# The lifestyle and biology of the Hooded Vulture at Sokoto, northern Nigeria, 1970 to 1973.

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## Summary

The Hooded Vulture was studied in and around Sokoto town, in north-west Nigeria, in the years end-1970 to mid-1973. We estimated that 1500-2000 Hooded Vultures lived at Sokoto, based on counts at the abattoir. We mainly followed the nesting of the species, and to that end located more than 320 nesting trees. *Faidherbia (Acacia) albida* was the tree most used; the average height of nests in eight species of tree was 8.1 m (sd ± 3.2), being highest in the Borassus Palm. Overall egg-laying dates for first-laid eggs were 16 October to 20 February (averaging 15 December); replacement eggs were laid on average on 17 February. The incubation period of 13 eggs averaged 51 days (range 50 to 54 days). Growth in weight of chicks rose to about 1500 g at 70 days and levelled off. The wing grew straight from day 30 to day 90 at 5.2 mm per day. It peaked at day 120 at 96% of the adult's wing length. The fledging period of 10 chicks averaged 108 days (range 98 to 123 days). During observations there was always an adult (sometimes two) present at the nest, and the chick is fed mouth-to-mouth by regurgitation. Average breeding success (chicks reared from eggs laid) was low at 41%, indicating some impact of our interference. Adults were caught on their nests eight times, and measured. There was little interaction between people and the vultures, and the local people were generally very tolerant of them.

## Introduction

We lived at Sokoto in the north-west corner of Nigeria in the late 1960s to early 1970s, and began a study of birds together in the then North-West province in December 1969. Hooded Vultures *Necrosyrtes monachus* were everywhere at that time, perching on roofs and garden walls, between our legs at the market, and once even seen riding on a local goat (Mundy 1974). No traveller to West Africa could fail to encounter the species, because "every village holds its quota" (Bannerman 1953). So common a bird and yet not any detailed study had been done on it by fifty years ago in that whole region. Indeed, throughout the entire range of the bird in sub-Saharan Africa only van Someren (1956) had thought it worth studying to any extent; he observed two nests for several years in his "forest sanctuary" near Nairobi, Kenya. Around the same period Serle (1943) was in Sokoto province and briefly described aspects of the vulture's nesting.

We therefore started to follow the Hooded Vultures in and around the town, from October 1970, when they started their breeding season. The bird's accessibility and abundance, in fact, made it something of a joy to follow. In northern Nigeria (at least) several folklore tales exist about it, e.g. the vulture always lays two eggs, one of which hatches into a fly. But the species is not held in the same superstitious awe as is the much larger (and wilder) Rüppell's Griffon *Gyps rueppelli*. At a practical level for us this was important, for it meant that we could study the vulture with apparent impunity, both to us and to the birds; we never had any intimation that our attentions caused it any problems. However in other countries it may be hunted and eaten, e.g. in the Ivory Coast to the west (Thiollay 1985).

Up until quite recently, and to our best knowledge, the Hooded Vulture had been studied in detail only in Zimbabwe (known as Rhodesia at the time of this field study) (Mundy 1982). The life-style of the species in southern Africa, however, makes it very difficult to study, in what one of us has called its other or second 'face' (Mundy 1976). Nevertheless more breeding records in South Africa are currently being documented (Roche 2006, Monadjem *et al*. 2016). In Uganda, its scavenging behaviour in competition with other species had been studied (Pomeroy 1975), as well as accounts of it within the wider vulturine community (Houston 1975, 1980). We ourselves described two instances of us double-clutching the bird (Mundy & Cook 1972a) which became a larger manipulated effort (Mundy & Cook 1975). We had estimated the numbers of the vulture in Sokoto town at 1000 to 2000 (Mundy & Cook 1972b), and also given a brief summary of our findings on its breeding (Mundy & Cook 1974).

In recent years, however, the situation of vultures in West Africa has gone sour. Rondeau (2004) alerted the ornithological community to their plight, and the actual count data supporting his alarm were published by Thiollay (2006a, b) from counts done in 2003 and 2004. It must be noted that Thiollay did road counts in Mali, Burkina Faso and Niger, which form only a part of West Africa. In Ghana, by contrast, in 1996, Hooded Vultures were common to abundant (Mundy 2000a), such that when PJM reviewed its situation in Africa in 1998 no alarm was sounded (Mundy 2000b). Unfortunately he had overlooked a curious observation made in northern Cameroon in 1996 (Scholte 1998), when he [Scholte] "observed several Hooded Vultures which literally fell out of the trees, and soaked by the rain quickly died (more than 100 dead birds were recorded)." Again, however, in Ghana, Hooded Vultures were abundant at the Legon campus of the University of Ghana (Accra) in 2005/2006 (Gbogbo & Awotwe-Pratt 2008) but with a decrease in numbers noted in later years (Gbogbo *et al*. 2016). Rondeau (2004) mentions this anomaly of the species having "totally disappeared" from places yet being "still present" in contiguous areas.

In the last decade or so, more studies on the Hooded Vulture have been done, particularly in The Gambia where the species is still abundant (Barlow 2012, Barlow & Fulford 2013, Smalley 2016, Jallow *et al*. 2016). It is also still common on the Legon campus, Ghana (Annorbah & Holbech 2012), and high numbers were counted at roosts in Ethiopia, averaging nearly 120 in total (Teklemariam & Verma 2013). In contrast, numbers have declined in towns of western Kenya (Odino *et al.* 2014). Most alarmingly, "medicinal traders" in northern Nigeria (113 interviewed at 39 village markets) used a lot of Hooded Vultures, and 11% offered vulture heads (Saidu & Buij 2013). A continental survey of the species led to it being uplisting to the Critically Endangered status, due to some "dramatic" declines from poisonings, illegal trade, and persecution (Ogada & Buij 2011), although this status is currently a matter of discussion and subject to review (e.g.

https://forums.birdlife.org/2022-1-hooded-vulture-necrosyrtes-monachus-revise-global-status/). In eastern Burkina Faso, a detailed study on up to 56 nests was done over two breeding seasons (Daboné *et al*. 2016); as yet this is the only such study published to date and will of course be closely compared with ours.

Also in Ghana, Campbell (2009) documented many groups of Hooded Vultures at eight settings (e.g. meat markets), and interestingly investigated interactions between vultures and people, and Pied Crows *Corvus albus*, in Accra and Kumasi. There was a lot of influence from human gender and age in people's responses to the vultures. In contrast to studies in The Gambia, Mullié *et al*. (2017) measured a very strong decrease in the numbers of Hooded Vultures in Dakar, Senegal, in the period 1969-2016. A strong decrease was also recorded in Edo State, southern Nigeria (Nosazeogie *et al*. 2018). Daboné *et al*. (2019) documented human impacts on nesting Hooded Vultures, such as removing eggs and chicks, though at the same time they showed that successful nesting increased with proximity to human habitation. In a particularly interesting paper, Thompson *et al*. (2020) showed that the average home range size for adults in western Africa was only 121 km² (= a circle of 12.4 km diameter) – as befits an urban bird!

In view of these recent and sometimes startling observations, it is necessary to put on record the study we did on the Hooded Vulture in northern Nigeria fifty years ago. Certain of the results were used by Mundy *et al*. (1992) in summary form and without reference to the present study. It is therefore not quite correct to say that West African vultures "have practically never been studied" (Rondeau 2004). Perhaps those days were indeed halcyon, and for the Hooded Vulture too. It was certainly very abundant in and around Sokoto town, accessible, tame, and apparently of small foraging range; ideal for a detailed study.

**Study Area and Methods**

In 1970 Sokoto was the state capital of the North-Western (NW) province of Nigeria, which along with other provinces had recently (1968) been fragmented from the huge Northern Region. Later it became the smaller Sokoto province. Around that time, the NW province was estimated to hold 7.3 million inhabitants (Kajubi *et al*. 1974), the great majority being rural and living in villages; the population of Sokoto town was estimated (semi-official) to be approaching 200,000. The town was founded by Shehu Usman dan Fodio and has been ever since a centre of trade and religion. It functions as the seat of the Sarkin Musulmi (Sultan), chief of Muslims in West Africa. Islam is by far the dominant religion in northern Nigeria, to the almost complete exclusion of anything else. This means that most families and households live behind two-metre high mud-plastered walls, out of eyesight of neighbours. In recent years much building on the outskirts of the true urban area has produced large suburban areas (government residential areas).

At 13°02'N, 05°16'E, the compact town is situated on higher ground at the confluence of the Sokoto and Rima Rivers, and at an altitude of about 360 m a.s.l. (Elgood 1982). In this area the two rivers form 'fadamas' (Hausa for wetland, or grassy floodplains) around their main streams, which flow westwards; both rivers are 'dammed' (i.e. weired) and therefore hold water near the town throughout the year. The landscape surrounding the town is rather flat, with very sandy soils which in many areas is a reddish laterite. The human population density within a radius of 50 km from Sokoto was estimated at about 160 per sq. km and, with the accompanying livestock abundance (cattle, goats, donkeys, and some camels and sheep), the countryside showed the combined impact: sparse grass, widely spaced trees, and erosion gullies everywhere.

The Harmattan is an annual south-bound wind in the dry season (especially December and January) that can blow fiercely at times and fills the air with dust; it can also lower the temperature dramatically. Sokoto has an extreme range of temperatures from an absolute minimum of about 8°C to an absolute maximum of about 43°C (Elgood 1982). The wind and the hot temperatures combine to make a highly desiccatory climate. Rainfall has an annual average of 600 mm, nearly all of which falls in the five-month period of May to September (incl.) (Dogondaji & Muhammed 2014). In 1970 the wet season amounted to 630 mm (in 43 days of rain), in 1971 to only 473 mm (37 days of rain) but 343 mm (30 days) in the afore-mentioned paper (both our figure and theirs coming from the Sokoto airport!), which is verging on a drought, though we do not recall it being communicated as such, and in 1972 the season produced 549 mm (and 38 days). In 1973, there was 330 mm (40 days) according to Dogondaji & Muhammed (2014), which is certainly a drought at only 55% of normal. We had already left Nigeria when this poor rainfall occurred.

Almost the whole province lies in the Sudan savanna zone of vegetation (Elgood 1982), or what White (1983) calls "Sudanian undifferentiated woodland". In and around Sokoto the winterthorn *Faidherbia (Acacia) albida* (re-named to *Faidherbia* some years ago, Timberlake *et al*. 1999) seemed to be the commonest species, with much Desert Date *Balanites aegyptiaca*, baobab *Adansonia digitata*, and Borassus Palm *Borassus aethiopum*. Winterthorn trees were often pruned of branches in order to feed livestock. Baobabs were also harvested, for their bark. In the grounds of the Senior Service Club was a woodland said to be 60 years of age (at that time in 1970) and dominated by tall Mahogany *Khaya senegalensis* and Silk Cotton *Ceiba pentandra* trees. The town had seen extensive planting of the alien Neem tree *Azadirachta indica* which was said to improve the soils (Radwanski 1969) for cultivation; this species was uncharacteristically evergreen and in addition most of its trees were thickly foliaged.

Our methods in following Hooded Vultures were simple. During ordinary bird watching sessions of about three hours each in the morning and afternoon, and in all months of the year except for April and May (annual home leave) in the years 1970-1973, we paid particular attention to Hooded Vultures, intensively so from October 1970 to July 1973. (PJM left Nigeria in March 1972 and AWC in July 1973). Nests that were discovered were then checked on a weekly basis. Eggs were measured with vernier callipers, and sometimes weighed. Egg-laying dates were estimated by means of mid-points between two visits, or by back-dating from a measured nestling. A sample of 27 accessible nests was used to measure growing nestlings: the wing was measured from the bend of the wrist along the flattened longest primary feather, and over the wing, for the maximum length; the tail from the hind end of the oil gland to the tip of the longest rectrix; bill horizontally from the skin of the head to the end curvature of the culmen, thus (unfortunately) the 'bill' length also included the cere (see drawing in Bannerman 1930: 183); and tarsus from the mid-point of the joint with the tibia (as far as could be ascertained) to the joint with the middle toe. All measurements were made in millimetres. Mass of the nestling was taken with a Salter spring balance, the bird being in a bag. On eight occasions we were also able to catch a parent at the nest, and it was subjected to the same procedures. Household-type maximum and minimum thermometers were used in the investigation of incubation temperatures. One was placed directly under the egg and the other was fixed at the same height close by on the shady side of the tree trunk. Trees that had nests were identified to species, numbered with metal tags, and heights of nests were estimated by eye (in feet at the time, and later metricated), sometimes with one of

us standing beside the trunk for scale (with upraised arm to approximate six feet). A map of the town and its surrounds was obtained from the Northern Nigerian Survey, edition 1967 (and reproduced here as Figure 1), and all nests of the Hooded Vulture that were found were plotted onto it as accurately as possible.

