NOTES ON THE DAILY DRINKING PATTERN OF CERTAIN BIRD SPECIES

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(With 4 graphs, 2 tables and 2 figures)

INTRODUCTION

In October and December 1967 observations were carried out at the waterhole in the fenced-off area of the Kuiseb river-bed directly below the Research Station at Gobabeb. These observations were made from a hide near the water's edge (Fig. 1) and were kept up from 6.30 hr. to 18.30 hr. continuously on 11 different days. Climatic conditions varied considerably: some days were clear and cloudless; on others there was fog, both with and without precipitation. On one occasion there had been a shower of rain the night before. Maximum day temperatures varied from 24°C to just below 40°C. The waterhole was about 25 feet by 6 feet and was the only one near the Station that still had water at that time of the year. A much larger waterhole 150 yards upstream had been kept under observation by Cade and Willoughby in July and August 1964 but was now completely dry.

Upstream, the nearest source of water during October was formerly to be found at the Natab Hottentot Settlement about 7 miles from the Station. Goats were formerly watered at troughs, made from hollowed-out tree trunks, to which many species of birds came to drink (Prozesky, 1963). But now 44-gallon metal drums, that have been cut in half, are used for drinking troughs. Since these vessels have straight sides the birds can no longer drink from them (Hamilton, in print). At the time that these observations were made W. Hamilton and K. Schaer travelled upstream from Gobabeb and found the first water at a small waterhole about 15 miles from the Station. Further upstream waterholes became more frequent.

Downstream there was a large shallow waterhole at the Soutrivier Hottentot Settlement about 2½ miles from the Station. Here there was no vegetation within 50 yards of the water except for a few large trees *(Acacia giraffae* and *Euclea pseudebenus)*. A count was carried out from a Land Rover parked about 50 yards from the water's edge, and the number of birds that came to drink proved to be surprisingly small. Between 10.00 hr. and 11.00 hr. on 29 October only 13 birds (4 species) came to drink, and 150 goats. Between 14.30 hr. and 15.30 hr. 157 birds (8 species) were counted. Only one goat was seen but some Hottentot women were collecting firewood near the waterhole. Counts made at the waterhole in the fenced-off area below the Station, between 10.00 hr. and 11.00 hr. and again between 14.30 hr. and 15.30 hr. on 23 October had given 1,190 (18 species) and 886 (16 species) respectively. On both 23 October and 29 October there was a high fog without precipitation, and the sun broke through at about 10.00 hr. Two counts carried out between 16.30 hr. and 17.30 hr., the one at Soutrivier on 27 October and the other at Gobabeb on 26 October, gave 220 (11 species) and 829 (17 species) respectively; both days were cloudless with no fog. But in the course of the Soutrivier count, goats came to the water on 10 different occasions, from a single goat to herds of over 40. There was hardly a five-minute period during which the birds could drink undisturbed. At the Gobabeb waterhole the birds were not disturbed at all. In the southern Sahara, men and cattle also keep the birds from drinking at wells (Bates, 1933). The numbers of *Streptopelia capicola* drinking at the Groot Okevi waterhole in the Etosha Game Reserve are similarly affected by the presence of game (Winterbottom, 1964). Below the Station, Hottentot settlements had also ceased, like those above the Station, to provide water for the birds. In fact the first free water to

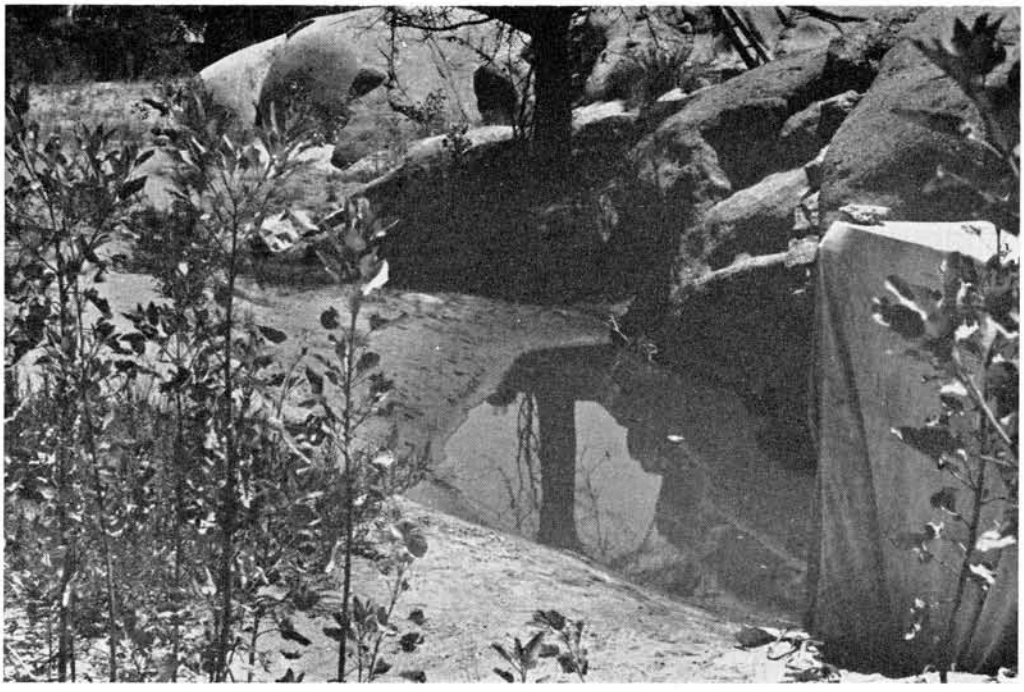


Figure 1: View at waterhole as seen from the hide showing the 30 feet of the water's edge.

be found downstream was at Rooibank, near the coast.

Conditions changed considerably between the end of October and the beginning of December, when the second series of observations began. As a result of the exceptional early-summer rains on the Khomas Hochland, an area which usually gets its rain in late summer, the Kuiseb River came down in flood in the middle of November, filling all the waterholes for several miles below the Station. When observations began on 8 December the waterhole at Gobabeb still had water, although the level had dropped slightly. The waterhole at Soutrivier, which had been flooded about 3 weeks before, was now dry. This should probably be attributed to higher daily temperatures and a higher rate of evaporation. The mean maximum temperature for the October period was 26.9°C, as compared with the mean maximum of 35.2°C for the December period. Upstream as far as Natab none of the waterholes had water; above Natab the holes were not checked.

