Table 1. Minimal inhibitory concentration of secondary metabolites

Organism	Secondary metabolites (mg/dl)				
	Ti-1	Ti-2	Ti-3	Ti	*cys* drug
Escherichia coli	17.25	15	10	12	12
Proteus vulgaris	23	24	22	16	15
Klebsiella pneumoniae	–	–	25	25	25
Serratia marcescens	30	30	23	23	18.75
Salmonella typhi	–	–	23	25	25
Aspergillus niger	17.25	25	16	16	21
Cryptococcus neoformis	17.25	20	11	16	18.75
Penicillium chrysogenum	23	20	6	8	12.5
Saccharoymces cerevisiae	25	25	19	23	25
Aspergillus flavus	25	23	20	21	25
Candida albicans	20	21	16	16	16

metabolites (cyclosporine-related) from these extracts were found to have a broad spectrum of antifungal activity and a narrow spectrum of activity against bacterial cultures. Most of the Gram-positive cultures were found to be resistant to these secondary metabolites, except *Serratia marcescens* which exhibited high susceptibility. In contrast, most of the Gram-negative bacteria showed susceptibility. Antifungal activity of these extracts revealed that the secondary metabolite from Ti showed efficient antifungal activity. Even a very low concentration (0.08 mg/ml) was found to be effective in inhibiting most of the tested fungal cultures. Isolates Ti-2 and Ti-3 showed similar antifungal activity. However, the commercially available *cys* drug exhibited poor antimicrobial and antifungal activity. The *cys* drug required a high MIC indicating its lower efficiency as an antimicrobial compared to the extracts from isolates. Molecular characterization (PCR–RFLP and RAPD) of these isolates is underway.

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A new fossil palm leaf from the Hemis Formation of Ladakh, Jammu and Kashmir, India

A field trip was undertaken during August–September 2005 to explore the Ladakh area for plant fossils. A new fossiliferous site was discovered near Shingbuk (35°27′N; 77°59′E), 12 km NNW of Tsokar (Figure 1 *a*), which yielded about ten leaf impressions. Though most of them are fragmentary in nature, two well-preserved specimens have been selected for the present study. It is interesting to note that all these specimens belong to palms and no dicot leaf has been recovered from the site.

The newly discovered fossiliferous locality (Figure 2) lies in the Indus Suture Zone which divides the Himalayas from the Karakoram Mountains as well as the Tibetan Plateau. In tectonic interpretation it can be said that a large gap of the Tethys Ocean was consumed along this zone as a result of collision of the Indian Plate with the Eurasian Plate. It is separated from the Karakoram Tethys in the north by the South Karakoram (Nubra–Shyok) Thrust and from the Himalayan Tethys in the south by the Zanskar Thrust. Marine flysch and continental deposits are found to lie in juxtaposition in the zone. The molasse horizons in the Indus Suture Zone are divisible into the southern Hemis Formation (middle–late Eocene) and the northern Kargil Formation (late Oligocene–middle Miocene), though there is an apparent lack of consensus on the issue of age range of these formations for want of age diagnostic fossil remains[1–6]. The isolated stratigraphic units of the northern molasse belt, namely Basgo, Karroo, Khuksho, Nyoma, etc. are either further subdivisions or local equivalent names of the Kargil Formation. Similarly, the Liyan molasse is equivalent to the Hemis Formation in space and time. The older Hemis Formation thrusts over the younger Kargil Formation along a south-dipping Upshi Thrust.

Leaf impressions were collected from the Hemis Formation considered as middle–late Eocene in age and characterized by rocks of either silty sandstone with fine-grained micaceous sand or greenish-grey siltstone alternating with purple-brown siltstone. The fossil remains are preserved predominantly in the finer part of the siltstone horizons (Figure 1 *b*). Although Lakhanpal *et al.*[7] have given a detailed account of the Tertiary palaeobotanical data known from Ladakh, the only known

