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NOTE

FIRST RECORD OF PALEOGENE ELEPHANTOIDEA (MAMMALIA, PROBOSCIDEA) FROM THE BUGTI HILLS OF PAKISTAN

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The Cenozoic geology of Pakistan is the result of the continental collision between the Indian and Eurasian plates. The subsequent Himalayan Foreland provided sediments that have been studied from both stratigraphic and paleontologic viewpoints since the mid-1800s. In the Lower Indus Basin (central Pakistan), the Sulaiman Geological Province has long been the subject of geological controversies. From this area, the Bugti Hills (southern Sulaiman Range, eastern Balochistan) yield a rich fossil fauna (Vickary, 1846; Blanford, 1883; Pilgrim, 1908; Cooper, 1922) whose age has been controversial because of an apparent mixture of Oligocene and early Miocene taxa (e.g., Pickford, 1988). The apparent lack of Oligocene sediments due to an erosional unconformity was generally assumed (e.g., Downing et al., 1993). Recent fieldwork in the Bugti area (Figs. 1–2) provided a stratigraphic reassessment (Welcomme et al., 1997, 1999, 2001). Five successive "bone beds" were found to bridge the supposed Oligocene sedimentary hiatus: the lowermost continental levels of the previously described Miocene Chitarwata Formation (=the Bugti Member) is Oligocene (Welcomme et al., 2001). For instance, the fluvio-deltaic sands of the Paali Nala locality (C2 in Fig. 2) yielded an unexpected early Oligocene fauna with characteristic cricetid rodents (Marivaux et al., 1999), and a remarkably diversified primate fauna with notably a strepsirrhine of lemuriform affinities (Marivaux et al., 2001). Moreover, no mixture of heterochronic taxa is seen in this area.

Although its precise age was controversial, the Bugti Fauna has always been considered as an earliest Neogene fauna. It was sometimes understood as the first occurrence of the basal major mammalian dispersal from Africa to Asia, before a second major dispersal toward Western Europe (Bernor, 1983). More generally, it was assumed to represent an important record of the eastern closure of the ancient Tethys Sea when Africa connected with Eurasia. The dispersal was called the "Proboscidean Datum Event," here PDE (Madden and Van Couvering, 1976), dated circa 17.5 Ma (Van Couvering and Berggren, 1977), because the paleontologic terrestrial markers of this event were the proboscideans, supposedly endemic to Africa during the Paleogene. Subsequently, it was hypothesized that the PDE was a more complex scenario than a unique dispersal during the late early Miocene and that the first occurrence of proboscideans in Eurasia may be older than 20 Ma (Tassy, 1990). Yet, Eurasian proboscideans were not supposed to antedate the Neogene.

We report here the discovery of a fragment of an upper incisor (tusk) of an elephantoid from the late Oligocene of the Bugti Hills, Pakistan (Fig. 1). This incisor represents the oldest elephantoid discovered so far, and is the first occurrence of an elephantiform proboscidean out of Africa prior to the PDE. The specimen DBJ1-1 was discovered as part of a joint project by the University of Montpellier 2, the Muséum National d'Histoire Naturelle in Paris, and the University of Balochistan (Welcomme et al., 2001; Marivaux et al., 2001).

The use of the taxon Elephantoidea Gray, 1821, of superfamilial rank, follows Tassy (1988). It is the clade formed by mammutids, gomphotheres sensu lato, and elephantids including stegodonts (see also Shoshani and Tassy, 1996). McKenna and Bell (1997) excluded mammutids from the Elephantoidea. Until the discovery of the incisor described here, elephantoids (including or excluding mammutids) were described only from Neogene sediments.

SYSTEMATIC PALEONTOLOGY

MAMMALIA Linnaeus, 1758
PROBOSCIDEA Illiger, 1811
ELEPHANTIFORMES Tassy, 1988
ELEPHANTOIDEA Gray, 1821
ELEPHANTOIDEA, indet.

Material—DBJ1-1 (i.e., Dera Bugti, Level J, Locus 1), a tip of left upper incisor (Fig. 3), temporarily housed in the Laboratoire de Paléontologie of the Muséum National d'Histoire Naturelle in Paris, and to be deposited in the Geology Department of the University of Balochistan in Quetta. A cast (PAK 2624, MNHN) is available in the Laboratoire de Paléontologie of the Muséum National d'Histoire Naturelle in Paris.

Locality and Horizon—Lundo-J1, in the Bugti Member of the Chitarwata Formation, Balochistan, Pakistan (Fig. 2: J1). It has been assigned a late Oligocene age by Welcomme et al. (1999, 2001) by means of mammalian biostratigraphy.

