

RESEARCH

The elephants (*Loxodonta africana*) of Gash-Barka, Eritrea: Part 1. Historical perspective and related findings

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Abstract

Historically, elephants inhabited the north, east, west and south-west of what is now Eritrea, a new nation in the Horn of Africa. Today, they are confined only to portions of Zoba Gash-Barka in the south-west. Historical observations are based on material from the National Museum of Eritrea, the Qohaito archaeological site, and documented observations that date to the third century BC when elephants were reported in parts of the Land of Punt, including portions of today's Eritrea. From the 16th through the late 19th century various authors reported on the presence of elephants in areas where there are none today, as well as in the Gash-Barka region. Throughout the 20th century reports were only from areas within Gash-Barka, and usually the elephants were in small numbers, except for one report of 100 to 200. The reasons for the shrinking elephant habitat in Eritrea vary from human settlements to lack of water resources. Observations of elephants during the 21st century have been helped by regular United Nations flights between Ethiopia and Eritrea. We also conducted ground surveys, which proved useful as it is difficult to observe elephants from the air in the dense riverine forest, composed mostly of doum palms. Two recent ground surveys (December 2001 and January–February 2003) provided valuable information on a relatively large elephant population in Eritrea. All 83 elephants, young and adult, observed in various locations within the watersheds of the Gash and Setit Rivers appeared in good physical condition. These data are welcome news of a large relict population of elephants in Eritrea, unheard of since 1955.

Additional key words: archaeological evidence, historical distribution

Résumé

Historiquement, les éléphants habitaient le nord, l'est, l'ouest et le sud-ouest de ce qui est maintenant l'Erythrée, un nouveau pays de la Corne de l'Afrique. Aujourd'hui, ils sont confinés dans des parties de Zoba Gash-Barka, dans le sud-ouest. Les observations historiques se basent sur du matériel trouvé au National Museum d'Erythrée, sur le site archéologique de Qohaito, et sur des documents qui remontent au troisième siècle AC et qui rapportent la présence d'éléphants dans certaines parties du Pont, dont certaines portions de l'Erythrée actuelle. Du 16ème à la fin du 19ème siècle, divers auteurs ont rapporté la présence d'éléphants dans des régions où il n'y en a plus aucun maintenant, ainsi que dans la région de Gash-Barka. Tous les rapports parus au 20ème siècle ne mentionnent que la région du Gash-Barka, et d'habitude les éléphants sont en petit nombre, à l'exception d'un rapport qui parle de 100 à 200 individus. Les raisons de la diminution de l'habitat des

éléphants en Erythré vont des installations humaines au manque d'eau. Les observations des éléphants qui ont eu lieu au 21^{ème} siècle ont été facilitées par les vols réguliers des Nations unies entre l'Éthiopie et l'Erythré. Nous avons aussi réalisé des études au sol, qui se sont avérées très utiles étant donné qu'il est très difficile d'observer des éléphants d'en haut dans la dense forêt riveraine, composée en majorité de palmiers doum. Deux études au sol récentes (décembre 2001 et janvier–février 2003) ont fourni des informations intéressantes sur une population d'éléphants relativement importante en Erythré. Les 83 éléphants, jeunes et adultes, observés à divers endroits entre les bassins versants du Gash et du Setit, semblent en bonne condition physique. Ces données sont autant de bonnes nouvelles d'une grande population d'éléphants en Erythré, dont on n'avait plus entendu parler depuis 1955.

Introduction

This paper is part one of our findings on elephants in Eritrea. The second will cover present numbers and distribution, ecology and behaviour, and fauna and flora in the biodiverse ecosystem of Zoba Gash-Barka. Gash-Barka is one of the six administrative 'zobas' (zones), in Eritrea. The others are Anseba, Debub, Debubawi Keih-Bahri, Maekel and Semenawi Keih-Bahri, each with its own geography, climate, vegetation, wildlife, ethnic composition, languages and trade.

