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Cover Page Footnote

We deeply appreciate the help received from the Ministry of Agriculture, Government of Eritrea in Asmara. Also acknowledged are Solomon Tewelde (Director of Administration of Haykota), Abraha Garza (head of Ministry of Agriculture Zoba Gash-Barka at Barentu), Aregay Haileselesse and Yohannes Ogbalidet (Ministry of Agriculture, Haykota), Haile Berhane, Yemane, and Kibrom Kifle who joined us on trips to Haykota, and farm owner Solomon Hagos. Dietmar Zinner, Yosief Libsequal (Director, National Museum of Eritrea), Kifle Ghebreab, Yonas Isaak, Matthew C. Curtis, and Jonathan Miran helped with other aspects of this study. This paper was reviewed by Ian M. Redmond.

OBSERVATIONS ON ELEPHANT HABITAT AND CONSERVATION OF ELEPHANTS IN ERITREA

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Abstract. Confined to a small area of about 100 by 50 km, the elephants in Eritrea are one of the northernmost populations in Africa. They are vulnerable because they appear to be genetically isolated and their small number may renders them a non-viable population. During 1997-1999 we visited elephant habitat in the Zoba Gash-Barka in southwest Eritrea to study problems of encroaching human populations on elephant habitat. This situation was described in the preceding article by Hagos Yohannes who is proposing to translocate farmers — with their willing cooperation — from the conflict zone to non-wildlife designated areas. Should such an ambitious plan be too difficult to execute, an alternative solution is being considered.

INTRODUCTORY COMMENTS

BACKGROUND

African elephants' habitat has been shrinking ever since humans began cultivating and developing wilderness areas, often encroaching into habitats designated to protect wildlife. This competition has resulted in the confinement of elephants and other wildlife to reserves and national parks. When elephant numbers are deemed to exceed the carrying capacity of an area, culling may be called for. Concomitantly, the previous popularity of ivory resulted in the killing of elephants to keep up with the demand. Poaching, habitat reduction, and habitat fragmentation are probably major causes for the drastic decline in numbers of wild African elephants (*Loxodonta africana*) — from about

Captions for figures, on next page

Figure 1. Map of Eritrea depicting major rivers, roads, towns, and elephant habitat [artwork by Jann S. Grimes].

Figure 2. A view near the “swollen” Gash River, Zoba Gash-Barka, southwest Eritrea [this photograph and Figs. 3, 5, 7, and 8 were taken by J. Shoshani].

Figure 3. In search of elephant spoor in doum palms woodland in the floodplain of the Gash River. In places the forest is dense which makes it difficult to spot elephants.

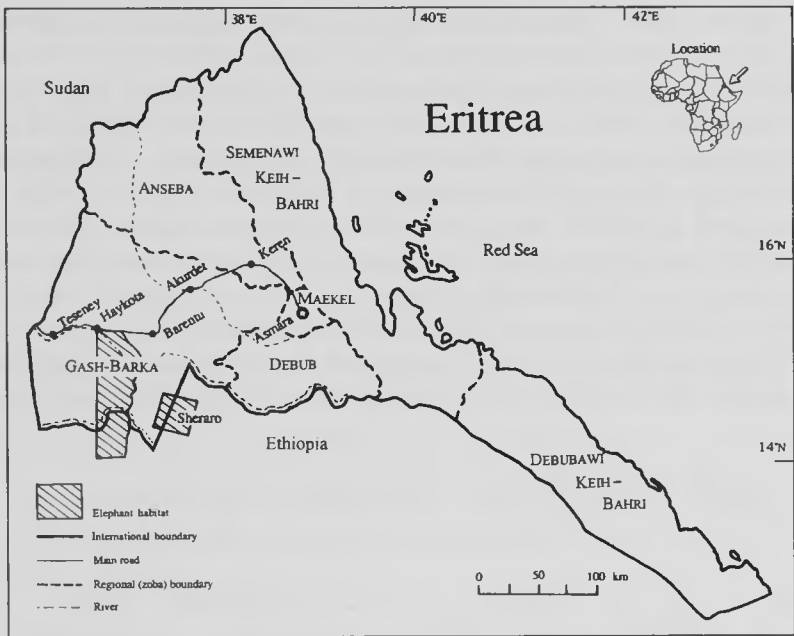
Figure 4. Four-month-old elephant scat in cultivated area near the Gash River, examined by the senior author [photograph by Yacob I. Yohannes].

