Occurrence of *Acrostichum* Linn., a coastal fern in the Tertiary sediments of Kasauli, Himachal Pradesh, north-west Himalaya

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A fossil fern frond resembling that of *Acrostichum* Linn. is described from the Kasauli sediments (Lower Miocene), exposed along Kalka-Shimla road between Kumar Hatti and Barog, Himachal Pradesh. This fern, being primarily coastal in its distribution, is highly significant from the view point of palaeoecology, phytogeography and depositional environment. It indicates near shore tropical conditions and tidal influence in the area during Early Miocene. This is the first megafossil record of *Acrostichum* from the Tertiary sediments of India.

Key-words —Megafossil, Pteridophyte, *Acrostichum*, Palaeoecology, north-west Himalaya, Lower Miocene (India).

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सारांश

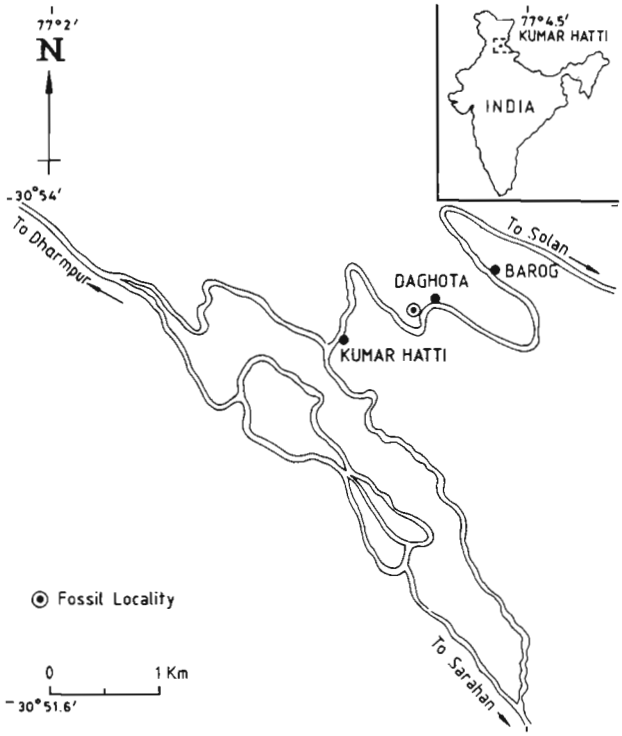
उत्तर-पश्चिम हिमालय में हिमाचल प्रदेश में कसौली के तृतीयक अवसादों से एक तटीय फर्न - *एक्रोस्टिकम* लिन्नॅयस की उपस्थिति

नीलाम्बर अवस्थी, जसवन्तसिंह गुलेरिया, महेश प्रसाद एवं रश्मि श्रीवास्तव

हिमाचल प्रदेश में कालका-शिमला रोड के संग-संग कुमार हट्टी एवं बारोग के बीच में अनावरित कसौली अवसादों (अधरि मध्यनूतन) से *एॅक्रोस्टिकम्* लिन्नॅयस से मिलता-जुलता एक अश्मित फर्न प्रपर्ण का वर्णन किया गया है। यह फर्न वितरण के आधार पर मूलतः तटीय होने के कारण पुरापरिस्थितिकीय, निक्षेपणीय पर्यावरण एवं प्रादप भौगोलिक दृष्टि से बहुत महत्वपूर्ण है। इस क्षेत्र में इसकी उपस्थिति से प्रारम्भिक मध्यनूतन काल में तटीय उष्णकटिबन्धीय परिस्थितियों एवं ज्वारीय प्रभावों का होना व्यक्त होता है। *एॅक्रोस्टिकम्* का यह अभिलेख भारत के तृतीयक अवसादों से प्रथम अभिलेख है।

THE Lower Miocene sedimentary succession in the Lesser Himalayan Zone of Kasauli Hills, Western Himalaya is known as Kasauli Formation. It is massively developed in and around Kasauli town and the outcrops can be seen along Kumar Hatti-Kalka, and Kalka-Shimla road between KumarHatti and Barog which contain plant fossils comprising leaves, flowers, flower buds, fruits/seeds. Until recently a few megafossils have been described although their occurrence is known since long. Among the known fossils the monocotyledons consist of *Sabalites* spp., *Clinogyne*, *Poacites* sp., *Palmophyllum* and other fragments of palm leaves (Sahni, 1953, 1964; Chaudhri, 1969; Arya & Awasthi, 1995). The dicotyledons are represented by leaf-impressions of *Bauhinia*, *Combretum*, *Garcinia*, *Gluta* and *Phyllanthus* (Arya & Awasthi, 1994, 1995) and *Dicotylophyllum* spp. In a series of reports Mehra *et al.* (1990a,b, 1995), Mishra and Mathur (1991, 1992) have reported various plant organs from the Kasauli sediments. However, the exact affinities of the reported flowers, fruits, bud, inflorescence, roots are yet to be ascertained. In their latest abstract, Mishra *et al.* (1995, p.98) have reported the occurrence of 23 dicot taxa in the Kasauli Formation alongwith two monocots, the details of which are awaited.

