The Straw-coloured Fruit Bat (*Eidolon helvum)* Colony in Kasanka National Park, Zambia

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Introduction:

Since 1986 it has been observed that a colony of *Eidolon helvum* lives in a small mushitu forest section in the Kasanka National Park, Zambia, each year from end October to end of December or early January. It is not known where they come from and why they come to this place. In 1994 a group of Manchester University students tried to establish the numbers of bats present and their diet. During two visits in November and December 2000 and 2001 we observed the colony of *Eidolon helvum* to find out more about their biology.

Study area:

Kasanka National Park lies in the North-East of Zambia, 70 km N of Serenje town, its size is 420 km^2. The park is dominated by Miombo, broad-leafed woodland and variations of this such as Chipya. Linear riperian forests and swamp forest (mushitu), as well as swamps and seasonally flooded grasslands knowns as dambos are also present. The bats occupy a section of Mushitu forest (evergreen swamp forest) along the Musola River at Fibwe. The size of the forest pocket is 16.66 ha. The dominant trees in the forest are Waterberry (*Syzgium cordatum*) and Large-leaved Swamp Fig (*Ficus tricopoda*).

Material and Methods:

Ecology:

In two consecutive years during a total period of 4 ½ months (15.11.2000 – 4.1.2001 and 12.10. – 15.12.2001) we documented the movement of the bats within their roosting forest, the times and densities of the evening fly-out to the feeding areas and some behaviour of the bats and their predators in the colony. Observations were also made at Luwombwa camp, 16 km direct flight line from Fibwe and at Chikufwe airfield 10 km direct flight distance from Fibwe.

Morphology and reproduction:

We also caught bats, often collecting injured and dead bats after a branch break, and measured head and body, tail, wingspan, forearm, hindfoot (*s.u.*), weight, testes length and foetal sac length and assessed sexual status.

Numbers of bats present:

To try and establish numbers of bats present at the colony, we took a series of photographs (transparencies) during the evening fly-out from 4 different points around the roost (see Map 1). We recorded the density of flying bats at the time the photos were taken and the total duration of each density period and the total fly-out time. Later the processed slides were projected onto a screen and the bats present on the photo counted. Knowing the distance from the centre of the colony (depending on the section the bats roosted in on the given day, we calculated three different centres: M1 – M3) to the observation point gave us the length of the circle around the forest all bats had to traverse. We measured the wingspan of the bats on the projected slide and knowing the actual

average wingspan we could calculate the width of the flight path covered by each slide. We presumed a constant fly-out around the 360° circle.

From one of the observation points (W, on the Chinyangale dambo) we also applied a direct counting method, counting the number of bats "touching" a fixed point (end of the car antenna) with any part of their body during 1 minute. Distance from colony centre and length of circle were calculated as above, the width of the flight path covered was calculated as twice the average wingspan (= 1.57m).

As a third method we also used video footage shot during the emergence from Fibwe camp, in this case we counted the number of bats emerging over a given time within the 14° wedge visible from the camera location towards the roosting forest.

Results:

