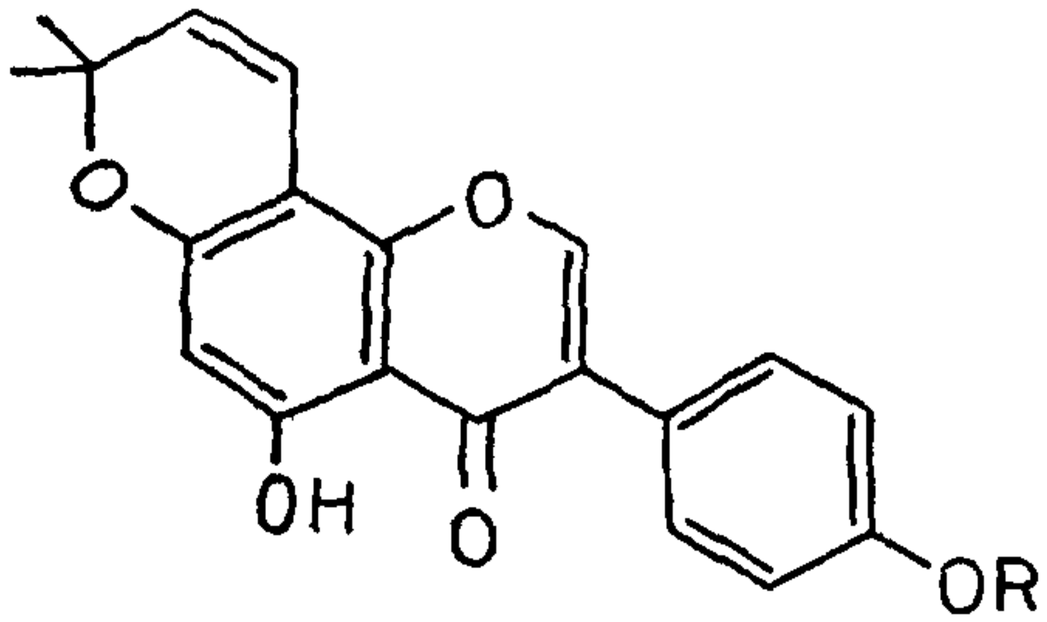

I R = CH_3 II R = H

residue[11]. Presence of a *gem*-dimethyl grouping was further supported by absorptions at 1384 and 1367 cm^{-1} in the IR spectrum. The location of the 2,2-dimethylchromen residue at 7,8-position was established by a negative Gibb's test[12] (suggesting the absence of unsubstituted CH *para* to the phenolic group). Two doublets ($J = 9$ Hz) at δ 7·34 and 6·83, each integrating for two protons, characteristic of A_2B_2 pattern in the NMR spectrum were assigned to 2′, 6′ and 3′, 5′ protons, respectively. The methoxyl is, therefore, assigned to 4′-position. On the basis of chemical and spectral data[13] of the compound, the structure (I) was assigned to it. The identity of the compound was finally confirmed by comparison (m.p., m.m.p., co-TLC and co-IR) with a sample[7] obtained by partial methylation (diazomethane) of derrne (II).

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AGE OF THE LADAKH-DEOSAI GRANITE BATHOLITH, TRANS-HIMALAYA

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LADAKH–DEOSAI Granite Batholith is exposed along the NW–SE trending Ladakh Range which runs more or less parallel to the Indus Suture Zone of the Trans-Himalaya. This batholithic granite body has been observed to extend from Gilgit in the northwest to Hanle (Ladakh) in the southeast for over 500 km beyond which it is expected to continue further southeast into the Tibetan region and measures about 50 km in width. A part of this body in Gilgit-Deosai region has been studied by Desio[1] and the major part which runs through Ladakh region has been studied in detail by various workers[2–6]. Recently, Gansser[7] has shown such granite bodies to extend as detached outcrops all along the Himalayan Arc. The age of this granitic belt has been widely fluctuating and very little radiometric age data was available to date the magmatic events which resulted in this complex batholithic body. An attempt has been made in the present paper to understand the magmatic history of this batholith with the help of 110 fission track mineral ages of sphene epidote, micas and apatite collected from various parts of the Ladakh region, *i.e.*, Hanu, Leh, Khardung La, Tirit, Charg La, Kiari and Chumathang.

In regional geological setting the Ladakh-Deosai Granite Batholith forms the basement for the Indus Molasse (Miocene-Pliocene) which occurs unconformably over it at Kargil and extends as a linear belt towards east, upto Hanle, although near Leh the contact is concealed under the terraces of the Indus River[4,8]. The northern contact of the Ladakh Granite is covered by the Shyok volcanics[8] which are also intruded at places by some younger phase of the Ladakh granite[9,10].

