*Ring D*: The values of C—S bond lengths of 1.824 Å and 1.796 Å are indicative of bonds involving 3d orbitals of sulfur and are quite close to the values reported in literature[4]. The pseudo-rotation parameters as described by Romers *et al.*[5] are $\Delta = 10.8°$ and $\varnothing_m = 42.4°$ showing the ring to be in conformation between that of half-chair and 13 envelope. The least squares plane of the ring shows that the atoms 15, 16 and 17 are in one plane with atoms 14 and 13 above and below by 0.134 Å and 0.521 Å respectively and hence the conformation of the ring is close to 13$\beta$ envelope. The two oxygens are symmetrically disposed to the ring.

In the methoxy side group O(3)—C(19) bond is trans to C(3)—C(14) and belong to A conformer of Duax *et al.*[2] The B, C and C/D junctions are both cis (which is unusual), indicating flexibility in the form[6] and as is to be expected the values of the two torsion angles at the cis junctions are nearly equal. The overall shape of the molecule suggests that it is in 8$\alpha$—9$\alpha$—13$\beta$—14$\beta$ conformation.

*Inter experimental comparison:* Three dimensional intensity data was collected with CAD-4 diffractometer (at Indian Institute of Science, Bangalore) with Mo $K_\alpha$ radiation, with another crystal of the same compound estra-sulfone. This data gave an R factor of 7.2% for non-hydrogen atoms and 4.8% for hydrogen atoms included. Inter experimental comparison has been done in the basis of half normal probability plots[7] on positional and thermal parameters (of non-hydorgen atoms only), from the CAD-4 and TXD (Trombay x-ray diffractometer) data sets. The positional and thermal parameters have been compared separately and the half normal probability plot for both are straight lines passing through the origin showing that the errors are normally distributed. The positional parameters give a half normal probability plot with slope 1.21 thereby showing that the standard deviations of Trombay data have been underestimated by 21%. The half normal probability plot for thermal parameter gave a slope of 1.32 indicating that the standard deviations for thermal parameters are also underestimated to a greater extent.

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## FOSSIL MAMMAL FOOTPRINTS FROM THE SIWALIKS OF SOUTH-CENTRAL NEPAL

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ABSTRACT

Footprint impressions made by two different mammals were found in fluvial sedimentary rocks of the Siwalik Group in south-central Nepal in 1982. These are the first ichnofossils reported from the Siwaliks through all of South Asia. The rocks are of late early middle Siwalik age. One animal was probably a bovid and the other an anthracothere.

### INTRODUCTION

THE Siwalik Group, a thick fluvial sedimentary sequence deposited from Miocene to Pleistocene along the southern flank of the Himalayas, has been studied extensively in India and Pakistan for over 150 years. However, only recently[1,2] has paleontologic investigation extended into the Siwaliks of Nepal. The

