobón were included among 218 Endemic Bird Areas (EBAs) worldwide. For oceanic islands, Príncipe and São Tomé were rated highly, in the top 25% of EBAs, for their species-richness. Each supports more than twice the number of restricted-range bird species than would be predicted from their land area alone. The rainforests of south-western and central São Tomé were ranked second in a list of 75 of the most important forests for conservation in tropical Africa. This was mainly due to the high number of threatened endemic species they contain.

São Tomé itself contains 16 single island endemics and a further 5 species which are near-endemics (shared with the neighbouring island of Príncipe). Two monospecific genera are endemic to São Tomé, *Amaurocichla* and *Neospiza*. The level of endemism is high. 57% (28 out of 49) of the breeding landbirds are either endemic species or subspecies.

São Tomé lies 255 km off the coast of Gabon and has an area of 857km^2. It is the larger of the two islands that make up the Democratic Republic of São Tomé and Príncipe. There is still a substantial area of primary rainforest on the island, together with large areas of secondary forest and cultivation. Some of the endemic bird species, such as the São Tomé paradise flycatcher *Tersiphone atrochalybeia* and the São Tomé prinia *Prinia molleri* have adapted well to anthropomorphic habitat change and are common. However, several endemic species are restricted to primary forest only. These species are of particular conservation interest as their population sizes are likely to be small (although they are unknown), and the habitat available to them is believed to be restricted to lowland rainforest, of which there is little remaining.

Rainforest on São Tomé has been described in three altitudinal layers. The lower rainforest region extends up to 800m. The region has been mostly cultivated except for along the rivers São Miguel, Ana Chaves, Xufexufe and Io Grande. The montane forest region (from 800m to 1400m) is fairly intact in the south west of the island. It has received little attention from ornithologists. Finally the mist forest region (1400m-2024m) consists of stunted trees with an open canopy is similarly poorly surveyed.

Four rare endemics, the São Tomé Fiscal Shrike *Lanius newtoni*, Dwarf Olive Ibis *Bostrychia bocagei*, the São Tomé Short-tail *Amaurocichla bocagii* and the São Tomé Grosbeak *Neospiza concolor* have only been seen in primary forest. Recent surveys in the 1990s rediscovered the four species. Their distribution is believed to be restricted to low-lying areas (below 450m). It has been difficult to estimate the range and population sizes of the rare endemics. If they are restricted to low-lying primary forest, then their population sizes and range is likely to be very small.

Aims

The primary aim of the project was to add to the generally poor knowledge surrounding the distribution, habitat use and population density of the endemic bird fauna of São Tomé. This was done by evaluating abundance and attempting to describe the habitat requirements the bird fauna. A secondary aim was to gather valuable morphometric data by catching and measuring as many of the endemic speices as possible.

Methods

Data on the distribution and abundance of the endemic avifauna of São Tomé in the full range of habitat types was collected in order to obtain an estimate of their abundance and habitat requirements. Bird communities were sampled using point counts with distance sampling. The study areas were divided into habitat types based on altitudinal bands. At least 50 point counts were made in each study area, and a total of 208 counts were made across the three altitudinal zones surveyed.

The three study areas covered the three main primary forest habitat types on the island. three major primary forest types recognised on São Tomé , described as mossy (>1400m altitude), montane (800 – 1400m) and lowland (0 – 800m). Particular emphasis was placed on lowland primary forest, as this is the only habitat type which is known to support all of São Tomé 's endemic species. The habitat types surveyed were: lowland primary rainforest, in and around Rio São Miguel in the south-west of São Tomé. Montane forest, in the area surrounding Lagoa Amelia in the mountainous centre of the island and Mossy, high altitude primary forest from Pico Calvario, via Estacao Sousa to Pico de São Tomé in the mountainous centre of the island. The three sites were selected to give a full coverage of the altitudinal variation of the island. Access was also a consideration. Each area was accessible and provided substantial areas of forest where survey work to be carried out. Much of São Tomé is highly mountainous and not suitable for survey work requiring access to relatively large areas of contiguous forest.

Within each study area, at least 50 point counts were performed. Mist-nets were also set and several hours mist-net data was gathered in parallel. Point count locations were at least 80 metres apart. In most cases 100 metres separated the points. Locations were chosen based on access. However, within any given forest block, point counts were performed in a randomly located grid.

At each point count location, the distance of any observed birds from the researchers was recorded using a Leica laser Rangefinder. This allowed the accurate measurement of distances to the nearest metre. In addition information was recorded on the location of the bird in the forest canopy, the gender of the individual (where possible) and, if a group was seen, the number of individual birds in that group. This information will allow an estimation of density and abundance to be made for all the species for which sufficient data was gathered. This analysis will be performed using the software package Distance 4.0.

In addition to the information on the birds seen, habitat data and data about the location and physical environment of each point count was also collected. A GPS, used in conjunction with detailed maps (1/25,000), was used to locate the points, and estimate altitude. Various measures of vegetation structure and habitat were also collected. The full list of habitat variables is given in Table 1.

