SEED DISPERSAL BY BIRDS:
IMPLICATIONS FOR FOREST CONSERVATION

Final project report for African Bird Club

Ana Isabel Cavaco Pinto Coelho

University of Lisbon

January 2018

Project description

Location of the project
São Tomé e Príncipe, São Tomé Island

Project start and end dates
01-09-2015 to 31-08-2016

Supervisors
Dr. Ricardo F. de Lima (Centre for Ecology, Evolution and Environmental Change, University of Lisbon; Associação Monte Pico) & Dr. Rúben Heleno (Centre for Functional Ecology, Coimbra University)

Team leader and report writer
Ana Isabel Coelho (Master in Conservation Biology, University of Lisbon)

Field assistants
Octávio Veiga, Gabriel Oquiongo, Sideney Samba (Associação Monte Pico), Leonel Viegas & Estevão Soares (Associação Monte Pico & Parque Natural do Obô de São Tomé).

Citation
Coelho, A. (2018). Seed Dispersal by Birds: Implications for Forest Conservation. Report for African Bird Club. Unpublished report, University of Lisbon, Portugal.

Photography credits
Ana Coelho ©

January 2018

FIGURE 1 – (Cover) São Tomé Speirops (*Speirops lugubris*), the most important seed disperser.

Funding and support

Introduction

As the world population increases, anthropogenic impacts on natural ecosystems are becoming increasingly evident. With species going extinct, ecosystem services and functions are being lost, rendering ecosystems more vulnerable to human pressures. Seed dispersal is one of such functions, essential to forest dynamics. In the tropics, most seeds are dispersed through mutualist relationships between plants and animals. The effectiveness of seed dispersal depends on the disperser itself, the treatment they provide to the seeds, and the amount of seeds dispersed. The loss of a key disperser in an ecosystem can compromise the viability of plant populations and alter vegetation dynamics.

The effects of the biodiversity loss are particularly severe in islands. As island systems evolved in isolation, they hold very high numbers of endemic species. On the other hand, they also have less species and these have lower functional redundancy, making island ecosystems particularly fragile. It is indeed in islands that most species extinctions have occurred. One of the main threats identified is the introduction of invasive species, which often can outcompete native species.

The island of São Tomé, in the Gulf of Guinea, is a biodiversity hotspot with a remarkable number of endemic species and unique forest ecosystems. Much of its biodiversity is currently threatened by the increasing human population and associated habitat change.

Aims

The main goal of this work is to gain a better understanding of the role of birds as seed dispersers in the forests of São Tomé. To do so, we implement a network approach that will allow evaluating the contribution of each bird species as a disperser for each plant species, while simultaneously detecting patterns at the level of pairwise species interactions and evaluate emergent community-level patterns. We will specifically evaluate the network structure of seed dispersal by montane forest understorey birds, comparing interaction patterns in old-growth and secondary forest.

FIGURE 2 – Old-growth forests of São Tomé, Montane region.

Methods

The study took place in the forests near Macambrará, at approximately 1,300 m a.s.l. Their location and configuration offer ideal conditions for this work, with a relatively accessible and extensive block of old-growth forest surrounded by secondary forest. Data were collected from two 0.5 ha plots in each forest type, between October and November 2015.

Seed dispersal was assessed by detecting intact seeds in the droppings of mist netted birds. Birds were captured using mist nets operated at ground level, opened before sunrise and left open while climate conditions were favourable (i.e. no heavy rain, wind or fog). Effort in each plot was standardized to 3,000 hours x meter. Captured birds were identified to the species level and left for up to 1 h in a disposable paper bag. Fecal samples collected from the bags were analyzed under a dissecting microscope and all intact seeds were extracted. These seeds were then identified to the species level using a seed reference collection. This collection was constructed with seeds from ripe fruits gathered in the study area. The seeds were extracted, cleaned, dried at room temperature, photographed, identified to the species level and stored. Unidentified seeds were further compared with specimens of the Tropical Research Institute (LISC) and University of Coimbra (COI) herbaria.

We quantified interaction frequency as the number of droppings from each bird species containing at least one intact seed of each plant species.