Historical records of elephants were documented in all zobas except Debubawi Keih-Bahri at the south-east of the country, bordering the Red Sea on the east, Ethiopia on the west, and Djibouti on the south. Zoba Debubawi Keih-Bahri was not always a desert as it is today and has been in the recent past. Palaeontological findings dating from the Pleistocene include *Elephas recki*, an elephant that was also found in other countries in the Horn of Africa and in eastern Africa (Abbate et al. 1998; Coppens et al. 1978). To understand better some of the possible factors for the shrinking range of living elephants in Eritrea, a brief description of the physical and climatic setting is in order.

Physical and climatic settings

Topographically, the highland of Eritrea is a part of the massif uplift that occurred in the Tertiary, although the rocks themselves are of Precambrian origin, at least 570 million years old. The mountains, with an average elevation of 2000–2500 m above sea level, continue southward into Ethiopia and Kenya. On either side of the mountains are lowlands; to the east is the escarpment overlooking the Red Sea, and to the west the topography slopes gradually into the Gash-Barka zone and stretches towards Sudan farther west and Ethiopia to the south. In essence these are

the three main geographic zones of Eritrea: the highland, the eastern lowland and the western lowland (Paice 1996; Tetley 1996). Further subdivisions into coastal lowland, eastern escarpment, central highland, western escarpment, and western lowland have been employed by Zinner et al. (2000). According to White (1983) the phytogeographic classification of Eritrea includes at least three regions: Somalia–Masai, Sudanian and Afromontane. The western lowland (including the Gash-Barka) is a part of the Sudanian phytogeographic region.

Moisture from the Atlantic Ocean is carried north-east across the Congo Basin. Upon rising at the Ethiopian Plateau, clouds release their water content, which constitutes the long summer rains from June to September. In the opposite direction, moisture from the north-east Asiatic landmass is carried south-west across the Red Sea and clouds drop their content once they clash with the mountains, around March to April, in the short winter rainy season. Yet another source of rain at other times of the year is from the Indian Ocean. Some parts of Eritrea, like Filfil and Mrara, in the 'green belt' on the eastern escarpment receive monthly precipitation year-round (close to 100 mm per month) and this rainforest is the only place in Eritrea with a spectacular habitat for birds and other wildlife.

Only a few countries in the world, such as Namibia, can claim to have desert or semi-desert elephants—Eritrea is one of them. Today the elephants, *Loxodonta africana*, in Gash-Barka are one of the northernmost populations in Africa, inhabiting areas north of 15° latitude (the elephants in Mali inhabit latitudes of 16.5° N; Barnes et al. 1999, p. 210). Although not all the elephant habitat in Eritrea is xeric (dry), vast portions are dry for most of the year. With the exception of one, all rivers in Eritrea are seasonal (wadis); they flow only during the rainy seasons. The exception is the Setit (Tekezze) River, which flows all year; this river marks the boundary

between Ethiopia and Eritrea in the south-west. When water is scarce, elephants dig water-holes in dry riverbeds. The riverine forest in the flood-plains of the Gash and Setit Rivers is composed, in part, of impressive doum palms that contribute a special atmosphere to this already captivating oasis-like habitat.

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Figure 1. A decorated war shield said to be made from elephant skin, believed to be from areas of historical distribution.

Research objectives

We have been seeking an overview of historical distribution of elephants in Eritrea to better understand current distribution. We are also interested in finding out whether the current distribution occurred in past habitats.

Materials and methods

For the extirpated elephant population in Eritrea, we referred to the available literature and consulted historians. For the extant population, we used direct and indirect observations (spoor such as dung and footprints, chewed vegetation, scratching posts) and employed any help possible, which included local residents and United Nations personnel. In 1996, the senior author found one tusk near Hasta, Sahel (Zoba Semenawi Keih-Bahri), 200 km north of Haicota, far beyond the current elephant distribution in Eritrea. In addition, the National Museum of Eritrea (NME) in Asmara has on display leather shields, said to be made from the hide of elephants that roamed in regions where they are not found today. In its storage area is a third cervical vertebra of an elephant of unknown origin; it appears, however, to be an old bone. Our plans include carbon dating this tusk, a shield, and the vertebra with the hope that they will shed light on the timing of past distribution of elephants in this country. Genetic testing might help narrow the general sources (within or outside Eritrea) of these items. Archaeological remains such as petroglyphs of elephants near Qohaito on the highland of Eritrea,

outside current elephant distribution, provided additional material evidence.

