

# The biodiversity and conservation of the birds of São Tomé and Príncipe

NICHOLAS B. PEET and PHILIP W. ATKINSON

School of Biological Sciences, University of East Anglia, Norwich, Norfolk NR4 7TJ, UK

Received 10 May 1994; revised and accepted 17 July 1994

At present the majority of the endemic bird species occurring on São Tomé and Príncipe remain common, the rarer species being those largely confined to primary rainforest. In 1990 the dwarf olive ibis (*Bostrychia bocagei*), São Tomé fiscal shrike (*Lanius newtoni*), São Tomé short-tail (*Amaurocichla bocagii*) were rediscovered and in 1991 the São Tomé grosbeak (*Neospiza concolor*) was seen for the first time since 1888. Lowland primary forest is the only habitat on São Tomé in which all the endemic species are found. Primary forest on Príncipe remains largely unsurveyed since the beginning of the century. Due to the decline in the cocoa industry and poor infrastructure post-independence the extent of secondary forest is probably at its greatest since the late 1800s. This habitat is an important buffer zone against development for the remaining primary forest and also contains important populations of many of the endemic species, in particular the São Tomé scops owl (*Otus hartlaubi*), São Tomé oriole (*Oriolus crassirostris*) and giant weaver (*Ploceus grandis*). On both islands the remaining areas of primary forest need immediate protection and suitable boundaries have been designated under the *Zona Ecológica* plan. Fortunately, except for an important area around Lagôa Amélia, primary forest is not under immediate threat, although a variety of pressures are likely to increase. In conjunction with the protection of primary forest, a plan for managing the remaining timber resource on the islands will be a vital requirement, particularly if areas of shade forest, an important habitat for endemic bird species and a potentially valuable economic resource, are to be conserved and sustainably managed.

**Keywords:** Gulf of Guinea, birds, conservation

## Introduction

This paper is intended as a summary of current knowledge of the status of the bird species of São Tomé and Príncipe. Further detailed accounts on the individual species can be found in Jones and Tye (1988) and Atkinson *et al.* (1991, 1994).

São Tomé and Príncipe form the middle part of the island group in the Gulf of Guinea, the other islands being Bioko and Annobón. They are part of a volcanic chain originating at Mount Cameroon and finishing with the island of Annobón. São Tomé lies 255 km, and Príncipe 220 km, off the coast of Gabon, with Príncipe being 150 km NNE of São Tomé. The latter is the larger having a total area of 857 km<sup>2</sup> whilst Príncipe is only 139 km<sup>2</sup>. Neither island has ever been connected to the African mainland or to each other and as a result of this isolation both have developed a rich endemic flora and fauna.

### Endemism among the avifauna and its conservation importance

São Tomé and Príncipe contain 28 species of bird that are endemic to one or both of the islands (Table 1). These include 23 single island endemics, 16 on São Tomé and seven on Príncipe with a further five being found on both islands. Two monospecific genera are endemic to São Tomé, *Amaurocichla* and *Neospiza*, and one to Príncipe, *Horizorhinus*. Of the mainland African species represented on the islands, 11 have developed subspecies (Table 2). In addition, an undescribed subspecies of the Madeiran Petrel (*Oceanodroma castro*), may breed on offshore islets (Harris, 1969). Despite a recent taxonomic review (Sibley and Monroe, 1990), where several species were elevated to specific status, the taxonomic status of three species, the two endemic kingfishers and the Príncipe Drongo, is still uncertain, but for the purpose of this paper are treated as endemic species. The monospecific genera *Thomasophantes* and *Dreptes* have been dropped as a result of this review.

**Table 1.** The endemic birds of São Tomé (ST) and Príncipe (P)

|                              |                                  |    |                                   |
|------------------------------|----------------------------------|----|-----------------------------------|
| Dwarf olive ibis             | <i>Bostrychia bocagei</i>        | ST |                                   |
| São Tomé green pigeon        | <i>Treron sanctithome</i>        | ST |                                   |
| São Tomé bronze-naped pigeon | <i>Columba malherbii</i>         | ST | P                                 |
| Maroon pigeon                | <i>Columba thomensis</i>         | ST |                                   |
| São Tomé scops owl           | <i>Otus hartlaubii</i>           | ST |                                   |
| São Tomé spine-tail          | <i>Chaetura thomensis</i>        | ST | P                                 |
| São Tomé kingfisher          | <i>Alcedo thomensis</i>          | ST |                                   |
| Príncipe kingfisher          | <i>Alcedo nais</i>               |    | P                                 |
| São Tomé fiscal shrike       | <i>Lanius newtoni</i>            | ST |                                   |
| São Tomé oriole              | <i>Oriolus crassirostris</i>     | ST |                                   |
| Príncipe drongo              | <i>Dicrurus modestus</i>         |    | P                                 |
| Príncipe glossy starling     | <i>Lamprotornis ornatus</i>      |    | P                                 |
| São Tomé thrush              | <i>Turdus olivaceofuscus</i>     | ST | (ssp. <i>olivaceofuscus</i> )     |
|                              |                                  |    | P (ssp. <i>xanthorhynchus</i> )   |
| São Tomé prinia              | <i>Prinia malleri</i>            | ST |                                   |
| São Tomé short-tail          | <i>Amaurocichla bocagii</i>      | ST |                                   |
| Dohrn's thrush babbler       | <i>Horizorhinus dohrni</i>       |    | P                                 |
| São Tomé paradise flycatcher | <i>Terpsiphone atrochalybeia</i> | ST |                                   |
| Príncipe sunbird             | <i>Nectarinia hartlaubii</i>     |    | P                                 |
| São Tomé sunbird             | <i>Nectarinia newtoni</i>        | ST |                                   |
| Giant sunbird                | <i>Nectarinia thomensis</i>      | ST |                                   |
| São Tomé white-eye           | <i>Zosterops ficedulinus</i>     |    | P (ssp. <i>ficedulinus</i> )      |
|                              |                                  | ST | (ssp. <i>feae</i> )               |
| Príncipe speirops            | <i>Speirops leucophaeus</i>      |    | P                                 |
| São Tomé speirops            | <i>Speirops lugubris</i>         | ST |                                   |
| São Tomé seedeater           | <i>Poliospiza rufobrunnea</i>    | ST | (ssp. <i>thomensis</i> )          |
|                              |                                  |    | P (ssp. <i>rufobrunnea</i> )      |
|                              |                                  |    | (ssp. <i>fradei</i> Ilhéu Caroço) |
| São Tomé grosbeak            | <i>Neospiza concolor</i>         | ST |                                   |
| Príncipe Golden weaver       | <i>Ploceus princeps</i>          |    | P                                 |
| Giant weaver                 | <i>Ploceus grandis</i>           | ST |                                   |
| São Tomé weaver              | <i>Ploceus sanctithomae</i>      | ST |                                   |

