

## The mammalian fauna of some jebels in the northern Sudan

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*(Accepted 10 July 1968)*

(With 1 figure in the text)

Mammals were collected and observed on seven jebels in the Sudan. A brief description of the position and geology, size, amount of soil, vegetation and rainfall is given for each jebel since these features are important in determining the variety and abundance of the mammalian fauna.

There are few mammalian species, if any, on the desert jebels. *Acomys cahirinus* is the commonest mammal on these jebels, and it may be very abundant if the jebel is large enough. Small desert jebels appear to have no mammals.

The jebels covered with trees and grass in the woodland savanna region have many species, although their densities are not as high as on the desert jebels. Larger size, dense vegetation cover, and many habitats may be responsible for this greater diversity (e.g. there are 34 recorded species, except bats, on Jebel Marra).

In the desert, the "jebel" and the "desert" faunas are distinct, whereas in the woodland savanna there is an overlap between the mammals of the jebel and those of the savanna. The desert jebels are now "islands", so each population is isolated from the next. This situation is probably due to the past climatic and vegetational history of the region. In the woodland savanna, jebel populations are continuous with those of the savanna.

All the populations of *Acomys* in the study area appear to belong to one subspecies, *Acomys cahirinus cineraceus*. The specimens from the north were the palest, and those from the south were the darkest. Probably all *Acomys* in this region belong to the same species which forms a cline showing great variation dependent on climate and topography.

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### Introduction

One of the characteristic features of the northern Sudan is the isolated rocky hills or jebels which project from the flat surrounding plains. These jebels may be single and isolated, or there may be several of them close together. They are especially interesting since they form a habitat unlike that of the surrounding woodland savanna or semidesert, and because the animal populations of each jebel are isolated from those on other jebels.

The northern Sudan extends from approximately 22° E to 37° E, and from 12° N to

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22° N, and consequently there is a wide range of climate and vegetation within these boundaries. The most northerly part of the Sudan is desert; there is practically no vegetation and the average annual rainfall is 4 mm (at Wadi Halfa). In some years there is no rain at all. The jebels in this region were not visited due to difficulties of travel. Further south, between 14°–17° N, is semidesert with an average annual rainfall up to about 160 mm (Oliver, 1965). The vegetation varies according to the soil: in some sandy regions, e.g. near Khartoum, it is *Acacia* scrub; in other sandy regions woody trees are absent and grasses, which are dry and dead for most of the year, are the principal plant cover. On the Butana clay plains between Khartoum and the Ethiopian border, trees are absent except around jebels and watercourses, but there is a dense growth of *Cymbopogon* and *Sorghum* grasses.

South of the semidesert is a zone of woodland savanna which extends from 10°–14° N. On clay soils there is savanna with *Acacia mellifera*, or *A. seyal* with *Balanites*, and on sandy soils *Terminalia* and *Anogeissus*, or *Combretum* and *Albizzia* are the dominant tree cover. The grasses in the woodland savanna are denser and more permanent than in the semidesert. The topography and vegetation are modified on Jebel Marra, the Nuba Mountains, and the hills along the Ethiopian border, and in Darfur Province the vegetation surrounding Jebel Marra is different to that of the main woodland savanna of the Sudan. The annual rainfall in the woodland savanna is 300–500 mm, depending on the locality, and up to 900 mm on Jebel Marra (Ramsay, 1957) and along the Ethiopian border. Barbour (1961) gives a general account of the geography of the Sudan and details of the vegetation are given by Harrison & Jackson (1958).

### Methods

Two sorts of traps, Havahart No. 0 and Museum Special, were used in this study. The traps were placed 10 yards apart in lines of 15 traps. Because of their smaller size, the Museum Special traps were easier to use on the jebels. The trap lines usually started a few yards up from the base of the jebel, and continued upwards for about 150 yards. The actual position of the traps depended on where it was possible to climb on the jebel. Usually traps remained in the same place for three nights but if there were very few animals the traps were moved to another position on the jebel. The traps were examined each morning for animals, and they were baited in the evening with soft dates. All specimens caught on the jebels were caught at night. Traps which were knocked over, or which sprung themselves, were discounted in the trap record figures (Table I).

Each animal was weighed to the nearest gramme and measured before skinning. The measurements were taken as follows: "head and body" length from the tip of the nose to the base of the tail, "tail" length from the base of the tail to the tip omitting the terminal hairs, "hindfoot" from the heel to the end of the longest toe excluding the claw, and "ear" from the notch to the tip. Some specimens were kept alive so only the weights of these animals were recorded.