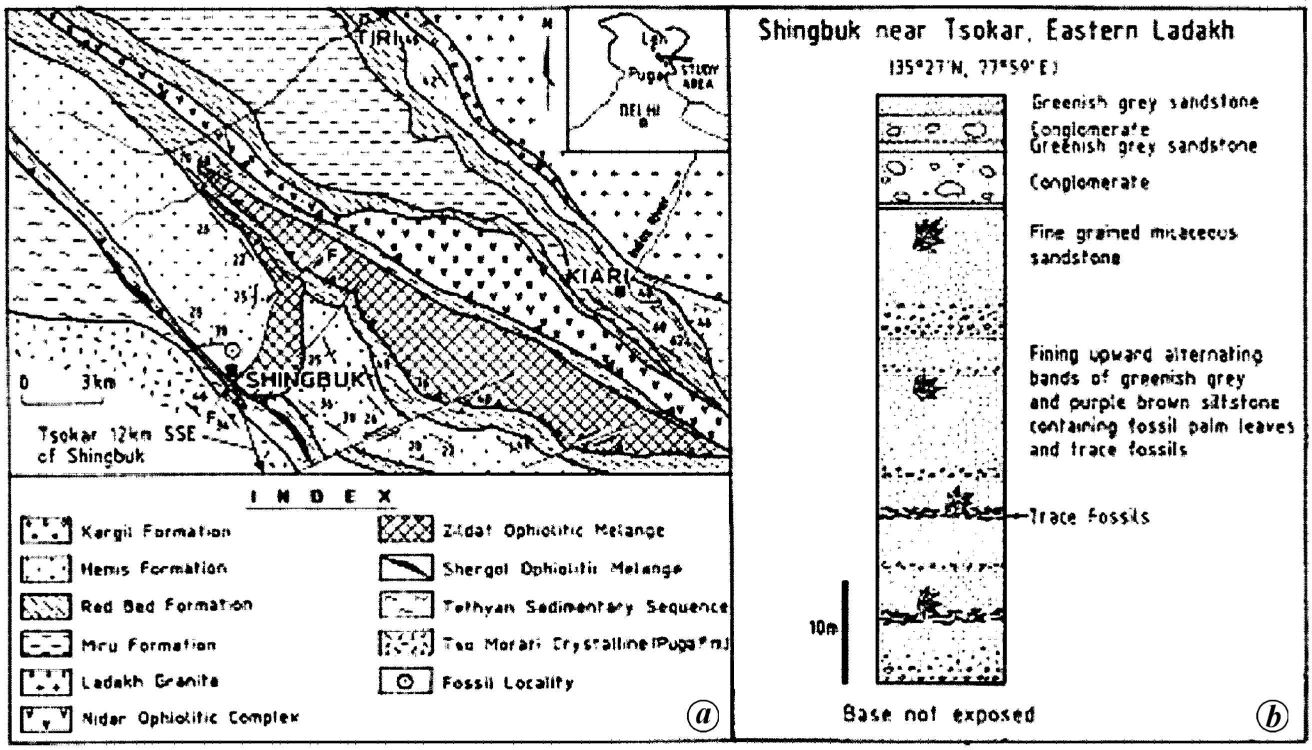

Figure 1. *a*, Geological map of eastern Ladakh showing fossiliferous site. *b*, Litholog showing stratigraphic position of fossil palm leaves.

Figure 2. A view of the fossiliferous site.

megafossil from this horizon is *Livistona wadiai* collected from northeast of Hemis Gompa, a famous Budhist temple situated about 50 km southeast of Leh.

Systematic description

Family Arecaceae
Genus *Palmacites* Brongniart[8]
Palmacites tsokarensis sp. nov.
Figure 3 *a* and *b*.

Material: The study is based on three incomplete but well-preserved specimens in the form of impressions.

Description: Leaf simple, palmate; preserved lamina length about 34 cm (maximum), preserved width about 20 cm (maximum), fan-shaped; texture coriaceous; petiole not preserved; hastula absent; absent; mid costa absent; lamina consisting of about 26 plicate segments/leaflets radiating and diverging from base, each leaflet symmetrical, seemingly fused, about 30 cm in preserved length and maximum 2.5 cm in width, with a distinct mid-rib; venation observed in some of the leaflets, finer veins closely placed and running parallel to each other.