Figure 5. An elephant scat with an encased whole doum palm seed, and separately collected seed, left foreground, from the Gash River vicinity (the length of the ruler is 16.5 cm, 6.5 inches).

Figure 6. An elephant that was killed in 1995 near the Gash River [photograph by Solomon Tewelde].

Figure 7. Four tusks of elephants; data given in Table 1.

Figure 8. One of the co-authors (Hagos Yohannes) holding tusk number 5 (data in Table 1) in his office in Asmara, Eritrea.



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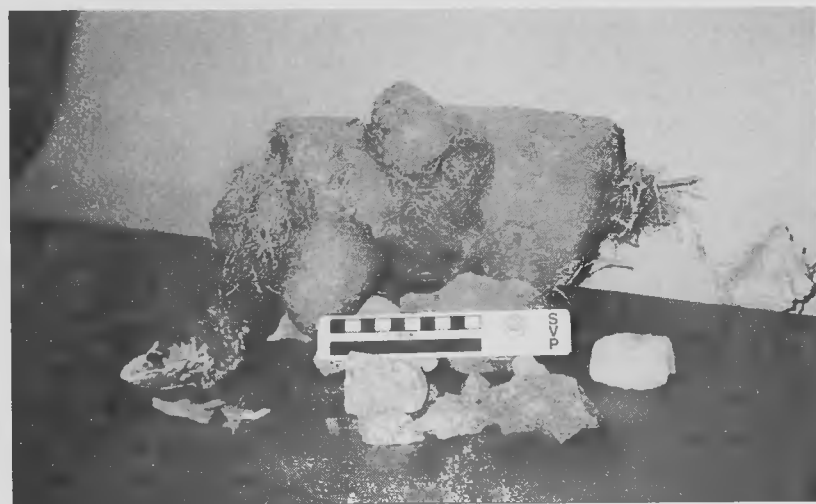
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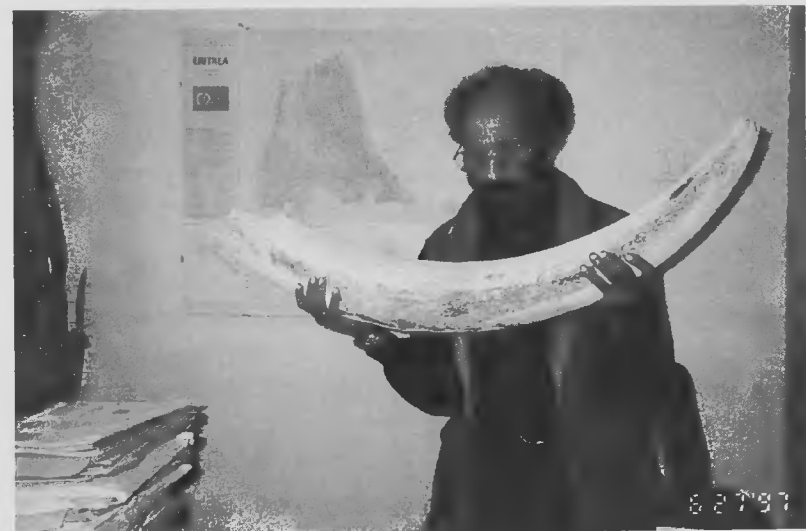
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1,300,000 in 1979 to 609,000 in 1989 (Douglas-Hamilton and Michelmore, 1996). Historical and paleontological records of elephants and proboscideans in Eritrea are noted in Appendix 1.

