

## NOTES ON ENTOMOGENOUS FUNGI FROM GHANA

### II. THE GENUS *AKANTHOMYCES*

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#### SUMMARY

Four species of *Akanthomyces*, collected on various arthropod hosts in Ghana, are described and illustrated. *Akanthomyces gracilis* Samson & Evans spec. nov. appeared to occur on a wide variety of insect hosts and is particularly common on ants. *Akanthomyces pistillariaeformis* (Pat.) Samson & Evans comb. nov. (= *Isaria pistillariaeformis* Pat.) is often found on moths together with *Cordyceps tuberculata*. The variability in synnematos habit and the associated *Cordyceps tuberculata* is discussed. *Akanthomyces arachnophilus* (Petch) Samson & Evans comb. nov. (= *Trichosterigma arachnophilum* Petch) was collected twice on spiders together with *Torrubiella flava* Petch. *A. araneorum* (Petch) Mains is rather common on spiders.

#### INTRODUCTION

The genus *Akanthomyces* Lebert was revised by MAINS (1950), who characterized it by cylindrical synnemata covered by a hymenium-like layer of phialides producing one-celled catenulate conidia. Species with clavate synnemata and a sterile stipe were placed in the genus *Insecticola* Mains. This synnematos habit does not allow a clear delimitation between *Akanthomyces* and *Insecticola*, since clavate as well as cylindrical synnemata, with or without sterile stipes, occur within the same species (e.g. *Isaria pistillariaeformis* Pat.).

In the *Akanthomyces* species accepted by MAINS (1950) the phialides are of different shapes. In *A. araneorum* they are cylindrical without distinct necks, while in *A. aculeatus* they are more or less flask-shaped, tapering to a short neck, thus resembling the conidiogenous structures of the genus *Paecilomyces* Bain.. However, the genus *Akanthomyces* is separated from *Paecilomyces* by the typical hymenium-like arrangement of the phialides. In *Paecilomyces* these structures are loose and verticillate. The conidiogenous structures of *Akanthomyces* are also somewhat reminiscent of the genus *Nalanthamala* Subr., which is sporodochium-like and not known to be entomogenous.

Four species belonging to *Akanthomyces* were regularly collected on various arthropod hosts in Ghana. New combinations are proposed for two species originally described in *Isaria* and *Trichosterigma* (= *Hirsutella*). One species differs sufficiently from the known taxa to warrant describing it as new.

***Akanthomyces gracilis* Samson & Evans, spec. nov. – Fig. 1, a-b; Figs. 2–6.**

Synnemata in insectis dispersa vel aggregata, alba ad flavobrunnea, plus minusve pulverulenta, cylindrica, plerumque simplicia, nonnumquam ramosa, longitudine variabilia, 0.7–2 mm  $\times$  100–400  $\mu$ m, nonnumquam ad 3 cm longa et 0.5 mm crassa. Phialides dense aggregatae, synnema in strato tegentes, leves, parte basilari cylindrica in collum tenerum attenuata, 7–10  $\times$  1.5–2.5  $\mu$ m. Conidia continua, catenis longis connexa, levia, hyalina, ellipsoidea vel fusiformia, 2.5–3  $\times$  1–1.6  $\mu$ m.

Typus CBS 141.73, isolatus e *Paltothyreo tarsato*, Atewa Forest Reserve, Ghana.

Synnemata on the insect hosts scattered to crowded, arising from the natural body openings and intersegmental and appendage joints, usually white to yellow-brown, more or less pulverulent, cylindrical, usually simple but sometimes branched, variable in size, according to the insect species and locality usually measuring 0.7–2 mm  $\times$  100–400  $\mu$ m, occasionally up to 3 cm in length and 0.5 mm in diameter. Phialides densely compacted into a layer covering the synnema, consisting of a cylindrical basal part tapering to a slender neck, 7–10  $\times$  1.5–2.5  $\mu$ m, smooth-walled. Conidia one-celled, in long chains, smooth-walled, hyaline, ellipsoidal to fusiform, 2.5–3  $\times$  1–1.6  $\mu$ m.