Larger mammals, which could not be caught, were observed with binoculars, and their identification and features recorded in a field notebook.

The species caught are given in Table I, and all the species recorded from the jebels are listed in Table II. The nomenclature is taken from Allen (1939), Happold (1967c) and Setzer (1956).

### The jebels

Mammals were trapped and observed on seven jebels (Fig. 1). These jebels were very varied, and certain features determine the number and variety of the mammals that live

on them; these features are (1) the geographical position, (2) geology, (3) amount of soil, (4) vegetation, (5) size, and (6) rainfall. Details of each jebel are given below.

*Jebel Guli* ( $11^{\circ} 44' N$ ,  $33^{\circ} 30' E$ ) is a single isolated jebel on the *Acacia seyal* plains that stretch between the Blue and White Niles. The jebel is elongated in shape, and its greatest

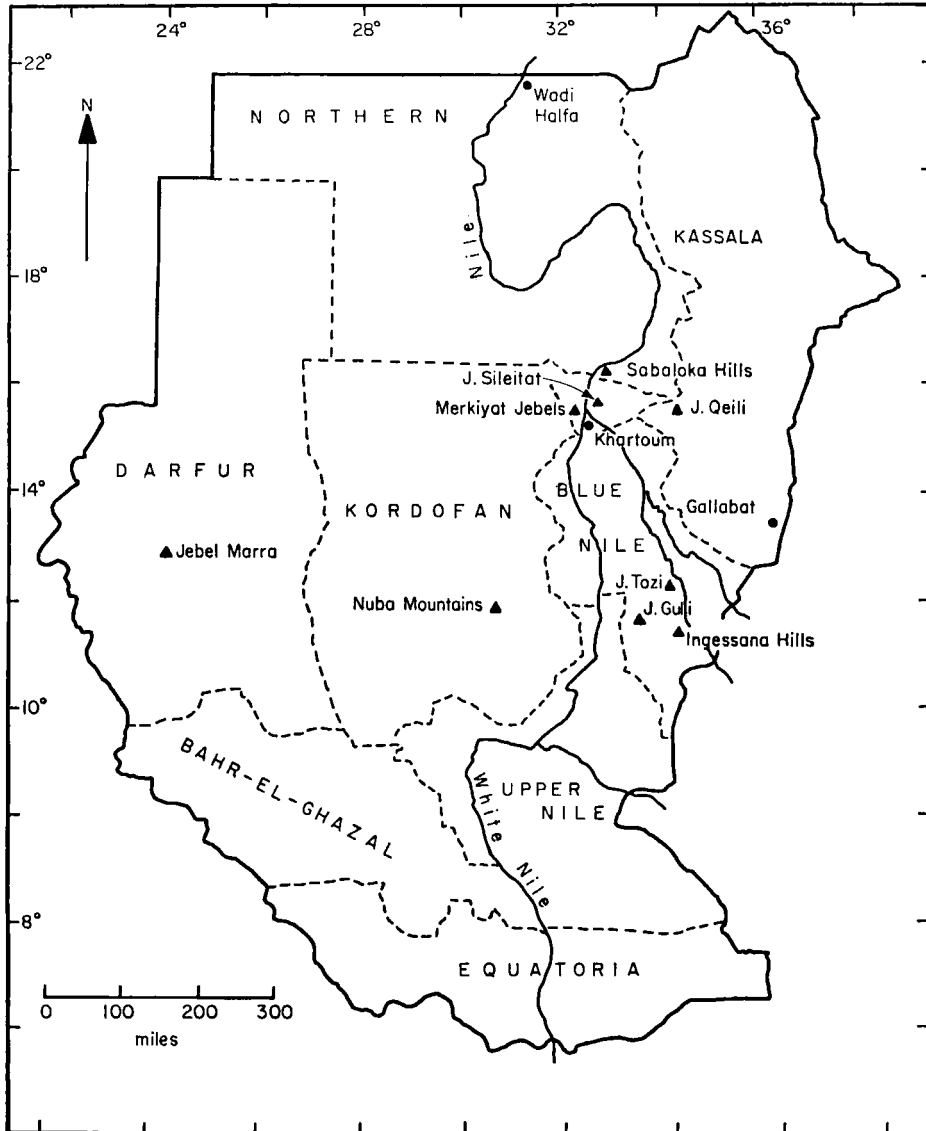


FIG. 1. Map of the Sudan to show the jebels where collections were made, and other localities mentioned in the text.

length is about a mile. The large granite boulders rise some 400–500 feet above the plain, and patches of grass and bushes grow in the soil between the boulders. Crevices and cracks are formed under and along the boulders, and these form hiding places for small

mammals. The annual rainfall is about 600–800 mm; there is a good growth of grass and herbs during the rains on the jebel and on the surrounding clay woodland savanna.