Results

Examination of material at the National Museum of Eritrea and petroglyphs at Qohaito

Using a magnifying lens, we examined the shields displayed at NME (fig. 1). We could not be certain that they are genuine elephant leather, which has characteristic hexagonally shaped studs with hair protruding in between the hexagons in the pattern (Horstman 1966). In some places a possible similar pattern was detected. Identifying these studs could be difficult because the leather had been worked and stretched in the tanning process. Genetic testing might

give credence to their authenticity as elephant products. As museum records indicate that these shields may have originated from outside Gash-Barka, it is possible that they came from an area that historically had had an elephant population. Radiometric dating on a sample from these shields would be useful as further corroboration of their age.

In the gorge close to the archaeological ruins of Qohaito one can find petroglyphs of animals, including those of elephants, engraved in sandstone (fig. 2). Peter Schmidt (pers. comm. 2003) suggested that the Qohaito site, including the petroglyphs, may date to the pre-Axumite period, ca 200 BC. The prehistoric artists who engraved these elephant petroglyphs evidently used as their models the live elephants that roamed this part of the country, an area that is included in the historical distribution.

Literature review and historical background for elephants in Eritrea

3rd century BC—Indirect evidence for the earliest observations of elephants in the Horn of Africa comes from writing on a stela (dated to the mid-6th century

AD) at the ancient sea port of Adulis on the coast of the Eritrean Red Sea. We learn that ‘the Red Sea coast of modern Sudan and Eritrea’, generally identified with Punt, ‘was rich in wild elephants, enough so that these two kings [Ptolemy III, 246–221 BC, and his father, Ptolemy II] mounted campaigns to hunt them’. These elephants were of two types: ‘Troglydte and Ethiopic’; possibly the reference is to the African forest elephants, *Loxodonta cyclotis*, and the African savannah elephants, *L. africana* (Phillips 1997, p. 445–446). Gowers (1948) reported that throughout the reign of Ptolemy III, elephants were caught on the Eritrean plateau and in the lowland between the escarpment and the sea. Pankhurst (2002a,b) confirmed that the Ptolemeic dynasty (Ptolemy II–IV) hunted elephants along the southern Red Sea coast.

16th century—One of the earliest documented observations of elephants is that of Francisco Alvares (narrated 1520, published 1961, p. 513), a Portuguese Jesuit missionary. His notes pertain to various parts of Eritrea, including an area where elephants are not found today, in Debre Bizen and vicinity, some 25 km east of Asmara, towards the Red Sea coast.

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Figure 2. A petroglyph of an African elephant (dating to the pre-Axumite period, ca 200 BC) found near Qohaito archaeological site on the highlands of Eritrea, an area of historical elephant distribution.

18th–19th century (1722–1899)—In a map provided by Largen and Yalden (1987, p. 104), it is evident that elephants were present in north-east Eritrea (in 1987 Eritrea was a province of Ethiopia), including areas along the coast of the Red Sea from Adulis to Karora region close to the border with Sudan. Today this region, which covers two administrative zones (Zoba Semenawi Keih-Bahri and Zoba Anseba), is devoid of elephants.

19th century (1859–1889)—Yalden et al. (1986, p. 47–50) provided comprehensive detailed records of elephants in Ethiopia (in 1986 Eritrea was a province of Ethiopia). Records pertaining to Eritrea were in areas where elephants are not found today.

Early 20th century (1900–1939)—Same source and comments as for ‘18th–19th century (1722–1899)’ preceding, but fewer elephants observed in these administrative zones. Yalden et al. (1986, p. 49) noted that Frade (1936) reported on elephants ‘between Gash River and Setit River; Mt Aightit’.