Colonies on mealworm-agar<sup>1</sup> growing moderately fast, attaining a diameter of about 5 cm within one month at 25°C, consisting of a white to creamish mycelial basal felt, from which numerous conspicuous slender synnemata arise

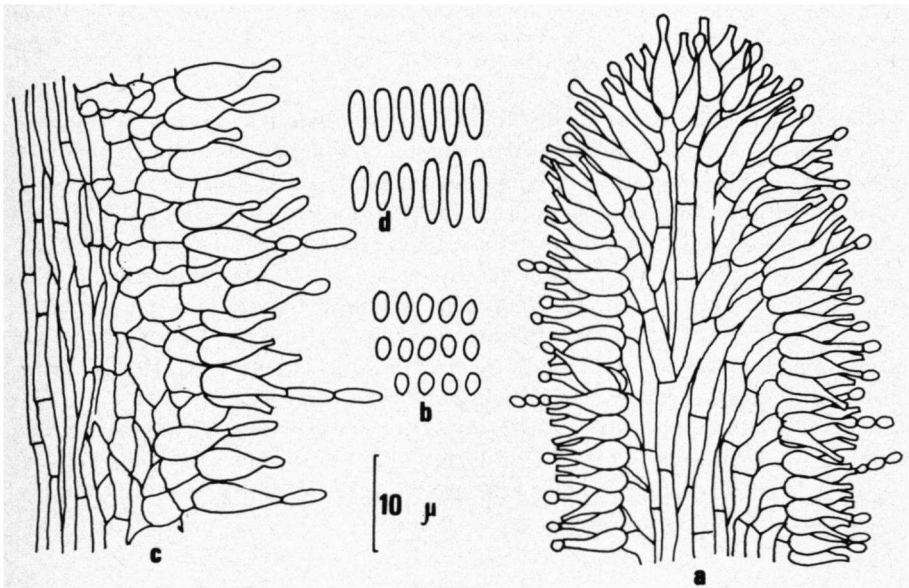


Fig. 1a, b. *Akanthomyces gracilis*; a. part of synnema, b. conidia, Fig. 1c, d. *A. pistillariaeformis*; c. part of synnema, d. conidia.

<sup>1</sup> Mealworm-agar contains an extract of 200 g ground dried mealworms, 20 g sucrose, 20 g agar and 1000 ml water.

developing in concentric rings, usually densely grouped towards the centre, sometimes intermixed with loose conidial structures. Synnemata positively phototropic, at first white, later becoming yellowish and pulverulent, cylindrical to slightly clavate, in age sometimes branched, measuring 2 to 35 mm in length and 0.1–0.5 mm in diameter, composed of smooth, longitudinal, hyaline hyphae. Phialides and conidia as on the natural substrate. Perfect state or chlamydo-spores not observed.

Colonies on PDA, malt or oatmeal agar as on mealworm agar, but growth thinner and synnemata less numerous.

#### Material examined:

##### *living cultures*

CBS 141.73, type culture, isolated from *Paltothyreus tarsatus* (Fabr.) collected in Atewa Forest Reserve (Ghana) (Herbarium specimen with accession number Ras 0102 in herb. CBS).

CBS 740.73 and 741.73, isolated from *Paltothyreus tarsatus* (Fabr.) in Atewa Forest Reserve.

CBS 728.73 and 742.73, isolated from Cercopidae species on cocoa leaf, Tafo.

CBS 727.73, isolated from Lepidoptera larva on cocoa bark, Tafo.

##### *Herbarium specimens*

Ras 0016 and Ras 0018 on *Paltothyreus tarsatus* (Fabr.) collected at Mt. Atewa and Begoro. Specimens of this collection are associated with different *Cordyceps* spp.. Ras 0023 on *Creमतogaster* spp., collected at Mt. Atewa. Ras 0107 on *Callibaphus longirostris* (Drury), collected at Nobi Scarp Forest. Ras 0108 on *Macromischoides inermis* Bernard, collected at Mt. Atewa. Specimens of this collection are associated with different *Cordyceps* spp.. Ras 0134 on *Polyrhachis militaris* (Fabr.), collected at Mt. Atewa. On the same host perithecia of a *Torrubiella* species were observed. Ras 0135 on *Camponotus brutus* (Forel) (♀ alates), collected in Tafo. Ras 0136 on *Creमतogaster bequarti* (Forel), collected at Mt. Atewa.

