EFFECT OF DROUGHT ON BIRDS AT MAIMAFU, EASTERN HIGHLANDS PROVINCE, PAPUA NEW GUINEA

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ABSTRACT

We mist netted understorey birds for eight days at Maimafu, to study the effects of drought on their fat concentrations, moulting and breeding. Our results suggest that many birds were doing well despite the presumed stressful conditions; most birds had large fat reserves and many were breeding or moulting. Breeding and moult were not significantly lower and fat levels were significantly higher than observed in an earlier netting study nearby in non-drought years. These results were contrary to our expectation that drought-induced stress would curtail moulting and breeding, and deplete fat reserves. It is possible that drought conditions provided additional foraging opportunities in what is typically a very rainy site. Long-term monitoring of natural populations is urged to adequately assess the impact of future El Nino droughts.

INTRODUCTION

The El Nino Southern Oscillation (ENSO) event of 1997-98 caused severe droughts and forest fires throughout the island of New Guinea and the Indo-Australian region in general. The ENSO is a periodic fluctuation in the upwellings and ocean surface temperatures in the Pacific Ocean that alter rainfall patterns throughout the Pacific Basin. Some models predicting the impact of global warming and accumulation of greenhouse gases suggest ENSO events could become more frequent and more severe. Indeed, the severity of the droughts of 1997 seem to corroborate these predictions. In Papua New Guinea garden failures were the worst in recent memory and wildfires were widespread in what was normally wet forest. Global warming has become a subject of major concern among climatologists, ecologists, conservationists, and more recently politicians.

Drought can create shortage of food for vertebrate populations causing stress and population crashes if the drought is sufficiently severe and prolonged (Foster, 1982). Birds can respond to the stress of low food in a number of ways. Among these are reduced fat deposition, interruption or avoidance of breeding and moult, and emigration to areas with more food. Birds can accumulate or lose fat rapidly according to recent foraging success. Migrating birds can accumulate 1-7% of their lean body mass in just 24 hours (Alterstam & Lindstrom, 1990). Although data on fat accumulation of sedentary tropical birds are poor, fat levels do provide a crude indication of recent foraging success (Blem, 1990). Moult and breeding are prolonged, energetically-demanding, activities often timed to coincide with times of greatest food availability (Carey, 1996, Murphy, 1996). They can be triggered by abundance of resources (Ewald & Rohwer, 1982) or interrupted by deficiency of resources (Murphy, 1996). Thus the presence of breeding and moulting birds in a population should indicate that those individuals, at least, are foraging successfully. The last alternative, emigration, is difficult to measure in the field but could be assessed in a situation where long-term monitoring baseline data is available.

In this study we mist-netted and observed birds to assess these indirect indicators of environmental stress. Because of the prolonged drought and numerous wildfires in the vicinity, we predicted we would find few birds breeding or moulting and that most birds would exhibit low fat levels.

METHOD

Study site

The study was conducted outside the village of Maimafu, Eastern Highlands Province (6° 30' S, 145° 01' E) at about 1600 m elevation. The site is within the Crater Mountain Wildlfe Mangement Area and the project was part of the annual University field-training course. The study area was comprised of disturbed primary lower to mid-montane forest surrounding the village. Some trees have been cut in the area for building material or fuelwood, enabling thicker undergrowth to develop under the partially opened forest canopy.

Techniques

Fourteen sets of nets were set in a line through the forest. Each set consisted of two nets, one above the other, on tall bamboo poles. Two sets were 9 m long and twelve were 12 m long for a total linear length of 162 m by 4 m. Netting was conducted from 25 November to 3 December 1997. On the first four days of netting only the lower net in a set was opened (up to 2 m). On the following days both nets in a set were opened. Nets were run a total of eight days between the hours of 0700 to 1400 but closed earlier if rain fell.

All birds captured were identified, weighed and examined for fat, moult, and presence of brood patch. Visible subcutaneous fat deposits above the pectoral muscles were scored 0-5 using a standard scale widely used by bird banders (Rogers, 1991). Visible fat scores are a reliable estimator of total body fat (Biebach, 1996). The number of remiges and retrices in moult was counted and recorded. Body moult (contour feathers) was scored 0-5 on a subjective relative scale also employed by bird banders. Presence or absence of a brood patch was noted. Presence is a positive indicator of active breeding. These methods replicate data collected 1990-1993 at a nearby site, the Crater Mountain Biological Research Station (CMBRS) locally known as Wara Sera. The Maimafu data are compared to data from non-drought years collected at CMBRS (Mack & Wright, 1996 and Mack unpublished data). A tail feather was clipped to identify recaptures; data was only recorded from first-time captures.