The Ladakh-Batholith is complex in composition and varies from quartz diorite (tonalite) to granodiorite to granite. The traverses taken across and along this body by one of the authors (KKS) reveal that it is zoned in nature at places and becomes more acidic towards the core. Three zones in general have been recognised in this body, *viz.*, aureole zone, border zone and core zone[11]. The aureole zone is characterized by large scale emplacement of apophyses, tongues (ramifications) and veins of granodiorite, granite aplite and pegmatite in the host rocks, which are generally

amphibolitic and schistose in character and show effects of contact metamorphism as noticed near Chumathang. The border zone is mainly tonalitic and granodioritic in composition with occasional tongues of hornblende poor pink granite as noticed near Khardung La. Intrusions of various sizes of pink granite into quartz diorite and granodiorite have also been observed in Karoo–Chang La–Darbuk section, Nyoma–Loma–Dungti section and Kargil–Batalik–Hanu section. The deeper parts of the Ladakh Batholith have been exposed around Gaik in the southeast and Hanu in the northwest where the Indus River has cut deep gorges through the granite. This zone consists of pink porphyritic granite which is further intruded by leucogranite, aplite and pegmatite phases towards its core.

Desio[1] reported Rb/Sr age of 48 Ma for the granodioritic rock from Sakardu region which has metamorphosed the argillaceous beds of the Burji La formation containing Turonian (Late Cretaceous) fossils. Recently[12], granitic rocks from Gilgit and Yasin valley have been dated by $^{40}Ar/^{39}Ar$ method between 40–42 Ma and 56–40 Ma confirming Late Palaeocene to Early Eocene age for the northwestern part of Ladakh–Deosai Granite Batholith. The southeastern part of this Batholith exposed in the Ladakh region, commonly called as Ladakh Batholith, has been assigned 'Hercynian' age by De Terra[13]. Shanker *et al.*[5] and Shah *et al.*[3] also consider Ladakh Granite to be Pre–Cretaceous and Pre–Tertiary respectively although they also feel that at least one of the phases of the Ladakh granite is Tertiary. Chumathang granite is even considered to be as young as Pliocene to Post-Miocene[5]. Only one Rb/Sr age of 38 Ma reported from Hemis (45 km southeast of Leh) has been overlooked as this age was determined on granite pebbles collected from the Hemis conglomerate[14]. Frank *et al.*[4] keeping in view the radiometric ages reported by Desio[1] and Desio and Zanattin[14] inconclusively suggested Ladakh Granite to be a continuous Late Cretaceous–Early Tertiary magmatic event. Another radiometric age, recently reported[15] from Hemiya for the pink porphyritic granite (K/Ar; $27 \cdot 8 \pm 0 \cdot 6$ Ma), a younger phase of Ladakh granite, could not throw much light on the age of the Ladakh Batholith.

Seventeen fission track ages of sphene determined on samples representing different phases of Ladakh Granite vary from $35 \cdot 4$–$24 \cdot 8$ Ma and are comparable with four epidote ages which also vary from $32 \cdot 5$ to $22 \cdot 4$ Ma. Micas from granites and younger pegmatitic phases have dated 15 Ma and 6–9 Ma. Eighty apatite ages determined on granite and aplite fall into 20–10 Ma and 7 Ma age groups respectively. Since, fission track mineral ages are cooling ages and record various isotherms during cooling, these ages are always younger than the granite emplacement and crystallisation. The closing temperatures for retention of fission tracks in sphene, epidote and apatite have been calculated as 320° C, 300° C and 100° C respectively[16]. The discordance in the ages of apatite and sphene is due to their different closing temperatures and has been used to decipher the cooling and the uplift history of this region which is being published, along with other details, elsewhere[17]. Age of the sphene (35 Ma) having closing temperature of 320° C suggests that the granitic magma after its emplacement and crystallization around 600° C might have taken at least a few million years to cool to a temperature for retention of fission tracks in sphene. The Rb/Sr and $^{40}Ar/^{39}Ar$ age of 56–40 Ma determined for the northwestern part of Ladakh–Deosai Granite Batholith, therefore, appears to hold good for its southeast part exposed in the Ladakh region, called the Ladakh Batholith.

The Rb–Sr, K–Ar and fission methods really date different thermo-metamorphic events, so that the above results are not inconsistent with the Ladakh Granite Batholith being a polyphase intrusion which has crystallized in a complex process.