*Akanthomyces gracilis* can be distinguished from the other species of *Akanthomyces* by its small ellipsoidal to fusiform conidia and cylindrical phialides tapering to a slender neck. The conidiogenous cells and conidia are reminiscent of those of *Paecilomyces farinosus* (Holm per Fr.) Brown & Smith. *A. gracilis* can be considered as an intermediate species between *Paecilomyces* and *Akanthomyces*; it is placed in the latter genus because of the hymenium-like layer of the phialides and the distinct synnemata produced regularly on the insect as well as on agar media. In synnematous *Paecilomyces* species the conidiogenous structures are verticillately and loosely arranged. Furthermore the synnema production in pure culture is usually lost after a few transfers.

*A. gracilis* resembles also *Syngliocladium araneorum* Petch (1932b). In this species conidia are small ( $1.5\text{--}2.5 \times 1 \mu\text{m}$ ), globose to ellipsoidal and produced by flask-shaped phialides. The conidia are, however, produced in heads and not in long dry chains as in *A. gracilis*.

## HOST LIST OF AKANTHOMYCES GRACILIS

## Hymenoptera, Formicidae

Ponerinae: *Paltothyreus tarsatus* (Fabr.), *Platythyrea conradti* Emery

Formicinae: *Polyrhachis militaris* (Fabr.), *P. monista* Santschi, *P. decemdentata* E. André, *Camponotus brutus* (Forel), *Oecophylla longinoda* (Latr.)

Myrmicinae: *Crematogaster bequarti* (Forel), *C. clariventris* Mayr, *C. striatula* Emery, *Macromischoides aculeatus* Mayr, *M. inermis* Bernard

Dorylinae: *Dorylus* sp.

Coleoptera: beetle larvae, beetle imago (adult)

Lepidoptera: moth larvae

Heteroptera, Pyrrhocoridae: *Callibaphus longirostris* (Drury)

Homoptera, Cercopidae: frogopper.

*A. gracilis* occurs on a wide variety of insect hosts and is particularly common on ants. The biotopes of the host habitats are diverse and it is probable that this pathogen is widely distributed throughout the tropics. The size and complexity of the synnemata appear to be related to the size of the insect host and to the habitat. Insects buried in soil, leaf litter or wood invariably bear very long, complex synnemata, which ramify above or within the substrate.

***Akanthomyces pistillariaeformis* (Pat.) Samson & Evans, comb. nov. – Fig. 1, c-d; Fig. 7.**

*Isaria pistillariaeformis* Pat. in Bull. Soc. mycol. Fr. 9: 163, 1893 (basionym) = *Insecticola pistillariaeformis* (Pat.) Mains in Mycologia 42:579. 1950.

Synnemata scattered, arising from different parts of the body, cylindrical to clavate and stipitate, white to creamish, pulverulent, 1–6 mm in length and 50–300  $\mu\text{m}$  in diameter, simple, occasionally branched. Mycelium white, covering the insect and spreading onto the leaf surface. Phialides densely compacted into a layer covering the synnema, more scattered or lacking at the base, consisting of a cylindrical basal portion, tapering abruptly to a distinct neck, 7–10.5  $\times$  2.7–3.5  $\mu\text{m}$ , smooth-walled. Conidia in short chains, one-celled, hyaline, smooth-walled, cylindrical to narrowly fusiform, 4.5–6  $\times$  1.2–1.5  $\mu\text{m}$ .

Often associated with *Cordyceps tuberculata* (Lebert) Maire in Bull. Soc. d'Hist. Nat. de l'Afrique du Nord 7: 165. 1917, see also PETCH (1932a), KOBAYASI (1941) and MAINS (1958).

## Material examined:

Ras 0031, 0032, 0061, 0124, 0125 and 0127 on moths, collected at Mt. Atewa, Tafo, Kukuran-tumi, Begoro. Specimens 0124, 0125 and 0127 containing also *Cordyceps tuberculata*. *Isaria pistillariaeformis* Pat. (FH) type on moth, labelled „Tuente de Chimbo sent 1891, Lagerh.”

