
Erikoidní mykorhiza

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- je vedle AM a OM třetím základním typem endomykorhizy na Zemi
- charakteristická pro stanoviště s vysokými C/N a C/P poměry v půdě
- většina zástupců řádu Ericales
- ca 140 miliónů let stará symbióza

Erikoidní mykorhiza (ErM)

- taxony hostitelských rostlin
- taxony mykorhizních hub
  - základní biologická charakteristika
- mykorhizní struktury
  - smyčky a klubíčka v epidermis jemných kořenů
- (fungování EKM)

Subalpine landscape
Vaccinium spp. predominant,
Manning Park,
British Columbia, Canada

Moors,
Yorkshire, England

Ericaceous plants, Badnant gardens,
Wales, British Isles

Ledum groenlandicum
(Labrador tea)
British Columbia,
Canada

Rhododendron canadense
Quebec wetlands, Canada
(Photo Courtesy of C.M. Panneton)

Kalmia augustifolia
(sheep laurel)
Quebec, Canada

Andromedea glaucophylla
(bog rosemary)
Quebec, Canada
(Photo Courtesy of C.M. Panneton)

Gaultheria shallon
(salal)
Vancouver Island
British Columbia
Canada

Vaccinium oxycoccus fruits
(bog cranberry)
British Columbia,
Canada

Vaccinium myrtilloides
(velvet-leaved blueberry)
British Columbia,
Canada

Hostitelské rostliny

- řád Ericales, čeleď Ericaceae (Empetraceae a Epacridaceae řazeny pod Ericaceae)
  - rody *Calluna*, *Erica*, *Rhododendron*, *Vaccinium*, *Ledum*
  - blueberries and cranberries
  - jemné kořeny (hair roots), rhizodermis bez rhizinů, velmi redukovaný kortex (často jednovrstevný + en, sekundárně netloustnou)
  - erikoidní + monotropoidní (mykoheterotrofní *Monotropa hypopitis*)+ arbutoidní mykorhizy (rody *Arbutus, Arctostaphylos*) hostitelé

Hostitelské rostliny

- rašeliniště, vrchoviště, subalpinská a alpinská flóra
- Epacridaceae: rašeliniště a (kyselé) písčité pláně

Mykorhizní houby

- poměrně malý počet druhů
- odd. Ascomycota, řády Helotiales
  - voskovička vřesovcová (*Hyaloscypha hepaticicola*, syn. *Rhizoscyphus ericae, Hymenoscyphus ericae, Pezizella ericae*); anamorfa *Scytalidium vaccinii*
  - *Meliniomyces* sp.
  - *Oidiodendron* sp. (anamorfní rod)
- odd. Basidiomycota, řád Sebacinales
- saprotrofové, snadno kultivovatelní
- produkce lytických enzymů (kyselé proteázy a fosfatázy, polyfenoloxidázy…)
- kolonizují i rhizoidy játrovek
- nekrotrofní atak nehostitelských taxonů!!!
- tolerance vůči těžkým kovům