Mid 20th century (1940–1986)—Same source and comments as in paragraph ‘18th–19th century (1722–1899)’ preceding, but this time elephants were recorded from Zoba Gash-Barka, south of Zoba Anseba. Largen and Yalden (1987, p. 104) stated that Leuenberger (1955) reported that herds of 100 to 200 elephants still roamed between the Setit and Gash Rivers. Additional records of elephants in Eritrea were reported by Yalden et al. (1986, p. 50).

Late 20th century (1993–1999)—Hagos (1993), Litoroh (1997, p. 16), and Barnes et al. (1999, p. 77) reported anywhere from two to eight elephants, some in Eritrea, others on the Ethiopian side of the border. Yacob (1998) reported on 20 to 50 elephants in Eritrea. Yalden et al. (1996) provided a revised checklist of mammals and notes on zoogeography and conservation in Ethiopia and Eritrea.

Turn of the 20th century (2000)—Marchant et al. (2000, p. 11) estimated the number of elephants in the Gash-Setit area, Eritrea, to be between 8 and 50. Hagos (2000) and Shoshani et al. (2000) provided the most recent data, including conflicts with farmers and ecological evaluation of the habitat in general.

21st century (2001–2003)—At least 28 elephants were observed on 25 December 2001 as reported in this paper. Various reports on elephants in Eritrea, some with photographs, with varying estimates were provided during 2002 (table 1). The minimum estimate of elephants in Eritrea in January–February 2003 was 83, with a guarded estimate of 100 elephants during the dry season.

The historical and current distribution map produced here (fig. 3) is based on the map provided by Largen and Yalden (1987, p. 104), and our observations on historical material noted above, as well as observations on living elephants during 2002 and 2003. In the second part of this paper we will provide details on the current distribution.

Habitat description of past distribution

Since past distribution included areas in the highlands, as well as the lowlands, a brief description of these habitats and comparison between lowlands and highlands will simplify discussion. The northern part of Eritrea and central plateau where elephants once roamed included both lowlands and highlands. Except for the central highland plateau, of all the regions where elephants roamed or are still roaming, the south-western part of the country (Zoba Gash-Barka) has the next highest average annual precipitation (up to 600 mm per year, during May and September). The central plateau receives 500 to 700 mm per year, in two rainy seasons. In the north-western region the temperatures are high and the precipitation is low, with average annual precipitation of up to 300 mm per year and typical xerophytic vegetation of open acacia woodland. The south-western portion of the western lowland (where elephants roam today) is described separately below. The north-eastern region and the Red Sea coastal region are rugged desert, with little (close to 100 mm per year) or no precipitation. Historical distribution of elephants included the portion of the coastal region as far south as the Buri Peninsula. In these coastal areas the habitat was dry during historical times, with average annual precipitation of 100 to 200 mm (Ministry of Education, State of Eritrea 1995). Fertile seasonal fluvial deposits from the highlands, however, provide substrate for greener vegetation in deltas or wadis than in the arid surroundings.

Acacia etbaica is the prevalent acacia species in the higher elevation (1400–2300 m), and *A. tortilis* is more adapted to lower elevations (0–1900 m) (Bein et al. 1996). In the highland afromontane, a dominant species in the past was the African pencil cedar (*Juniperus procera*); at higher elevations, *Juniperus* is associated with African wild olive (*Olea europaea africana*). Similarly, broadleaved trees such as *Combretum fragrans* are usually associated with relatively high precipitation such as found in the Gash River basin. Here one can find another broadleaved species, bitter frankincense (*Boswellia papyrifera*),