These two sets of data combined will allow us to describe in some detail the habitat features that correlated with the highest densities of birds. It will also allow us, for the first time, to describe some of the habitat requirements of the rare rainforest endemics.

Table 1. A list of the habitat and physical environment variables

Variable	How measured
Date/Time/Weather	
No of canopy trees	A count of all the canopy trees within a 15m radius of the point location
Canopy height	Leica rangefinder to measure the height of the underside of the canopy branches in metres.
Canopy cover	Estimated % canopy cover
No of mid-layer trees	All the mid-layer trees within a 15m radius of the point location
Mid-layer cover	Estimated % mid-layer cover
Ground cover	The number of stems in a 1 metre radius 1 metre above the ground. An average of two counts taken.
Fruit/Flower	The number of fruiting and flowering trees within 15 metres of the point count location.
Climbers	The abundance of climbers on a scale from 0-10
Epiphytes	The abundance of epiphytes on a scale of 0 to 10
Aspect	Aspect of the slope in degrees, measured using a compass
Slope	Using a clinometer, the slope was measured to the nearest 5 degrees
Ridge position	A scale from 1 (valley floor) to 5 (ridge top)
GPS	Latitude, longitude and altitude readings taken where possible using a Garmin GPS12 handheld unit

Results

Point Count Data

Across the three habitat types a total of 19 species were recorded, and 884 individual registrations made from 208 point counts. Table 2 summarises this information. The most diverse habitat type was the primary lowland rainforest where 19 species were recorded. The most species poor habitat type was the montane forest, with only 13 species recorded. However most point counts were also done in the lowland forest.

Analysis of the main point count dataset is currently underway. However, due to the size and detail of the dataset, this is likely to be a lengthy process. A report, together with an abstract suitable for any publicity, on the results will be forwarded as soon as it is available.

Table 2. A summary of the study areas and data gathered.

Study area	Habitat type	Altitude	Point counts	Registrations	Species
São Miguel	Lowland primary rainforest	100-550m	93	406	19
Lagoa Amelia	Montane primary rainforest	1200-1450m	57	251	13
Estacao Sousa	Mossy forest	1550-2000m	227	58	14

Mist Net Data and Observations

Several sightings of the São Tomé grosbeak, including the first photograph and observations of its feeding behaviour and habitat, were made. A brief article has been prepared for the Bulletin of the African Bird Club (Appendix A).

A single sighting of the São Tomé short-tail was made in mossy forest at an altitude of 1600m. Previous work restricts the range of the short-tail to low altitude forest. This sighting

could considerably increase the potential habitat available to this species.

Some detailed morphological measurement of many of the forest endemics were gathered by carrying out mist-net study in parallel with the point count surveys. The data gathered includes significant contributions to the knowledge about many of the species. A detailed report, intended for the in-country hosts, ECOFAC, is included in Appendix B.

Discussion

Although the major body of analysis has yet to be completed, it is clear that this expedition has already made a contribution to the knowledge of the habitat of the rainforest endemics of São Tomé. Detailed observational and habitat preference data were gathered on the rare endemics – the São Tomé grosbeak, the São Tomé fiscal shrike and the São Tomé short-tail. Additionally much data has been gathered on the more common forest endemics such as the São Tomé sunbird *Necatrinia newtonii,* the São Tomé weaver *Thomasophantes sanctithomae*, the São Tomé prinia *Prinia molleri* and the Gulf of Guinea thrush *Turdus olivaceofuscus*. The only species that we were unable to survey was the dwarf olive ibis. The dwarf olive ibis lives in several discrete locations, which are well known to the forest guides on São Tomé. However financial and logistic constraint prevented us from visiting these areas. There therefore remains much to do before sufficient information has been gathered on all the rainforest endemics. What is clear at this early stage of the analysis is the importance of the remaining lowland rainforest to the conservation of the bird fauna of São Tomé.

Appendix A – for publication in the Bulletin of the African Bird Club

New Sightings of the São Tomé Grosbeak Neospiza concolor

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Summary

The São Tomé grosbeak is only known from a single surviving museum specimen and a few sightings in the 1990s. The grosbeak is believed to be a primary rainforest specialist. Therefore we conducted two separate surveys of the primary lowland rainforest in the south west of São Tomé in early 2002. The surveys focussed on the forest in the upper reaches of the Rio São Miguel, some areas of which had not previously been visited by researchers. A single brief sighting was followed by two sightings when the birds were observed for several minutes. The overall impression was of a heavy-set bird. The body feathers were of uniform dark reddish colour and the tail appeared slightly notched. The beak was relatively massive compared to the head and its pale, almost white colour contrasted with the head and body plumage. The song of the grosbeak consisted mainly of a two note whistle, the second note higher than the first. The whistle was continuous with a lower note in-between the two main notes. This was repeated frequently. The song recalls a Príncipe seed-eater, but is lower in tone and more rounded in quality. Our observations, the first of the feeding habits of the grosbeak, show it to have at least two food plants, *U. guineensis* and *D. thomensis*. The grosbeak appears to be a bird that is both curious and conspicuous and is perfectly happy foraging close to the forest floor. This suggest that the reason the grosbeak has been seen so infrequently is that it is indeed a rare species with a restricted range as opposed to an inconspicuous species that has often been overlooked. It is therefore imperative that the population size and range for the grosbeak is identified so appropriate conservation action can be taken.