Mykorhizní houby

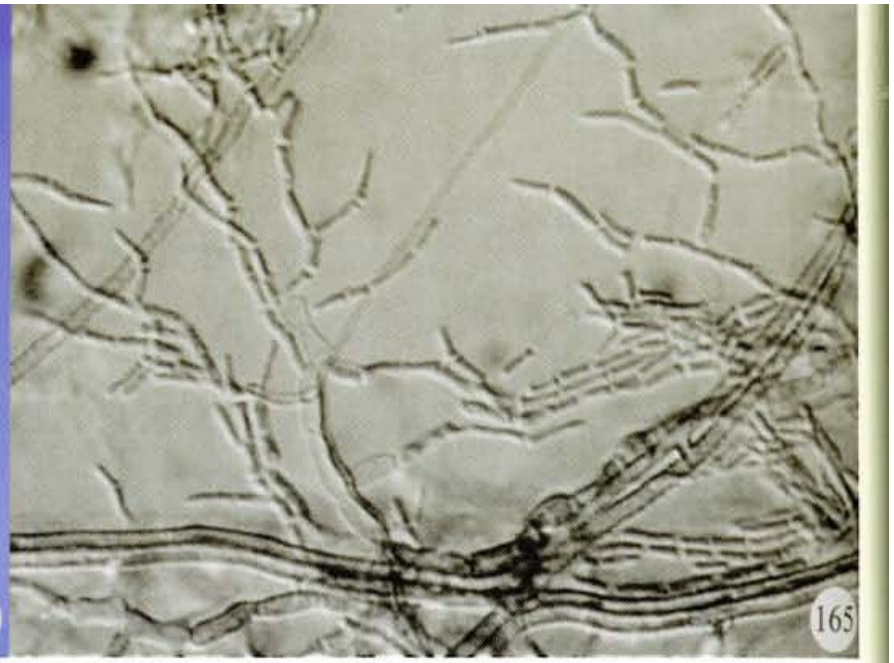


Figure 164. Culture of *Hymenoscyphus ericae*.

Figure 165. Arthroconidia (asexual propagules) of *Scytalidium vaccinii* (the anamorph state of *Hymenoscyphus ericae*). Photo from Hambleton and Currah. Can. J. Bot. 75: 1570–1581 (1997).

Mykorhizní struktury

- Smyčky a klubíčka hyf
  - převážně v epidermis
  - > každá buňka samostatná infekční jednotka
  - > fungují po celou vegetační sezónu, někdy však relativně krátká životnost klubíček (několik týdnů), poté kolaps podobný „stravování“ klubíček hyf u orchideoidní mykorhizy
  - přitom neuvažována trofická (mykoheterotrofní) role tohoto procesu!
- ERM