While observations were in progress the bird bath at the Station was drained. The numerous doves and the few other birds that usually drink at the bird bath were therefore forced to drink at the waterhole 150 yards away. Although a few goats managed to climb through the fence and come down to the waterhole for a drink, this did not appear to affect the results obtained at the hide. During the 11 days on which observations were made the birds were left virtually undisturbed by either human beings or animals.

The number of birds that came to drink at the waterhole fluctuated considerably. On 26 October 11,544 birds (24 species) were seen at the water, either drinking or bathing. On 9 December only 3,991 (18 species) were counted. In July and August 1964 the average daily number at the two waterholes was 3,142 (Willoughby and Cade, 1967). Although the water at the Station is essential to the survival of the birds that frequent the river-bed the size of the populations of different species is determined by the amount of food available. Weeds like the thistle *Argemone subfusiformis,* a species of Datura and the grasses *Stipagrostis namaquensis, Eragrostis* spp. etc., now flourish in the fenced-off stretch of river, for they are no longer razed to the ground by herds of goats. The seeds of these plants provide seed-eaters like *Passer melanurus* and *Streptopelia senegalensis* with food. For October counts, see Tables IA and IB. December counts for these two species show a marked decrease (Tables IA and IB). In October, *S. senegalensis* averaged 620 daily (hourly mean 52) as against 399 (hourly mean 33) in December; *P. melanurus* averaged 1,598 (hourly mean 133) in October as against 536 (hourly mean 46) in December. This decrease in numbers in December was possibly due to the fact that since much of the seed in the river-bed had been washed away by the flood the birds had been forced to look for food elsewhere. In July and August 1964 the average daily count of *S. senegalen-*

TABLE 1: **Number of birds per hour from 6.30 hr. to 18.30 hr.**

A.

S. senegalensis

													Total
Oct. 22	66	61	18	164	22	48	5	10	48	18	47	27	534
24	24	124	168	71	18	13	27	9	18	20	55	67	635
26	52	162	126	59	30	18	30	19	25	41	73	60	695
Dec. 9	7	125	88	25	44	9	4	10	28	14	27	18	399

B.

P. melanurus

													Total
Oct. 22	40	101	110	192	162	116	207	164	145	156	115	31	1539
24	42	49	170	218	225	157	174	201	175	154	93	39	1527
26	54	62	216	183	164	144	161	157	242	184	101	59	1727
Dec. 9	9	38	44	87	22	60	38	55	47	34	69	33	536

C.

P. nigricans

													Total
Oct. 22	347	220	238	441	244	209	377	324	267	270	254	81	3272
24	255	313	416	398	347	289	345	307	367	367	252	60	3716
26	353	417	485	376	400	260	316	360	331	334	260	121	4013
Dec. 9	—	40	42	30	1	12	30	—	3	9	31	1	199

D.

Z. pallidus

													Total
Oct. 22	142	194	140	121	132	132	159	116	97	104	132	126	1595
24	84	235	223	268	192	205	147	126	128	133	166	136	2043
26	83	197	332	180	166	176	137	144	149	147	209	190	2110
Dec. 9	409	331	80	71	62	104	167	52	171	159	134	90	1850

E.

TOTAL ACTIVITY (All species)

													Total
Oct. 22	734	693	566	1089	647	724	952	812	747	741	737	313	8755
24	480	914	1157	1220	997	928	998	992	1121	912	700	323	10,742
26	589	1086	1367	1067	1037	914	1002	992	1065	1070	829	526	11,544
Dec. 9	439	577	331	309	186	283	377	182	912	367	362	166	3991

TABLE 2: **Number of birds per hour from 6.30 hr. to 18.30 hr.**

A.

S. senegalensis

													Total
Oct. 26	52	162	126	59	30	18	30	19	25	41	73	60	695
23	36	93	99	66	92	46	—	37	35	19	27	55	605
28	25	72	33	161	53	24		7	25	53	72	106	631
Dec. 10	—	—	—	—	—	—	—	3	1	1	42	1	48

B.

P. melanurus

													Total
Oct. 26	54	62	216	183	164	144	161	157	242	184	101	59	1727
23	58	85	110	142	237	203	160	191	178	181	108	35	1688
28	5	1	16	99	168	189		216	152	229	105	52	1237
Dec. 10	—	—	22	—	6	47	1	15	23	54	12	7	187

C.

P. nigricans

													Total
Oct. 26	353	417	485	376	400	260	316	360	331	334	260	121	4013
23	311	261	314	395	421	336	276	324	306	323	257	89	3603
28	42	3	—	24	275	397		348	372	481	328	115	2365
Dec. 10	—	—	4	2	19	33	2	29	3	51	—	—	143

D.

Z. pallidus

													Total
Oct. 26	83	197	332	180	166	176	137	144	149	147	209	190	2110
23	162	131	158	182	141	216	127	133	129	148	147	144	1868
28	20	5	29	90	193	195		144	140	169	175	214	1374
Dec. 10	—	—	2	—	—	2	—	6	9	82	43	67	211

E.

TOTAL ACTIVITY (All species)

													Total
Oct. 26	589	1086	1367	1067	1037	914	1002	992	1065	1070	829	526	11,544
23	597	640	770	901	1190	1006	606	903	886	908	613	376	9456
28	99	85	98	708	1062	1053		1103	992	1304	894	548	7846
Dec. 10	—	—	31	5	27	110	—	96	67	301	148	100	885

sis was about 1,600 (hourly mean 133; Willoughby and Cade, 1967). This suggests that in 1964 the dove population near the Station was very much larger than in 1967.

In the fenced-off area the vegetation on the river-banks has become much more luxuriant than usual. There was a very heavy crop of *Salvadora persica* berries. In all probability insect populations have also increased considerably. In December the wild figs *(Ficus sycamorus)* were ripe and *Solanum nigrum* berries were ripening in the river-bed. This abundance of food had attracted large numbers of fruit- and insect-eaters. In October and December the daily counts for *Zosterops pallidus* averaged 1,900 (Table ID); in October the daily count for *Pycnonotus nigricans* was 3,667 (Table IC). Though only a few bulbuls came to the water in December (see discussion) large numbers were seen feeding on the wild figs. In December, therefore, the bulbul population was still large.