Table 1. Data on elephants observed in Eritrea since the 3rd century BC

Date	No.	Locality	Observed by	Comments
3rd century BC 246–221 BC	many	Land of Punt (part)	Ptolemy III Ptolemy II	elephants were hunted (Phillips 1997, p. 445–460)
16th century 1520	?	Debre Bizen and vicinity	Francisco Alvares	today no elephants are found in Debre Bizen between Asmara and the Red Sea
18th–19th century 1722–1899	?	north-east Eritrea	various authors	reported by Largen and Yalden (1987, p. 104). Today no elephants are found here
19th century 1859–1889	?	Eritrea, where there are no elephants today	various authors	reported by Yalden et al. (1986, p. 47–50)
20th century 1936	?	between Gash and Setit Rivers, and near Mt Aighir	Frade	reported by Yalden et al. (1986, p. 49)
1955	100–200	between Gash River and Setit River	Leuenberger	reported by Largen and Yalden (1987, p. 104). Other records on elephants for the period of 1940–1986 were given by Yalden et al. (1986, cf. p. 50)
Unpublished	2–8	Gash River	Hagos	some in Eritrea, others in Ethiopia
1997	2–8	Gash River	Litoroh	2 in Eritrea, 6 in Ethiopia
2000 December	4	near Bimbina	UN staff	2 large and 2 small
21st century 2001 April	1	on road between Antore and Um Hagar close to Ethiopia	UN staff	'very large' [p]
2001 May 18	3	near Solomon farm	Shoshani and UN staff	in doum palm forest [p]
2001 August	1	Om Hajer near Tekezze River	Yacob Yohannes and other MoA staff	calf about one year probably swept by Setit River [p]
2001 Sept 19	15	Tekezze River 20 km east of Om Hajer	UN staff	family of 10+ [p] and 5 bulls [p]
2001 Dec 25	28+	junction of Gash River and Bayaye wadi	Shoshani, Ghebrehwet, students	adult, young and newly born [p]
2002 February	?	near Adi Omar	Ghebregesus Ghebrelul	
2002 March	2	near Antore and Awagaro	Emun Kebrom	elephants were killed
2002 April 5	~ 30	near Awagaro	Mahmud M. Osman	filmed a herd of elephants [p]
2002 ~ Sept–Oct	~ 40	near Tekezze River	UN staff	aerial photographs [p]
2003 January 7	~ 40	Gash River, near Gogne	Tedros Kebede, Travel House Int'l	filmed elephants move towards Haicota
2003 Jan 10–11	?	near Antore and Awagaro	Kebrom and Shoshani	fresh elephant footprints
2003 Jan 26–Feb 11	83+	Gash-Barka	Elephant Team	live elephants, footprints and dung

Shoshani et al. (2000) provided data with photographs up to the year 1999; previous data are given in the text. [p] = photographic evidence, not included here; MoA = Ministry of Agriculture, Asmara, Eritrea