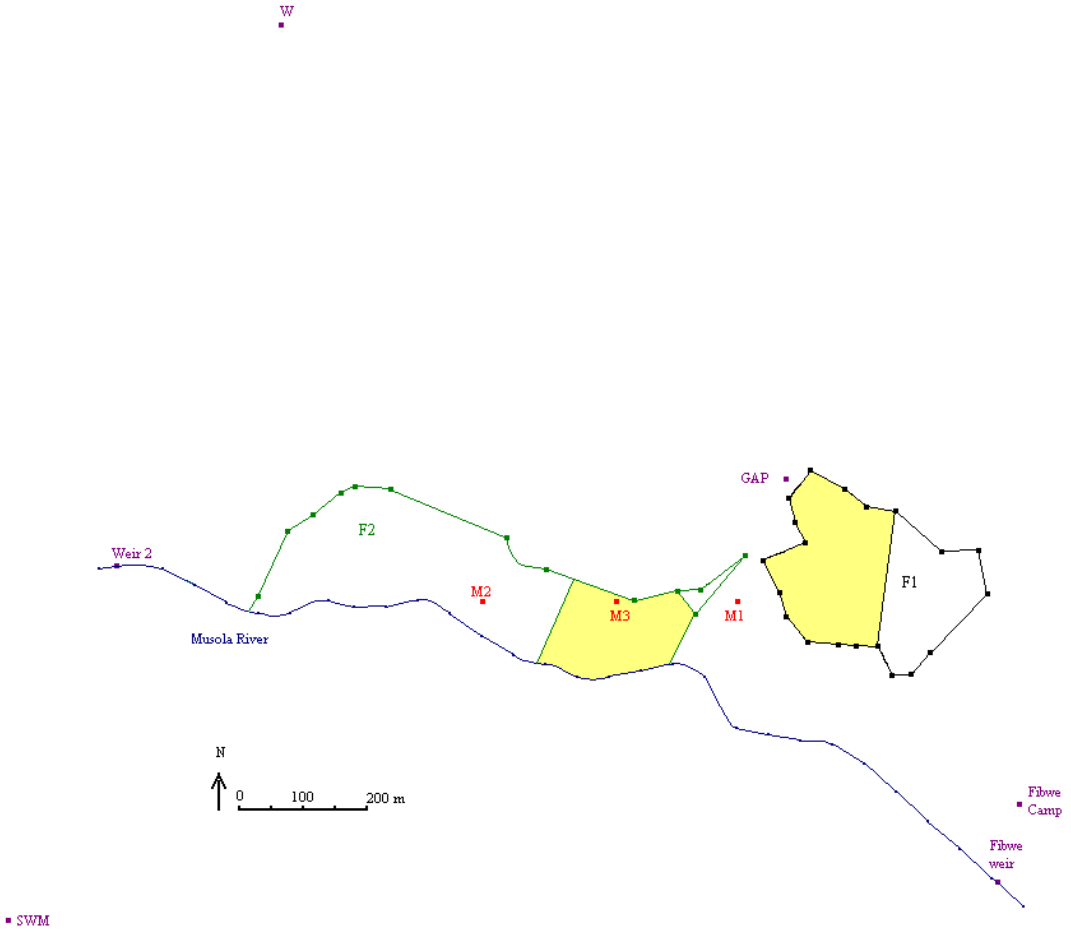
Ecology:
In 2000 the colony of *Eidolon helvum* was already present on our arrival on the 15th of November, in 2001 we could document the arrival of the first bats in Fibwe on the 20.10. at 11h45 from the West. The density increased gradually during the rest of October 2001, highest density was observed in the first half of November, a reduction of numbers present was clearly observed around the 3rd of December 2001, earlier than the year before, where reduction took place in the last week of December. The earliest time of emergence from the forest was at 17h35 , the latest at 18h54, average length of emergence was 28 min, the longest 60 minutes. After arrival the bats first occupied the eastern third of the forest (F1, see Map 1), later they move westward, also occupying F2, the highest concentration could be found in the area marked yellow on Map1. In the second half of their stay, they moved out of F1 altogether.

African White-backed vultures (*Gyps africanus*), Lappet-faced vultures (*Torgos tracheliotus*) and Palm-nut vulture (*Gypohierax angolensis*) were observed in and over the Fibwe bat roost. In the first season three pairs of African White-backed Vultures with flying young were seen, Their nests were located on the northern fringe of the forest but within the area of greatest bat concentration. During the second season just two pairs of white-backed with flying young were present. Over the two seasons African White-backed Vultures were seen on several occasions tearing up bats on the ground following branch breaks. Other raptors directly observed catching and, or eating fruit bats were one pair of Martial Eagles (*Polemaetus bellicosus*) and one subadult of the same species, Crowned Eagle (*Stephanoaetus coronatus*) and Fish Eagles (*Haliaeetus vocifer*). Several other species of raptor were frequently observed but not observed catching or feeding on the bats.

Crocodiles also ate *Eidolon helvum*, coming out onto the forest floor from the Musola River after branch breaks.

Average flying speed of the bats was calculated as 24.3 km/h. On the 6th December 2001 a steady stream of *Eidolon helvum* could be observed flying high over Luwombwa Camp in a NW 300° direction. Kasanka staff also reported bats flying over Chikufwe airstrip.

Map 1: Fibwe Mushitu forest and bat occupation



F1 (black dots and lines) = eastern third of the Mushito forest (total area 6.88 ha)
F2 (green dots and lines) = western two thirds of the forest (9.78 ha)
Purple = observation points
Yellow areas = area densest and longest occupied by bats (55% of F1=3.78 ha + 33% of F2 = 3.26, total = 7.04 ha)
M1, M2, M3 = centres of colony dependant on occupation
Total area covered by evergreen swamp forest used by bats = 16.66 ha

Morphology and reproduction:
Body measurements of *Eidolon helvum* are presented in Table 1. T-tests showed no significant difference between males and females regarding head and body and wingspan. Fourty-nine specimen were caught and measured, all were adults, 35 females and 14 males. 31 (89%)of the females were pregnant with foetuses at different stages of development. Mating was observed on numerous occasions in the colony.

Table 1: Male and female *Eidolon helvum* body measurements (in mm, g) and sexual status. Sample sizes are not the same for all measurements due to some specimens being damaged.