OBSERVATION TABLES

During the 11 days of observation a count was made of every bird coming to the water to drink or bathe. In the discussion of the daily drinking patterns, however, only 4 species will be referred to: 2 seed-eating species and 2 fruit- and insect-eating species. The total activity of all the species is also given. Tables 1 and 2 indicate the numbers of:

A.: *S. senegalensis,* B.: *P. melanurus,* C.: *P. nigricans,* D.: *Z. pallidus* as well as E.: Total activity (all species).

The reason for choosing these 4 species is that they were present in such large numbers at that time.

[In all probability individual birds came to the waterhole several times a day. One *Serinus atrogularis* was a partial albino and was seen at the waterhole four times on the 9th December.]

Graphs 1 and 2 represent the activities shown on Tables I and II. These are expressed not numerically but as percentages. The highest activity per hour for a specific day is taken as one hundred percent activity and the other hourly activities are determined accordingly. This makes it possible to use a uniform scale, which greatly simplifies the comparison of data. Temperature, R.H., radiation and evaporation at hourly intervals are also given. Previous observations have shown that strong east winds have a pronounced effect on the behaviour of the birds at the waterhole. But the days in question were not particularly windy, and owing to the sheltered position of the waterhole the birds did not appear to be affected by occasional gusts of wind. Hence wind velocity and direction are not shown on the graph.

The days chosen for Graph 1 were similar: three in October without fog and clear; one in December also without fog but with broken cloud in the middle of the day. On that day the maximum temperature was much higher than on the three days in October. The days chosen for Graph 2 were all different. October 26 was a clear, fogless day; on October 23 there was a high fog, without precipitation, and the sun broke through at about 10.30 hr. On October 28 there was a low fog with precipitation (0.6 mm) and the sun broke through at about 9.00 hr. December 10 was cloudy for most of the day, 2.3 mm of rain having fallen the night before.

[On Graph 2 the shaded portions represent the periods in which there was no sunshine. The broken line between 12.30 hr. and 13.30 hr. indicates a break in the observation.]

DISCUSSION

A.
S. senegalensis

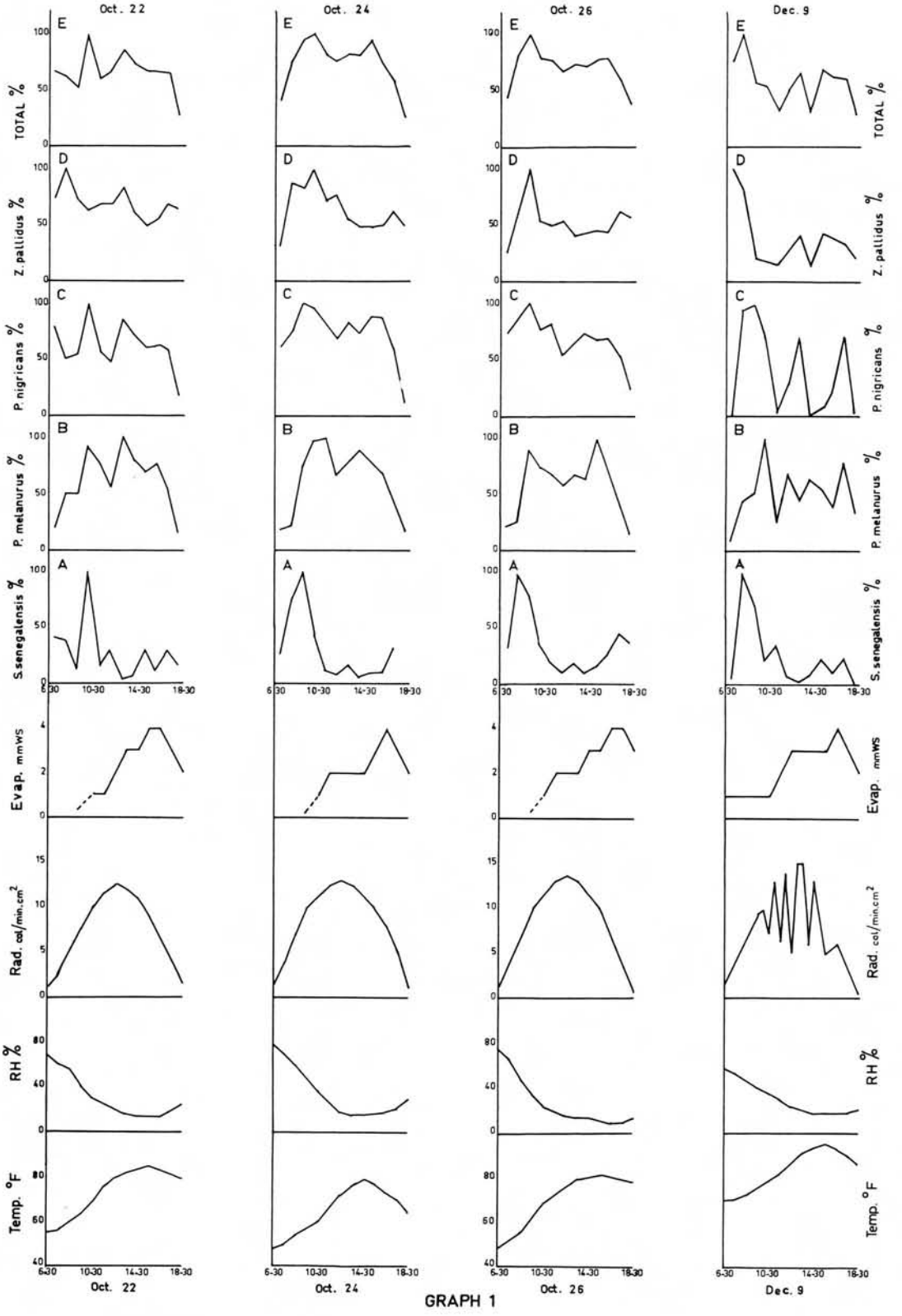
Graph 1

On these four days the only activity peak was between 8.00 hr. and 10.00 hr. On two days there was a slight increase in activity in the late afternoon, but not once after the morning peak was 50% activity reached.