Habitat fragmentation results in isolation of elephant populations. They have become islands of demes or separate sub-populations, developing their own behaviors and "cultures" (Redmond, 1986). These 'islands', if not well monitored and protected may, depending on their size, soon lose genetic diversity, and be engulfed by the growing human population. The elephants at Zoba Gash-Barka in Eritrea (Fig. 1) are a classic example of isolated deme. The elephants in Eritrea are confined to a small area of about 100 by 50 km and are especially vulnerable. Since achieving independence in 1991, Eritrea has been coping with a variety of challenges in its effort to recover from war damages. Notwithstanding its struggles, Eritrea is devoting much effort to wildlife conservation. The suggested proposal by Hagos Yohannes (Hagos, 2000) for relocating farmers away from the elephants' habitat to developing (non-wildlife designated) areas is a testimony to Eritrea's priorities. The vulnerability of the elephants in Eritrea and their value as part of the international wildlife heritage cannot be overstressed.

PURPOSE

Short term plans of the Ministry of Agriculture include: continuing with the survey and assessment of populations of elephants (their numbers, ages, demography, and distribution) in preparation for conservation management plans, with emphasis on the possible translocation of local inhabitants from elephant habitat to non-wildlife designated areas. Long term plans include: implementing a well-planned translocating project, including the local people in the overall management plan to give them incentive to participate in these efforts and help improve their living conditions [for example, by building a bridge over the Gash River, constructing fences, as needed, and, if possible, collecting blood and other tissue samples from elephants for genetic studies. Should the translocating project be too difficult to execute, an alternative solution — to erect an electric fence using solar power — is being considered. It is possible that an elephant-proof fence may be needed even after translocation to prevent elephants from moving into other cultivated areas.

HABITAT OF THE GASH-SETIT PROPOSED RESERVE

The Gash-Setit area in zoba Gash-barke (Fig. 1) is riverine bush, composed mostly of ziziphus (*Ziziphus spina-christi*) and doum-palm bush (*Hyphaene thebaica*; Figs. 2 and 3, and Appendix 2), as well as acacia woodland and savanna. Mosquitoes are commonly found in this area, but not tsetse flies. The Gash River (a wadi) flows during the rainy season (Fig. 2) from about June through September, whereas the Setit (Tekezze) River is a permanent river. Elephants are usually located south of the Gash River in the Tekezze Valley, Ethiopia, and migrate between Eritrea and Ethiopia. Local people (usually of the Kunama Tribe) reside on the periphery of the proposed reserve area in sparse habitations with their domestic stocks of camels, cattles, goats, and sheep.

RESULTS AND DISCUSSION

OBSERVATIONS AND INFORMATION FROM LOCAL INHABITANTS

We traveled in desert and semi-desert habitat from the Asmara plateau (2,400 meters, or 7,000 feet, above sea level) to the lowlands via Keren, Akurdad (or Akordat), Barentu, and Haykota (or Haicota, about 500-1,000 meters above sea level; Fig. 1). The Gash River was swollen and gushing from the recent rains (Fig 2),

at which time the elephants do not cross the river; thus we were not able to see them. We found, however, scats in the middle of cultivated areas close to the river, a total of five dung boluses (Figs. 4 and 5). A medium-sized bolus measured 15 x 15 x 15 cm, and a large one measured 20 x 18 x 15 cm. Upon close examination of one of the boluses, we found many fibers, parts of palms, and complete fruits and seeds of doum palms. We also inspected two upper molars of a dead elephant whose age was estimated to be 12-18 years at time of death, and stored tusks of elephants from that region (Table 1 provides essentials; cf. Figs. 6-8). Note that the eight tusks are about the same length (with an average of 107.3 cm) and with an average weight of 9.8 kg per tusk.

Table 1. Data on tusks of elephants from Eritrea [1].

Tusk No. [2]	Weight	Total Length [3]	Circumference at base [4]	Pulp Length [5]
1	13 kg	120.0 cm	43.0 cm	64.5 cm
2	12 kg	105.0 cm	43.4 cm	76.5 cm
3	8 kg	114.5 cm	37.5 cm	62.5 cm
4	7 kg	104.0 cm	36.5 cm	59.0 cm
5	— [6]	106.7 cm	42.5 cm [7]	47.0 cm [7]
6	~5 kg	90.0 cm	26.5 cm	29.0 cm [8]
7	~12 kg	104.0 cm	42.5 cm	- - - [9]
8	11.5 kg	114.5 cm	40.5 cm	70.5 cm [9]
Average per tusk	9.8 kg	107.3 cm	39.5 cm	59.1 cm

GENERAL NOTES: Tusk nos. 1 through 4 were collected in the vicinity of Haykota in Zoba Gash-Barka, as recently as December 1996. Tusk no. 5 was collected in 1996 near Hasta, Sahel (Zoba Semenawi Keih-Bahri), 200 km north of Haykota, far beyond the current "elephant zone" in Eritrea.

