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Anaerobes in the digestive tract of wood-eating grub *Acanthophorus* sp.

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The presence of cellulolytic anaerobes and methanogens (H_2 oxidizers and acetate utilizers) in the gut of *Acanthophorus* larvae, which feed on citrus root, was observed. The cellulolysers concentrate in the midgut and the methanogens were harboured in the hindgut. The cellulolysers were mostly *Clostridium* sp. while the methanogens were fluorescent rod-shaped bacteria.

THE digestive tract of the animal species normally paves a suitable niche for a variety of microorganisms to inhabit and multiply. Special attention is given to these gut microflora due to the fact that they play a major role in the host's digestion, reproduction, excretion, etc.[1]. The conditions prevailing in the gut favour the establishment of anaerobes which are also reported in insects. Substantial literature exists on the gut microflora of termites[2] and other xylophagous insects like cockroaches[3] and *Oryctes* larvae[4]. But little is known on anaerobes in the gut of wood-feeding grubs like root-feeding *Acanthophorus* sp. or stem-feeding *Batocera* sp.

In the present research, the gut microflora of citrus root grub (*Acanthophorus* sp.) were examined. These grubs bore holes and feed on cellulose-rich bark and trunk. They plug the boreholes with the chewed frass material behind and hence reside under a partial anoxygenic condition. Due to this reason, the presence of anaerobes was suspected and assessed.

The grubs were collected from infected trees and reared under laboratory conditions on moistened saw dust separately up to last instar, which weighed about 50 g and was 10.5 cm in length. The last instar grub was anaesthetized in chloroform and dissected in an anaerobic hood under CO_2 stream to prevent the loss of anaerobes during dissection. The foregut, midgut and hindgut regions were incised separately and transferred to vials with modified Hungate's broth[5]. The vials were sealed and flushed periodically with N_2 gas. The total anaerobes, cellulolysers and methanogens were enumerated by Hungate's roll tube technique using specific media[6]. The distribution of various anaerobes in different regions of the gut is given in Table 1. Degradation of the cellulosic substrates was observed through clearance in the opaque surrounding medium in the roll tubes. Filter paper degradation was also noted in the enrichments. Metabolic products of anaerobic cellulolytic bacteria were assessed by gas chromatography[6]. Cellulolysers were rod-shaped and mostly sporulating. Few of the purified isolates were characterized as *Clostridium* sp. The cellulolysers converted the feed into acetate and propionate (Figure 1). Such volatile fatty acids production might support the host's nutrition. Apart from strict anaerobes in the gut, microaerophilic cellulose-degrading bacteria were also observed in the posterior region of the hindgut.

Fluorescing methanogenic colonies isolated from the gut showed wide variation in their colony characteristics.

Table 1. Population ($\times 10^5$ ml^{-1}) of anaerobes in the gut

Anaerobes	Foregut	Midgut	Hindgut	*Predominant* cell shape
Total anaerobes	12.7	7.0	2 5	Rods, cocci
Cellulolysers	ND*	4.2	1.1	Rods
Methanogens				
H_2 oxidizers	1.0	3.1	6.1	Rods
Acetate utilizers	2.5	2.0	3 0	Rods-forming filaments

*Not detected even in direct sample enumeration.