FIGURE 3 – Octávio Veiga, our main field assistant, extracting a Principe Seedeater (*Serinus rufobrunneus thomensis*) from the net, and a bird's dropping with seeds (on the top right).

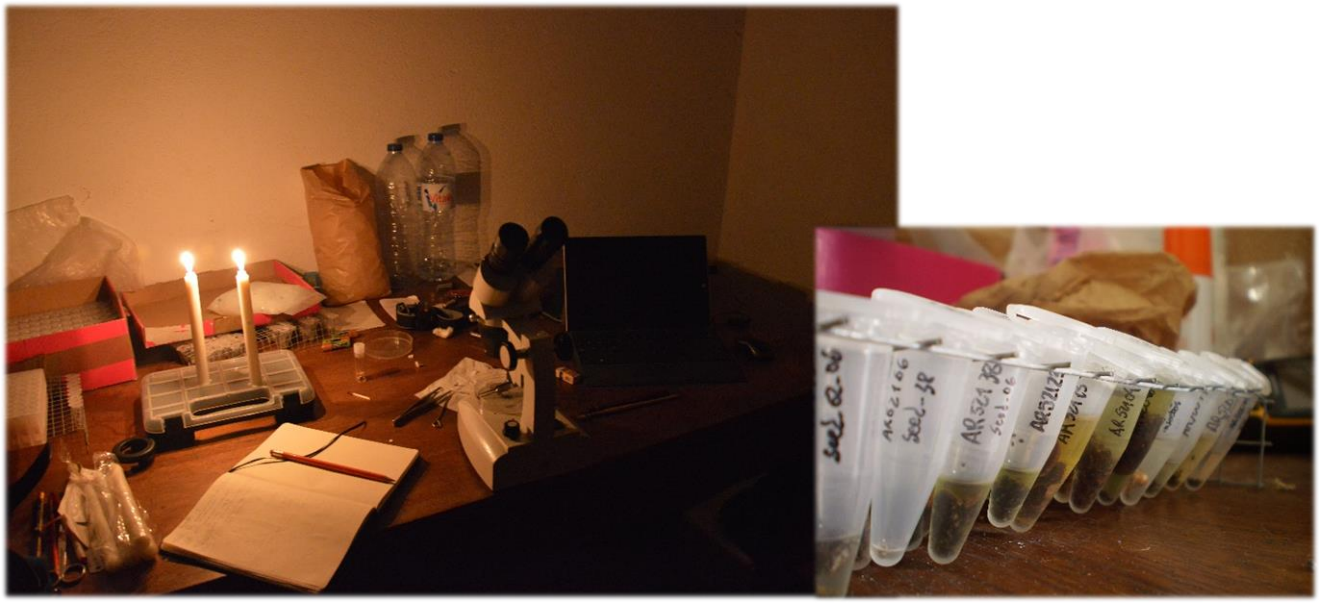

FIGURE 4 – Improvised laboratory, at Associação Monte Pico headquarters, Monte Café, São Tomé, and some of the epandorfs with seeds extracted from birds droppings.

Results

During 21 sampling days, we captured 743 birds belonging to 15 species, all of which were endemic to the Gulf of Guinea, at least at the subspecies level (Table 1 – Supplementary information). These birds produced 228 droppings with entire seeds (Table 2 - Supplementary information). A total of 4828 intact seeds from 43 plant species was retrieved, corresponding to 433 dispersal events (i.e. occurrences of seed species in droppings) by six disperser species (Fig. 5).

