BREEDING OF THE BLACK-HEADED HERON AT NAIROBI, KENYA, 1958-62

By

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(Photographs 1-16 by the author, two tables, a histogram and a map)

Contents

1. Introduction

In 1954, a number of Black-headed Herons, Ardea melanocephala Vigors and Children, appeared at the Stores Yard of the East African Railways in Nairobi and at once began to breed in a clump of tall Eucalyptus trees. The colony prospered, and in 1958 the Committee of the East Africa Natural History Society decided that this was suitable for a detailed study, which has continued ever since and still continues. The organization of the work and most of the watching have been my responsibility and this report summarizes the 4-year period May 1958 to May 1962, plus some additional observations up to the time of going to press in October 1962. The main activity, making a monthly count of occupied nests, was undertaken by me except during part of 1959 when Mr. Leslie Brown kindly took over while I was on leave. In addition to the counts, an attempt was made to study various other aspects of the biology of this species. My observations were necessarily intermittent on account of absences from Nairobi, but over 200 hours' field work has been spent on the investigation to date.

At each monthly count during this period there have been at least some occupied nests, which proves that breeding has been continuous over these four years. It has been remarked that in tropical climates there is no reason why birds should not breed all the year round; here is evidence that they do. It so happens that continuous, less-than-annual or annual breeding on the part of the seabirds of Ascension Island has recently been the subject of an authoritative report by the members of the B.O.U. Centenary Expedition, Stonehouse et al.,1962, and the analytical accounts here given are most relevant for the understanding of similar behaviour in A. melanocephala. Further, Stonehouse, 1962:121 has coined some useful breeding definitions which will be used here. These stem from the dictionary definitions of season as a time of year, period as an amount of time and cycle as a recurrent series of events. Thus, breeding season is the time of year during which breeding activities of any kind take place; laying season, the time of year when individuals of a species normally lay eggs; breeding cycle, the sequence of events which a bird follows from the beginning of courtship to the independence of its offspring, and breeding period, the length of time required to complete the breeding cycle.

The breeding cycle of A. melanocephala is discussed in detail and illustrated by a histogram in Part IV. It is of considerable interest and by no means easy to summarize in a few words; further, four years are a short period and much will no doubt be learnt in the years to come. However, evidence accumulated to date indicates that: (1) Peaks in breeding are linked with rain and lulls with drought. (2) Where rains are exceptional, the result may be a large breeding occupation which persists for many months to come. Whether such persistence is caused by successive broods on the part of resident birds, or by additional birds arriving to breed, or by both, is a matter for speculation. (3) Poor rains result in a small occupation which then dwindles. (4) The period of minimum activity is during the dry weather of August-September after poor rains in April-May.

Although activity nearly ceased twice (both times in August) it never ceased entirely, and in fact there is cause to suspect that breeding at this colony has been continuous ever since it was first occupied in 1954. One year's continuous breeding has recently been proved at a small colony in the grounds of Makerere College, Kampala, Uganda, and it is further suspected that fairly continuous breeding may have been the case at this colony for many years past.

A. melanocephala breeds in colonies which can be exclusive, consisting of this one species only, or mixed, where it breeds with other aquatic birds. The only exclusive colony known to me in Kenya, apart from Nairobi's, is at Kakamega, in the grounds of the hospital. Mixed colonies have been recorded in a few areas, e.g. Kisumu, also the lower Tana River particularly at Garsen. In Uganda Mr. Brown informs me that this species is much commoner than in Kenya, and that there are plenty of colonies of both types. To date, the evidence of continuous breeding is from some exclusive colonies only, and it may well be proved that over Africa generally, seasonal breeding is the commoner.

Apart from the continuous breeding, other interesting features of this investigation include the fact that at the beginning of the breeding cycle the bird's iris changes in colour from yellow to red, (Part VIII), and that it suffers from a habitual predator, an eagle, which takes serious toll of the young, the adults being too frightened to attempt any form of defence, (Part VII). Unfortunately it is not possible to tell the sexes apart in the field, and indeed all normal birds look alike, though there are occasional melanistic individuals with highly distinctive plumage. I owe a curious record to these latter - a pair of normal birds hatched young and then (it seems) deserted them; anyhow, a pair of melanistic birds apparently adopted and reared the surviving chick, (Part IX). It would of course have been most advantageous if birds could have been colour-ringed so that the actions of individuals could be studied, but to date colour-ringing has been considered impractical for various reasons including the height and inacessibility of the nests, the large number of birds needing to be ringed and the problem, as yet unsolved, how to catch adult birds for ringing.

Certain authorities - Jackson 1938, Lowe 1954, Meyerriecks 1960, Pitman 1927 and Sneyd Taylor 1948 - are constantly cited, so for these an abbreviated method of reference has been used in the text, mentioning author and page only, e.g. Lowe: 67.

Many people have helped this investigation. Their assistance is gratefully acknowledged at the end of this paper.

II. The Nesting Site

To the south-west of Nairobi Railway Station (altitude 5343 ft.) lies the Stores Yard - a large open enclosure with sidings for the deposit and removal of bulky stores which can be kept in the open air, such as rails, pig-iron and drums. The Yard is fenced and constantly patrolled by watchmen, and visitors may enter only with a pass. Over much of the Yard, Eucalyptus trees have been planted, the average height being about 70 ft. It is these which the herons occupied in 1954 and have used ever since. For several reasons

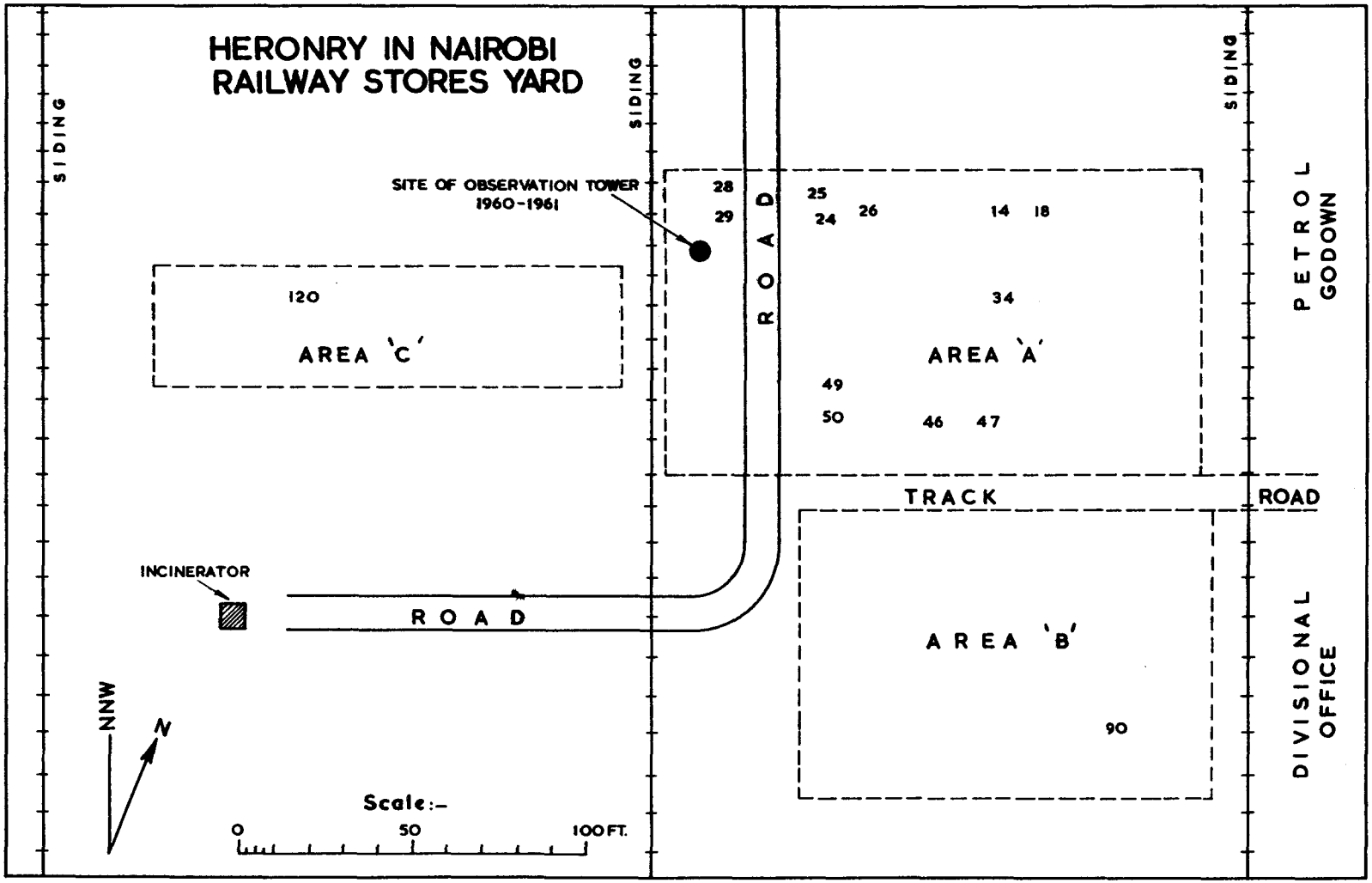
they could hardly have chosen a better site: (1) They have complete freedom from molestation because the Yard is carefully guarded and orders have been issued that the birds shall in no way be disturbed. (2) They are no nuisance to anybody here, in contrast to a colony at Entebbe, Uganda, where, according to Pitman: 27, the pertinacity of the birds in trying to breed in unsuitable places - such as in trees over houses - was unbelievable; in order to get rid of the herons it was usually necessary to lop or cut down the trees. (3) The particular type of gum which our Nairobi birds use - which Mr. Lucas of the East African Herbarium has identified as Eucalyptus camaldulensis Dehn, (Pl. 2, Fig. 6), seems ideal for the purpose, as it provides many excellent nesting crotches at the top, and further, the limbs are flexible and rarely break in strong winds even when loaded with the heaviest nests, nor do these nests cause the branches to wither and die, and there are no thorns to catch young birds. (4) The trees in the vicinity provide an ample supply of nesting sites and nesting materials. (5) The country round Nairobi must be excellent for foraging, otherwise the birds surely could not manage to rear their young at any time of year, even in drought, as they do.

From the watcher's point of view the colony is ideal, because the birds are so accustomed to seeing trains passing by and stores being loaded that they pay no attention to anything which anybody does on the ground, and in particular they even ignore being watched, so can be studied behaving perfectly naturally. They are, however, considerably shyer when a person climbs to nest level, (Part V).