- [1]. Data collected June 26, 1997, by J. Shoshani and Yacob Yohannes, with the help of Solomon Tewelde and others.
- [2]. The first four (nos. 1 and 2, and 3 and 4) may be pairs.
- [3]. Measured along center of tusks as they lay flat on ground.
- [4]. Measured as close to the proximal end as possible.
- [5]. Measured by inserting a wire into the pulp until it stopped.
- [6]. Estimated weight is similar to tusk number 3.
- [7]. Circumference is estimated because base was broken. This also affected the measurement for the pulp length. Length of pulp cavity was 38.5 cm, and the estimated length is 47.0 cm.
- [8]. Tusk no. 6 was displayed at the Expo/Festival, Asmara, Eritrea, September 6, 1998.
- [9]. Data on these tusks were taken at the Jolly Gift Shop, Asmara, Eritrea (November 26, 1999); tusks are said to have been collected in the Gash-Barka area, Eritrea.

Based on information from local inhabitants, as conveyed to us by Abraha Garza (head of Ministry of Agriculture Gash-Barka Zone at Barentu), it is evident that there is a conflict between elephants and farmers. The elephants destroy or uproot crops, and the people replant with those that elephants prefer less. For example, many banana plantations close to the river floodplain have been replaced with citrus trees or vegetables such as eggplants and peppers. In recent years angry farmers have shot and killed elephants on their cultivated fields (Fig. 6). In 1993, for example, a mature elephant (?male) was killed near Tekezze River, and in 1995, a pregnant female was killed near Haykota; her calf was not fully developed and also died.

ESTIMATED NUMBER OF ELEPHANTS IN ERITREA

Said *et al.* (1995, p. 68) reported on an estimate of 70-100 individuals in the Gash-Setit area and noted that in the aerial reconnaissance survey in October 1993 (based on an unpublished report of Hagos, 1993) six elephants were definitely sighted. Said *et al.* (1995) also reported that the elephants in Eritrea spend a part of each year on the Ethiopian side of the border, south of the Setit River. A more recent survey (Litoroh, 1997) reported on the sighting of eight elephants, with the possibility of missing some elephants due to dense vegetation, inexperienced crew, and movement of elephants during a period in which the survey was interrupted (see also Appendix 2). Litoroh (1997, p. 16) noted that "... the Tekeze valley elephants probably have some linkage with elephants in Sudan." Our estimate on the number of elephants in Eritrea is somewhere between the two extremes noted above (between 8 and 100); obviously long term data collection is required to have a better understanding of the nature of the elephants and their possible local short distance migratory paths.

COMPARING ELEPHANT CONSERVATION PROJECTS

Very few projects may be compared to the suggested conservation plan in Eritrea. Most field observations on elephants deal with ecology and ethology (e.g., Buss, 1961, 1990; Kahl and Armstrong, 2000; Moss, 1988; Sikes, 1971). Some studies are geared towards gathering basic data and recommendation for a management plan, e.g., opening corridors (when such options exist; Douglas-Hamilton and Douglas-Hamilton, 1975, 1992) or suggesting culling (when a park's carrying capacity of elephants has been exceeded, Buss, 1980; Hanks, 1979). We are not aware of any conservation-related projects on elephants in which wildlife authorities are recommending translocating people with goodwill and cooperation from a previously inhabited elephant range (Hagos, 2000), rather than translocating elephants, as implied in certain literature (Douglas-Hamilton and Douglas-Hamilton, 1992; Leakey, 1992; Owens and Owens, 1992). Of course, many workers suggested compensation to farmers/land owners for damage caused by elephants (e.g., Sukumar, 1994).