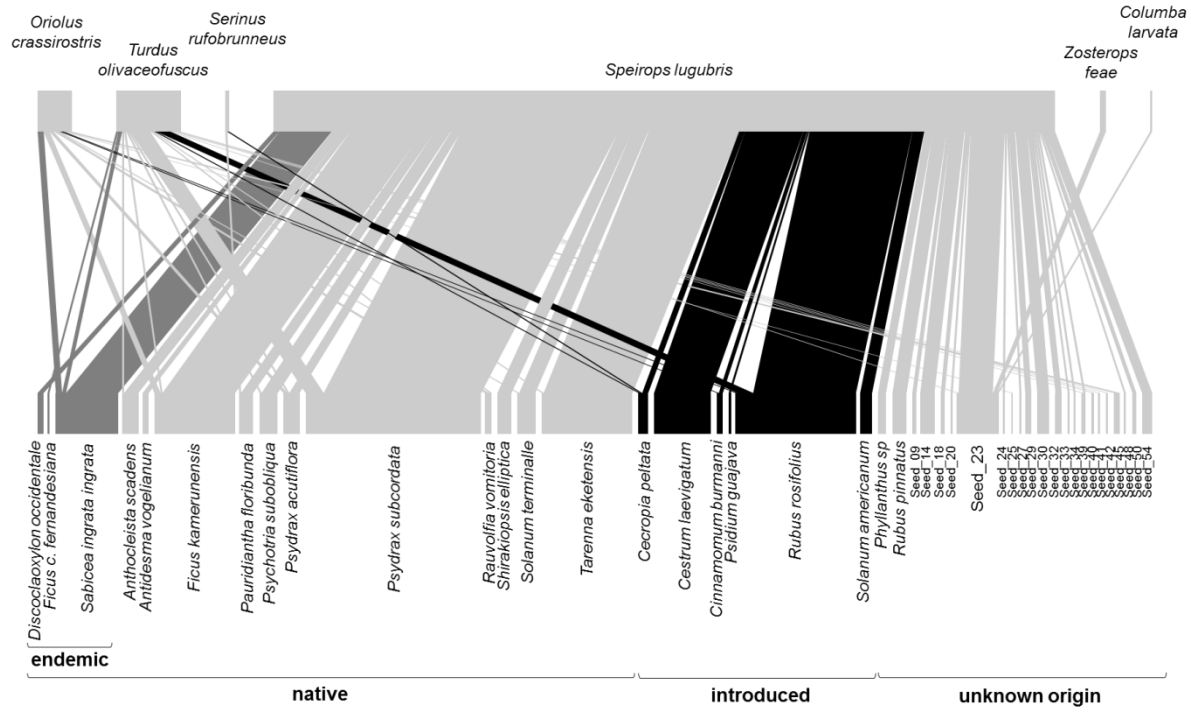

FIGURE 5 - Visualization of the seed dispersal network by understorey birds of São Tomé montane forests. Upper boxes represent bird species whereas lower boxes represent plant species. The width of the lines connecting two species is proportional to the interaction frequency between each bird and plant species. Introduced plant species are coloured in black and endemic in dark grey. All dispersers are endemic.

Most of the dispersal events (88% of interaction frequency) were promoted by a single bird species: the São Tomé Speirops (*Speirops lugubris*), dispersing 4274 intact seeds of 36 species, and producing 84% of all droppings with seeds (Table 2 - Supplementary information). The São Tomé Thrush (*Turdus olivaceofuscus*) and the São Tomé Oriole (*Oriolus crassirostris*), produced respectively 9% and 5% of all droppings with seeds, and dispersed 16 and nine plant species, respectively. The remaining three dispersers were the São Tomé White-eye (*Zosterops feae*), the Príncipe seedeater (*Serinus rufobunneus*) and the Lemon Dove (*Columba larvata*), together responsible for only 2% of the droppings with seeds.

FIGURE 6 – Some of the bird dispersers. From left to right: São Tomé Oriole (*Oriolus crassirostris*), São Tomé Trush (*Turdus olivaceofuscus*) and the Príncipe White-eye (*Zosterops feae*).

We found 43 plant species being dispersed: 14 were native to the island (59% of interaction frequency), six were introduced (23%), and 23 were of unknown origin (18% of interaction frequency), either because they could not be identified or because it is not clear if they are native or introduced (Table 3 - Supplementary information). Three of the native species (8% of interaction frequency) are endemic to the Gulf of Guinea, including the Near Threatened *Leea tinctoria* (Leeaceae) and the Vulnerable *Discoclaoxylon occidentale* (Euphorbiaceae).

