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by

S. Taseer Hussain Howard University

Jens Munthe University of California, Berkeley Robert M. West Milwaukee Public Museum

John R. Lukacs University of Oregon



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REVIEW COMMITTEE FOR THIS PUBLICATION:

Richard H. Tedford, Department of Vertebrate Paleontology, American Museum of Natural History, New York; Louis L. Jacobs, Laboratory of Paleontology, University of Arizona, Tucson; Everett H. Lindsay, Laboratory of Paleontology, University of Arizona, Tucson, William E. Clemens, Department of Paleontology, University of California, Berkeley.

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S. Taseer Hussain Department of Anatomy College of Medicine, Howard University Washington, D.C. 20059

Jens Munthe Department of Paleontology University of California Berkeley, California 94720 Robert M. West Department of Geology Milwaukee Public Museum Milwaukee, Wisconsin 53233

John R. Lukacs Department of Anthropology University of Oregon Eugene, Oregon 97403

Abstract

A recently discovered vertebrate fauna from the Miocene lower Siwaliks near Daud Khel, Trans-Indus Pakistan, contains abundant and diverse mammals. Six families of rodents and two of insectivores are represented. Three of the rodent families are new to south Asian fossil deposits. The occurrence of *Hipparion* in this fauna suggests that its immigration into south Asia may have taken place earlier than previously documented, or that Siwalik sedimentation is time-transgressive toward the west.

Introduction

Many of the fossil vertebrates comprising the well-known Neogene Siwalik faunas (e.g. Matthew, 1929; Colbert, 1935) have been collected in the eastern and southern Potwar Plateau (Fig. 1), southwest of Rawalpindi. The stratotypes of all the fossiliferous Siwalik formations currently recognized by the Stratigraphic Committee of Pakistan (Fatmi, 1973) are located in this area. These stratotypes often lack upper or lower contacts and include only a portion of the formation's presumed thickness. This, together with the generally poor stratigraphic data available for the earlier vertebrate collections, make it difficult to understand the sequence of Neogene vertebrate faunas and environments in the Pakistan Siwaliks. Recently field parties from Yale University, Dartmouth College, Lamont-Doherty Geological Observatory, and the University of Arizona working in the Potwar Plateau have accumulated detailed locality data, thereby considerably improving the level of sophistication of paleoecologic and systematic studies.

The 1976-1977 Howard University-Geological Survey of Pakistan (hereafter H-GSP) field groups investigated Siwalik Group rocks in the Trans-Indus region of Mianwali District. No previous systematic paleontologic surveys had been conducted there. Fossil vertebrates were found at 39 sites near Daud Khel in the eastern Trans-Indus ranges and at 18 sites near Mitha Khatak west of the Indus River (Fig. 1). Most of these sites yielded either faunas large enough or taxa sufficiently restricted stratigraphically to allow placement within the traditional Siwalik biostratigraphic framework (Pilgrim, 1913).

The fault-bounded section north of Jaba Nala (Figs. 2,3) is one of the thickest structurally uncomplicated and continuously exposed Siwalik sections yet studied in Pakistan. We have collected vertebrate fossils at several levels within this section and placed them stratigraphically within measured sections. When our current studies of this section have been completed, it will provide a standard Siwalik reference section for the Trans-Indus region. We cannot assign traditional Siwalik formation names to the units within this section at this time. This is due to lithological disparity between the stratotypes and the upper part of the Daud Khel section and to lack of demonstrated lateral continuity with the stratotypes which could only be achieved by strike-mapping. We do not wish to name new formations at Daud Khel, because these names would have no regional utility. At Mitha Khatak, for example, only 40 kilometers from Daud Khel, the Siwalik section is so dramatically different that completely new names would have to be used. We use informal alphabetic designations herein to refer to mappable lithologic units. The columnar section (Fig.

3) indicates the thickness and lithologic composition of these units, the positions of vertebrate fossil localities within them, and provisional correlation of the Daud Khel units with the Siwalik formations/zones of the southern Potwar Plateau. This correlation is based in part on lithologic similarity and in part on faunal similarity.

Daud Khel Local Fauna

The mammalian assemblage from 1976 H-GSP localities 17, 18, and 19 (detailed locality data are on file with the Geological Survey of Pakistan, Quetta, and with the authors) in the upper part of unit C east of Daud Khel (Figs. 2-4, Table 1) is here designated the Daud Khel local fauna (*sensu* Tedford, 1970). Locality 18 is stratigraphically five meters higher than both 17 and 19, which are at the same level. Despite some diversity of depositional environments, the close contemporaneity of these sites is beyond question.

The Daud Khel local fauna is of particular significance as it contains the most diverse small-vertebrate fauna from lower Siwalik rocks and an equid, probably *Hipparion*. There are scattered small-mammal specimens in earlier Siwalik collections, but no concentration of such specimens has been reported previously. Of the 235 Siwalik mammalian taxa listed by Colbert (1935), only seven are rodents, while the most recent review by Black (1972) listed only 16 rodent species. Insectivores and bats have not been reported from the Pakistan Siwaliks, although Sahni and Khare (1976) described a soricid tooth from middle Siwaliks of India.