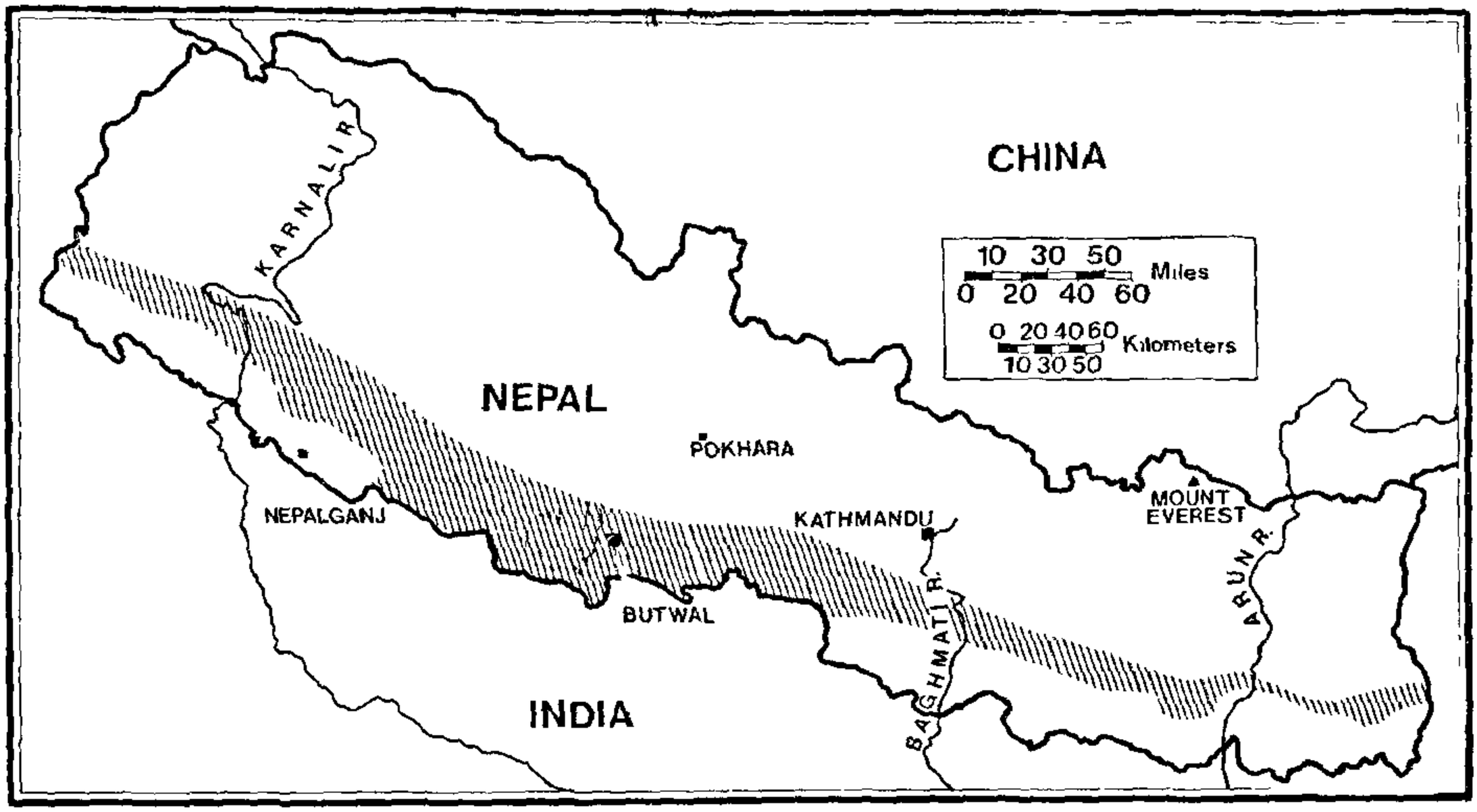


**Figure 1.** Nepal, with the exposure area of Siwalik Group rocks indicated by diagonal lines. The area of figure 2 is the small square marked Butwal.

first reported occurrence of mammalian footprints preserved in rocks of the Siwalik Group was found in south-central Nepal by the Milwaukee Public Museum-Tribhuvan University expedition of 1982. Modestly distinct impressions made by two different mammals, both probably artiodactyls, were discovered in lower or middle Siwaliks rocks by Hutchison.

## Locality And Age

The footprint locality (N-25 in the National Museum of Natural History of Nepal palaeontology catalogue) is on the south side of Tinau Khola, approximately 8 km northeast of Butwal, Lumbini District, along the Sunauli-Pokhara Highway (figures 1 and 2). It is about 100 m west of the Aam Bridge, at 83° 29′ 30″ East, 27° 45′ North, on Survey of India of India map 63 M/6. The rocks of the Siwalik Group there strike east-west and dip about 53° to the north. They are composed largely of fine-grained, cross-bedded gray to buff sandstone with some ripple-marked surfaces. Interbedded with the sandstone are reddish and greenish clay and clay-pebble, intraformational conglomerate beds. Elsewhere in the immediate vicinity the intraformational conglomerates yield small quantities of fossil bone and teeth.

