

Figure 2. *Ditremaster* sp., aboral view ($\times 1.75$ approx.).

small tubercles is present on coastae between each pore pair. In ambulacrum III both the pores of pore pair are elliptical in shape (maximum and minimum diameters 0.45 mm and 0.15 mm respectively) and are separated by a single tubercle.

Ambulacral plates simple and in poriferous zone each plate is perforated by a pore pair. The length and width of the largest ambulacral plate are 2.28 mm and 0.45 mm respectively. The specimen has only a 1.14 mm wide peripetalous fasciole which passes all around the extremities of petals, curving sharply inwards just posterior of petals II and IV.

The test is ornamented with non-perforated and non-crenulated tubercles which are sunken in small circular scrobicules. Orally, these are denser than those on aboral side. However, peristome and periproct are not preserved in the specimen.

The presence of a peripetalous fasciole and ethmolytic apical system with two genital pores confirms it to be a hemiasterid. It has also been observed that at the generic level, the other morphological characters of the specimen share with two genera namely *Ditremaster* Munier-Chalmas, 1885 and *Opissaster* Pomel, 1883, but the former differs from the latter in not having an oval test, deep frontal sinus and a centrally situated apical system¹⁰.

The specimen no. I-133 has been deposited in the Regional Palaeontological Laboratory, Geological Survey of India, Jaipur.

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Marine Permian fossils from foothills of Bhutan Himalaya

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The sequence of rocks with marine Permian fossils referred to as Seti Khola Formation in the present paper is well exposed in the Sankosh valley of Bhutan. The 1000-m-thick fossiliferous Formation is overlying Siwalik, with a northward dipping thrust (Main Boundary Thrust) separating the two. Fossils, represented by brachiopods, gastropods, bryozoans and crinoids, suggest late Lower Permian age. Sedimentological studies indicate a shallow-water mixed environment to lagoonal environment.

WELL-PRESERVED marine Permian fossils represented by brachiopods, gastropods, bryozoans and crinoids have been discovered from the Sankosh valley of Bhutan Lesser Himalaya (see Figure 1). The fossil locality is defined by coordinates $26^{\circ}44'$ and $89^{\circ}48'$; best outcrops are exposed along the Seti Khola. The Seti Khola Formation that lies north of Siwalik and south of Phuntsholing formation was considered part of the continental Gondwana sequence by majority of workers^{1,2} and Eocene by others³. Profuse biotic activity in the Formation warranted a closer examination and systematic search for the fossils.

Three mappable units separated from each other by a tectonic plane are demarcated (Figure 1). The Siwalik Group of rocks (thickness ~ 1700 m) are exposed in the south of the area and are thrust over by the rocks of the Seti Khola Formation. The northward dipping thrust designated as Main Boundary Thrust (MBT) separates the two units. In the north, Phuntsholing formation with quartzite and phyllite is thrust over the Seti Khola Formation. This Formation with over