All small-mammal specimens of the Daud Khel local fauna have been recovered from H-GSP locality 18 (Fig. 5). These specimens were obtained by surface collection and dry-screening of approximately 20 kilograms of sediment in 1976 and by wet-screening of approximately 1,000 kilograms of sediment in 1977. Some 200 cheek tooth specimens have so far been identified, about half of which were picked from five kilograms of wet-screened concentrate. An additional 130 kilograms of this concentrate remain to be picked.

At least six families of rodents (Sciuridae, Gliridae, Ctenodactylidae, Rhizomyidae, Cricetidae, and Muridae) are represented at Daud Khel. Sciurids, glirids, and cricetids previously were unreported from south Asian fossil deposits. The most abundant rodents at Daud Khel (98 specimens) are ctenodactylids, apparently represented by only a single rather variable species of Sayimys (Fig. 6). The Daud Khel specimens share features not only with the Siwalik specimens previously described as Sayimys (Wood, 1937; Prasad, 1968; Black, 1972), but also with Sayimys obliquidens from western Kansu (Bohlin, 1946).

Cricetids are also common (49 specimens) in the Daud Khel fauna. A species of *Copemys (Democricetodon)* is represented by 36 specimens (Fig. 7). Although morphologically quite similar to early *Copemys* in both Europe and North America (e.g. *C. minor*, *C. pagei*), the Daud Khel species is probably too large to be assigned to any known morphologically simple species. The remainder of the cricetid material (13 specimens) is assignable to *Myocricetodon*. Even this small sample shows great variation in size and morphology, but more material will be necessary in order to determine the number of species involved.

The murid Antemus is represented by 28 specimens. This genus was recently described from the lower Chinji Formation stratotype by Jacobs (1977), who considers it very primitive and near the origin of the Muridae. The much larger sample from Daud Khel will allow a quantitative treatment of the variation within a population of Antemus which will be important in comparisons to the abundant Vallesian murids of Europe. A smaller and more derived murid, which cannot be assigned to any known taxon at present, is represented by a single lower molar.

Twenty-four specimens are identified as rhizomyids and all are probably assignable to *Kanisamys*. This sample is equally divided between upper and lower teeth. The upper teeth do not compare favorably with those of any described taxon, but this is almost certainly because no upper teeth have been described for the *Kanisamys-Protachyoryctes* lineage (Black, 1972). The upper teeth from Daud Khel are more progressive morphologically than the lowers. They show the same type of large, laterally elongated cusps seen in the lower teeth of *Protachyoryctes*. This evidence supports Black's (1972) suggestion that *Kanisamys* was ancestral to *Protachyoryctes*.

There are 16 sciurid specimens in the collection. These have not yet been extensively studied, nor has the single third molar which is so far the only representative of the Gliridae from Daud Khel.

Five specimens represent insectivores, including a dentary fragment containing worn M_2 - M_3 . This latter specimen is probably a soricid, but is not identifiable below the family level. The remaining insectivore specimens are all isolated erinaceid teeth which are too fragmentary to allow generic determinations.

Most of the large mammals from the Daud Khel local fauna (Table 1) are similar to those from the lower Siwaliks (Chinji

Formation) in the southern Potwar Plateau. However, the occurrence of an equid, probably Hipparion, in this fauna is of particular importance for both Siwalik and intercontinental biostratigraphic correlations. This probable Hipparion is represented in the Daud Khel local fauna by a single metatarsal (proximal extremity and part of the shaft). This specimen (Fig. 8) is somewhat corroded (proximal extremity) and the shaft is compressed along its length. The morphology of the proximal extremity is indicative of Hipparion. The shape of the shaft is not equid-like but this is probably the result of compression during preservation. Anchitherium is the only other genus to which the metatarsal could possibly be assigned. This genus occurs earlier than Hipparion in Europe, but has never been reported from the Siwaliks. The metatarsal was recovered from a sandstone lens at locality H-GSP 17 by quarrying at a depth of one meter below the surface. This quarry is at the highest level from which fossils have been recovered at locality 17, is five meters stratigraphically below locality 18, and is 15 meters stratigraphically below the base of the lowest thick, laterally persistent sandstone which we consider the bottom of unit D. Thus the Hipparion specimen was found 15 meters below the top of unit C.

In addition to the probable *Hipparion* metatarsal, horn cores of *Miotragocerus* sp. (locality 17) and *Gazella* sp. (near locality 18, at the same level) are also present in the Daud Khel local fauna. The Daud Khel *Miotragocerus* specimen resembles those found in the Nagri and Dhok Pathan Formations of the southern Potwar Plateau. It is unlike *M. gradiens*, the typical Chinji formation species. *Gazella* is found in both the Chinji and Nagri fromations of the Potwar Plateau, but it is rare in the Chinji (H. Thomas, pers. comm. 1977).