The accompanying map shows three breeding areas, "A", "B", and "C". Of these, "A" is the core and "B" and "C" are overflow areas used only at times of high-density breeding. At the start of the investigation any tree likely to carry a nest was labelled with a serial number; fourteen of the most-favoured trees are shown on the map. Area "A" at its highest density - during the short rains of 1961 - had some 120 occupied nests. No single tree had more than 10, which is small compared with the Entebbe heronry where Pitman: 26, 29 states that a single large tree might contain as many as 2 - 3 dozen nests, sociability at nesting time appearing to be essential. The same applies to this colony, though here the birds are obliged to use a number of small trees close together instead of a large one. Since there are plenty of other trees near by, the birds concentrate from choice and not from necessity. Lowe: 71 says that in China, entire heronries of the Grey Heron Ardea cinerea Linn. may be contained in a single tree, but most trees in Europe contain only a single nest, four or more in one tree being exceptional.

III. Occupation, 1954-8

For the following account I am indebted to Col. P.H. Byers of the Railway Stores Department, whose work has involved constant visits to the Yard since 1951, and who is a keen bird observer. From 1951 - 54 he saw no herons here; then, suddenly, at the end of 1954, these appeared and at once began to nest, and although he made no periodical counts of nests he has a strong impression that from 1954 until 1958 the nesting was as continuous as it has been from 1958 onwards. (If there had been any obvious gaps when no herons were present, he feels sure that he would have noticed them, but he did not). As soon as the birds arrived he reported the fact to Mr. Lardner, the Stores Superintendent, who issued instructions



Map of the Heronry. Three breeding areas, "A", "B", and "C" are shown inside the dotted lines. "A" is the core of the colony and "B" and "C" are overflow areas. All trees likely to be used for nesting were marked with serial numbers, "A" with Nos. 1-66; "B" with 72-94 and "C" with 100-127. The numbers of some of the most regularly-used trees are shown. The site of the observation tower is indicated. Refer to Part II.

TABLE 1. Monthly Counts of Nests.

1 Date Counted	2 Total Nests Counted	3 Number Seen Occupied	4 Estd Addtl Occpd Nests	5 Estd Total Occpd Nests	6 Estd State of Occupation Buildg. %	Incubtg. %	Young. %
1958							
24/5	176	A	-	160B	-	40B	60B
19/7	121	A	-	100B	10B	-	90B
24/8	134	A	-	110B	10B	-	90B
7/10	157	A	-	120B	-	10B	90B
1959							
1/1	121	A	-	90B	-	-	100B
17/2	105	27C	13	40	10	-	90
17-8/3	96	17	3	20	-	-	100
23/4	75	51	9	60	10	80	10
29/5	76	61	4	65	-	10	90
26/6	64	28	2	30	-	-	100
16/7	61	13	2	15	-	-	100
31/8	44	3	1	4	-	-	100
14/10	40	4	-	4	100	-	-
14/11	27	19	1	20	90	10	-
19/12	47	38	7	45	10	80	10
1960							
26/1	32	28	2	30	10	-	90
20/2	25	21	-	21	-	-	100
31/3	78	74	-	74	90	10	-
26/4	179	169	-	169	-	100	-
28/5	119	A	-	85B	-	10B	90B
18/6	111	55	5	60	10	10	80
1/8	92	23C	7	30	10	10	80
13/9	48	27	3	30	80	10	10
13/10	39	28	5	33	10	80	10
8/11	43	31	4	35	-	70	30
3/12	42	30	3	33	10	30	60
1961							
7/1	30	15	-	15	-	10	90
2/2	29	21	2	23	50	-	50
9/3	23	17	2	19	60	10	30
2/4	32	30	-	30	90	10	-
3/5	54	46	4	50	10	80	10
3/6	45	29	6	35	-	50	50
2/7	38	31	2	33	10	10	80
30/7	34	24	1	25	30	10	60
2/9	26	4	1	5	50	-	50
30/9	33	29	1	30	90	10	-
28/10	93	83	2	85	70	30	-
2-3/12	192	104C	21	125	10	80	10
30-1/12	207	166	9	175	10	10	80
1962							
28-9/1	185	146	9	155	10	10	80
3-4/3	161	134	11	145	10	60	30
29-30/3	159	120	15	135	10	30	60
29-30/4	178	138	15	153	10	10	80
26/5	204	146	18	164	10	30	60
27/6	160	95	20	115	10	10	80
4/8	137	D	D	87	10	10	80
26/8	104	D	D	80	30	35	35
3/10	112	D	D	100	20	50	30

fig. 1

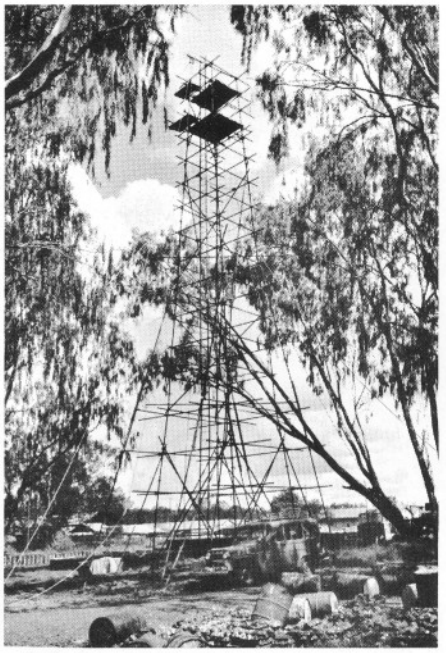


fig. 2

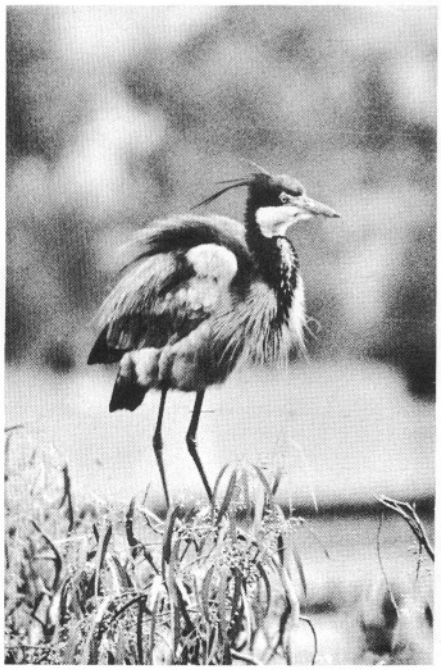


fig. 3

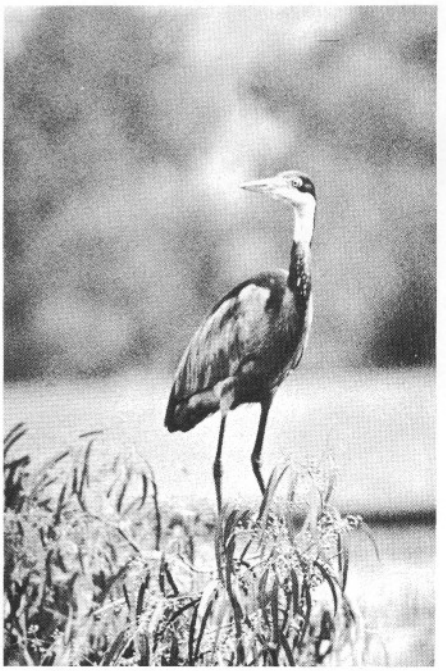


fig. 4

fig. 1. Black-headed Heron in hunched position.
fig. 2. The 80-foot observation tower showing floors of double-storey hide before the hessian walls were added.
fig. 3. Bird fluffing out plumage.
fig. 4. Same bird an instant later, with feathers smoothed down.

fig. 5

fig. 6

fig. 7

fig. 8

fig. 5. Aggressive pose towards diving kite (on left).
fig. 6. Nests in Eucalyptus trees, seen from below.
fig. 7. Bird calling before it alights.
fig. 8. Bird at rest (right) inflates cheeks in display to landing bird (left).

fig. 9

fig. 10

fig. 11

fig. 12

fig. 9. Young bird doing downward-stretch exercise.
fig. 10. Nest and eggs.
fig. 11. Young doing wing-stretch with leg also extended.
fig. 12. Young doing flapping exercise.

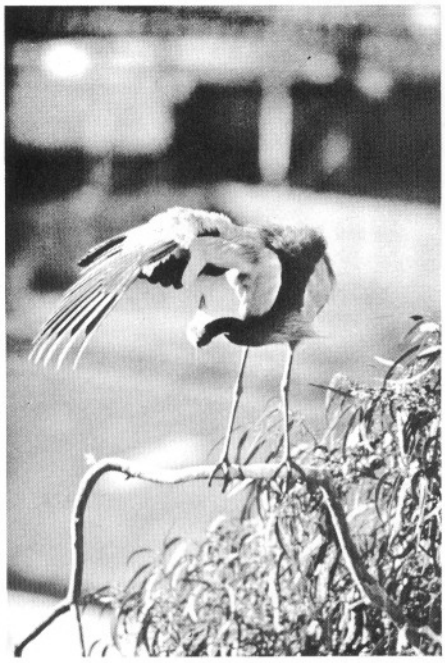


fig. 13

fig. 14

fig. 15

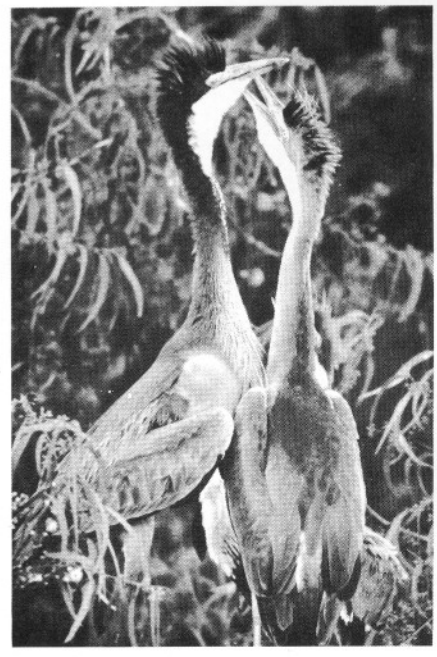


fig. 16

fig. 13. Bird preens under-wing.
fig. 14. Bird doing stretch display. (Note colour of iris, which is red at this stage of breeding).
fig. 15. Bird with young looking at observer, using binocular vision.
fig. 16. Young (right) leaps to catch bill of adult (left) prior to being fed by regurgitation.

that the birds must not be molested. Very soon the colony became concentrated in area "A" which still constitutes its core. By the long rains of 1955, Col. Byers thinks that there were some 30 occupied nests. It seems clear, therefore, that colonization was made by a number of pairs within a short space of time. Sneyd Taylor: 203 mentions that a colony at Fort Beaufort, Cape Province, South Africa, was also established suddenly, eight nests being started within a month of the first arrival of the birds.