New Sightings of the São Tomé Grosbeak Neospiza concolor

The São Tomé grosbeak *Neospiza concolor* is only known from a single surviving museum specimen and a few sightings in the 1990s (Sargeant *et al.* 1992, Christy and Clarke 1998, Jones and Tye in press) and is classed as 'Critically Endangered' by BirdLife International (Stattersfield and Capper 2000). Nothing is known about the population size, its ecology or range, although it is considered to be a primary rainforest specialist. The lack of sightings has been attributed to the grosbeak being both rare and a secretive canopy dweller that is frequently overlooked (Christy and Clarke 1998). Further information on this species is therefore essential if appropriate conservation needs are to be assessed.

We conducted two separate surveys of the primary lowland rainforest of the South West of São Tomé from 4th to 10th January and 7th to 13th February 2002. The surveys focused on areas of forest in the upper reaches of the Rio São Miguel valley and the surrounding ridges and tributaries. Although some of this area has been surveyed in the past (Atkinson 1991, Christy and Clarke 1998) there is no record of the grosbeak occurring in this area. Previous recent sightings have all been in the catchment of the Rio Xufexufe (Sargeant *et al.* 1992, Jones and Tye in press).

The area surveyed included the ridges connecting and running down from the peaks Zagaia and Queijo, as well as some of the ridges marking the catchment boundary between the rivers Sao Miguel, Xufexufe, and Lemba. The altitudinal range was from 177m to 536m. Some of this area had not previously been explored by researchers. All the descriptions of the grosbeak and its song are taken directly from field notes.
The grosbeak was first seen by one of us (M.D.) on 7th January 2002 at 11.45 in the upper reaches of the Rio Sao Miguel (0° 11' 01"N 6° 30' 38"W at 380m Garmin GPS12 hand-held unit) within closed canopy primary rainforest. The individual was foraging in a fruiting *Uapaca guineensis* (Euphorbiaceae) tree (Figure 1) about 15m up on a horizontal branch. Canopy height in the area ranged from 17m to 24m (Leica laser rangefinder). The huge pale, thick bill contrasted with the dark, reddish brown thick-set head and body. After a few moments the individual flew straight and direct to another *U. guineensis* tree and out of sight. Only indistinct whistles were heard.

The second visit to the area concentrated on the forest below Zagaia and Queijo, including several ridges adjoining those two mountains. Grosbeak sightings by the entire party were made on a ridge running south from Zagaia towards Monte Verde in closed canopy primary rainforest. Canopy height ranged from 12m to 22m. The first sighting, on 9th February 2002 at 07:40 h (location 0° 10' 38"N 6° 30' 49"E altitude 400m) was of a single individual about 10m away, one or two metres above eye-level feeding on the fruit of and moving between several *Dicranolepis thomensis* (Thymelaeceae) trees (Figure 2) of between three and five metres height. The trees were fruiting and had both ripe and unripe fruit. The grosbeak was large, brick red with a bone coloured bill. The body was all the same colour with no discernible markings and was noticeably darker than any other local species. The legs appeared pale. The tail was notched. After ten minutes feeding and singing, often appearing agitated, the grosbeak flew off beneath the canopy.

Flight was direct and relatively rapid (Figure 3).

The second sighting occurred on the same day at 12:00 h about 1km further south on the same ridge (0° 10' 15"N 6° 30' 41"E, altitude 498m) in a small opening in otherwise closed canopy primary rainforest. Canopy height was around 17m. We observed the grosbeak for about 15 minutes. After flying rapidly across the ridge, about three metres up, it moved around in the mid-storey, sometimes out of sight, singing frequently. The grosbeak was then harassed and chased by a Príncipe seed-eater (*Serinus rufobrunneus*) and a Gulf of Guinea thrush (*Turdus olivaceofuscus*) before it settled about 15m away in the mid-canopy of a *U. guineensis* tree, where it was seen feeding, foraging and preening. There were also several fruiting *D. thomensis* trees in the vicinity. We got several more brief views as the grosbeak flew rapidly around the opening singing loudly and conspicuously. The overall impression was of a heavy-set bird. Again the body feathers were of uniform dark reddish colour and the tail appeared slightly notched. The beak was relatively massive compared to the head and its pale, almost white colour contrasted with the head and body plumage.