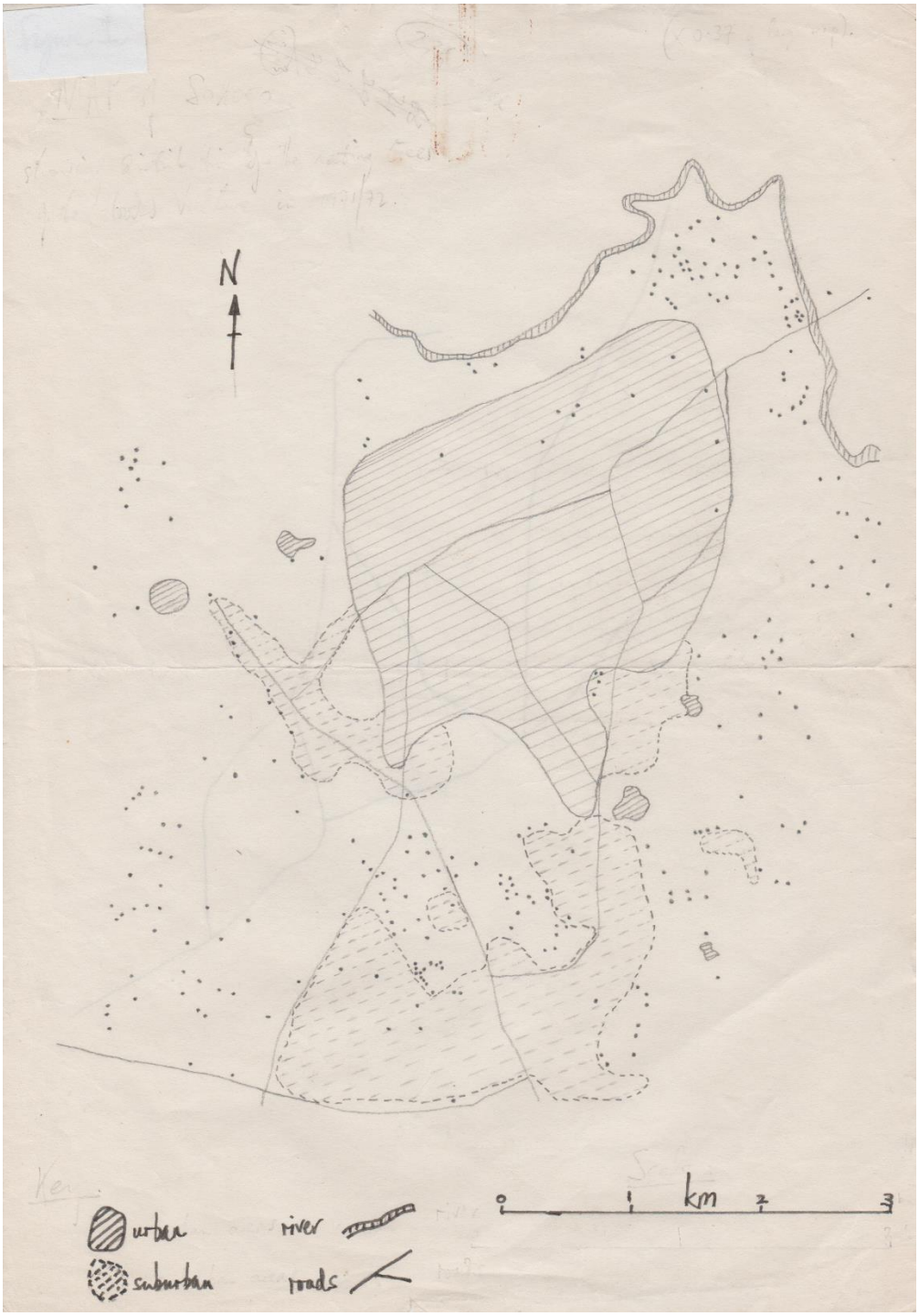


**Figure 1**: Map of Sokoto town with 276 Hooded Vulture nests marked as black circles.

**Results and Discussion**

***Observations on plumage and ageing:***

Initially we had access only to Bannerman (1953) as our guide to the species; as he provided the barest details we had to study each bird seen. Quickly we saw that all presumed parents at nests were what we called at the time "white-headed", confirming later from Bannerman (1930) that adults had "brownish-white down" on the neck. More recently this plumage character is described as a pale buff and close-cropped woolly down on the head and nape, with sometimes a balding crown (Mundy *et al*. 1992: 138). The crop patch is also covered in a close-cropped buffy down, with a tuft of black feathers on its top margin. The bill proper is brownish-black, and the long cere is the same colour as the face. These descriptions fitted the birds we saw, and apply to the adults (Plate 1). The nestling by contrast has a downy cowl reaching along its head ('forehead') of a chocolate-brown colour, which becomes rather buff on the crown and almost black around its face by the time it fledges (Plate 2). The buffy crown must quickly go dark in colour, as we noticed none of this colour scheme in and around the town. Young birds with blackish-brown cowl are also profusely covered on the face in black whiskers. In a group of variously-aged birds such differences are conspicuous (Plate 1). In flight, the adult has a pale area or 'window' all the way along its underwing, which is very conspicuous and diagnostic of species and age (Plate 3); the underwing of immatures is darker and lacks this 'window'.

***Observed abundance and distribution:***

During our general bird watching surveys in the study, vultures were seen everywhere in small numbers, particularly among the butchers at the market, and up to 100 were occasionally seen there, e.g. on 10 April 1973. Sometimes we saw them on carcasses (see section on feeding behaviour later). Birds were also seen at ponds of water, such as 11 (only three adults) with the lone Cattle Egret *Bubulcus ibis* in Plate 1. Adults, incidentally, often stood or perch together in twos (as in Plate 1), and we presumed that these were two partners of a pair. The same effect can be seen in a photo of 13 birds standing on the ground at Dori in northern Burkina Faso (Mundy *et al*. 1992: 345); only four were adults with two of these standing together. And again, a photo of 11 birds in a dead tree has two adults perched side by side (Dalling 1976).

On 7 March 1972, about 300 vultures were counted in a thermal over open ground near to the confluence, forming a high column. This was the largest number of birds that we saw in a thermal. Meanwhile in the non-breeding season (i.e. in the wet season), Hooded Vultures went into communal roosts for the night. The tall trees of the Senior Service Club served as a roosting place, and at dusk on 18 July 1970 as just one example, we saw "very many" perhaps 50 congregating there.

It was at the Sokoto abattoir that we often saw huge numbers of Hooded Vultures gathered. Once we realised this, in 1973, we made a habit of visiting the place to make observations. The largest of these are listed in Table 1, and part of one flock is shown in Plate 4. Curiously there was almost never a Pied Crow to be seen at the abattoir.

At the Sokoto market on 18 April 1973, AWC first saw the 'mad man', at its entrance; he was cutting up three dead Hooded Vultures! At the time there were 20 birds around the place, on the roof and in neighbouring trees. Locals informed AWC that he did this every day and has done so for the past three or four years. This activity is both bizarre and incredible, on the face of it accounting for nearly 1000 vultures per year. If true, how could there be any Hooded Vultures left remaining in and around Sokoto town? And how did we not see him before this date? Rather it may be that, in typical fashion for a 'mad man', he keeps the carcasses with him for a period of time as part of his baggage,

and that he is not actually despatching three new vultures per day. Unfortunately, from the present far distance in time we can offer no more insight into this activity. Certainly, we cannot begin to imagine how many birds he dispatched per month and year.

**Plate 1:** Group of 11 Hooded Vultures at a pond, of different ages. Note the two adults standing together (possibly a pair), and a third with a full crop.

**Plate 2:** Large Hooded Vulture nestling leaning out of a nest, showing its head colouring.

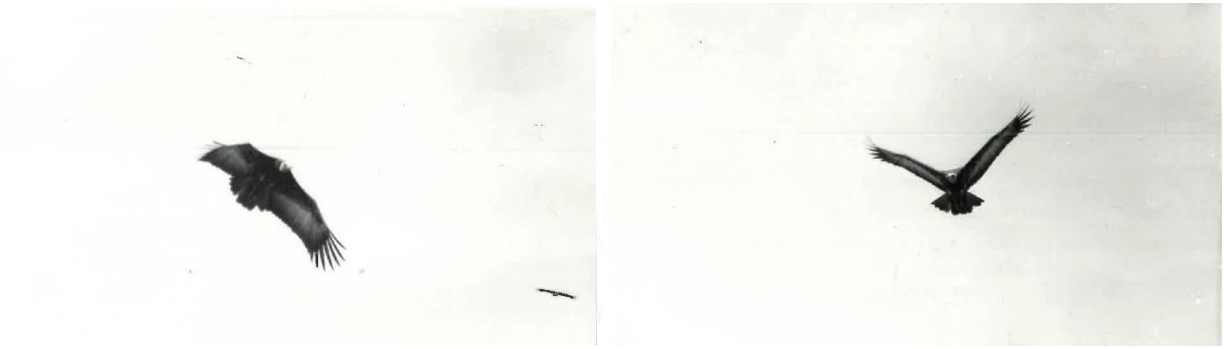

**Plate 3:** Underwings of two flying Hooded Vultures to show the 'window' on the secondaries.

**Plate 4:** Hooded Vultures at the Sokoto abattoir.

**Table 1:** Observations of some gatherings of Hooded Vultures at the Sokoto abattoir in 1973.

| Date | Time | Estimated number | Notes |
|---|---|---|---|
| 31 March | 09h00 | 500 | |
| 10 April | - | 1550 | Around butchers' area only. |
| 20 April | 11h00 | Nearly 1000 | On ground, in drainage ditch, on roofs, in trees, in the air, and on bone pile (30). |
| 5 June | 09h40 | 1500 | No ringed vultures seen. |
| 10 June | 12h00 | 1500 | No ringed vultures were seen. One adult had no toes on one foot. |
| 28 June | 10h00 | 750 | Photographed (Plate 4). Many juveniles noticed. |
| 8 July | 09h00 | 700 | No ringed vultures seen. |
| 20 July | 08h30 | 1000 | Incl. 232 perched on the roofs, 280 near outside channel. AWC ascertained that a dead adult bovine had been thrown away into the 'disease corner'. |

We thought there were about 300 nests (= pairs of vultures) in and around Sokoto in any one year. But as we kept finding more (and sometimes old) nests, we can suppose that there may have been 400 nests in a 40 sq. km area around the town (= 800 adults). An extra one-third (= 270 birds) can be added to account for immatures and juveniles (Mundy *et al*. 1992: 71). If on average about one-fifth of adults fail to breed in any one year (Mundy *et al*. 1992: 96, Daboné *et al*. 2016), then we can add another 80 pairs (= 160 adults) plus one-third (= 53 immatures). Assuming that average breeding success per pair is at 40%, then each year 160 fledglings are produced. Altogether these estimates now total 1443, or approximately 1500 Hooded Vultures that called Sokoto town and environs their home. Could these balance with the maximum estimate of birds at the abattoir (in June 1973)? Unfortunately we noted no ages there.

Our previous estimate of "between 1000 and 2000" birds (Mundy & Cook 1972b) is now considered by us to be on the low side, especially as our absolute minimum seems to be 1500 vultures. This contrasts with estimates of around 500 in Abéché, Chad (Salvan 1968), "hundreds" in Kano (Serle 1943), at least 215 in Kampala, Uganda (Pomeroy 1975), but about 440 by 2005 (Anon. 2005), and a stunning 171 per 100 km of road census in Senegal (Thiollay 1977). In the north Sudanian zone (see map in Thiollay 1978), where Sokoto is situated, Thiollay (1977) counted up to 34 Hooded Vultures per 100 km; these distances would include 'much' empty area between villages.

We recall very few observations of lone (single) birds during our study, so we quickly viewed it as a sociable species. However on occasions it did occur by itself, such as the individual riding on a goat. Probably we failed to document single occurrences, and they could have been more numerous.

***Nest trees and nests:***

Hooded Vultures at Sokoto used 11 species of tree for nesting (Table 2). Although we did no sampling of the area's vegetation it did seem that tree species were used in about the same proportions that they occurred in the landscape. Thus, *Faidherbia albida* was the commonest tree all over; there were many palms particularly in the bend of the river; the Neem had been planted throughout; etc. Sixteen nests were built in an *F. albida*-Neem 'pair' – this

was where one tree of each species were growing up together, and the *F. albida* became surrounded by the Neem's thick foliage. Only four species of tree (including the 'pairs') hosted no less than 92% of the nests, and the *F. albida* alone (again including the 'pairs') had 58%, in spite of the local people's demands on this species as browse for their livestock. Thirteen trees had two nests each in them, but in only one of these were there two pairs of vultures nesting simultaneously; this was in a *F. albida*. The two nests were about 6 m apart.

We crudely estimated the heights (initially and surprisingly in feet, then converted them to metres by x 0.308) of the nests above ground level in most of the trees (Table 3). Regretfully, we did not also estimate the full height of the trees. Taking all the trees together the average height of nests was 8.1 m, range 3.1- 20 m. The lowest nests, at 3.1 m (initially measured as 10 ft), were very low and easily accessible to humans; it seemed that nobody wanted to gain access to these nests, except us. In addition, a very few nests were in dead and therefore bare trees, and very conspicuous. Again, they seemed to us to survive undisturbed. As expected the nests in palms and mahoganies were on average much the highest, at about an average of 11 m above ground. Both *Ziziphus* and *Balanites* are short trees, and in them the nests averaged 5.7 m in height above ground. The third, and interesting, point is that nests in the *F. albida*-Neem 'pair' at an average height of 5.1 m, were significantly lower than in either the *F. albida* or Neem by themselves (*t*-tests, $P< 0.01$ and $P< 0.05$ respectively). We estimated every height, and none was actually measured, so the decimal points in the metres probably gives a rather spurious sense of precision.