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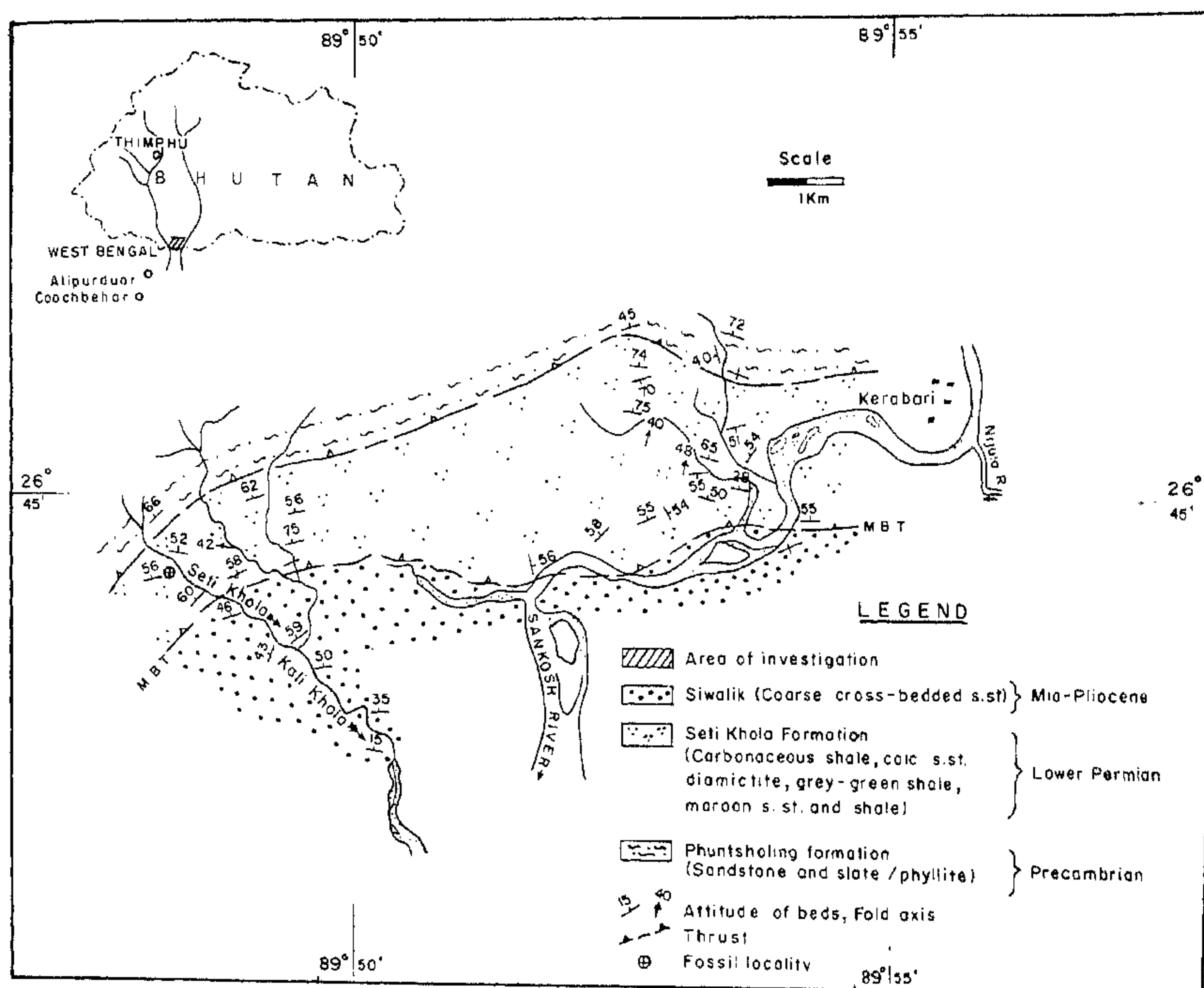


Figure 1. Geological map of part of Sankosh valley.

1000 m of thickness is divisible into three members, viz. Lower, Middle and Upper each with a distinct lithological character (Figure 2). The Lower Member comprises maroon sandstone and shale and grades upward into a Middle Member that consists of rhythmically interbedded black, grey, green shales and calcareous sandstone. The Upper Member comprises a sequence of thickly bedded dirty white to grey sandstone, carbonaceous nodular shale and diamictite. The medium-to-fine grained sandstone is generally calcareous and at places coarse. The sandstone-shale ratio is variable and sandstone often occurs as boudins and lenses within the shale. The rocks have a general NE-SW trend with northwesterly dips. The folds of the Seti Khola Formation have a superposed character with NE-SW and NW-SE trending axes.

As indicated in the lithotectonic column (Figure 2), the fossils occur at different levels. There are two modes of occurrence of these fossils; one in nodules and the other as clustered facies of shells. The nodules have spherical to oblate shapes and they consist of very fine and dense carbonate. Many of these nodules have fossil impressions on the surface but it is the core that