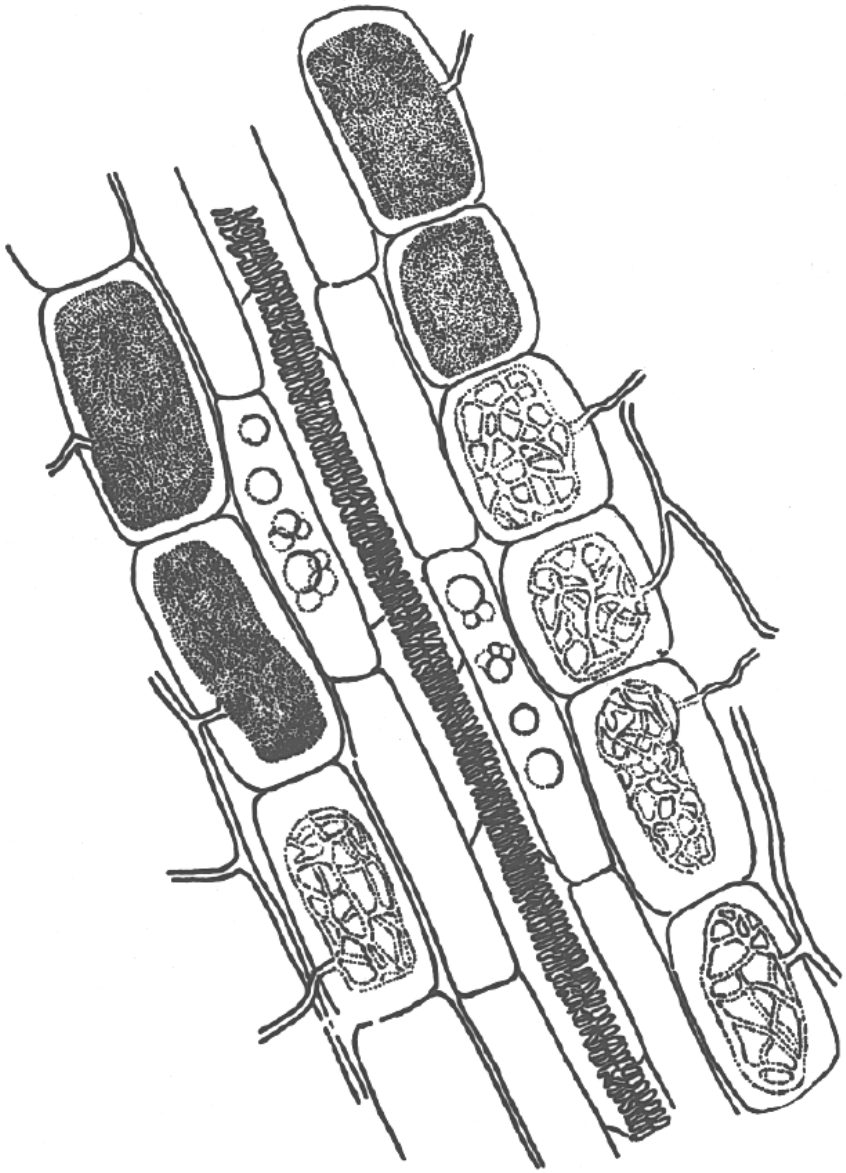


FIG. 1. The ericoid mycorrhizal root of *Epacris impressa* as originally depicted by McLennan (1935). Epidermal cells heavily colonized by hyphal complexes are seen to enclose narrow cells of the exodermis, endodermis and the monarch stele.

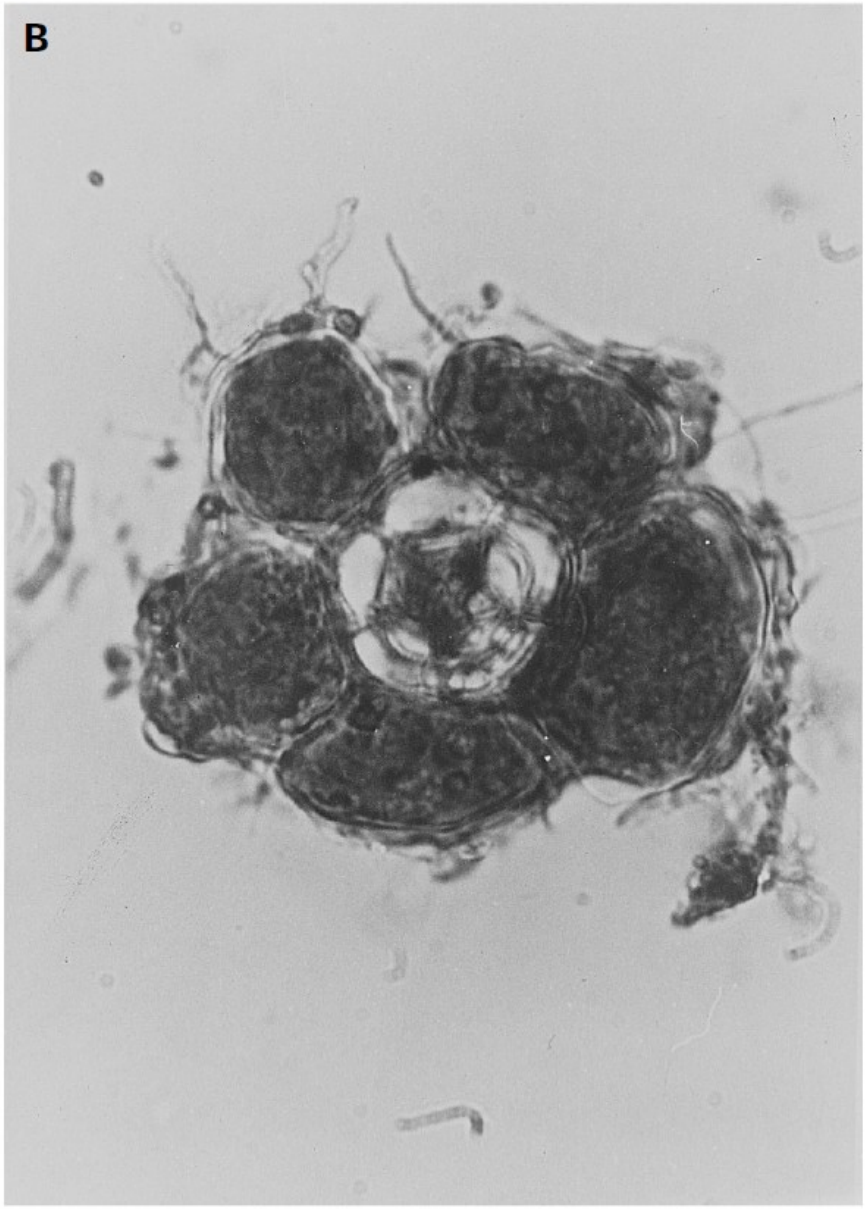
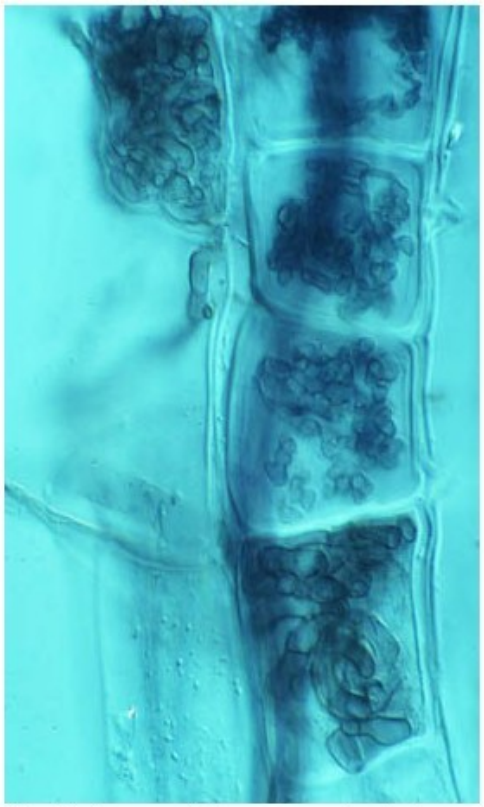


