Seasonal changes in the food supply, numbers and male plumages of Pigmy Geese on the Thamalakane river in northern Botswana

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Most authorities consider the Pigmy Goose *Nettapus auritus* is resident (Cave & Macdonald 1955; McLachlan & Liversidge 1978; Serle *et al.* 1977; Williams 1963) or generally resident, with some movement locally (Benson *et al.* 1971; Clancey 1967; Mackworth-Praed & Grant 1957), yet the only two population monitoring studies made in southern Africa suggest that movement may occur on a greater scale than is generally acknowledged. In Rhodesia, at a dam near Lake MacIlwaine, Pigmy Geese were common only from October to December (Campbell & Miles 1956), whereas in Zambia, at Lochinvar National Park, they were abundant only from March to May, leaving as their food supply disappeared (Douthwaite 1978). To learn more about its residential status, counts were made between December 1977 and March 1979 along part of the Thamalakane river, a perennial effluent of the Okavango Delta in northern Botswana; its food supply, fruits of the water-lily *Nymphaea caerulea*, was also monitored.

Three post-juvenal plumages of the male have been described (Verheyen 1953): a sub-adult 'juveno-nuptial' (i.e. first pre-nuptial) plumage, in which the white cheeks are speckled with grey; an adult nuptial plumage, in which the cheeks are plain but the cinnamon-brown breast is barred anteriorly by two or three darker lines; and an adult pre-nuptial plumage, in which the cheeks and breast are plain. At Lochinvar most males in May 1972 were in the sub-adult 'juveno-nuptial' plumage, yet most appeared to be mated and many were in wing-moult suggesting they were, in fact, adult (Douthwaite 1978). In an attempt to determine the proper significance of the speckling, its occurrence on closely observed males was recorded.

The study area and methods

Monthly counts of Pigmy Geese were made from a boat between the downstream corner of Maun Game Park and a point 4 km upstream. Whenever possible birds were sexed and aged and, with males, the presence or absence of grey speckling on the cheeks was noted. On about the same date the flowers and partially-opened buds of water-lilies were counted in three permanently inundated plots measuring 730, 580 and 290 m^2. The plots, bounded in shallower water by grasses and sedges and in deeper water by the main stream, encompassed the zone of submerged- and floating-leaved herbs—*Nymphaea caerulea, Brasenia schreberi, Nymphoides indica, Najas pectinata* and *Utricularia* sp.—which formed the Pigmy Goose's habitat. In addition, 100 water-lily buds, flowers and fruits growing within 20 cm of the surface were gathered at random from three or four sites outside the plots and their edibility to Pigmy Geese assessed by observing the seed colour. As water-lily seeds ripen their colour changes from white to yellow, orange, red and finally black: only red and black seeds are eaten by Pigmy Geese (personal observation).

Eight Pigmy Geese were shot in June and July, when water-lily fruits were relatively scarce, and the contents of their crops examined.

Seasonal changes in some environmental variables are shown in Figure 1.

Results

Diet and the food supply

Brasenia and *Nymphaea* were the only aquatic herbs to fruit heavily in the study area. Pigmy Geese were never seen feeding amongst *Brasenia* and its hard, mucilage-covered fruits are presumably unpalatable. In contrast birds were often seen eating water-lily fruits and even when the fruits were scarce, in June, July and August, they provided the main source of food. Water-lily seeds constituted an average of 99% (extremes 98–100%) of the dry weight of food (mean 2·3 g, extremes 0·2–5·4 g) in the crops of seven birds shot between 9 June and 29 July. An eighth bird had an empty crop but water-lily seeds were the main food in its gizzard.

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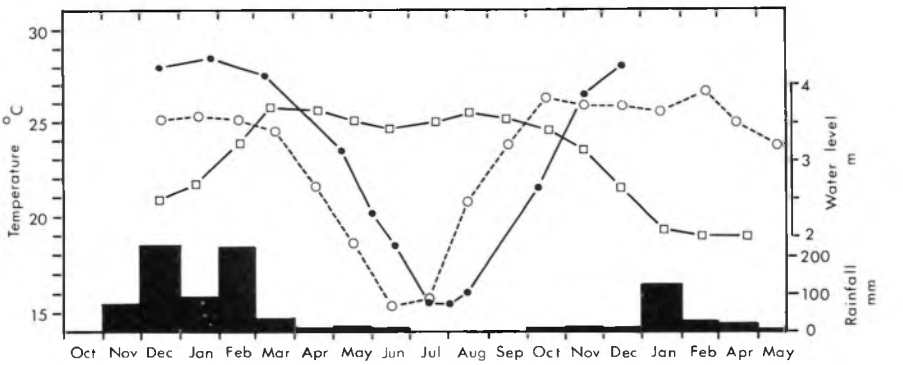

Figure 1. Some environmental variables at Maun. Monthly rainfall (histogram), water level (□——□), and mean monthly air temperature (○ - - - ○) during the study. Also, mean water temperature (●——●) at Maphaneng Lagoon, near Maun, from July 1976 to July 1977 (P. Fox *in litt.*).