TABLE 1. Monthly Counts of Nests.

Abbreviations:
A. No count made.
B. Guess made in default of count.
C. Numbers probably under-estimated.
D. Modified system of counting used.

This table should be read in conjunction with Part IV and the accompanying histogram.

Column

(1) Date of count. All counts were made by me except the following: 23/4/59 and 26/4/60, by Mr. Leslie Brown and myself. In 1960, 29/5, 26/6, 16/7, 31/8, and 14/10, by Mr. Brown.

(2) Total nests counted, whether occupied or not. All counts were made from the ground.

(3) Total nests positively seen occupied.

(4) An estimate of the nests believed occupied but omitted because there was no positive sign of occupation.

(5) An estimate of the total occupied nests; the aggregate of the two previous columns.

(6) An estimate of the percentage of birds building, incubating or with young. For instance, on 26/5/62 a small number were building, a fair number incubating and the majority were with young, and the result is construed as building, 10%, incubating, 30%, and with young, 60% - but such percentages must on no account be regarded as more than a rough, subjective estimate of the actual situation.

TABLE 2. Nairobi Rainfall.

MONTH	1958	1959	1960	1961	1962	Average (34 years to 1960)
				Inches		
January	3.13	0.77	3.80	0.07	8.63	1.71
February	8.92	0.58	0.43	0.65	0.19	1.82
March	2.21	6.06	9.04	2.28	1.35	4.36
April	2.58	3.98	5.47	4.52	6.41	7.82
May	18.78	5.07	3.00	5.07	7.88	5.52
June	2.00	0.06	0.51	0.47	4.46	1.69
July	2.66	0.50	0.20	0.36	0.01	0.59
August	0.00	0.55	0.40	0.28	1.04	0.77
September	0.24	2.84	0.65	1.74	0.61	1.08
October	0.41	0.14	2.65	5.09	-	2.00
November	1.00	10.02	3.65	21.67	-	4.67
December	3.92	1.41	2.17	9.33	-	2.74
Total	45.85	31.98	31.97	51.53	-	34.77

The figures were recorded at the Ministry of Works Hydrological Office, Nairobi, which is only a quarter of a mile from the heronry, so these rainfall totals may be taken as the totals for the heronry.

IV. Occupation, 1958-62

Since May 1958 a count of nests has been made regularly each month (or as near as practicable). The results are summarized in the accompanying Table 1. The nests were always counted by trees in accordance with the serial numbers mentioned in Part II. The total nests, whether occupied or not, are shown in column 2 of the Table. Such a count entailed no difficulties, but in addition, it was essential to estimate how many of these nests were occupied. Since they are in trees 60-70 ft. high and the counts had to be made from the ground, this was no easy problem, and nests in fact occupied were often no doubt recorded as unoccupied, in default of any positive sign of occupation. While the observation tower mentioned in Part V was *in situ*, the ground results were, of course, checked from here as far as possible, but the tower commanded only a limited number of nests and was available only for a limited period, so the bulk of the observations had, inevitably, to be made from the ground. However, a good deal can be ascertained with binoculars, and small signs, such as a protruding bill or tail, should be looked for. Visibility often depends upon the state of breeding when any given count is made; thus, a building bird standing on a nest will be very visible; an incubating bird sitting low in the nest may be invisible; eggs or small young are usually invisible, though the latter may be audible; large young are usually visible, and so on. The time of day for making a count is important, the best period being the evening, within an hour or so before sunset, since many birds will then be active and visible, awaiting their evening meal. Another excellent time to make a count is after a shower, when the birds stand up and dry themselves.

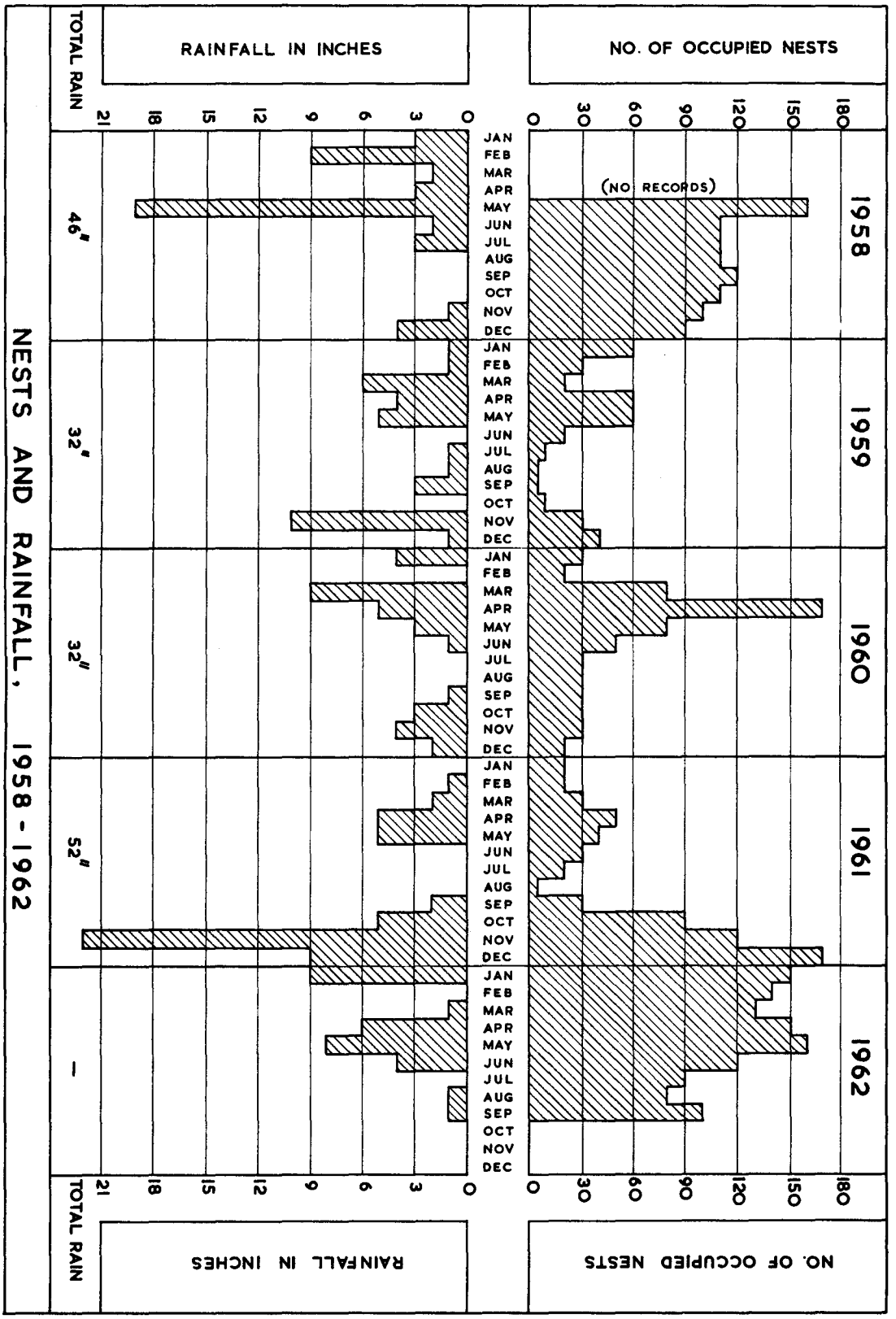
Three systems of estimating occupied nests have been successively tried, a major problem being the large number of nests and the consequent need for a reasonably fast method of counting. Under the first system, used from May 1958 until January 1959, I merely assumed, fairly correctly, that the bulk of the nests were occupied. However, this was far to vague, so the second system was adopted in February 1959 and continued until July 1962. Here, the nests were counted in each tree, and then an effort was made to see how many of these were occupied. The total nests seen occupied are shown in column 3 of the Table. However, a proportion must inevitably have been missed, so these were arbitrarily assessed for column 4; thus, an estimated total of occupied nests (columns 3 + 4) can be shown in column 5. This system worked pretty well but took a great deal of time, and even so, the number of occupied nests in any given tree had to be assessed with speed, so the figures obtained could not be more than approximate. From August 1962, therefore, a third system has been tried which takes half the time of the second and is, I think, little if any less accurate. First, a quick count of all nests is made for column 2, with no attempt to count the occupied nests. Instead, a few sample trees are selected as representative of the colony, and here a careful count is made of both the total nests and the number occupied, and the proportion of the one to the other is taken as the proportion for the colony. For instance, if the colony has 120 nests and the selected trees 20, of which 15, or 75%, are occupied, then the occupied nests for the colony are estimated as 75% of 120, or 90.

In addition, it is desirable to gauge the state of occupation for any given count, i.e. what proportion of the occupied nests are being built, or have eggs or young?. To this, some sort of answer is shown in column 6, in the form of percentages, but it must be emphasized that these are at best a rough estimate and often an informed guess. In fact, up to 1962 all data so provided should be regarded as mere informed guesses construed from field notes made at the time. From 1962 onwards, special attention has been paid to this point, and the soundest estimates have probably been formed under the third system, since, with only sample trees to study, one can now pay far more attention to the state of each individual nest than when attempts were made to cover all the occupied nests of the colony.

On the assumption that the estimated total of occupied nests shown in Table 1 is near actuality, the monthly nest totals have been plotted opposite the monthly rainfall totals on the accompanying histogram, since breeding is clearly linked with rainfall. The nest totals are calculated from Table 1 as for the last day of each month under reference, to reflect any reactions on the part of the herons to the presence or absence of rain during that month. The rainfall totals, recorded a quarter of a mile from the heronry, are shown in the accompanying Table 2. Brief comments on the successive years 1958 - 62 will now be made.

1958. (From May, when the counts began.) In May, there was an exceptional rainfall of 19 inches, but precipitation for the rest of the year was below average. The May total of nests was very high - 160 - and occupation remained high for the rest of the year at 90 or over. Nothing comparable to this re-occurred until 1961 - 62.

1959. Although the long rains were not much below average, occupation was poor and dropped sharply, until in August-September there


NESTS AND RAINFALL, 1958 - 1962
NO. OF OCCUPIED NESTS
RAINFALL IN INCHES
TOTAL RAIN
0
30
60
90
120
150
180
3
6
9
12
15
18
21
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
(NO RECORDS)
1958
1959
1960
1961
1962
46"
32"
32"
52"
—

were only 4 nests, which is the nearest approach to a pause in breeding yet noted, and even an exceptional rainfall of 10 inches in November resulted in only a small increase in nests, contrary to expectation. Perhaps 1959 may have been a resting-period after the big occupation of 1958 ?.