One pair of vultures had its nest in a tall Mahogany at 8 m below a nest of Black (Yellow-billed) Kites *Milvus aegyptius*; both species bred successfully. A second pair nested at 3 m from a kites' nest, and also successfully raised a chick. This conjunction has been noted before (Boughton-Leigh 1932). At another nest, in an Acacia, where the vultures occupied but did not breed, a pair of White-faced Owls *Otus leucotis* hollowed out a space for themselves in the base and laid two eggs. A few pairs of vultures used what originally may have been nests of Pied Crows in that the nests were very small; we saw no interactions between the two species at nests, though occasionally a crow or crows 'mobbed' a vulture at a perch or in flight. Nearly all the nesting trees we found are located on a sketch map of the town and its environs in Figure 1; there are 276 trees marked here. The positions of each tree are the best we could manage, as there was no GPS in those days. Very few trees (only ten) were situated actually in the urban area; i.e. where the space is almost fully occupied by 'compounds' and businesses. One such is shown here (Plate 5), being inside the wall of the family's compound. Not many more (23) are in suburban areas. The great majority of nesting trees are located in 'bush' areas which are mostly cultivated fields with scattered trees. A particular concentration (45) was found in the palm grove in the bend of the Sokoto river on the north side of the road (Figure 1). In fact 279 nesting trees were located in January 1970 to March 1972; 40 more were found in June 1972 to March 1973; and eight old nests were found in 1971/72. These produced the total shown in Table 2.

The inter-nest (= inter-tree) distances were measured for 264 nests (= trees) to their nearest neighbours. The two nests at 6 m apart in one tree were excluded. The average distance between trees used for nesting was 130 m (sd ± 98 m), range 25-590 m. Figure 1 indicates that there was no truly 'lone' nest, all nests were clumped to a greater or lesser extent, and fairly well surrounded the town. Unfortunately, we did not make a detailed study of the nests, nor did we measure them. Suffice to say that they are sturdily built of sticks and placed in a big crutch, well below the crown of the tree. In a

well-foliaged tree a Hooded Vultures' nest is difficult to find. Much dry grass is swirled around in the cup, and many green leaves of *F. albida* and Neem in particular were used for lining; the vultures brought green leaves to their nests throughout the breeding period it seemed. Some human rubbish was also used as a lining in many nests, e.g. clothes, plastic bags, cardboard, old paper. Sometimes we noticed both partners at a nest bringing nesting material, such as sticks from the ground, but made no study of this aspect either. One nest was noteworthy for its "huge" construction with a "great mass" of sticks. It was not flattened into a cup but an egg was laid into it; the egg eventually fell out but became lodged below in the nest material. Another noteworthy nest had sticks being laid on the branch for another 1.5 m (5ft).

**Table 2:** Tree species used for nesting by Hooded Vultures in and around Sokoto, 1970-1973.

| Common name | Scientific name | Number of trees used |
|---|---|---|
| Winterthorn | *Faidherbia (formerly Acacia) albida* | 172 |
| Borassus Palm | *Borassus aethiopum* | 46 |
| Neem | *Azadirachta indica* | 41 |
| Mahogany | *Khaya senegalensis* | 25 |
| Winterthorn/ Neem pair | | 16 |
| Baobab | *Adansonia digitata* | 8 |
| Buffalo thorn/ Jujube | *Ziziphus* sp. | 7 |
| Desert Date | *Balanites aegyptiaca* | 4 |
| White Stinkwood | *Celtis integrifolia* | 2 |
| Black Plum | *Vitex doniana* | 1 |
| Silk Cotton | *Ceiba pentandra* | 1 |
| Tamarind | *Tamarindus indica* | 1 |
| Unidentified / not documented | | 3 |
| | **Total:** | **327** |

**Table 3:** Heights (m) of Hooded Vulture nests in trees of various species in and around Sokoto.

| Tree species | Number sampled | Mean average height of nest (m) | Standard deviation | Range |
|---|---|---|---|---|
| *F. albida* | 165 | 7.6 | (2.91) | 3.1 - 15.4 |
| *B. aethiopum* | 45 | 11.2 | (1.21) | 7.7 - 13.9 |
| *Az. indica* | 40 | 6.8 | (2.99) | 3.1 - 16.9 |
| *K. senegalensis* | 22 | 10.8 | (3.76) | 6.2 - 20.0 |
| *Acacia/ Neem* | 14 | 5.1 | (1.07) | 3.7 - 7.7 |
| *Ad. digitata* | 7 | 7.1 | (3.49) | 3.1 - 13.9 |
| *Ziziphus* | 7 | 5.8 | (2.37) | 3.7 - 10.8 |
| *B. aegyptiaca* | 4 | 5.6 | (0.73) | 4.6 - 6.2 |
| *Celtis integrifolia* | 2 | 7.2 | - | 3.7 - 10.8 |
| **Total:** | **306** | **8.1** | **(3.21)** | |

**Plate 5:** Hooded Vulture nest tree inside an urban compound.

***Intra- and inter-specific interactions:***

On two occasions we saw Hooded Vultures in serious disputes with each other. On 14 January 1972, three were involved in a fight in the middle of an old cultivated field (Plate 6a). Two of these – an adult and an immature – were grappling together on the ground for two or three minutes; the immature was leaning backwards on its 'haunches' and had its wings partly outspread. The third bird – another adult – was close by and watching the conflict. Soon the assailants were flying but still attacking each other. When one perched at the top of an Acacia tree the other swooped down and knocked it out, twice. On another occasion (date not recorded) an adult and an immature were in serious combat beside a dirt road, both on their 'haunches' and with wings partly outspread (Plate 6b).

We considered neither of these fights to be territorial disputes. Instead, they presumably had something to do with a dominance hierarchy. Many times, we saw one bird being attacked by another, usually when one was perched in a tree, sometimes one bird advanced on another on the ground, causing it to retreat. Regretfully we did not pay attention to the ages of the vultures. On occasions we saw birds attacking each other while in flight. For example, on 27 October 1971, two vultures flew round and round for some minutes, with one frequently attempting to clutch at the back of the other with its claws. The pursued bird always took evasive action. Finally the two separated and went their different ways. If these disputes involved adults then perhaps they are concerned with territoriality. Several times we saw one of the nesting birds chase another bird out of its tree, sometimes adults, sometimes immatures. Otherwise there were no other overt indications of 'ownership', and we therefore suppose that with these Hooded Vultures at Sokoto the nesting territory was confined to the nesting tree itself.

Hooded Vultures were often in disputes with Pied Crows, usually being harassed by them. It was easy for a crow to disturb a vulture from its perch in a tree by alighting on top of the larger bird; crows are very agile in the air compared to vultures. This amounted to the vulture being 'mobbed'. Occasionally vultures chased crows; one nesting adult pursued crows throughout ten minutes whilst it waited for us to leave its nest. At a nest where the chick had just fledged and was seen perched in the next tree, there was at the same time a Pied Crow actually standing in the nest; it aroused no response.

At one nest on 1 February 1971, the adult vulture did not leave the tree while we examined the hatching chick. No less than 25 crows and two Yellow-billed Kites arrived and flew around for five minutes calling noisily; it seemed that they were mobbing us rather than the parent bird. In fact crows were often attracted to us when we climbed trees to examine nests. Hooded Vultures rarely interacted with kites, though the kites would harass them at carcasses.

***Copulations:***

Copulations between Hooded Vultures were seen (and heard) several times, always between adults. The male needed to balance himself on the back of the female for up to many (~20) seconds before success was achieved. One or both partners emitted a shrill but soft whistling sound during the performance, and when the male jumped off the female's back she usually pecked at him. We saw copulations in nesting trees, in other trees, and occasionally on the tin roofs of houses. We never recorded a copulation on the ground. A couple of times we heard (then saw) two adult vultures perched on a branch together and one or both whistling, but no copulation. By contrast, allo-preening between two adults was often seen, being what looked like a gentle nibbling by one bird on the other's neck and ruff. Sometimes it was reciprocated (see Whyte 2007). We never recorded allo-preening between black-cowled juveniles.

**Plate 6:** Left: Three Hooded Vultures fighting in a cultivated field. Right: Two Hooded Vultures fighting at the roadside.

***Egg-laying dates and egg measurements:***

Egg-laying dates were estimated, some more precisely than others, in the three seasons separately (Table 4). The average dates for the seasons were: 31 December 1970, 15 December 1971, and 5 December 1972. For the few replacement eggs (laid after the first eggs were lost) the average dates were: 22 February 1971, 23 February 1972, and 6 February 1973. Overall, with all years combined, the average date of laying of 150 first eggs was 15 December, and of 26 replacement eggs was 17 February (Figure 2). However, this combination masks that egg-laying dates in the first two seasons (1970/71 and 1971/72) were significantly later than in 1972/73 (*t*-test, $P < 0.01$). Table 4 shows the egg-laying season of the Hooded Vulture at Sokoto in the years 1970 to 1972. Birds are 'aiming' to lay by end-December, and indeed over the three years 77% had achieved that. In fact, 50% of the pairs had laid by 9 December. Nevertheless, the overall length of the egg-laying season for first-laid eggs was rather long – estimated 16 October (1972) to 20 February (1972) or a period of just over four months. When replacement eggs are included, then the period extends to 2 April (1972) or five-and-one-half months. Early nest building was noticed by four pairs on 1 October 1971.

All the clutches of the Hooded Vulture that we examined were of one egg only (n=143). Serle (1943) reports the same (n=64), as does Daboné *et al.* (2019) (n=64). At one nest over three seasons we estimated the egg-laying dates at 8 December 1970, 17 December 1971, and 2 December 1972. No other nest produced such a circannual rhythm.

Two anomalies must be mentioned here. First, on 22 January 1931, in SW Nigeria, Ronald Shuel found a clutch of two eggs "obviously the work of the same bird" (Boughton-Leigh 1932); this is still the only genuine two-egg clutch so far recorded. Secondly, E.M. Cawkell reported on 200 clutches of "Hooded Vulture" that had been in "Walton's collection"; he stated that the "clutch is two" and that egg laying was in November to March (Cawkell & Moreau 1963: 177). The nesting period is correct (see our Table 4), but the 200 clutches are from the Yellow-billed Kite surely? As yet we have not located this collection in order to check our suggestion (kites' eggs are much smaller), but we certainly deem the identification to be wrong.

**Table 4:** Estimated egg-laying dates by Hooded Vultures at Sokoto in each of three seasons. Replacement eggs are separately indicated (R).

| Month | 1970/71 | 1971/72 | 1972/73 | Totals |
|---|---|---|---|---|
| October | | | 1 | 1 |
| November | 2 | 26 | 15 | 43 |
| December | 9 | 46 (1R) | 16 | 71 (1R) |
| January | 7 | 17 (1R) | 4 (2R) | 28 (3R) |
| February | 3 (3R) | 4 (4R) | (7R) | 7 (14R) |
| March | (1R) | (6R) | | (7 R) |
| April | | (1R) | | (1 R) |
| *Totals:* | *21 (4R)* | *93 (13R)* | *36 (9R)* | *150 (26R)* |


**Figure 2**: Overall egg-laying dates, first laid eggs and replacements after failures for the sample of surveyed Hooded Vulture nests.

All the eggs, except four, had both a 'blunt' end and a 'pointed' end; both ends were blunt in two eggs, and both ends were pointed in another two. From 96 eggs that were colour coded, the majority (60) were spotted or splotched with reddish-brown at the blunt end, or were marked all over but more heavily so at the blunt end. By contrast only seven were spotted/splotched at the pointed end. Nine were coloured all over, usually in reddish-brown, occasionally purplish. Sixteen of this sample of eggs were white. Two eggs were slightly glossy.

The average sizes of all eggs that were measured (143) were: length (L) 72.3 mm (sd ± 3.65) and breadth (B) 53.9 mm (sd ± 1.92); the size ranges were: length 64.0 – 84.0 mm, breadth 48.0 – 60.0 mm. There were no differences between first-laid eggs (122) and replacement eggs (17) in length (*t*-test, P= 0.1) or breadth (P= 0.7). The largest eggs were found in the same nest: 82 x 59 mm in December 1971 and 82 x 60 mm in December 1972. The late William Serle collected 13 eggs at Sokoto in March and April 1939 (*in litt*.); average sizes were 71.0 mm (sd ± 1.69) in length and 54.2 mm (sd ± 2.13) in breadth. In five nests we measured the eggs in all three seasons (Table 5); in four of them (excepting no. 42) the sizes suggest that the same females were laying in all three years.

Fifteen eggs were found fresh, i.e. within two days of being laid. Their average weight was 107.3 g (sd ± 11.99), range 74 – 130 g. The egg size was taken as $LB^2$ and the egg weight was regressed against it; there was of course a significant correlation, r= 0.938, P< 0.001. Using this regression formula, the two largest eggs mentioned above had calculated weights of 154.2 and 159.7g respectively. The earlier one was actually weighed at 157g. Again, following the formula, the average fresh egg weight of all first-laid eggs (122) was calculated as 113.1 g (sd ± 11.81), range 88 – 160 g. This average egg weight is 6.7% of the average adult body weight (from Table 6).

We examined 21 pairs of eggs, being the original first eggs that were then lost, followed by the replacement second eggs. Maximum and minimum intervals in days were estimated between losing the first egg and laying the replacement egg. The average delay was then adopted. Six of these 21 nests gave good estimates, i.e. the difference between maximum and minimum delays was ten days or less. Thus the overall average delay was 32.5 days (sd ± 7.15), range 21 – 43 days. Twelve more nests provided less precise estimates, their overall average delay being 37.7 days (sd ± 9.61), range 28 – 60 days.

Fertile eggs are known to lose weight during incubation; 30 were weighed at least twice some time during this period. Each fertile egg's loss in weight was converted to a percentage loss and then regressed against the period within the incubation (Figure 3). The correlation was highly significant, r= - 0.838, P< 0.001. From the regression formula, a fertile egg will lose 17.7% of its initial weight during the incubation period of 51 days. Eighteen eggs were weighed at first pipping, and the newly hatched chick was then weighed. At this time the average loss in weight from fertile (pipping) egg to newly hatched chick was 18.06 g (sd ± 3.95), range 10 – 23 g. The average eggshell weight is 9.23 g, range 8.1 – 11.1g (Schönwetter 1967).