The most commonly dispersed species is the native tree *Psydrax subcordata* (Rubiaceae; 263 seeds present in 85 droppings), followed by the invasive shrub *Rubus rosifolius* (Rosaceae; 1929 seeds in 58 droppings; Table 3 - Supplementary information). Together with *Tarenna eketensis* (Rubiaceae), *Ficus kamerunensis* (Moraceae), *Sabicea ingrata* (Rubiaceae), *Cestrum laevigatum* (Solanaceae) and one unidentified seed (morphotype Seed_23), they represent about 70% of the interaction frequency.

Discussion

Two out of the six seed dispersers in São Tomé are currently listed as Vulnerable, and one other is classified as Near Threatened by the IUCN (Table 1 - Supplementary information). This is particularly worrying as we have found little functional redundancy among the few dispersers in São Tomé, indicating that the loss of any of these threatened dispersers could cause a substantial loss in seed dispersal service available to plants, with unknown consequences for ecosystem stability.

The seed dispersal network is dominated by native plant species, including some endemics, and only a few introduced plant species. However, knowing that introduced species are among the major threats to biodiversity, further studies will allow a better understanding of this topic, namely how their spread and impacts can be mitigated in São Tomé.

Birds are therefore playing a double role in forest dynamics, contributing to the dispersal of native flora, while at the same time facilitating the spread of introduced species.

Project outputs

Seed reference collection

Besides the seed database built with the seeds gathered from the bird droppings, we built an extensive physical seed reference collection, organized by taxonomical order, with over 260 species represented out of the c. 1000 flowering plants listed for São Tomé. A digital seed collection was also organized, including pictures of most seeds in the physical collection. This digital collection would be available for online, but it is still being organized and improved. A copy of the physical collection will be sent to the São Tomé and Príncipe national herbarium, which is currently being reformed and seeking formal recognition by the local government.

FIGURE 7 – Organization of the seed reference collection.

Capacity building

We carried out six mist netting sessions to train local staff. These built on previous training, which had been provided by Dr. Martim Melo, and introduced one new person to the mistnetting techniques. All fieldwork activities involved local field assistants, providing them with extensive opportunities to improve the capacities they acquired during previous training sessions.

FIGURE 8 – Mistnetting training sessions: after a sudden rain fall and a run to close the nets, we had to move to the closest building to finish ringing the birds captured. From left to right: Dr Ricardo Lima, Ana Coelho, Sideney Samba and Leonel Viegas.

Master thesis

This work was part of Ana Coelho's master thesis at the University of Lisbon, entitled "The dispersal of native and introduced seeds by São Tomé forest birds" (Coelho 2016). She was able to complete her master's degree in Conservation Biology with a grade of 18 out of 20.

Report to local authorities

A project report was hand delivered in person to the following local authorities: General-Directorate for the Environment, the General-Directorate for Agriculture, the Forestry Directorate, the São Tomé Obô Natural Park and the local environmental NGO Monte Pico Association. The report was written in Portuguese, the country's official language, and had a specific focus on the impacts of invasive species, in the hope to raise awareness to this conservation issue in São Tomé.

Communications in scientific meetings

This work was presented at the:

- 2nd International Conference on Island Evolution, Ecology and Conservation, Portugal, and published as:

Coelho, A.P., J.M. Palmeirim, R.H. Heleno & R.F. Lima 2016. The dispersal of native and exotic seeds by São Tomé forest birds. Pp. 321 in: R. Gabriel, R.B. Elias, I.R. Amorim & P.A.V. Borges (Eds). Conference program and abstr:acts of the 2nd International Conference on Island Evolution, Ecology and Conservation: Island Biology 2016, 18-22 July 2016, Angra do Heroísmo, Azores, Portugal. Arquipelago. Life and Marine Sciences. Supplement 9.

- Island Ecology Symposium, Seychelles

R Heleno, **A Coelho**, F Mendes, R de Lima 2016. The impact of introduced mammals on the seed-dispersal network of São Tomé island, Island Ecology Symposium, University of Seychelles, Mahé, Seychelles, 18.11.2016

- 16th National Ecology Encounter SPECO, Portugal

Coelho, A, R.H. Heleno & R.F. Lima 2017. Dispersão de sementes por aves florestais em São Tomé. 16º Encontro Nacional de Ecologia, SPECO, 9-10 November 2017, Lisbon, Portugal

Data

Regarding bird captures, besides collecting the droppings, we also ringed and measured them, according to international protocols. These data were introduced in SAFRING's database (http://safring.adu.org.za/), shared between researchers in São Tomé, and is currently being used for a master thesis at the University of Lisbon.