1960. The long rains began in a very promising way, with the March rainfall, at 9 inches, double the average; then, during April and May, precipitation fell off, though not abnormally, and the short rains were average. From this, one would not have anticipated the remarkable nesting curve shown on the histogram, with a record total of 170 nests in April, followed by a rapid collapse. Apparently many birds were encouraged to breed by the excellent start of the rains, then lost interest when this early promise was not fulfilled. However, although 90 out of 170 pairs abandoned the attempt to breed, the remaining 80 persevered, and indeed there was a fair core of breeders, about 30, for the rest of the year. Possibly the 90 failures included birds reared in 1958 now breeding for the first time, perhaps not seriously?

1961. Rainfall in both 1959 and 1960 had been below average and continued poor in 1961 till September - in fact, this period in many parts of Kenya was regarded as one of the worst droughts in memory. It is thus astonishing that the herons continued to breed in fair numbers throughout the whole period. The nesting curve for the long rains of 1961 is just what one might expect under the circumstances - a small maximum followed by a steady decrease, with a very low total of 5 nests in August. Then, the short rains turned out to be phenomenal, with the huge precipitation of 22 inches in November alone, and from October occupation soared to a record total of 170 nests at the end of December. Such a rise might well have been predicted, as there had been no large occupation since 1958.

1962. (To date of going to press in October.) Although the long rains were no more than average, breeding ever since the beginning of the year has remained at an unparalleled level, 1958 being the only other comparable season. In fact, for the 12-month period from October 1961 till September 1962, the average occupation has been 125 nests, with a maximum of 170 in November and a minimum of 80 in August. Let it be assumed that there will now be at least one more month of breeding at a comparable level, as is most likely. This would bring the period up to 13 months, or about 400 days. In part IX it will be mentioned that the breeding period of this species appears to be about 100 days; therefore, 400 days are equivalent to four successive breeding periods. Very likely a statistical analysis would throw light on these problems, but meanwhile, two extreme hypotheses, each unlikely, can be postulated : first, that during the 400-day period, 125 pairs could each have had four broods in succession; or secondly, that during this period, 600 pairs (125 x 4) could each have had one brood. Perhaps the truth may lie somewhere between these two assertions, bearing in mind that 400 days could cover either four successful breeding periods or a series of unsuccessful attempts of irregular duration, or any combination of the two. In default of large-scale colour-ringing there is no positive evidence of successive broods; nevertheless, the probability that many pairs may have had at least two broods during the period under discussion is surely very strong. A similar probability occurred to Pitman:32 with regard to the Entebbe heronry. He writes : "I have little hesitation in saying that the Black-headed Heron is .... double brooded, and it is possible

that more than two broods may be reared in one year". But to return to the Nairobi colony, as an alternative to successive broods one may well assume that since October 1961 a number of pairs have bred and left, and have been succeeded by others. The latter could be locally-reared young birds now breeding for the first time, or local adults returning to breed, or immigrants arriving from elsewhere (attracted, maybe, by the success of the colony). In general, it seems that the exceptional rains of both May 1958 and November 1961 resulted in a period of high-level occupation which persisted for many months subsequently, even though the rainfall during most of these months was nothing out-of-the-way. However, the effect of the 1961 short rains is still evident : many temporary pools have persisted and the streams remain unusually high; also, the seasonal vegetation has remained exceptionally green - all of which may well have created unusually favourable conditions for the creatures mentioned in Part VI which constitute the herons' prey.
P.S. The nest-count for the 21st. of October was as follows: total nests, 139; number estimated occupied, 110 - building, 50%; incubating 25%, with young, 25%. Rainfall, 1st. to 21st. October, 2 inches.

If reference is made to the map in Part II it will be noted that there are three breeding areas, "A", "B" and "C". Of these, "A" is the core which is always occupied and "B" and "C" are outlying areas used during big occupations. The history of these outliers is a useful indication of the success, or otherwise, of the colony. In fact, they have been used only three times during the period of study, the first two occasions being failures and the last, a spectacular success. During the long rains of 1958 and also of 1960 about 20% of the nests were in the outlying areas at the peak of the breeding season, but nearly all of them were abandoned within a month of occupation. During the short rains of 1961, however, both these areas were occupied at a far higher level than previously, and occupation has since been continuous to date. They have contained up to 40% of the nests of the colony. Lowe: 83, discussing A. cinerea, thinks that outlying nests may be the product of birds breeding for the first time. This might well apply to the Nairobi colony, but might not adult immigrants also tend to use these outlying areas ?

There is no evidence that non-breeding herons come to the colony at night to roost, and therefore no likelihood that such birds could be confused with the breeders. Herons seen at the colony appear to be exclusively : (1) birds which want to breed - usually with the red eye; (2) birds actually breeding, and (3) young which are still being fed at the nest.

The breeding fluctuations of the Nairobi colony over the years of study may be briefly summarized, as follows: (1) Exceptional rains in May 1958 and November 1961 resulted in many months of high-level occupation (and note that one case concerns the long rains, and the other, the short, which indicates flexibility on the part of the birds); (2) when the long rains were moderate or poor, as in 1959 and 1961, occupation was poor and then dwindled; (3) the failure of the birds to respond to the good rains of November 1959 and the breeding fiasco of April 1960 are difficult to understand; (4) the nearest approach to a cessation in breeding occurred during the dry weather of August 1959 and 1961 after poor long rains; (5) nevertheless, breeding was continuous over the four years.

This 4-year period of continuous breeding is particularly unexpected in a locality such as Nairobi, with its two pronounced dry periods - June to October and January to March - during which one might well have thought that the commencement of breeding would be highly improbable. On the other hand, continuous breeding could well be anticipated in the humid parts of Uganda or West Africa, and evidence of this is accumulating. In West Africa, Guichard, 1947 : 461 was shown an A. melanocephala colony in Nigeria and the local inhabitants told him that the birds occupied the tree throughout the year. In Uganda, Miss Allen has recently been studying a colony in a tree at Makerere College, Kampala, and has now, by periodical counts, proved one year's continuous occupation, which is all the more remarkable as this colony is small and never, during the year, much exceeded 20 nests. Captain Pitman knew this colony from 1925 and Mr. Basil Sebley, who lived at Kampala from 1939 - 61, frequently visited it and can never remember failing to see at least some birds present. From this, one may suspect almost continuous occupation over the last 20 years at least.

Perhaps, therefore, continuous or near-continuous breeding on the part of A. melanocephala may prove to be more of a normal practice than has been suspected hitherto; nevertheless, the picture should not be over-drawn and seasonal breeding is clearly widespread and may well be the more normal, judging by the periods mentioned in Praed and Grant, 1952 : 40 for many parts of Africa, all of which are seasonal, though in some cases these are prolonged.

To date, I have been able to discover only a few records for continuous breeding comparable to A. melanocephala, but Stonehouse et al. 1962, have some interesting examples, especially for Tropic Birds, Phaeton spp., on Ascension Island, while for land birds there is a remarkable record for Scotland by Lees, 1946 : 136, who studied the breeding of Rock-Doves, Columba livia Gmelin, in the coastal caves of Cromarty over a period of nearly two years. Of the four caves so studied, each contained a small colony of these doves and breeding continued more or less throughout the two years, with a maximum in April and a minimum in July, and in each cave there were alternate periods of nesting and quiescence, the latter usually short. Presumably the all-weather shelter which the caves provided, combined with an all-year-round food supply, rendered this feat possible.

V. The Observation Tower, 1960 - 61

To study the herons at nest-level, a hide was required. In default of a tree suitable for the purpose, the only alternative was a tower which, however, needed to be very high - 80 ft. - to command the nests, so its construction was a professional undertaking. A reconnaissance of suitable nests having first been made with the assistance of a Nairobi City Council Fire Escape, the Railway engineers then constructed a fine temporary tower of tubular scaffolding (Pl. 1, Fig. 2). The base was 14 ft. square, tapering to 7 ft. at the top, stability being assisted by cross-bracing and external props. The tower was surmounted by a double-storey hide with the lower compartment enclosed in hessian; but the upper, at the 80 ft. level, had an open balcony with unobstructed views in all

directions. A vertical ladder afforded access to the hide from the ground. A pulley and rope were used for securing inexperienced climbers or for hauling up equipment. Equipment was tied to the two ends of the pulley-rope which were knotted together to form a loop which passed through a shackle secured to the ground ten yards from the base of the tower. This kept the equipment well away from the tower and prevented it from striking against the structure.

In practice, the balcony was used much more than the hide because the views were so extensive and the behaviour of the birds differed very little no matter whether the observer was on the balcony or in the hide. The more regularly the observer was present, the tamer the birds became. Their young ignored him completely and so would the parents unless the nest was very close to the tower, but incubating birds could be shy and might perch on a neighbouring tree and wait; if so, it was necessary to descend to the ground when they would return at once. It was rare for any action or noise on the part of a person on the balcony to alarm birds enough to cause them to take flight; in fact, they seemed more disturbed by the pulley-rope when it flapped about, perhaps because it resembled a snake. By far the best observations and photographs were made from the tower immediately after its erection, when some 50 existing nests could be studied, many within a distance of 30 to 60 feet. However, birds which began to nest after the erection of the tower tended to build somewhat further away and to seek a little concealment by intervening leaves. The Railway authorities kindly left the tower up for 15 months, eventually dismantling it at the end of August 1961. Full advantage was taken of the opportunities for study thus provided.

VI. Food, Foraging and Roosts

During 1961, some 52 casts were collected at intervals from beneath the trees of the heronry and analysed by Mr. J.G. Williams, Ornithologist, and Mr. J.D.L. Fleetwood, Mammalogist, of the Coryndon Museum, Nairobi. The results provide an interesting picture of the varied diet of this species, though not, of course, a complete picture, since certain forms of prey like frogs or fish may be totally digested and will thus leave no trace in the casts. As a characteristic sample, here are details of ten casts collected on the 16th. April, 1961:

1. Skull of domestic duck; fur and teeth of rodent Otomys.
2. Rodent hair, fish scales, heron feathers.
3. Coarse white hair, probably goat.
4. Mass of large grasshopper and some beetle fragments.
5. Fur and bones of rodent Otomys; fish scales.
6. Rodent fur and bones, grasshopper fragments, fish scales.
7. Mass of grasshopper fragments.
8. Mass of feathers - most, perhaps all, from neck of domestic fowl.
9. Rodent fur and bones; fragments of bark.
10. Fur and bones of Otomys, water beetle fragments, fish scales; unidentified avian bone fragments.

Of the 52 casts analysed, 34 contain traces of rodents, 23 of grasshoppers, 19 of fish, 16 of beetles, 10 of birds, 5 of vegetable matter, 4 of mammals other than rodents, 2 of frogs and 1 of a crab.