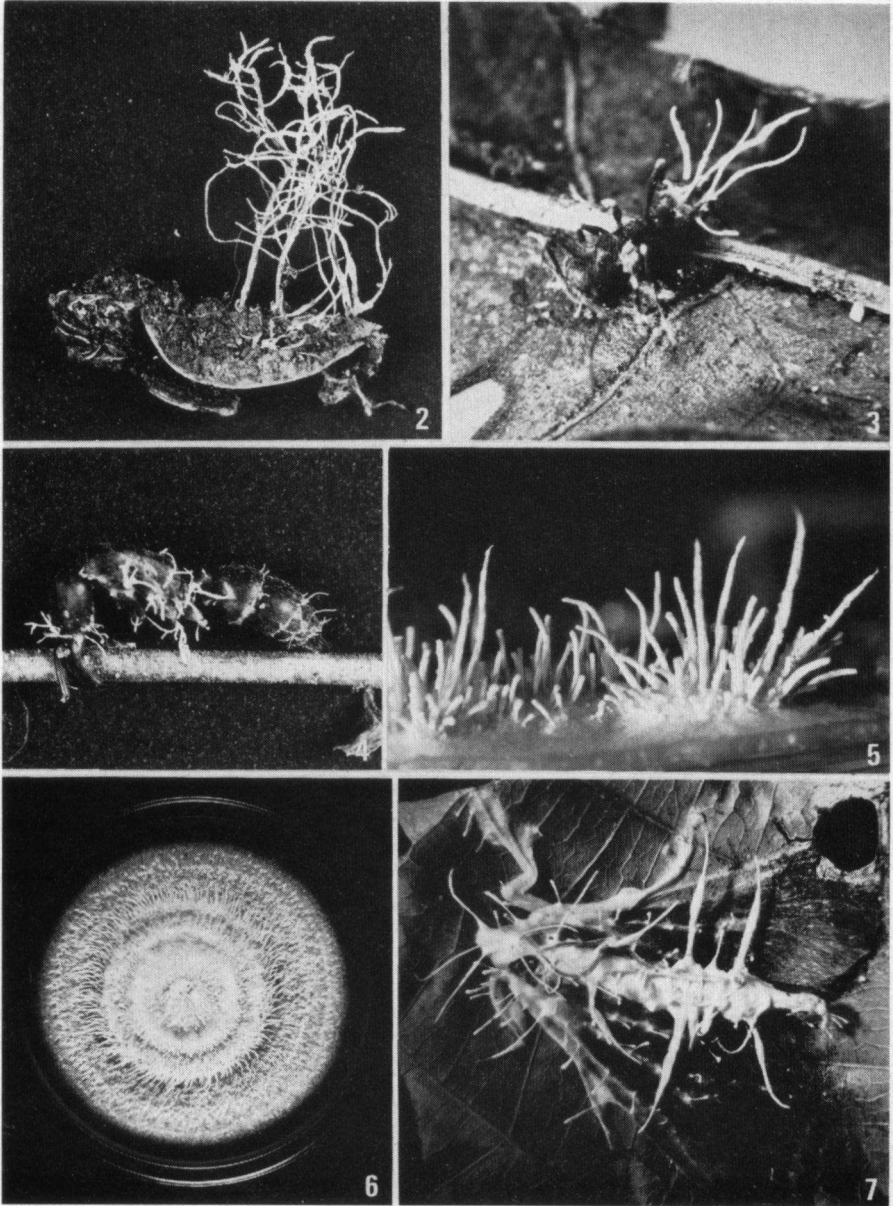


Fig. 2-6. *Akanthomyces gracilis*  
 2. on *Callibaphus longirostris* (c.  $\times$  2),  
 3. on *Macromischoides inermis* (c.  $\times$  8.5),  
 4. on *Palthothyreus tarsatus* (c.  $\times$  3),  
 5. synnemata growing on oatmeal agar,  
 6. mealworm agar culture showing zoned growth,  
 Fig. 7. *A. pistillariaeformis* on moth (c.  $\times$  5).