*The Ingessana Hills* (11° 23' N, 34° 05' E at the village of Bau) form a circle of low wooded hills around a central depression. The hills, formed of serpentinite, are covered with soil and a thick cover of tall grasses, bushes and trees. The country is gently rolling with small valleys and rocky outcrops. There are approximately 600–800 mm of rain annually, and the grasses, even when dead, remain throughout the year. The vegetation on the hills is similar to the *Acacia seyal*—*Balanites* woodland savanna. The diameter of the hills is about five miles.

*Jebel Marra* (13° 10' N, 24° 22' E) is an extinct volcano, and the largest mountain in the Sudan. The highest peaks are over 9000 feet and the crater and crater lakes at 7100 feet are 4000 feet above the surrounding plains. Because of its huge size, some 20 miles in diameter, there are many habitats: heavily wooded valleys with deep litter soil, rocky outcrops, several types of tall grass savanna, and high altitude plateaux of volcanic ash with short grasses and windblown bushes. The annual rainfall may be up to 800 mm, and perennial streams flow on the mountain (see Happold, 1965).

*Jebel Qeili* (15° 30' N, 33° 47' E), like *Jebel Guli*, is an isolated jebel rising 200–300 feet above the plains. It is circular, and is surrounded by the almost treeless Butana plains which are covered with tall grasses after the rains. The boulders, formed of syenite (a rock similar to granite), are interspersed by clumps of grasses and a few bushes. Grasses also grow in cracks and crevices in the rock, and these cracks are hiding places for small mammals. The rainfall is low, about 200 mm annually, but the water table is near the surface at the base of the jebel and there are many wells used by the nomads and their livestock. To the north, but not visible from *Jebel Qeili*, are several other similar jebels.

*The Merkiyat Jebels* (15° 42' N, 32° 25' E) are small hills of fragmented Nubian sandstone. They are 50–100 feet high, flat-topped, and the rock is broken into small pieces so that little vegetation is able to grow. A few stunted bushes manage to survive throughout the year, and after the rains, about 150 mm annually, there are a few small low growing grasses in the gullies. There are several hills, separated by valleys, which together occupy about a square mile. The surrounding *Acacia tortilis* semidesert is grazed by goats, and the trees are cut by local inhabitants.

*The Sabaloka Hills* (16° 20' N, 32° 42' E at the northern end by the sixth cataract of the Nile) are the eroded remains of an old volcano. The hills, divided into eastern and western portions by the Nile, extend for ten miles north to south, and five miles from east to west. Some slopes of the hills are fragmented rock, but there are also rock outcrops and steep cliffs with cracks and valleys. There is hardly any soil, but there are a few short grasses after the rains and some wind-blown trees grow in the cracks in the rock. The annual rainfall is 100 mm, and the surrounding semidesert supports *Acacia tortilis* bushes, and short grasses after the rains.

*Jebel Sileitat* (15° 50' N, 32° 40' E) is a small granite jebel in the almost treeless semidesert north of Khartoum. It is 50 feet high, about 300 feet in diameter, and is formed of large boulders. A few grasses and bush-like trees grow among the rocks but it is almost devoid of vegetation. The low annual rainfall of 150 mm and lack of soil prevents growth of vegetation, and there are few hiding places for mammals.

Sufficient grasses, seeds and fruits are essential as food for small rodents. Some of the smaller jebels on the semidesert regions have no trees and practically no grasses and

consequently few mammals, if any, live there. Rock formation, e.g. granite and syenite, which form boulders result in crevices which provide shelter and protection for small Jebels of volcanic origin and Nubian sandstone are generally formed of broken mammals, rock fragments and have a sparse fauna; volcanic turf, as at the northern end of the Sabaloka Hills, has vertical and horizontal cracks which are inhabited by bats.

The most northerly jebels in the semidesert are in the regions of low rainfall, and so there is little chance of grasses and small trees surviving if the rain flows straight off into the surrounding desert. A large jebel in these regions holds water better than a small one and so plants become established. In contrast, jebels in higher rainfall areas where vegetation is more plentiful have a larger mammalian fauna, and size, by itself, is of less importance.