Description

Although fragmentary, the tooth can be unambiguously interpreted as belonging to a member of the Elephantoidea. It is the anterior part of a small upper tusk (Fig. 3). Its length is 29.3 mm. Its diameter is 15.8 mm (width) by 20.4 mm (height). The lateral wear facet at the tip is deep and slightly concave. This means that despite its small size it did not belong to a juvenile individual but rather a young or even mature adult. The lateral face is flattened, and lacks an enamel band, which may be due to the weathering of the fragment (upper tusks of Elephantiformes bear a lateral enamel band which is lost in derived species). The transverse section is oval. A ventral keel is present, bordered by longitudinal ridges. This cross section, in addition to its size, closely matches that of Paleogene elephantiform proboscideans from Northern Africa (Fayûm of Egypt) such as *Phiomia*, and, especially, to that of the earliest known African elephantoid, *Eozygodon morotoensis*, a mammutid from Meswa, Kenya, an early Miocene locality dated 21.7 Ma (Tassy and Pickford, 1983:fig. 14). Moreover, the structure of the dentine is clearly apparent on the broken surface (Fig. 3E–G). It shows the characteristic elephantoid arrangement of dentinal tubules, sometimes called "engine turning" or "checkered pattern," a pattern due to the interweaving of Schreger lines, that is clockwise and counterclockwise curving of lines of dentinal tubules.

DISCUSSION

The "engine turning" pattern has been described in elephantids, gomphotheres, and mammutids (e.g., Miles and Poole, 1967; Saunders, 1979; Shoshani, 1996a; Fisher et al., 1998; Palombo and Villa, 2001). This structure can be seen with the unaided eye on any small fragment of elephant dentine, and it is no surprise that its first description appeared as soon as the middle of the eighteenth century (Daubenton,

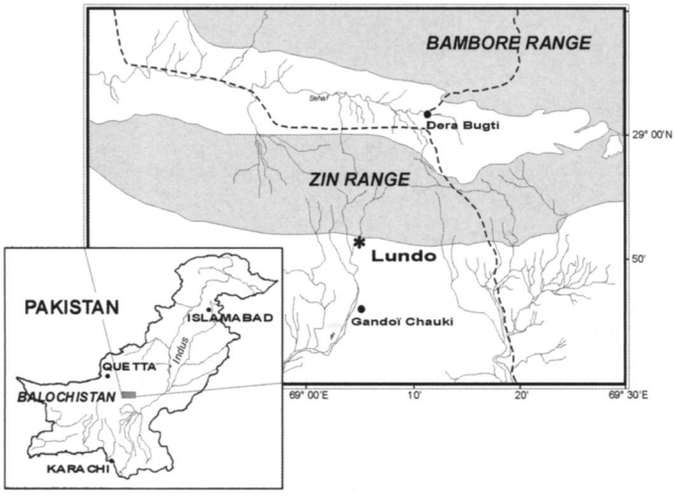

FIGURE 1. Map showing location of the Paleogene elephantoid-bearing Lundo-J1 locality (denoted by an asterisk) in Pakistan.

