

**Figure 2.** SEM of *C. acrotrichum* Schiffn. **a**, Marginal hairs towards apex. **b**, Surface and marginal hairs. **c**, Spore in surface view. **d**, Portion of the same, magnified.

however, differs from the former in having much larger plants up to 26 mm broad with 5–18 involucre per thallus, absence of surface hairs on the thallus, presence of tubers, operculum of the capsules with four outer and 12–14 inner cells and spores having spines with more or less bulbous base (Srivastava and Dixit<sup>3</sup>; figure XVII: 1, 2). In its sporo-

derm ornamentation, *C. acrotrichum* closely resembles *C. mehranum* D. K. Singh. However, it is easily distinguishable from the latter<sup>4</sup>, which has smaller, 5–8 mm long and 1–3 mm wide female plants devoid of adventitious branches and surface hairs; dorsal pores with 0–3 concentric rings; tubers on both sterile as well as fertile plants; involucre mouth

lined by thick-walled cells with purple pigmentation, and much larger elaters measuring  $640\text{--}900 \times 20\text{--}24 \mu\text{m}$ . Any doubt about the taxonomic status of *C. acrotrichum*, therefore, is unfounded.

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**ACKNOWLEDGEMENTS.** We are grateful to the Director, Botanical Survey of India, Kolkata for facilities and encouragement; the Indian Botanical Liaison Officer, Royal Botanic Gardens, Kew (UK) for relevant literature, and the Ministry of Environment and Forests, New Delhi for financial support under the All India Co-ordinated Project on Taxonomy.

Received 25 May 2006; revised accepted 22 January 2007

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## Occurrence and prevalence of *Cyllamyces* genus – A putative anaerobic gut fungus in Indian cattle and buffaloes

Anaerobic fungi are an unusual group of zoospore fungi occupying a unique niche in the digestive tract of wild and domesticated ruminants and large monogastric herbivores<sup>1</sup>. They were first isolated from the rumen of sheep<sup>2</sup>. Until this discovery, the microbial population in the rumen was believed to be made up of bacteria and protozoa only. Among the rumen microbes, anaerobic fungi are important as they produce highly active enzymes for degradation of lignocellulose<sup>3,4</sup> and

have the unique ability to break and penetrate the fibrous feed particles through fungal mycelium, providing more surface area for the action of other microbes.

All the anaerobic fungi studied so far are cellulolytic and are able to degrade structural carbohydrates of plant cell walls playing a vital role in the digestion of high-fibre poor-quality forages. Thus in tropical regions where forages are generally fibrous and of poor quality, development of methods to manipulate superior

strains of fungi, naturally selected or genetically engineered, in the rumen would afford a means of improving the digestion of poor-quality fodder by large ruminants, particularly lactating cows and buffaloes.

The isolation procedure involves ten-fold serial dilution of rumen liquor or freshly voided faeces in a complex medium under strictly anaerobic conditions. Colonies picked from roll tubes were grown at 39°C and transferred after three

days into broth medium with the procedure being repeated thrice with alternate supplementation of penicillin–streptomycin or lincomycin–chloramphenicol combinations to check bacterial contamination. Being native only to the digestive tract of ruminants along with being obligate anaerobes, the possibility of secondary contamination in faecal sample collections would not arise in their isolation.

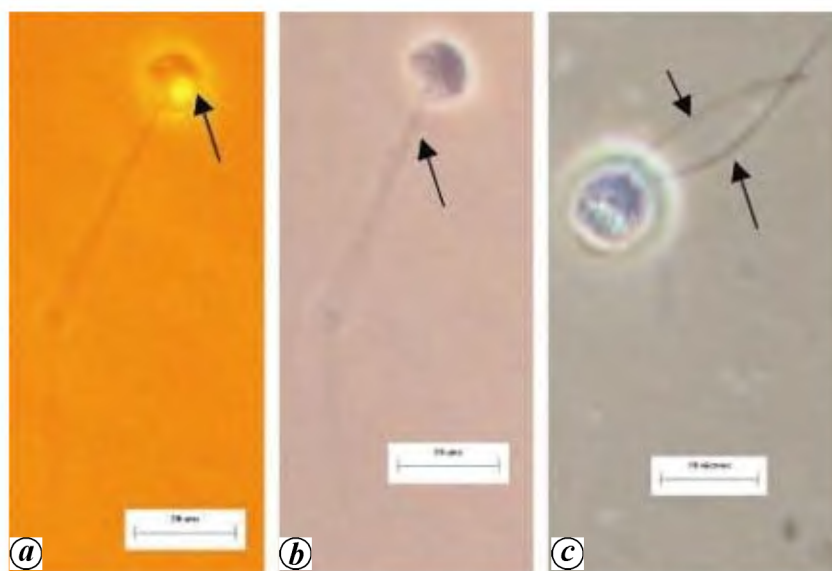
Ho and Barr<sup>5</sup> described gut fungi entirely based on thallus morphology as seen under light microscope into two types – monocentric (one reproductive body) and polycentric (many centres of reproduction). The genus *Neocallimastix* embraces polyflagellated species in which vegetative growth consists of a single sporangium borne on a much-branched rhizoidal system, while in the genus *Piromyces*, the vegetative stage is smaller with more highly branched filamentous rhizoids. *Orpinomyces* are characterized by the presence of spherical sporangia developing on simple or branched sporangiophore complexes that arise as outgrowths of hyphae or are terminal. *Anaeromyces* are readily distinguished from the sporangia, which are solitary and frequently have a pointed projection at the apex. *Caecomyces* are monocentric with either a single or several bulbous holdfast(s), upon which a single globose, ovoid or ellipsoidal sporangium develops.