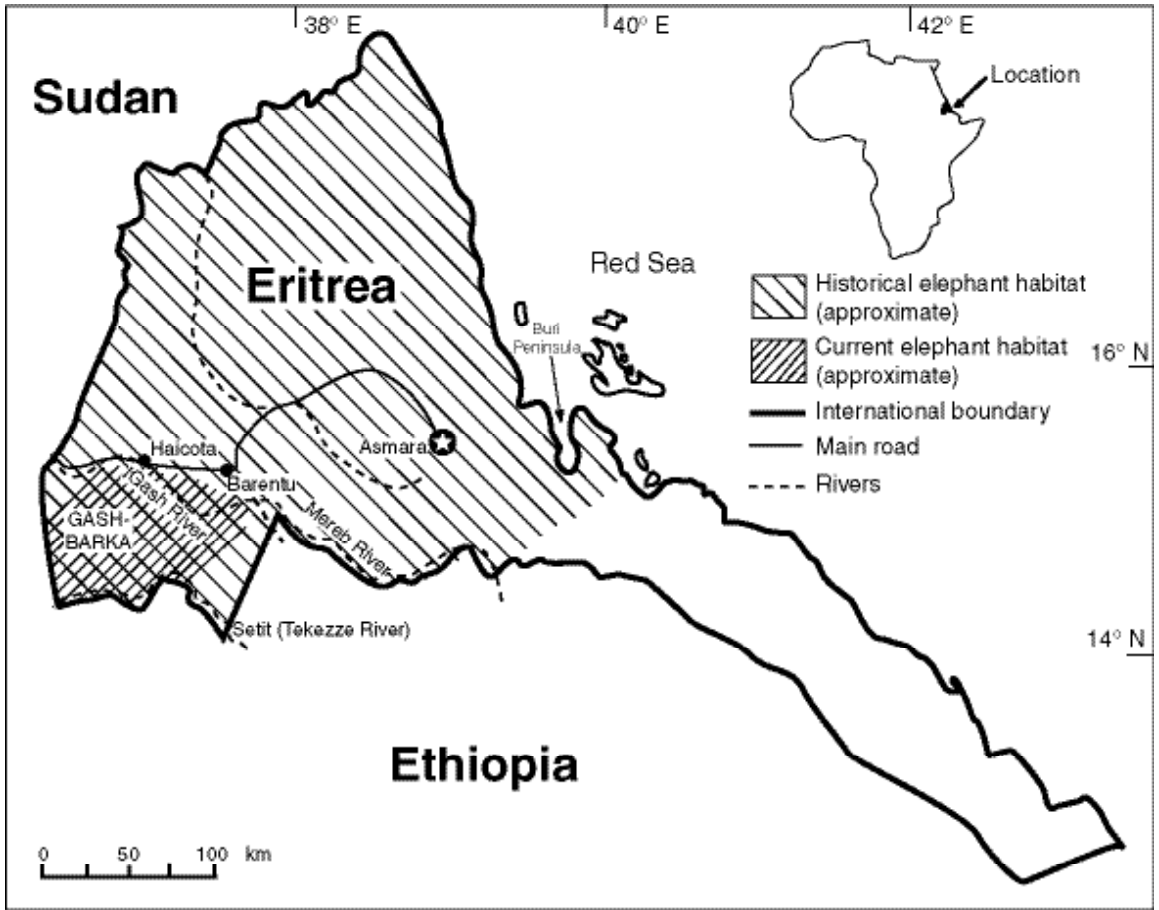


Figure 3. Map of Eritrea with historical and current distribution of elephants. It is possible that in historical times elephants roamed over all or most of what is now Eritrea; present evidence, however, is not conclusive.

which has been used for centuries as ceremonial incense. Overall, the northern highland and escarpment regions are more xeric than the south-western region. Major river basins include the seasonal Barka River in the north-west, the seasonal Anseba River in the central and north regions, the seasonal Felket River in the north-east, the seasonal Merab River in the south, and the permanent Setit (Tekezze) River in the south-west. River watersheds and divides are good habitat for many wildlife species, each region with its characteristic fauna and flora.

Habitat of current elephant distribution in south-western Eritrea

The south-western portion of the country incorporates Zoba Gash-Barka, where elephants have been observed at least since 1936 but possibly since the third century

BC (table 1). The riverine semi-desert habitat of this region is composed mostly of doum palm and ziziphus bush, acacia woodland and open grassland savannah. The terrain is mountainous to hilly, rising to between 500 and 1000 and punctuated with wadis. Average temperatures range from 25°C in January to 35°C in June. The rains fall from June to September, with average precipitation of 300 to 600 mm per year in the wetter parts. August has the highest rainfall. The elephants are located north and south of the Setit (Tekezze) River; they migrate between Eritrea and Ethiopia. Members of the Kunama and Nara tribes reside in Gash-Barka with their camels, goats and sheep.

Results from most recent ground surveys

Table 1 includes documentation of elephants from historical times to the present. We conducted our most

recent ground surveys in December 2001 and January–February 2003. In 2001 we observed at least 28 elephants and in 2003 the minimum number of elephants observed in various locations was 83, within the watersheds of the Gash and Setit Rivers. Herd composition included calves, juveniles and adults, and all appeared in good physical condition.

Discussion

Current taxonomic knowledge integrated with historical and ecological considerations

Historically, the elephants in Africa have been classified as one species with two subspecies: *Loxodonta a. africana*—the bush or savannah elephants of eastern, southern and central Africa—and *L.a. cyclotis*—the forest elephants of central Africa (Laursen and Bekoff 1978; Sikes 1971). Recently, however, Grubb et al. (2000) provided morphological evidence for elevating the two subspecies to species level. Roca et al. (2001), and Eggert et al. (2002) provided molecular evidence corroborating these morphological findings. Data from Eggert et al. (2002) provide additional genetic evidence that the populations of the forest and savannah elephants of West Africa may be interpreted to constitute a third species in Africa.