Eleven of the casts consist of rodent remains only, but the rest have more than one ingredient and some as many as four. The rodent remains are almost certainly those of the Swamp-Rat Otomys angoniensis Osgood, a nocturnal rat living in long grass. Though insect remains are fairly plentiful, Mr. Williams believes that many are digested and leave no trace, e.g. the Mole Cricket Gryllotalpa, which he knows from stomach contents to be a common prey. The same applies to fish; in fact, it is lucky that the one identified, a Barbus, leaves indigestible scales. The bird and mammal remains contain some surprising items including a domestic duck's skull, a Lesser Flamingo's skull, heron's feathers, fowl's feathers, also hair from a Marsh Mongoose Atilax paludinosus (Cuvier) and from a goat - which may indicate that this bird is something of a scavenger in addition to capturing live prey. The vegetable matter includes bark and fibre (and in addition, Mr. A.D. Forbes Watson once found a cast with several undigested maize seeds in it). The scarcity of frog remains is no doubt because these are digested; in fact, Mr. Williams believes that rodents and frogs constitute the main diet of this species.

Lowe : 51 -3 stresses the fact that British frogs and fish are totally digested by A. cinerea and do not show in casts, thus, to ascertain what the bird eats, the cast-analyses must be supplemented by stomach contents and by watching what the birds catch. He says that too much vegetable matter is found in A. cinerea stomachs to be likely to be accidental and wonders if this is consumed for roughage. Pitman : 34 considered that A. melanocephala at Entebbe subsisted mainly upon rats, frogs, mice, lizards, beetles and other insects, with an occasional snake. Sneyd Taylor : 208, summarizing the analysis of some 200 casts at Fort Beaufort, found the diet very varied, insects, especially grasshoppers, Mole Rats Cryptomys and House Lizards Mabuya being prominent. As a result of his investigation he concluded that A. melanocephala was agriculturally beneficial. The same may well apply to our East African birds.

This species can operate two kinds of vision : monocular, with each eye covering a separate arc, or binocular, with both eyes converging forwards (Pl. 4, Fig. 15). This latter type of vision must be particularly advantageous when the bird is hunting prey near at hand on the ground or in water. It has not yet been possible to make any detailed study of its hunting methods, which will no doubt vary considerably in relation to the type of prey sought. However, one morning recently an instructive 1½ hours was spent watching a bird catching mice in the Nairobi National Park, the locality being an open ridge with short grass and patches of sedge near Lone Tree. The bird, which was an adult, was so accustomed to cars that it permitted a Jeep to accompany it at a distance of 30 - 60 ft. during the whole of this period while it carried on with its hunting (which was photographed). Most of the time the bird strode across the grass using a formal, peculiar and comic gait, raising the feet high, perhaps to avoid making a noise. For a step or two the neck would be at full stretch and angled slightly forward, with the head and bill horizontal; then, for the next step or two, the head and neck would be bent sharply backward in the form of an S, which, with the slow, ponderous strides, resulted in a goose-step effect. The two poses would be adopted again and again as the bird walked over the grass and were, presumably, in some way linked with the hunting. It was the patches of sedge which interested the bird most. Here it would stop, with the head in the high forward position, and might

then perform a remarkable series of sideways undulations of the neck, at about two per second, with body and head remaining still. Immediately after a series of such undulations the bird struck downwards with its bill, catching a small mouse between the mandibles which it immediately swallowed. A second mouse was caught similarly, but without the undulations. These two mice were the only prey captured during the 1½ hours of observation.

Jackson : I. 34 has an excellent account of the hunting of this bird in a sweet-potato plot; the bird moved "very quietly and cautiously, drawing up each foot slowly and extending it at each step with the utmost deliberation, with neck stiff and held well forward. On detecting its prey, rat, lizard or insect, it occasionally snapped it up at once; but more often it began to sway its neck sideways, slowly at first, but getting faster and faster until the body also began to sway. While this movement was going on, its head and neck were being gently lowered until within exact striking distance, when both were suddenly shot forward. In this manner it caught several small rats, striped mice and lizards." Jackson's bird thus seems to have acted very much like the Nairobi individual did, though he does not mention any goose-step. He comments : "It has always been a puzzle to me why this bird and the Buff-back wriggle their necks in the way they do. In the case of rats and mice, and perhaps lizards, it certainly may have a mesmeric effect, but it is incomprehensible in the case of locusts, grasshoppers and such-like."

At the Nairobi heronry the young are fed by day, at any time, though the main feed is in the evening, before dusk. Col. Byers and the Watchmen agree that there is little, if any, feeding of the young by night; if there was, it would surely be obvious on account of the loud "kek-kek" hunger calls which the young make when about to be fed. However, the birds may well hunt by night as they can often be seen leaving the heronry at dusk; and how otherwise could they catch a nocturnal rat like Otomys ? Praed and Grant, 1952 : I. 39 say that this species feeds mainly by night and it seems that the night-feeding of the young is normal in Uganda (Jackson : 35, Pitman : 27) and at Fort Beaufort, S.A. (Sneyd-Taylor : 205).

With regard to the hunting grounds and the flight-lines between these and Nairobi, only a limited study has been practicable to date, though it is hoped that more will be possible later. At Nairobi, inward and outward flights have been watched both from the heron-tower and from the roof of the Ministry of Works. It is not easy to assess direction from inward flights, as the birds become visible only when relatively near, but outward flights can be observed for a considerable distance : a departing bird was once kept in view for 4 minutes, during which it may have travelled some 2 miles, assuming a speed of 30 m.p.h. Mr. J.B. Smart was once able to follow a flying bird by car along a road for about 4 miles, and it maintained a speed of 30 - 35 m.p.h. which can be taken as the air-speed, there being little or no wind that day. Lowe : 113 gives 30 m.p.h. as the normal speed for A. cinerea.

The speed of wing-flap for this species, taken from a number of stop-watch timings of birds in horizontal flight, is regularly 170-180 per minute. Lowe : 113 gives the comparable speed for A. cinerea as 120 - 130 flaps per minute, which is considerably slower; indeed, this difference in flap-rate should be a good distinguishing feature between the two species. Of course, A. melanocephala, with a wing of

about 400 mm., is smaller than A. cinerea, with about 460 mm. (figures approximated from Praed and Grant, 1952 : 38 - 9).

Though birds have been seen departing from the heronry in all directions, the most favoured line is certainly between west and north-west, in the direction of the Kikuyu country which rises towards Limuru, with its swamps, streams and cultivated lands. Mr. H.J. Lee, when living at Dagoretti Corner, five miles west of the heronry, constantly noted birds passing over and there are many other records from the Kabete region, 7 - 8 miles north-west. The most distant feeding ground from the Nairobi heronry yet discovered has been located by Mr. Smart at Nyakumu Swamp, 3 miles west of Kikuyu Railway Station and 15 miles from Nairobi. Witherby, 1938 : III. 126, states that the regular feeding range of A. cinerea is up to 12 miles.

To date, no evidence has come to light that non-breeding birds use the Nairobi breeding colony (or other such colonies) for roosting, and evidence is only now beginning to accumulate to show where such birds do roost. Mr. Smart has recently located and shown me a substantial roost of about 60 birds in a fig-tree beside the Nyakumu Swamp, most of them in juvenile plumage. They arrived from all directions and were very noisy, barking and growling just like the adults do. A few birds have also been noted roosting with other species in a tree beside a dam at Karen, about 8 miles from Nairobi.

VII. Relationship with other Birds

The gum trees of the Stores Yard, besides accomodating the heronry, are also used for roosting by numbers of Kites Milvus migrans (Bodd.) and Pied Crows Corvus albus Muller all the year round, though neither species breeds here. According to Col. Byers this roost anteceded the heronry. The kites roost anywhere in the gums, including those of the herons, but usually at a lower level, beneath the canopy. The crows mostly roost clear of the heronry at the south edge of area "B". However, both species, when they first come in, may perch anywhere, often right among the herons, and the latter only show antagonism if one of these passes or perches very close, in which case the heron's reaction is a hostile posture often accompanied by a squawk or peck (Pl. 2, Fig. 5) - which is merely how it would react to another heron under similar circumstances. Relations are thus amicable, and I have not yet seen a kite or crow attempt to molest the eggs or young of the herons. Few small birds are seen around the colony, but when a heron is preening, a small piece of fluff often floats away from the tip of its bill and may be seized by a Little Swift Apus affinis (Gray) for nesting material.

It seems that the Nairobi colony has only one serious bird enemy - the African Hawk-Eagle, Hieraaetus spilogaster (Bonaparte), which seems to be a habitual predator upon the young of this heron. In 1958 an eagle in puzzling immature plumage, eventually identified as H. spilogaster by Mr. D.K. Bednall, was often seen at the heronry, the normal sequence being : (1) Eagle flies to colony. (2) As soon as it is visible, all herons capable of flight take wing, shrieking. (3) Eagle alights on chosen nest, unmolested by the herons, and feeds on the young. (4) Meanwhile herons alight on adjoining nests

and carry on normally. (5) When eagle takes flight to depart, the herons take wing, shrieking as before, but soon return. This sequence was filmed by Mr. S.J.K. Collins and a sound-recording was made by me. It would seem that an eagle in flight is the chief cause of terror to the herons, though they do not normally molest it when perched, either. This bird often used a tree a little way from the heronry to rest, with bulging crop, after a meal, and one evening a couple of Pied Crows turned up prior to roosting, saw the eagle and kept diving at it with loud caws until it flapped off. Thus, mere roosting crows could eject the eagle, which apparently the nesting herons dared not do. It was feared that this eagle would disrupt the colony if left unmolested, so Col. Byers shot it at our request. He says that two other eagles of the same species have preyed upon the colony since then. The first, which was shot in November 1960, proved to be an adult female. When this was perched on a nest he saw a heron actually diving at it. A third eagle arrived in 1962 but left at once.

It appears that the young of A. melanocephala may be a normal prey of this eagle, judging not only by the examples just mentioned, but from Jackson : 181, where at Kampala one of these birds "for many consecutive days visited and raided, twice daily, a large breeding colony of A. melanocephala that nested in a single very tall tree in the market place. Directly the eagle appeared, every heron able to fly left the tree and circled round uttering their harsh croaking squawk; but in spite of their numbers they had not the courage to attack the intruder and drive it away. The eagle then took up its position on a bough, and after calmly surveying its surroundings for some little time, would half jump, half fly on to a nest containing young birds, pick one up, hop back on to a bough and devour the hapless youngster. The operation was repeated two or three times; it then rested for a short period and finally took its departure." The bird was collected, and proved to be a fine male, and "when shot, its stomach and crop contained three young herons the size of doves, and in each case the head had been torn off and bolted whole."