Related work

After this short project, we got additional funding from the Rufford Foundation to continue this research on this topic, throughout a whole year (https://www.rufford.org/projects/ricardo_faustino_de_lima). In 2016-2017, a master student from University of Coimbra conducted the thesis on seed dispersal by native and introduced animals in São Tomé (Mendes 2017). In 2017 we applied for a larger project in São Tomé, part of which concerns seed dispersal and its consequences for forest dynamics, financed by FCT (Portuguese national funding agency for science, research and technology), which we are still waiting for the results.

Scientific publication

Two scientific articles based on the results of this study are being prepared, one focusing on the changes in seed dispersal across the year and between forest types, and another one assessing current knowledge on bird seed dispersal in São Tomé, to identify knowledge gaps and priorities for future research.

Challenges

During the project, we faced several difficulties, which halted the success of the project. Nevertheless, these challenges have been identified and can be improved upon in future work:

- Fruit availability and regeneration – Plant species identification was particularly difficult for seedlings and juvenile plants were hard to identify and often impossible to distinguish between species. Fructification of canopy species was also hard to detect, probably overestimating the proportion of understorey fruit availability. Nevertheless, we have collected data on forest composition, fruit availability and regeneration, which despite being scant will be linked to the bird seed dispersal data in the scientific publications which are in preparation.
- The impact of introduced plant species – Introduced species were detected both on old-growth and secondary forest, but these data did not allow us to understand whether these species are competing with the native ones.
- Seed identification – Despite the seed reference collection having over 260 species, 23 species of plants (18% of interaction frequency) found in the droppings were not possible to identify by comparison with this collection. This reflects the difficulty in assembling a comprehensive seed collection: São Tomé's forests are very diverse, having over 1000 described species. Furthermore, many species produce fruits in the high canopy, making them hard to collect and identify.
- Comparing old-growth and secondary forest networks - Due to logistic constraints, the sampling sites had to be located next to each other and near the forest edge, being influenced by edge effects that might not be persistent further away from the habitat interface.

Conclusion

Our work constitutes an important first step to understand animal seed dispersal in São Tomé. These results pose a pressing conservation dilemma, since birds are simultaneously contributing to native forest regeneration and to biological invasion. They should be taken in consideration in the management of the Obô Natural Park, recognising that the complex threat of invasive plant species may go far beyond those of direct human impact.

Acknowledgements

We are grateful to 'Associação Monte Pico' and 'Direccão-Geral do Ambiente', and to the people who provided technical support in São Tomé, namely to Luís Mário Almeida. We thank Martim Melo for providing the mist netting material, and Jorge Palmeirim, Ana Rainho, Estrela Figueiredo, Luís Catarino, Maria Cristina Duarte, Jorge Paiva and Fátima Sales for helping with the interpretation of the results, seed identification, and access to reference collections.

References

Albuquerque, C., Cesarini, D., 2009. Plano de Gestão do Parque Nacional Obô de São Tomé. ECOFAC IV, República Democrática de São Tomé e Príncipe.

Atkinson, P.W., Peet, N., Alexander, J., 1991. The status and conservation of the endemic bird species of São Tomé and Príncipe, West Africa. Bird Conservation International 1, 255–282.

Bleher, B., Böhning-Gaese, K., 2001. Consequences of frugivore diversity for seed dispersal, seedling establishment and the spatial pattern of seedlings and trees. Oecologia 129, 385–394.

Coelho, A., 2016. The dispersal of native and introduced seeds by São Tomé forest birds. Master's Thesis, University of Lisbon, Lisbon.

de Lima, R.F., Dallimer, M., Atkinson, P.W., Barlow, J., 2013. Biodiversity and land-use change: Understanding the complex responses of an endemic-rich bird assemblage. Diversity and Distributions 19, 411–422.

Fernández-Palacios, J.M., 2010. Why islands? Islands and Evolution 19, 85–109.