**Table 2.** African mainland species with endemic subspecies on São Tomé (ST) and Príncipe (P)

|                          |                               |    |                             |
|--------------------------|-------------------------------|----|-----------------------------|
| Olive ibis               | <i>Bostrychia olivacea</i>    | P  | (ssp. <i>rothschildi</i> )  |
| Harlequin quail          | <i>Coturnix delagorguei</i>   | ST | (ssp. <i>histrionica</i> )  |
| African green pigeon     | <i>Treron calva</i>           | P  | (ssp. <i>virescens</i> )    |
| Lemon dove               | <i>Aplopelia larvata</i>      | ST | (ssp. <i>simplex</i> )      |
|                          |                               | P  | (ssp. <i>principalis</i> )  |
| Emerald cuckoo           | <i>Chrysococcyx cupreus</i>   | ST | P (ssp. <i>insularum</i> )  |
| Barn owl                 | <i>Tyto alba</i>              | ST | (ssp. <i>thomensis</i> )    |
| Little swift             | <i>Apus affinis</i>           | ST | P (ssp. <i>bannermani</i> ) |
| Blue-breasted kingfisher | <i>Halcyon malimbicus</i>     | P  | (ssp. <i>dryas</i> )        |
| Chestnut-winged starling | <i>Onychognathus fulgidus</i> | ST | (ssp. <i>fulgidus</i> )     |
| Olive sunbird            | <i>Nectarinia olivacea</i>    | P  | (ssp. <i>cephaelis</i> )    |
| Vittelline Masked weaver | <i>Ploceus vitellinus</i>     | ST | (ssp. <i>peixotti</i> )     |

The level of endemism is high on the islands with over half of the breeding landbirds either being an endemic species or subspecies. As a result both islands have been designated as individual Endemic Bird Areas (EBAs) (Bibby *et al.*, 1992). The importance of these two EBAs is such that they are rated as critical. Collar and Stuart (1988) ranked the rainforests of south-western and central São Tomé second in a list of 75 of the most important forests for conservation in tropical Africa, mainly due to their high threatened species score.

### Changes in the vegetation since colonization in 1470–1471

To understand the current issues in the biogeography and conservation of the avifauna of São Tomé and Príncipe, it is necessary to examine the changes in the islands' vegetation since their colonization by man. Before man's arrival, the natural vegetation of the islands was tropical forest, some of which remains today. Exell (1944, 1956) identified three distinct zones within this natural forest:

#### *Lower rainforest region*

Extends from sea level to 800 m. This region has now been almost entirely cultivated. Only areas along the Rios Ana Chaves and Xufexufe and perhaps to the west of the upper reaches of the Rio Io Grande remain intact. Most of the forest along the rivers in the south-east and south-west is mature secondary growth, dating back to the 1930s.

#### *Montane forest region*

Extending from 800 m to 1400 m. Much of this habitat is intact in south-west and central São Tomé but has been destroyed in most of the northern and eastern areas of the island, where it has been replaced by coffee plantations and vegetable farming.

#### *Mist forest region*

This extends from 1400 m to 2024 m. This habitat is mainly confined to the Pico de São Tomé and is characterized by stunted trees with an open canopy.

After colonization in 1470–1471 clearance of forest for cultivation took place, mostly in lowland areas. Sugar cane was the first major crop to be grown on São Tomé and areas of lowland forest were cleared. By the 1540s São Tomé was the largest exporter of sugar in the world. It was not until 1800 with the introduction of coffee that forest clearance took place at a very fast rate as coffee is best grown at mid- to high-altitudes. After its introduction in 1822, cocoa became São Tomé's major export in the 1880s. Between 1908 and 1919, São Tomé was the largest cocoa producer in the world. In 1907, Cadbury calculated that 42% of the total area of São Tomé (approximately 45 000 ha) was given over to cultivating cocoa (Cadbury, 1910). This 'scramble for land' left very little primary forest on the islands and most is now at mid- to high-altitudes on the steep inaccessible slopes. Approximately 70% of São Tomé's forest was cleared for cultivation.

As a result of a crash in cocoa prices and also because of independence in 1975, much of the area formerly covered with plantations has reverted into secondary forest. In 1989, Interforest (1990) calculated that approximately 90% of the area of both São Tomé and Príncipe was now covered with forest of different types; primary forest (unaltered by human activity); secondary forest (forest regrowth in previously man-altered environments); shade forest (plantations with mature trees used for shading the crop). This is probably the largest area of forest there has been in São Tomé since the introduction of coffee in 1800. Approximately 30% of the area of the two islands is secondary forest, 30–40% shade forest and approximately 30% primary forest (Interforest, 1990).