In view of the remarks by Serle (1943: 279) that "relatively large number of embryo deaths … may be due to the bitterly cold nights during the mid-winter months", we took temperatures at two nests each with an egg. One was at 3.4 m height in a *Faidherbia albida* and considered to be 'exposed'; the egg was laid on 28 January 1972, and the thermometers were put in place on 27 February. The egg was fertile but disappeared after 15 March. Meantime we had collected readings from 29 February to 15 March (Figure 4). The maximum and minimum temperatures in the nest closely matched the ambient, but at 1.1- 5.0 °C higher (actually measured in Fahrenheit, 2 – 9 °F). The

second nest was at 6.2 m height in a Neem tree and was considered to be 'sheltered'. The egg was laid by 6 December 1971 and the thermometers were put in place on 19 December and we collected temperature readings through to 3 February 1972 (Figure 4). The chick hatched on 24 January and survived to fledging. Ambient minimum dropped to 14.4 °C (measured as 55 °F) while ambient maximum in the shade eventually rose to 40 °C (96 °F). Nest minimum was about 12.5 °C (20 °F) higher than ambient, while nest maximum was about 3.8 °C (6 °F) higher. In short, these readings give little credence to Serle's opinion, the pairs in these nests keeping the minima mostly above 26.9 °C (75 °F).

**Table 5:** Lengths and diameters at widest point of eggs (mm) laid in the same Hooded Vulture nests for three consecutive seasons.

| **Nest no.** | **1970/71** | **1971/72** | **1972/73** |
|---|---|---|---|
| 007 | 70 x 55 | 69 x 55 | 69.5 x 54 |
| 11 | 71 x 54 | 78 x 55 | 78.5 x 56 |
| 42 | 73 x 57 | 70 x 53 | 72.5 x 54 |
| 95 | 68 x 52 | 69 x 52 | 69.5 x 53 |
| 140 | 71 x 54 | 70 x 54 | 68.0 x 55 |

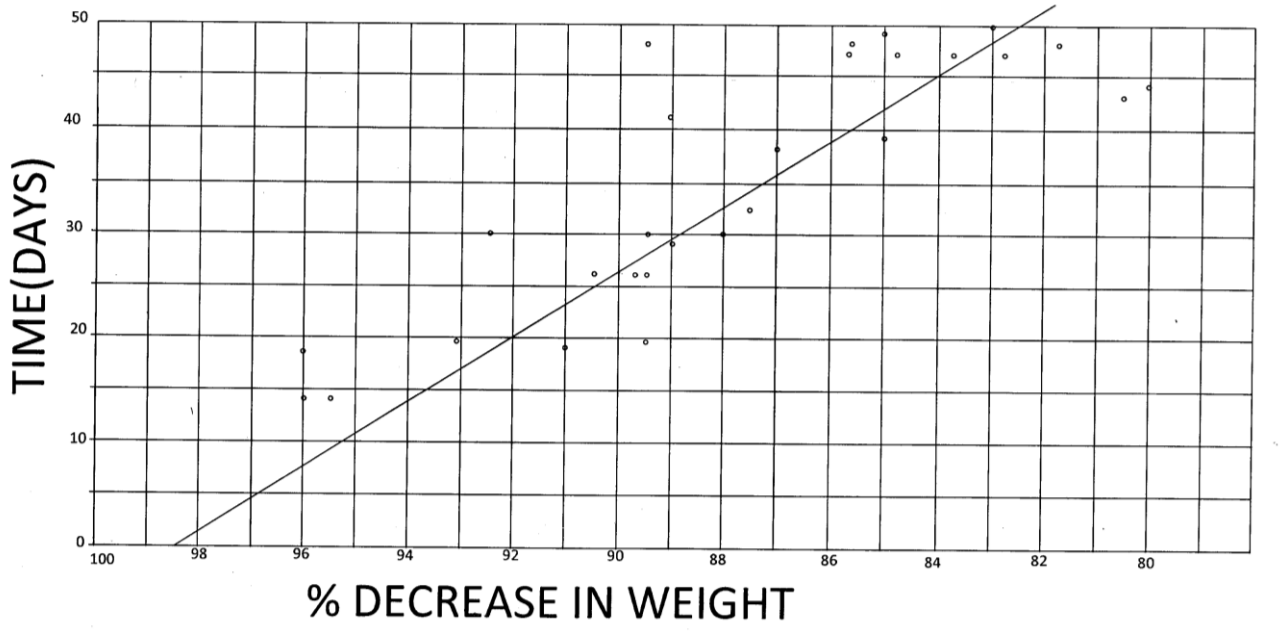


**Figure 3:** Percentage loss in weight of incubated Hooded Vulture eggs through the incubation period.

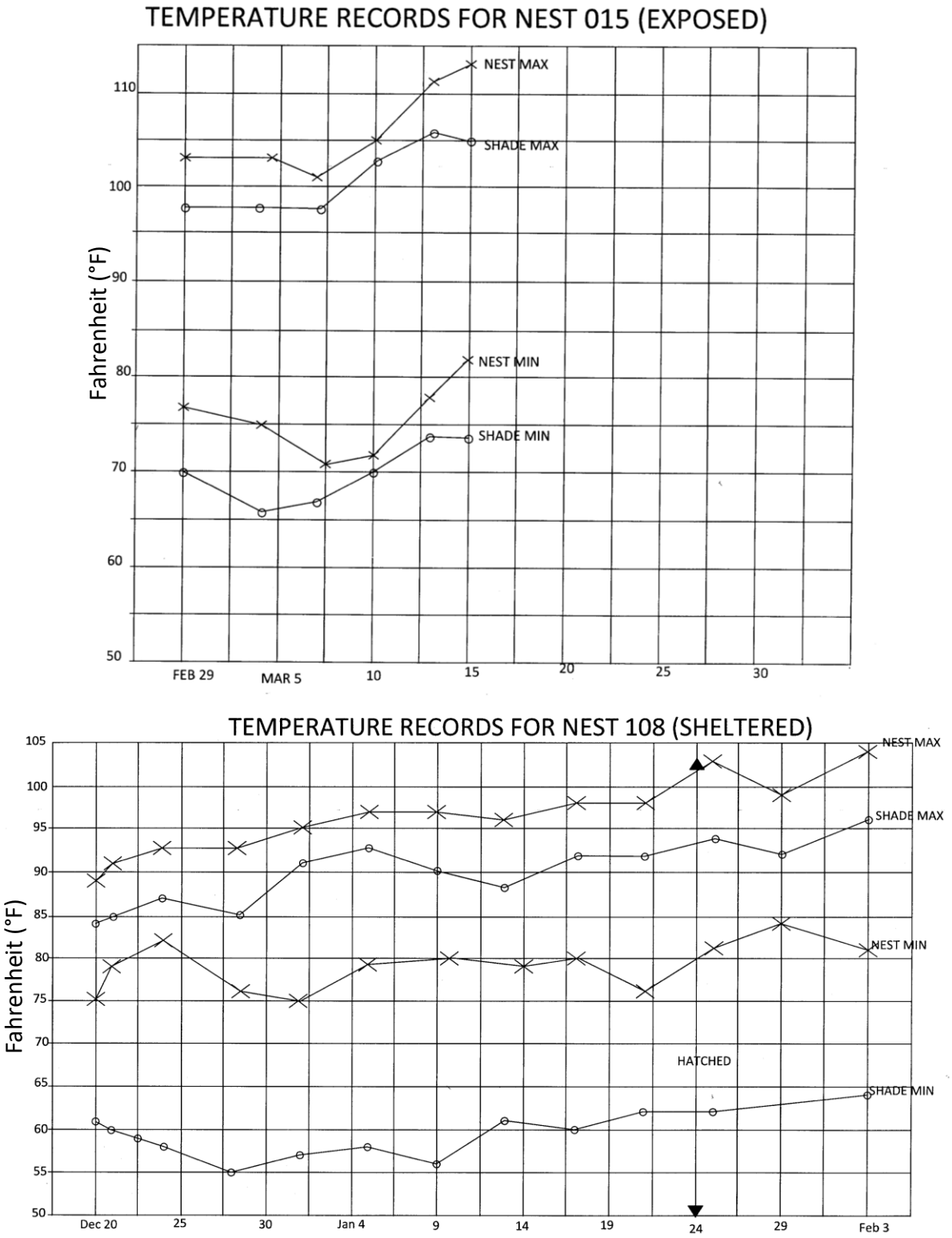


**Figure 4:** Maximum and minimum temperatures recorded at an exposed nest (top) and at a sheltered nest (bottom).

**Table 6:** Measurements of adult Hooded Vultures captured at nests in 1972 and 1973.

| Nest code | Date of visit | Weight (g) | Wing (mm) | Tail length (mm) | Bill length[1] (mm) | Tarsus length (mm) | Cloacal temperature (°C)[2] |
|---|---|---|---|---|---|---|---|
| 101 | 13 Feb 1972 | 1590 | 500 | 240 | 62 | 86 | 38.6 |
| 111 | 13 Feb 1972 | 1930 | 475 | 225 | 61 | 81 | 37.8 |
| 74 | 22 Feb 1972 | 1900 | 462 | 221 | 61 | 86 | 38.9 |
| 135 | 22 Feb 1972 | 1610 | 480 | 235 | 61 | 87 | 39.7 |
| 135 (again) | 5 March 1972 | 1590 | 485 | 230 | 57 | 87 | 38.6 |
| 100 | 19 March 1972 | 1610 | 464 | 223 | 55 | 78 | 38.9 |
| 42 | 27 Feb 1973 | 1730 | 460 | 215 | 52 | 75 | - |
| 11 | 28 April 1973 | 1530 | 470 | 210 | 48 | 73 | - |
| | **Mean averages**: (± sd) | **1686** (± 152) | **474.5** (± 13.6) | **225** (± 10) | **57** (± 5) | **82** (± 6) | **38.8** (± 0.6) |

Notes: 1. Bill measurement included the cere (see Methods).

2. Thermometer readings were in $^0$F, which were then converted to $^0$C by: ($^0$F – 32) x 5/9.

***Incubation and hatching:***

We were able to obtain good estimates of the Hooded Vulture's incubation period from 13 nests. The average period was 51.1 days (sd ± 1.04), range 50 – 54 days. In all these instances the hatching dates were exactly known, but the laying dates were usually estimated during two- to four-day periods. For two further eggs where the chicks died prematurely in shell, the minimum periods were 48 days. Generally, chicks took two days to hatch (n=18). On day 0, the chick can be heard squeaking inside the intact shell. On day 1, the chick pipped the eggshell, which had become a small hole of about 2 cm diameter on day 2. By day 3 the chick had hatched. There were usually fragments of eggshell in nests with small chicks, though we could not determine whether adult or chick tried to eat the eggshell.

***Measurements of adults caught at nests:***

Many nesting adults were 'tame' in that they remained perched in their trees near to the nests as we examined the nest contents. Indeed we were able to capture seven or eight adults a total of eight times – capture seems a strong word, for rather the birds allowed us to pick them up from the nests or from next to the nests. Our measurements of these birds, taken in the manner described earlier, are shown in Table 6. We could not sex them. Routinely we also took the bird's temperature by gently inserting an ordinary clinical thermometer a little more than bulb-deep into its cloaca. The average temperature for five/six different birds was 101.8 °F (sd ± 1.25) (= 38.8 °C). We cannot be sure if the bird at nest 135 was captured twice (the measurements are very similar), or if both partners were in fact captured. The measurements of the first six birds were done by PJM, and the last two by AWC, which might account for the average differences in the bill and tarsus lengths: our method for the bill is not easily reproducible (and was wrong), and the tarsus is difficult to discern clearly in a bird. The averages for these eight northern Nigerian adults are about the same as the measurements listed by Bannerman (1930: 183) for eight adults from the "West Coast". Curiously, the bill measurements are the same, though we did ours 'horizontally' while we expect that Bannerman used the 'chord' method (i.e. from the junction of the cere with the skin of the head diagonally to the tip of the bill). Later, PJM calculated a conversion factor from Hooded Vultures in southern Africa, which gave an average bill length for our Nigerian sample of 30 mm. This is the proper chord

measurement of the maxilla (rhamphotheca) itself. From the accurate drawing in Bannerman (1930: 183), at his stated scale of 9/10, the bill chord is 31 mm. C.S. Roselaar (in Cramp & Simmons 1980: 72), on eight museum specimens from West Africa, measured the following averages: wing 479 mm, tail 219 mm, bill 31 mm, tarsus 83 mm. However, they were half males (av. wing = 474 mm) and half females (av. wing = 484 mm), with no significant difference in this measurement (*t*-test, P>0.1). Note that our method of measuring the tail (see Methods) would produce a slightly longer measurement by a very few mm.

The average cloacal temperature of these eight adults was almost 39 °C. We presumed that the vultures were stressed when we handled them, and therefore the body temperature would be expected to be high. However, it is on the lower side if the usual avian body temperature is 40 ± 2 °C (P.J. Jones in Campbell & Lack 1985: 279).