On the basis of the detailed geological observations made by one of the authors (KKS) supported by radiometric data, it is suggested that the Ladakh Granite Batholith is a polyphase intrusion and has crystallised more or less in a continuous process. The magmatic activity resulting this Batholith started sometime in the Late Palaeocene (55–60 Ma ago), continued differentiation and crystallization in successive phases through Eocene to Late Oligocene or Early Miocene (20–25 Ma ago), K–Ar age of $27 \cdot 8 \pm 0 \cdot 6$ Ma for the pink porphyritic granite having tongues and veins of leucogranite, aplite and pegmatite in the deeper parts of the body further confirm the lower age limit of the magmatic activity. The fact that nowhere granite has so far been found to intrude the Indus Molasse (Miocene–Pliocene?) also suggests that the magmatic activity more or less ceased before the deposition of the Indus Molasse.

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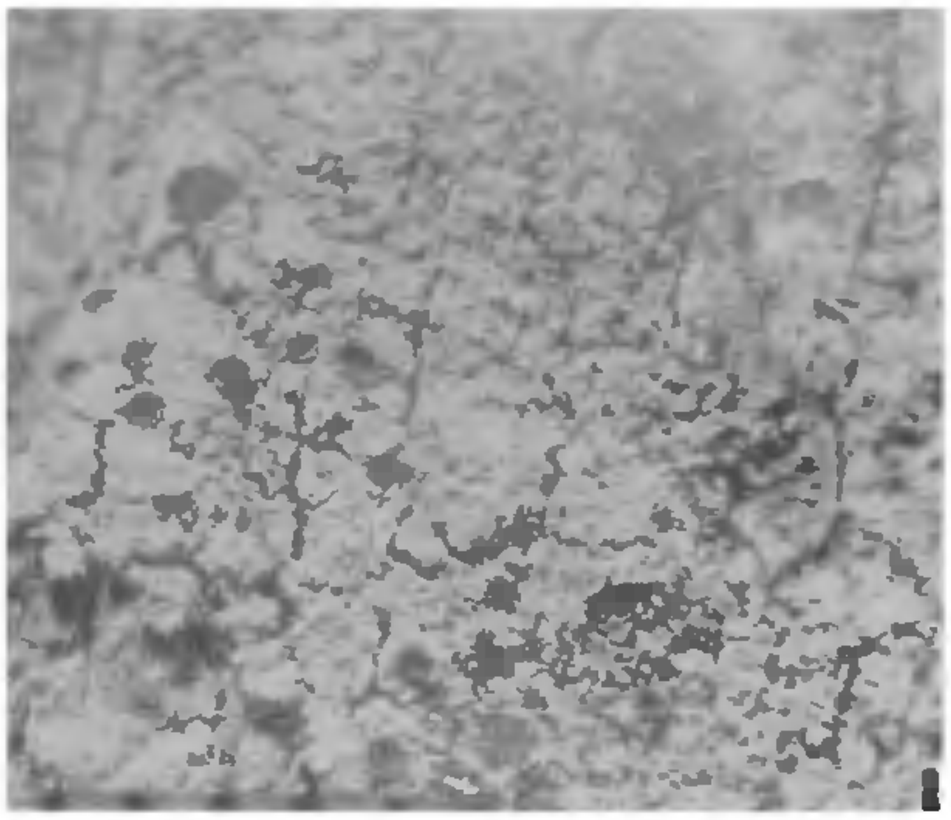
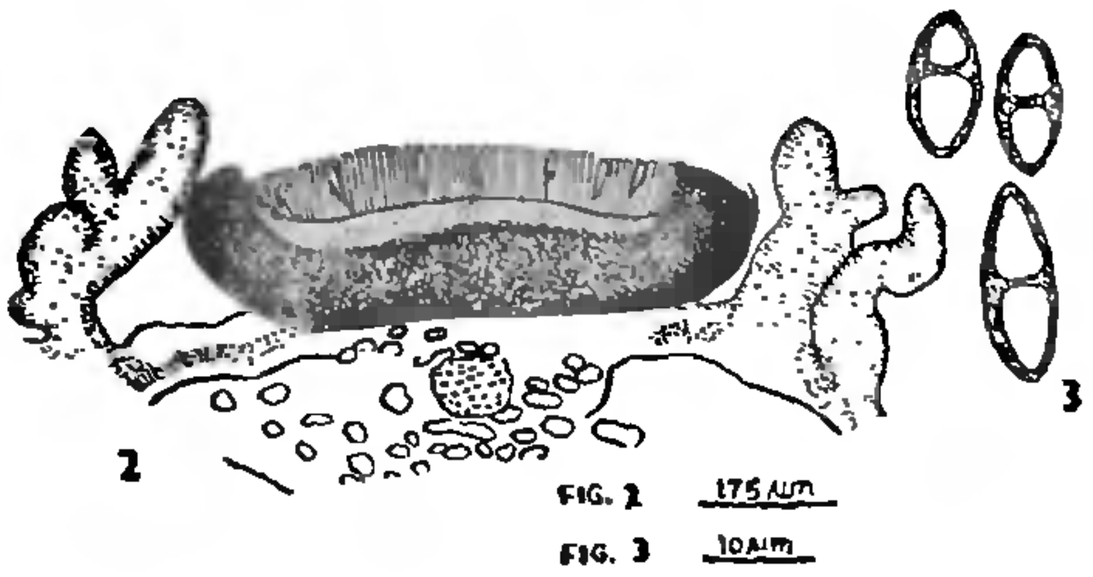


FIG. 1. Part of the holotype of *Buellia isidiophora* Awas. et Upreti. Each div. of scale = 1 mm.