FIG. 2. A, Transverse section of ericoid hair root of *Leucopogon ericoides* Smith R. Br. fixed in glutaraldehyde and embedded in Spurrs resin. Root diameter approx. 67 μm. Material fixed sectioned for TEM and photographed by Suzanne Bullock. This section is taken in a mature region of the hair root and shows relatively light colonization. B, Transverse hand section of young hair root of *Calluna vulgaris* indicating very heavy colonization of all of the epidermal cells by a mycorrhizal endophyte. Root diameter approx. 70 μm.

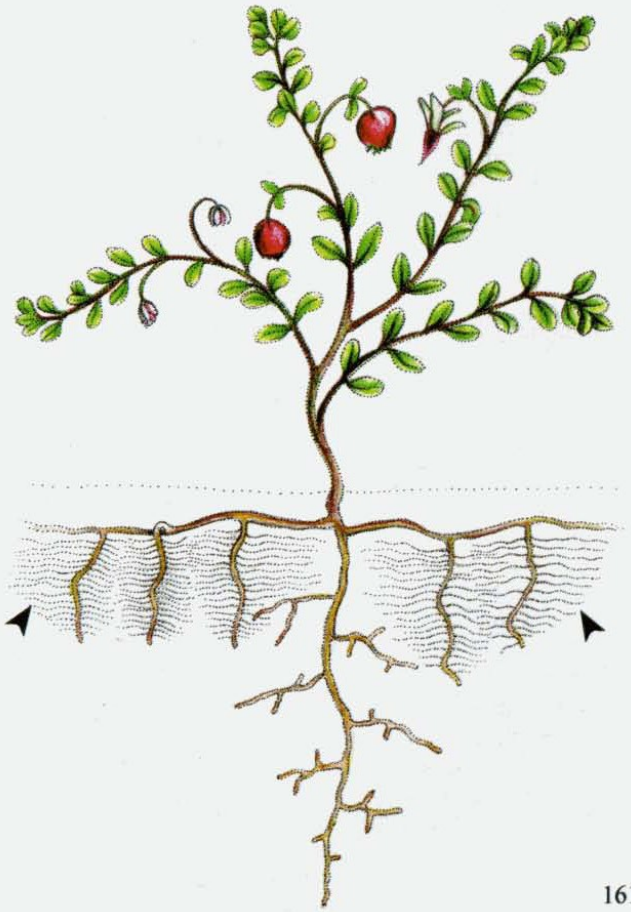
Figure 161. Diagrammatic representation of an ericoid species with numerous hair roots (arrowheads).

Figure 162. Diagram of a transverse section of a hair root showing enlarged epidermal cells (E) with a thickened outer tangential wall, one layer of cortex (C), an endodermis (En), a few xylem tracheary elements (X), and a few phloem cells (P).