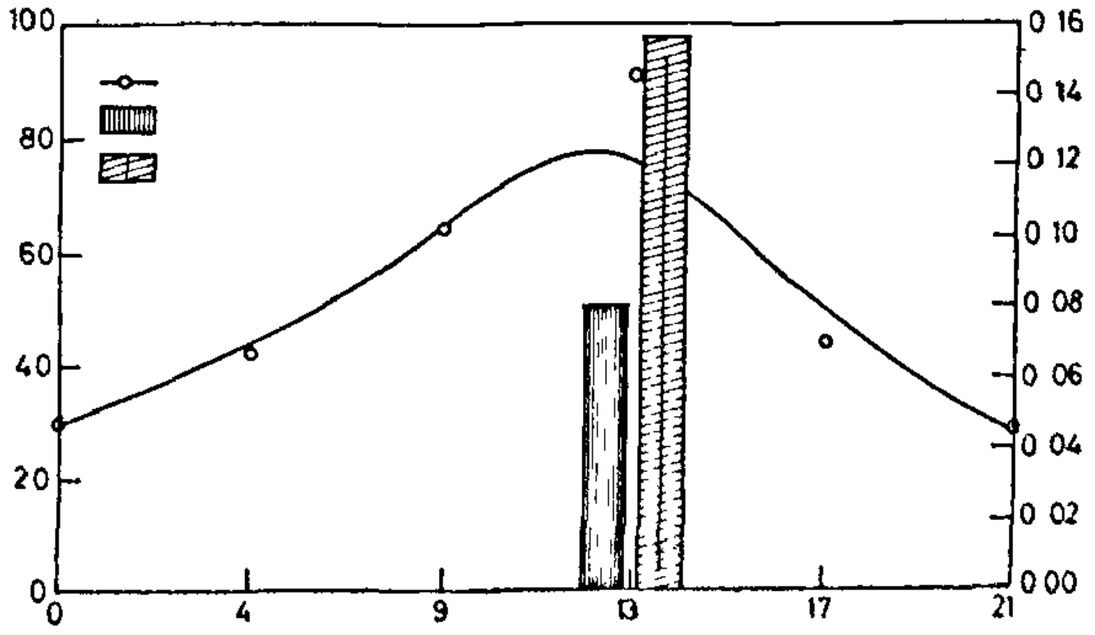

Figure 1. Growth and product profile of a cellulolytic clostridia isolated from the gut of *Acanthophorus* grub.

UV-fluorescing microscopic observation of the purified cultures revealed that they were rods forming filaments with similarity to the known *Methanothrix*. They used acetate and methanol as a substrate for growth.

The present report highlights the prevalence and distribution of anaerobic microflora in *Acanthophorus* grub similar to xylophagous termites[7] and cockroaches[5]. The concentration of cellulolysers in the midgut and their metabolic products show that these anaerobes play a role in the digestion of cellulose. Anaerobic environment of the gut was also supported by the presence of methanogens. Detailed on the cellulolysers will surely help us to identify efficient strains that can be harnessed for lignocellulose waste treatment.

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Possible indicators of neotectonic activity near Bhimunipatnam coast, Andhra Pradesh

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Archaean meta-sedimentaries, Pleistocene sedimentaries and Holocene sediments characterize the 'badlands' of coarser ferruginated sands in the north-eastern part of the dune of finer yellow sand near Bhimunipatnam coast. The gullies of the badlands show preferred orientation in two directions. The Pleistocene sedimentaries exposed in one of the gullies show variation in dip. One of the tributary gullies is aligned in line with an important lineament. The spring, the double-cone structure and calcrete in the unconsolidated aeolian sand, within the lineament gully, the change in the dips of the sedimentaries, the sub-trellis pattern of the gullies, are all characteristic of possible neotectonic activity around 6000 years BP.

AEOLIAN sands of mean size 1.69–2.54 Ø (ref. 1) occur in a palaeobay-like configuration south of the east–west Bhimunipatnam ridge (Figure 1). The ridge consisting of Archaean khondalites is 5 km long and about 1 km wide. It has a relief of about 100 m with a wind gap disrupting its continuity. The area north of this ridge is drained by Gostani River, whose southern distributary changes its course suddenly from S30°W to S60°E. The satellite imagery on 1 : 1,000,000 scale shows a prominent lineament passing through the S30°W section of the distributary and through the wind gap in khondalite ridge[2]. South of the ridge is a vast sand dune. It is about 4 km long and 2 km wide and is bounded by the streams Chittigadda in the northwest and Peddagadda in the southwest. The mean size of the sand ranges from 2.06–2.54 Ø. The northeastern part of the sand dune is characterized by the aeolian sand of mean size 1.69–1.99 Ø. Deep gullying and ferrugination characterize these sands. Ferric iron coats the loose sand grains of original aeolian origin[3]. Study of aerial photos on 1 : 60,000 scale shows two sets of preferred orientations to the gullies – N30°W and N30°E. The southwesternmost