In this respect, the proposed conservation plan in Eritrea is unique, and it is hoped that it will be an example for future similar programs. One must keep in mind, however, that the combination of circumstances that exist in Eritrea may not exist in other countries. These include farmers who are willing to move to other areas and wildlife authorities who see the potential in providing a safer environment for the already relict elephant population (elephants have been killed by farmers near the Gash River). Management plans to protect the elephants and their ecosystem in Eritrea will, undoubtedly, necessitate the cooperation of three governments, those of Eritrea, Ethiopia, and Sudan.

CONCLUSIONS

Several elephants were observed in the Gash-Setit Reserve area (Litoroh, 1997). It is possible that there are more elephants, but they are difficult to spot from the air among the dense "forest" of doum palms and other vegetation. It is also possible that many of the elephants are nocturnal; in June 1999 JS and YY revisited the Haykota area and did not see elephants, but did see many fresh spoor. Interviews with Haile Berhane (a wildlife scout in the Gash-Setit Reserve area since 1992) and farmers revealed that elephants are active at night to avoid human harassment. Haile Berhane also informed us that in the dry season elephants move from Tekeze River to the Gash River area, and during the rainy season when insects are plentiful, they return to Tekeze valley. During the years he has observed a maximum of 18 elephants

including young in one day in one locality. Regardless of the exact number, this elephant population is small and isolated (thus may not be viable unless interbreeding with viable populations occurs **). Efforts must be made to protect them. Their value cannot be expressed monetarily, but it is substantial ecologically within their ecosystem, both as keystone or super-keystone species (Shoshani, 1992, 1993) and in the context of ecotourism (Redmond, 1992, 1996). These authors stressed that saving elephants would automatically save large areas that would also protect other wildlife in the same ecosystem.

** There appear to be some positive development for elephants in Eritrea — on September 6, 1998 Kifle Ghebreab, Yonas Isaak, and J. Shoshani of the University of Asmara purchased a video tape (filmed on April 4, 1998 by Mahmood Mohamed) depicting elephants in Haykota area, some with young calves.

ACKNOWLEDGMENTS

We deeply appreciate the help received from the Ministry of Agriculture, Government of Eritrea in Asmara. Also acknowledged are Solomon Tewelde (Director of Administration of Haykota), Abraha Garza (head of Ministry of Agriculture Zoba Gash-Barka at Barentu), Aregay Haileselesse and Yohannes Ogbalidet (Ministry of Agriculture, Haykota), Haile Berhane, Yemane, and Kibrom Kifle who joined us on trips to Haykota, and farm owner Solomon Hagos. Dietmar Zinner, Yosief Libsequal (Director, National Museum of Eritrea), Kifle Ghebreab, Yonas Isaak, Matthew C. Curtis, and Jonathan Miran helped with other aspects of this study. This paper was reviewed by Ian M. Redmond.

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Appendix 1. Elephants and proboscideans in Eritrea in historical and paleontological records.

Although there are no elephants today in the eastern portion of Eritrea, it is possible that they roamed this land in the not very distant past. A clue that elephants may have inhabited regions close to the Red Sea in historical times comes from the name of a fishing village "Irafale" (or "Irafaile") not far from Adulis, about 85 kilometers south of Massawa. Irafale means "the place or pasture of elephants" (in Arabic and possibly in any Semitic derivative language, "ard" means soil or land, and "fil" means elephant). It has also been reported that Adulis wharves were used to ship African elephants trained for war in an incident called "the Battle of the Elephants", apparently in Yemen across the Red Sea. The southern coast of the Red Sea, corresponding to modern Eritrea, Ethiopia, Djibouti, Somalia, and the adjacent coast of the Gulf of Aden is said to be the ancient Land of Punt, the place of legend and fable, the "Divine Land", mentioned in early scripts as trading post with Egypt [Queen Hatshepsut, reigned circa 1503-1482 BC, is said to have traveled to Punt to fetch/trade incense trees, ostrich feathers, gold, ivory, and even live elephants]. The 16th century Portuguese Jesuit missionary, Francisco Alvarez, is said to have observed elephants and giraffes in the vicinity of Debre Bizen, a monastery, about 25 km east of Asmara, the capital of Eritrea. More concrete evidence for the presence of elephants in Eritrea in historical times comes from archeological sites. Qohaito (or Kohaito), a site on the highland of southern Eritrea, is interpreted to have been an ivory trade post. In Ham Monastery (about 100 km south of Asmara) sixty mummies were found wrapped with what is believed to be elephant skins. It is possible that this part of the Horn of Africa is the origin of the mummification process. In addition, some archeological sites in Eritrea include engravings, petroglyphs, and pictographs of elephants (Yosief Libsequal, personal communication). In the autumn of 1998, at the Expo/Festival ground in Asmara, Kifle Ghebreab, Yonas Isaak, and J. Shoshani, took measurements and photographed war shields made from ancient hippopotamus and elephant skins; some are said to be from animals originating in Eritrea, possibly from regions other than the western part of the country where elephants are found today. Recently, remains of extinct proboscideans (elephantids and gomphotheres) have been found in the plains towards the Red Sea.