Water-lily flowers were plentiful from mid-September to June but the proportion of edible fruits fell towards the end of the period so that food was most abundant from mid-September to January (Figures 2–3). The number of edible fruits/ha averaged 111 (n = 5) between late September and January, 56 (n = 5) between February and May, and 5 (n = 3) between June and early September.

The Pigmy Goose population

In 1978 and 1979 several pairs probably nested between January and March in riverine woodland in the study area; juveniles were present from February to July. No flightless birds in wing-moult were seen, but two birds shot on 9 June had recently completed their wing-moult. The main population increases were in July and December and the highest counts were made in December 1977 and December 1978 (Figure 3). Numbers fell after the December influxes more rapidly in 1978 than in 1979. The lowest counts were made between March and June 1978. The sex ratio in the counts was 162 males: 100 females (n = 736). Excluding the counts of December 1977 and 1978, and January 1979, the predominance of males was positively correlated with population size ($r = 0{\cdot}94$; t-test: $p < 0{\cdot}001$) (Figure 4).

None of the 98 males examined closely between November and March had grey speckling on its white cheeks or green of the neck, but 15 (33%) of the 46 examined between June and October did (Table 1). A high proportion of the males at Lochinvar during the wing-moult in May 1972 was speckled. The occurrence of speckling on museum specimens from various parts of

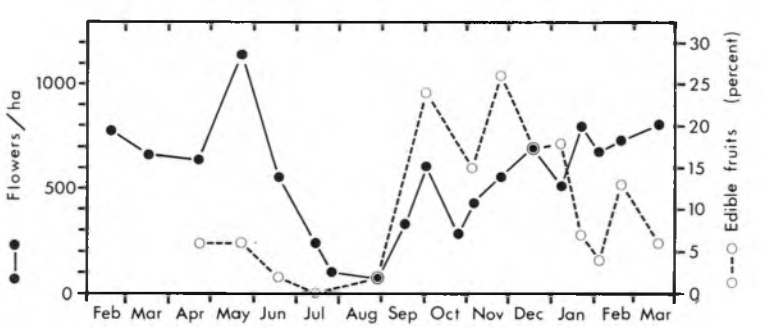

Figure 2. Average number of water-lily flowers/hectare in the three plots, and percentage of edible fruits, between February 1978 and March 1979.

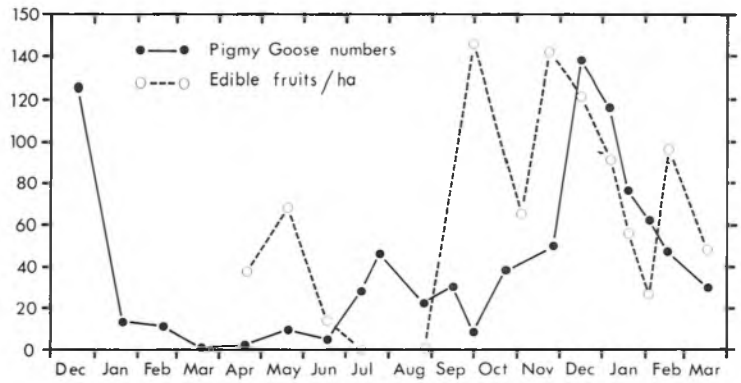

Figure 3. Pigmy Goose numbers in the study area, and abundance of edible water-lily fruits, December 1977–March 1979.

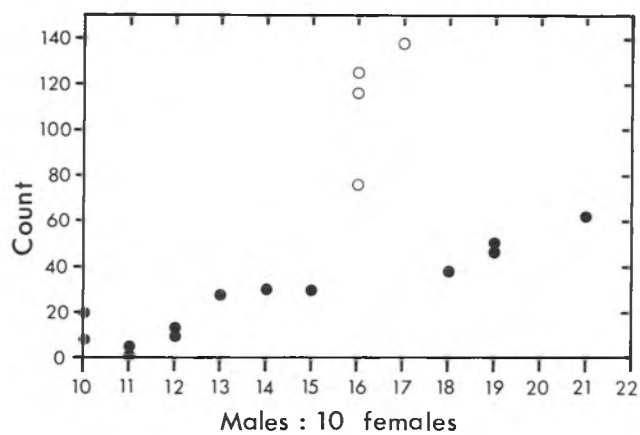

Figure 4. Sex ratios in the counts. Ratios in the counts of December 1977 and 1978, and January 1979, are shown by open circles.

Table 1. Seasonal occurrence of speckled male Pigmy Geese. Specimens from Africa south of 5°S, including Madagascar, were examined at the British Museum, Tring, the Department of Zoology Museum, Cambridge, and Livingstone Museum, Zambia.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Thamalakane river	speckled	0	0	0	—	—	1	0	2	8	4	0	0
	total	30	25	14	—	—	1	1	11	14	19	3	28
Lochinvar N.P.	speckled	—	—	—	—	11	—	—	—	—	—	—	—
	total	—	—	—	—	15	—	—	—	—	—	—	—
Museum skins	speckled	0	—	0	—	1	1	3	2	3	0	0	0
	total	2	—	2	—	4	2	4	3	4	2	2	1
Total percentage	speckled	0	0	0	—	63	67	60	29	61	19	0	0

southern Africa was consistent with the observations made at Maun; in addition it was noticed that localized barring of the cinnamon-brown breast feathers was present on both speckled and unspeckled birds, but heavy barring of the whole breast was restricted to unspeckled birds.