Graph 2

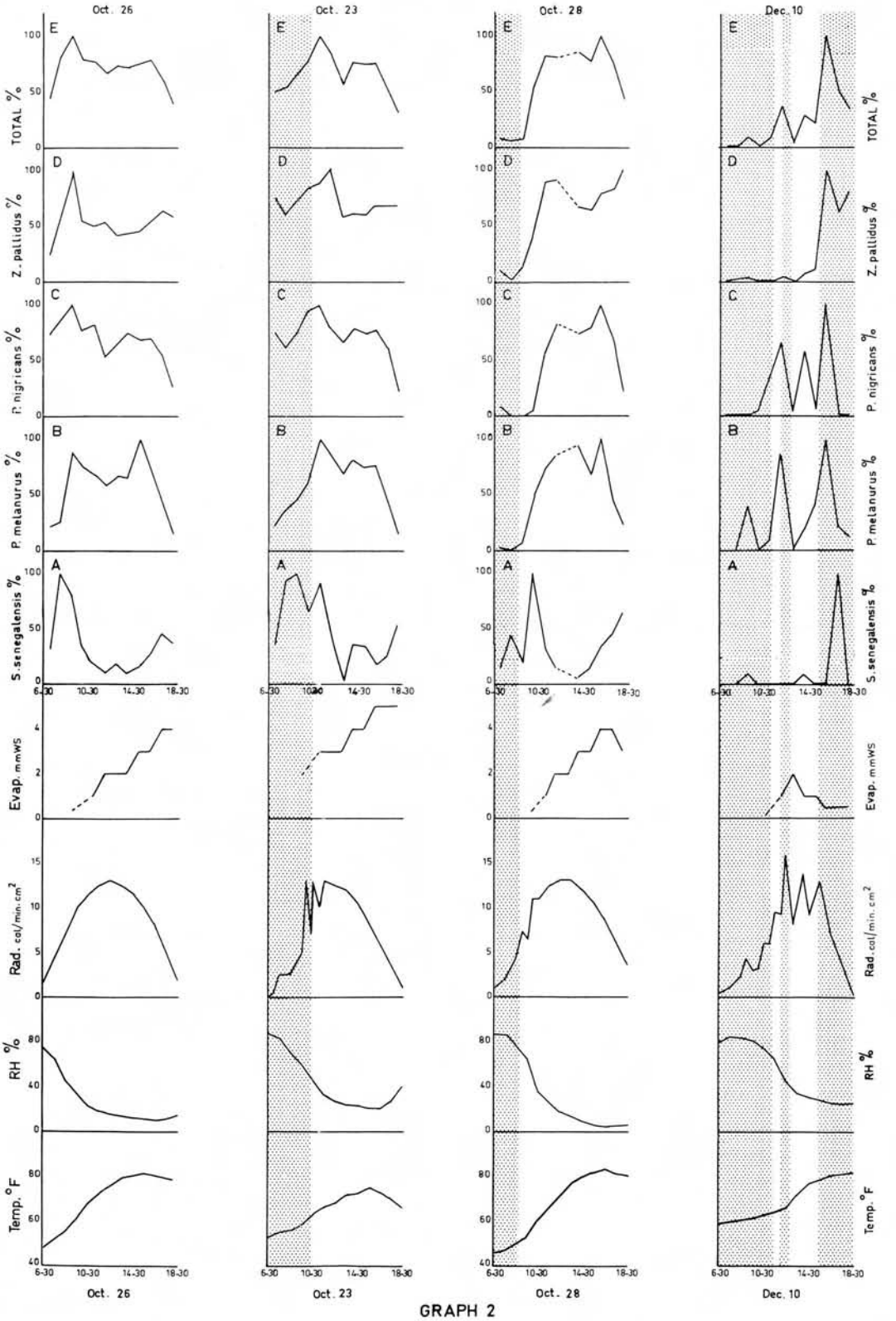
(N.B. Data for October 26, already shown on Graph I, have been repeated here for purposes of comparison).

The pattern for the two days with fog (with or without precipitation) is basically the same: a single activity peak during the morning and increased activity in the late afternoon. With fog precipitation, however, the activity was relatively slight and reached a peak only after the sun had been shining for about an hour. The double peak on October 23 may have been caused by some disturbance, in between the two peaks, of which the observer in the hide, with his limited view, was not aware (see Graph 4 A). December 10, the day after the rain, shows a completely different pattern, with hardly any activity all day, except for a slight peak at about 16.30 hr., and with only 48 doves coming in to drink during the day as against 399 the day before. Apparently they obtained sufficient moisture from the seeds they ate. From Graphs 1 and 2 it appears that there is no correlation between the daily drinking pattern of these doves and temperature, R.H., radiation or evaporation. On the Marshall-Transvaal Museum Kalahari Expedition this single activity peak during the morning for *S. senegalensis* and *S. capicola* was also observed at Dcuia (20°00′, 21°15′) in September 1961 and at Mathlobahubilo (20°50′; 22°13′) in October 1961.



GRAPH 1

Drinking activity (expressed as %) of 4 bird species, correlated with climatic data.



GRAPH 2

Data for cloudless day as compared with those of overcast days.

These waterholes are both in Botswana, and each is the only source of water for miles around. In July and August 1964 a morning peak between 9.00 hr. and 10.00 hr. and an afternoon peak between 13.00 hr. and 14.00 hr. were recorded at Gobabeb (Willoughby and Cade, 1967). In February 1968, 12 doves (*S. capicola, S. senegalensis* and their hybrids) in the Museum aviary showed a similar pattern: a morning peak between 10.00 hr. and 11.00 hr. and an afternoon peak between 15.00 hr. and 16.00 hr. In March 1968, 20 *S. senegalensis* in this aviary showed a single activity peak between 10.00 hr. and 11.00 hr.

The effects of the rain are clearly apparent in the drinking pattern for 10 December. On 28 October fog precipitation produced a similar but much slighter effect. On these two days the food the doves were eating was wet, and as most seeds are highly hygroscopic it may be assumed that the seeds eaten during the morning provided the doves with sufficient water for their needs, even if this was only temporary. Only after the seeds were dry did the doves come in to drink once more.