The locality is near the top of a 2,000 m thick section which is best exposed in the canyon of Tinau Khola between Butwal and Dobhan where the khola cuts across the structural grain. In the area of N-25, Tinau Khola follows the strike of the Siwaliks and does not reveal significant amounts of section.

The palaeomagnetic stratigraphy of the Siwalik rocks between Butwal and Dobhan is currently under study by W. F. Kean of the University of Wisconsin-Milwaukee. Preliminary results suggest that the rocks in the canyon are 9.0–11.5 million years old; loc. N-25 is the upper end of the undisturbed sequence, suggesting an age of 9.0–9.5 million years, or late early to early middle Siwaliks[3].

## Palaeobiology

The mammal tracks are on a large exposed face which has its base at river level, and is about 6 m high and 20 m long. In addition to the footprints, the ripple-marked surface (visible in figures 3 and 4) shows indications of worm burrowing and has impressions apparently produced by accumulated vegetation.

Each mammal left several footprints, in the form of poorly preserved trackways apparently oriented in the same direction. It is unfortunate that only one of each footprint type, is clear enough, for a detailed description.

One of the mammals is clearly a cloven-hooved artiodactyl, with hooves 7.5 cm long and 6 cm wid-

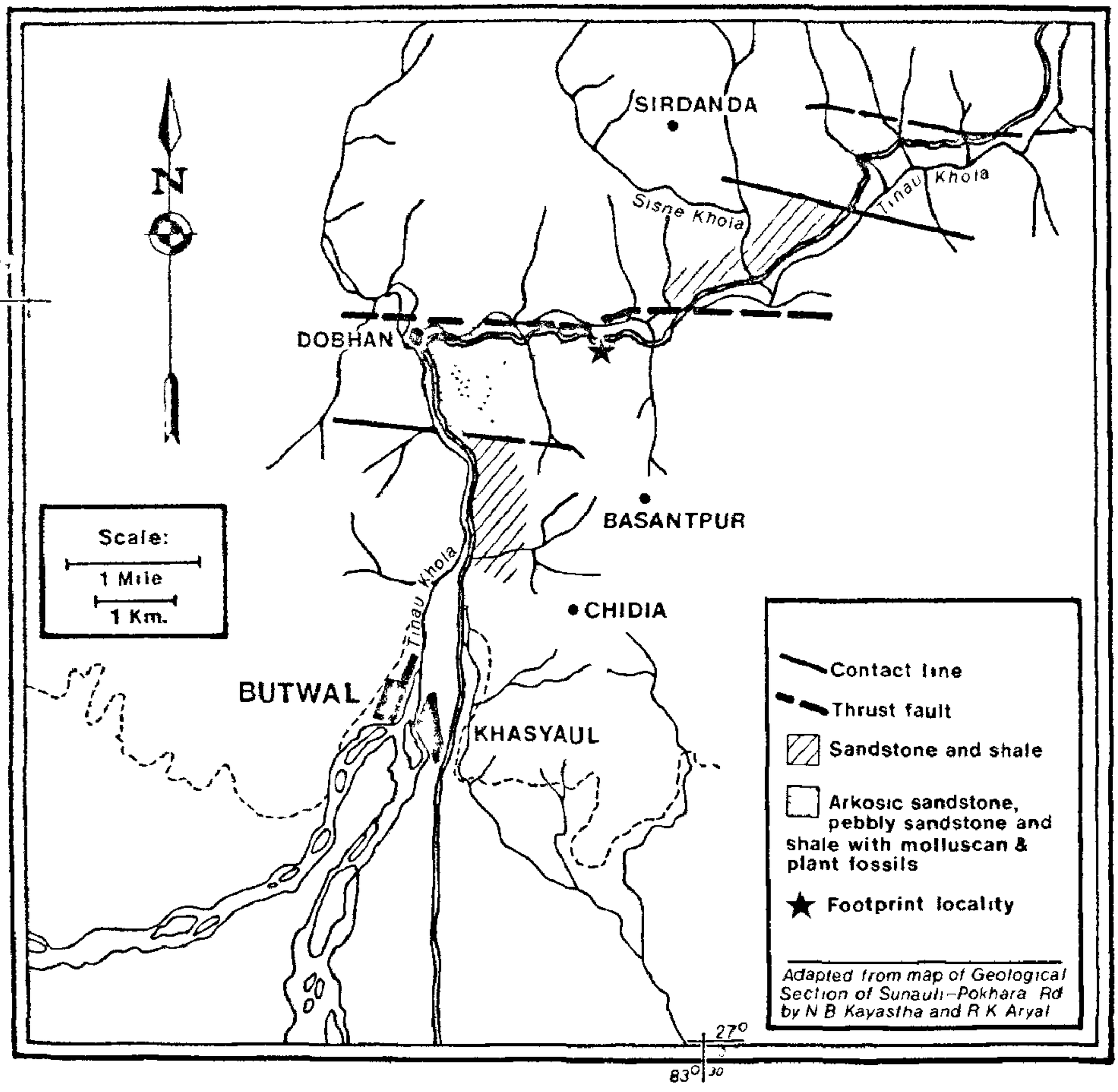