Even though the elephants in Eritrea often visit forested regions, they are classified as bush African elephants, *Loxodonta africana*. Some people believe that these elephants are supposed to be, or include, hybrids between the native African elephants and Asian elephants. This possibility is based on a historical 19th century event. In 1868 the British General Sir Robert Napier brought 44 elephants from India to fight the Ethiopian King Theodore of Magdala (Markham 1869, p. 140; Myatt 1970, p. 90). It is said that an unspecified number of these Asian elephants (*Elephas maximus*) were released or escaped from Napier's camp and mated with native African elephants. The elephants we saw in Gash-Barka were, as well as could be judged externally, typical African elephants (*L. africana*), not hybrids. Yet to be absolutely certain, genetic tests will be conducted to test this hypothesis. It should be noted that there is one known case of a hybrid produced in captivity between an African and an Asian elephant (Howard 1979); thus there is reason to believe that such a hybrid is possible.

Although there are no elephants today in the eastern portion of Eritrea, indirect evidence indicates that they may have roamed portions of the Land of Punt in the recent 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, an ancient port on the Red Sea, about 65 km south of Massawa. Villagers say the name means 'I see elephants' or 'I can see elephants' (from *ara*, 'I see' and *fil*, 'elephant') in the Semitic language Saho. It has also been reported that in an incident called 'the Battle of the Elephants', African elephants trained for war were shipped from Adulis, apparently to Yemen across the Red Sea (Hillman and Hillman 1998).

From the accounts related by Gowers (1948) we learn that what is now Eritrea played a fundamental role in the history of domesticating elephants.

The Ptolemies in the third century BC deliberately sought their own source of elephants, to counter the Seleucids, who got theirs from their Indian allies. Ptolemy II established a catching base at Ptolemais, on the Baraka (Barka) River. Although they caught elephants all along the coast as far as Cape Guardafui in what is now Somalia, the port of shipment back to Egypt was Adulis, near Massawa, which was founded in the reign of Ptolemy II.

Pankhurst (2002a) also corroborates that the Ptolemy rulers hunted elephants for military purposes along the southern Red Sea coast for about a century, that is, during the reigns of Ptolemy II (280–246 BC), Ptolemy III (245–221 BC) and Ptolemy IV (221–204 BC). This interest then shifted to hunting elephants to furnish the 'white gold' of the ivory trade. Pankhurst (2002b) elaborated on ancient hunting methods. He also reported that 'a large group of elephants, about five thousand in number' was seen at Aue, midway between Aksum and Adulis. This area today is partly in Ethiopia (Aksum) and partly in Eritrea (Adulis). Pankhurst (2002b) quotes Kosmas Indikopleustes, an Egyptian merchant-cum-monk who visited both Adulis and Aksum: 'The country abounds with them, and they have large tusks which are exported by sea from Ethiopia even into India and Persia and the Homerite country [south Arabia] and the Roman dominion.'

More concrete evidence for the presence of elephants in Eritrea in historical times comes from archaeological sites. Qohaito, an archaeological site on the highland of eastern Eritrea, is said to have been

an ivory trade post. As noted above, Qohaito site includes at least one petroglyph of an African elephant, which appears to have been engraved during the pre-Axumite period, ca 200 BC, close to the time when the Ptolemaic dynasty reigned in this part of Africa. In the Ham monastery, about 100 km south of Asmara, 60 mummies were found wrapped with what is believed to be elephant skins (Yosief Libsequal, pers. comm. 2002). The war shields housed in NME are possibly made from ancient 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. It appears that there is museum and archaeological evidence to substantiate the historical distribution of elephants in Eritrea. This evidence is augmented by documented observations of elephants and giraffes close to the Debre Bizen monastery some 25 km east of Asmara made by the 16th century Portuguese Jesuit missionary Francisco Alvares (narrated 1520, published 1961). Travellers and scientists reported on elephants in various parts of Eritrea, so that we can safely assume that they were found all over the country, particularly in the northern regions, until 500 years ago (fig. 3). Recently, remains of extinct proboscideans—elephantids and the forerunning gomphotheres, which were proboscideans that lived from the early Miocene to the early Holocene, about 24 million to 10,000 years ago, and that gave rise to stegodontids and elephantids, including the extinct mammoth—have been found in the plains near the Red Sea (Shoshani et al. 2001) and in the Danakil Depression (Abbate et al. 1998).