Holotype: Specimen no. BSIP 39272
Paratype: Specimen no. BSIP 39273
Horizon: Hemis Formation
Locality: Shingbuk near Tsokar, eastern Ladakh, Jammu and Kashmir, India
Age: middle–late Eocene

Affinities: The characteristic features of the fossil, viz. large palmate leaf without hastula and mid-costa, having coriaceous texture and many leaflets diverging from the base of the lamina with a distinct midrib and parallel venation, indicate its affinity with palm leaves belonging to Arecaceae. Read and Hickey[9], in their revised classification of fossil palm and palm-like leaves, have pointed out that it is difficult to assign them to the modern taxa due to similarities in their external morphological features. According to them, 'since it is very difficult to identify specimens of modern palms accurately from their leaves alone, no attempt should be made to place fossil palm fragments in genera of modern palms unless unquestionably identifiable with them'. According to the key proposed by Read and Hickey[9] to the genera of fossil palm and palm-like foliage, it was concluded that the present fossil should be kept under the genus *Palmacites* Brongniart[8]. Only two species of the genus, namely *P. khariensis* Lakhanpal & Guleria[10] and *Palmacites* sp. Mehrotra & Mandaokar[11], are known from India. The former described from the Miocene of Kachchh differs from our fossil in presence of hastula and smaller size of the blade (9 × 9 cm) and leaflets (0.1–0.5 cm). The latter known from the Oligocene sediments of Arunachal Pradesh, is a small fragmentary leaf consisting of three plicate segments and therefore is not comparable with the present fossil.

The fossil records of Arecaceae known from the Tertiary of Ladakh are poor. So far only two genera, viz. *Livistona* and *Trachycarpus* have been described from there. *Livistona wadiai* Lakhanpal *et al.*[7] is known from the same horizon where the present material was collected, but differs in having costapalmate leaf in which mid-costa is present and extends 12 cm from the base of the lamina. Leaflets are more in number (90) but less in width

Figure 3. *Palmacites tsokarensis* sp. nov. ***a***, Palmate leaf in reflected light, × 0.4; specimen no. 39272. ***b***, basal portion of another specimen in reflected light, × 0.8; specimen no. 39273.

(maximum 1 cm). *Trachycarpus ladakhensis* Lakhanpal *et al.*[4], known from the Liyan Formation, differs from the present fossil specimen in having an irregular, semilunar ring-like hastula and smaller lamina of length 19 cm and width 14.6 cm.

As our fossil specimen is different from all the known species of *Palmacites*, it is being described here as a new species, *P. tsokarensis* sp. nov.; the specific epithet is after the locality Tsokar from where the fossil was collected. Its presence not only indicates that palms were abundant during the middle–late Eocene in the region, but also suggests that the area had not attained as much height as it has today (about 5000 m amsl). The present fossil, along with *Livistona*, indicates tropical conditions during the depositional period. The discovery is also important for enriching the palaeoflora in view of the paucity of palaeobotonical material from the Tertiary of Ladakh, especially from the Indus Suture Zone.

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Tapping earth's upper-mantle methane gas resource at a nuclear drilling initiative area, Palk Bay, India/Sri Lanka

The first practical concept for drilling through the Mohorovicic seismic discontinuity stratum to penetrate the upper mantle for geochemical investigative purposes was proposed[1] during 1957. Later, Thomas Gold (1920–2004) in the USA and others active in the former USSR since the insightful 1951 hypothesis of Nikolai A. Kudryavtsev (1893–1971), alleged the existence of enormous commercially valuable methane deposits deep in the earth, giving geo-science and geo-resource specialists a truly down-to-earth reason to undertake such a technically challenging and financially speculative effort in the quest for an almost 'unlimited' energy resource, derived solely from a degassing earth-mantle, to power human civilization. *In situ* production of methane under laboratory conditions[2] replicating those that exist in the earth's upper mantle was first accomplished by 2004. Methane generation is likely to occur at temperatures ~ 500°C when ambient pressure is <7 GPa and such conducive conditions are expected to be found at depths of 100–200 km inside the earth[3]. Industrial tapping of this suspected energy resource entails development of the world's biggest 'gas field'.