There is a case on record (Pitman, 1942 : 254 and personal communication) where a couple of Fish Eagles, Cuncuma vocifer (Daudin) are strongly suspected of the wanton destruction of a whole Black-headed Heron colony with some 50 nests which were in low vegetation on an islet of Lake Mutanda, S.W. Kigezi, Uganda. One day Pitman noted a tremendous commotion in the heronry and saw the eagles amongst the agitated herons, after which most of the latter disappeared. Next day he found that 47 nests with eggs had been destroyed, presumably by the eagles. Mr. Brown informs me that he has noted Cunouma systematically preying upon the young of this heron in similar style to that of H. spilogaster.

If H. spilogaster preys on young herons, at least it appears only to molest the birds which it eats, though it might, in time, destroy all the young of a small colony. It seems that A. melanocephala is partial to nesting near the haunts of man and it might be wondered if this has any effect of discouraging the attacks of large birds of prey such as H. spilogaster ? Any such effect, being negative, would be difficult to prove and the positive evidence from H. spilogaster - a very bold bird - indicates that in Nairobi and Kampala the presence of man in no way discourages the

eagle from attacking the herons.

VIII. Breeding - Early Phases

The early phases of breeding are complex, and I cannot yet claim to have more than a general idea of what goes on. For this, Meyerriecks' account of his four North American species, with Mrs. Buffler's admirable illustrations, has been invaluable.

The sexes of A. melanocephala are indistinguishable in the field, which is a handicap to study : the same applies to A. cinerea and herodias, it seems. However Meyerriecks : 72, who made a 3,000 -hour field study of Butorides virescens (Linn.) gives a useful table of the field-distinctions between the sexes of this species, some of which might well apply to the other herons. In the normal adult plumage A. melanocephala has the chin white, a speckled band down the front of the dark throat and the under-parts grey. However, fully melanistic birds can very occasionally be seen with the chin and entire underparts black, and it is not unusual to see birds where the throat is plain rufous and not speckled. It is remarkable how instantaneously a bird can alter the set of its plumage, e.g. compare Pl. 1, Fig. 3 with Fig. 4, taken within a second or two of each other. In Fig. 3 the bird was shaking out its plumage; it retracted the neck, erected the plumes of the crown, chest and back and relaxed the wing-feathers. Then, in Fig. 4, it extended the neck and smoothed down the feathers which transformed its appearance in a flash. (In general, raised plumes with shortened neck usually imply aggression, and smoothed plumes with elongated neck, fear). The preening of this species seems to be identical with that of A. cinerea, so thoroughly described and illustrated especially by Percy, 1951, and I have only one feature to add : the spectacular habit of preening the under-wing (Pl. 4, Fig. 13). The bird stands on a perch in the normal way, stretches out one wing horizontally, lowers the neck, twists the head upwards to inspect the outstretched under-wing and pokes about with the bill.

The iris of the normal adult bird (and of the young) is yellow, but when birds arrive at the colony with the presumed intention of breeding, the iris in both sexes is ruby-red and remains thus throughout the period of claiming the nest-site and building the nest, but by the time that the eggs are laid the iris will have reverted to yellow through an intermediate orange phase. Odd to relate, no evidence has been found that this colour-change has been published before, though it regularly occurs at Nairobi and elsewhere and is undoubtedly a normal feature of the species. So far as can be ascertained, the iris of no other heron has been observed to change colour in a comparable way, though a similar but much less-pronounced tendency has been noted for A. cinerea (Lowe : 73). However with both A. cinerea and many other herons the bill and feet may change colour in the breeding season, whereas with A. melanocephala it is believed that they do not.

With many herons it appears normal for the male to take up a prominent position on a branch in the place where he intends to nest, and here to advertise his presence in various ways in order to attract a mate; in fact, with A. cinerea, Lowe : 76 points out that it is the female who selects her male as she can move round and make

her choice, whereas he remains static. Very likely A. melanocephala behaves similarly, though it has not yet been possible to make a close study of this. One often sees a red-eyed bird in beautiful plumage, standing passively and silently on a branch or nest, with the head sunk between the shoulders in a vulture-like pose. I call this the hunched position (see Pl. 1, Fig. 1, though the iris of this particular bird was yellow). The bird is not usually aggressive and makes no attempt to build, so it is uncertain how serious the breeding urge may be, though surely there must be some urge or the bird would not be hanging round the colony or have a red eye ? Lowe: 83 mentions mate-less A. cinerea with strong sexual desires which are found in colonies and often constitute a nuisance to the nesting birds; perhaps the same may apply to A. melanocephala ? More than once the iris of an inactive red-eyed bird has been observed to fade from red to orange, which was taken as a sign of the diminution of the breeding urge.

On the other hand, a red-eyed bird positively staking a claim to a nest-site is both active and aggressive. The chief actions and calls centre round what Meyerriecks : 43 calls the stretch display (Pl. 4, Fig. 14). A typical display, done alone by a presumed male perched on a branch, is as follows: The bird, usually starting from the hunched position, straightens the legs, elevates the body till it is steeply canted upwards, elongates the neck and raises the head till the bill is almost vertical. The three long occiputal plumes may or may not be raised; the plumes of the lower throat and breast are normally raised, but those of the back remain down. At the top of the stretch the bird makes a soft deep little noise, slurred-down in pitch, resembling a dove's coo or the whine of a dog, "how-oo", often accompanied by a puffing-out of the cheeks or throat; then, keeping the bill pointed upwards as before, the bird slowly sinks by bending the legs and lowering the neck backwards, and while doing this it usually makes a gentle gurgle, "roo-roo-roo-roo". Finally, it resumes the hunched position. Displays vary, however; for instance, during the descent the neck may at times be swayed from side to side, and the stretches can either be silent or accompanied by the coo and gurgle. An intense bird may stretch every few moments. If another individual approaches, the reaction of the perched bird will be hostile and may include a remarkable threat display in which it raises the three long occiputal plumes, one vertically, one horizontally to the right and one horizontally to the left, the action often being accompanied by a peck and by the threat-note, a harsh, screeched "keh". Lowe : 76 points out that with A. cinerea a male holding a nest-site will at first be equally hostile both to other males and to other females; in short, it takes him a little time to recognize a female as such and to accept her. Another typical action of the perched male at this stage is slowly reaching out the neck towards a nearby twig, which may be grasped between the mandibles, but not broken off - presumably the first stage towards nest-building. It would seem that the stretches of A. cinerea, herodias and melanocephala are very similar, judging by Lowe, Percy, Witherby, Meyerriecks and Cottrille. All three species belong to the large type of heron which functions in a stately manner; with the smaller species such actions may be accelerated considerably - for instance, Meyerriecks : 136 actually describes and illustrates an aerial stretch display for the American Snowy Egret Leucophorax thula (Gmelin) and thinks (personal communication) that one or two of our little African species may well do something similar : if so, it would be worth watching.

After a single bird has occupied a perch and displayed alone for a time, one next sees two birds together, bending earnestly over the slender twig-foundation of a nest : the male, it appears, has secured his mate, and building has begun. After this, I assume (following A. cinerea analogies) that the male will take over the duty of bringing materials, and that the female stays on the nest and builds. One often sees a red-eyed bird doing a solitary stretch on a nest, and this could either be a male occupying a nest at the pre-mate stage, or a female stretching while the male is away collecting materials. Many nests of the heronry, especially in area "A", seem to be constantly used; as soon as the young of one family are fledged the nest may soon be re-occupied, by the original pair for a second brood, perhaps, or else by another pair.

If a pair take over a ready-made nest, there may be no need for them to do any more building, though in fact they often do plenty until it becomes huge, like some of those shown in Pl. 2, Fig. 6. It is believed that the Nairobi birds use materials from gum-trees exclusively, with bare twigs for the structure and leafy ones for the lining. All materials are carried in the bill, not with the feet. At Entebbe, Pitman : 26, 31 describes varied linings of rags, grass, hair, etc., and says that these linings are usually held in the feet, though sticks are carried in the bill. At Nairobi, individuals differ in their methods of collecting materials : some break twigs off the nesting tree; others bring them from a distance and yet others take them from unoccupied nests near by. Only very rarely do birds take twigs dropped from the nesting tree.

A bird about to arrive at a nest makes a series of loud barks which are usually known as the greeting call, though I prefer "alighting call" as I do not believe that it is invariably made as a greeting. My impression is that this call is most intense and prolonged during the nest-relief ceremony done by incubating birds, and less so for building birds or those about to feed young. A building bird bringing material will bark "kow-owk, kow-owk, kowk" without opening the bill much (or it would drop the twig) so the effect is somewhat muffled. The bird (presumed male) then presents the twig to its mate with crest raised, and the mate, before taking the twig, often makes a brief silent stretch display to the male. (Quite possibly, females do not coo.) The male has not been observed to do a stretch in return. The female then places the twig in position with the male looking on and sometimes assisting. No bill-snapping display has yet been noted as for A. cinerea, (see Witherby 1938 : III. 128·) and herodias (Meyerriecks : 98).

Coition on the nest has been seen on several occasions : the female lies passively in an incubating position, with her chin resting on the brim. The male then mounts her, resting his tarsus on her back with his toes well forward near her nape, and often wing-flapping to keep his balance. One male after coition stood on the female's back for a couple of minutes while she raised her head and looked round.

After the eggs have been laid, the birds relieve each other from time to time, when, judging by the calls, emotion is at a high level. The returning bird (Pl. 2, Fig. 7) first makes the normal alighting barks, but these are then followed by prolonged growls "kwo-o-oh, kwo-o-oh" and short conversational calls "kut-kut-kut"

to which the bird being relieved may answer similarly. In one case a relieved bird made an alighting-type growl before taking off. The normal clutch is 3, sometimes 2. The eggs are pale blue and resemble those of A. cinerea. One is figured in colour by Priest, 1948, Plate 1. My Pl. 3, Fig. 10 shows a nest with eggs. Unfortunately I have not yet succeeded in recording an incubation period, on account of a series of mishaps, but Priest, 1948, 3 gives this as 23 - 27 days and Lowe : 81 considers the average for cinerea 25 days; therefore, when estimating A. melanocephala's total breeding period in Part IX I have assumed the incubating period to be about 25 days.