Males:	**Ave.**	**Min.**	**Max.**	**N**
H&B	208.8	190.0	225.0	14
Forearm	119.5	107.5	127.0	14
Hfsu	28.3	22.0	32.0	14
Wingspan	772.5	730.0	820.0	12
Tail	15.5	11.0	21.0	14
Ear	29.1	27.0	33.0	14
Weight	254.5	242.0	276.0	4
Testes length	13.5	12.0	16.0	5

Females:	**Ave.**	**Min.**	**Max.**	**N**
H&B	210.1	180.0	225.0	33
Forearm	122.2	115.0	135.0	35
Hfsu	29.7	21.0	45.0	35
Wingspan	787.5	670.0	860.0	34
Tail	13.9	6.5	23.0	34
Ear	29.0	26.0	32.0	35
Weight	266.1	196.0	>300	16
Fetal sac	31.0	10.0	40.0	15

Numbers of bats present:
Our results for the total number of bats vary greatly from a minimum of 366 000 to a maximum of 4,1 million, the average being 1.7 million.

Table 2: Calculations of numbers of *Eidolon helvum* in colony using fixed-point (car antenna).

Date	**Locality**	**Time**	**E.h./min**	**Fly-out Start**	**Fly-out End**	**E.h. nos per period**	**Distance to centre**	**Circumf. of circle**	**Total no. of E.h.**
23.12.2000	W	18:04	8	17:45	18:32	192	1,235	7759.73	
		18:09	15			90			
		18:15	33			165			
		18:20	2			24			
						471			**2,327,918**
25.12.2000	W	18:18	24	18:11	18:33	216	1,235	7759.73	
		18:20	18			72			
		18:24	15			135			
						423			**2,090,678**
26.12.2000	W	18:09	19	18:08	18:33	95	1,235	7759.73	
		18:13	16			80			
		18:18	14			210			
						385			**1,902,863**

Table 3: Calculations of numbers of *Eidolon helvum* in Fibwe colony from transparencies and video footage.

DATE	Locality	To colony centre (m)	Width covered by slide (m)	Circumf. of circle (m)	Time	Density	No. of bats on slide	Time to transverse frame (sec)	Total high fly-out time (min)	Total low fly-out time (min)	Total no. of E.h. in colony
08.12.2000	GAP	328	55	2,061	18:06	low	114	7.8		16	
					18:14	high	176	7.8	24		**1,743,972**
08.12.2000	GAP	328	23	2,061	18:14	high	116	4.0			
					18:14	high	95	4.0	24	16	**4,143,342**
09.12.2000	Fibwe camp	900	23	5,655	18:25	high	20	2.5			
					18:25	high	21	2.5	21	11	**2,973,320**
23.12.2000	W, Chiny.	1,235	75	7,760	18:00	low	183	28.6			
					18:07	high	207	28.6	8	35	**1,934,632**
02.12.2001	SWM	1,077	68	6,767	18:15	low	5	3.5			
					18:20	high	22	4.0	7	16	**366,313**
03.12.2001	Fibwe camp	707	68	4,442	18:12	low	22	3.7			
					18:19	high	17	3.8	10	22	**687,791**
09.12.2001	W, Chiny.	1,235	68	7,760	18:18	low	16	4.0			
					18:22	high	27	3.8	7	10	**614,409**
Nov. 2000	Fibwe (video footage)		14° wedge			high		15.0	20		**3,109,880**

Discussion:

Ecology:

Although *Eidolon helvum* arrive in Kasanka at the time of fruit abundance, we do not believe that food is the main reason for the bats to spend two months here. We hypothize that these bats come from different colonies in Central Africa to mate and exchange genetic material with bats from other colonies. This presumption can only be proven if further studies are undertaken using satellite transmitters to follow the bats when they return to their home destinations. Also genetic studies with comparison to the genetic make up of known colonies would be an essential component. During the early part of their stay bats use food sources closer to Fibwe, later they need to forage further away from the roost, and they fly well over Luwombwa Camp and Chikufwe airstrip, also villagers at the borders of the Park have reported night visits of *Eidolon helvum*, they are known to fly 40 – 50 km one way to feeding trees.

Morphology and reproduction:

The fact that 89% of females caught were pregnant does not contradict the hypothesis that mating is a major cause for their visit to Kasanka, delayed implantation is known in *Eidolon helvum.* Females within any given colony synchronize pregnancy and birth, so finding females at different stages of pregnancy supports the theory that they come from different colonies. Aspects of reproduction are being investigated in collaboration with Rhodes University Grahamstown.

Numbers of bats present:

The great differences in the end figure for the colony size shows the difficulty of actually establishing an accurate figure. The consistently lower figures in 2001 could mean that in that year not as many bats came to Kasanka, or it supports the subjective feeling that the bats started to leave earlier than the year before. No counts were done in November 2001. We don't believe it is possible for the human eye to count the actual numbers of bats flying overhead in a 10 metre field of view over 1 minute at dusk The slide method is open to errors, wrong slide identifications, bad light conditions and blurred images. We feel that the best method is the counting of bats flying directly overhead with one fixed point of reference, this is acceptable for the human eye. Other recommendations for future counts are: 1) Count on three consecutive nights in early November and early December. 2) On these three nights have 4 teams of counters to the West, East, North and South of the colony, each team using a fixed reference point.

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