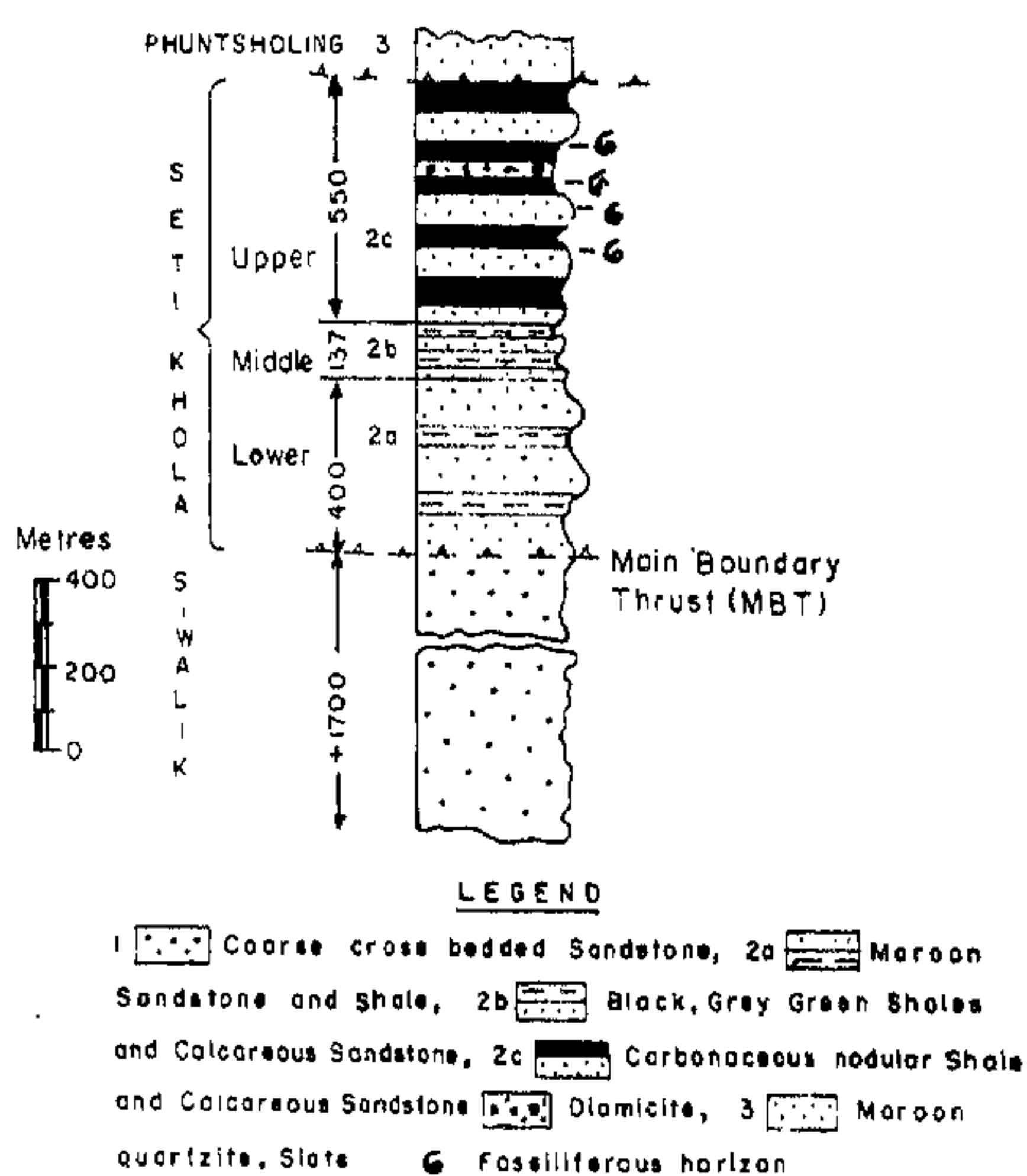


Figure 2. Lithotectonic column of Seti Khola.

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invariably contains well-preserved fossils with pyrite disseminations. Many coarse platy nodules also occur where organisms are present only as graphitic or carbonaceous film. The fossils in sandstone occur as clustered and recrystallized shells. Recrystallization has

rendered the preservation poor and obscured the details. The following species have been provisionally identified (Figure 3) from the collection: 1. *Neospirifer* cf. *fasciger* Keyserling; 2. *Trigonotreta* sp.; 3. *Platyteichum* sp.; 4. *Protoretrepora* cf. *ampla* Lonsdale; 5. *Ortho-*