Mega-remains of gymnosperms and pteridophytes have not been encountered so far in the Kasauli sediments inspite of large collections made by various workers. The algae is represented



Map 1—Showing the fossiliferous locality.

by charophytic gyrogonites (Mehra *et al.*, 1990b). It is apparent from the available account that no fern fossil has been reported from the Kasauli sediments so far. The present fossil was collected from near Daghota situated between Kumar Hatti and Barog on Kalka-Shimla road (Map 1).

SYSTEMATIC DESCRIPTION

Family — Pteridaceae

Genus — *Acrostichum* Linn.

Acrostichum lanzaeanum (Visiani) Reid & Chandler 1926
Pl. 1, figs 1, 3, 4

The species is represented by two fragmentary sterile pinnae. The pinnae are poorly preserved as impressions on an argillaceous greenish-grey, compact shale. Of the two, the description is based on better preserved incomplete pinna representing basal part measuring 9 cm in length and 2 cm in width (only one side of midrib), pinna seemingly linear-oblong, coriaceous, midrib prominent, thick; margin entire ?; secondaries numerous, arising at acute angle from the midrib, anastomose copiously forming elongate-narrow meshes due to reticulate venation, meshes of various sizes, mostly angular, linear, less than 2 mm wide and of variable length, without free veinlets, sori not seen.

The distinctive features of the fossil are reticulate or netted venation, coriaceous lamina, thick midrib and meshes without free veinlets. In all these features the fossil compares well with the pinna of extant *Acrostichum* Linn. belonging to the family Pteridaceae (Willis, 1973; Tryon & Tryon, 1982).

The genus *Acrostichum* is represented by three species, of which, *A. aureum* L. is found in India. The fossil shows close resemblance with the sterile pinna of *A. aureum* (Ettingshausen, 1865; Beddome, 1970; Clarke, 1973; Tryon & Tryon, 1982).

Specimen—No. BSIP 37566.

Locality—Between Kumar Hatti and Barog (near Daghota) on Kalka- Shimla road, Himachal Pradesh.

Horizon—Kasauli Formation.

Age—Lower Miocene.

COMPARISON AND DISCUSSION

Ferns constitute a big group of highly advanced vascular cryptogams. They are usually perennial and grow abundantly in cool, shady, moist places and distributed all over the world. Because of large compound leaves, the fern leaves are called megaphylls. They first appeared in the Upper Devonian time. Fern or fern-like plants were scarce in the pre-Gondwana and Lower Gondwana deposits of India. They diversified during the Mesozoic Period in India and are represented by a number of families. With the advent of angiosperms, pteridophytes declined alongwith gymnosperms. Nevertheless, India has a rich pteridophytic flora especially of ferns represented by more than 100 genera and over 750 species. In view of this, a rich ancestral fern flora is expected in the geological past, particularly in Tertiary Period. Unfortunately very few records of ferns are known from the Tertiary sediments of India. The earliest record of Tertiary ferns is from the Deccan Intertrappean sediments (of Late Cretaceous-Early Tertiary time) which have provided the well preserved fossils of water ferns belonging to Salviniaceae and Marsileaceae (Sahni & Rao, 1943; Nambudiri & Chitaley, 1991). In contrast to Deccan intertrappean records, the pteridophytes are rarely preserved throughout the Tertiary. The other known records are *Goniopteris*

prolifera of the family Thelypteridaceae from the Siwalik of Kathgodam in Nainital District of Uttar Pradesh and *Adiantum*, *Dryopteris*, *Pteridium aqualinum* from the Lower Karewas (Upper Pliocene) of Kashmir (De Terra & Paterson, 1939; Awasthi & Guleria, 1982). Both are represented by their fronds. Thus the present fossil forms the first record of a megafossil of *Acrostichum* from the Indian Tertiary sediments. Microfossils of *Acrostichum aureum* have been reported by Kar (1992) as *Acros-*