The song of the grosbeak consisted mainly of a two note whistle, the second note higher than the first. The whistle was continuous with a lower note in-between the two main notes. This was repeated frequently. The song recalls a Príncipe seed-eater, but is lower in tone and more rounded in quality. In the near 30 minutes we observed the birds we did not hear any other types of song or call. The seed-eater has a much wider repertoire. The deeper sound of the grosbeak and the lack of variety in the song make it possible to distinguish the two calls.

Two further sightings were made by one of us (P.L) on the same ridge on the same day. We also heard a grosbeak song on 10th February at 07:55 h, 100m before the south-west cliffs of Queijo, about 600 metres from the first sighting (0° 10' 59"N 6° 31' 00"E), but were unable to locate the individual.

Our observations, the first of the feeding habits of the grosbeak, show it to have at least two food plants, *U. guineensis* and *D. thomensis*. Both trees were among the commonest fruiting trees seen. The former is a common forest tree endemic to the Gulf of Guinea and occurs widely throughout the primary rainforests of São Tomé. The latter is endemic to São Tomé and Príncipe. The family Thymelaeceae is also endemic to the islands and contains only two species. *D. thomensis* tends to be restricted to ridges within the primary rainforest, especially in the south west of the island (Faustino de Oliveira pers comm). Our observations confirmed that *D. thomensis* was most numerous on the ridges throughout the area. However it did also occur on lower slopes, though less abundantly. Figure 4 shows some typical forest habitat in the area where the grosbeaks were sighted.

Our sightings of the grosbeak do not support the frequently cited opinion that the bird is a quiet, retiring canopy dweller that is difficult to see (Sargeant *et al.* 1992, Christy and Clarke 1998). On the contrary, our observations suggest a bird that is both curious and conspicuous and is perfectly happy foraging close to the forest floor. Whilst this is good news for future surveys, it does suggest that the reason the grosbeak has been seen so

infrequently is that it is indeed a rare species with a restricted range. However, the similarity of the grosbeak song to that of the seed-eater could mean that it is possible to overlook the species which would contribute to an impression of rarity. It is imperative that the population size and range for the grosbeak is identified so appropriate conservation action can be taken.

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Figure 1. Fruit and leaves of *Uapaca guineensis*.

Figure 2. Fruit and leaves of *Dicranolepis thomensis*.

Figure 3. The São Tomé grosbeak *Neospiza concolor*

Figure 4. Typical grosbeak habitat. Photograph taken on the ridges south of Zagaia, south west São Tomé.

Appendix B

Habitat use, activity patterns and morphometrics of the birds of São Tomé and Príncipe

Tony King and Martin Dallimer

Introduction

This study used mist-net techniques to provide quantitative data about habitat use, activity patterns and morphometrics of the birds of São Tomé and Príncipe, particularly of the endemics found in primary forest.

Methods

Between December 2001 and February 2002, mist-net surveys were conducted within each of the three major primary forest types recognised on São Tomé, described as mossy (>1400m altitude), montane (800 – 1400m) and lowland (0 – 800m) (Peet and Atkinson 1994, Juste and Fa 1994). Particular emphasis was placed on lowland primary forest, as this is the only habitat type which is known to support all of São Tomé's endemic species (Peet and Atkinson 1994). Lowland primary forest on Príncipe was also surveyed, as were a small number of other sites in both São Tomé and Príncipe (Table 1).

Mist nets (generally 6m x 2.5m but also 10m x 1.5m; total area 15m^2) with 38mm mesh were used during this study. Most were set at understory level (between 0.5m and 4m from the ground), with a few set at mid-story level (between 3m and 9m). No canopy nets were set. Whenever possible, nets were opened at 0500, before dawn, and kept open until after 1800 (dusk), although times were often constrained by logistical factors. Therefore net-effort was quantified in terms of net-hours, rather than net-days. Bird capture rates per net-hour (all species) were calculated for 2-hour time periods throughout the day, and these figures used to calculate capture rate per net-day. For individual species, capture rates per 100 net-hours were used for site comparisons.

Birds captured were identified (and occasionally sexed by plumage characters) using Christy and Clarke (1998). Individuals with large and/or bright gapes were recorded as probable juveniles. Mass was measured using spring balances, to the nearest gram for birds under 65g, or to the nearest 5g for heavier birds. Wing length was measured to the nearest mm, using a wing-rule and flattening the primaries gently against the rule. All other measurements were taken using a pair of dial callipers. Tarsus length was measured to the lower edge of the last complete scale before the toes diverge, and bill length to the base of the feathers of the forehead (both methods after Svensson 1992). Tail length was measured to the anus, and body length from the anus to the tip of the bill. Total length is the sum of the body and tail lengths.

Results and Discussion

Habitat use

The most striking difference in the capture rates (Table 2) is on the island-scale, with high capture rates in São Tomé and low rates in Príncipe. No birds were captured at all in 35 net hours in lowland primary forest in Príncipe. Although bird abundance is only one of several factors influencing capture rate, this result does indicate a much lower density of birds flying at low level in the primary forests of Príncipe than is the case in São Tomé.

