JOURNAL OF PALEONTOLOGY, V. 52, NO. 5, P. 1015–1022, 3 TEXT-FIGS., SEPTEMBER 1978

VERTEBRATE FAUNA FROM NEOGENE SIWALIK GROUP, DANG VALLEY, WESTERN NEPAL

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ABSTRACT—The Siwalik Group of western Nepal was explored paleontologically in 1976. A small vertebrate fauna from the Dang Valley, containing fish, reptiles and mammals, appears most similar to the assemblage from the Lower Siwaliks of Pakistan.

INTRODUCTION

THE SIWALIK Group, a thick fluvial sedimentary sequence derived from the Himalayan uplift, was deposited across the northern edge of the South Asian subcontinent from middle Miocene to middle Pleistocene time. It can be traced, under various names, from Baluchistan and Iran in the west to Burma in the east (Gansser, 1964).

Siwalik Group rocks have been best studied in the markedly fossiliferous areas in the Siwalik Hills of India, and in the extensive open syncline of the Potwar Plateau, Pakistan. On the basis of lithic nature and fossil content, the Siwalik Group of India and Pakistan has been divided informally into lower, middle and upper units (Pilgrim, 1910). The Lower Siwaliks includes the Chinji Formation, the Middle Siwaliks the Nagri and Dhok Pathan formations, and the Upper Siwaliks the Soan Formation in Pakistan or the Tatrot and Pinjor formations in India (Fatmi, 1973; Colbert, 1935; and references cited therein). In the very broadest sense, the rocks become coarser grained upwards through the Group, being dominated by claystones and siltstones in the Chinji Formation and terminating with conglomeratic beds in the uppermost units. The entire sequence in Pakistan and India is estimated to be from about 4,865 m thick (Colbert, 1935) to 6,080 m thick (Wadia, 1975).

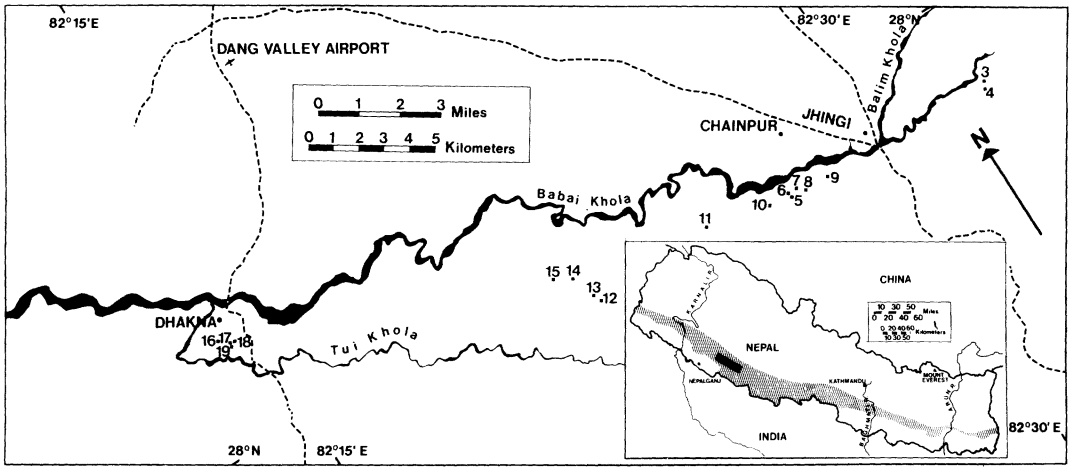
Ongoing remapping and intensive paleontologic and magnetostratigraphic studies of the Pakistan Siwaliks are resulting in revision of the traditional concepts of the Siwalik formations and their fossil contents. One of the more important aspects of this work is the confirmation of marked lateral lithologic change within the Siwalik Group, as originally suggested by Gill (1952) for the western end of the Potwar Plateau. The resultant diminution in importance of the lithologies for correlation purposes has placed more emphasis on paleontologic correlations, especially those using fossil mammals.

PREVIOUS STUDIES OF NEPAL SIWALIKS

Nepal was essentially closed to Westerners until the middle 1950's, so the Siwaliks (Text-fig. 1) of the sub-Himalayas in that country were not studied along with the Indo-Pakistan beds. Lateral correlations of the Nepal Siwaliks with those of India and Pakistan have been further hampered by the relatively poor exposures and virtual absence of paleontologic data.