Within the colony, there is a good deal of quarrelling, mostly trivial, between nesting birds and their neighbours or with intruding birds. In threat, the long plumes of the crown and chest, and particularly the short feathers of the throat, are raised and often accompanied by the threat call "keh" and a peck, corresponding to Meyerriecks' "forward display"; I have not yet noticed the "aggressive upright display" of both A. cinerea (Lowe : 19) and herodias (Meyerriecks : 96) where the bird takes up a hostile pose with neck arched and crest raised. A. melanocephala does, however, adopt a distinct posture of aggression-cum-fear if it is perched on a branch and another bird (crow, kite or heron) dives close past (Pl. 2, Fig. 5). Here, the wings are extended with the neck held stiffly upwards and the throat feathers raised to an extreme; the head is kept horizontal, at right-angles to the neck; the crest feathers and occiputal plumes may also be raised, and the display is often accompanied by the threat-call. I have not read of anything similar for A. cinerea or herodias, but this seems to correspond to the "stiff-necked upright display" for B. virescens as described by Meyerriecks : 30, which also seems to combine the conflicting tendencies of aggression and fear. A mildly anxious bird, usually with extended neck and slimmed plumage (Pl. 1, Fig. 4), makes a series of soft, deep calls "kah, kah, kah, kah" often kept up for some time; this was characteristic of birds which did not dare visit their nests while an observer was in the tower. The call of extreme alarm, as used for a Hawk-Eagle, is a prolonged screech, "kaah".

IX. Breeding : The Young Birds

For this part, Lowe's Chapter 7 has been invaluable. In Part VIII it was mentioned that the normal clutch for A. melanocephala is three eggs; from these, three young are normally hatched, but only two are fledged. Occasionally all three young may be fledged, but this is exceptional. Quite a number of small young seem to get killed by falling out of the nests; for instance, on 31.12.61 when there were 175 occupied nests, 25 dead chicks were counted beneath the trees. Sneyd Taylor : 206 has a similar observation.

The breeding cycle of this species can be divided into three parts - nest-building, incubation and fledging of the young. As a working hypothesis I have assumed that the breeding period may be about 100 days : 15 for building, 25 for incubation (see Part VIII) and 60 for fledging, the latter being in accordance with the figure given for A. cinerea by Lowe : 95. But the building figure, in particular, is certainly most variable, since it includes not only active building, but alternatively the period of adoption of an already-built nest. "Breeding cycle" as defined in Part I starts with

courtship, which postulates a mated pair. With A. melanocephala, the activities of such a pair commence when they start to build a new nest or occupy an existing one. A bird seen standing on an already-built nest is here assumed to be mated and thus within the breeding cycle as defined, but a solitary red-eyed bird occupying a branch with, as yet, no signs of a nest is assumed to be un-mated and thus still outside the cycle. Such assumptions are arbitrary and may not always be correct, but they provide a clear working rule and thus enable observations to be consistent.

Three nesting records will now be mentioned. These are incomplete, since my visits to the heronry, though as frequent as possible, were irregular. Most of the data were obtained while the tower was up.

The first record relates to nest 1 of tree 34 in 1960. 14/7/60, birds actively building. 19/7, no eggs but bird in incubating position. 24/7, coition took place. 21/8, three small chicks. 2/9, still three. 11/9, probably two. 2/10, two large young. 9/10, two still present, after which observations ceased until 7/11 when the nest was found to be re-occupied and with 3 eggs. This example might fit the assumed 100-day breeding period fairly well, if building began about 7/7, incubation on 24/7 and fledging from 18/8 to 18/10.

The second record refers to the "great nest" of tree 24 in 1961. 20/1/61, a yellow-eyed bird standing on the nest. 11/2, nest repaired but no birds about. 9/3, bird incubating. 10/4, three smallish chicks. 3/5, still three, now big. 7/5, at least one of these can now fly. 3/6, two big young still in nest; this may well be an example of a pair rearing all three. 2/7, nest empty, but it was re-occupied, I think, early in September. In this case it looks as if the "building" period - really, the occupation of this existing nest - was much prolonged, between 20/1 and 9/3, and it is odd that the bird of 20/1 had a yellow (not red) eye.

The third and last record is of some interest, as it appears to involve a change from parents to "guardians". It concerns nest 1 of tree 47 in 1960. 20/6/60, a pair of normal-throated birds building. 2/7, birds standing about, not building. 8/7, bird incubating. 31/7, bird still incubating. 21/8, two smallish chicks, perhaps 14 days old. 28/8, only one chick, with two rufous-throated birds standing beside the chick but not seen feeding it; no positive sign of the normal-throated parents. 2/9, chick lying passively in nest with one rufous adult standing beside it. 11/9, chick makes an abnormal call, "zee"; the two rufous birds still present and still showing no signs of feeding it during period of observation. 17/9, the young bird now looks much more robust and had the normal "kek" hunger call. 2/10 and 9/10, the young is standing on the topmost branches of the tree and should soon be fledged.

From these observations (incomplete, unfortunately) it would appear that around the end of August the normal pair deserted or died, and that the surviving chick was adopted and reared by the two rufous birds. It is possible but highly improbable that the normal pair might suddenly have become rufous, and in any case these rufous birds sat passively beside the chick and thus did not behave like normal parents, which arrive, feed the young and depart promptly. In fact, there is no positive evidence that the rufous birds

did feed it, though it is reasonable to assume so, as they were in undisputed loco parentis and the chick must have been fed to survive. Two comments may be added : (1) in the light of this record, a bird in charge of a chick need not necessarily be its parent, and (2) if the two pairs concerned had not differed in colouration, the change very likely would have been impossible to detect.

The newly-hatched downy chick has bare patches on the front of the throat and on the belly, and long pale down sprouting from the forehead. The iris of young birds at all stages is yellow, like that of the adult except in the red-eyed stage. A newly-fledged juvenile can be distinguished from an adult in a number of ways:

Feature	Adult	Newly-fledged juvenile
1. Crown.	1. Black, with long occipital plumes.	1. Dark grey. No plumes.
2. Chin.	2. White.	2. Pale rufous.
3. Strip down front of throat.	3. Speckled black and white.	3. Plain pale rufous.
4. Belly.	4. Dark grey.	4. Near white.

The best distinguishing feature for a juvenile is the rufous, un-speckled throat.

A description of a one-year-old juvenile follows. The age of this bird was precisely known, since it was rescued as a fledged chick from beneath the trees by Mr. Des Bartlett and reared by him. The crown was still dark grey, not yet black, but the chin had become nearly white, with only a little rufous remaining; the front of the throat, though still with a rufous tinge, had begun to show black dots and the belly was beginning to look grey, rather than white. If this is a normal one-year plumage it throws considerable light on the age at which birds may first breed, because in four years a bird in this plumage was only once seen at the heronry; all other flying birds seen here (bar a few melanistics of doubtful age) were either full adults or newly-fledged juveniles (the latter, no doubt, still being fed at the nest). It looks very probable, therefore, that birds only breed when they attain adult plumage, perhaps at the age of two years or so. (Lowe : 82 quotes evidence that the male A. cinerea breeds at 2 - 3 years, though one-year-old females have been seen feeding young.)

The adult feeds the young by regurgitation of food from the stomach, though a bird was once observed carrying food - an elongated rat-like object - in its bill, which it fed to a nestling. As soon as the chicks think that they are going to be fed - from the sight of the approaching parent, which it is thought they can recognise some way off - they start the hunger call, "kek-kek-kek-kek-kek, kek-kek-kek-kek-kek", a series of short, sharp reedy notes all at the same pitch, repeated again and again in groups as shown in the present example, with say 3 - 6 calls to a group. The notes are high-pitched and thin with small chicks, then deepen in pitch as the bird gets older. The young continue the hunger call during the whole of the time while the parent is at or near the nest, and only cease calling when it leaves. The hunger calls plus the arrival barks of the adult are the most characteristic sounds of the heronry. Lowe : 86 points out that young A. cinerea make these hunger calls till they leave the nest, and then never again.

The parent arrives at the nest making a short version of the arrival call (as for nest-building), and alights beside or upon the nest with crest raised; then, before regurgitating, raises the neck in a manner resembling the stretch display, except that the bill is horizontal (Pl. 4, Fig. 16). At times the wings may be raised and the cheeks puffed out as in Pl. 2, Fig. 8, but less intensively. As the parent arrives, the young on the nest increase the loudness of the hunger calls, lower their bodies by bending the legs, raise their crests, open the wings and often flutter them with a slow rotary motion (Pl. 4, Fig. 15) - all of which are presumably "releasers" to stimulate regurgitation on the part of the parent. With this species it seems clear that parents do not feed young anywhere but on the nest, and Lowe : 95 implies the same for A. cinerea. However, in Tanganyika recently one of the small herons, the Squacco Ardeola ralloides (Scopoli) was observed constantly feeding the young away from the nest, so the practice of feeding the young only on the nest clearly does not apply to all members of the family.

During regurgitation, the young bird seizes the bill of the parent near its base, and the latter passes the food direct into the mouth of the young in such a way that it is rarely possible to see what is passed. Regurgitation of food on to the floor of the nest has never yet been observed. On the few occasions when the food was seen it was the result of an accident, e.g. on one occasion a young bird was unable to swallow its regurgitated rat completely, and a brother caught hold of the protruding end, which resulted in a prolonged tug-of-war. Parents do not seem to find it easy to regurgitate, for which they need a short interval of peace and quiet, with neck stretched, and this, with the larger young anyway, is precisely what they do not get, as the young are constantly making leaps upwards to try to catch the parent's bill (Pl. 4, Fig. 16) and generally behaving in a rowdy manner; indeed, the later stages of parenthood in this species are in no way to be envied. When the chick catches the bill of the parent it pulls this down to near the floor of the nest, where regurgitation takes place, often with violent wing-flaps on the part of both birds. There is no evidence of young from one nest joining another and there being fed; in one case, when a parent was feeding its small chicks a large young bird flew over from another nest and begged for food, but was promptly ejected by the parent.

With this species it seems unusual for a parent with young to bring sticks to the nest or for young to play with sticks or add them to the nest, though both have been observed; judging by Lowe : 92 the practice is much commoner with A. cinerea. Twice chicks - not much more than half grown - were seen to do stretch displays; one of these was silent and the other a squeaky groan instead of the normal adult's coo. As will be mentioned shortly, a large flying young arriving at the nest will make an alighting call like an adult's, and this once caused a small brother to adopt the begging attitude, momentarily. The young do a number of exercises including stretching one wing outwards and downwards, the leg on the same side always being raised and stretched simultaneously (Pl. 3, Fig. 11). Lowe : 90 mentions the same for A. cinerea. Another interesting exercise is when the bird, on nest or branch, half-raises its wings, stretches the neck diagonally downwards with raised feathers and often pushes the bill into a patch of leaves (Pl. 3, Fig. 9). The only comparable observation which I can discover is from Meyerriecks

:11 for B.virescens, which he saw more often in nestlings than in adults, and where "the bird stretches its head and neck fully forward, then raises both wings over the body so that they meet".