Appendix 2. Animals and plants encountered in the Gash-Setit area.

Appendix 2, Part A — Large mammals counted during aerial survey at the Gash-Setit area between October 31 and November 16, 1996, as reported by Litoroh (1997, pp. 12, 16).

African elephant (*Loxodonta africana*) — 8 individuals
 Greater kudu (*Tragelaphus strepsiceros*) — 9 individuals
 Waterbuck (*kobus ellipsiprymnus*) — 7 individuals
 Bushbuck (*Tragelaphus scriptus*) — 3 individuals
 Oribi (*Ourebia ourebi*) — 2 individuals

NOTE: Litoroh (1997, p. 16) wrote: "All these species occur at low numbers, probably due to human activity in the region." According to Kingdon (1997), Eritrea is on the northern-most and northeastern-most distribution boundaries of these mammals.

Appendix 2, Part B — Observation of wildlife and trees by J. Shoshani and Yacob Yohannes or by J. Shoshani and students during June 25-27, 1997, December 11-13, 1998, and June 1-4, 1999. Observations were made on the way from Asmara to Haykota via Keren, Barentu, Akurdar, particularly in the vicinities of Haykota, Awgaro, and Tokombiya, all within the Zoba Gash-Barka close to the Eritrean-Ethiopian border (Fig. 1). Arid savanna-like landscape, mountainous, hills, wadis, oases. In Barentu and vicinity, on June 25, at about 2:45 PM the temperature in the shade was 24° C and in the sun was 30° C. In Haykota and vicinity, on June 26, at about 12:00 noon the temperature in the shade was 34° C and in the sun was 44° C. Identifications of taxa below are after B+=Bein *et al.* (1996, for trees), V=Van Perlo (1995, for birds), K=Kingdon (1997, for mammals); page or plate numbers are given in square brackets with initials. Note: many of the avian and mammalian species observed do not resemble those in the sources consulted, but are close to them; see # below. When known, names in Tigrigna are in quotes inside parentheses. Unless stated otherwise, plants and animals are indigenous.

Plants:

- Acacia* sp., thorn-tree ("chea"; Litoroh, 1997, p. 13 provided a sample of common trees in the Gash-Setit region, e.g., *Acacia nilotica*, *A. seyal*, and *A. tortilis*) [B+:32-3, 42-3, 46-7]
Adansonia digitata, baobab tree ("duma") [B+:50-1]
Agave aff. *sisalana/americana*, agave or sisal ("ika"; introduced, originally from Mexico)
Aloe, aloe ("ire")
Azadirachta indica, neem tree introduced from India ("nim") [B+:78-9]
Calotropis procera, Dead Sea fruit or "Apple of Sodom" ("ghindae") [B+:110-1]
Dodonaea angustifolia, hop bush, tooth-brush bush ("tahses"; used by people in the highlands) [B+:172-3]
 epiphytes on doum palms
Euphorbia abyssinica, African candelabrum tree ("kolqual") [B+:198-9]
Ficus vasta, ficus tree ("daero") [B+:216-7]
Hyphaene thebaica, doum palm, or Egyptian doum palm ("arkobkoba") [B+:236-7]
Opuntia ficus-indica, prickly pear, Indian fig ("beles"; introduced, originally from Central America) [B+:288-9]
Salvadora persica, tooth-brush tree ("ada"); used by people in the lowlands) [B+:350-1]
Ziziphus spina-christi, ziziphus shrub/tree ("gaba") [B+:402-3]

Reptiles:

- Varanus* aff. *niloticus*, monitor lizard, has affinity to Nile monitor ("angog")

lizard (“tebek”), unidentified — On June 2, 1999, at 9:50 AM (it was hot, about 35° C) J. Shoshani stopped for to urinate next to an acacia tree not far from an aardvark burrow, and saw a long (about 30 cm) yellow lizard come close to him from among the branches on the ground. It came closer to the urine puddle and licked from it 4-5 times.