### The mammalian fauna

The relative abundance and diversity of the fauna can be estimated by the numbers of animals trapped using a standard trapping method (see Methods), by observation and by records in the literature.

TABLE I

*Mammals trapped on seven jebels in the northern Sudan, and in desert regions near Khartoum*

Jebel	Number of trap-nights	Trapping success (%)	Species
Jebel Guli	108 (2)	26-35	<i>Acomys cahirinus</i> 31; ? <i>Leggada</i> sp. 1; (at base of jebel in grassland: <i>Arvicanthis niloticus</i> 1; <i>Crocidura</i> sp. 1).
Ingessana Hills	386 (5)	0-8	<i>Acomys cahirinus</i> 12; <i>Arvicanthis niloticus</i> 3.
Jebel Marra	630 (9)	0-15	<i>Crocidura nyansae</i> 4; <i>C. sericae</i> 1; <i>Praomys fumatus</i> 27; <i>Grammomys macmillani</i> 1; <i>Tatera benvenuta</i> 3; <i>Leggada tenella</i> 4; <i>Mastomys natalensis</i> 6; <i>M. kulmei</i> 1; <i>Acomys cahirinus</i> 2; <i>Gerbillus lowei</i> 6; <i>Arvicanthis niloticus</i> 1.
Jebel Qeili	198 (3)	20-37	<i>Acomys cahirinus</i> 48; <i>G. campestris venustus</i> 10.
Merkiyat Jebels	45 (1)	0	—
Sabaloka Hills	305 (5)	1-14	<i>Acomys cahirinus</i> 18; <i>G. c. venustus</i> 4.
Jebel Sileitat	46 (1)	0	—
Desert regions near Khartoum	252 (7)	0-26*	<i>G. pyramidum</i> 6; <i>G. watersi</i> 10.

\* See comments in text. Actually 0, 0, 0, 0, 7, 11, and 26%. The 26% was seven animals caught in 26 traps.

Trap nights are the number of traps used multiplied by the number of nights of trapping. The actual number of nights are shown in brackets.

Trapping success varied from zero to 37% (Table I). The numbers of specimens obtained on jebels was always higher than in the desert; trapping in the desert was abandoned since it was easier to obtain specimens by chasing after them with a net (see Happold, 1967a). The only place where trapping was worthwhile in the desert was where *Capparis* bushes, grazed by goats, formed a dense growth which collected and stabilized blown sand. The resulting sand heaps were sometimes colonized by *Gerbillus pyramidum*. A similar situation was found in an experimental patch of mesquite bushes south of Khartoum where a colony of *G. watersi* lived (Happold, 1967b). The high trapping success in the desert was

only found in these two habitats, and is unrepresentative of the desert as a whole where trapping success is normally 0%. Consequently jebels are "islands" of high population.

The highest trapping percentages (Jebel Qeili and Jebel Guli) are on jebels of granite and syenite where there are many crevices and abundant grasses. On Jebel Qeili parts of the jebel had been burnt, so the percentages may be higher than normal since the mammals clustered in the unburnt regions. The habitat on each of the jebels is rather homogeneous, and only one species of small mammal, *Acomys cahirinus*, has successfully occupied the habitat. Jebel Sileitat, also formed of granite, is probably too small and the vegetation is too sparse to maintain a population of *Acomys*.

The Merkiyat Jebels near Khartoum are composed of small fragments of Nubian sandstone with no crevices nor cracks, and are a poor habitat for mammals. On the Sabaloka Hills, although looking superficially similar, scattered grasses grow in gullies and crevices, and these support small populations of *Acomys cahirinus* and *Gerbillus campestris venustus*. Jebels composed of rock, whatever its origin, with few plants, have a small sparse fauna. Larger jebels have a greater diversity of structure and usually a more varied and abundant fauna. Jebels of granite or syenite, provided they are sufficiently big, support large populations of *Acomys*.

The Ingessana Hills and Jebel Marra are both large hill groups with many trees and grasses. The Ingessana Hills, with a similar vegetation in all places, had an unexpectedly low population of small mammals. *Acomys cahirinus* was found near rocks and also in overgrown grass. The populations on Jebel Marra were not as concentrated as on the semidesert jebels but there were many more species which is partly due to the zonation of vegetation on the mountain (Happold, 1965).