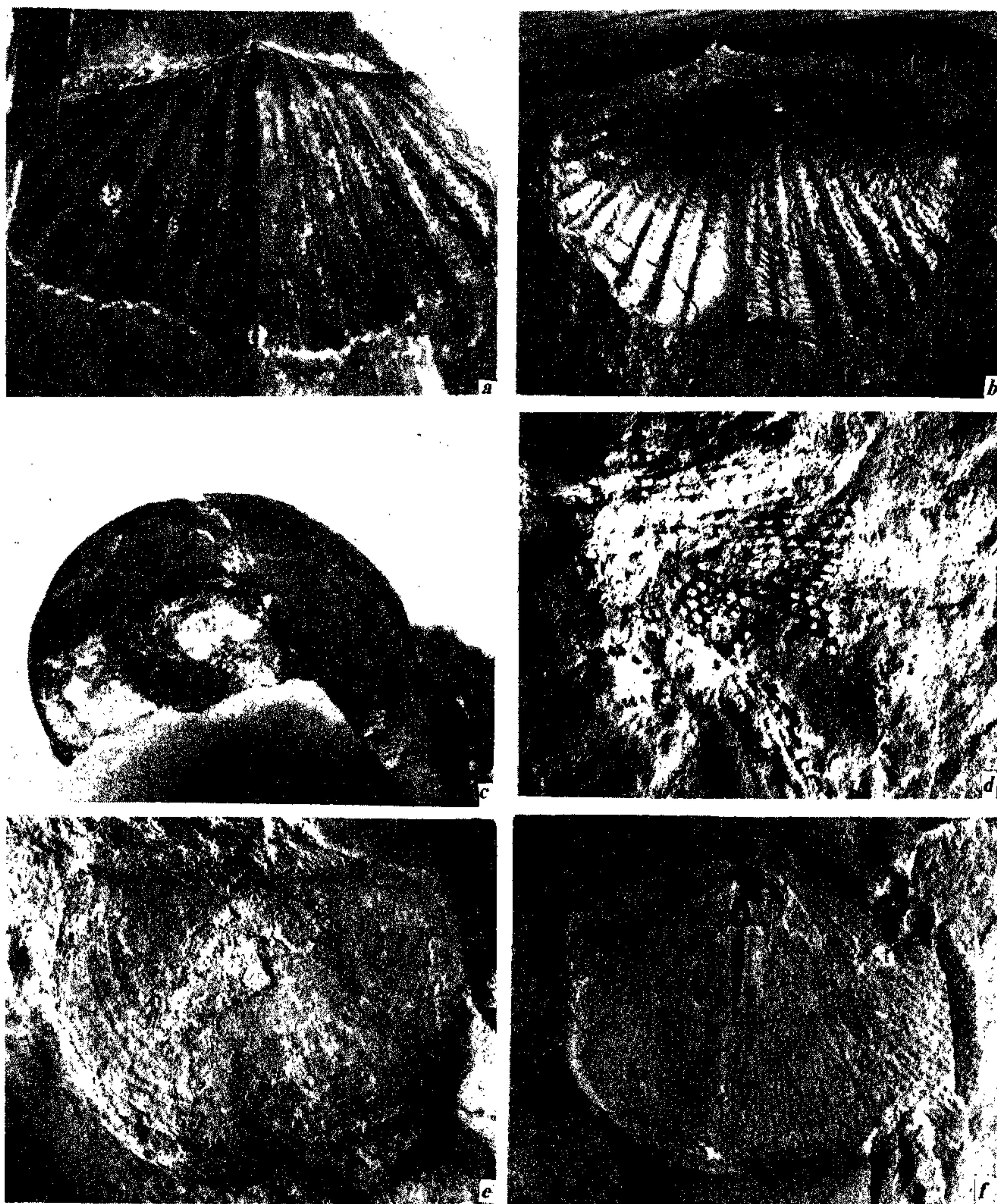


Figure 3. *a*, *Neospirifer* cf. *fasciger* Keyserling ($\times 1.5$, GSI type no. 20321). *b*, *Trigonotreta* sp. ($\times 2$, photo of plasticene cast, GSI type no. 20318). *c*, *Platyteichum* sp. ($\times 2$, part of the spine, GSI type no. 20319). *d*, *Protoretrepora* cf. *ampla* Lonsdale ($\times 1.5$, GSI type no. 20320). *e*, *Orthotetes* sp. ($\times 3$, GSI type no. 20322). *f*, *Waagenoconcha* sp. ($\times 4$, GSI type no. 20325).

tetes sp.; 6. *Waagenoconcha* sp.