Examination of the Ghanian specimens and those identified by Petch (in herb. K) as *Cordyceps tuberculata* showed that there is a great variation in perithecial form. Perithecia are arranged loosely or in stromata, while intermediate forms occur. Petch apparently used the terms "*Cordyceps*" – and "*Torrubiella*" – form, probably to indicate the difference in stroma development. Similarly there is great variation in synnema size and shape. Long cylindrical pointed as well as short stipitate clavate synnemata were observed. The cylindrical synnemata often occur on large moths, whereas the short clavate synnemata are associated with small insect specimens. On some specimens both extremes of synnema form occur. These observations showed the variability in *Cordyceps tuberculata* and the associated *Isaria pistillariaeformis* Pat. Accommodation of this species in *Akanthomyces* seems better justified than in *Insecticola*.

*Akanthomyces arachnophilus* (Petch) Samson & Evans, comb. nov. – Fig. 8, a–b; Fig. 10.

*Trichosterigma arachnophilum* Petch in Trans. Br. mycol. Soc. 8: 215. 1923 (basionym). = *Hirsutella arachnophila* (Petch) Petch in Trans. Br. mycol. Soc. 9: 93. 1923 (and ibid. 10: 43. 1924).

Cream mycelial cushion completely covering very small spiders and spreading onto the leaf surface; margin fimbriate. Synnemata erect, simple or branched, cylindrical, 2.5–5 mm × 50–75 μm, creamish yellow to pale brown. Phialides in a single layer, scattered to crowded, consisting of a globose basal part, tapering abruptly to a distinct neck, 3.2–4.3 × 6.5–8.5 μm, smooth-walled. Conidia in short chains, one-celled, hyaline, smooth-walled, fusiform, 4.5–5.5 (–6) × 1.5–3 μm.

Associated with *Torrubiella flava* Petch (1923).

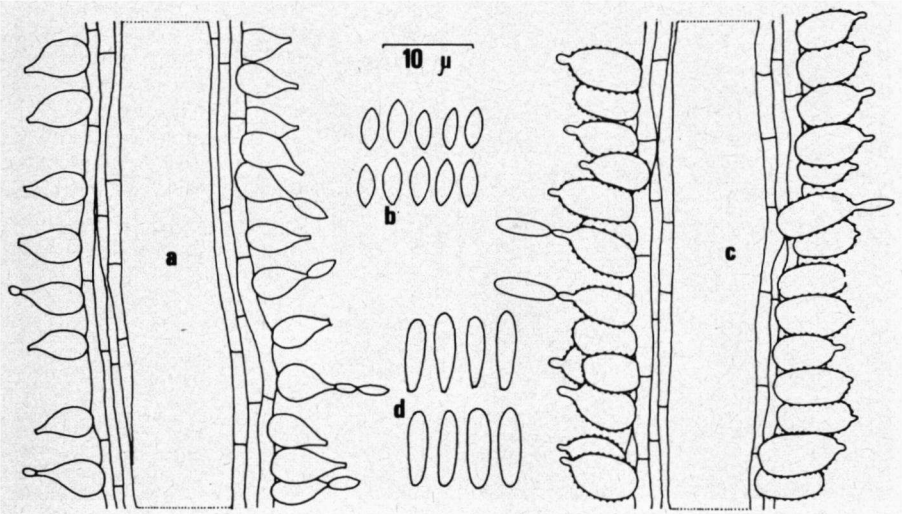


Fig. 8a, b. *Akanthomyces arachnophilus*; a. part of synnema, b. conidia, Fig. 8c, d. *A. araneorum*; c. part of synnema, d. conidia

**Material examined:**

*Hirsutella arachnophila* (Petch) Petch (K) type on spiders, Hakgala, Ceylon, March, 1922  
Additional specimens collected in Ceylon, Feb. and Sept. 1923.

*Akanthomyces arachnophilus* (Ras 0109 A en B) on spiders, Begoro Forest Reserve, Ghana, on underside of leaves of rubiaceous shrubs.

The arrangement of phialides in a hymenium and the production of conidia in dry chains readily justify the inclusion of this species in the genus *Akanthomyces*.