RESULTS

Ninety-nine birds were captured and examined (not including recaptures), representing a capture rate of about 0.03 captures per net meter hour (see Table 1). Overall the data indicate that the drought (Maimafu sample) did not cause notable stress in the birds relative to the CMBRS sample collected in the same months in non-drought years.

Breeding

Of 86 birds examined for a brood patch, eight (9%) had brood patches. During the months of November and December at CMBRS 21 of 179 captures (12%) exhibited brood patches; these two samples do not differ significantly ($\chi^2 \pm 0.009$, df=1, P>0.90). Additionally, although not collected in a quantitative manner, incidental observations suggested that many birds were actively breeding: six species were observed with active nests (nest-building or incubating eggs).

Fat

The mean fat score of the Maimafu birds (3.0 ± 1.6, n= 96) was significantly greater than the mean fat score (mean=1.7 ± 1.0, n=179) of birds from the CMBRS sample (t=7.22, df=138, P<0.001).

Moult

More birds exhibited some retrix moult at Maimafu than at CMBRS (32% vs. 24%) but this was not statistically significant (χ^2= 1.58, P>0.2). There was not a significant difference in the mean number of retrices in moult (an indication of moult intensity) between Maimafu (mean=0.91 ± 2.06, n=94) and CMBRS (mean=1.00 ± 2.4, n=179) (t=0.32, df=217, P>0.74). A larger (34.2% vs. 24.5%) but statistically insignificant percentage of birds exhibited remige moult in the CMBRS sample (χ^2=2.34, P>0.2). There was not a significant difference in the mean number of remiges in moult (intensity) between Maimafu (mean= 1.4, ± 3.24, n=94) and CMBRS (mean= 1.9, ± 3.14, n=184) (t= 1.15, df=184, P>0.25). Lastly body moult between the two samples was also not significantly different. The percentage of birds with body moult at Maimafu (39%) was not significantly lower than the percentage (47%) at CMBRS (χ^2=1.45, P>0.2). Nor was there a difference in the mean body moult score at Maimafu (mean=1.03 ± 1.55, n=93) versus CMBRS (mean=0.97 ± 1.18, n=177) (t=0.36, df=149, P>0.7).

DISCUSSION

Areas to the immediate north of Maimafu, in the Tua River drainage, were burning at the time of this study. Smoke from the fires often shrouded the village and study area, reducing visibility at times to less than one kilometer. The leaf litter and understory vegetation were exceptionally dry and easily ignited. Fires in gardens around the study area often spread into the surrounding forest. Significant rainfall had not occurred for more than three months prior to the study, causing exceptionally dry conditions (R. Bino, personal communication). Such dry conditions are especially unusual in the high rainfall area of Crater Mountain (Wright *et al.*, 1977, A. Mack personal observation).

Drought conditions rarely occur in wet tropical forests and their effects are not well understood. In a well-documented study in Panama, drought caused starvation of many animals and caused other species to alter their normal foraging behaviors (Foster, 1982). Believing that the drought in Papua New Guinea during 1997 was equally as severe as the Panamanian drought, we expected to find similar evidence of stress at Maimafu. Our results, therefore surprised us; most birds captured seemed to be in good physical condition.

Most notable were the significantly elevated fat scores for the Maimafu birds relative to data collected nearby at the CMBRS during November-December in non-drought years. This difference was not an artefact of observer bias in scoring fat levels. One of us (Mack) inspected all the birds at Crater and Maimafu; data collection was methodologically consistent in the two studies. The birds inspected during the drought were exceptionally fat for birds netted in Papua New Guinea at any time of year (A. Mack, personal observation). This is notable in itself but even more so given our initial prediction that birds would exhibit lower fat scores. For all but one species the sample sizes were inadequate (<6 individuals) for within-species comparisons of body mass. For the one species with adequate samples at both sites, *Toxorhampus poliopterus*, the means at Maimafu and CMBRS did not differ significantly (11.7 g vs. 11.9 g respectively).

We predicted we would encounter few birds in moult or breeding because these energy- and nutrient- demanding activities can be suspended or avoided in times of stress. Contrary to our prediction, there was no significant difference in incidence of moult or breeding between the drought and non-drought samples. Clearly birds were not stressed sufficiently to preclude the extra demands of breeding or growing new feathers. These findings necessitate re-analysis of the initial assumption that drought causes widespread stress in birds.

One can posit three alternate hypotheses that might explain our failure observe stress:

Alternative 1. The birds actually were stressed relative to their normal condition at this time of year, and had we netted at Maimafu during non-drought years we would find even more birds breeding and in moult. This assumption would mean our data from CMBRS are not comparable. We reject this hypothesis. The comparative data from CMBRS were collected just 25 km away within contiguous forest. Although the CMBRS data were collected at a lower elevation 1000-130° m, most of the species netted at Maimafu (67%) were also netted at CMBRS. One of us (Mack) has netted extensively throughout Papua New Guinea and other tropical countries. He noted that the fat deposits of the Maimafu birds were exceptional relative to his broader netting experience, including a site at the same elevation roughly 18 km away in May 1996.