***Growth of nestlings:***

*Weight change:* Eighteen newly-hatched chicks weighed on average 76.9 g (sd ± 10.21), range 60-94 g. Their eyes were watery and weakly open, and they were covered in a sparse brown down. In 1970/71, 12 nestlings were monitored, 18 were so in 1971/72, and finally 14 in the 1972/73 breeding season. We expected the growth in weight to be different in their growth curves year by year, as this parameter must be dependent on the environment pertaining in that year, i.e. the amount of food available. The supplies at the abattoir, however, and thence at the market at Sokoto, presumably 'dampen' the impact of annual fluctuations. In addition, it seemed that human faeces were a common and favourite food. Thus in 1970/71 weight gain was virtually a straight line increase up to 1500g at the age of 70 days, at 21.4g per day increase. Similarly in 1971/72, a weight of 1550g was achieved by 70 days of age. The curve for 1972/73 was fast until 50 days (1360g) and the increase then stopped, so that by 70 days of age the average weight was still only 1390g. These curves are similar enough that we have added them together for the composite and average curve shown in Figure 5, for 44 nestlings over the three seasons. This curve is rather more of a sigmoid shape, nevertheless again the maximum weight of 1460g average was reached at 70 days of age. For the final 40 days or so until fledging the average weight of these older nestlings held steady at about 1430g, or about 85% of the adult's average weight (from Table 6).

In order to plot these growth curves, and for the subsequent curves, we used the following method. The initial age of each nestling was first estimated, some more accurately than others especially if we knew the hatching dates. Ages and sizes were then grouped into 10-day increments except for the hatchlings which were placed into a 0–5 day age grouping; thereafter 6-15, 16-25 days, and so on. Within the groups, an average could be calculated from the sample of measurements, therefore also ± s.d. (white box) and S.E.mean (black box), and the range of sizes. All these values are then plotted at 10-day intervals, as shown in Figure 5 etc.

Using a slightly larger sample of 23 nestlings in the 1971/1972 breeding season, we have plotted their growth curves in weight by actual date in Figure 6. As it happened, they all hatched in 1972, from very early in January through to about mid-May; nevertheless 15 of them hatched within a 32-day period. Whatever the calendar date, from January through to June and into early July, the increases in growth were all very similar, indicating a low effect from the season (or parents). We measured nestlings in three nests (our numbers 007, 11, 42) in all three seasons 1970/71 through to 1972/3. These nine growth curves are shown in Figure 7, by actual date. Again they followed very similar increases, indicating perhaps that parents were equally adept at all three nests in all three seasons at finding food.

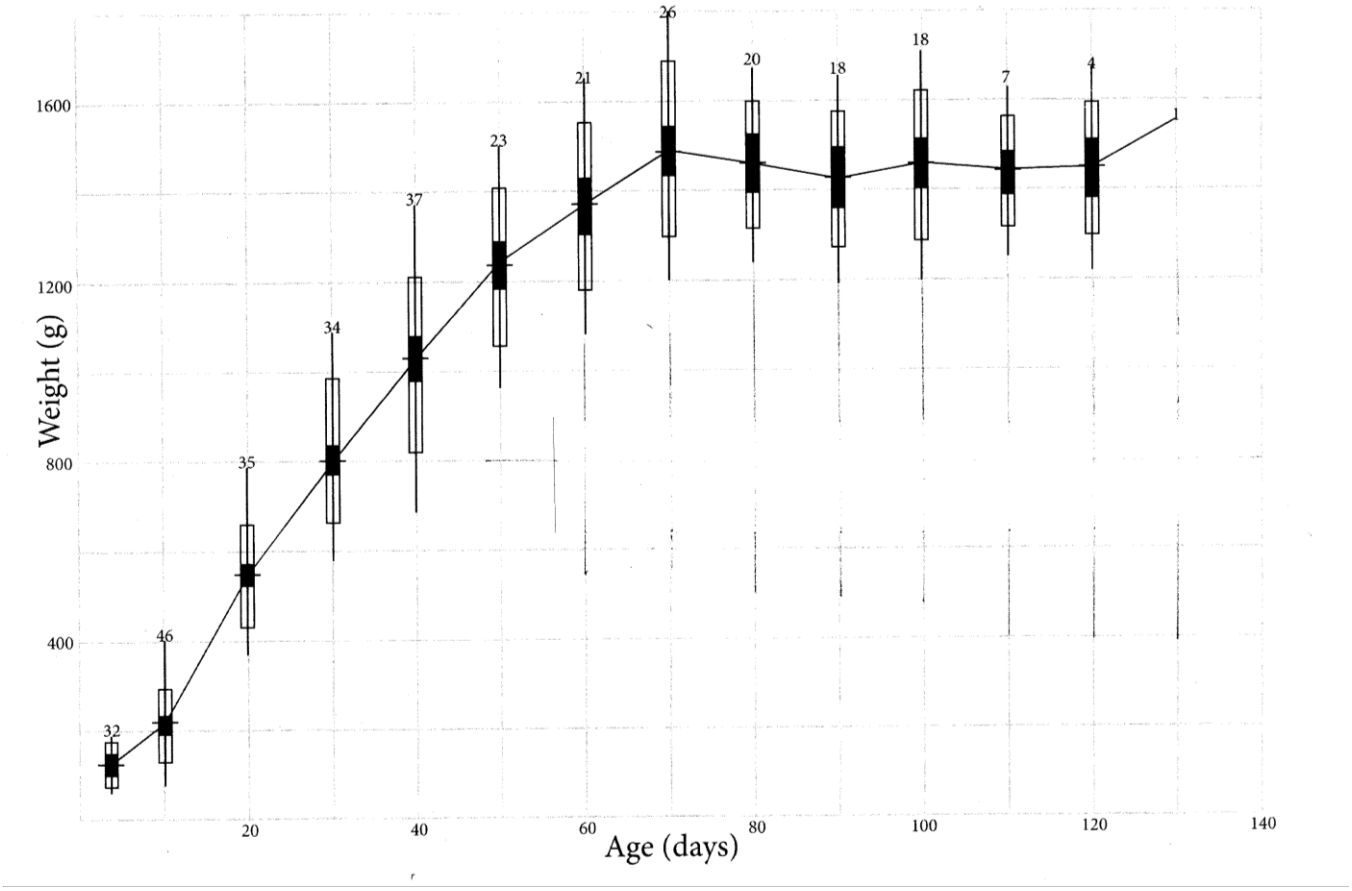


**Figure 5:** Composite growth in weight of Hooded Vulture nestlings from all three survey years (n=44).

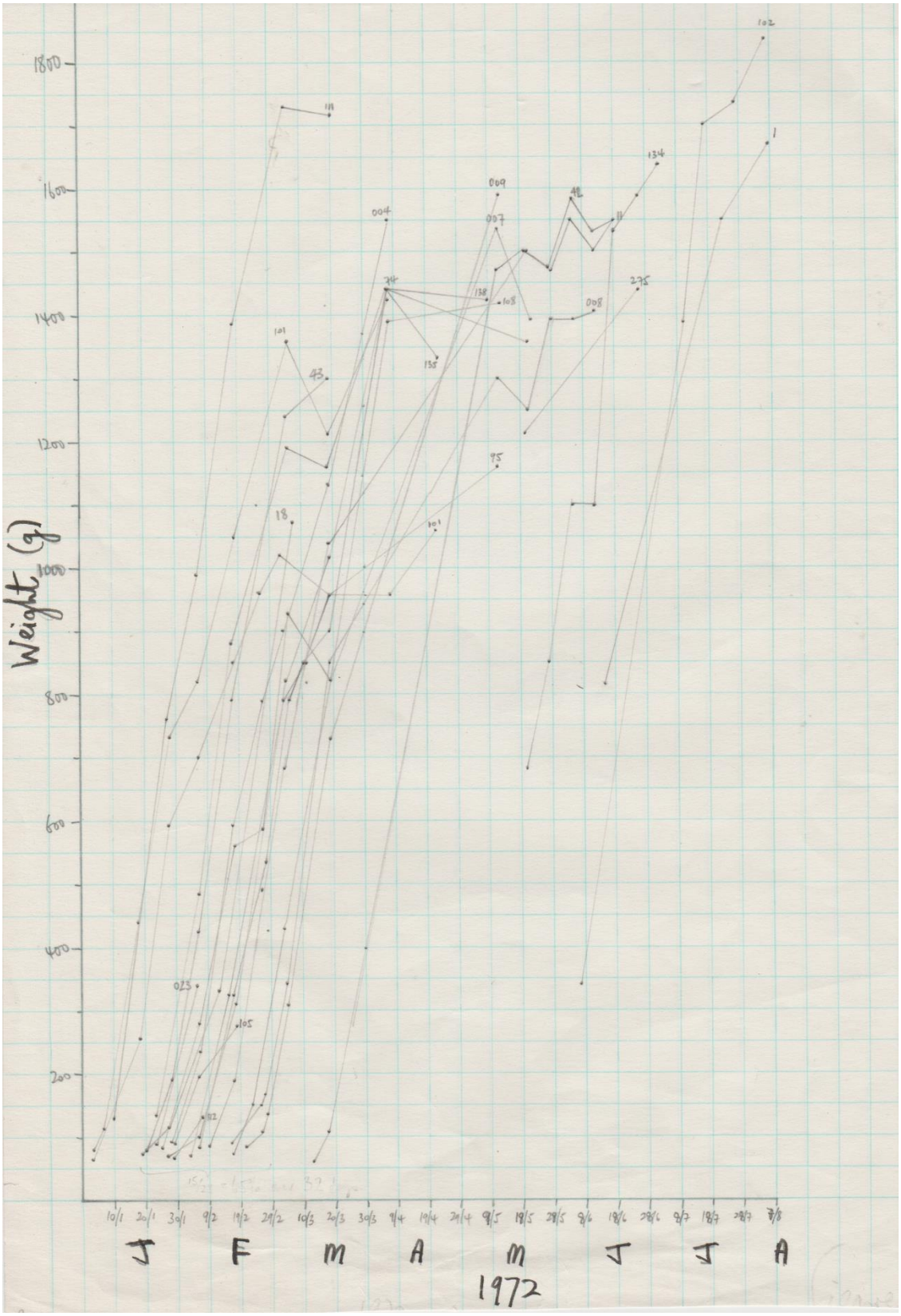


**Figure 6:** Hooded Vulture nestling **g**rowth in weight by date, 1971/1972 (n=23). Numbers annotated on the graph indicate nest numbers; letters along the horizontal axis indicate months.

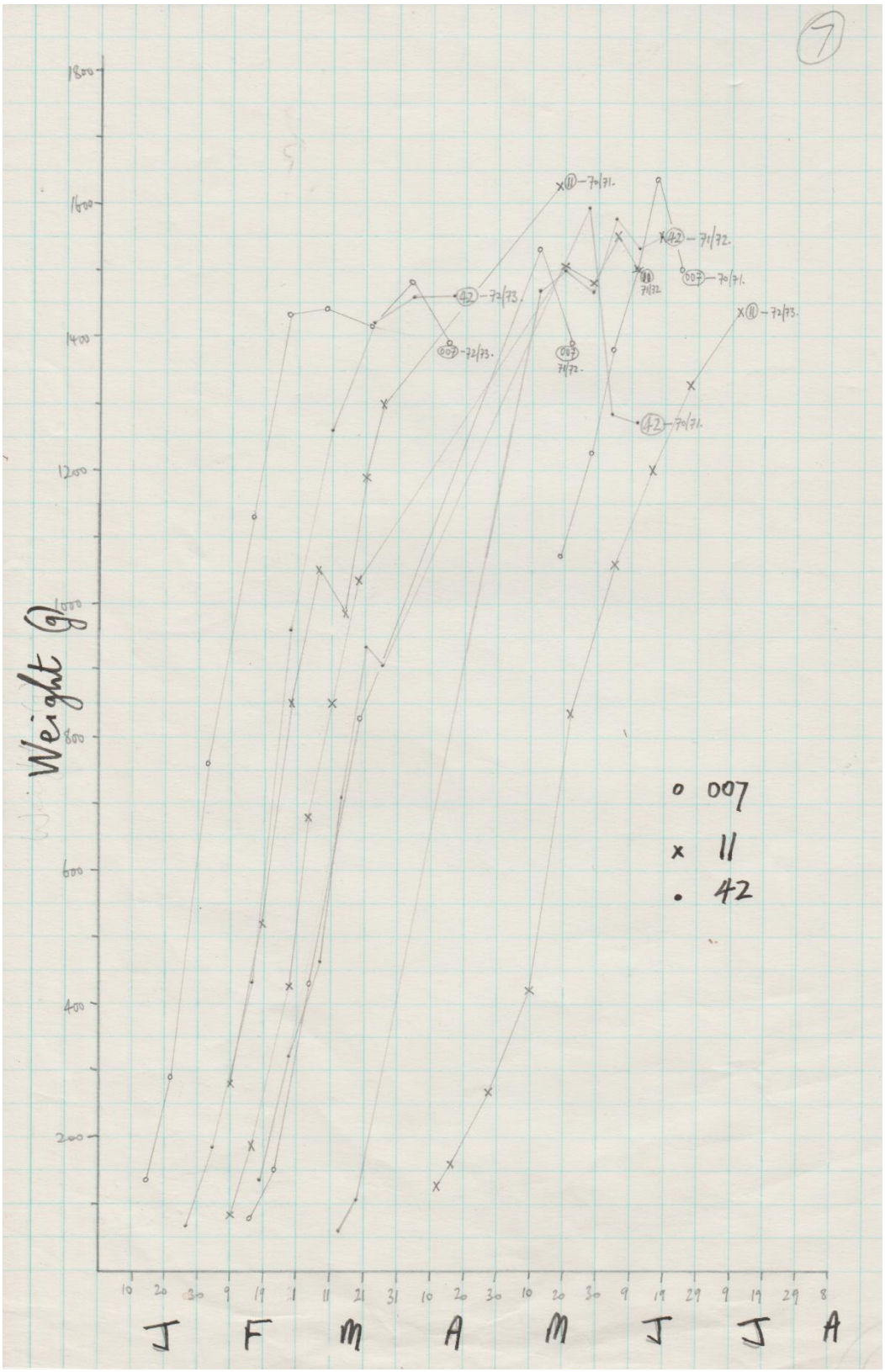


**Figure 7:** Hooded Vulture nestling weights by date across each of three survey seasons. Numbers annotated on the graph indicate nest numbers; letters along the horizontal axis indicate months.