The total number of mammalian species (Table II) shows that jebels in the semidesert regions have fewer species than jebels in woodland savanna. In both these regions large jebels have a greater number of species than small jebels. Some species, e.g. foxes, hawks, owls, striped weasels, use the small jebels as a home during the day and go out into the desert at night to search for food. The sandy desert at Khartoum has a greater variety of species than any of the nearby jebels, but the populations are usually small and scattered. Eight species are seen frequently in the desert: hedgehog *Atelerix pruneri*, Egyptian gerbil *Gerbillus pyramidum*, Water's gerbil *G. watersi*, jerboa *Jaculus jaculus*, Desert hare *Lepus capensis*, Sand fox *Vulpes pallida*, and the Nile fox *V. v. niloticus* which lives near the Nile and goes into the desert at night (see Happold, 1967b).

In the semidesert, where the vegetation and habitat of the jebels is different to that of the surrounding semidesert, the mammal species which are found on the jebel are confined to the jebel, and the desert species, with a few exceptions, remain in the desert. In the woodland savanna, where there is less contrast between the jebel and the surrounding vegetation, jebel species are also found in the savanna. The abundance and number of species is a reflection of the variety of the jebels. In general, the northern jebels have a poorer fauna than jebels in the woodland savanna zone, but favourable conditions of rock formation can result in high populations of rodents on northern jebels.

### *Acomys* in the northern Sudan

Setzer (1956) lists four species of *Acomys*, one with two subspecies, in the northern Sudan: *Acomys cahirinus cineraceus*, *A. c. hunteri*, *A. intermedius*, *A. lowei*, and *A. albigena*.

TABLE II  
Mammals, except bats, recorded on jebels in the northern Sudan

Jebel Guli 7	Ingessana Hills 9 (16)	Jebel Marra 34
<i>Crocidura</i> sp.	<i>Cercopithecus aethiops aethiops</i> (L.)	<i>Crocidura sericea marrensis</i> Thomas & Hinton*
<i>Papio doguera</i> ?heuglini Matschie	<i>Erythrocebus patas</i> ?pyrrhonotus	<i>Crocidura marita</i> Thomas & Hinton*
<i>Acomys calirinus cineraceus</i>	(Hemprich & Ehrenberg)	<i>Crocidura nyanzae darfurea</i> Thomas & Hinton
Fitzinger & Heuglin	<i>Heliosciurus gambianus</i> ?gambianus (Ogilby)	<i>Erythrocebus patas pyrrhonotus</i> (Hemprich & Ehrenberg)
<i>Arvicanthus niloticus</i> ?pesticularis	<i>Euxerus erythropus leucoumbrius</i> (Ruppell)	<i>Cercopithecus aethiops marrensis</i> Thomas & Hinton*
(Sundevall)	<i>Acomys calirinus cineraceus</i>	<i>Papio doguera heuglini</i> Matschie
<i>Leggada</i> sp.	Fitzinger & Heuglin	<i>Lepus capensis hawkeri</i> Thomas
<i>Hystrix cristata</i> L.	<i>Arvicanthus niloticus</i> ?pesticularis (Sundevall)	<i>Euxerus erythropus limitaneus</i> Thomas & Hinton
<i>Procavia ruficeps</i> ?ruficeps	<i>Hystrix cristata</i> L.	<i>Heliosciurus gambianus canaster</i> Thomas & Hinton
(Hemprich & Ehrenberg)	<i>Procavia ruficeps</i> ?ruficeps	<i>Tatera benvenuta benvenuta</i> (Hinton & Kershaw)
	(Hemprich & Ehrenberg)	<i>Taterillus emini clivus</i> Thomas & Hinton
	<i>Sylvicapra grimmia</i> (L.)	<i>Gerbillus (Dipodillus) lowei</i> (Thomas & Hinton)*
	(lion, leopard, hyaena, jackal, elephant, gazelle, waterbuck†)	<i>Steatomys aquilo</i> Thomas & Hinton*
		<i>Mastomys natalensis marrensis</i> Setzer*
		<i>M. kulmei</i> Setzer*
		<i>Acomys calirinus cineraceus</i> Fitzinger & Heuglin
		<i>Arvicanthus niloticus</i> ?centralis Dollman
		<i>Lemniscomys dunni dunni</i> (Thomas)
		<i>Lemniscomys lynesi</i> Thomas & Hinton*
		<i>Leggada tenella</i> Thomas
		(Porcupine quills)
		<i>Felis libyca libyca</i> Forster
		<i>Herpestes sanguineus sanguineus</i> Ruppell
		<i>Hyaena hyaena dubbath</i> Meyer
		<i>Canis aureus sudanicus</i> Thomas*
		<i>Vulpes vulpes pallida</i> (Cretzschmar)
		<i>Ictonyx striatus sudanicus</i> Thomas & Hinton
		<i>Panthera pardus</i> L.
		<i>Panthera leo</i> L.
		<i>Lycan pictus</i> (Temminck)
		<i>Procavia ruficeps marrensis</i> Thomas & Hinton*
		<i>Sylvicapra grimmia</i> (L.)
		<i>Gazella rufifrons</i> Gray
		<i>Strepsiceros strepsiceros</i> (Pallas)