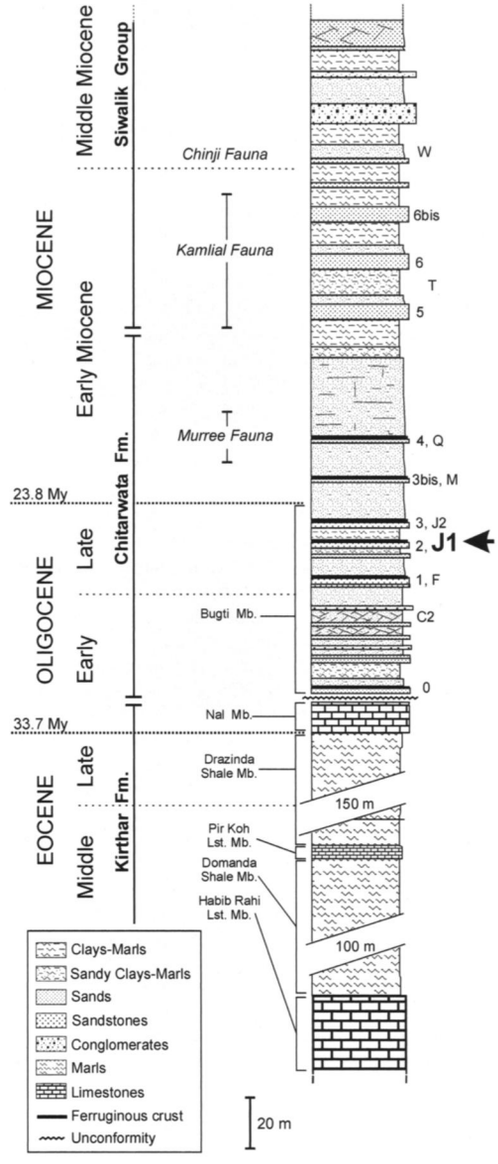

FIGURE 2. Stratigraphic position of the Paleogene elephantoid-bearing Lundo-J1 locality (indicated by an arrow) in the synthetic section of the Tertiary deposits from the Bugti Hills (Balochistan, Pakistan). Lundo-J1 corresponds to a ferruginous crust which is interbedded in fluvial sands, within the upper part of the Bugti Member of the Chitarwata Formation (late Oligocene). Numbers (0 to 6bis) and letters (C2 to W) located on the right of the stratigraphic section indicate the successive mammal-bearing levels recorded in the southern and northern sides, respectively, of the Zin Range (Fig. 1). Correlations with Potwar Plateau mammal localities (italicized) are mentioned for information only. **Fm.**, Formation; **Mb.**, Member. (Modified after Welcomme et al., 2001.)

1764). This elephantine ivory pattern is unique among mammals. Among proboscideans, it is a derived trait of Elephantoidea: it is lacking on known tusks of the most common Paleogene elephantiform genus, *Phiomia* (direct observation by P.T.), and in all non-elephantiform proboscideans (i.e., *Moeritherium*, *Numidotherium*, *Barytherium*, deinotheres)—all African taxa. No incisor is described of the earliest known proboscidean, *Phosphatherium* of the early Eocene of Morocco (Gheerbrant et al., 1996). The distribution of tusk characters (Fig. 4) is consistent with previously published parsimony analyses of proboscideans (e.g., Shoshani, 1996b; Tassy, 1996) and shows that the checkered pattern of dentinal tubules is autapomorphic for Elephantoidea.

Although the tusks of elephants are permanent incisors, probably I2 (Luckett, 1996), a problem of primary homology persists. As a consequence, although vague, the characters "pair of enlarged upper and lower incisors" and "hypsodont incisors (tusks)" are retained here (Fig. 4), which is sufficient for the purpose of this paper.

The fragmentary tusk DBJ1-1 demonstrates the existence of a member of the Elephantoidea in the late Oligocene of Pakistan. The PDE, if any, is older than 18 Ma and goes back to the Oligocene. The first offshoot of the Elephantoidea (i.e., the sister taxon of other elephantoids) is *Hemimastodon crepusculi*, a species only known from two upper third molars (Tassy, 1982, 1990), and also classified as family Hemimastodontidae by McKenna and Bell (1997), sister group of (Mammutoidea, Elephantoidea). These molars were found ninety years ago at Kumbi, in the Bugti Hills area (Pilgrim, 1912). This elusive species, with molars more primitive than those of all known Neogene elephantoids, was supposed to come from the Bugti Member, associated with gomphotheres typical of the early Miocene (Pilgrim, 1912; Cooper, 1922). Recent investigations assign a late Oligocene age to lower levels in the Kumbi section (Welcomme et al., 2001), where both specimens could have originated. Hence, this taxon could well be Oligocene and predate the classical PDE, as supposed by Tassy (1990) who hypothesized a differentiation of African and Asian elephantoids before 22 Ma. Yet, no anatomical connection is available to allocate this partial incisor DBJ1-1 to *Hemimastodon crepusculi*. Perhaps the rarity of *Hemimastodon crepusculi* (two molars found in ninety years) is due to the scarcity of Oligocene localities in this region compared to Miocene ones.

DBJ1-1 is not the first proboscidean described from the Paleogene of Eurasia. A lower incisor of "a possible proboscidean" was found in the Uzunçarsidere Formation, Central Anatolia, of Eocene age, together in a peculiar fauna with embrithopods and marsupials (Maas et al., 1998). The specimen is a tip of a small incisor covered by enamel, with lateral bulges that somehow recall those of lower tusks of *Phiomia serridens*. But the size, overall morphology, and shape of the cross section differ from all known incisors and tusks of Paleogene proboscideans, so that its systematics needs to be corroborated by further discoveries. In any case, the fauna from the Uzunçarsidere Formation was understood as a mixture of endemic and Afro-Arabian taxa (Maas et al., 2001).