*Wing growth:* We measured linear parameters in only two seasons, 1971/72 and 1972/73, totalling 32 nestlings. Each follows a sigmoid (logistic) shape, and the two are very similar. They are added together for a composite and average curve, shown in Figure 8. The straight line section of the curve is from an age of 30 days to 90 days; in this time period the wing (= mostly primary feather) grows at an average of 5.2 mm per day, from 96 mm to 410 mm. By 120 days of age the nestling's wing length is at 96% of the adult's. One chick of wing length 430 mm (age about 110 days, nest 007) would move several metres along a large horizontal branch at our approach.

A method of transforming the sigmoid shape of the growth in wing length to a straight line was presented by Ricklefs (1967). The growth of 32 nestlings according to this transformation is shown in Figure 9. The line very closely follows an asymptote of 455 mm, which in fact is 96% of the adult average of 475 mm. The equation for the line is: y= 21.6 + 1.4553x. The constant K ("proportional to the specific rate of growth", i.e. 1.4553/100 x 4) is 0.0582 per day. The time interval for growth from 10% to 90% of the asymptote was 75.5 days.

By comparison with the average growth in weight (Figure 5), the average growth in wing length (Figure 8) has less scatter around the line itself. Considering also that the wing grows throughout the lifespan of the nestling, then the wing length is a less variable and therefore better means of ageing young birds. This was also noted later for vultures in southern Africa (Mundy 1982: 138). In Figure 10 we have graphed the average growth in weight over three seasons (n= 44 chicks) against the average growth in wing length over two seasons (n= 32). Wing length of course is almost entirely length of the growing primary feathers. Given that the wing grows at a standard and very uniform (between chicks) rate over 120 days, Figure 10 indicates that weight also increases in a standard way. This is surprising given the number of chicks and three different seasons. It shows that weight gain levels off at a wing length of about 300 mm (= about 70 days of age), as noted above. The chick is presumably now using more of its food supply in extra behavioural activity, for example moving around and flapping its wings.

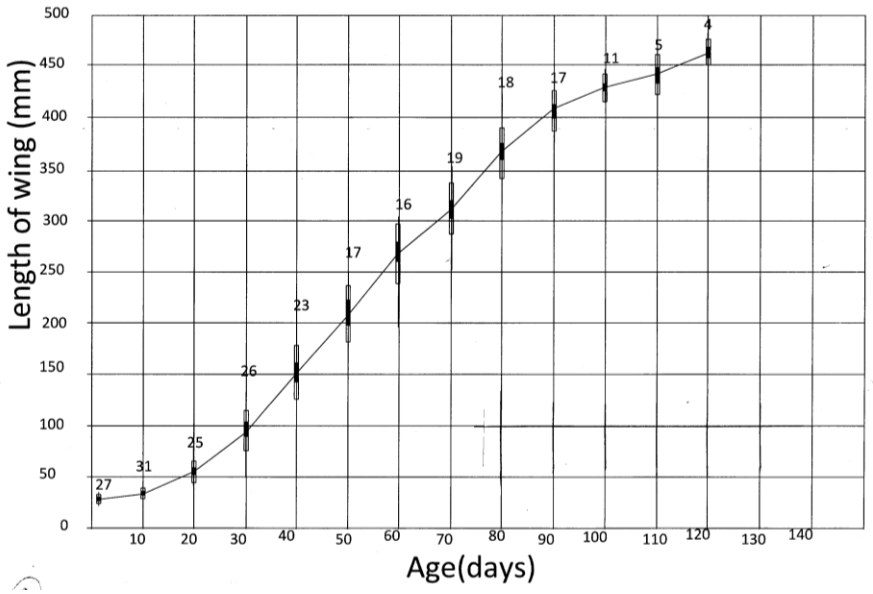


**Figure 8:** Composite growth in wing length of Hooded Vulture nestlings (n=32).

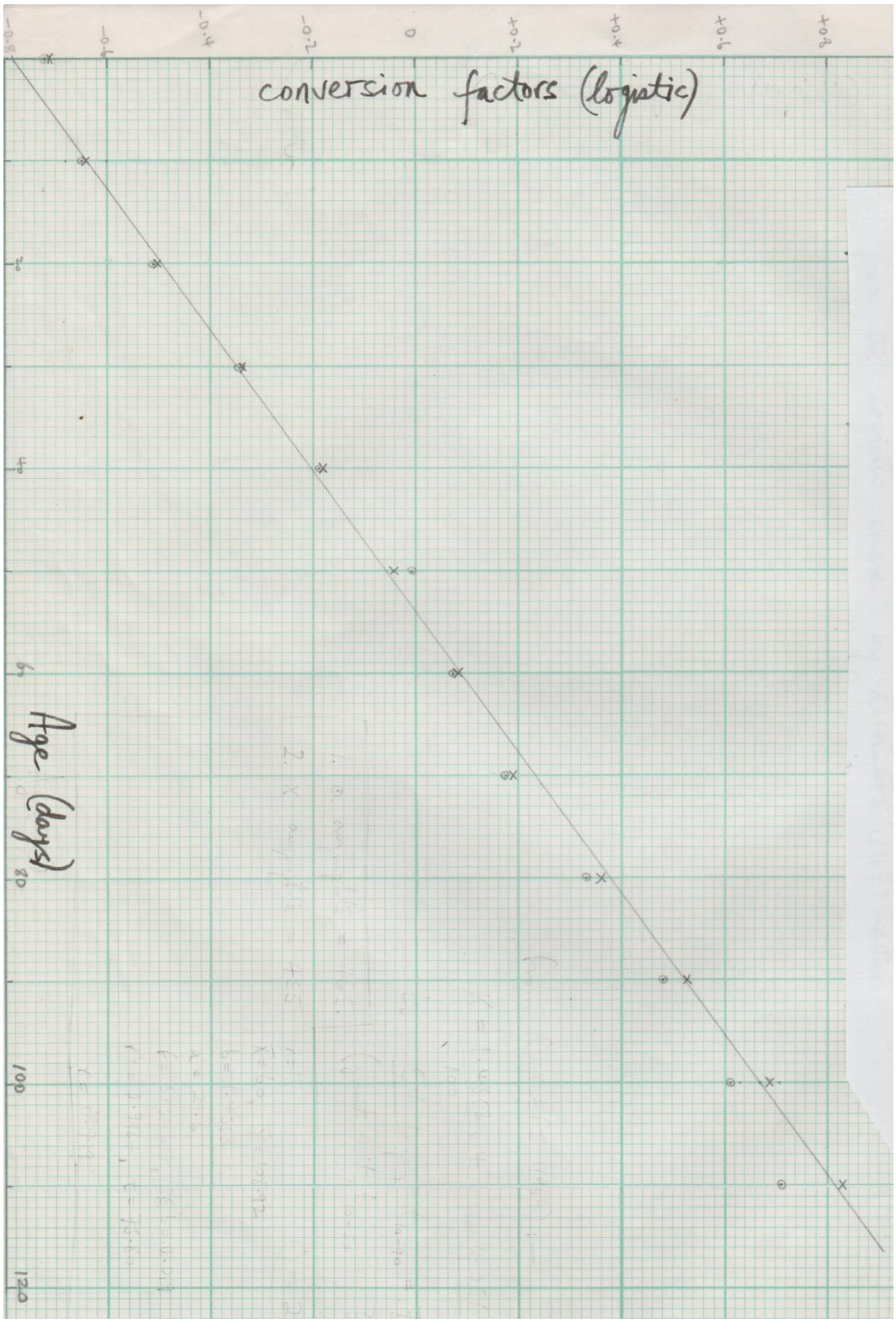


**Figure 9:** Ricklefs (1967) method of graphing wing growth of Hooded Vultures by age (refer to results section for explanation of method).