Auden (1935), the first to describe eastern Nepal Siwaliks, noted the three Siwaliks units, as to the west, with the same general upward increase in average grain size. Lombard (1958) and Bordet (1961) briefly discussed the Siwaliks of eastern Nepal. Hagen (1959) published a series of cross sections through the Siwaliks at numerous localities the length of Nepal, indicated the three-fold stratigraphic division, and suggested that most of the exposed Nepal Siwaliks are "Middle Siwaliks." None of these earlier workers reported fossil materials in the Nepal Siwaliks.

More recently, Glennie and Ziegler (1964) made seven traverses through the Nepal Siwaliks. They defined a lower sandstone facies



TEXT-FIG. 1—Dang Valley Siwalik Group fossil vertebrate localities. Insert shows mapped area and distribution of Siwalik Group in Nepal (adapted from Sharma, 1973).

and an upper conglomeratic facies. They also noted lateral facies variations, although the conglomeratic facies tended to be higher in the section than the sandstone facies. No fossil materials were found during their survey. In conjunction with United Nations groundwater studies, Ithihara et al. (1972) studied the Siwaliks of eastern Nepal. They recognized three units and found occasional plant fossils in the middle unit. Mathur (1972) reported on pollen from presumed lower Siwalik rocks near Nepalganj in western Nepal.

The first primarily paleontologic field work in the Nepal Siwaliks was reported by West et al. (1975) who prospected part of the area mapped by Ithihara et al. Only poorly preserved molluscs were found. These were in the unit considered Middle Siwaliks by Itihara et al., but were inadequate for paleontologic correlation with the western Siwaliks of India and Pakistan.

The Nepal Geological Survey has mapped numerous areas within the Siwaliks but the individual reports are not published. Some of that information is included in Sharma (1973). Nepal Geological Survey mappers utilize the three-fold subdivision of the Siwaliks, but for mapping purposes they recognize four to six lithic units which they do not correlate explicitly with the formations of Pakistan and India. They estimate the entire Siwalik Group to have a thickness of 4,250 to 8,200 m within Nepal. Several reports mention plant, mollusc and vertebrate remains, especially in the lower and middle Siwaliks. This material was not collected, and locality data is not available.

THE PRESENT STUDY

In March 1976, the authors collected fossil vertebrates in rocks mapped by the Nepal Geological Survey as Lower Siwaliks in the range of low hills immediately south of Babai Khola in western Nepal. This area of the Dang Valley was selected from aerial photographs studied at the Forest Resources Service, Kathmandu, and from the comments on fossil occurrences in several unpublished Nepal Geological Survey reports.

Seventeen vertebrate-producing sites were found in a region about 34 km long and 3.25 km wide. The localities are scattered through about 500 meters of steeply dipping fine-grained rocks on the north slope of the first line of hills south of the Main Boundary Fault. Recent deforestation by local residents has resulted in rapid erosion of the steep hillsides, exposing the steeply dipping Siwaliks.

The Dang Valley Siwalik Group dips generally southward, so the oldest rocks are low on the northernmost hills. These sub-Himalayan hills are faulted synclines reflecting structural proximity to the Main Boundary Fault. Younger beds of the Siwalik Group overlie the 1976 localities, to the south of Tui Khola, so the present study sampled only a small part of the available Siwalik sequence.

The presumed Lower Siwalik rocks of the Dang Valley are fine-grained, buff, purple to

TABLE 1—Dang valley vertebrate fossil localities.