Within São Tomé, the results illustrate the importance of primary forest for the country's endemic species. While all species captured in primary forest were endemics (either to São Tomé or to São Tomé and Príncipe; one at sub-specific level only), elsewhere one third of the species captured were widespread non-endemics.

Although altitude appeared to have species-specific impacts on capture-rate, it did not affect capture-rate generally. Indeed, inter-site variation in capture-rates is reduced substantially simply by excluding the data for the most commonly captured species, *Speirops lugubris*.

Many species were captured within all three altitudinal zones of primary forest. Of these, *Turdus olivaceofuscus*, *Prinia molleri* and *Thomasophantes sanctithomae* were captured at similar rates within each zone, *Terpsiphone atrochalyheia* was captured more often at lowland sites, and *Nectarinia newtonii* more often in montane and mossy areas. This latter result may support the theory that *N. newtonii* exhibits seasonal altitudinal shifts (Cheke and Mann 2001). *Speirops lugubris* was also captured at all altitudinal levels, but exhibited much variation in capture-rates between sites within the same altitudinal zone, suggesting that local habitat differences may affect the distribution of this species within primary forest areas. *Serinus rufobrunneus* was captured at mossy and lowland sites, but at a low frequency; therefore, with greater net-effort, it may be assumed that this species would also be captured in montane forest.

None of the species captured were restricted to mossy or montane forest, but several were captured only in lowland forest. For *Columba malherbii* and *Aplopelia larvata simplex*, this may be attributed to higher net-effort in this zone, while for *Amaurocichla bocagei* and *Dreptes thomensis* it indicates a higher abundance in this zone. Single individuals of *Lanius newtoni* and *Ploceus grandis* were also captured in lowland forest.

Activity patterns

Within primary forest, capture-rates tended to be higher between 0600 and 1000 hours than at other times in the day (table 3). However, individual species exhibited high variation in their daily capture rates (table 4). Of the more frequently captured species, *Speirops lugubris* and *Necatrinia newtonii* tended to be captured before 1400 hours, *Terpsiphone atrochalyheia* exhibited a tendency to be captured during the middle of the day, and *Turdus olivaceofuscus* had an unusually high capture-rate through the afternoon. These results suggest that factors such as daily activity patterns should be considered when planning and analysing bird monitoring programmes.

Morphometrics

With such limited distributions, the endemic birds of São Tomé and Príncipe have received very little detailed study in the past. Therefore, the morphometric data presented in tables 5 to 8 is in itself a useful addition to the current knowledge of many of these species. Further analysis of such data can also lead to inferences regarding the ecology of some of the species. For example, Cheke and Mann (2001) have found *Dreptes thomensis* to be sexually dimorphic in several morphometric characters. Comparing the two sets of data, it appears that the groups of *D. thomensis* captured during this study were single-sex, with the largest group consisting of six males (figure 1). This result is consistent with the suggestion of Cheke and Mann (2001) that the species may be polygamous, based on the observation of twice as many males at sites than females. The related *Nectarinia newtonii* also exhibited a higher catch-rate for males than for females, an observation based on distinct plumage characters rather than morphometrics. Other species exhibited either an equal capture-rate for males and females (eg *Terpsiphone atrochalyheia*), or showed no distinct sexual dimorphism in plumage or morphometrics (eg *Speirops lugubris*).

Table 1. Summary data for mist-net sites in São Tomé and Príncipe, Dec 2001 – Feb 2002. (*Endemics to São Tomé and/or Príncipe, to specific or sub-specific level. **Primary/old secondary transition).

Forest type	SiteID	No of nets	Total net hours	No of species	No of endemics*	No of birds	Birds per net-hour
São Tomé							
Mossy primary	MP	2	16	2	2	4	0.25
Mossy primary	ES	2	42	7	7	14	0.34
Montane primary	LA	3	30	5	5	25	0.83
Lowland primary	Q	4	92	8	8	20	0.22
Lowland primary	QR1	3	9	3	3	6	0.67
Lowland primary	QR2	4	97	11	11	37	0.38
Lowland primary**	RSM	5	92	6	6	14	0.15
Montane cultivated	BS	9	167	9	6	26	0.16
Coastal cultivated	SC	1	1	1	1	1	1.00
Total		33	545	16	13	147	0.27
Príncipe							
Lowland primary	RST	4	35	0	0	0	0.00
Coastal / secondary	PST	2	8	0	0	0	0.00
Coastal / secondary	PN	3	19	2	2	2	0.11
Total		9	62	2	2	2	0.03

Table 2. Capture rates of each species at each site (or grouped site).