### **The biogeography of the avifauna of São Tomé**

#### *Colonization*

The degree of endemism is highest among the passerines with few of the non-passerines having endemic forms on the islands. 92% (35 out of 38) of the non-breeding birds (migrants and vagrants) recorded from São Tomé are non-passerines. Only three non-resident species of passerines have been recorded on the island. Two were Palearctic migrants (swallow *Hirundo rustica* and the spotted flycatcher *Muscicapa striata*) and one an Afrotropical migrant (red-bellied quelea *Quelea quelea*). The former undertake long migrations and are less likely to remain on the island than Afrotropical migrants or other mainland species with lower dispersal rates. However, some other Afrotropical migrants may have been overlooked as they are not morphologically different from birds resident on the island. For example, the red-headed quelea (*Quelea erythrops*) has been irregularly recorded and may be a sporadic, seasonal migrant (Jones, 1994). This very low immigration rate for passerines perhaps explains the high degree of endemism found among the passerines compared with the non-passerine species.

#### *Habitat usage*

Recent surveys have clarified much of the habitat usage by the endemics (Jones and Tye, 1988; Atkinson *et al.*, 1991, 1994). Table 3 shows the number of endemic and non-endemic birds found in each of the major habitat types now found on São Tomé. Forested areas, including mature secondary forest, exclusively hold populations of endemic birds. These species evolved in tropical rainforest, which covered nearly all of

**Table 3.** The number of endemic and non-endemic bird species found in different habitat types on São Tomé

| Status             | Primary forest |     | Mature<br>Secondary<br>forest | Plantation | Savanna | Marsh/<br>river | Oceanic |
|--------------------|----------------|-----|-------------------------------|------------|---------|-----------------|---------|
|                    | High           | Low |                               |            |         |                 |         |
| Endemic species    | 15             | 19  | 14                            | 9+(1?)     | 10      | 1               | 0       |
| Endemic subspecies | 2              | 2   | 3                             | 3          | 4       | 0               | 0       |
| African species    | 0              | 0   | 0                             | 5          | 17      | 6               | 11      |
| Total              | 17             | 21  | 17                            | 17(18)     | 31      | 7               | 11      |

São Tomé until human colonization. Since then the range of habitats available to the island's avifauna has increased, particularly in the north of the island where substantial areas of savanna and open cultivation now exist. It seems probable that dry forest dominated in this area prior to human disturbance and subsequent pressures from tree felling, grazing and natural and anthropogenic fires have maintained an open grassland. Small pockets of dry forest still remain and often contain a few of the most widely distributed endemic species (e.g. São Tomé Sunbird, São Tomé Speirops). However the cultivated and open grassland areas are very little used by endemic species and none has a substantial part of its population within these habitats. However several mainland African species are found in these habitats (Table 3). Plantations, which represent the mid-stage of a gradient between man-altered habitats and primary forest, contain populations of both endemic and non-endemic species. Purely forested habitats contain only endemic species (Table 3).

#### *Feeding ecology*

Within the forest, endemic birds have evolved wider niches than members of their families on mainland Africa. They often exploit several dietary sources (Table 4) and utilize a wider variety of feeding methods than non-endemic species (Table 5). For instance, the giant sunbird (*Nectarinia thomensis*) feeds on nectar and invertebrates, exploiting a wider niche than other members of the same family. It both hovers in front of flowers as well as piercing the base of others to feed on nectar. It also creeps along branches, probing into the bark, in search of invertebrates, in a similar manner to spider hunters (*Arachnothera* spp.). Despite there being relatively few species in the forest habitats, their expanded niches mean that rates of competition for potential colonizers is high. This, coupled with the low incidence of migrants to the island, probably results in low rates of colonization, especially before human disturbance of the habitat.

As most endemic species have not managed to adapt fully to savanna or cultivated habitats (with the exception of plantations) these represent the most suitable areas for new colonizers to exploit. Pressures from competition from endemic species are low and many of the plants and invertebrates are not endemic whereas rates of endemism in these groups is very high within the forest. Non-endemic species are mainly specialist feeders, exploiting only one dietary type. In addition the variety of feeding methods is lower amongst the resident non-endemic species compared with the endemic species (Table 5). These species have managed to occupy new habitats created by man. Indeed

**Table 4.** The different diets of the endemic and non-endemic birds on São Tomé

| Food Taken             | Endemic birds | Non-endemic birds |
|------------------------|---------------|-------------------|
| <b>Specialists</b>     |               |                   |
| Carnivores             | 1             | 1                 |
| Fruit                  | 4             | 3                 |
| Fish                   | 1             | 4                 |
| Insects                | 7             | 1                 |
| Seeds                  | 0             | 8                 |
| Total                  | 13            | 17                |
| <b>Non-specialists</b> |               |                   |
| Seeds/fruit            | 1             |                   |
| Insects/seeds          | 4             | 3                 |
| Insects/fruit          | 2             |                   |
| Insects/nectar         | 2             |                   |
| Insects/plant material |               | 2                 |
| Insects/amphibians     | 1             |                   |
| Nectar/seeds/insects   | 1             |                   |
| Fruit/insects/nectar   | 1             |                   |
| Seeds/fruit/insects    | 3             |                   |
| Total                  | 15            | 5                 |

Endemic birds are more likely to take a wider variety of prey items than non-endemic birds ( $\chi^2 = 20.94$ ,  $p < 0.0001$ )

**Table 5.** The number of endemic and non-endemic species using different feeding methods

|                   | Feeding type |                   |        |              |                  |             |        |
|-------------------|--------------|-------------------|--------|--------------|------------------|-------------|--------|
|                   | Fully aerial | Aerial from perch | Pounce | Ground glean | Vegetation glean | Hover glean | Fisher |
| Endemic birds     | 2            | 2.33              | 2.33   | 3.67         | 15.67            | 1           | 1      |
| Non-endemic birds | 1            | 0                 | 1      | 7            | 8                | 0           | 1      |

Note: species using two methods are scored 0.5 in each; species using three feeding methods are scored 0.33 in each.

eight of the 22 non-endemic species are seed eating specialists which inhabit open grassland and cultivation, feeding mainly on introduced crop plants. Some finches and weavers may have been introduced by man as several species are kept as cage birds but for the purposes of this paper they are treated as colonists.