B.
P. melanurus

Graph 1

On these four days there were two activity peaks: a morning peak between 9.00 hr. and 10.30 hr. and an afternoon peak between 12.30 hr. and 16.30 hr. In all cases the activity dropped sharply after the afternoon peak.

Graph 2

The pattern for the two days with fog also shows the two basic peaks and a sharp decline in activity after the afternoon peak. The graph for 23 October (a high fog without precipitation) shows that only after 11.00 hr. did the morning activity reach its peak. Here light intensity affected the behaviour of the birds, who reached maximum activity only after the sun had come out. The effect of sunlight on the drinking activity of *P. melanurus* has also been observed in the museum aviaries, where the 22 sparrows in Cage A, which faced south and caught the early morning sun, began drinking much earlier than the 35 sparrows in Cage B, which faced west and caught the sun some 1½ hours later. Of the birds that drank between 7.00 hr. and 8.00 hr only 12% were in Cage B. Ambient temperature too may be a factor here, although at Gobabeb there was no appreciable rise in temperature when the sun broke through. On the 28th there was no activity while the low fog lasted. Sparrows were seen and heard during this period, but very few came to the water. It was only after the sun had dispersed the fog and the precipitated water had evaporated that these birds again became active at the waterhole. They, like the doves, must have obtained sufficient water for the time being from the wet seeds.

The pattern for 10 December (the day after the rain) is quite unlike the basic pattern, and shows three peaks with virtually no activity in between. Probably the wet seeds supplied the birds with most of the water they needed for the day, for only 187 came to drink, as compared with 536 on 9 December.

From Graphs 1 and 2 it appears that the afternoon activity peak of these sparrows is reached during the hottest part of the day, when evaporation is at a maximum and R.H. at a minimum. 57 Sparrows kept under observation in the Museum aviaries showed a similar basic pattern: a morning peak between 8.00 hr. and 9.00 hr. and an afternoon peak between 12.00 hr. and 13.00 hr.

C.
P. nigricans

Graph 1

The pattern for the three days in October shows great activity from early morning (over 60% during the first hour) to late afternoon, with a sharp decline in activity during the last two hours and a slight activity peak between 9.30 hr. and 10.30 hr. The pattern for 9 December shows no resemblance to the above and will be discussed under a separate heading.

Graph 2

On 23 October (the day with high fog and no precipitation) the pattern is similar to the basic pattern shown on Graph 1, except that the peak was reached later, at 11.30 hr., when the sun had broken through. As with the sparrows, light intensity may be a factor here. On 28 October (the day of low fog accompanied by precipitation) the pattern is quite different, with no activity during the greater part of the morning, an activity peak in the late afternoon and a sharp decline in activity during the last two hours. On 10 December (the day after the rain) there was no activity during the greater part of the morning, and then three activity peaks, each followed by a period of no activity. The drinking patterns for 28 October and 10 December will be discussed, with that for 9 December, under a separate heading.

Graphs 1 and 2, therefore, show no correlation between the drinking pattern of these bulbuls and any of the four climatic factors indicated.

D.
Z. pallidus

Graph 1

On the three days in October the drinking pattern was the same: an activity peak between 7.30 hr. and

9.30 hr. followed by over 50% activity for the rest of the day, until all activity stopped. There was no decline in activity towards evening. On 9 December there was an activity peak in the first hour, followed by under 50% activity for the rest of the day.

Graph 2

On 23 October (the day with high fog and no precipitation) the pattern is similar to the basic pattern for the three days in October (Graph 1), except that the peak was reached between 11.30 hr. and 12.30 hr. and not between 7.30 hr. and 9.30 hr. Light intensity appears to be a factor here. On 28 October, when there was fog precipitation, no activity took place while everything was dripping wet, but a sharp increase in activity was observed after the sun had come out and the place was dry again. In the late afternoon there was intense activity; this follows the basic pattern. On the day after the rain there was less than 5% activity before 15.30 hr.; for the last three hours there was increased activity and then all activity ceased. The drinking patterns for 28 October and 10 December will be discussed under a separate heading.

Graphs 1 and 2 also show no correlation between the drinking pattern of these white-eyes and any of the four climatic factors indicated.

E.

Total Activity

The following table indicates the number of species that came to drink at the waterhole during the seven days shown on Graphs 1 and 2. For a list of names of species see Appendix.

Date	22 Oct	23 Oct	24 Oct	26 Oct	28 Oct	9 Dec	10 Dec
No. of sp.	24	26	25	27	24	16	17

The total activity patterns for the days in October (Graphs 1 and 2) closely resemble the drinking patterns of *P. nigricans* (cf. C and E). This is not surprising, for on those days the number of *P. nigricans* that visited the waterhole constituted 35% of the total number of birds that came to drink. The patterns for the days in December are similar to those of *Z. pallidus* (cf. D and E). On those two days white-eyes constituted about 35% of the birds that came to drink.

And so although a large number of species may visit a waterhole, the total activity pattern actually reflects little more than the activity of the numerically predominant species.

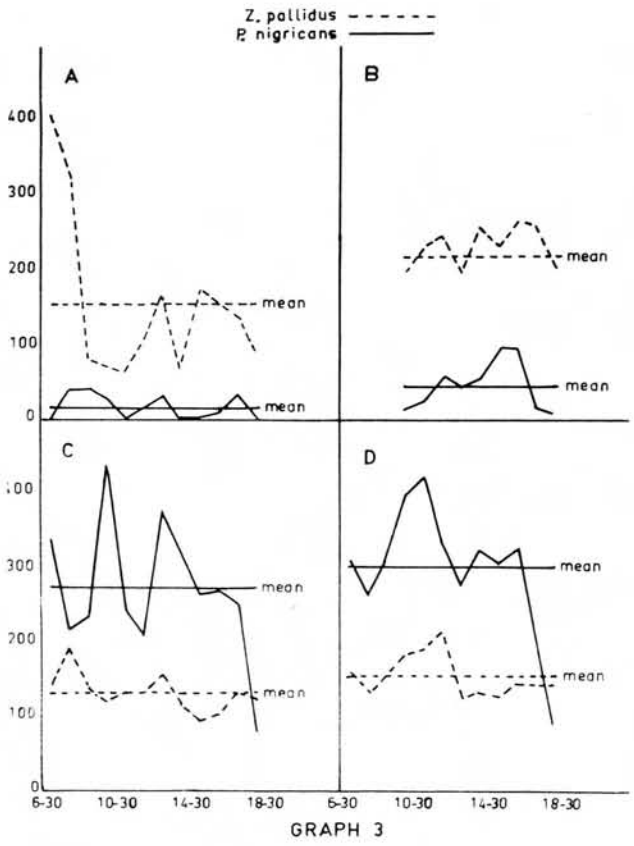
FACTORS, OTHER THAN CLIMATIC CONDITIONS, THAT AFFECT THE DAILY DRINKING PATTERNS