		Birds per 100 net hours							Total birds
Family	Species	MP/ES	LA	Q	QR1/2	RSM	BS/SC	PN	captured
Ardeidae	*Bubulcus ibis*						0.6		1
Columbidae	*Columba malherbii*				0.9				1
Columbidae	*Aplopelia larvata simplex*			1.1		2.2			3
Alcedinidae	*Alcedo leucogaster nais*							5.4	1
Alcedinidae	*Halcyon malimbica dryas*							5.4	1
Turdidae	*Turdus olivaceofuscus*	3.5	3.3	2.2	6.6	3.3			15
Sylviidae	*Prinia molleri*	1.7	6.7	1.1	0.9	1.1	1.2		8
Monarchidae	*Terpsiphone atrochalybeia*	1.7		4.4	5.7	3.3	0.6		15
Timaliidae	*Amaurocichla bocagei*				1.9	3.3			5
Nectariniidae	*Nectarinia newtonii*	13.9	13.3	2.2	3.8		2.4		22
Nectariniidae	*Dreptes thomensis*			8.7	2.8				11
Zosteropidae	*Speirops lugubris*	5.2	56.7		11.3		7.1		44
Laniidae	*Lanius newtoni*			1.1					1
Ploceidae	*Ploceus grandis*				0.9				1
Ploceidae	*Thomasophantes sanctithomae*	3.5	3.3	1.1	2.8	2.2	0.6		10
Estrildidae	*Estrilda astrild*						1.2		2
Viduidae	*Vidua macroura*						0.6		1
Fringillidae	*Serinus rufobrunneus*	1.7			2.8		1.8		7
All species		31.3	83.3	21.9	40.7	15.2	16.1	10.8	149
All species except *Speirops lugubris*		26.1	26.7	21.9	29.3	15.2	8.9	10.8	105

Table 3. Time of capture at primary forest sites in São Tomé .

SiteID	Birds per net hour							Birds per net day
	0500-0600	0600-0800	0800-1000	1000-1200	1200-1400	1400-1600	1600-1800	
MP/ES	0.14	0.67	0.30	0.14	0.00	0.50	0.09	3.56
LA	0.00	1.03	0.98	0.83	1.33		0.00	8.35+
Q	0.00	0.11	0.17	0.13	0.19	0.17	0.42	2.35
QR1/QR2		0.48	0.50	0.42	0.41	0.20		4.03+
RSM	0.00	0.00	0.44	0.30	0.03	0.17	0.10	2.09
All sites	0.08	0.47	0.46	0.34	0.32	0.19	0.21	4.05

Table 4. Time of capture for endemics at all sites in São Tomé (*for nets in which that species was captured).

Family	Species	Birds per 100 net hours*							Total
		05-06	06-08	08-10	10-12	12-14	14-16	16-18	
Columbidae	*Columba malherbii*		0.0	0.0	0.0	0.0	21.1		4.3
Columbidae	*Aplopelia larvata simplex*	0.0	0.0	16.7	0.0	0.0	12.9	0.0	4.4
Turdidae	*Turdus olivaceofuscus*	0.0	3.7	8.7	2.8	6.3	6.9	6.3	5.9
Sylviidae	*Prinia molleri*	0.0	2.8	5.9	4.6	8.3	0.0	5.6	4.3
Monarchidae	*Terpsiphone atrochalyheia*	0.0	2.8	7.4	8.8	0.3	2.5	4.4	4.2
Timaliidae	*Amaurocichla bocagei*	0.0	10.5	6.3	0.0	0.0	7.7	11.5	5.8
Nectariniidae	*Nectarinia newtonii*	3.3	10.4	3.9	6.1	5.6	0.0	2.7	4.9
Nectariniidae	*Dreptes thomensis*	0.0	0.0	0.0	0.0	6.2	0.0	19.0	4.3
Zosteropidae	*Speirops lugubris*	0.0	6.8	8.7	5.5	13.1	2.0	1.2	6.3
Laniidae	*Lanius newtoni*		0.0	0.0	0.0	0.0	18.2	0.0	4.4
Ploceidae	*Ploceus grandis*		20.0	4.2	0.0	0.0	0.0		4.0
Ploceidae	*Thomasophantes sanctithomae*	0.0	9.8	0.5	10.6	1.0	2.5	2.4	4.0
Fringillidae	*Serinus rufobrunneus*	0.0	18.8	0.0	3.4	1.8	0.0	0.0	4.0

Table 5. Morphometric summary for *Turdus olivaceofuscus* (Turdidae), *Prinia molleri* (Sylviidae) and *Terpsiphone atrochalyheia* (Monarchidae). Measurements given in mm except mass in g.