A great deal remains to be researched on the ecology of the avifauna of São Tomé and current knowledge makes understanding the biogeography of the island's avifauna difficult. The situation for Príncipe is worse, with knowledge of the avifauna being very restricted. However it seems likely that the colonization processes which appear to have occurred on São Tomé will also have taken place on Príncipe.

### **A summary of the current status of the endemic birds of São Tomé and Príncipe**

As over 90% of the islands are now covered with forest-type habitats, many of the endemics are common (Table 6). The abandoned plantations have now regenerated into secondary forest and provide suitable habitat for several endemic species and also buffer the primary forest from disturbance.

However several species are confined to a certain type of forest. The primary forest specialists on São Tomé are the São Tomé fiscal shrike *Lanius newtoni*, dwarf olive ibis (*Bostrychia bocagei*), giant sunbird, maroon pigeon (*Columba thomensis*), São Tomé short-tail (*Amaurocichla bocagei*) and the São Tomé grosbeak (*Neospiza concolor*). Of these species the ibis, fiscal shrike, short-tail, and grosbeak are only known from lowland primary forest. In addition the lowland primary forest holds a major proportion of the populations of São Tomé scops owl (*Otus hartlaubi*), São Tomé green pigeon (*Treron sanctithome*), São Tomé oriole (*Oriolus crassirostris*), giant sunbird and São Tomé white-eye (*Zosterops ficedulinus*). A small population of maroon pigeon also exists, the only one outside high altitude primary rainforest. All the remaining endemics also occur in lowland primary forest. No other habitat on the island contains populations of every one of the endemic species.

Mid- to high-altitude primary forest (>1400 m) is the stronghold of the maroon pigeon and supports populations of the giant sunbird, São Tomé scops owl and São Tomé oriole and São Tomé white-eye, together with the commoner endemics.

On São Tomé mature secondary forest is especially important for the São Tomé scops owl, São Tomé thrush (*Turdus olivaceofuscus*) and giant weaver (*Ploceus grandis*), species which occur at low overall densities, but which have a substantial proportion of their populations in this habitat. The owl and thrush are also common in primary forest. The giant weaver seems to be a secondary habitat specialist. Mature secondary forest also provides a valuable subsidiary habitat for the São Tomé oriole. All the endemics occur in secondary forest with the exception of the six primary forest specialists.

Several endemic species have adapted to plantations, especially those with shade trees which retain a forest-type structure of upper and lower storeys. Plantations support significant populations of the São Tomé paradise flycatcher (*Terpsiphone atrochalybeia*), São Tomé sunbird, São Tomé speirops, São Tomé prinia (*Prinia malleri*), São Tomé thrush and São Tomé weaver, all of which are mainly insectivorous. The removal of shade trees from cocoa and coffee plantations has been shown to cause the thrush to disappear and also reduce numbers of the above species (Atkinson *et al.*, 1994)

The situation on Príncipe is similar with several very rare endemic species and subspecies which have their strongholds in primary forest, for example the Príncipe subspecies of olive ibis, São Tomé white-eye and the São Tomé seedeater (*Polioptila rufobrunnea*). However, Príncipe has been neglected in favour of São Tomé in recent years and primary forest has not yet been successfully visited by ornithologists this century.

**Table 6.** The current status of the endemic birds of São Tomé and Príncipe

| Red Data Book status* | Species                                       | Distribution | Habitat        |   | Secondary forest | Plantation | Savanna |
|-----------------------|-----------------------------------------------|--------------|----------------|---|------------------|------------|---------|
|                       |                                               |              | Primary forest |   |                  |            |         |
| Endemic species       |                                               |              |                |   |                  |            |         |
| Indeterminate         | Dwarf olive ibis                              | ST           | +              |   | -                |            | -       |
|                       | São Tomé green pigeon                         | ST           | +              |   | +                |            | -       |
|                       | São Tomé bronze-naped pigeon                  | ST           | P              | + | +                | +          | +       |
| Vulnerable            | Maroon pigeon                                 | ST           | +              |   | +                |            | -       |
|                       | São Tomé scops owl                            | ST           | +              |   | +                |            | -       |
| Rare                  | São Tomé spinetail                            | ST           | +              |   | +                | +          | +       |
|                       | São Tomé kingfisher                           | ST           | +              | R | +                | R          | +       |
|                       | Príncipe kingfisher                           | P            | +              | R | +                | R          | R       |
| Indeterminate         | São Tomé fiscal shrike                        | ST           |                |   | -                |            | -       |
|                       | São Tomé oriole                               | ST           | +              | + | +                |            | +       |
|                       | Príncipe drongo <sup>\$</sup>                 |              | ?              |   | +                | +          |         |
| Near-threatened       | Príncipe glossy starling                      | P            |                |   | +                | +          |         |
|                       | São Tomé thrush (ssp. <i>olivaceofuscus</i> ) | P            |                |   | +                | +          | +       |
|                       | (ssp. <i>xanthorhynchus</i> )                 | ST           | +              | + | +                | +          | +       |
| Indeterminate         | São Tomé prinia                               | ST           | ?              |   | -                | +          | +       |
|                       | São Tomé short-tail                           | ST           | +              |   | +                | +          |         |
|                       | Dohrn's thrush babbler                        | P            | ?              |   | +                | +          |         |
| Near-threatened       | São Tomé paradise flycatcher                  | ST           |                |   | +                | +          | +       |
|                       | Príncipe sunbird                              | P            | ?              |   | +                | +          |         |
| Near-threatened       | São Tomé sunbird                              | ST           | +              | + | +                | +          | +       |
|                       | Giant sunbird <sup>†</sup>                    | ST           | +              | + | +                | +          |         |
| Indeterminate         | São Tomé white-eye (ssp. <i>ficedulinus</i> ) | P            | ?              |   | -                |            | -       |
|                       | (ssp. <i>feae</i> )                           | ST           | +              |   | +                | +          | +       |
|                       | Príncipe speirops <sup>†</sup>                | P            | ?              |   | +                | +          |         |
| Near-threatened       | São Tomé speirops                             | ST           |                |   | +                | +          |         |
|                       | São Tomé seedeater (ssp. <i>rufobrunnea</i> ) | P            | ?              |   | +                | +          | +       |
|                       | (ssp. <i>thomensis</i> )                      | ST           | +              | + | +                | +          |         |