The faunal assemblage indicates late Lower Permian (Artinskian) age for the Upper Member, favouring a quiet water marine environment. The lithological character of this Member suggests a reducing environment facilitating the formation of carbonaceous shale and pyrite. A partial or semi-isolation of the basin such as that found in the lagoonal environment could deposit coarser clastics during higher energy and fine clays at tranquility. The rocks of the Middle Member represent deposit of an unstable shelf environment characterized by extensive slumping while at the time of deposition of the Lower Member, the basin must have remained very shallow as indicated by sedimentary structures. Bioturbation, burrows and clastic dykes occur frequently in the lower and middle members.

The present find has established a chain of Permian horizons all along the foothills from Arunachal Pradesh in the east to Jammu and Kashmir in the west. This find may help in revision of chronostratigraphy of Bhutan Lesser Himalaya as these rocks (Seti Khola Formation) occur immediately to the north of Siwalik all along the foothills except for a stretch of about 30 km between Sarbhang and Geylephug. Close proximity of marine Permian sequence, Gondwana and Siwalik exposed along foothills suggests possibilities of existence of marine Permian horizon underneath the Siwalik.

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Electrophoretic variation in laboratory strains of two sibling *Drosophila* species

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Genetic variation at eight gene-enzyme systems has been studied in laboratory strains of *Drosophila takahashii* and *Drosophila lutescens* which constitute a pair of sibling species. Comparison of the genetic structure of *D. takahashii* and *D. lutescens* reveals that ADH, ODH, α -GPDH and EST-7 constitute non-differentiating loci

since both the electrophoretic phenotypes and allelic frequencies are similar for these loci. However, MDH-1, AO and APH-3 loci constitute species-discriminating loci because except for a few shared alleles, the allelic frequency patterns are differential in the two sibling species. The data on the indices of genetic diversity patterns in the sibling species pair are discussed.

THE use of allelic isozymes (allozymes) as probes of genetic structure of populations and species has revolutionized the status of population, ecological and evolutionary genetics¹. The gel electrophoretic analysis of gene-enzyme systems has made it possible to infer genotypes from electrophoretic phenotypes due to codominance of allelic expression². Thus, the data on electrophoretic mobility differences in species individuals have been used to infer genetic differences at enzyme loci in various drosophilids but there is little information on the allopatrically distributed sibling species populations of *D. takahashii* and *D. lutescens*^{3,4}. The present paper reports the patterns of electrophoretic variability for eight gene-enzyme systems in laboratory strains of these two sibling *Drosophila* species.

Isofemale lines of *D. takahashii* and laboratory strains of *D. lutescens* were characterized after Bock⁵. About 12–14 homogenates of single individuals of both species were loaded in each horizontal starch gel slab (15 × 10 × 1 cm) and run electrophoretically at 250 V and 30 mA at 4°C for 4 h and the gel slices were stained for different gene-enzyme systems⁶. Enzymes include octanol dehydrogenase (ODH, E.C.1.1.1.73); esterase (EST, E.C.3.1.1.1); acid phosphatase (ACPH, E.C.3.1.3.2); α -glycerophosphate dehydrogenase (α -GPDH, E.C.1.1.1.8); alkaline phosphatase (APH, E.C.3.1.3.1); malate dehydrogenase (MDH, E.C.1.1.1.37); aldehyde oxidase (AO, E.C. 1.2.3.1) and alcohol dehydrogenase (ADH, E.C.1.1.1.1). The genetic basis of enzyme-banding patterns was interpreted from the segregation ratios of electrophoretic phenotypes of the parents and progeny (F_1/F_2 /backcross) of species-specific genetic crosses (Table 1). The segregation ratios (1:1 or 1:2:1) of electrophoretic phenotypes for all the enzymes in both species agree with monogenic Mendelian inheritance. The population genetic structure of each species was described in terms of genetic indices^{7,8}.

Figure 1 depicts the electrophoretic banding patterns of different gene-enzyme systems in *D. takahashii* while the species-specific allelic isozymes (allozymes) for the polymorphic gene enzyme systems have been represented in Figure 2. The polymorphic zones of ODH, ACPH, APH-3, MDH-1 and AO are represented by segregating single-band variants (fast or slow) and triple-banded patterns. On the contrary, segregating two-banded patterns (conformational isozymes) for ADH and α -GPDH represent allelic isozymes. The