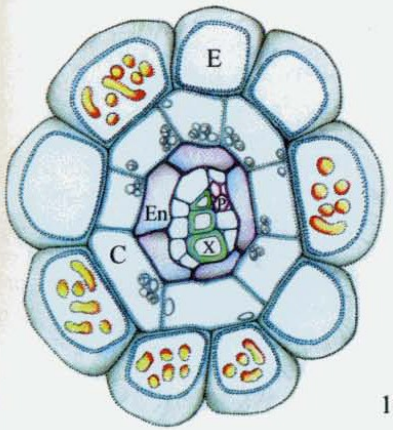
Figure 163. Diagram of epidermal cells showing entry of fungal hyphae through the thickened wall (arrowhead), hyphal complexes (HC), and a narrow hypha (double arrowhead) connecting adjacent epidermal cells.



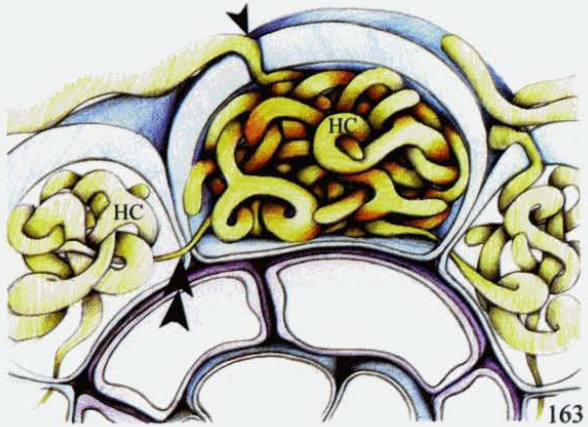
LS of a fine root of Leucopogon juniperinum. The fungus forms coils in each colonised cell from a single penetration point on the outer surface. (Photo of A. Ashford)



161



162



163

Figure 166. Dark septate fungal endophytes (arrowheads) in cleared roots of *Gaultheria shallon*.

Figure 167. Microsclerotia (arrowheads) of dark septate fungal endophytes in cleared roots of *Vaccinium* sp.

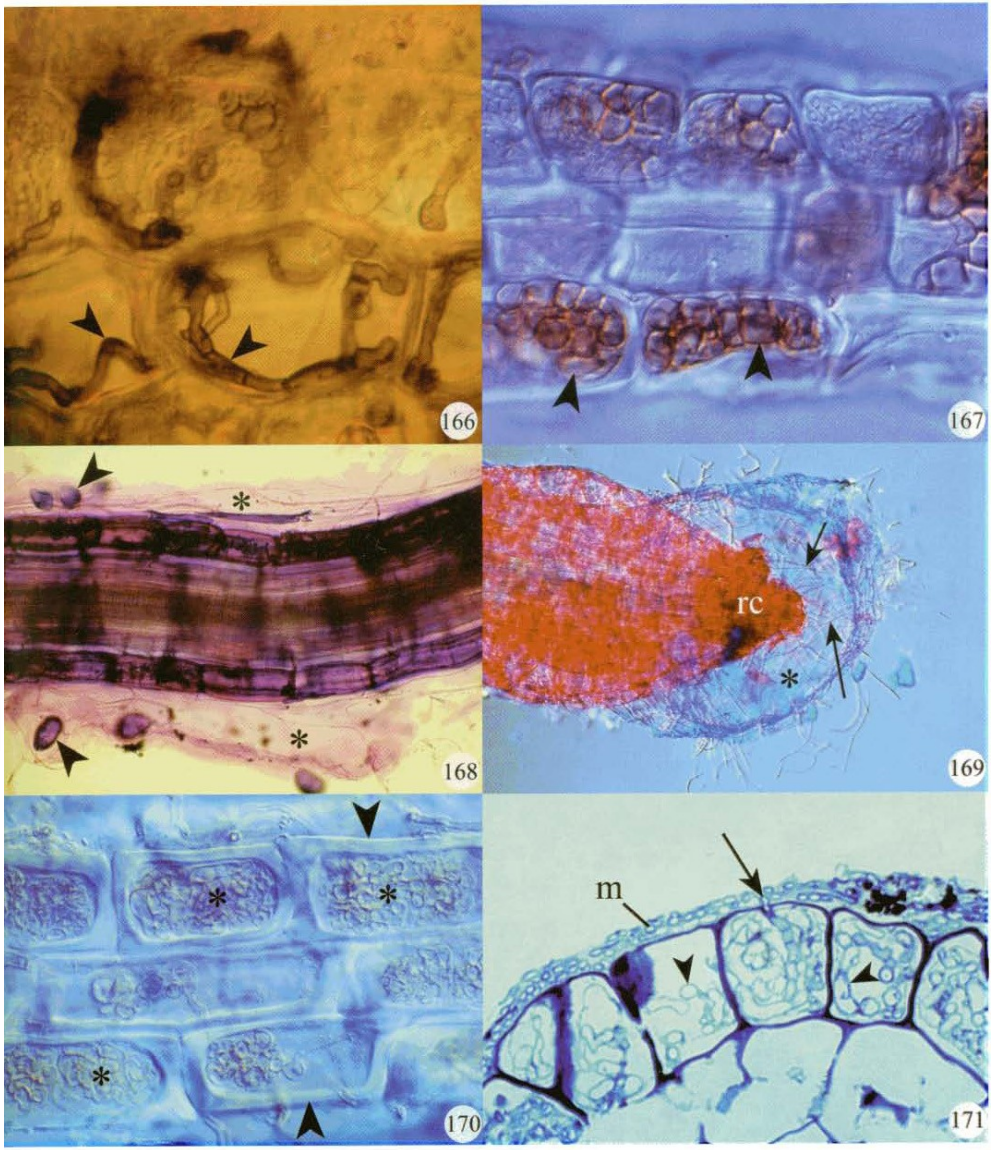
Figure 168. Hair root of *Gaultheria shallon* stained with toluidine blue O showing the mucilage sheath (*) and trapped sloughed root cap cells (arrowheads).