Species		Tarsus	Bill	Wing	Tail	BL	TL	Mass
Turdus olivaceofuscus	range	39.0 - 44.4	22.2 - 27.9	118 - 136	80 - 101	130 - 170	212 - 260	75 - 95
	mean	41.82	25.27	125.8	89.4	151.7	241.2	84.2
	sd	1.70	1.67	5.4	6.2	11.9	13.7	4.9
	n	14	14	14	14	13	13	13
Prinia molleri	range	21.7 - 25.5	11.6 - 14.2	52 - 58	62 - 79	71 - 81	141 - 150	8 - 11
	mean	23.47	12.80	53.8	69.0	77.5	146.8	9.8
	sd	1.39	0.83	2.4	5.5	3.2	3.1	1.0
	n	7	7	6	6	7	6	6
P. molleri (juvenile)	value	22.6	12.0	49	60	74	134	9
Terpsiphone atrochalyheia (male)	range	20.8 - 24.4	10.8 - 13.7	81 - 92	91 - 162	83 - 109	181 - 267	14 - 18
	mean	22.55	12.25	83.4	127.5	93.1	220.6	15.6
	sd	1.11	1.09	3.6	28.6	8.7	30.3	1.3
	n	8	8	8	8	8	8	8
T. atrochalyheia (female)	range	19.5 - 23.7	11.1 - 13.1	75 - 81	74 - 99	89 - 103	167 - 188	13 - 16
	mean	21.56	12.16	77.4	81.1	93.6	174.7	13.7
	sd	1.48	0.68	1.9	8.2	5.2	8.7	1.3
	n	7	7	7	7	7	7	7

Table 6. Morphometric summary for *Nectarinia newtonii* and *Dreptes thomensis* (Nectariniidae). Measurements given in mm except mass in g.

Species		Tarsus	Bill	Wing	Tail	BL	TL	Mass
Nectarinia newtonii (male)	range	17.8 - 21.0	14.4 - 16.5	51 - 58	33 - 43	63 - 73	102 - 113	7 - 9
	mean	19.35	15.45	54.7	37.9	69.4	107.8	7.8
	sd	1.21	0.73	1.9	3.4	2.7	4.0	0.6
	n	11	11	10	11	10	10	12
N. newtonii (female/juvenile)	range	17.7 - 19.6	12.8 - 14.7	46 - 52	28 - 35	60 - 73	93 - 103	6 - 8
	mean	18.58	13.60	49.6	31.3	66.2	97.5	6.8
	sd	0.71	0.81	2.2	3.0	5.5	4.6	1.0
	n	5	5	5	5	5	5	6
N. newtonii (juvenile)	value	16.8	13.1	48	34	54	88	6
Dreptes thomensis	range	27.2 - 33.5	29.0 - 39.7	81 - 93	69 - 98	111 - 131	186 - 227	21 - 28
	mean	31.10	35.92	87.3	84.7	124.0	208.7	24.8
	sd	2.24	3.82	4.3	9.1	6.4	14.4	2.2
	n	9	9	9	9	9	9	9
D. thomensis (juvenile)	values	28.0, 28.6	28.4, 29.4	77, 78	67, 68	102, 101	169, 169	17, 18

Table 7. Morphometric summary for *Amaurocichla bocagei* (Timaliidae), *Lanius newtoni* (Laniidae), *Speirops lugubris* (Zosteropidae), *Ploceus grandis* and *Thomasophantes sanctithomae* (Ploceidae) and *Serinus rufobrunneus* (Fringillidae). Measurements given in mm except mass in g.

Species		Tarsus	Bill	Wing	Tail	BL	TL	Mass
Amaurocichla bocagei	range	24.5 - 26.7	14.8 - 17.5	67 - 70	31 - 39	98 - 104	130 - 138	19 - 21
	mean	25.72	16.20	68.5	33.6	100.2	133.8	19.6
	sd	0.96	1.18	1.3	3.0	2.5	3.8	0.9
	n	5	5	4	5	5	5	5
NB: missing wing measurement recorded as 59 mm - not included here as probably error for 69 mm.								
Lanius newtoni	value	26.6	14.5	91	98	99	197	27
Speirops lugubris	range	21.1 - 26.8	10.4 - 13.5	69 - 77	39 - 56	80 - 98	126 - 143	15 - 21
	mean	23.74	11.90	72.1	47.9	87.5	135.4	17.3
	sd	1.30	0.87	1.9	4.4	4.4	4.6	1.5
	n	31	31	30	31	31	31	31
Ploceus grandis (female/?juv)	value	30.8	28.8	110	76	140	216	65
Thomasophantes sanctithomae	range	21.5 - 26.0	15.1 - 17.7	68 - 79	45 - 53	82 - 96	127 - 149	17 - 24
	mean	24.36	16.76	73.7	47.8	90.1	137.9	21.8
	sd	1.57	0.77	3.8	2.7	3.8	6.1	2.5
	n	9	9	9	9	9	9	9
Serinus rufobrunneus	range	20.4 - 24.3	12.2 - 14.8	77 - 84	48 - 54	86 - 92	136 - 143	21 - 26
	mean	22.47	13.26	80.6	50.7	89.3	140.0	23.3
	sd	1.47	0.87	2.6	2.2	2.2	2.6	1.8
	n	7	7	7	7	7	7	7

Table 8. Morphometric summary for *Aplopelia larvata simplex* and *Columba malherbii* (Columbidae), *Alcedo leucogaster nais* and *Halcyon malimbica dryas* (Alcedinidae), *Bubulcus ibis* (Ardeidae), *Estrilda astrild* (Estrildidae) and *Vidua macroura* (Viduidae). Measurements given in mm except mass in g.