We report here the presence of a sixth genus of putative anaerobic gut fungus – *Cyllamyces*, in cattle and buffaloes in India and more likely from entire Asia. We have recorded the existence of genus *Cyllamyces* in buffaloes in the Indian sub-continent. To date only the five major aforementioned genera had been reported from the faeces of cattle and buffaloes in India. This fungus has been isolated from the faeces of both cattle and buffaloes from a number of states all over India. The characteristic features of this genus as observed are the presence of mono or bi-flagellate zoospores, mostly spherical but occasionally oval, which ranged from 10.32 to 18.06  $\mu\text{m}$  ( $14.33 \pm 1.88 \mu\text{m}$  (mean  $\pm$  SD);  $n = 52$ ) in diameter, with flagellum varying in length from 42.86 to 95.5  $\mu\text{m}$  ( $70.17 \pm 14.14 \mu\text{m}$ ;  $n = 42$ ; Figure 1). Nucleus of zoospores observed by ultra-violet fluorescence microscopy (Nikon Eclipse 50i microscope fitted with 575 nm excitation and 590 nm barrier filters) after staining with fluorochrome, propidium iodide (0.01% w/v in phosphate buffered saline) was found to be uni-nucleate

(Figure 1 a). Bulbous holdfasts without rhizoids, which grow to a diameter of up to 54.92  $\mu\text{m}$  ( $36.50 \pm 8.87 \mu\text{m}$ ;  $n = 26$ ) were predominant, with each thallus giving rise to several branched sporangiophores with an average length of 111.2  $\mu\text{m}$  (Figure 2). Each of these sporangiophores culminated into numerous (two to twelve) sporangia having a diameter ranging between 8.69 and 25.88  $\mu\text{m}$  ( $14.35 \pm 5.41 \mu\text{m}$ ;  $n = 74$ ). Ozkose *et al.*<sup>6</sup> discovered the presence of genus *Cyllamyces* in cattle of

the United Kingdom. Limited polycentric thallus development (including branched sporangiophores), possession of a single bulbous holdfast and absence of rhizoids were the main features of this fungus that distinguished it from the other five genera of gut fungi reported so far.

The UK isolate seems similar to our isolate with respect to the holdfast diameter of 54  $\mu\text{m}$  ( $33.9 \pm 6.0 \mu\text{m}$ ;  $n = 40$ ) and sporangia with a diameter of  $14.7 \pm 3.1 \mu\text{m}$  ( $n = 60$ ). However, the difference in spo-



**Figure 1.** Zoospores of isolates. a, Uni-nucleated ( $\rightarrow$ , nucleus); b, Mono-flagellated ( $\rightarrow$ , flagellum), and c, Bi-flagellated ( $\rightarrow$ , flagellum).



**Figure 2.** Mature isolate showing development of sporangia. 1, Hold-fast; 2, Bifurcated sporangiophore; 3, Immature sporangia; 4, Mature sporangia, and 5, Sporangial sac after zoospore release.

rangioophore length ( $85\ \mu\text{m}$ ), zoospore diameter ( $7.8 \pm 1.1\ \mu\text{m}$ ;  $n = 80$ ) and flagellum length ( $27.33 \pm 1.1\ \mu\text{m}$ ;  $n = 30$ ) compared with the UK isolate may probably lead to the possibility of existence of an altogether new *Cyllumyces* sp. in India. The answer lies in molecular characterization studies of the Indian isolates<sup>7</sup>, which are under progress.