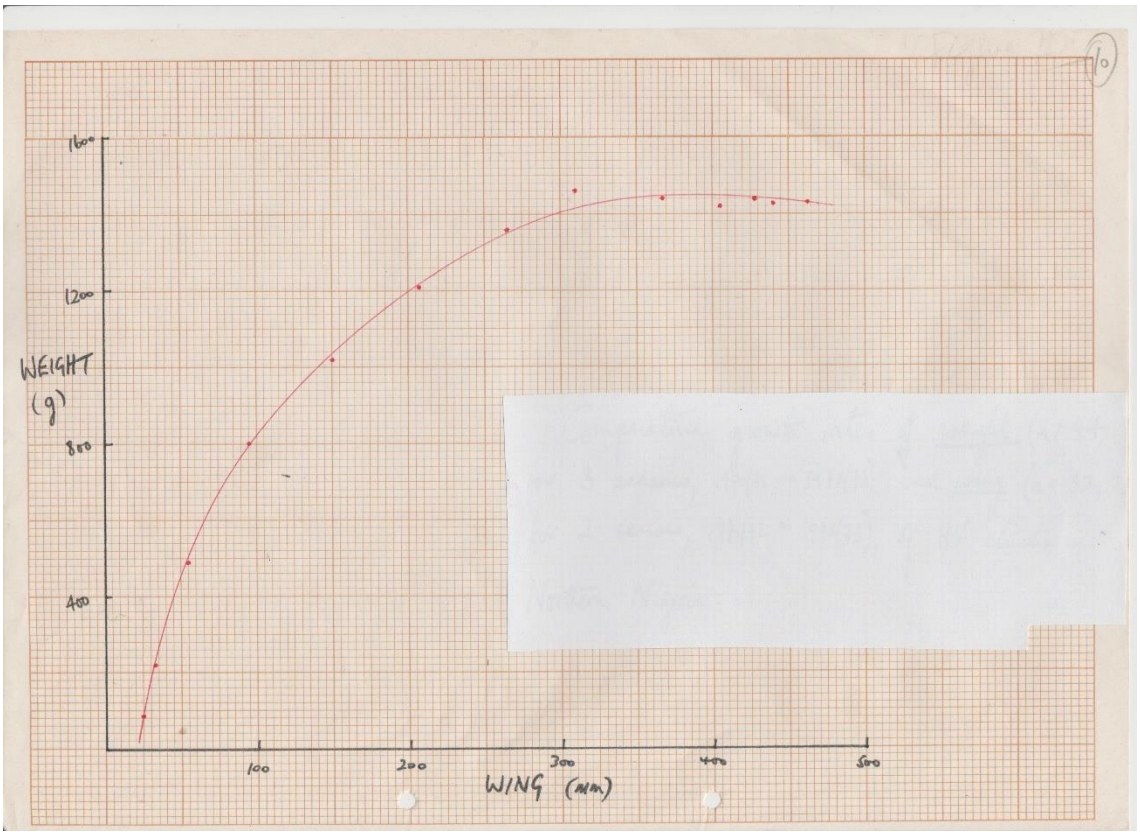


**Figure 10:** The relationship between weights and wing lengths of Hooded Vulture nestlings.

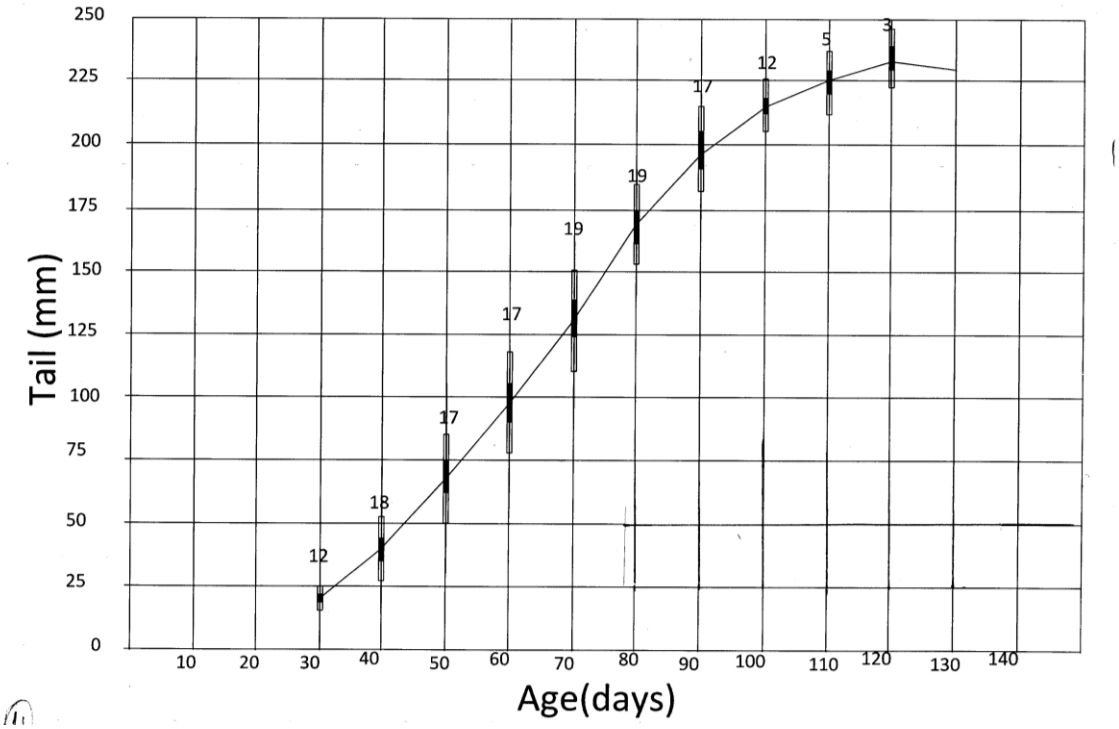


**Figure 11:** Composite growth in tail length of nestling Hooded Vultures, 1971/1972 and 1972/1973 (n=30).

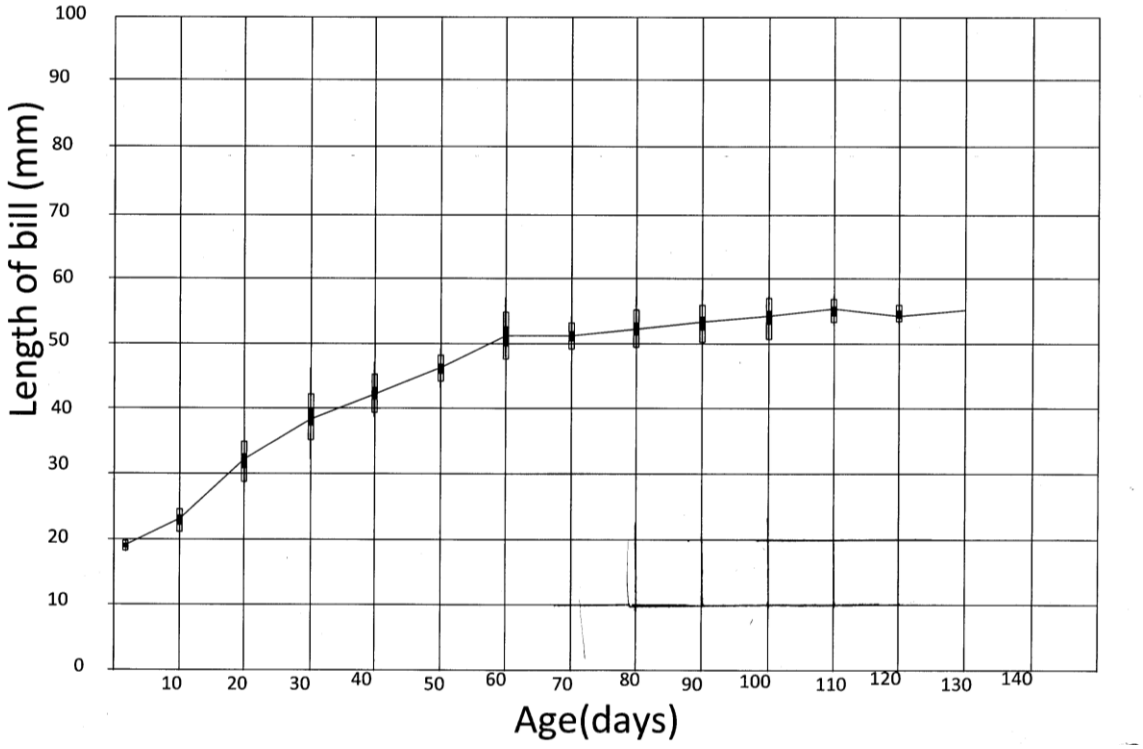


**Figure 12:** Bill growth in nestling Hooded Vultures, 1971/1972 (n=18).

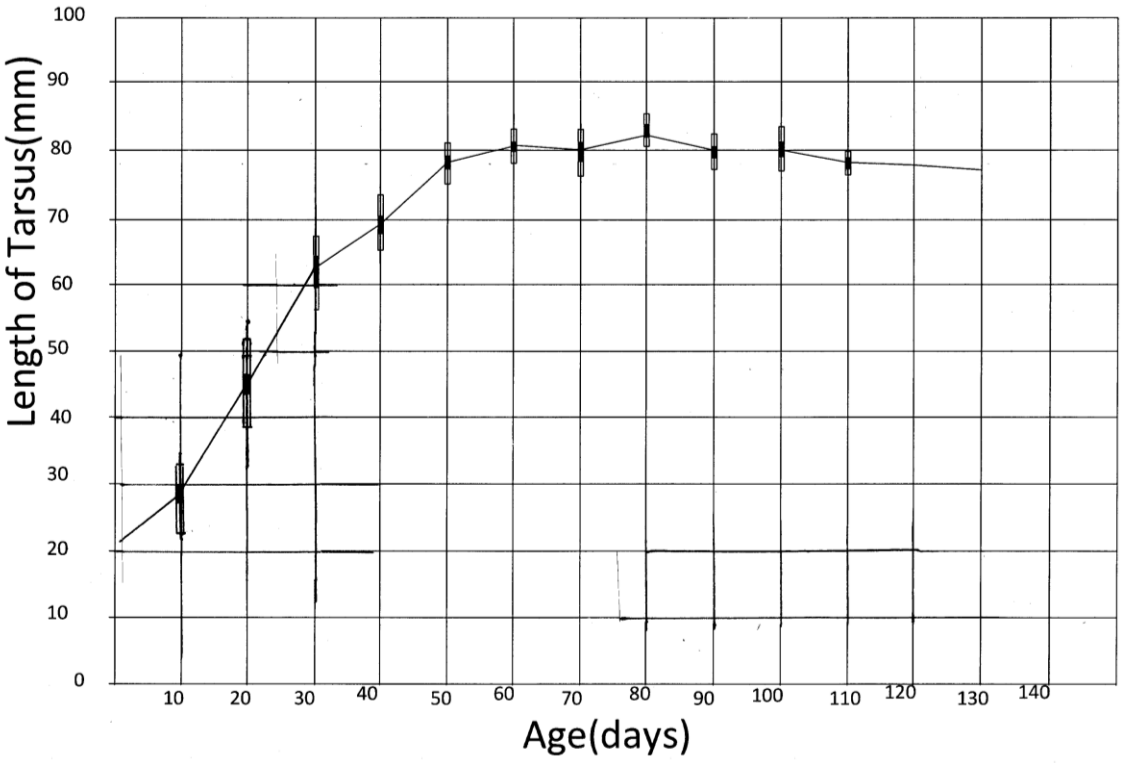


**Figure 13:** Growth in tarsus length of nestling Hooded Vultures, 1971/1972 (n=18).

*Tail, bill and tarsus growth:* the composite increase in growth in the tail of 30 nestlings is shown in Figure 11. Again a sigmoid curve is indicated, with a straight line in growth between days 40 and 90 in age. During this period the tail grew at an average of 3.4 mm per day. The rectrices of the tail were first noticed around day 26 or so, and the adult's average length had been reached by day 110. We also have growth increases for bill and tarsus (Figures 12 and13). Suffice to say that both reached their asymptotes at a much earlier age, by an average of 60 days.

***Behaviour at nests:***

There was always an adult present at the nest when we visited, lying in it and brooding when the nestling was small and downy. As it aged and became feathered, then the adult stood on the nest edge or on a branch to the side. Very occasionally both adults were at the nest. Adults also sleep on the nests at night time (n= 3) (Josh Taylor *in litt*.).

Adults fed chicks by regurgitation, beak to beak. Almost all feedings were done at or in the nest itself; a very few times we saw a large nestling or fledgling being fed in the tree but close to the nest. In one tree the chick had fallen out of the nest to a fork 70 cm below, in which position it was being fed. We never saw a youngster being fed in a nearby tree, or on the ground. Large nestlings begged at an adult by crouching low in the nest, head very low, partly opening their wings, and shaking all over. At the same time the youngster 'whistled', usually in a muted voice, sometimes 'urgently'. Most nests with a large chick were full of small clean bones as though they had been swallowed then regurgitated. Unfortunately we paid little attention to these bones (and calcium supply). At and just after fledging time, the young vulture would fly to a nearby tree and perch there for some time. But the fledgling has to return to the nest in order to get a meal. We made no observations on the post-fledging dependence period; Van Someren (1956: 43) intimates that this period lasts for a "month or two".

***Nestling period:***

In 1970/71, we were able to obtain fairly accurate fledging dates for 10 nestlings. For those where we had two dates – an earlier one when the chick was in the nest and a later one when it was away from the nesting tree or simply absent – then we took the middle date. Thus the average nestling period was 108.1 days (sd ± 9.2) range 98-123 days. The range seems rather widespread to us and it may be that our two shortest periods (98 and 99 days) are very much minima and erring on the short side. Van Someren (1956: 40) has done the most detailed observations at the nest; one bird that he watched first flew "about four months after hatching" (actually 125 days). Note that the Hooded Vulture in East Africa is slightly larger than the one in West Africa (Mundy 2020).

***Hand-reared chicks:***

We took a chick into captivity that had fallen out of its nest in the bush; the date was 14 February 1972 and its wing (330 mm), tail (145 mm) and weight (1160 g) were measured. The wing and tail indicated that it was about 73 days of age (though the weight was very low). On 20 March, 35 days later, it measured 467 mm in the wing, 245 mm in the tail, and 1470 g in weight. It had grown apace. It was now being looked after by a friend of ours (Mr Simon Glenn) who tried to release it on 6 April, at an estimated age of 128 days, but it would not fly away. Eventually it disappeared from sight on 11 April, but returned to the house and garden every day where it was friendly with the dog and cat. Finally it flew away on 27 April, never to be seen again. It was considered to be a "real character" by Simon. During its stay in captivity, its cloacal temperature was taken at weekly intervals: seven readings produced an average of 104.8 °F, sd ± 0.95 (= 40.4 °C). Note that these readings are markedly

higher than those for the adults captured on the nests (av. = 101.8 °F, or 38.8 °C).

Another chick was taken into captivity on 12 January 1973. It weighed 1150 g, and its wing and tail measured 130 and 20 mm in length, respectively; it was estimated to be about 36 days of age. It was successfully raised until 91 days later (13 April), when it had to be put down, as it was unable to stand and walk. Meanwhile its weight had fluctuated around an average of 1140 g (sd ± 84 g), i.e. it failed to increase in weight. But the wing length (mainly the primary feathers) had grown to a length of 475 mm; up until an age of 90 days (7 March) the wing had grown linearly to 413 mm at a rate of 5.24 mm per day. Likewise, in the same period, the tail had also grown linearly at 3.3 mm per day. These were at exactly the same increases as those for the wild chicks. The captive chick ate very little meat (26 g) on the day following its removal, but this almost immediately increased to 70 g per day and soon 120 g per day; from 10 February it was fed 150 g per day. In total, therefore, it was estimated that we had given it 12.26 kg food up until its death at an age of 127 days. Assuming a fledging age of 108 days, it would have been fed 9.41 kg. Whereas it had grown normally in size (as we had expected), it was decidedly underweight – it should have been weighing about 1450 g on average (Figure 5). We assumed that it required at least 1.8 kg food in its first 36 days, to give a total of 11.21 kg – an insufficient total – to produce a fledgling Hooded Vulture. Would it have required 27% (1450/1140) more food for an average size? – now a total of an estimated 14.26 kg. Mundy *et al*. (1992: 146) had estimated 15 kg. On occasions it had regurgitated pellets.

***Breeding success:***

In the late 1970/71 season we found 28 attempts at nesting, which produced 12 fledglings; one of these was stoned to death later after it was prematurely evicted from its nest by an unseasonal storm. Thus 11 from 28 is an overall breeding success of 39% (chicks per nesting pair). There were 26 eggs produced from these attempts, of which we saw 17; clearly if we later found a chick then there must have been an egg laid. Of these 26, five were known to fail, and another five certainly failed to produce a nestling; thus 16 from 26 is a hatching success of 62%.

We found 16 nestlings, of which 10 reached the fledging stage though one died from the stoning. Two more had almost reached fledging when we went on leave; thus 11 from 16 is a success of 69%. By using Mayfield's (1961) more exact method, being the minimum days of exposure at each nest, we calculated the overall breeding success from eggs laid at 41%. In the 1971/72 season, we followed 32 attempts which laid eggs, and determined that 13 chicks fledged; this is the same success (41%) as in the previous year.

The Hooded Vulture is very accessible in its breeding, both in its low nesting heights and its proximity to humans and their activities. Nevertheless, did our interference with the breeding – climbing trees and handling and measuring the nestlings – cause failures? Due to the number of nests in and around Sokoto we were easily able to choose a random sample of nests that would not be interfered with by us, noting that perhaps the nests were higher and they were further away from humans (although you cannot get away from village boys!). Thus we chose 50 nests. However, five of these were probably never used. Of the remaining 45, eight were seriously used (i.e. new nest material, adults present, faeces spattered about) but later abandoned. Of the now 37, 12 failed, nine apparently during incubation and three in the chick stage, and six certainly produced a fledgling. Thus six from 25 occupying pairs is only 24%. Of the remaining 19 'doubtful' nests, we thought that one more had failed (= 13), and five more nests had produced a fledgling (= 11), and no

decision could be reached on the last 13. Thus, overall in our random group, 11 fledglings came from 32 pairs, of which 24 had laid eggs, being a success of 34% from occupying pairs and 46% from eggs laid. This compares with 41% success from eggs laid in our manipulated/interfered group, which is a small albeit measurable difference (= decline) due to our interference.

Only 11 nests were occupied in all three seasons, 1970/71 through to 1972/73. Regretfully, none of the adult birds was ringed.

With an incubation period of 51 days and an average nestling period of 108 days, the immediate breeding season is therefore just over five months (159 days) in length. Some birds were at their nests for weeks before an egg was laid, but we cannot even estimate the nest-building/refurbishment stage; could it be as long as one month on average? Perhaps the more critical period is the post-fledging dependence period (PFDP), and again we have no observations here. Could it be as long as 3.5 months? If so, then a fully successful breeding attempt (i.e. the fledgling leaves after its PFDP) could take this small vulture 9.5-10 months in operation. The latest in the year that we saw a fledgling/juvenile in a nest and begging at an adult was 30 August (1971), but we did not know its egg-laying date. At another nest in 1973, a youngster was fed in the nest mouth-to-mouth on 18 July; this was several days after it had fledged. One ringed juvenile was seen at the abattoir three weeks after fledging; another one (ringed) which was seen there was now about 10 km from its nest at about one month after fledging.