PETCH (1924 a and b) considered *Torrubiella flava* Petch to be the perfect state of *H. arachnophila*, although the two stages were never found together on the same stroma. Two specimens of *A. arachnophilus* collected in Ghana possess one to several yellow-brown ovoid perithecia attached laterally near the base of the synnema. The description fits that of *Torrubiella flava* and it would seem that Petch was justified in linking this with *A. arachnophilus*.

***Akanthomyces araneorum* (Petch) Mains – Fig. 8 c–d; Fig. 9.**

*Akanthomyces araneorum* (Petch) Mains in Mycologia 42: 574. 1950. = *Hymenostilbe araneorum* Petch in Trans. Br. mycol. Soc. 16: 221. 1932.

A distinctive species, characterized by its verrucose phialides and obclavate conidia in short chains. The brown synnemata and verrucose phialides may suggest that this species belongs to *Hymenostilbe*, but *A. araneorum* is separated from this genus on the basis of the catenulate conidia. Nevertheless the chains are very short and fragile and without sufficient material the species may easily be mis-identified as a *Hymenostilbe*.

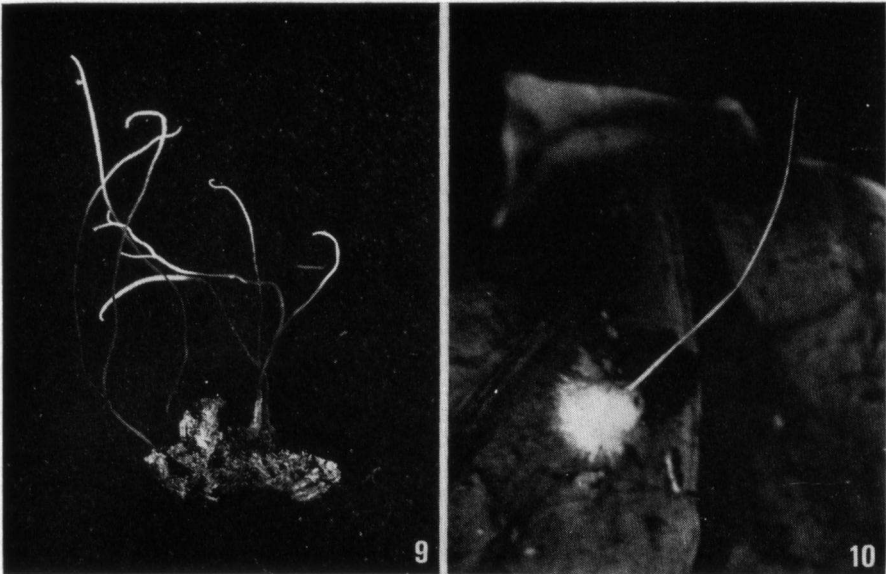


Fig. 9. *Akanthomyces araneorum* on spider (c.  $\times$  3.5),

Fig. 10. *A. arachnophilus* on spider (c.  $\times$  8.5).

**Material examined:**

Ras 0003 and 0133 on spiders collected in Begoro, Tafo, Mt. Atewa, Oyoko and Bunso. Dr. W. Gams collected *A. araneorum* on a spider in Houdringen (Bilthoven), Netherlands (WG 1522).

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**REFERENCES**

- KOBAYASI, Y. (1941): The genus *Cordyceps* and its allies. *Sci. Rep. Tokyo Bunrika Daig.*, Sect. B, **5**: 53–260.
- MAINS, E. B. (1950): Entomogenous species of *Akanthomyces*, *Hymenostilbe* and *Insecticola* in North America. *Mycologia* **42**: 566–589.
- (1958): Entomogenous *Cordyceps* from North America. *Mycologia* **50**: 168–222.
- PETCH, T. (1923): The genus *Cladosterigma* Pat. *Trans. Br. mycol. Soc.* **8**: 212–215.
- (1924a): The genus *Trichosterigma* Petch. *Trans. Br. mycol. Soc.* **9**: 93–94.
- (1924b): Studies in entomogenous fungi III. *Torrubiella*. *Trans. Br. mycol. Soc.* **10**: 108–128.
- (1932a): Notes on entomogenous fungi. *Trans. Br. mycol. Soc.* **16**: 209–245.
- (1932b): A list of the entomogenous fungi of Great Britain. *Trans. Br. mycol. Soc.* **17**: 170–178.