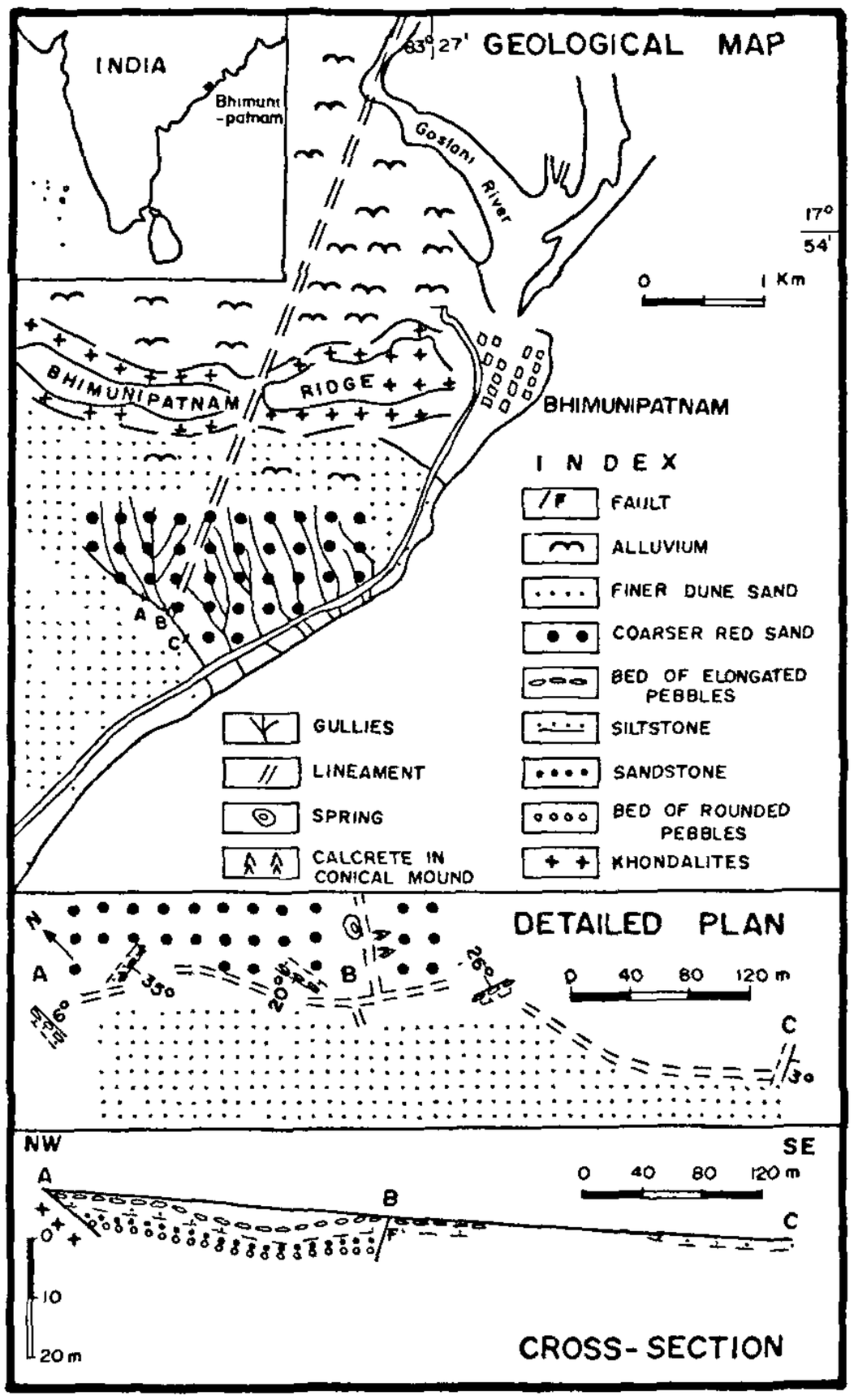

Figure 1. Geological map showing the location of sands.