Figure 169. PAS-stained root tip of *Gaultheria shallon* counterstained with alcian blue showing root cap (rc), mucigel (*) and fungal hyphae of *Hymenoscyphus ericae* (arrows).

Figure 170. Cleared root of *Gaultheria shallon* showing thickened epidermal cell walls (arrowheads) and intracellular fungal coils (*).

Figure 171. Transverse section of *Gaultheria shallon* hair root showing a mantle-like structure (m), a hypha penetrating the epidermis (arrow), and hyphal coils (arrowheads).

Cultured seedlings of *Gaultheria shallon* inoculated with *Hymenoscyphus ericae* used for Figures 168, 169 were provided by Dr. Shannon Berch.



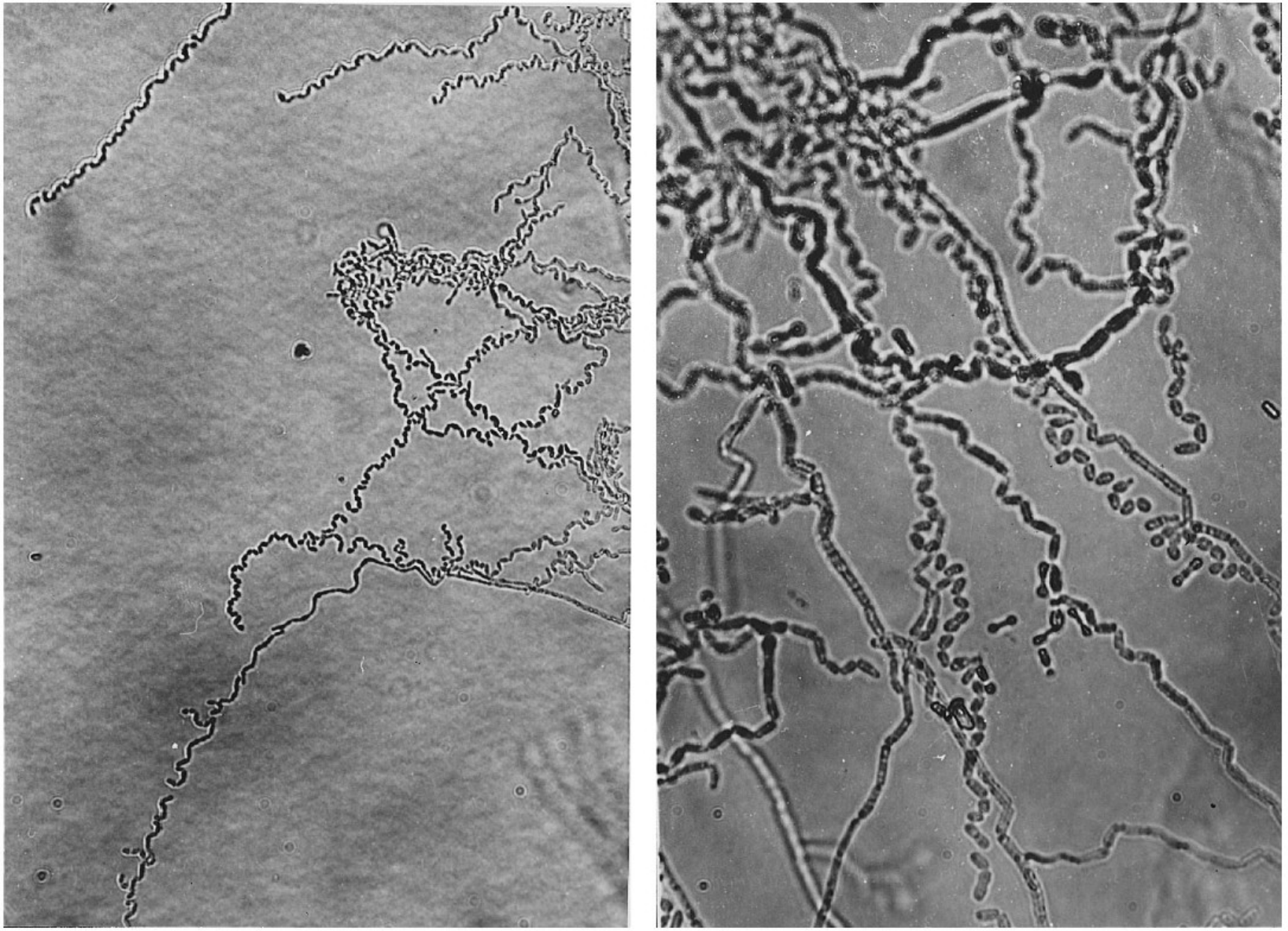
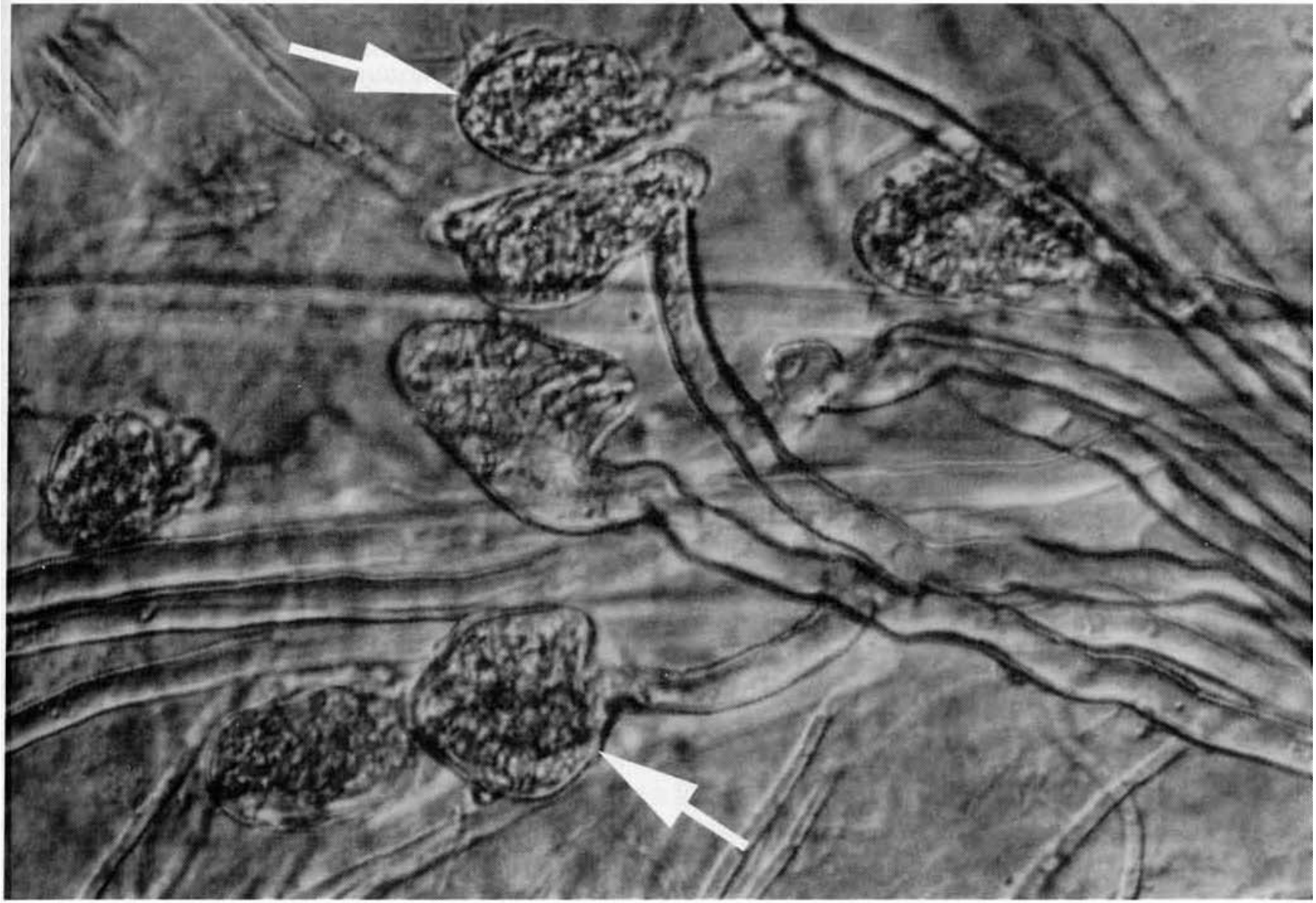