Secondary forest on Príncipe is also an important habitat for several endemic species especially Dohrn's thrush babbler (*Horizorhinus dohrni*), Príncipe sunbird (*Nectarinia hartlaubii*), Príncipe drongo (*Dicrurus modestus*), Príncipe glossy starling (*Lamprotorornis ornatus*) and Príncipe speirops (*Speirops leucophaeus*).

### **The extent of primary forest and the distribution of the rarer endemics on São Tomé**

The recent forest inventory (Interforest, 1990) provides figures for the amount of different types of forest found on São Tomé and Príncipe. *Floresta Natural*, i.e. forest not logged over, covered 28.5% of the two islands which represents 18 500 ha.

Figure 1 outlines the main block of forest on São Tomé, defined by the forest inventory as *floresta natural* i.e. primary forest or forest which has not been logged since 1956. They do not distinguish between the two types of forest. Both the forest inventory and BDPA (1985) delineated this main block of forest as a nature reserve (the *Zona Ecológica*) and recommended that it be preserved. Interforest designated a slightly larger area, including some areas on the south-west coast which BDPA excluded. The majority of forest within the 'Zona Ecológica' is at low- to mid-altitudes between 0–1000 m (Table 7). Using the BDPA figures for forest area for São Tomé the Zona Ecológica would encompass 24 350 ha of rainforest. However much of the main forest block delineated by BDPA and Interforest is in fact old secondary forest which is unsuitable for the six primary forest specialists. To what extent the Zona contains secondary forest is unknown but it should be noted that even land above the 900 m was cultivated during times of peak coffee and cocoa production. The 1990 University of East Anglia expedition visited areas within the Zona around Jou, São Miguel, Lagôa Amélia, the base of the Rio Ana Chaves and the Rio Quija which were covered with either secondary forest or the remains of old plantations (Atkinson *et al.*, 1994).

It seems very likely that much of the forest below 500 m is secondary with the exception of several valleys in the south-west, south east and north-west of the reserve.

Knowledge of the extent of different forest types has an impact on assessments of the range of the endemic species. The four rare endemics, the shrike, short-tail, grosbeak and ibis have not been seen in any habitat other than primary forest and, in recent times, none have been seen over 450 m. Although the forest along the Quija river has regenerated, it is not yet in a similar condition to that of the lowland primary forest in the Xufexufe valley, only 2 km away, where all four species have recently been found. This suggests that these four species cannot survive in this secondary habitat. There is some evidence of small scale plantation activity having taken place on the lower reaches of the Xufexufe but it does not seem to have been as intensively cultivated as the Quija valley.

Estimating the range of the rare endemics is difficult. The short-tail is associated with mainly fast flowing rivers and streams on São Tomé and also occurs on the lower reaches and in forest as well, though maybe at lower densities. Knowing its habits, it may well be restricted to a few areas on the island, the Rios Xufexufe and Ana Chaves being certain sites. Other rivers which may well hold populations are the upper reaches of the Rios Martin Mendes and Lembá and perhaps the upper reaches of the Rios Contador and Io Grande but these may be too developed.

If the ibis, short-tail, grosbeak and shrike are restricted to altitudes below 500 m then only the forest in the Xufexufe and Ana Chaves valleys will be of sufficient