TABLE II continued  
Mammals, except bats, recorded on jebels in the northern Sudan

Jebel Qeili 3	Merkiyat Jebels 0	Sabaloka Hills 4	Jebel Sileitat 0 (1)
<i>Atelerix pruneri pruneri</i> (Wagner)	—	<i>Acomys cahirinus cineraceus</i>	<i>Vulpes pallida pallida</i>
<i>Acomys cahirinus cineraceus</i>		Fitzinger & Heuglin	(Hemprich & Ehrenberg)
Fitzinger & Heuglin		<i>Gerbillus campestris venustus</i> (Sundevall)*	
<i>Gerbillus campestris venustus</i> (Sundevall)*		<i>Vulpes pallida pallida</i> (Cretzschmar)	
		<i>Procavia ruficeps ruficeps</i>	
		(Hemprich & Ehrenberg)	

\* Endemic species and subspecies.

‡ Recorded by Evans-Pritchard (1927) from local knowledge.



In a later paper (1959) he considers that *hunteri* is, in fact, a subspecies of *A. dimidiatus*. It appears that *A. dimidiatus* is found only in the extreme north of the country along the Egyptian border, *A. cahirinus* in the region of the Blue and White Niles, and also on Jebel Marra, *A. intermedius* in Kordofan, *A. lowei* in Darfur around the base of Jebel Marra, and *A. albigena*, an Ethiopian species, at Gallabat on the Ethiopian foothills. Most of the *Acomys* in this study were collected from the region of *A. c. cineraceus* in Setzer's 1956 map. Some were collected further south, and others on Jebel Marra. The first *Acomys* from Darfur, collected in 1920, were originally described as *A. witherby*, which is now a synonym of *A. c. cineraceus*, but Setzer (1956) described those lighter coloured ones from El Fasher and district as *A. lowei* but did not redescribe or mention the Jebel Marra specimens which are *A. c. cineraceus*.

There is great variety in size (Table III) and colour of the *Acomys* collected. The specimens from Sabaloka are the palest with no black along the mid-dorsal line, and those from the Ingessana Hills are the darkest with extensive black colouring on the back, head and sides. Three specimens from the base of Jebel Tozi, north of Roseires on the west bank of the Blue Nile, are the darkest specimens of all. These, except for their larger size, might be *A. albigena* which is recorded from Gallabat, 150 miles to the east. The presence of a bicoloured tail, used by Setzer (1956) to distinguish *A. albigena* from the other *Acomys*, is not a reliable character since some *A. cahirinus* also have a bicoloured tail and others do not. None of the specimens from the northern part of the study area have dark feet, a feature used by Setzer (1959) to distinguish *A. dimidiatus hunteri* from *A. cahirinus*.

The specimens were compared with those of *Acomys cahirinus cineraceus*, *A. c. hunteri*, and *A. albigena* in the British Museum (Natural History). The specimens of *A. c. hunteri* are lighter in colour than most of the present specimens, except for some of those from the Sabaloka Hills. The *A. albigena* are generally darker and smaller although the specimens from Jebel Tozi and the Ingessana Hills are almost as dark. Skull characters varied in all the specimens so it is not possible to draw any definite conclusions about the relationships of the specimens. It seems likely that all the *Acomys* in the northern Sudan form a cline from north to south, dependent on climate and topography, which will be more obvious when additional specimens are available. All the present specimens are considered to be *A. c. cineraceus*.

In the Sudan, *Acomys cahirinus* is exclusive to the rocky regions in the desert, and to rocks and dense grass in the woodland savanna zone. None were found in buildings. In Egypt, however, *A. cahirinus* is found in buildings and in the "desert" and "dry cultivated areas near buildings" (Hoogstraal, 1963), and Setzer (1959) remarks that it is commensal. *Acomys dimidiatus* and *A. russatus* in Egypt are found among rocks and boulders, living in ecologically similar habitats to *A. cahirinus* in the Sudan. This reversal of habitat preference is difficult to understand, but it may be a result of competition between commensal species, or because of the denser human habitation in Egypt, which results in "jebel-like" habitats.