**Figure 2.** Detailed map of Tinau Khola, north of Butwal. Rocks of the Siwalik Group have been mapped only adjacent to the highway.

(figure 3). From the single well-preserved track to the next identifiable one in the trackway is 59 cm. The two hooves are clearly indicated, and there is no sign of lateral hooves. The size and shape is in the general range of the North American white-tailed deer (*Odocoiluus virginiana*); the individual hooves are not as broad as in the Suidae. We speculate that this animal is a cervid or a bovid, and there is known to be a reasonably diverse bovid assemblage in rocks of early Siwalik age elsewhere in South Asia[4]. A medium sized bovid, known from two specimens (NP-68 and NP-69 in the vertebrate palaeontology collection of the National Museum of Natural History, Kathmandu), was collected from a locality in the same series of rocks and within a few meters stratigraphically of N-25, so there is evidence of the presence of the appropriate taxon.

The second mammal left the impression of a symmetrical four-toed foot, approximately 10 cm in length from the poorly preserved pad to the tip of the toes (figure 4). The distance between adjacent prints could not be measured. This animal also is an artiodactyl and probably is an anthracothere, a group with several lower Siwalik representatives[5]. No anthracotheres have been found in the sequence north of Butwal; but a *Merycopotamus*-sized creature is known


**Figure 3a.** Footprint impression made by cloven-hoofed artiodactyl indicated by arrow. Note impressions of organic debris on rock surface. Scale length approximately 16 cm (6.25 inches).