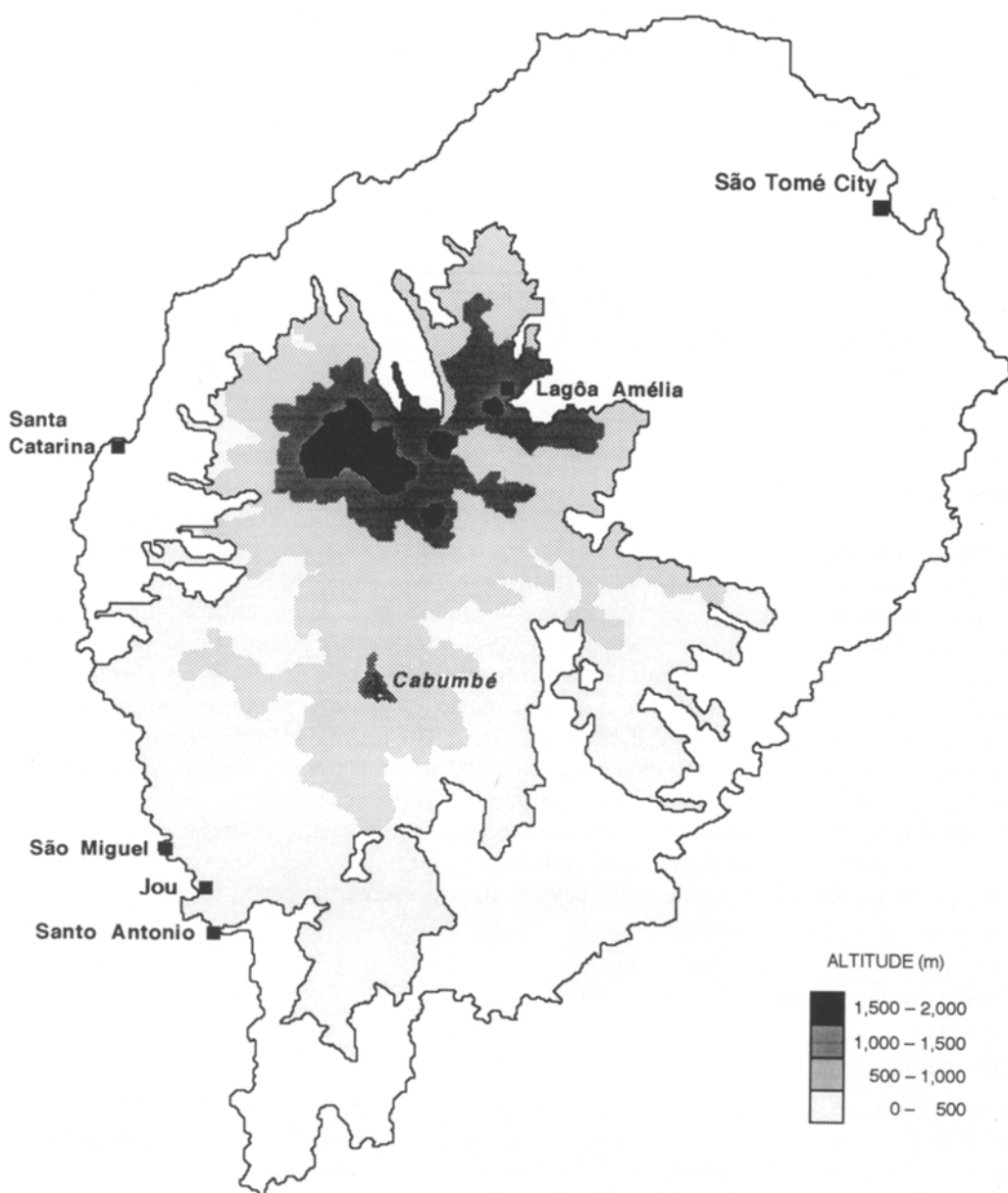


**Figure 1.** Altitudinal zones within the main block of forest. This area has been recommended by Interforest (1990) to be preserved as a nature reserve or *Zona Ecológica* on São Tomé.

area to support viable populations, though these would be precariously small. However there are considerable areas of primary forest between 500 and 1000 m in the centre of the island around the upper reaches of the Rios Lemba and Ana Chaves. These areas have not been visited by ornithologists and it is possible that

**Table 7.** Areas of forest at different altitudes within the main forest block on São Tomé

| Altitude (m) | %  | Area (ha) |
|--------------|----|-----------|
| 0–500        | 40 | 9738      |
| 500–1000     | 46 | 11 198    |
| 1000–1500    | 11 | 2678      |
| 1500–2000    | 3  | 730       |

Note: Areas have been calculated from the area (24 350 ha) recommended by BDPA (1985) to be conserved as a *Zona Ecológica*. Interforest (1990) recommends a slightly larger area.

these three species occur within this area. It is important that these areas are reached and surveyed.

At a very approximate estimate, if the four rare endemics can survive at altitudes above 500 m then the population would be in hundreds or very low thousands. If not then in some cases the population could be in the tens or low hundreds.

It is possible to be more precise about the numbers of short-tails. Using figures of bird densities from Atkinson *et al.* (1991, 1994) and lengths of rivers and tributaries in apparently suitable short-tail habitat taken from a series of 1:25 000 maps (Junta de Investigações do Ultramar, 1958), it is possible to estimate a maximum and minimum size of the short-tail population if birds occurred. The estimated total population of this species would be between 680–930 birds to 1 000 m, whereas the population below 500 m would approximate 380–525 birds. Some of the stream lengths included in these measurements will be unsuitable habitat, particularly the smaller tributaries which often only have seasonal water flow. Small numbers of birds have been seen within the forest but it is not known how extensively they are distributed in the forest itself.

## Threats to the avifauna

### *Habitat alteration*

This is the single most important threat facing the endemic species. Of the 28 endemics on São Tomé and Príncipe, 12 species would be seriously at risk from the alteration or destruction of a single habitat type. Due to the small size of the islands, reduction in areas of suitable habitat could well jeopardize the ability of some endemic species to maintain a viable population. The lowland primary forest specialists are most at risk.

### *Lowland primary forest*

The Dwarf olive ibis, São Tomé fiscal shrike, São Tomé short-tail, São Tomé grosbeak and giant sunbird would be seriously threatened by any loss of lowland primary rain-forest. Major losses of habitat would almost certainly see the extinction of the four lowland primary forest specialists, the ibis, short-tail, shrike and grosbeak.

Whilst lowland primary forest is not immediately threatened with destruction, due to its remoteness and a lack of finances for development, the small size of the remaining areas leaves them very vulnerable even to limited development. Clearance for plantations is unlikely at the moment as so many existing plantations are in disrepair. Timber extraction, mainly for fuel and building materials, is a major threat despite a recommendation by BDPA (1985) and in the 1990 Interforest report that remaining primary rainforest be protected from exploitation. Of particular importance are plans to sell off forested areas, currently owned by the government, to private concerns.

#### *Mid-altitude primary forest*

This habitat may contain populations of the ibis, shrike, short-tail and grosbeak and the other rare endemics but again these populations will be limited by the small area of habitat. The threats to this habitat are the same as those for its lowland equivalent, with its vulnerability due to its small area being overridingly important. This habitat is one of the least known on the island.