### Discussion

The suitability of a jebel as a habitat for mammals depends on its size and position, the amount of cover, and the availability of food. Consequently semidesert jebels, whatever their size, have fewer species and individuals than jebels in woodland savanna. Jebels of

TABLE III  
*Measurements and weights of adult Acomys cahirinus from six populations in the northern Sudan*

N =	Jebel Guli			Ingessana Hills			Jebel Marra			Jebel Qeili (male)			Jebel Qeili (female)			Sabaloka Hills			Jebel Tozi (grass around base)		
	Mean	Range	S.D.	Mean	Range	S.D.	Mean	Range	S.D.	Mean	Range	S.D.	Mean	Range	S.D.	Mean	Range	S.D.	Mean	Range	S.D.
14	8	2	10	9	9	2															
Head and body (mm)	100.7	90-110	6.7	97.4	85-100	7.3	100.0	90-100	—	99.0	85-105	6.6	101.6	95-110	4.3	96.3	90-103	4.4	113.3	110-120	—
Tail (mm)	105.5 (13)	92-117	6.5	91.4	75-100	7.5	80.0	70-90	—	83.2 (5)	80-87	3.5	84.3 (7)	75-90	7.9	94.0 (7)	85-100	6.4	85.7	85-86	—
Hindfoot (mm)	17.4	15-19	1.6	17.4	16-18	0.7	17.0	16-18	—	16.3	15-18	1.0	16.1	15-17	0.6	15.1	13-17	1.1	15.3	14-16	—
Ear (mm)	15.9 (8)	15-17	0.6	15.3	15-16	0.5	16.5	16-17	—	14.6 (7)	14-15	0.5	14.9 (8)	14-16	0.8	15.5 (8)	15-16	0.5	15.3	15-16	—
Weight (g)	28.7	20-35	4.7	27.8	21-35	4.0	27.0	26-28	—	31.5	26-37	3.6	32.4	27-43	5.2	29.1	25-34	4.0	—	—	—
Greatest length of skull (mm)	28.4	27.1-30.0	1.0	27.9	26.0-29.6	1.1	27.3	27.3	—	27.9	26.6-29.0	0.8	28.1	26.8-28.9	0.8	27.4	26.6-28.4	0.6	28.4	27.7-29.4	—
Condylar-incisive length (mm)	25.8	24.9-26.9	0.8	25.2	23.6-26.8	1.0	25.4	25.4-25.5	—	25.5	24.8-26.9	0.9	25.6	24.0-26.4	0.7	25.3	24.8-26.2	0.4	26.1	25.5-27.2	—
Width zygomatic arch (mm)	13.7	13.2-14.0	0.4	13.3	12.6-13.5	0.3	12.6	12.6	—	13.1	12.2-13.9	0.5	13.1 (8)	12.5-14.0	0.5	12.8 (7)	12.4-13.3	0.4	12.5	12.4-12.7	—

Body measurements correct to nearest mm; skull measurements correct to nearest 0.1 mm; weights correct to nearest g. Mean values and s.d.'s correct to nearest 0.1 mm and 0.1 g. When the number in the sample is less than that indicated at the top of each column, this is indicated in brackets after the mean value.

granite and syenite provide boulders and crevices for shelter and for retaining dried grasses, seeds, and moisture. Food for herbivorous mammals in the semidesert may be a limiting factor at certain times of the year but the high populations on suitable jebels suggest that abundant food is available there. It is not known whether there is a seasonal fluctuation in the numbers of jebel mammals. Woodland savanna jebels, exemplified by Jebel Marra, have many ecological niches, and presumably no lack of cover nor food.

The jebels in the semidesert are isolated ecological habitats entirely different from the surrounding desert plain; this is equally true whether sand, clay, or cotton soil surround the jebel. As shown above, the jebel fauna is unique and confined to the jebel, and is discontinuous with most of the desert fauna. *Acomys cahirinus* and *Gerbillus campestris venustus* are only found on jebels and *G. pyramidum*, *G. watersi* and *Jaculus jaculus* are only found in the desert. There appears to be no movement of small mammals to and from the jebel. The larger mammals move to the base of the jebel, or into the desert at night: hyrax feed on the nuts of the *Balanites* trees which are commonly found growing at the base of jebels; hedgehogs and foxes leave their resting places to hunt in the desert.