Percy, 1951 : 33, mentions that with A. cinerea one or other parent keeps a constant guard upon the young until they are about three weeks old. This does not seem to be a normal practice with A. melanocephala, though it is sometimes done - e.g. the pair at the "great nest" of tree 24 did so in April 1961. Once, when a certain nest was unoccupied, it was taken over by a flying young from a neighbouring nest, which then drove off an adult that perched near by: it is surprising how aggressive these large young often are. Lowe : 91 refers to the bottle-like silhouette of the young heron when standing upright and points out that the near-vertical stance which herons often adopt gives them an advantage over most other birds as it enables them to stand back-to-wind without having their feathers ruffled. A young bird was observed asleep at 6.30 a.m. on a cold morning. It stood on one leg with the other tucked in; the body feathers were much fluffed out, the head sunk between the shoulders with the bill pressing against the breast, and the long downy feathers on either side of the head were raised to protect the face. Perhaps this is a normal cold-weather roosting posture.

Earlier in this account it was mentioned that parent birds will feed their young only on the nest; therefore, when the young finally leave the nest, they must fend for themselves from then onwards. For perhaps the last fortnight of their 60-day fledging period they are able to fly but cannot feed themselves, so must return to the nest to be fed. This is a critical stage in the life of these birds, since they must learn to take off from the nesting trees 70 feet above ground level, and, after flying about, land safely at the nest, and woe betide the young bird which lands on the ground, because normally it will have insufficient strength to take off again, and will starve. (Twice a juvenile was seen actually taking off from the ground, and several times birds succeeded after first climbing an elevated object in the Yard, such as a pile of drums; but such cases are exceptional).

A chick, as soon as it is sufficiently fledged, will prepare for flight by flapping exercises (Pl. 3, Fig. 12). These are done first on the nest, then on a branch, the flapping usually being stimulated by a gust of wind, with the bird facing into the wind, of course. The flapping is usually done in short bursts, and is vigorous and rapid. In the early stages the bird does not wish to be airborne, so, to prevent this, it will grasp the floor of the nest, or a branch, with both feet. Next, it lets go with one foot, waving it in the air with a pedalling motion, but holds on with the other. Finally it releases the grasp of the remaining foot and flies. It has not yet be possible to study an individual bird closely enough to ascertain what was a genuine first flight, and in any case "flight" would need to be defined; this should surely be more than a mere hop of a few inches. Genuine early flights of at least a hundred yards have often been observed, however, and follow this pattern : the bird takes off, usually in a gust of wind, and at once flies vigorously and with fair skill, the only obvious amateur features being the fact that it tends to keep the neck extended, instead of retracting it, and peers around; also, the feet are often left to dangle.

After flying about a little, it lands on one of the topmost branches of a neighbouring group of gums, with much difficulty, flapping wildly to keep its balance and bending forwards and backwards before becoming securely perched. After this, other landings, including back at the nesting tree, become progressively more skilful and graceful. When about to land at the nest the young bird often makes an alighting bark just like an adult's; indeed, a half-grown chick once uttered a squeaky alighting call on returning to the nest from a pedestrian excursion to a neighbouring branch.

Often these early flights to the clump south of area "B" are undertaken in the evenings, when the Pied Crows C. albus are coming in to roost, and the latter will dive at the perched heron, cawing vigorously, though these dives are not pressed home and look like play. By such tactics the young heron is by no means intimidated; it adopts the stiff-necked aggressive pose, with neck vertical, wings waving and open bill, making the threat-call "keh", and the crows do not persist. By this time, the flying young appears to possess most of the vocabulary of the adult bird, except the stretch-coo; nevertheless, when the parent appears with food, these flying young will rush back to the nest and squat down, begging and making the hunger call, just as if they were babies again. This account closely corresponds with that given for young A. cinerea by Lowe : 92 - 5, except that these do not appear to attain the adult vocabulary quite so soon.

This period of flying but needing to be fed has been included as part of the 60-day fledging period, and may, as already mentioned, last about a fortnight, Lowe's estimate for A. cinerea being 2 - 3 weeks. It is deemed correct to regard a young heron as unfledged till it finally leaves the colony. Once it does so, there is no evidence that the parents ever feed it again. Lowe : 95 believes the same for A. cinerea.

X. Photography and Sound-Recording

Most of the photographs which illustrate this article were taken from the balcony of the tower in 1960, shortly after its erection, while many nests were in easy photographic range. In all, I have some 350 black-and-white pictures of the heronry taken on either Ilford H.P.3 or Kodak Plus X film, and 230 colour pictures taken on Kodak High Speed Ektachrome film. The 16 photographs here reproduced provide, it is thought, a fair cover of the breeding activities of these herons. In 1960 I used a Minolta S.R.2 camera with its 250 mm. lens, and from 1961 a Leica M.3 camera with the Visoflex housing and 300, 400 and 600 mm. Kilfitt lenses. Most of the pictures illustrating this article were down with the Minolta, usually at a fast exposure of 1/1,000 second, with a fairly large stop, such as f.5.6. All were hand-held, without a tripod, this being a positive disadvantage with many action subjects, where it is essential to hold the camera free to aim instantly in any direction. The photography of birds in action has been revolutionized by the use of the miniature camera with a direct-vision penta-prism viewfinder and light lenses of about 300 mm. focus which can be held by hand. To view the subject, one looks directly through the lens, reflex-fashion - and a 300 mm. lens has the magnification of a x6

monocular. Moving objects can be focussed with great rapidity, and one can see what part of the picture will be in or out of focus and judge what the effect will be. Pl. 4, Fig. 14 - of the stretch display - was taken from a distance of 100 ft. with a 600 mm. lens on a tripod. This big lens, equal to a x12 monocular, can be invaluable for long-distance subjects, but is too heavy for use by hand and needs support.

Tape records of the vocabulary of this species were made with machines on loan from Cornell University, U.S.A. The noises made by these birds are raucous and difficult to convey in print, so it was advantageous to be able to record the actual sounds.

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Summary

1. The results of a four-year investigation - from 1958 to 1962- of a nesting colony of the Black-headed Heron, Ardea melanocephala Vigors and Children, are described and illustrated. The investigation continues.

2. The colony is located in Eucalyptus trees in the Stores Yard of the East African Railways at Nairobi, Kenya. The Railway authorities have co-operated in many ways, in particular by protecting the birds and by erecting an 80-foot observation tower.

3. A count of occupied nests was made each month over the 4-year period and each count was positive, i.e. breeding has been all-the-year or continuous over these four years. Such continuity occurs because individual pairs breed at different seasons and their respective breeding periods, taken in aggregate, result in a continuous overlap. Thus, the colony's breeding season is spread over the whole year. Similarly continuous breeding occurs with certain seabirds of Ascension Island and there is one comparable record for a land bird - a dove - in Scotland.

4. The Nairobi heronry was first occupied in 1954 and breeding may well have been continuous ever since, though proof prior to 1958 is lacking. Similarly, there is cause to suspect that another A. melanocephala colony at Kampala, Uganda, may have been occupied almost continuously for over 20 years. Taking Africa generally, however, the indications are that the breeding of this species may be seasonal rather than continuous.

5. Although breeding in the Nairobi heronry was continuous, there were pronounced peaks in occupation associated with rains and lulls associated with drought.

6. When rains were exceptional, a large increase in occupation followed, as could have been expected; however, the subsequent persistence in high-level occupation was unexpected : in 1958 this lasted for 8 months and in 1961-2 it has lasted for 12 months up to the time of writing, and still continues. Since A. melanocephala's breeding period is estimated at just over 3 months, such continuance implies that existing residents are having successive broods or that new birds are joining the colony, or both.

7. Poor rains resulted in small occupations which then dwindled. Periods of minimum activity were during the dry weather of August-September following poor rains in April-May.

8. Some evidence was obtained concerning food, hunting methods, roosts and the foraging area for breeding birds (up to 15 miles from Nairobi).

9. The colony periodically suffered from the depredations of the African Hawk-Eagle Hieraaetus spilogaster, which preyed on the young.

10. The iris is normally yellow, but changes to ruby-red with

breeding birds up to the time of egg-laying, when it again reverts to yellow. This is unusual.

11. Parents feed their young only on the nest. The latter, perhaps for their last fortnight at the nest, learn to fly but must return to the nest to be fed. The early efforts in flight of a young bird are thus critical, since if it lands on the ground it may well have insufficient strength to take off again, and will starve. After a young bird finally leaves the nest it is believed to feed itself from then on.

12. Efforts were made to obtain comprehensive photographs, 16 of which illustrate this paper. Calls were tape-recorded.

13. Much reference is made to available literature both of this species and of its near relations A. cinerea of Europe and A. herodias of North America. In this respect the works of Lowe, 1954 and Meyerriecks, 1960 were of outstanding value.

References

COTTRILLE, W.P. and B.D. (1958), Great Blue Heron : Behaviour at the nest. Museum of Zoology, University of Michigan, Misc. Publication 102 : 1 - 15.

GUICHARD, Kenneth M. (1947), Birds of the inundation zone of the river Niger, French Soudan. Ibis 89 : 450 - 89.

JACKSON, Sir F.J. (1938), Birds of Kenya Colony and Uganda Protectorate. London : Gurney and Jackson.

LOWE, Frank A. (1954), The Heron. London: Collins.

LEES, John. (1946), All the year breeding of the Rock-Dove. British Birds 39: 136 - 141.

MEYERRIECKS, Andrew J. (1960), Comparative breeding behaviour of four species of North American herons. Nuttall Ornith. Club Publication 2: ;1-158. Cambridge, Massachusetts.

NORTH, Myles E.W. (1961), Herons in the Railway Stores. Spear 5 no. 3: 51 - 3. Nairobi : E.A. Railways and Harbours.

PERCY, Lord William (1951), Three studies in bird character. London : Country Life.

PITMAN, Capt. C.R.S.(1927), Some notes on the breeding and other habits of Ardea melanocephala. Oologists' Record 7 : 26 - 34.

PITMAN,Capt. C.R.S. (1942), A game warden takes stock. London, Nisbet.

PRAED, C.W.M. and GRANT, C.H.B. (1952), Birds of eastern and horth eastern Africa. London : Longmans Green.

PRIEST, Capt. Cecil D. (1948), Eggs of birds breeding in South Africa. Glasgow : Maclehose.

SNEYD TAYLOR, J. (1948), Notes on the nesting and feeding habits of Ardea melancephala. Ostrich 19 : 203 - 10.

STONEHOUSE, B. et al. (1962), B.O.U. Centenary Expedition Volume 2. Ibis 103b.

STONEHOUSE, B. (1962), Ascension Island and the B.O.U. Centenary Expedition 1957 - 9. Ibis 103b : 107.

WITHERBY, H.F. et al. (1938 seq.), Handbook of British Birds. London : Witherby.

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