Discussion

Water-lily fruits were most abundant when the temperature was rising and high and scarcest when it was low (cf. Figures 1 and 3). The die-back of water-lilies at Lochinvar, in May, also occurred as temperatures fell. However the main changes in Pigmy Goose abundance were probably related more to the suitability of the area for nesting, and its unsuitability for wing-moult, than to the abundance of water-lily fruits. Fewer males were present in the influxes of December 1977 and December 1978 than expected, comparing the number with that predicted from the correlation between sex ratio and population size (Figure 4). As immigration occurred immediately before breeding it seems likely that most of the immigrants were pairs looking for nest sites. The earlier emigration of 1978, compared with 1979, may have reflected the availability of alternative nest sites in the former year, for the rains of 1977/78 filled the pools in nearby woodland, whereas the rains of 1978/79 did not. The low numbers of March–June 1978, coinciding with the period of wing-moult on the Kafue Flats (Douthwaite 1978), probably reflected a moult-migration from which most birds returned in July. In conclusion, the counts show that the Pigmy Goose is largely migrant to Maun, but the source of the December immigrants, and the species' whereabouts in the off-season are unknown.

In Zambia and Rhodesia breeding occurs between September and April, with almost all the clutches being laid in January and February (Benson *et al.* 1971; Boulton & Woodall 1974). A similar pattern probably prevails in northern Botswana, despite an apparent abundance of food from late September. More detailed information on the diet during the rains is needed however before food supply can be discounted as a proximate factor in breeding.

Brown & Seely (1973) drew attention to the abundance of Pigmy Geese in the Okavango Delta having counted 255 along 200 km of the Boro river in July. The narrower course of the Boro may explain their relatively low count compared with those in the present study. The Delta covers some 22,000 km^2, but less than 1% is classed as open water (FAO 1977) and potentially suitable for Pigmy Geese. Assuming 220 km^2 of suitable habitat supporting densities similar to those on the Thamalakane between July–October 1978, a crude estimate of the total population can be made. The study area extended to 0·6 km^2; in six counts it held 29 ± 12 birds (mean and standard deviation) giving an estimate of $10{,}600 \pm 4{,}400$ Pigmy Geese in the whole Delta. By comparison, 5,000–15,000 Pigmy Geese were present on the 12·5 km^2 lagoon at Lochinvar in April and May 1971–1973 (Douthwaite 1978). That a moult-migration occurs between the two areas is an intriguing possibility.

The sex ratio on the Thamalakane was almost identical with that recorded at Lochinvar between February and May 1972, namely 164 males : 100 females (n = 740) (Douthwaite 1978 & unpublished).

Sub-adult birds in 'juveno-nuptial' plumage (*sensu* Verheyen 1953) are absent from southern Zambia and northern Botswana between November and March, but by May they are plentiful, many as mated birds in wing-moult. If Verheyen is correct young birds must mate and undergo one complete moult within four months of hatching, or alternatively, juveniles must migrate and only return as conditions are deteriorating in the following year. Neither alternative seems plausible. A further difficulty with Verheyen's interpretation is that speckled birds appear more numerous than juveniles, suggesting several and not one year class is speckled. I suggest that speckled birds are in a pre-nuptial 'eclipse' plumage, assumed between April and July in a post-nuptial moult by adults, and in a post-juvenal moult by sub-adults. Fewer than half the birds seen in the six months May–October had speckling, suggesting it lasts for only two or three months. Similar 'eclipse' plumages, in which mottling of the white areas on the head and neck makes the male more like the relatively cryptic female, have been reported in the two other species of *Nettapus*, the Green Pigmy Goose *Nettapus pulchellus* (Frith 1967) and the White Pigmy Goose *Nettapus coromandelianus* (Phillips 1926). The restriction of heavy barring to the breasts of unspeckled birds suggests such plumage may be the full nuptial dress, in which case birds

with neither speckling nor barring (i.e. Verheyen's pre-nuptial plumage) are likely to be moulting between the 'eclipse' and nuptial plumages, and *vice versa.*

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Summary

Monthly counts of Pigmy Geese *Nettapus auritus* were made along 4 km of the Thamalakane river in northern Botswana between December 1977 and March 1979. The species was migratory, highest counts (138, 125) being made in December and lowest (1, 2) in March and April. Ripe fruits of the water-lily *Nymphaea caerulea*, its principal food, were most abundant from late September to January and scarcest from June to early September, but fluctuations in the numbers of geese were probably related more to the suitability of the area for breeding, and its unsuitability for wing-moult, than to changes in the food supply. The population in the Okavango Delta may number 5,000–15,000 birds. The sex ratio in the counts was 162 males: 100 females. Excluding counts made in December and January, the proportion of males increased with population size. Males in southern Africa probably assume an eclipse plumage for part of the period April to October.

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