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**ACKNOWLEDGEMENTS.** We are grateful to the Indian Council of Agricultural Research, New Delhi and Australian Council for International Agricultural Research, Queensland for bilateral collaboration in the project 'Increasing productivity of cattle in India and

Australia by rumen fungal treatments' under the aegis of which this work was carried out.

Received 21 March 2006; revised accepted 12 January 2007

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## Ostracod fauna from the non-marine Inter-trappean bed of Mohgaon-Haveli, Chhindwara District, Madhya Pradesh

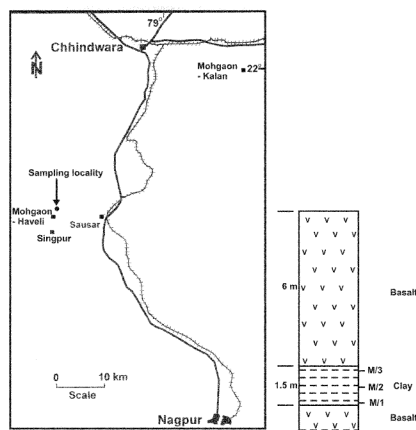
This correspondence records a rich and interesting ostracod assemblage from the non-marine Inter-trappean sedimentary bed associated with Deccan basalt (Late Cretaceous, Maastrichtian) exposed in a well, under excavation near Mohgaon-Haveli ( $21^{\circ}38'15''\text{N}$ ;  $78^{\circ}44'15''\text{E}$ ) near Singpur, Sausar Taluka (Tehsil), Chhindwara District, Madhya Pradesh (MP). The fossiliferous locality is about 10 km west of Sausar town on the Nagpur–Chhindwara road (Figure 1). The sedimentary bed comprises about 1.5 m thick, green fossiliferous clay, interbedded in basalts at about 6 m below

the surface (Figure 2). The well did not touch the groundwater table, which enabled one of us (M.L.N.) to descend into it and collect three samples from near the base, middle and top of the sedimentary bed. The sample (M/1) from the basal part yielded abundant ostracods, which were rare in the other two samples (M/2–3) from the middle and upper parts. In all, 16 species were recorded from these samples.

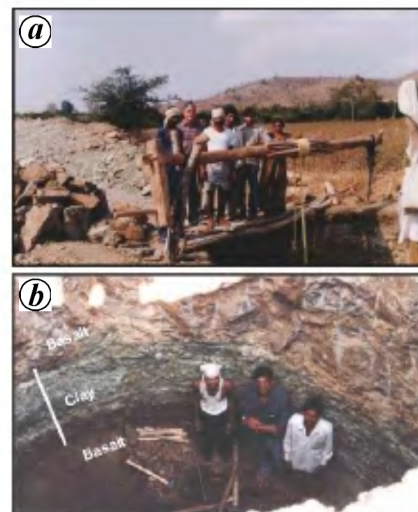
The Inter-trappean beds of Sausar Taluka are familiar to the scientific community for their plant fossils<sup>1–3</sup>. Recently, Samant *et al.*<sup>4</sup> have recorded Maastrichtian palynomorph assemblage from the Inter-trappean beds of Singpur. As far as is known to the authors, there is no reported work on ostracods from the Inter-trappean beds in this area. However, from a distant locality 0.5 km west of Mohagaonkala (Mohgaon-Kalan) ( $22^{\circ}1'\text{N}$ ;  $79^{\circ}11'\text{E}$ ), also in Chhindwara District, Whatley *et al.*<sup>5</sup> have described nine species from the Inter-trappean beds from a spoil heap, produced by digging of an unlined well. Three of these species, viz. *Gomphocythere paucisulcatus*, *Cypridopsis elachistos* and *Zonocypris labyrinthicos* were new. The other recorded species are: *Cypripa cyrtionidion* Whatley and Bajpai, *Eucypris intervalcanus* Whatley and Bajpai, *Eucypris pelagicos* Whatley and Bajpai,

*Frambocythere tumiensis lakshmiiae* Whatley and Bajpai, *Mongolianella* sp. and *Paracyprretta bhatiai* (Khosla and Sahni).

Of the 16 ostracod species recorded from Mohgaon-Haveli, ten have been assigned to previously described taxa. These are: *Darwinula torpeda* Whatley *et al.*,



**Figure 1.** Location map of Mohgaon-Haveli and the well section studied.



**Figure 2.** Field photographs of Inter-trappean bed in a well near Mohgaon-Haveli, Sausar Taluka, Chhindwara District. *a*, Generalized view of the well. *b*, Close-up view of Inter-trappean bed.