Many species of insect- and fruit-eating as well as carnivorous birds are not dependant on free water (Brehm, 1874; Naumann, 1905; Hildebrandt, 1929; Bates, 1933; Schildmacher, 1936; Willoughby, 1967). The food of these birds has a water content of between 50% and 85%, and this is usually sufficient for their daily needs. In 1964 Willoughby found *P. nigricans* visiting the waterholes in question at an average rate of 24 per hour. On 22 and 23 October 1967 the hourly mean for *P. nigricans* (Graph 3, C and D, expressed in actual numbers and not as a percentage, along the vertical axis) is about 285. As stated above, *P. nigricans* was the numerically predominant species in October. These birds feed chiefly on fruit, berries and occasional insects (Roberts, 1940), and at Gobabeb at that time of the year they were feeding chiefly on *Salvadora persica* berries. Since these have a moisture content of approximately 70% and the average maximum temperature for October was only 26.9° C one would not have expected to find them at the waterhole in such large numbers. In December the average hourly mean for these bulbuls had dropped to about 20 (Graph 3A and B, for 9 and 12 December), although, as stated above, the bulbul population had not changed to any marked degree. This drop from an average hourly mean of 285 to one of 20 is not owing to a change in climatic conditions, for the higher maximum temperature on 12 December (37.8° C) did bring about some increase in activity (Graph 3 B).

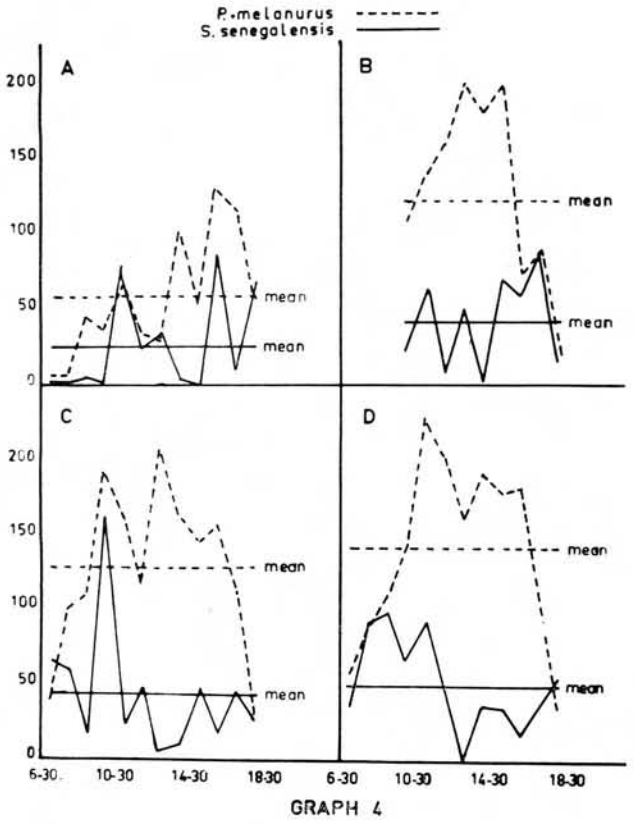
The average hourly mean activity of approximately 150 for *Zosterops pallidus*, which are also chiefly fruit- and berry-eaters (Roberts, 1940) is more or less constant in both October and December, although there was an increase in activity on 12 December (Graph 3 B), when the maximum temperature was over 10° C higher than on the other three days under discussion (Graph 3 A, C and D).

The drinking pattern of starlings is affected by the type of food they eat (Hamilton, in print). During the October observations both bulbuls and white-eyes were feeding mainly on Salvadora berries. In December, however, the bulbuls were feeding mainly on ripe figs. On 11 December, between 8.15 hr. and 9.15 hr. 95 bulbuls were seen in the fig-tree, 53 of them actually eating figs. None were seen hawking or catching insects. During the same period 80 white-eyes were counted in the same tree, but only 13 of these were actually feeding on figs. The other 67 were either hawking a species of Drosophila (large numbers of which had been attracted by the fermenting figs) or foraging for insects in the tree itself.

On the same morning at a *Salvadora persica* patch of about 20 yards square, chosen at random and about 200 yards from the fig-tree, only 16 bulbuls were seen, 7 of which were actually eating berries. 78 white-eyes were seen in the same patch, 24 of which were actually feeding on the berries.



GRAPH 3



GRAPH 4

During this time there was no hawking of insects, and none of the birds was seen to eat an insect during this time. It can be assumed that the white-eyes had come to the patch mainly for the purpose of feeding on the berries. If we compare the number of white-eyes feeding on figs with those feeding on Salvadora berries, we may safely conclude that in both October and December the white-eyes fed mainly on Salvadora berries. The bulbuls, however, fed mainly on Salvadora berries in October (when the figs were not yet ripe), but on figs in December. Observations showed that in December the bulbuls that came to the waterhole did so mainly to bathe. Only about 20% were actually seen to drink. The majority must have obtained sufficient water from the figs they were eating (moisture content 82%). Although the berries of *Salvadora persica* have a moisture content of about 70% they have been found to contain a fairly high percentage of Benzyl mustard oil (Wehmer, 1931). This oil is an irritant and extremely 'hot' when eaten. According to A. v.d. Merwe of the National Nutrition Research Institute of the C.S.I.R. the Ova Tjimba, a primitive tribe living on the Kunene River, eat these berries only if plenty of water is available to counteract the irritation set up by the oil. Apparently, therefore, both bulbuls and white-eyes that are feeding on *Salvadora persica* berries, drink water to allay the irritation set up by the Benzyl mustard oil.