#### *Montane primary forest*

This habitat is limited to the Lagôa Amélia/Calvário area and the Pico de São Tomé. Further loss of this habitat would seriously endanger the maroon pigeon and dangerously reduce populations of the São Tomé oriole, São Tomé scops owl, giant sunbird and São Tomé white-eye. This area is immediately at risk from encroaching agriculture. Its proximity to the island's main centres of population and a climate that allows year-round cultivation make it an obvious site for agricultural expansion. However, there is much land outside the forest block which would be equally suitable for cultivation without impinging on the area around the Lagôa itself.

#### *Secondary forest on São Tomé*

The São Tomé thrush and São Tomé scops owl would suffer significant population reductions if secondary forest were destroyed. The giant weaver, whilst it is not totally confined to secondary habitats, would be put at risk if large areas of secondary forest were cleared. This habitat also provides a valuable subsidiary habitat for the São Tomé oriole, though it is usually only found in mature secondary forest.

Whilst exploitation of this habitat is currently low, the development of agriculture and an increasing demand for timber will pose a serious threat to it and its associated bird community. It would be impossible to protect all areas of secondary forest but mature regrowth needs to be protected, as do all areas which buffer primary forest. Where areas are developed, work should, where possible, be carried out so as to preserve the forest type structure of the vegetation. This will be particularly important where old plantations, currently overrun with secondary regrowth, are once again brought back into production or developed for different forms of agriculture. Wood is the basic building material used on the island and is the most commonly used fuel source both for domestic purposes and commercially in the drying of cocoa. An opportunity exists for sustainably exploiting the areas of secondary forest of least conservation value as a source of timber, particularly through selective logging and replanting. This would limit the damage to bird populations as the commoner endemics could probably withstand limited disturbance. The São

Tomé scops owl and the São Tomé oriole would probably be lost from an area that was selectively logged.

#### *Shade forest on São Tomé*

Several of the commoner endemics have adapted to plantation shade forest. Surveys in 1990 showed that if shade trees are removed there is a reduction in the numbers of the lemon dove (*Aplopelia larvata*), São Tomé paradise flycatcher and São Tomé prinia in plantations and importantly causes the São Tomé thrush to disappear from plantations (Atkinson *et al.*, 1994). The threat to shade forest is increasing as agricultural aid to São Tomé and Príncipe from the EC, World Bank and Portuguese interests also increases (Jones and Tye, 1988). The aid is designed to increase cocoa production and to encourage diversification into oil-palm plantations and market gardening. Shade trees in plantations are a valuable source of timber. If, as suggested by Interforest (1990), a rotational system were adopted with the replanting of shade trees after removal, this would provide a sustainable timber resource as well as minimizing the damage to associated bird populations. Such a system would also reduce the pressure to remove trees from the major forest blocks. This habitat will be under the most pressure in the near future and is likely to be substantially altered. Without planning these alterations could destroy valuable wildlife habitat and a very valuable social and economic resource.

#### *Hunting*

Birds, wild pigs and monkeys are hunted for food. Currently hunting is on a limited scale and does not pose an immediate threat to any one species, although an escalation in hunting pressure would pose a threat to several species. Various species of pigeon and dove are the most favoured bird quarry. Atkinson *et al.* (1991) reported the São Tomé green pigeon (*Treron sanctithome*) to be the most commonly hunted species, being shot wherever it occurred close to human habitation and by hunters spending several days in the forest. The São Tomé bronze-naped pigeon (*Columba malherbii*) is also frequently shot, particularly in the south-west of the island. The similar lemon dove is also a quarry species.

The species most at risk from any increase in hunting pressure is the maroon pigeon, which is considered tame and easy to kill, particularly as it is attracted to smoke (Jones and Tye, 1988). At Santo Antonio hunters reported killing this species whenever they encountered it, although this was rarely. It is also hunted at its stronghold at Lagôa Amélia by local villagers and inhabitants of the nearby roca at Monte Café. De Naurois (1983) considered it to have become rare by 1973 due to hunting. If high-altitude plantations are rehabilitated, with an associated increase in the human population of the highlands, hunting pressure on the maroon pigeon is certain to increase. Only a moderate increase in hunting would start to threaten the species especially in view of its restricted range, small total population size and the ease with which it can be killed. Hunting pressures may also increase if cartridges, at present expensive and hard to obtain, become cheap and readily available.

#### *Pesticides*

During the early 1970s massive quantities of pesticides were used in the cocoa plantations. This greatly reduced the population of the São Tomé paradise flycatcher and the

São Tomé oriole (de Naurois, 1984) and probably affected other insectivorous species, particularly the São Tomé thrush and São Tomé speirops. Although the paradise flycatcher population has recovered, now that pesticide use has declined, the oriole population has not, and it is no longer found in plantations. On Príncipe the Príncipe drongo (*Dicrurus modestus*), Dorhn's thrush babbler, Príncipe sunbird and Príncipe speirops would be threatened by an increase in pesticide use.

Rehabilitation of plantations will almost certainly involve a dramatic increase in the use of pesticides and this will have a major impact on the aforementioned species and possibly others such as the São Tomé weaver, São Tomé seedeater (*Polioptila rufo-brunnea*) (which also feeds on invertebrates) and the São Tomé white-eye.

#### *Wildlife trade*

Red-headed lovebirds (*Agapornis pullaria*), grey parrots (*Psittacus erithacus*), common waxbill (*Estrilda astrild*), bronze mannikin (*Lonchura cucullatus*) and cordon-bleu (*Uraeginthus angolensis*) are all trapped for keeping as pets both locally and for export. The red-headed lovebird formerly occurred on Príncipe and trapping may have contributed to its extinction there. Currently none of the endemic species are involved in this trade.

#### *Tourism*

Current tourist developments are concentrated on the north-east and east coasts and present little threat to São Tomé's avifauna. Increased tourism might encourage the trade in wild birds and an escalation of hunting activities. The impact of tourism on the avifauna can be minimized by ensuring responsible behaviour from developers, travel operators and airlines.