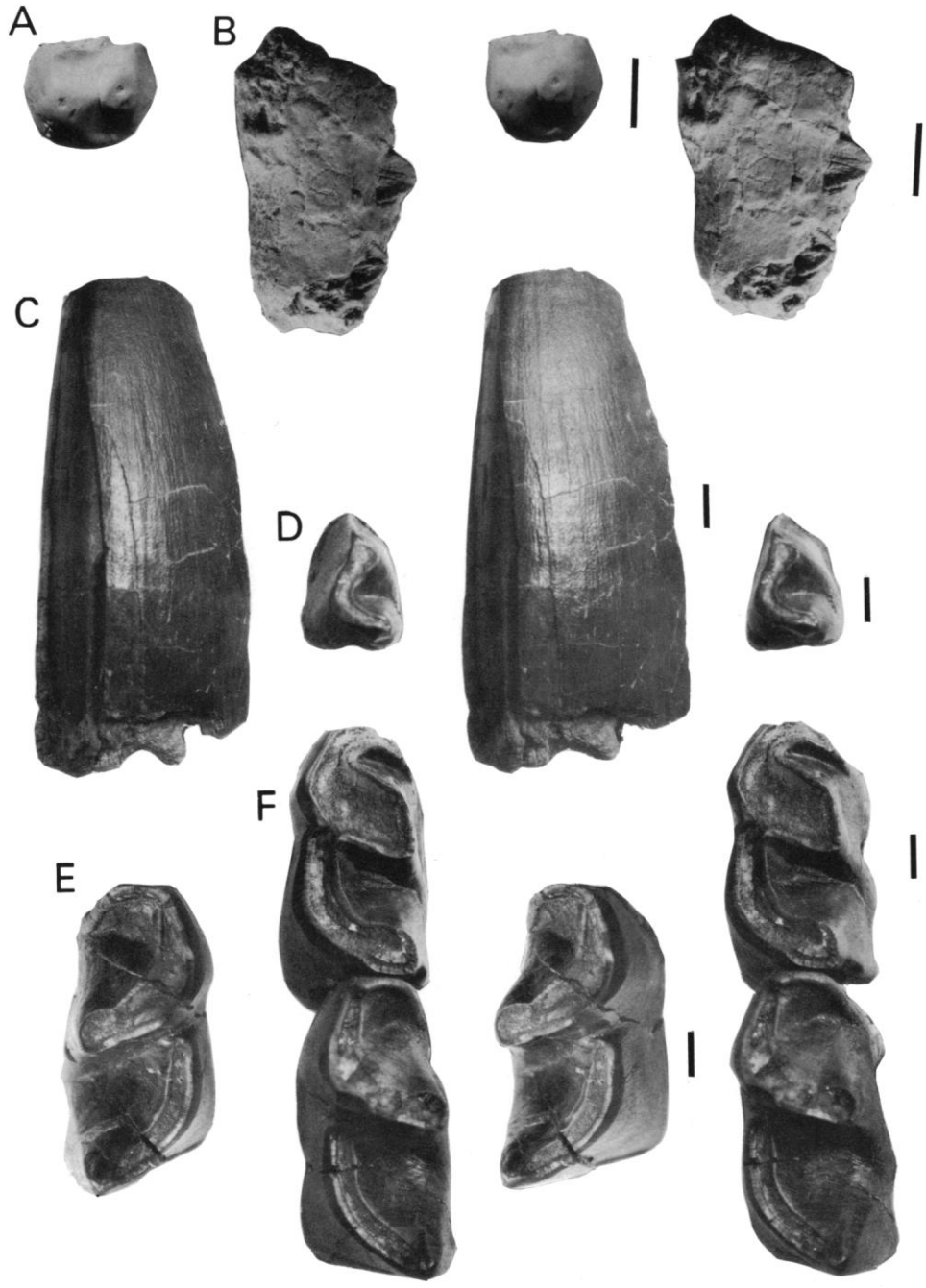
Name	Latitude	Longitude	Lithology	Assemblage
MPM N-3	27°58′25″N	82°32′45″E	Massively bedded gray-green to brown mottled claystone	Crocodilians, chelonians, proboscidean, large and small mammals
MPM N-4	27°58′25″N	82°32′45″E	Same as MPM N-3	*Hemimeryx pusillus*
MPM N-5	27°58′30″N	82°27′30″E	Yellow claystone	*Deinotherium pentapotomiae*
MPM N-6	27°58′35″N	82°27′30″E	Yellow claystone	*Amphicyon* cf. *palaeindicus*
MPM N-7	27°58′35″N	82°27′40″E	Alternating buff sandstones and claystones	Chelonians
MPM N-8	27°58′30″N	82°27′50″E	Mottled yellow claystone	Crocodilian, chelonians, *Dorcatherium* sp.
MPM N-9	27°58′30″N	82°28′30″E	Yellow-green-gray mottled claystone	Gomphothere
MPM N-10	27°58′35″N	82°26′50″E	Alternating buff claystone, sandstone and marlstone	Trionychid turtles
MPM N-11	27°58′55″N	82°25′20″E	Gray nodular marlstone	Teleost fish, trionychid turtles
MPM N-12	27°58′45″N	82°22′20″E	Greenish-purple rubbly marlstone	Trionychid turtles
MPM N-13	27°59′00″N	82°22′15″E	Brown-green sandy marlstone	Chelonians
MPM N-14	27°59′20″N	82°21′55″E	Yellow-brown siltstone	Large mammal
MPM N-15	27°59′40″N	82°21′30″E	Reddish claystone	Chelonians
MPM N-16	28°02′35″N	82°14′15″E	Blue-gray marlstone	Large mammals
MPM N-17	28°02′20″N	82°14′30″E	Buff sandstones and claystones with interbedded purple marlstone	Teleost fish, crocodilians, chelonians, snake, proboscideans, *Brachypotherium perimense*, large mammal
MPM N-18	28°02′20″N	82°14′30″E	Same as MPM N-17	Teleost fish, crocodilians, trionychid turtle, gompothere, *Brachypotherium perimense*, small mammal
MPM N-19	28°02′20″N	82°14′35″E	Yellow-purple mottled claystone	Gomphothere