Species		Tarsus	Bill	Wing	Tail	BL	TL	Mass
Aplopelia larvata simplex	range	33.6 - 39.9	16.5 - 19.0	148 - 153	87 - 95	166 - 184	260 - 270	160 - 200
	mean	36.40	17.57	150.0	89.3	174.1	263.3	176.7
	sd	3.21	1.29	2.6	4.5	9.0	5.8	20.8
	n	3	3	3	3	3	3	3
Columba malherbii	value	23.8	16.9	170	116	177	293	165
Alcedo leucogaster nais	value	10.2	30.7	58	29	137	166	19
Halcyon malimbica dryas (juv)	value	21.1	52.7	128	88	197	285	70
Bubulcus ibis	value	74.8	53.8	250	83	407	490	270
Estrilda astrild	values	15.8, 15.6	8.5, 8.5	48, 46	52, 47	59, 66	110, 113	8, 5
Vidua macroura (breeding male)	value	17.1	9.0	72	226	153	378	15

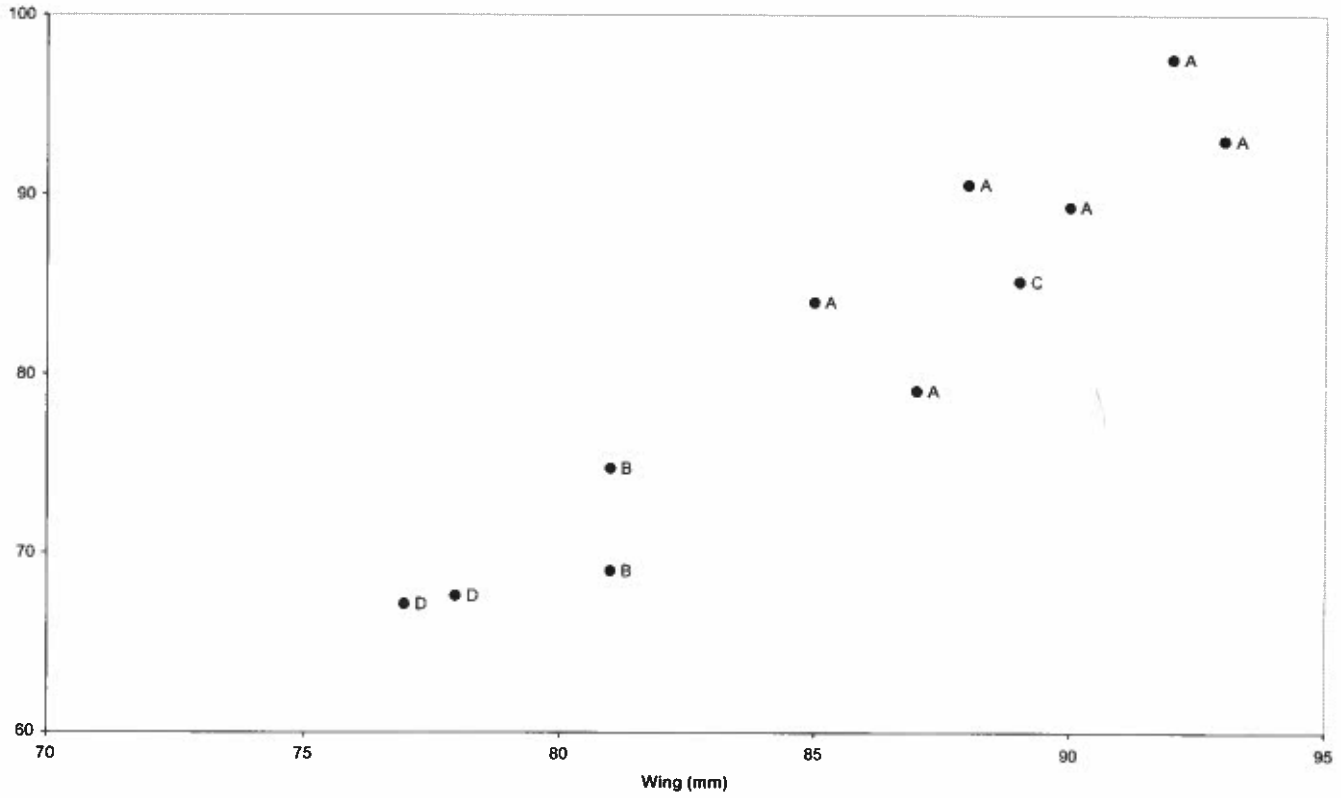

Figure 1. Determination of sex-ratios within groups of *Dreptes thomensis* based on morphometrics. Labels A – D indicate groups of individuals captured in the same net at the same time. Cheke and Mann (2001) give values for wing measurements as 79-84mm (female) and 88-94mm (male); for tail, 69-76mm (female) and 84-98mm (male). Therefore groups A and C are likely to consist of all males, group B of females, and group D of juveniles (the latter supported by observation of gape). Note that groups C and D were captured within 5 metres and 15 minutes of each other.

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