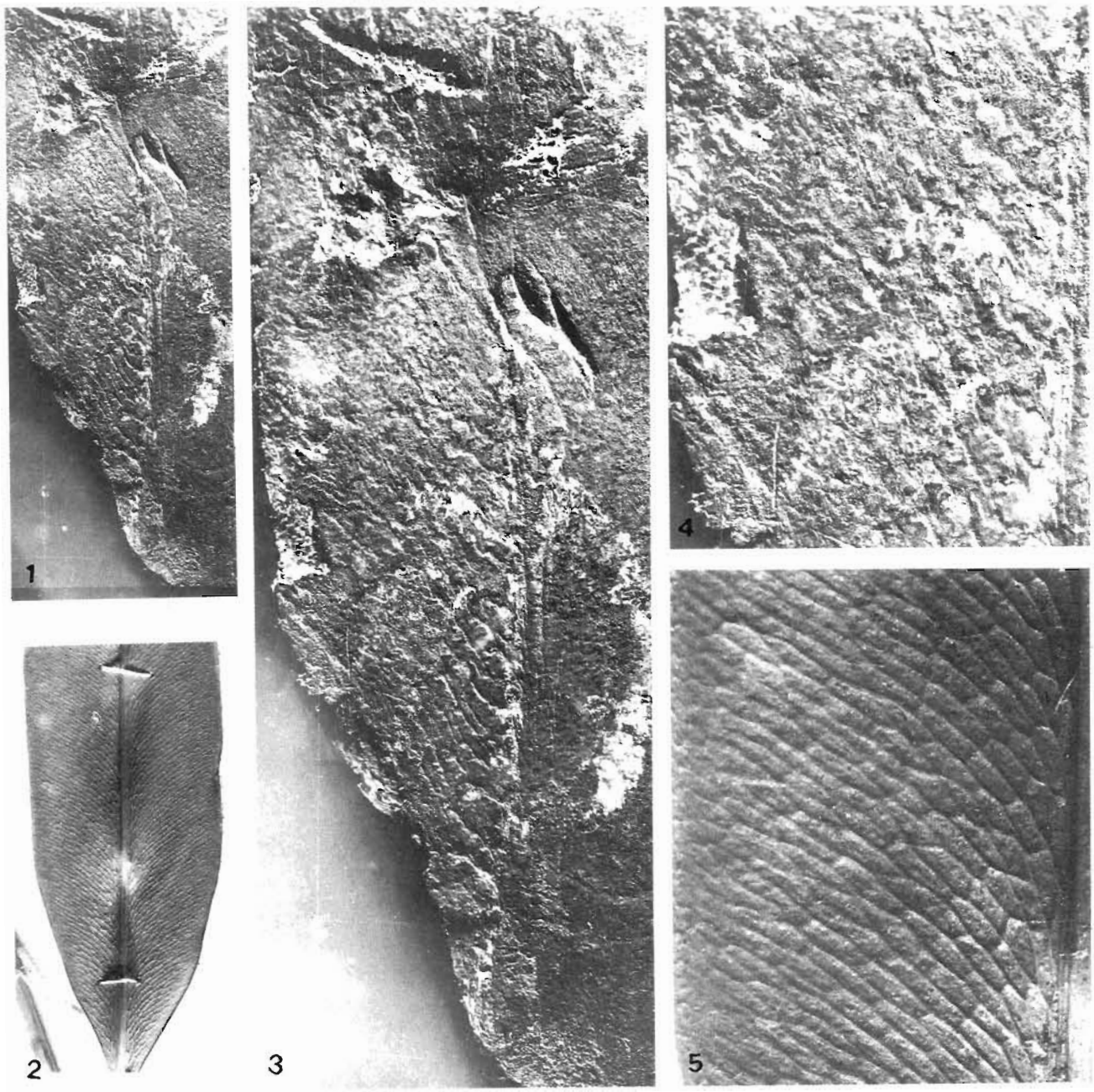


PLATE 1

1. *Acrostichum lanzaeanum* (Visiani) Reid & Chandler — A fossil frond in natural size showing shape and size.
2. *Acrostichum aureum* L — A modern frond in natural size showing similar shape and size.
3. *Acrostichum lanzaeanum* (Visiani) Reid & Chandler — Fossil slightly magnified to show shape, size and venation pattern x 2
4. *Acrostichum lanzaeanum* (Visiani) Reid & Chandler — A part of fossil frond magnified to show details of venation x 3.2
5. *Acrostichum aureum L* — A part of modern frond magnified to show similar venation pattern x 4.

tichumsporites from the Langpar Formation (Early Palaeocene) of Meghalaya, north-east India.