Alternative 2. The birds had not yet been stressed by the drought, but would become stressed eventually. This alternative hypothesis could be partially valid Certainly if the drought continued indefinitely many forest plants would die and eventually birds would suffer. However, at the time of the study the drought had been serious for at least three months. Avian fat deposits can accumulate or deplete in just a few days (Alterstam & Lindstrom, 1990), so we would expect stress to have been manifest by the time of the study. We did not observe interrupted moult, but instead all birds in moult were actively growing new feathers. We observed many brood patches, indicating birds with recently-laid eggs and also witnessed several active nests. It is likely that such activities would have been interrupted by the time of the study if the drought was going to have such an effect.

Alternative 3. Many birds were stressed, but not the species sampled. We believe our netting efforts, though by no means exhaustive for the local avifauna, represented a good cross-section of understory birds. In total 32 spp. were netted out of 99 spp observed during the study period. Two of five species observed with active nests were canopy species not netted. Three species of bird of paradise were actively displaying during the study period, an activity they would presumably forgo if they were significantly stressed.

It appears at the time of the study the general understory bird population was not particularly stressed by the drought. Perhaps the drought in fact had not reduced or even increased food availability. Perhaps the drought killed enough birds prior to the study that competition was reduced sufficiently to allow normal activities. We have few data with which to address these possibilities. However, we feel it is reasonable that the reduced rainfall benefited the birds in at least two ways. First, the absence of rains typical at this site might have actually increased the amount of time available to birds for foraging. During heavy rains many birds reduce their foraging activities. Second, the decrease in heavy rainfall might have somewhat reduced birds' heat loss during wet conditions and thus benefited the energy balance of birds.

Whatever the explanation, it is not safe to assume that drought conditions cause serious problems for all taxa. Without long-term field studies, any understanding of the implications of drought cannot be understood. Indeed, this study could not have drawn many conclusions without the long-term baseline data from the nearby CMBRS. If global warming will increase the severity and/or frequency of ENSO events, it is urgent that baseline data be collected now in order to assess the true consequences of the anticipated droughts.

ACKNOWLEDGEMENTS

This study was principally funded by Conservation International through a grant from USAID with additional support from the Wildlife Conservation Society. All students on the training course assisted with data collection, as did the course instructors Mike Moore, Steve Richards and Debra Wright. Logistical support was provided the Research and Conservation Foundation staff in Goroka and especially Robert Bino in Maimafu. We thank the people of Maimafu for hospitality.

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Table 1. Moult, brood patch (bp) and fat data for birds netted at Maimafu between 25 November and 3 December 1997.