Figueiredo, E., Paiva, J., Stévart, T., Oliveira, F., Smith, G.F., 2011. Annotated catalogue of the flowering plants of São Tomé and Príncipe. Bothalia 41, 41–82.

Groombridge, B., 1992. Global Biodiversity: Status of the Earth's Living Resources. World Conservation Monitoring Centre. Chapman & Hall, London.

Heleno, R., Garcia, C., Jordano, P., Traveset, A., Gómez, J.M., Blüthgen, N., Memmott, J., Moora, M., Cerdeira, J., Rodríguez-Echeverría, S., Freitas, H., Olesen, J.M., 2014. Ecological networks: delving into the architecture of biodiversity. Biology Letters 10, 20131000.

Heleno, R., Olesen, J.M., Nogales, M., Vargas, P., Traveset, A., 2013a. Seed dispersal networks in the Galápagos and the consequences of alien plant invasions. Proceeding of the Royal Society B. 280(1750).

Howe, H.F., Smallwood, J., 1982. Ecology of seed dispersal. Annual Review of Ecology and Systematics 13, 201–228.

IUCN, 2016a. The IUCN Red List of Threatened Species. Version 2016-2. <http://www.iucnredlist.org>. (accessed 08.2016).

IUCN, 2016b. Why is biodiversity in crisis? <http://www.iucnredlist.org/news/biodiversity-crisis> (accessed 09.2016)

Jones, P.J., Tye, A., 2006. The birds of São Tomé and Príncipe, with Annobón: islands of the Gulf of Guinea. British Ornithologists Union, Oxford.

Kaiser-bunbury, C.N., Traveset, A., Hansen, D.M., 2010b. Conservation and restoration of plant-animal mutualisms on oceanic islands. Perspectives in Plant Ecology, Evolution and Systematics 12, 131–143.

Lawton, J.H., Brown, V.K., 1993. Redundancy in ecosystems. In: Schulze, E.D., Mooney, H.A., (Eds.), Biodiversity and Ecosystem Function. New York: Spinger, pp. 255–268.

Melo, M., Ryan, P., 2012. Endemism gone wild, the forgotten bird islands of São Tomé and Príncipe. African Birds & Birding. São Tomé and Príncipe, 33-41.

Melo, M., Warren, B.H., Jones, P.J., 2011. Rapid parallel evolution of aberrant traits in the diversification of the Gulf of Guinea white-eyes (Aves, Zosteropidae). Molecular Ecology 20, 4953–4967.

Mendes, F, 2017. The impact of introduced animals and plants on São Tomé seed-dispersal network. Master's Thesis, University of Coimbra, Coimbra.

Oliver, T.H., Heard, M.S., Isaac, N.J.B., Roy, D.B., Procter, D., Eigenbrod, F., Freckleton R., Hector, A., Orme C.D.L., Petchey, O.L., Proença, V., Raffaelli, D., Suttle, K.B., Mace, G.M., Martín-López, B., Woodcock, B.A., Bullock, J.M., 2015. Biodiversity and resilience of ecosystem functions. Trends in Ecology & Evolution 30, 673–684.

Schupp, E.W., 1993. Quantity, quality and the effectiveness of seed dispersal by animals. Vegetatio 107/108, 15–29.

Schupp, E.W., Jordano, P., Gómez, J.M., 2010. Seed dispersal effectiveness revisited: a conceptual review. New Phytologist 188, 333–353.

Terborgh, J., Robinson, S.K., Parker, III, T.A., Munn, C.A., Pierpont, N., 1990. Structure and Organization of an Amazonian Forest Bird Community. Ecological Monographs 60, 213–238.

Traveset, A., Richardson, D.M., 2006. Biological invasions as disruptors of plant reproductive mutualisms. Trends in Ecology & Evolution 21, 208–216.

Whittaker, R. J., Fernández-Palacios, J.M., 2007. Island biogeography: ecology, evolution, and conservation. Oxford University Press, Oxford.