The fossil history of *Acrostichum* can be traced back to Palaeocene. Fritel (1910) reported a frond fragment from the Paleocene sediments of Paris Basin as *A. palaeocenicum*. Leafy material of *Acrostichum* is commonly recognised from its typical netted venation. The genus has frequently been reported from the Lower Tertiary of Europe. Barthel (1976, pp. 453-454) has given a detailed list of megafossils of *Acrostichum*. The leaf remains of the genus was first described as *Fortisia lanzaeana* by Visiani (1858) from the Eocene of Monte Promina. Gardner and Ettingshausen (1879) figured small pieces of *Chrysodium lanzaeanum* from the lower Bagshot of England. Later, Gardner (1886) opined that *C. lanzaeanum* (Visiani) is identical to recent *Acrostichum aureum* L. and therefore its name was formally changed to *Acrostichum lanzaeanum* (Visiani) by Reid and Chandler (1926) while describing this species from the Bembridge limestone of England. In addition to the fossil record listed by Barthel (1976), Beauchamp *et al.* (1973) described the frond remains from the Oligocene of Ethiopia as *Acrostichum palaeoaureum*. Well preserved petrified remains of *Acrostichum*, consisting of stems, roots, petioles, midribs, pinnae, sporangia and spores have been reported from the Clarno Chert, Oregon, U.S.A. (Arnold & Daugherty, 1963). Dispersed sporangia of the genus have been reported from the Eocene/Oligocene of England by Collinson (1978).

While comparing the present fossil with the available records it was found that the secondaries do not form meshes in *A. palaeocenicum* Fritel, and hence differ distinctly from it. The meshes formed by the secondaries in *A. palaeoaureum* Beauchamp *et al.* also differ from the present fossil in angle, shape and size. The pinna of *A. preaureum* Arnold & Daugherty (1963, pl. 5, fig. 2) although shows netted venation similar to present fossil yet it cannot be compared exactly with the present fossil as it is based on the sections of the petrified material whose morphological details are lacking. The present fossil shows nearest resemblance with *A. lanzaeanum* (Visiani) Reid & Chandler (1926, fig. 1) and hence it is placed under the same species. Barthel (1976) merged all the known fossil species of *Acrostichum* under a single species, *A. aureum* L. *fossilis* belonging to different ages and based on different organs. The authors do not agree with Barthel's view and in their opinion it is not appropriate to merge the various species based on different organs like rhizome, rachis, petiole and pinna from distant areas and ages under a single species.

Acrostichum aureum Linn. with which the fossil shows resemblance is a semi-aquatic species. It grows in brackish or salt water and is a characteristic member of mangrove swamp communities of tropical regions. Occasionally it is found in fresh water above sea level and rarely on sea-cliffs (Tryon & Tryon, 1982). It generally does not grow beyond the reach of tidal influence (Macnae, 1968). In India, the species is found on the banks of rivers and backwaters in Sunderbans, estuaries of Orissa, and on the western coast from Kerala to Karnataka (Beddome, 1970, p. 69; Clarke, 1973, p, 582; Rao *et al.*, 1973; Rao & Sastry, 1974). Thus its occurrence in the north-west Himalaya is phytogeographically very significant. Fronds of *Acrostichum* are rarely preserved as they normally collapse or shrivel on the plant itself like other herbaceous leaves. Some kind of inundation or flooding has to be invoked for the chance preservation of the partially preserved material (pinna/pinnae). Thus possibility of tidal influence cannot be denied in the preservation of the fossil. Evidently occurrence of *Acrostichum* indicates the presence of coastal river banks in the flood-plain area or perhaps coastal lake and tropical climate. The presence of palms together with some of the coastal genera such as *Garcinia speciosa*, *Gluta tavoyana*, already reported from the area (Sahni, 1953; Chaudhri, 1969; Arya & Awasthi, 1995) also indicates the vicinity of the sea near Kasauli at the time of deposition of the fossils. The landscape today is dominated by gregarious conifer forest of chir, deodar, blue pines, etc. Obviously the area has undergone tremendous change in the topography, climate and vegetation due to uplift of the Himalaya and recession of the Tethys Sea.

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