In Graph 4, the vertical axis represents the actual numbers of *S. senegalensis* and *P. melanurus* that came to the waterhole. As stated above, the populations of these two species were much smaller in December than in October, the average hourly mean for *S. senegalensis* in December being 63% of that in October and the average hourly mean for *P. melanurus* 35% of that in October. But on 12 December both these species had approximately the same mean as on 22 and 23 October (Graph 4 B and D). The increased activity on 12 December (Graph 4 B) should probably be attributed to the higher maximum ambient temperature (37.8° C as against an average maximum of about 27° for the days in October).

The waterhole contained a very large number of small bream (a species of Talapia). In December, during the first hour or so after sunrise, these fish would swim close to the surface with their mouths protruding above it, and gasping all the time. For the rest of the day they would not show themselves. The water level was dropping, and this behaviour was probably owing to a lack of oxygen in the water. As a rule the fish kept to the middle of the waterhole and did not disturb the doves and sparrows drinking at the water's edge, or the bulbuls

Graphs 3 and 4: Drinking activity of 4 bird species expressed numerically.

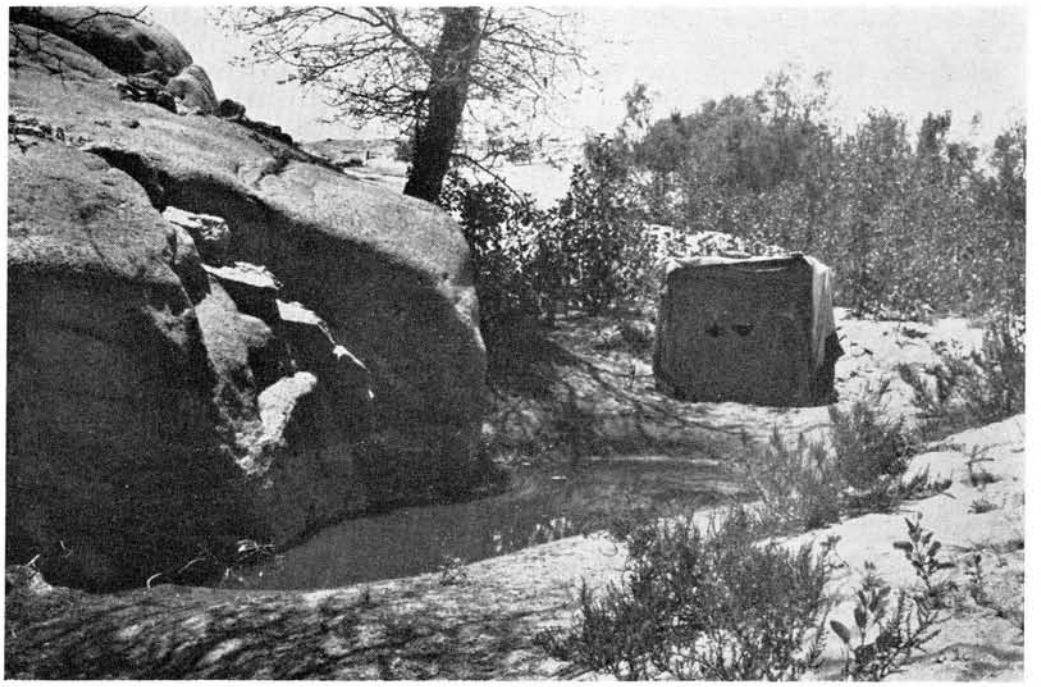


Figure 2: Waterhole showing roots in the lower left hand corner and the dead branch in the water from which the bulbuls and the white-eyes normally drank.

and white-eyes drinking from the overhanging roots at both ends of the pool, or the twigs of the dead branches in the water (Fig. 2). On 8 December (Graph 4 A) the fish swam close to the water's edge until about 9.00 hr. and before 9.30 hr. only 4 doves came to drink. Large numbers of doves came to the water, but being afraid of the fish they did not venture right up to the edge. The sparrows were also deterred by the presence of the fish (only 12 drank during the first 2 hours), but then they flew to the branches in the water to drink. During the next hour 81 drank. Doves were never seen to drink from these perches. It was noted on various occasions that Laughing and Turtle Doves came to drink only after other species, usually sparrows or canaries, had begun to drink. Large numbers of doves would gather near the water, and then there would be a concerted rush as soon as the small seed-eaters had led the way.

On the same day, at 14.35 hr., a pair of Lanners made their appearance. The doves that were still present in fairly large numbers scattered and took shelter in neighbouring trees, and most of the other birds followed suit. It was observed that whenever the birds were disturbed by birds of prey flying overhead, or even attempting to kill at the waterhole, Namaqua Doves *(Oena capensis)* and Black-throated Canaries *(Serinus atrogularis)* were not flushed, but froze. They remained perfectly still until the danger had passed and then went on drinking. Namaqua Doves, unlike the other two species of doves, did not wait for other birds to drink before they themselves began.

The Lanners remained at the hole for a little over an hour, the female making a few unsuccessful attempts to kill. The doves did not become active again until after the Lanners had left, but the sparrows came back soon after having been flushed. As a result of all these disturbances the activity peak for both sparrows and doves occurred in the late afternoon (Graph 4 A).

INTERSPECIFIC COMPETITION

Very little, if any, competition was observed among the species that came to drink along the 30 feet of water's edge. Any bird that was pushed aside by a member of a more domineering species would simply move a foot or two away where it could drink or bathe undisturbed. The activity peaks of *S. senegalensis* and *P. melanurus* often coincided. There was marked competition, however, among the species using the perches. During the October observations it was only on the 26th that the activity peaks of *P. nigricans* and *Z. pallidus* coincided. On all the other days, most of the white-eyes came to drink either before or after the bulbuls. In December there was no competition between the two species, as the bulbuls did not drink but only bathed in the shallow water near the edge. The white-eyes, therefore, were not disturbed by them

while using the perches. But the activity of the white-eyes continued throughout the late afternoon, when the other species that used the perches — including the Masked Weavers *(Ploceus velatus)* — had just about stopped coming to the waterhole. This clearly shows that these small birds bided their time: they waited until they could drink undisturbed.