The vegetation on the jebels in the woodland savanna usually merges into that of the surrounding plain (Jebel Marra, Ingessana Hills). In contrast, a granite jebel in these regions (e.g. Jebel Guli) shows less continuity since there is an abrupt change from the boulders of the jebel to the sand of the plain. But in both instances there is a grass cover on and around the jebel so that some species thought of as "jebel species" in the semidesert are found in the grass surrounding the jebel.

Another interesting feature of the semidesert jebels is the abundance of *Acomys*, usually to the exclusion of all other small mammals. With the exception of Jebel Marra, *Acomys* is the most abundant small mammal on all jebels. On Jebel Guli, apart from one *Leggada*, *Acomys* was the only species of small mammal, and on Jebel Qeili and the Sabaloka Hills there are *Acomys* and *Gerbillus campestris* in the ratio of about 5:1. There is no conclusive evidence why *Acomys* is the dominant small mammal. It may be because of the past climatic and vegetational history of the region to be discussed below; or *Acomys* may be the only species capable of living successfully in rocky regions; or it has competed with and excluded all other small species except *G. campestris*. This last suggestion seems unlikely since *Acomys* are not common where there are many other species (Table I) and in captivity, at least, it is shy and retiring. *Acomys* does not breed at a faster rate than other local species since limited evidence suggests a breeding period similar to other small mammals in the northern Sudan (Happold, 1966), and it has only one to four embryos (Dieterlen, 1963; Happold, 1966). However, the very specialized maternal care shown by *Acomys* (Dieterlen, 1963) may result in a high breeding success and, in the absence of competition, a high population. It would be interesting to know the exact ecological requirements of *Acomys* and *G. campestris*, and whether they are spatially isolated and how much competition there is between them.

At the present time each population of *Acomys* on a semidesert jebel is isolated from each other. Because of the intervening desert between the jebels, there is no chance of the populations mixing. There is now good evidence that in the past this region of the Sahara was a sort of woodland savanna, composed of Ethiopian species, or Mediterranean ones, or perhaps a mixture of both (Monad, 1961; Moreau, 1966 especially chapter 3). During the last million years, the northern limit of the Ethiopian savanna has moved north and south due to the effects of glaciation and interglacial periods. The last glaciation was

approximately 25,000–15,000 years ago and present temperatures were not resumed until about 8000 years ago (Moreau, 1966). During the last glaciation the northern limit of the savanna would have been further south than at present, and likewise further north during the warm interglacial periods. The populations of *Acomys*, like those of other jebel species, and like elephants and giraffes (see Monad, 1961) had expanded or diminished distributions dependent on the climatic conditions. Between the last glaciation (15,000 years ago) and the drying of the Sahara (5000 years ago) *Acomys* was probably widely distributed and existed in localities other than jebels, as it does in the present woodland savanna zone, and many populations were more or less continuous. The eastern Sahara has probably been drier for a longer period than the western Sahara, but it was humid during the Neolithic period. This suggests that the desert jebels have been isolated for perhaps 10,000 years. This explains the present discontinuous distribution of the jebel species, and the lack of differentiation at the species level in most populations. *Acomys cahirinus* is distributed in rocky regions in most of northern Africa (even in the Hoggar Mountains—see Niethammer, 1963). *Gerbillus campestris* is also found on widely scattered rocky regions in northern Africa, and *G. lowei*, a similar and closely related species, occurs on Jebel Marra. Since jebel mammals have restricted habitats, distribution maps without ecological details are very misleading, e.g. Setzer's (1956) map of the distribution of *Acomys* in the Sudan.

Jebel Marra, formed in the Miocene, is the only jebel where several endemic species and subspecies are found: five endemic species and reputedly five endemic subspecies (Table II). Jebel Marra is sufficiently large and varied in habitat to support a diverse mammal fauna which in turn allows for a greater chance of speciation. The mammals of the other jebels have not undergone speciation to the same extent. The jebels in the eastern Sudan are not sufficiently large, nor have they been isolated from long enough, to have allowed as much speciation. *Acomys cahirinus* has two subspecies (Setzer, 1956): *cineraceus* in the area round the Niles, and *hunteri* in the northern Sudan towards the Egyptian border. But as Setzer remarks, there is intergradation between these subspecies.

I wish to thank the University of Khartoum for funds for my research and travel, and Dr G. B. Corbet of the British Museum (Natural History) for his comments on the manuscript and for comparing some of my *Acomys* with specimens in the Museum.

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