Birds:

- Aquila rapax*, tawny/steppe eagle (“nisri”) [V:plate 19. figure 3]
Bubulcus ibis, cattle egret (“---”; it was hot, a large flock was seen in the shade of an acacia tree, some were panting) [V:7.7]
Ciconia abdimii, Abdim’s stork (“ raza”) [V:8.7]
Columba guinea, speckled pigeon (“rigbit”) [V:38.7]
Coracias abyssinica, Abyssinian roller (“ufmeskel”) [V:49.5]
Coracias garrulus, Eurasian roller (“ufmeskel”) [V:49.3]
Corvus rhipidurus, fan-tailed raven (“kuak”) [V:85.16]
Cypsiurus parvus, African palm swift (“lequaquito”) [V:45.6]
Fringilla leucoscepus, yellow-necked spurfowl (“kokah”) [V:24.22]
Laniarius erythrogaster, black-headed bush-shrike, or gonolek (“hagos”) [V:83.12]
Milvus migrans, black kite (“shila”) [V:12.7]
Numida meleagris, helmeted guinea fowl (“zagra”) [V:25.19]
Oena capensis, Namaqua dove (“quatra”) [V:39.4]
passerine birds (e.g., sparrows, sunbirds, finches, serins)
Ploceus cucullatus, black-headed weaver (“---”) [V:89.1]
Psittacula krameri, rose-ringed parakeet (“hentsai”) [V:40.15]
Pterocles exustus, chestnut-bellied sandgrouse (“serenih”) [V:38.10]
Pycnonotus barbatus, common bulbul # (“fahru”) [V:62.11]
?Spreo superbus, superb starling (“wari”) # [V:87.8]
Threskiornis aethiopica, sacred ibis (“---”) [V:9.6]
Tockus flavirostris, eastern yellow-billed hornbill (“---”) [V:50.14]
Upupa epops, hoopoe # (“kumbraza”) [K:49.16]
Buphagus erythrorhynchus, red-billed oxpecker (“chirna”) [V:87.4]
Colius striatus, speckled mousebird (“- - -”) [V:47.3]

Mammals (listed as they appear in Kingdon, 1997):

Order Primates

Papio anubis, olive or anubis baboon (“hebey”) [K:34]

Order Lagomorpha

Lepus capensis, cape hare (“mantile”), dentary, scat, and live individuals [K:154]

Order Rodentia

Euxerus erythropus, striped ground squirrel # (“mintsutsulay”) [K:161]

Hystrix cristata, crested porcupine (“kinfiz”; scats and spines) [K:187]

rodents, small, rat-sized (“anchuwa”)

Order Carnivora

Canis mesomelas, black-backed jackal (“wekharia”) [K:219]

Herpestes sp. aff. *ichneumon* ?, *ichneumon*, or Egyptian mongoose (“---”; seen briefly in doum palm thicket) [K:240]

Order Tubulidentata

Orycteropus afer, aardvark (“fehira”; burrows and scats) [K:294]

Order Proboscidea

Loxodonta africana, African elephant (“harmaz”), spoors included scats, footprints, sliding marks, chewed vegetation (the scats, five boluses, about four months old, described in text) [K:305]

Order Perissodactyla

domesticated animals — donkey (“adgi”), donkey (“riff”; a ‘breed’ of light-colored donkey with tall legs, walks faster than the ‘regular’ donkey and is said to be adapted to lowland)

Order Artiodactyla

Gazella dorcas, dorcas gazelle (“irab” or “tele-bedu”) [K:410]

Phacochoerus africanus, common warthog (“mefles”) [K:335]

domesticated animals — cattle (“kebti”), camel (“gemel”), goat (“tiel”), sheep (“bege”) 🐏