Besides the implications of this enigmatic fauna, a terrestrial connection between Africa and Asia is likely to have occurred before the early Miocene. More western trans-Tethyan intermittent Palaeocene/Eocene dispersals between Eurasia and Africa have been invoked by Gheerbrant et al. (2001) for primitive ungulate taxa. Also, intermittent (Eocene, and Eocene/Oligocene) trans-Tethyan dispersals between Asia and Africa have been suggested for rodents, primates, and anthracotheres (Jaeger et al., 1985, 1998; Ducrocq, 1997; Marivaux et al., 2002). In any case, the presence of elephantoids in the Oligocene of the Bugti Hills is a record of a common Paleogene history between Africa and Balochistan, and more generally Southern Asia. The Tethys probably played the role of an irregular barrier for faunas already widespread in the late Oligocene so that successive dispersal and vicariant events could have oc-

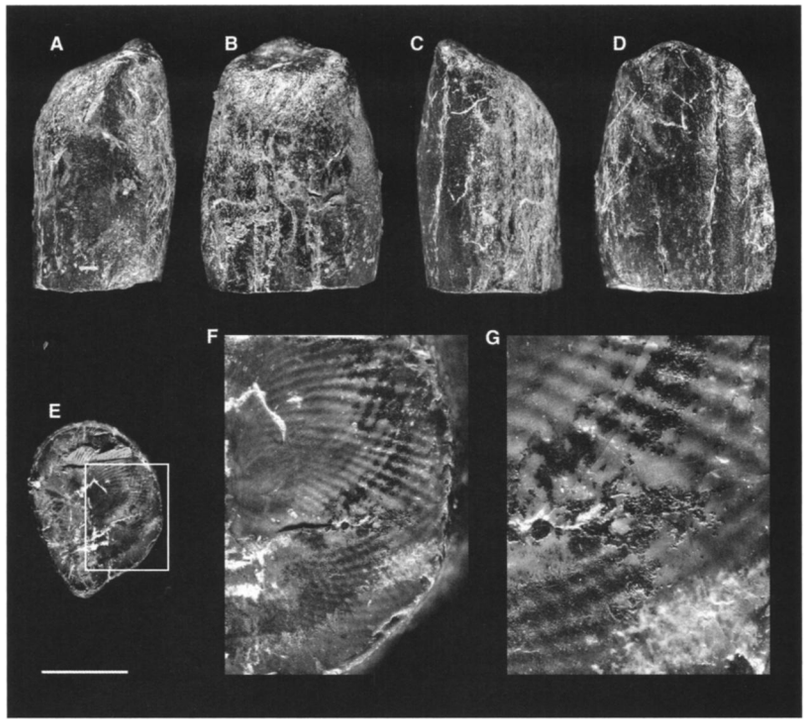

FIGURE 3. Tip of upper left incisor (DBJ1-1) of an elephantoid from the Chitarwata Formation, late Oligocene of Balochistan (Pakistan). The different views are: **A**, dorsal; **B**, ventral; **C**, buccal; **D**, lingual; **E**, rear view of the cross section; **F**, detail of the cross section showing the elephantoid pattern of dentinal tubules × 4; **G**, detail of the cross section × 10. Scale bar for A–E = 1cm.

curred between 28 and 18 My. Yet, the initial differentiation of so-called Neogene mammalian faunas first took place in the Paleogene of Africa and Asia as well. Although the Asian Oligocene fossil record is still scarce, Africa can no longer be considered the exclusive center of differentiation of elephantoids and, perhaps, of other higher groups of mammals.

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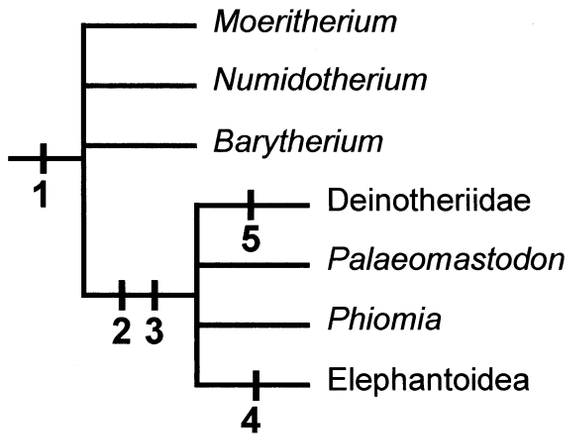

FIGURE 4. Distribution of five characters of incisors among the Proboscidea. **1**, a pair of enlarged upper and lower incisors; **2**, a pair of upper and lower hypsodont incisors (tusks); **3**, loss of enamel on mature tusks except for the lateral enamel band; **4**, checkered pattern of dentinal tubules; **5**, loss of upper tusks.

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