gray sandstones, siltstones and marlstones. Little coarse sandstone or conglomerate is present, and channel deposits are not prominent. Marlstones make up many of the more resistant units; this facies is markedly different from presumably time-equivalent Lower Siwalik rocks of India and Pakistan and from lower Siwalik red and maroon clays near Nepalganj reported by Mathur (1972). Lower Siwalik rocks in western Nepal appear to have been deposited in poorly drained areas, characterized by ponds and sloughs, in contrast to the almost entirely fluvial depositional environment of Lower Siwalik rocks to the west in India and Pakistan. The abundance of fossil fish, crocodilians and turtles in the Nepal Siwaliks tends to substantiate this.

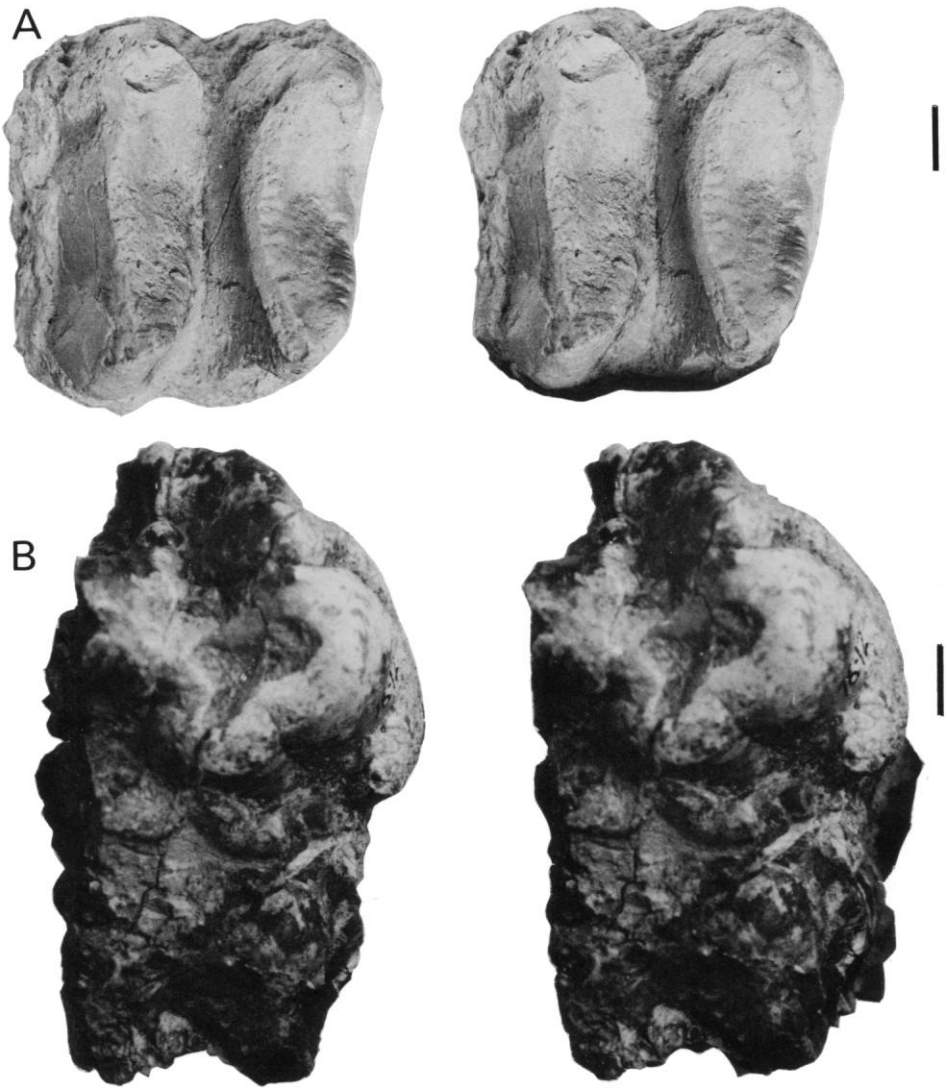
The fossils usually were found as surface lag fragments; no excavations were undertaken and only one specimen was found in situ. The fragmentary nature of the specimens coupled with the relative infrequency of fossils suggests that this particular area of Nepal Siwaliks is not nearly as productive as exposures of equivalent size farther west. Although fossil vertebrates previously had been found in Nepal (Sharma, 1973), these are the first instances of vertebrate assemblages coupled with adequate locality data.