Tusk size

Most of the tusks measured and those observed on live elephants in Eritrea appeared to be small. From previous data on eight isolated tusks (based on tusks salvaged and examined post mortem) we measured an average of 107 cm in length and 9.8 kg in weight (Shoshani et al. 2000). Among the tusks measured was the one found in 1996 in Sahel, 200 km from current elephant distribution. Measurements of this tusk fell within the range of other tusks examined. With caution, it is possible to surmise that there was apparently little or no variation in tusk size in historical times. Baker (1871, p. 219) noted that most Abyssinian elephants have short but thick tusks. One possible explanation for the almost uniform tusk size

and weight in Eritrea is the homogeneous genetic make-up of the population. This hypothesis may be related to isolation and inbreeding. Genetic testing may help answer some of these intriguing questions.

Possible explanation for the shrinking elephant habitat

All water courses (rivers and wadis) in Eritrea are seasonal except for the permanent Setit (Tekezze) River within the jurisdiction of Gash-Barka, where elephants have been documented since early history. Elephants do not stay far away from water for long (see Sikes 1971); even the 'desert elephants' of Namibia seek water as often as possible and will travel long distances in search of water and food (Walker 1982; Olivier 1983). Water alone appears to be the single most important factor of elephant distribution; next is food.

In Eritrea, the groundwater level (aquifer) appears to be lower in the highlands, in Zoba Anseba and Zoba Semenawi Keih-Bahri (including historical elephant distribution) than in Zoba Gash-Barka. It is also possible that above-ground perennial springs in the area of historical elephant distribution dwindled or dried out in recent times (Semere Berhe, Department of Water Resources, Ministry of Land Water and Environment, pers. comm. 2003). It would thus have been more difficult for elephants during dry seasons to reach water as the water level was deeper in historical times than it is at present. To these factors we may add expansion of human population and deforestation. Thus it appears that in historical times the area outside the current distribution might not have been able to support a large elephant population, and gradually their permanent home range shifted towards the watersheds of the Setit and Gash Rivers.

Future investigations

One of our long-term plans is to continue our surveys of elephants and attempt to apply radio collars to be able to study their migratory routes. Concomitantly, we will continue ecological and behavioural studies and continue to collect data on the biodiversity of Zoba Gash-Barka. In an effort to convey a simple and powerful message on the value of elephants in their ecosystem, we plan to develop an educational programme in the three major languages spoken in Eritrea (Tigrigna, Arabic, English). Radiocarbon dating on a leather shield,

the tusk and the cervical vertebra at NME might help us better understand the historical distribution of elephants in Eritrea. Finding the possible sources of these items, within or outside Eritrea, may be difficult, but genetic testing should help narrow the guesses. Genetic tests will also be conducted to ascertain that the elephants of Eritrea are typical African elephants (*L. africana*), not hybrids between the Asian (*E. maximus*) and African elephants.

Concluding remarks

Only a fraction of what has been documented as elephant habitat in historical times is currently available for elephants now. Further shrinkage of elephant habitat may have an irreversible effect on their long-term viability. A possible explanation for the shrinking of their habitat may focus on the lack of water throughout the year. The vulnerability of the elephants in Eritrea, their role in the ecosystem, and their value as part of the international wildlife heritage cannot be overstressed. The highest number of elephants observed in Gash-Barka was in 1955, at an estimate of 100 to 200. In 2003 we estimate this number to be close to 100. Elephants inhabit areas where doum palms dominate. The elephants we observed in the Gash River were a healthy, fecund and viable population. The elephants of Gash-Barka area may be a classic example of isolation, a hypothesis to be tested.

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