FIG. 4. Segmentation of hyphae of an isolate of *H. ericae* to zig-zag chains of arthroconidia which are characteristic of *Scytalidium*.



Swollen rhizoid tips of the liverwort, *Calypogeia muellerana*, colonized by the ericoid fungus *Hymenoscyphus ericae*. From Duckett and Read. New Phytol. **129:** 439–447 (1995).

Box 14: Ericoid mycorrhizal fungi access various sources of nitrogen

Ericoid mycorrhizal fungi assist a broad spectrum of plants in the large order Ericales in the acquisition of nitrogen. Plant habitat varies considerably but most soils are characterized as being low in nutrients, particularly available nitrogen (Read 1996). Many fungi, including ericoid mycorrhizal fungi, are able to assimilate both ammonium and nitrate obtained from the soil solution (Read 1996). However, other important sources of nitrogen have been documented. *In vitro* experiments have shown that a number of amino acids (Bajwa and Read 1986), peptides and proteins (Bajwa and Read 1985; Bajwa et al. 1985) can be utilized by ericoid fungi as sources of nitrogen. *Hymenoscyphus ericae*, the most common fungal endophyte in the Ericales, produces an extracellular proteinase with a very low pH optimum (pH 2.2). Similar low pH levels may be encountered by this fungus in association with the fine hair roots of ericoid species that occur in the litter layer of acidic heathlands (Leake and Read 1989). Plant, fungal, and animal proteins therefore become potential sources of nitrogen for ericoid fungi and their plant hosts. Nitrogen from proteins that are complexed with polyphenolic compounds can also be accessed by these fungi (Bending and Read 1996); in addition, soluble phenolics and lignin can be degraded by *Hymenoscyphus ericae* (Bending and Read 1997).

Of particular interest, ericoid mycorrhizal fungi are able to use the polymer, chitin, as their sole source of nitrogen (Leake and Read 1990). An important source of chitin for these fungi would be the large biomass of hyphal walls of necrotic mycorrhizal and other fungi as well as insect remains in these soils.

There is convincing experimental evidence that species in the Ericaceae show increased growth when colonized with ericoid mycorrhizal fungi (see Read 1978, 1996); there is less evidence for this in the Epacridaceae (Bell and Pate 1996).