FIGS. 2–3. *Buellia isidiophora*. Fig. 2. Vertical section through apothecium; Fig. 3. Spores.

BUELLIA ISIDIOPHORA AND *LOPADIUM AUSTROINDICUM*—TWO NEW SPECIES OF LICHENS FROM INDIA

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INVESTIGATIONS on the lichens collected from Karnataka and Kerala States of India have resulted in the discovery of two new species, which are rather remarkable in their morphology. The TLC observations about the lichen products in them are according to the method by Culberson[1].

1. *Buellia isidiophora* Awas. et Upreti sp. nov. (Figs. 1–3)

Thallus corticola, crustaceus, pallido-cinerascens, isidiosus. Apothecia sessilia, nigra, 0·5–1 mm lata. Excipulum fusco-nigrum. Hymenium 93–135 µm altum, haud oleoso-inspersum, I + coerulescens. Asci 8 spori; sporae diblastae, fuscae, ellipsoidae, laevae, 9–18 (23) × 5–12 µm. Paraphyses simplices vel ramoses. Medulla K + rubescens, P + flavo-aurantiaca; atranoricum et acidum norstictieum continens.

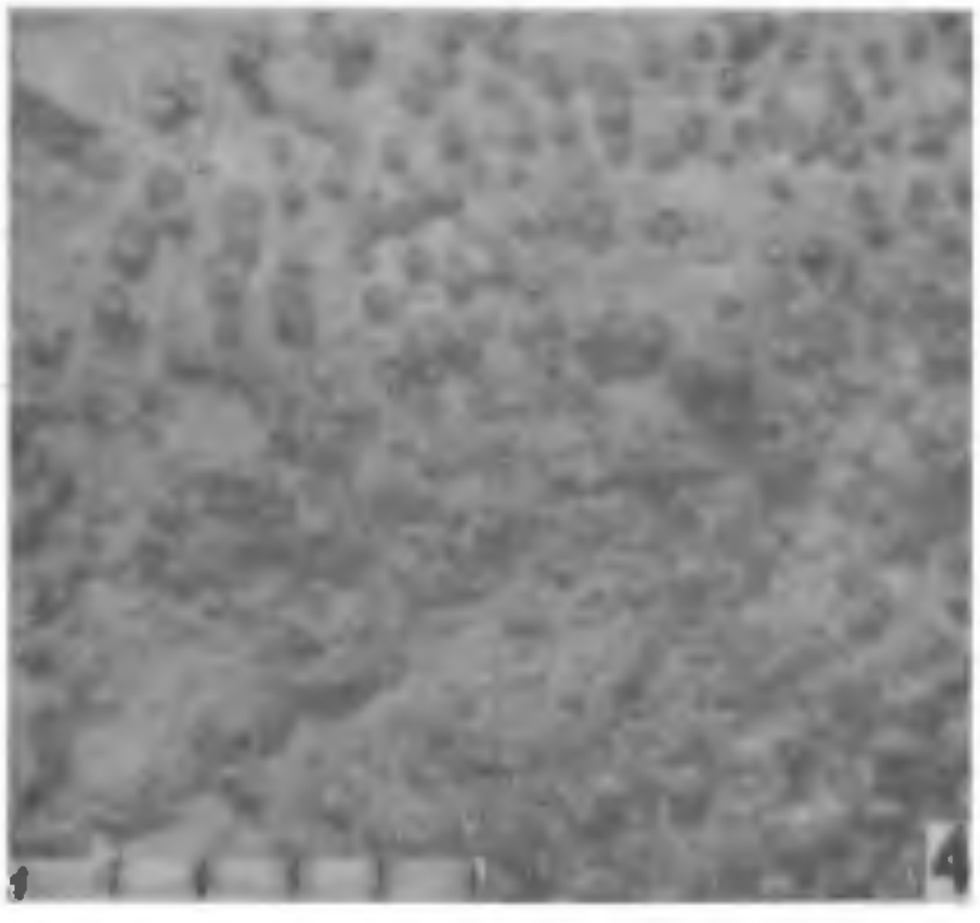

FIG. 4. Part of the holotype of *Lopadium austroindicum* Awas. et Upreti. Each div. of scale = 1 mm.