Supplementary information

FINANCIAL REPORT

Description	Predicted cost	Actual cost	Justification
International transportation	709£	709£	Flight 595£ Visa 43£ Yellow fever + medical appointment 71£
Local transportation	283£	140£	Due to logistic constraints we had to camp near the study site, greatly reducing the transportation costs: 4 trips to São Tomé city to buy supplies = 10£ x 4 = 40 4 trips (return) to the field site = 25£ x 4 = 100
Field assistants salary	213£	428£	Besides the predicted field assistant, we hired 2 additional assistants: Full time mistnetting assistant = 26 days x 10£ = 260£ Additional mistnetting assistant = 12 days x 8£ = 96£ Plant expert assistant = 4 days x 18£ = 72£
Accommodation	213£	213£	71£ per month x 3months = 213£
Material	71£	69£	700 plastic boxes = 55£ 2000 eppandorfs = 14£
Report production	142£	72£	We had to reduce report production costs, sending reports by email or delivering it in person, to stay in budget.
Total	1631£	1631£	

Even though the official local currency is the Santomean dobra (STD), large payments are usually made in Euros, since they have a fixed exchange rate (1 € = 24,500 STD). Conversion rate 1€ = 0.70899 GBP (conversion rate for 2015).
Equipment not mentioned here was borrowed from previous research projects.

TABLES

TABLE 1 – Details on bird species mentioned in the text. ST refers to São Tomé, P to Príncipe and A to Annobón. The conservation status according to the IUCN Red List (IUCN, 2016a) categories: Not evaluated (NE), Least Concern (LC), Nearly Threatened (NT) and Vulnerable (VU). *species described by Melo *et al*., 2011.

Species	English name	Local name	Family	Distribution	Conservation status
Speirops lugubris (Hartlaub, 1848)	São Tomé Speirops	Olho-grosso	Zosteropidae	ST endemic species	LC
Anabathmis newtoni (Bocage, 1887)	Newton's Sunbird	Selêlê	Nectariniidae	ST endemic species	LC
Turdus olivaceofuscus (Hartlaub, 1852)	São Tomé Thrush	Tordo	Turdidae	ST endemic species	NT
Serinus rufobrunneus thomensis (Gray GR, 1862)	Príncipe Seedeater	Pardal	Fringillidae	STP endemic species, ST endemic subspecies	LC
Terpsiphone atrochalybeia (Thomson, 1842)	São Tomé Paradise Flycatcher	Jegue-jegue	Monarchidae	ST endemic species	LC
Prinia molleri (Bocage, 1887)	São Tomé Prinia	Truqui-sum-Dessu	Cisticolidae	ST endemic species	LC
Ploceus sanctithomae (Hartlaub, 1848)	São Tomé Weaver	Tchin-tchin-txoló	Ploceidae	ST endemic species	LC
*Columba malherbii (*Verreaux and Verreaux, 1851)	São Tomé Bronze-naped Pigeon	Rola	Columbidae	STPA endemic species	NT
*Dreptes thomensis (*Bocage, 1889)	Giant Sunbird	Selêlê-mangotchi	Nectariniidae	ST endemic species	VU
*Oriolus crassirostris (*Hartlaub, 1857)	São Tomé Oriole	Papafigos	Oriolidae	ST endemic species	VU
*Columba larvata simplex (*Temminck, 1809)	Lemon Dove	Mucanha	Columbidae	ST endemic subspecies	LC
*Zosterops feae** *(*Hartlaub, 1866)	Príncipe White Eye	Neto-de-olho-grosso	Zosteropidae	ST endemic species	NE
Otus hartlaubii (Giebel, 1849)	São Tomé Scops-owl	Kitóli	Strigidae	ST endemic species	VU
Zoonavena thomensis (Hartert, 1900)	São Tomé Spinetail	Andorinha	Apodidae	STP endemic species	LC
Chrysococcyx cupreus insularum (Shaw, 1792)	Eemerald Cuckoo	Ossobó	Cuculidae	STPA endemic subspecies	LC
Onychognathus fulgidus fulgidus Hartlaub, 1849	Chestnut-winged Starling	Pastro	Sturnidae	ST endemic subspecies	LC

TABLE 2 – Bird species captured with mist nets. Percentages refer to the relative proportion to the total for each column