LOCALITIES

The 17 localities collected in 1976 are indicated on Text-fig. 1 and described in Table 1. Despite their proximity to one another, most are effectively isolated by large areas of uneroded subrecent alluvium and expanses of dense and hostile vegetation. Correlation between localities is further complicated by local attitude variations. Locality designations refer to Milwaukee Public Museum field numbers;



TEXT-FIG. 2—Stereophotographs of Dang Valley fossil vertebrates. *A*, Molar trigonid, MPM N-76-6, referred to *Amphicyon palaeindicus*, from a cast; *B*, Mandibular fragment, MPM N-76-4, referred to *Hemimeryx pusillus*, from a cast; *C–F*, MPM N-76-48, *Brachypotherium perimense*; *C*, Incisor; *D*, Right P_2; *E*, Right M_2; *F*, Left M_1–M_2. Scale lengths represent 1 cm.



TEXT-FIG. 3—Stereophotographs of Dang Valley proboscideans. *A*, Upper second molar, MPM N-76-5, of *Deinotherium pentapotamiae*, from a cast; *B*, Molar fragment, MPM N-76-12, referred to the Gomphotheriidae. Scale lengths represent 1 cm.

more detailed data and field maps are in the authors' files.

SYSTEMATIC PALEONTOLOGY

General.—Fifty-two field-catalogued vertebrate specimens were recovered from the 17 fossil localities in the Dang Valley. All these specimens are in the possession of the Research Division of Tribhuvan University, Kathmandu, and are to be permanently deposited in the Nepal National Natural History Museum located near Swyambunath Temple on the outskirts of Kathmandu. The authors have photographs and latex molds of some of the better specimens; the following notes are based upon those materials and field observations. Specimens are indicated by Milwaukee Public Museum field numbers, prefixed by MPM N.

Teleost fish.—These are common components of the Dang Valley assemblage. Eight catalogued suites of specimens, representing as many as 25 individual animals, were collected from three localities. Both isolated vertebrae

TABLE 2—Measurements of teeth of MPM-N-76-48, *Brachypotherium perimense*.

Tooth	Length (mm)	Anterior Width (mm)	Posterior Width (mm)
Left P_2	36.0	19.2	
Left M_2	53.2	28.5	22.5
Left M_3	64.0	33.3	37.5
Right M_3	68.0	30.5	31.9

TABLE 3—Published stratigraphic ranges of mammals present in Dang Valley Siwaliks.

Taxon	Kam-lial	Chin-ji	Na-gri	Dhok Path-an
Amphicyon palaeindicus		X	X	
Deinotherium pentapotamiae		X		
Gomphotheriidae	X	X	X	X
Brachypotherium perimense	X	X	X	X
Hemimeryx pusillus		X	X	
Dorcatherium sp.		X	X	X

Ranges based on Colbert, 1935; Dehm et al., 1963; and Heissig, 1972.

and complete tooth-bearing elements were collected. Two specimens (MPM N-76-35) from locality MPM N-17 are possibly catfish premaxillae, and another premaxilla may be percomorph. Other specimens are not diagnostic.

Crocodilians.—Eight catalogued specimens from four localities are crocodilians. Teeth, dermal scutes and large vertebrae are all preserved, but these specimens are not adequate for differentiating between gavials and crocodiles, both of which are known from Siwalik rocks in India and Pakistan.