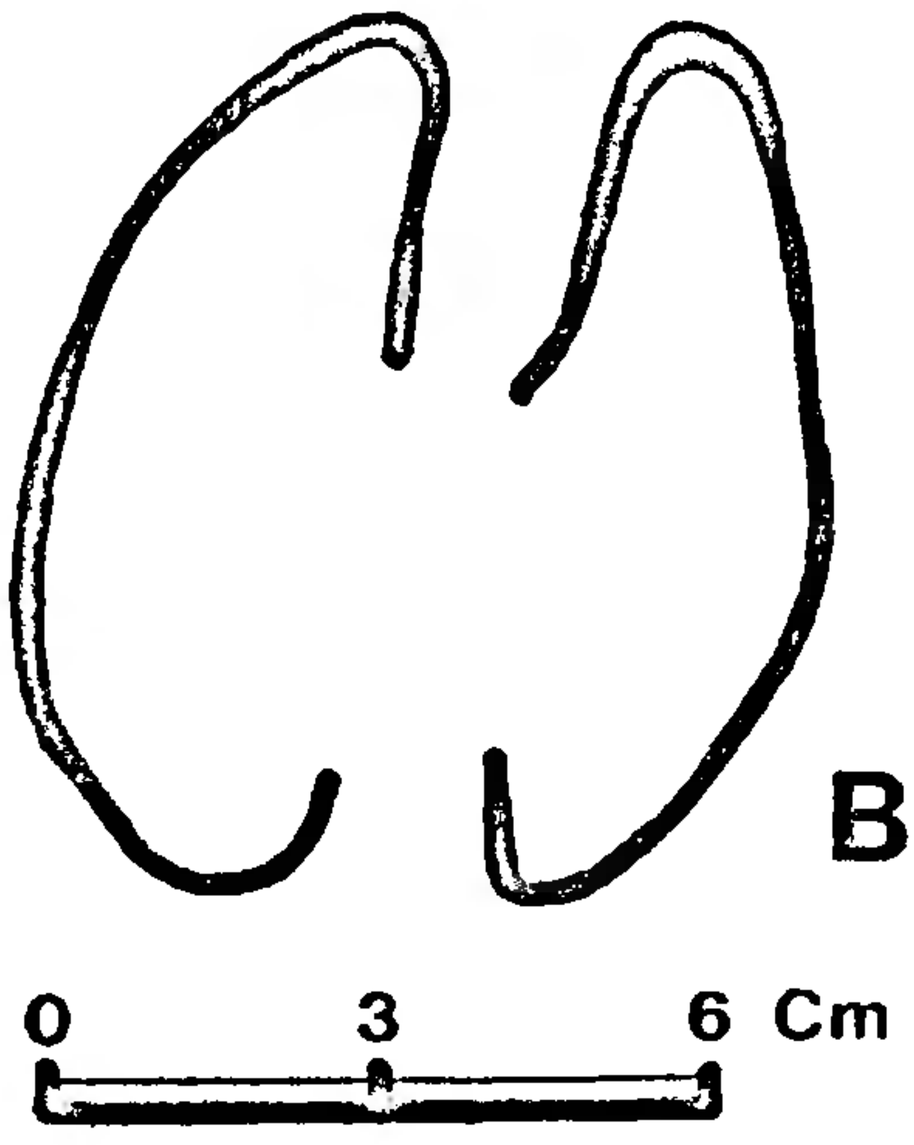


**Figure 3b.** Sketch of footprint shown in 3a.

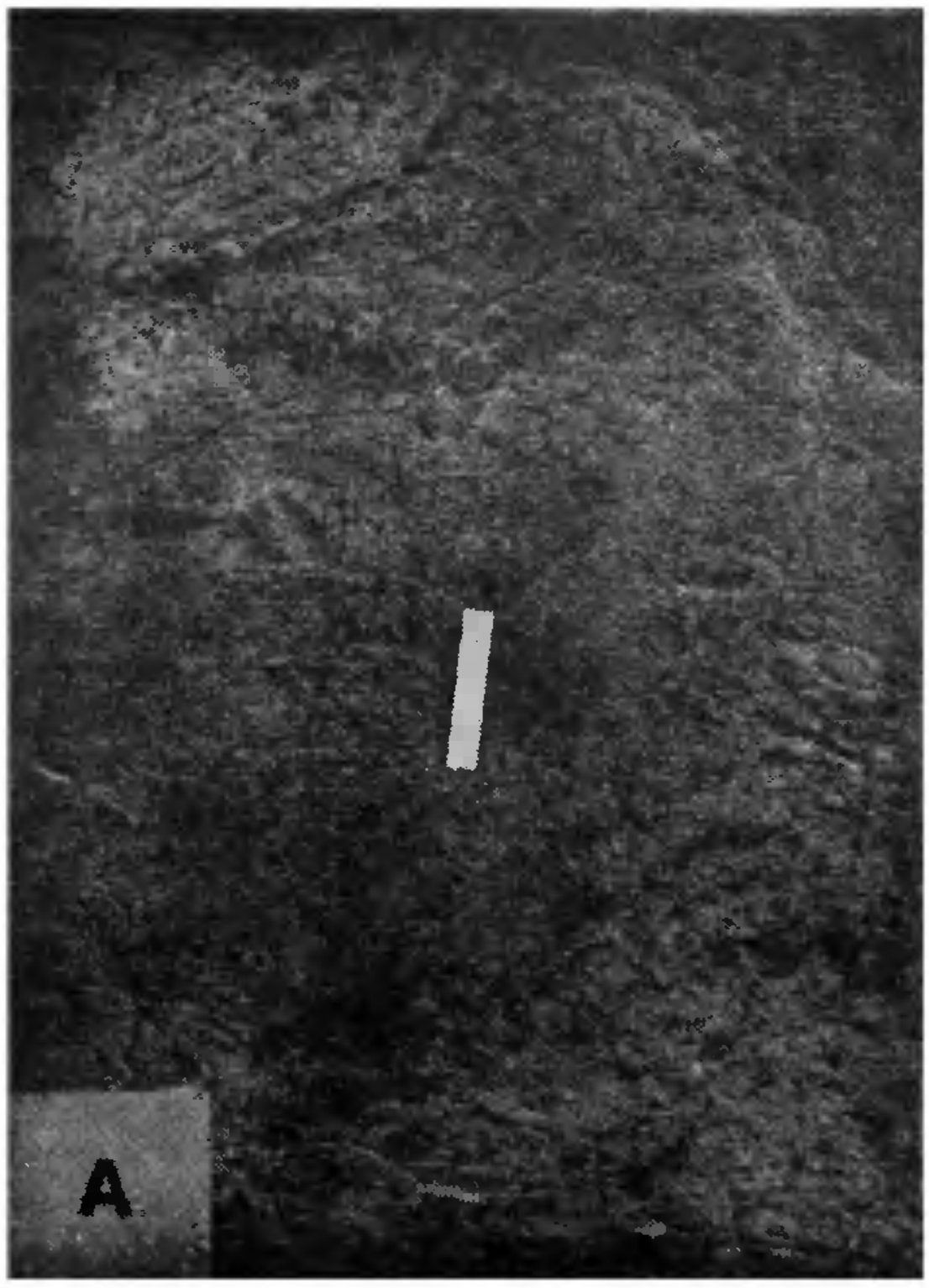


**Figure 4a.** Footprint impressions made by four-toed artiodactyl; clearest impressions indicated by arrow. Note impressions of organic debris on rock surface. Scale length approximately 16 cm (6.25 inches).