Although *Hipparion* was previously considered to be present in the fauna of the Chinji stratotype (e.g. Colbert, 1935:155), recent opinion regarding provenance of older collections, corroborated by recent detailed fieldwork in the southern Potwar Plateau, places the lowest occurrence of this equid well above the base of the Nagri (Hussain, 1971, 1973; Simons *et al*, 1971). Based solely on current knowledge of *Hipparion* occurrences, then, it is possible that: 1) the onset of Nagri-type sedimentation (dominantly massive sandstones) is time-transgressive toward the west, or 2) *Hipparion* occurs earlier at Daud Khel than in the southern Potwar Plateau. Westward time-transgression of Siwalik lithostratigraphic units has been suggested (e.g. Morris, 1938), but there is at present no convincing faunal or radiometric evidence to support this view.

As in many other parts of the world, the so-called "*Hipparion* datum" (papers cited by MacFadden and Skinner, 1977) is recognized in the southern Potwar Plateau by the lowest occurrence

of isolated Hipparion teeth on the surface. These specimens need not be particularly abundant in order to recognize this level, because Hipparion teeth are very distinctive and the genus can frequently be positively identified from a small fragment of a tooth. Assuming that Nagri-type sedimentation began at approximately the same time at Daud Khel and the southern Potwar Plateau, we expected to begin recovering Hipparion teeth several hundred meters above the base of unit D at Daud Khel. The lowest level at which Hipparion teeth were actually found (localities 135, 137) was 398 meters above the base of unit D and 413 meters above the Hipparion metatarsal from locality 17. The occurrence of Hipparion in the upper part of Daud Khel unit C, in association with the mammalian assemblage correlated with that from the Chinji and Nagri formations of the southern Potwar Plateau, suggests that at Daud Khel we are probably sampling at or near the Chinji - Nagri boundary. The sedimentary rocks deposited during this time have been searched thoroughly in the southern Potwar but are sparsely fossiliferous. Thus it is not yet clear how far down in the Potwar section the joint occurrence of Hipparion, Miotragocerus and Gazella (the traditional Nagri fauna) extends. Assuming that our correlations of Daud Khel units with the formations of the southern Potwar are correct, Hipparion appears slightly earlier in south Asia than was previously thought.



Figure 1. Location map of H-GSP Trans-Indus study areas. Previous Siwalik paleontologic work has centered in the southern Potwar Plateau south and southwest of Rawalpindi.

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Figure 2. Geological map of area northeast of Daud Khel, Mianwali District, Pakistan.





Figure 3. Columnar section of Siwalik rocks exposed north of Jaba Nala and provisional correlation with Siwalik formations/zones of the southern Potwar Plateau. Stratigraphic position of H-GSP vertebrate fossil localities indicated by arrows.



Figure 4. View toward north showing area of Daud Khel local fauna sites. H-GSP locality 18 indicated by arrow. H-GSP localities 17 and 19 out of sight behind the prominent buttress north of locality 18. Cliff above locality 18 formed by basal massive sandstones of unit D.



Figure 5. H-GSP locality 18. Only the 40 cm thick unit capping the hill at center and its continuation at left contain small-vertebrate specimens.



1 mm

Figure 6. Scanning electron micrograph of Sayimys maxilla $({\rm P}^4\mathchar`-M^3),$ H-GSP 247.



Figure 7. Scanning electron micrograph of Copemys mandible $(\mathrm{M}_{1}\text{-}\mathrm{M}_{3}),$ H-GSP 248.



Figure 8. Hipparion metatarsal II, proximal articular surface, from H-GSP locality 17, H-GSP 150. Natural size.



Figure 9. Hipparion metatarsal III, from H-GSP locality 17, H-GSP 150, anterior view. Natural size.

Table 1. Composition of the Daud Khel local fauna.

Pisces Siluriformes Reptilia Chelonia Trionyx sp. Squamata Agamidae Crocodilia Crocodylus palaeindicus Mammalia Insectivora Erinaceidae Soricidae Creodonta Hyaenodontidae Dissopsalis carnifex Proboscidea Gomphotheriidae Perissodactyla Equidae cf. Hipparion sp. Rhinocerotidae Brachypotherium perimense Gaindatherium browni Chilotherium sp.

Artiodactyla Giraffidae Giraffokeryx punjabiensis Giraffokeryx sp. Suidae Listriodon pentapotamiae Listriodon sp. Palaeochoerus sp. Tragulidae Dorcatherium minus Dorcatherium sp. Bovidae Miotragocerus sp. Gazella sp. Rodentia Sciuridae Gliridae Ctenodactylidae Sayimys sp. Rhizomyidae Kanisamys sp. Cricetidae Copemys (Democricetodon) sp. Myocricetodon sp. Muridae Antemus cf. A. chinjiensis murid genus A

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