Snakes.—Fragmentary vertebrae from loc. 17 appear best referable to boid snakes. Despite their incompleteness, they have the complex structure of ophidian vertebrae, and are not massive enough to be crocodilian.

Turtles.—Shell fragments from five localities show the characteristic "cratering" of trionychids, the common soft-shelled turtles. Two subfamilies are known from the Neogene of South Asia, and it is not possible to assign the available material to either.

Numerous other turtle shell fragments (six suites of specimens from five localities) are present. All are smooth and undefinitive beyond the ordinal level.

Carnivora.—Text-fig. 2. The trigonid of a lower right second molar from locality MPM N-6 undoubtedly belongs to *Amphicyon palaeindicus*. MPM N-76-6 is 17.2 mm wide, somewhat larger than the *A. palaeindicus* M_2 figured by Colbert (1935, p. 84), but known variation in tooth size among other species of amphicyonids suggest that Colbert's figured specimen is a small individual (Tedford, pers. comm. to Munthe, July 12, 1976). Colbert (1935, p. 30) considered the species to occur in both Chinji and Nagri formations.

Proboscidea.—Text-fig. 3. MPM N-76-5 is two upper molars of *Deinotherium* from locality MPM N-5. M^2 is complete. It measures 65.6 mm in length, 70 mm in anterior width and 69 mm in posterior width. Dehm et al. (1963) reviewed the species of *Deinotherium* from the Siwaliks of Pakistan and concluded that *D. pentopotamiae* is the sole valid species in the Lower Siwaliks (Chinji Formation). MPM N-76-5 compares favorably in both size and morphology with *D. pentapotamiae*.

Gomphotheres are present at three localities. None of the three specimens (MPM N-76-12, 45 and 49) is complete enough for generic identification, measurement or morphologic study. Gomphotheres range through the entire Siwalik Group in Pakistan.

Five other specimens are of exceedingly large mammals, probably proboscidean, but far too fragmentary for even subordinal level identification. Nonetheless, the Proboscidea seem to be numerically the most abundant mammals in the Dang Valley fauna.

Perissodactyls.—Text-fig. 2. The best preserved specimen in the 1976 collection is MPM N-76-48, much of the lower dentition of a rhinoceros, *Brachypotherium perimense,* from locality MPM N-18. Colbert (1935) regarded this species as belonging to the genus *Aceratherium;* Heissig (1972) recently has reviewed the Lower and Middle Siwaliks rhinoceroses and places *Brachypotherium* in a different tribe (Teleoceratini) from *Aceratherium* (Aceratherini). MPM N-76-48 compares very well morphologically with Heissig's specimens, although the M_3's of the Nepal specimen are about 10% longer than those measured by Heissig (Table 2). A fragment of the tip of a canine (MPM N-76-27) from locality MPM N-17 also appears referable to *B. perimense*. Colbert (1935) recognized *B. perimense* in the Chinji, Nagri and Dhok Pathan Formations, while Heissig indicated that the species is also in Kamlial Formation rocks.

Artiodactyla.—Text-fig. 2. A poorly pre-

served right mandibular fragment with two unerupted premolars is tentatively referred to the small anthracothere *Hemimeryx pusillus,* a Chinji-Nagri species according to Colbert (1935). MPM N-76-4, from locality MPM N-4, however, is considerably smaller than AMNH 19370 which was illustrated and measured by Colbert (1935, fig. 121, p. 274), so the species reference is questionable. More secure identification of the specimen awaits its complete preparation.

A tragulid is represented by the distal end of a right tibia from locality MPM N-8. This specimen. MPM N-76-9, compares well with *Dorcatherium* tibiae in the American Museum of Natural History collection, and is probably referable to one of the two small species of *Dorcatherium* discussed by Colbert, *D. minus* of the Chinji, Nagri and Dhok Pathan formations or *D.* sp. from the Chinji and Dhok Pathan formations.