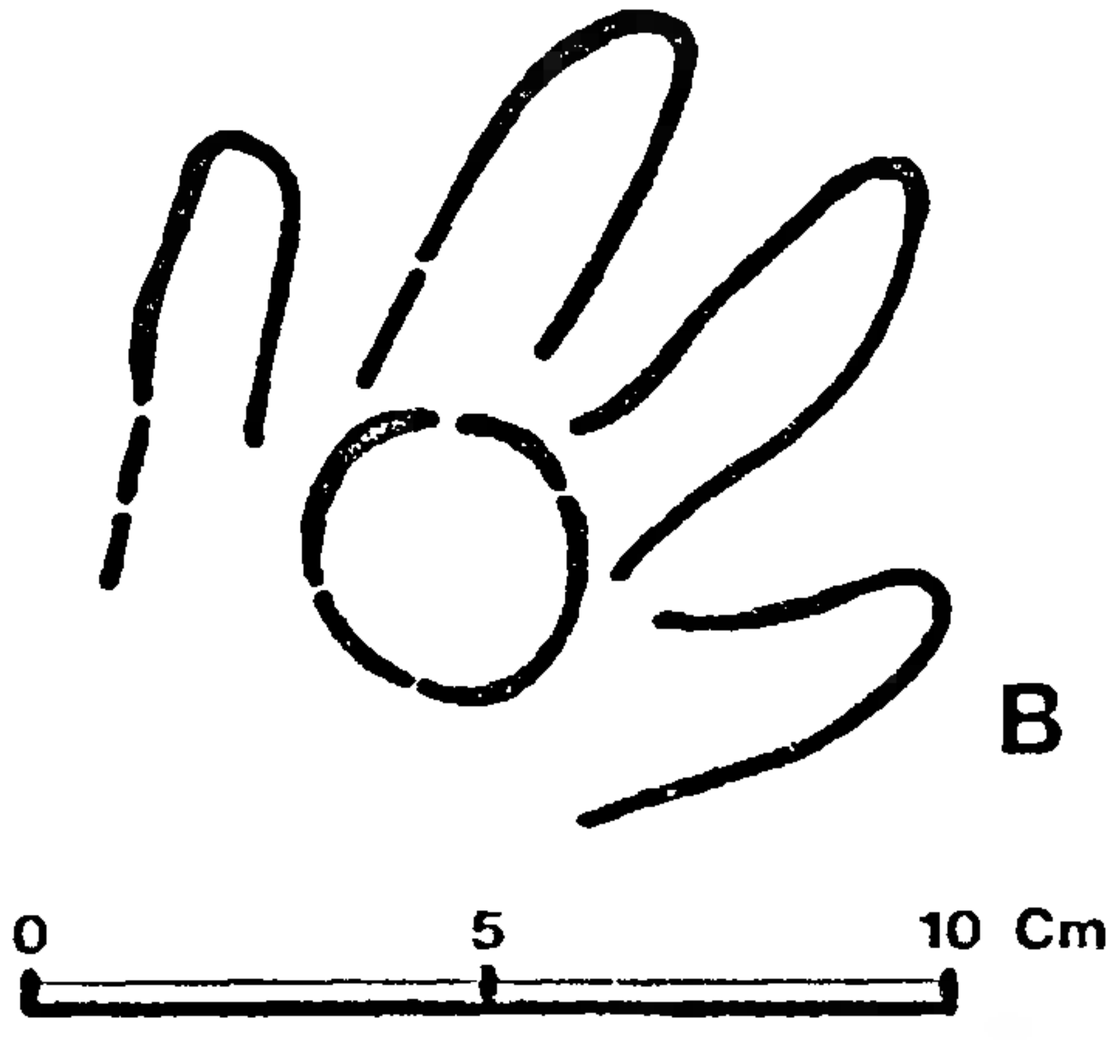


**Figure 4b.** Sketch of footprint shown in 4a.

from the Dang Valley lower Siwaliks, 75 miles to the west.

The footprint-bearing level is exposed only locally, as exposure development is directly related to the course of Tinau Khola. Thus it has no significance for regional correlations, and does not help in unravelling Siwalik stratigraphy in the Butwal area.

Biostratigraphic dating of the Tinau Khola section also indicates an early to early middle Siwalik age. The presence, in the middle of the canyon (and thus in the middle of the local sequence), of the suid *Conohyus sindiensis*, a rhizomyid rodent and the primate *Ramapithecus punjabicus*[6] suggests an age there of nine to ten million years[7].

## Palaeoenvironment

The palaeoecologic conditions indicated by the footprints and associated trace fossils at loc. N-25 corroborate interpretations of the Nepal Siwaliks based on lithologic and palaeontologic evidence. The impressions were preserved under moist and well-vegetated conditions. The composition of the Siwalik faunas from Nepal (mammals are rare and dominated by large folivorous perissodactyls, while fish and aquatic reptiles are the most abundant vertebrates) suggests abundant moisture and open water. The rocks of the Siwaliks and Nepal are marly, fine-grained, often chemically reduced, and indicate low depositional gradients and a relatively stagnant flow regime.

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# CORRELATION OF MEMBRANE RESTING POTENTIAL OF MESOPHYLL CELLS AND DROUGHT RESISTANCE IN WHEAT (*TRITICUM AESTIVUM* L.) CULTIVARS

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## Abstract

Drought susceptible and tolerant varieties of wheat cultivars, exposed to Polyethylene glycol (PEG) induced water stress show marked and systematic differences in the value of the resting potential ($E_M$) of mesophyll cell membrane. The $E_M$ of susceptible variety invariably depolarized while that of tolerant variety showed hyperpolarization. This correlation is fully substantiated by theoretical considerations of the genesis of resting potential. It is suggested that this technique could provide a reliable index of drought tolerance.

## Introduction

IN our earlier communication[1] we have put forward the hypothesis that the change in membrane resting potential ($E_M$) could be used as an index of drought tolerance of crop plants. In contrast to our earlier experiments on coleoptile cells in which the $E_M$ was measured under non-stress condition, in the present