Note: In October, two species of mousebirds came to the waterhole in fair numbers. On 26 October 544 Red-faced Mousebirds *(Urocolius indicus)* and 86 White-backed Mousebirds *(Colius colius)* were recorded. There was no competition, as the Red-faced Mousebirds drank at the water's edge, and the others from the perches. On only two occasions were the White-backed Mousebirds seen to drink at the water's edge, and then they looked most ungainly, lying flat on the ground with outstretched legs, and then awkwardly hopping to the water's edge.

SUMMARY

The isolated waterhole in the fenced-in area in the Kuiseb River bed directly below the Research Station at Gobabeb was kept under observation continuously from 6.30 hr. to 18.30 hr. for 11 days during October and December, 1967. Daily climatic conditions varied considerably. Every bird that came to the water either to drink or bathe was recorded. The daily drinking patterns of only 4 species, two of them seed-eating *(Passer melanurus* and *Streptopelia senegalensis)* and the other two both insect- and fruit-eating *(Pycnonotus nigricans* and *Zosterops pallidus)* are discussed.

Under normal climatic conditions (cloudless days with little wind) and when not disturbed, the doves and the sparrows have a fixed drinking pattern. Both species have a morning activity peak, but only the sparrows have an afternoon peak, though the doves may show a slight increase in activity during the late afternoon. The drinking behaviour of doves cannot be correlated in any way with the daily climatic conditions (temperature, R.H., radiation and evaporation). The afternoon activity peak of the sparrows on the other hand coincides with the maximum temperature and a low R.H. When the seeds on which these two species feed are wet either from fog, dew or rain the water obtained in this way temporarily satisfies their needs.

As a rule insect- and fruit-eating species seldom if ever drink water as the water content of the food they eat is normally sufficient for their needs. During October both the bulbuls and the white-eyes drank a great deal throughout the day, whereas only the white-eyes drank during December. During this period the bulbuls came to the waterhole mainly to bathe. During October both species were feeding on *Salvadora persica* berries, whilst in December the bulbuls were eating mainly figs and the white-eyes mainly the Salvadora berries. Their daily drinking pattern is determined by the type of food they eat. While eating these berries, which contain Benzyl mustard oil, both species were obliged to drink water frequently to allay the irritation caused by the oil contained in the berries. The daily drinking pattern of neither species can be correlated with climatic conditions (temperature, R.H., radiation and evaporation).

The daily drinking patterns of all four species were temporarily affected by any disturbance e.g. animals coming to drink, the presence of birds of prey, fish in the water, etc. There was no interspecific competition between the doves and the sparrows as there was ample room for both to drink along the water's edge. Their activity peaks usually coincided. On the other hand the bulbuls and the white-eyes usually drank from the limited number of perches and the larger bulbuls simply pushed the smaller birds aside. Their activity peaks did not coincide and the white-eyes were the only birds coming to the waterhole in the late afternoon after all other drinking activity had stopped and they could drink and bathe undisturbed.

The activity of all four species reached its peak during the early part of the morning. Apparently most birds need water after the long night's rest. The actual time at which their activity reaches its peak is probably determined by light intensity.

APPENDIX

List of birds seen at the waterhole during October and December 1967.

(N) Species not recorded by Willoughby during 1964.
* Species that were not seen drinking.

* Grey Heron *Ardea cinerea.*
(N) * Black-headed Heron *Ardea melanocephala.*
* Cattle Egret *Bubulcus ibis.*
* Hamerkop *Scopus umbretta.*
* Lanner Falcon *Falco biarmicus.*
Chanting Goshawk *Melierax musicus.*
(N) * Steppe Buzzard *Buteo buteo.*
(N) * Black-shouldered Kite *Elanus caeruleus.*
(N) * Curlew Sandpiper *Calidris testacea.*
(N) * Little Stint *Calidris minuta.*
(N) * Redshank *Tringa totanus.*
Namaqua Sandgrouse *Pterocles namaqua.*
Rock Pigeon *Columba guinea.*
Cape Turtle Dove *Streptopelia capicola.*
Laughing Dove *Streptopelia senegalensis.*
Namaqua Dove *Oena capensis.*
(N) * Diederik Cuckoo *Chrysococcyx caprius.*
White-backed Mousebird *Colius colius.*
Red-faced Mousebird *Urocolius indicus.*

* Swallow-tailed Bee-eater *Dicrocecus hirundineus.*
* Scimitar-bill Hoopoe *Rhinopomastus cyanomelas.*
Pied Barbet *Tricholaema leucomelas.*
* Cardinal Woodpecker *Dendropicos fuscescens.*
European Swallow *Hirundo rustica.*
Larger Striped Swallow *Hirundo cucullata.*
Rock Martin *Ptynoprogne fuligula.*
(N) * European Oriol *Oriolus oriolus.*
Pied Crow *Corvus albus*
(N) * Grey Tit *Parus afer.*
Red-eyed Bulbul *Pycnonotus nigricans.*
(N) Cape Thrush *Turdus olivaceus.*
Mountain Chat *Oenanthe monticola.*
Familiar Chat *Cercomela familiaris.*
(N) * Willow Warbler *Phylloscopus trochilus.*
(N) * African Marsh Warbler *Acrocephalus baeticatus.*
Black-chested Prinia *Prinia flavicans.*
* Spotted Flycatcher *Muscicapa striata.*
Tit Babbler *Parisoma subcaeruleum.*
Cape Wagtail *Motacilla capensis.*
(N) * Red-backed Shrike *Lanius collurio.*
Wattled Starling *Creatophora cinerea.*
Cape Glossy Starling *Lamprocolius nitens.*
Pale-winged Starling *Onychognathus nabouroup.*
Dusky Sunbird *Cinnyris fuscus.*
Cape White-eye *Zosterops pallidus.*
Cape Sparrow *Passer melanurus.*
Grey-headed Sparrow *Passer diffusus.*
Masked Weaver *Ploceus velatus.*
(N) Red-billed Quelea *Quelea quelea.*
(N) Red-headed Amadina *Amadina erythrocephala.*
Scaly-feathered Finch *Sporopipes squamifrons.*
Common Waxbill *Estrilda astrild.*
Black-throated Canary *Serinus atrogularis.*
White-throated Seed-eater *Serinus albogularis.*
Yellow Canary *Serinus flaviventris.*
Lark-like Bunting *Fringillaria impetuani.*

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