Species	Captured birds (%)	Droppings with intact seeds (%)	Interaction frequency (%)	Dispersed plant species (%)
Speirops lugubris	261 (35)	192 (84)	380 (88)	36 (84)
Anabathmis newtoni	109 (15)	0	0	0
Turdus olivaceofuscus	86 (12)	20 (9)	31 (7)	16 (37)
Serinus rufobrunneus thomensis	82 (11)	2 (1)	2 (<1)	2 (5)
Terpsiphone atrochalybeia	81 (11)	0	0	0
Prinia molleri	40 (5)	0	0	0
Ploceus sanctithomae	33 (4)	0	0	0
Dreptes thomensis	18 (2)	0	0	0
Oriolus crassirostris	13 (2)	11 (5)	17 (4)	9 (21)
Columba larvata simplex	12 (2)	1 (<1)	1 (<1)	1 (2)
Zosterops feae	4 (1)	2 (1)	2 (<1)	1 (2)
Otus hartlaubii	1 (<1)	0	0	0
Zoonavena thomensis	1 (<1)	0	0	0
Chrysococcyx cupreus insularum	1 (<1)	0	0	0
Onychognathus fulgidus fulgidus	1 (<1)	0	0	0
TOTAL	743	228	433	43

TABLE 3 – Complete list of plant species retrieved from the droppings of mist netted birds. Interaction frequency of each species is given by the number of droppings where it was present. Origin in São Tomé is based on Figueiredo *et al.* (2011) and Estrela Figueiredo pers. comm.. ST = São Tomé, P = Príncipe; Percentages refer to the relative proportion to the total for each column *likely introduced species.

Species	Origin in ST	Interaction frequency (%)	Number of dispersers
Anthocleista scadens	Native	7 (1.6)	2
Antidesma vogelianum	Native	3 (0.7)	1
Cecropia peltata	Introduced	5 (1.2)	3
Cestrum laevigatum	Introduced	28 (6.5)	1
Cinnamomum burmanni	Introduced	3 (0.7)	2
Discoclaoxylon occidentale	STP endemic species	3 (0.7)	1
Ficus chlamydocarpa fernandesiana	ST endemic subspecies	1 (0.2)	1
Ficus kamerunensis	Native	39 (9.0)	3
Pauridiantha floribunda	Native	7 (1.6)	2
Phyllanthus sp.	Unknown	4 (0.9)	1
Psidium guajava	Introduced	1 (0.2)	1
Psychotria subobliqua	Native	9 (2.1)	2
Psydrax acutiflora	Native	8 (1.8)	3
Psydrax subcordata	Native	85 (19.6)	2
Rauvolfia vomitoria	Native	3 (0.7)	2
Rubus pinnatus	Unknown*	7 (1.6)	1
Rubus rosifolius	Introduced	58 (13.4)	3
Sabicea ingrata ingrata	ST endemic subspecies	30 (6.9)	3
Seed_09	Unknown	2 (0.5)	1
Seed_14	Unknown	7 (1.6)	1
Seed_18	Unknown	2 (0.5)	1
Seed_20	Unknown	1 (0.2)	1
Seed_23	Unknown	20 (4.6)	4

Seed_24	Unknown	1 (0.2)	1
Seed_25	Unknown	1 (0.2)	1
Seed_27	Unknown	1 (0.2)	1
Seed_29	Unknown	3 (0.7)	1
Seed_30	Unknown	6 (1.4)	1
Seed_32	Unknown	3 (0.7)	1
Seed_33	Unknown	1 (0.2)	1
Seed_34	Unknown	1 (0.2)	1
Seed_39	Unknown	2 (0.5)	2
Seed_40	Unknown	1 (0.2)	1
Seed_41	Unknown	1 (0.2)	1
Seed_42	Unknown	1 (0.2)	1
Seed_45	Unknown	3 (0.7)	1
Seed_48	Unknown	1 (0.2)	1
Seed_50	Unknown	2 (0.5)	1
Seed_54	Unknown	5 (1.2)	1
Shirakiopsis elliptica	Native	7 (1.6)	1
Solanum americanum	Introduced	6 (1.4)	1
Solanum terminalle	Native	9 (2.1)	2
Tarenna eketensis	Native	45 (10.4)	2
TOTAL		433	6