	Mass (g)	bp	age/ sex	wing molt	tail molt	body molt	total molt	fat level
Arses telescophthalmus	17	no	ad m	0	0	0	0	0
Chaetorhynchus papuensis	33.5	yes	ad f	0	1	0	1	1
Cicinnurus magnificus	85	no		0	0	0	0	0
Colluricincla megarhyncha	34	no		0	0	0	0	0
Colluricincla megarhyncha	35			3	0	3	6	4
Colluricincla megarhyncha	37	no	ad	0	0	0	0	1
Crateroscelis murina	14	no	ad f	0	1	0	1	4
Crateroscelis murina	15.5	no		0	2	4	6	4
Crateroscelis murina	16	no	ad m	0	2	0	2	4
Crateroscelis murina	16	no	f	0	0	0	0	2
Erythrura trichroa	16	no		0	0	0	0	1
Erythrura trichroa	14.5	no	ad f	0	0	0	0	3
Erythrura trichroa	16	no		0	0	0	0	5
Erythrura trichroa	15.5	no	f	0	0	0	0	4
Machaerirhynchus nigripectus	11	no	ad m	0	0	3	3	4
Melanocharis longicauda	13		ad m	0	0	0	0	0
Melanocharis longicauda	14		m	0	0	0	0	0
Melanocharis longicauda	15	no	ad m	6	2	4	12	3
Melanocharis longicauda	15.5	no		0	0	1	1	5
Melanocharis longicauda	16.5	no	ad f	0	0	0	0	3
Melanocharis longicauda	17	no	f	0	0	4	4	4
Melanocharis nigra	16	?		0	0	0	0	5
Melanocharis striativentris	18	no		6	0	2	8	3
Melanocharis striativentris	21	no		0	0	0	0	1
Melanocharis striativentris	21	no		0	0	0	0	3
Melanocharis striativentris	22	no		0	0	0	0	2
Melanocharis striativentris	22	no		0	0	0	0	5
Melanocharis versteri	12		ad m	0	0	0	0	1
Melanocharis versteri	17.5	no	ad m	0	0	1	1	1
Melilestes megarhynchus	45.5	no		0	0	0	0	3
Meliphaga albonotata	22.5	no		0	1	0	1	2
Meliphaga albonotata	25.5	no		0	0	0	0	2
Meliphaga albonotata	28	no		8	1	3	12	4
Meliphaga mimikae	24	no	ad	0	0	1	1	4
Meliphaga mimikae	37.5	no		0	0	0	0	4
Meliphaga orientalis	17			0	1	3	4	4
Meliphaga orientalis	18	no		0	0	0	0	2
Meliphaga orientalis	18	no		0	0	1	1	0
Monarcha axillaris	16	yes	ad f	0	0	0	0	2
Monarcha axillaris	14	no	ad	0	0	0	0	3
Monarcha axillaris	16	no	m	0	1	0	1	0
Monarcha axillaris	16.5	no	ad f	0	1	0	1	3
Monarcha axillaris	17	no	ad m	0	0	0	0	1
Monarcha guttula	14.5	no		0	0	0	0	2
Monarcha guttula	17.5	yes	ad f	0	0	0	0	3
Oedistoma iliolophus	12	no	ad	0	2	3	5	3
Oedistoma iliolophus	15	no		4	2	2	8	4
Oedistoma iliolophus	12	no		0	0	2	2	5
Pachycephala schlegeli	26.5	yes	ad f	0	0	1	1	2
Pachycephala soror	24	no	f	8	1	3	12	4
Pachycephala soror	25.5	no		1	0	0	1	5
Peltops montanus	34.5	no	ad	0	0	0	0	3
Phylloscartes trivirgatus						?		
Phylloscartes trivrgatus	7.5	yes		0	0	0	0	2
Pitohui dicrous	69	yes	ad f	0	0	1	1	2
Pitohui nigrescens	71	no		0	0	0	0	0
Rhagologus leucostigma	29	yes	ad f	0	0	0	0	0
Rhagologus leucostigma	30.5	no		0	0	0	0	4

	Mass (g)	bp	age/ sex	wing molt	tail molt	body molt	total molt	fat level
Rhipidura atra		no	m	0	1	0	1	5
Rhipidura atra	12.5	no	f	0	6	1	7	4
Rhipidura atra	13	yes	ad m	0	1	1	2	1
Sericornis arfakianus							?	
Sericornis arfakianus	10	no		2	4	3	9	0
Sericornis arfakianus	10	no		4	12	5	21	4
Sericornis arfakianus	7.5	no		0	0	0	0	4
Sericornis arfakianus	8	no	ad f	0	0	0	0	4
Sericornis arfakianus	8	no	ad	0	0	0	0	4
Sericornis arfakianus	9	no		6	2	2	10	2
Sericornis arfakianus	9.5	no		6	7	4	17	0
Sericornis nouhuysi	16.5	no		2	0	3	5	2
Sericornis spilodera	11	no		13	0	3	16	2
Sericornis spilodera	11	no		8	4	5	17	5
Toxorhamphus poliopterus							?	
Toxorhamphus poliopterus	10	no		0	0	0	0	4
Toxorhamphus poliopterus	10	no	ad	0	0	0	0	5
Toxorhamphus poliopterus	10.5	no		0	0	0	0	5
Toxorhamphus poliopterus	11	no		0	1	1	2	4
Toxorhamphus poliopterus	11	no		3	0	2	5	2
Toxorhamphus poliopterus	11.5	no		0	0	0	0	4
Toxorhamphus poliopterus	11.5	no		0	4	0	4	5
Toxorhamphus poliopterus	12	no		2	0	4	6	4
Toxorhamphus poliopterus	12	no	ad m	1	2	0	3	4
Toxorhamphus poliopterus	12	no	ad	0	0	0	0	5
Toxorhamphus poliopterus	12	no	f	0	0	0	0	4
Toxorhamphus poliopterus	12.5		ad m	2			2	3
Toxorhamphus poliopterus	13	no		0	0	2	2	3
Toxorhamphus poliopterus	18	no		0	0	0	0	4
Toxorhamphus poliopterus	8.5		f				?	5
Toxorhamphus poliopterus	10	no	ad m	4	1		5	5
Tregallasia leucops	11.5	no	ad	18	7	5	30	3
Tregallasia leucops	14	no		0	0	0	0	1
Tregallasia leucops	15.5	no		11	9	3	23	4
Tregallasia leucops	15.5	no	ad m	0	0	0	0	3
Tregallasia leucops	15.5	no	ad	6	5	4	15	2
Tregallasia leucops	18	no		10	0	5	15	3
Zoothera dauma	69	no	f	0	0	0	0	5
Zoothera dauma	74	no		0	1	0	1	4