Tourism may also be beneficial to the island's avifauna. São Tomé's host of rare endemic species are an attraction to specialist natural history and bird tours. If this industry can be encouraged and responsibly managed it will place an economic value on the island's forests and wildlife.

#### *Introduced mammals*

Dogs, cats, the african civet (*Viverra civetta*), the weasel (*Mustela nivalis*), the mona monkey (*Cercopithecus mona*), wild boar (*Sus scrofa*) and two rat species *Rattus rattus* and *R. norvegicus* have all been introduced into São Tomé (Dutton, 1994). Most of these species have been present for a century or more and there are no records of their effect on the endemic birds. Collar and Stuart (1985) reported old stories of wild dogs taking the eggs and young of dwarf olive ibis. Rats, and the weasels and civets introduced to control them (Bocage, 1904; Frade, 1958), are very likely to have had a deleterious effect upon nesting birds. Rats and civets have both colonized primary forest or certainly the edges of it (Atkinson *et al.*, 1994; Dutton, 1994). Not enough is known about the effects of these introductions on the island's avifauna to quantify any threat they pose.

#### **Conclusion**

Many of the endemic bird species of São Tomé and Príncipe remain common, in particular those that have adapted to secondary forest and plantations. The abandonment of

many plantations since 1975 has meant an increase in the area of secondary forest. Current exploitation of primary forest is low. However the remaining areas of primary forest, in particular lowland forest, are very small and they require immediate protection to safeguard not only the endemic avifauna but also the endemic plants and other fauna contained within them, many of which are poorly known, and some perhaps undescribed. Creation of national parks (*Zonas Ecológica*) to protect the remaining primary forest is a priority and these areas have now been officially designated by the government.

Knowledge of the rarer endemic bird species of RDSTP has increased in recent years and it is encouraging that all the species thought possibly to be extinct, the dwarf olive ibis, São Tomé fiscal shrike, São Tomé short-tail and São Tomé grosbeak, have all been rediscovered since 1990. However some areas of primary forest remain unsurveyed and detailed knowledge of the ecology of most of the endemic birds does not exist. Future research must be co-ordinated to achieve specific objectives and as such some degree of prioritization of research is needed.

## References

- Atkinson, P.W., Peet, N.B. and Alexander, J.M.W. (1991) The status and conservation of the endemic birds of São Tomé and Príncipe, West Africa. *Bird Conserv. International* **1**, 255–82.
- Atkinson, P.W., Dutton, J.S., Peet, N.B. and Sequeira, V.A.S. (1994) *A study of the birds, small mammals, turtles and medicinal plants of São Tomé and Príncipe*. Cambridge: Birdlife International.
- BDPA (1985) *Potencialidades agrícolas: República Democrática de São Tomé e Príncipe*. Paris: Bureau pour le Développement de la Production Agricole.
- Bibby, C.J., Collar, N.J., Crosby, M.J., Heath, M.F., Imboden, C., Johnson, T.H., Long, A.J., Stattersfield, A.J. and Thirgood, S.J. (1992) *Putting Biodiversity on the map: Priority Areas for Global Conservation*. Cambridge: International Council for Bird Preservation.
- Bocage, J.V. Barboza du (1904b) Contribution à la faune des quatre îles du Golfe du Guinée. 4. Île de São Tomé. *Jour. Acad. Sci. Lisboa*. **7**, 65–96.
- Cadbury, W.A. (1910) *Labour in Portuguese West Africa*. London: Routledge Ltd.
- Collar, N.J. and Stuart, S.M. (1985) *Threatened birds of Africa and related islands*. Cambridge: International Council for Bird Preservation.
- Collar, N.J. and Stuart, S.M. (1988) *Key forests for threatened birds of Africa*. Cambridge: International Council for Bird Preservation (Monograph 3).
- de Naurois, R. (1983) Les oiseaux reproducteurs des îles de São Tomé et Príncipe: liste systématique commentée et indications zoogéographiques. *Bonn. zool. Beit.* **34**, 129–48.
- de Naurois, R. (1984) La moucherolle endémique de l'île de São Tomé, *Terpsiphone atrochalybeia* (Thompson 1842). *Alauda* **52**, 31–44.
- Dutton, J.S. (1994). The impact of introduced mammals on biodiversity in São Tomé and Príncipe. *Biodiv. Conserv.* **3** (9), 927–938.
- Exell, A.W. (1944) *Catalogue of the vascular plants of São Tomé*. London: British Museum (Natural History).
- Exell, A.W. (1956). *Supplement to the catalogue of vascular plants of São Tomé (with Príncipe and Annobón)*. London: British Museum (Natural History).
- Frade, F. (1958) Aves e mamíferos das Ilhas de São Tomé e do Príncipe – notas de sistematica e de protecção a fauna. *Conferencia Internacional dos Africanistas Occidentais*, Lisboa **4**, 137–50.

- Harris, M.P. (1969) The biology of Storm Petrels in the Galapagos islands. *Proc. Acad. Sci. Calif.* 37, 95–166.
- Interforest AB (1990) *Democratic Republic of São Tomé and Príncipe, 1: results of national forest inventory; 2: national forest inventory, study of supply and demand of primary forest products – conclusions and recommendations*. São Tomé: Interforest AB.
- Jones, P.J. (1994) Biodiversity in the Gulf of Guinea: an overview. *Biodiv. Conserv.* 3, 000–000.
- Jones, P.J. and Tye, A. (1988) *A survey of the avifauna of São Tomé and Príncipe*. ICBP Study Report 24. Cambridge: ICBP.
- Junta do Investigacoes do Ultramar (1958) *Carta de São Tomé*. 5 sheets. Lisbon: Ministerio do Ultramar.
- Sibley, C.G. and Monroe, B.L. (1990) *Distribution and taxonomy of the birds of the world*. New Haven: Yale University Press.