***Feeding behaviour:***

Hooded Vultures were always at the abattoir and at the market whenever we visited. Indeed, at the market birds would even run between the legs of people in an effort to get a scrap. And there were plenty of scraps as the butchers were so involved in cleaning and 'shaping' their pieces of meat. PJM has seen exactly the same behaviour from the vultures at Kumasi market and Accra slaughterhouse in Ghana (Mundy 2000a), and also the vulture being willing to run between the legs of Spotted Hyaenas *Crocuta crocuta* in southern Africa (Mundy *et* al. 1992: 142). It is a very nimble vulture. As just one example, on 19 April 1973, at 09h45, there were only six adults perched around at the Sokoto market. Meat arrived by lorry at 09h50 and 11h30, and by 12h45 there were about 50 birds present, only two of them noticed as immatures. It is as though only the most experienced (oldest?) adults can be successful at the crowded market. They quickly clean up the guinea corn stalk 'beds' where the meat is cut up, but here literally only morsels are available.

Occasionally when we visited nests, the attending parent would retire to the top of the tree and regurgitate – sometimes right over us! At times the vomit smelled like human faeces, and this food source has been well described by Allan (1996) from his observations in Addis Ababa.

Very occasionally we would see the birds at carcasses of domestic animals, cattle or donkeys. Thus we once saw five immatures at a dead donkey, and 20 (not aged) at a dead bovine. On 22 July 1970 we saw ten vultures chasing, catching and eating winged termites; this is a well-known activity of Hooded and other Vultures (Mundy *et al*. 1992: 273). Because we concentrated so much on nesting, we paid rather scant attention to these feeding bouts, regretfully not often noticing adults (white head down) or immatures (brownish-black head down). And of the 11 vultures at the pond (Plate 1), only three are adults, one of which has a conspicuous full crop (all the others are empty).

In 1973 we were more observant. Thus at a donkey carcass on 24 February, in the morning at 09h10, one adult was feeding and 14 immatures were standing up to 10 m away. If one of them approached the carcass, the adult chased it away, and once attacked an immature very viciously. The

adult also chased off a Pied Crow and Cattle Egrets. A second adult arrived, without any interaction with the first adult, but then they attempted a copulation which failed (the male did not mount properly). A dog arrived briefly. Feeding continued throughout the day, with just a few vultures at the carcass. By 17h00, two adults were feeding. At a goat carcass nearby, again with just a few vultures present, a Pied Crow pulled the wing-tip of an adult and was chased off. Often adults were seen to chase immatures, but then an immature and an adult fought together and the immature 'won', to our surprise. Four vultures were still feeding at 17h45.

At yet another donkey carcass, at 18h45, three dogs were feeding and there were many vultures looking on. AWC chased off the dogs and immediately 15 adults and 2 immatures got to the carcass; 13 more were perched in nearby trees. There were several 'fights', and again an immature 'won' against an adult.

On 11 April, a female donkey died in giving birth, and the foetus and placenta were quickly eaten. There was a terrific mêlée of about 60 vultures, all jumping over each other. Immatures seemed just as aggressive as adults. Birds got their fill in just a few minutes (though crops were not looked for), and then they simply stood around nearby. At a donkey carcass on 12 April, there were about 100 vultures on the ground, at some metres away because a dog was feeding, although one or two birds managed to peck at the carcass. AWC chased away the dog and the vultures immediately swarmed over the dead donkey. While a (feral?) dog must presumably eat quite a lot of meat, nevertheless it does perhaps open up the carcass thereby helping the vultures to get access.

At a dead donkey on 1 June, at 06h25, there were already four adults present and feeding. Two Pied Crows pecked at the wings and back of a vulture perched at the top of a nearby tree, and one eventually alighted on its back and knocked it off its perch; the vulture flew off with the Pied Crow pecking at it in mid-air! We saw many such interactions between vultures and crows, and PJM has seen the same in southern Africa, mostly crows and the Cape Griffon *Gyps coprotheres*.

The demeanour of Hooded Vultures at the abattoir was altogether different, with birds perched on roofs or standing around on the ground in very relaxed manner. Indeed we often saw bouts of allo-preening, both between adults, occasionally between immatures, and once or twice between an adult and an immature (e.g. on 2 June). On 31 March, at 06h45, there were already 25 birds present, of all ages (did they roost for the night at the abattoir?), pecking at dried skins on the ground or on the heaps of manure/rumen contents. By 08h00, 250-300 had gathered, most on the ground and some on the roof tops, but a few drinking and pecking in the blood stream flowing in the drainage canals – there are lots of small items floating in the streams. Some camel and cattle heads are cut up on an outside concrete slab, and always there were ten or so vultures persistently trying to glean something; whenever the butcher isn't looking the vultures will approach intact heads, but are chased away. There are a myriad of bone chips lying around, but we did not notice vultures collecting any. A pile of cattle trotters left unattended did not attract any birds. By 09h00 there were about 500 vultures at the abattoir. Officials told us that the only meat actually thrown out is the occasional foetus. Diseased carcasses are buried.

On only a couple of occasions did we notice Hooded Vultures at a termite emergence, catching and eating the flying and crawling insects. One such was on 11 July, already well into the rainy season. Hooded Vultures are well known to be attracted to these emergences (e.g. Smalley 2016).

***Interactions with humans:***

There were very few of these. Even with the vultures at the market, the butchers and certainly the customers paid scant attention to them.

Occasionally a person would trip over an enthusiastic vulture but such would elicit no response from either party; in general of course the behaviour of the vultures at the market was altogether importunate, but we never noticed anyone retaliating. A butcher would flick something to the ground and immediately there was a vulture gobbling it up. Back in those days regretfully we never thought to look at the vultures' crops in order to see if any of them could actually fill up at the market. Exactly the same sort of behaviour was on view at the Kumasi (Ghana) market (Mundy 2000a). We made no observations on this human-vulture interface at the Sokoto abattoir.

Usually boys are a nuisance, as they continuously roam around in the bush with their catapults. A couple of times we found small rocks/pebbles in a nest as though boys had been throwing stones at nesting vultures. And once we had circumstantial evidence that boys (probably) had stoned to death a chick that fell out of its nest. In general, however, boys were not attracted to our activities at trees with nesting vultures, and so we can say that boys were of negligible impact. Only once did we ever find a dead vulture, a bird (not aged) lying in a ditch, found on 9 February 1973. Bearing in mind the likely mortality of the species, it is really remarkable that we found only one.

As mentioned before, the acacia trees were pruned to provide browse for livestock (also reported by Daboné *et al*. 2019). One tree was severely cut back, only leaving one branch which supported a vultures' nest. That in our view was respect/tolerance!

The fact that we found ten nesting trees actually within the urban area, and occasionally even inside a walled compound (Plate 5), bespeaks of a huge tolerance, perhaps even disinterest, on the part of the local people towards the vultures. We noted too that Pink-backed (Grey) Pelicans *Pelecanus rufescens*, Marabou Storks *Leptoptilos crumenifer* and Yellow-billed (Wood) Ibis *Mycteria ibis* nested in (taller) trees within the urban areas (Mundy & Cook 1974) and inside some compounds.

Only ever once did an adult Hooded Vulture actually 'buzz' us at its (presumed) nest, i.e. flying at us in aggressive mode. It was 4 February 1971, and it was incubating an egg. It then perched on a nearby branch, half raising its wings and opening its mouth at us. This is in marked contrast to the behaviour of Yellow-billed Kites and Pied Crows which mobbed us often. Frequently a Hooded Vulture perched on the wall around our houses, and occasionally too on the roofs. It was probably this sort of intriguing sight which sparked our interest in the species. And then in December 1970, PJM photographed an immature (possibly a juvenile) perched on the back of a goat (Mundy 1974), in behaviour that looked altogether normal though we never saw it a second time (photograph in Mundy 1976). Nor have we seen it mentioned elsewhere, except by Huxley (1945).

For most of our study we had worked in ignorance of the 'mad man'. Nobody ever told us about him. Also we were entirely in ignorance of the more modern threats to Hooded Vultures, viz. poisonings, belief-based usage in superstitions (previously and wrongly, 'muthi'), and eating the bird as if it were a chicken. Certainly, back in those days, our ignorance was probably bliss, but that's not to say that these threats did not occur, simply that we never heard anything of them. And certainly nothing of the order documented by Saidu & Buij (2013) with 500 parts of the Hooded Vulture being found among a sample of 113 traders (but Sokoto state was not visited!), nor what Nikolaus (2001) documented, 48 Hooded Vultures among a sample of 24 fetish markets.

**Table 7:** Comparison of the results from this study with those of Daboné *et al.* (2016).

| Parameter | Sokoto, Nigeria | Garango, Burkina Faso |
|---|---|---|
| Locality | 13°02' N, 5°16' E | 11°48' N, 0°33' W |
| Mean annual rainfall | 682 mm v-ix<br>(551 mm in study) | 600 – 900 mm v - ix |
| Years of study | 1970 – 1973 | 2013 - 2015 |
| Commonest nesting tree | *Faidherbia albida* (53%) | *Parkia biglobosa* (71%) |
| Av. height of all nests | 8.1 m (±3.2 m) (n = 306) | 13.0 m (±3.6 m) (n = 65) |
| Inter-nesting tree distance | 130 m (±98 m) | 334 m (±272 m) |
| Egg-laying dates | 16/10 – 20/2 (n = 150)<br>Most in December<br>Av. date 15 Dec | 30/10 – 2/2 (n= 19)<br>Most in November<br>Av. date 27 Nov. |
| Clutch size | 1 (n = 143) | 1 (n = 19) |
| Incubation period | 50 – 54 days (n = 13)<br>(av. 51 days) | 45 – 52 days (n = 14)<br>(av. 48 – 49 days; actually 47) |
| Nestling period | 98 – 123 days<br>(av.108 days) (n = 10) | 101 – 121 days<br>(av.111 days) (n = 13) |
| Breeding success | 24 fledged from 58 eggs = 41% | 45 fledged from 64 eggs = 70% |

**Reflections**

Clearly those days in the early 1970s were halcyon. There was of course no intimation whatsoever of the impending decline, to crisis levels, coming to the Hooded Vulture (Rondeau & Thiollay 2004) within 30 years, a period when the human population of West Africa more than doubled (Thiollay 2006b). Specifically the human population in Nigeria was estimated at 65 million in 1972 (Kajubi *et al*. 1974: 367) and 124 million by thirty years later (Times Atlas of the World 2003: 65). For us, with our memories of Sokoto and its Hooded Vultures, the present scenario is unthinkable, and distressing, assuming that the species has also declined there. However we have been shown a photo of an adult bird in Sokoto, taken by A.S. Ringim on 8 December 2018, who nevertheless notes that the species has "seriously declined in the north" (email dated 28 March 2021). Ogada & Buij (2011) proposed that the decline in West Africa regionally was at least an estimated 22.5%, and perhaps double that. In particular, Nigeria was pinpointed by them for the trade in vultures for 'traditional medicine' and food. As we said earlier, these aspects were never in our line of thinking or seeing, back in the early 1970s.

As far as we know, our study at Sokoto was the first detailed study of the breeding of the Hooded Vulture. Then we were schoolteachers and amateurs in ornithology, so that one or two of our methods needed correction. The species lived so close with humans that we barely gave a thought to our interference and its possible impact, indeed we captured adults on their nests eight times, they appeared to be so relaxed with us around. Notwithstanding, the overall breeding success that we measured, i.e. chicks fledged from eggs laid, was low at 41%. This compares unfavourably with a success rate of 70% as measured by Daboné *et al*. (2016, 2019); those authors appeared not to handle any chicks. In Table 7 we have compared their results with ours, and the breeding success shows the largest difference between the two studies.

There are also slight differences in peak egg-laying dates (earlier in Burkina Faso), and in incubation period (by four days shorter in their study). Is this period affected by winter temperatures after all?

Hooded Vultures in Sokoto start breeding, i.e. nest-building and copulating, in October after the rains have finished usually in September. Is that their cue (and for a circannual rhythm)? Egg-laying then reaches its peak in December, and hatching of chicks in early February; fledging then occurs from the end of May onwards, which is at the start of the next rainy season. We have shown the growth of chicks in five size parameters, and at least in weight over three breeding seasons; we were surprised that these growth increases were so uniform from one year to the next. It should be emphasised with these growth curves that we are dealing with the continent's smallest Hooded Vultures (Mundy 2020). The growth in wing length gives a continuous assessment of the chick's age; this parameter was chosen to be transformed by the method of Ricklefs (1967), and the results obtained are mostly of interest when comparing Hooded Vultures both intraspecifically with other populations or years, and interspecifically. This applies particularly to our value of the constant K. Regretfully Figure 9 cannot be compared with PJM's later work on vultures (including the Hooded Vulture) in the then Rhodesia, due to the very small sample size for the southern birds.

The post-fledging dependence period (PFDP) for fledglings/juveniles lasts throughout the rains. We assume that the rainy season is a good time for herbivores and therefore a lean time for vultures (outside of the abattoir and market). The PFDP probably finishes with the end of the rains and the youngsters are now on their own, and the parents are free to think about breeding again. There was some evidence for annual breeding by at least a few vultures, and even a circannual rhythm. These adults must have survived well during the rains. We wonder how important the abattoir and market were to their food budget, and it is of course a pity that we made no detailed observations at these sites.

All in all, we hope that our study albeit reported on fifty years later, will be seen as a useful contribution to the biology of the Hooded Vulture in its current period of anthropogenic threats and decline.

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