DISCUSSION

The small size of the Dang Valley assemblage makes paleontological correlation to the Siwaliks of India and Pakistan difficult. Table 3 gives the published stratigraphic ranges, in India and Pakistan, of the taxa which have been found in Nepal. With the sole exception of *Amphicyon palaeindicus,* all the Dang Valley forms are known from both the Chinji and Nagri formations (Lower and lower Middle Siwaliks) to the west. However, the equid *Hipparion,* a virtual index fossil for the Nagri Formation (Hussain 1971, p. 62), is absent from the Dang Valley assemblage. Despite the obvious difficulties and uncertainties of basing correlations on absences from a fauna, the lack of representation of *Hipparion* is likely to be significant. Although this conclusion is hesitantly drawn, the strongest equivalence is to the fauna of the Chinji Formation of the southern Potwar Plateau of Pakistan. Therefore, we now regard the Dang Valley vertebrate fauna as representative of the Lower Siwaliks and late Miocene in age.

This correlation is drawn with the clear understanding of the technical difficulties of adequate definition of the Siwalik formations of India and Pakistan, and the nomenclatorial problems of separating rock and time units bearing the same name. Siwalik formations have been extended across much of South Asia using subjective criteria of both lithology and contained fauna, although it is now clear that major lithologic variations occur within only a few kilometers of the type sections. A program of section measuring, strike mapping and recollection of classic localities is underway in Pakistan, with the intention of providing a realistic basis for study of geologic and evolutionary events in South Asia. Our correlation of the Dang Valley assemblage with the fauna of the Chinji Formation of Pakistan, therefore, suggests a basic biological similarity but does not necessarily imply temporal or stratigraphic equivalence.

A further difficulty with the long-distance correlation of the Dang Valley fauna with Pakistan arises from the apparent differences in depositional regimes. The absence of *Hipparion* from Nepal may well be best explained paleoecologically rather than temporally, so a Nagri Formation equivalence for the lower part of the Dang Valley Siwaliks is by no means impossible.

A paleomagnetic reversal chronology is now being developed for Pakistan (N. Johnson and G. Johnson, pers. comm., 1976), but at present there is no means of extending it into Nepal. Thus all correlations are paleontologically based.

The general geologic mapping of the Nepal Geological Survey apparently is confirmed paleontologically. Beds referred to the Lower Siwaliks on lithologic and superpositional grounds contain a vertebrate fauna which, although low in diversity, is suggestive of the Lower or lower Middle Siwaliks in Pakistan. Thus, despite the different lithologies, this faunal assemblage extends across some 1,200 km of Siwaliks exposures.

ACKNOWLEDGMENTS

The 1976 Milwaukee Public Museum paleontological work in Nepal was supported by the Chapman Foundation, the Verne R. Read family, and the Friends of the Museum, Inc., of Milwaukee, Wisconsin. Travel as far as Pakistan was provided by a Smithsonian Foreign Currency Program grant to Hussain. Tribhuvan University in Kathmandu provided the research base; we are most grateful to Mr. Krishna Raj Pandey and Mrs. Bina Pradhan of the Research Division and Dr. B. M. Pradhan of the TriChandra College Department of Geology. Mr. G. S. Thapa of the Nepal Geological Survey, Mr. U. B. Shrestha of

the Forest Resources Service and Dr. C. K. Sharma of the Groundwater Project provided valuable information, literature and photographs. Mr. Mervin Stevens, United Nations Development Project in Nepal, and Mr. Kent Obee, U.S. Information Service in Kathmandu, were of great help in logistics problems.

Dr. David Pilbeam of Yale University, Dr. Martin Pickford of the University of London, Dr. Gary Johnson of Dartmouth College, Dr. Herbert Thomas, National Museum of Natural History, Paris, Dr. Neil Opdyke of the Lamont-Doherty Geological Observatory and Mr. Louis Jacobs of the University of Arizona have graciously shared with us the preliminary results of their ongoing research in the Siwalik stratotypes of the Potwar Plateau region in Pakistan.

Dr. Kurt Heissig, Bayerischen Staatssamlung für Paläontologie und historische Geologie, Munich; Dr. Richard Tedford and Mr. Earl Manning, American Museum of Natural History, New York; Dr. Richard Estes, San Diego State University; Dr. J. Howard Hutchison, University of California, Berkeley; and Dr. Wann Langston, Jr., University of Texas, Austin, assisted with specimen identifications. Dr. Tedford critiqued the manuscript.

The photographs were prepared by the Photography Department of the Milwaukee Public Museum; Susan Kirchner and Christine Costello prepared the illustrations; and Cheryl Castelli typed the manuscript.

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MANUSCRIPT RECEIVED MAY 23, 1977
REVISED MANUSCRIPT RECEIVED OCTOBER 11, 1977