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## Nonconstricting-ring formation in two species of nematode-capturing hyphomycetes

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**Abstract** *Dactylella leptospora* and *Dactylaria candida*, and *Arthrobotrys dactyloides* (Hyphomycetes), capture nematodes by nonconstricting- and constricting-ring traps, respectively. In the formation of the constricting-ring trap of the latter fungus, the basal portion of a curved hyphal branch put forth a bud to fuse with its advancing tip to make a ring. However, in nonconstricting-ring formation in the former two fungi, the portion behind the tip of the curved branch did not develop such a bud before fusion with the tip.

**Key words** *Arthrobotrys dactyloides* · *Dactylaria candida* · *Dactylella leptospora* · Nonconstricting-ring trap

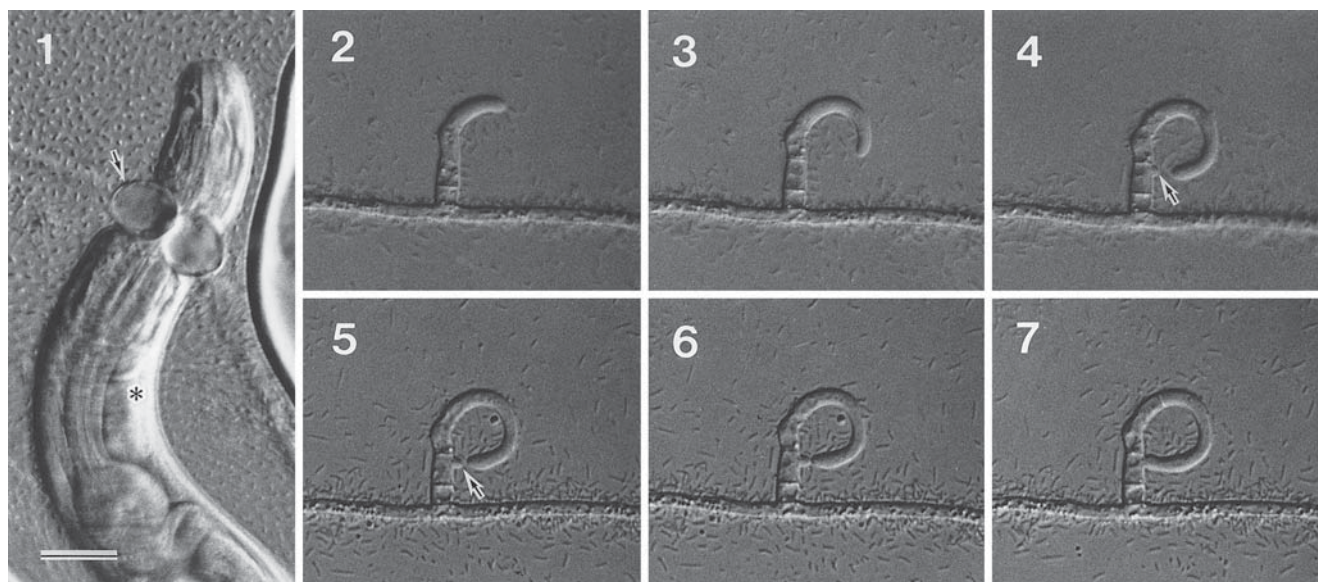
Hyphomycetes that capture nematodes have well been known to produce various hyphal traps, such as nonconstricting rings, constricting rings, adhesive knobs, adhesive branches, and adhesive networks (Drechsler 1937; Barron 1977). In the formation of the adhesive network in *Dactylaria* (*Dactylar.*) *eudermata* Drechsler and the constricting-ring trap in *Dactylella* (*Dactylel.*) *aphrobrocha* Drechsler, Drechsler (1950) depicted that the portion of hypha to be fused with the advancing tip of curved hypha developed a bud right before fusion to make a loop or a ring. Higgins and Pramer (1967) also showed bud formation in *Arthrobotrys dactyloides* Drechsler using the technique of time-lapse photomicrography. In the present study, the morphological changes in the formation of the nonconstricting ring were shown for the first time in *Dactylar. candida* Drechsler and *Dactylel. leptospora* Drechsler. The ring in the latter fungus has already been shown in electron micrographs to capture nematodes with adhesive secreted from the curved ring cell (Saikawa 1985).

*Dactylaria candida*, *Dactylel. leptospora*, and *A. dactyloides* were isolated from orchard soil collected in the campus of Tokyo Gakugei University (TGU) in April 1998, June 1998, and June 1999, respectively. These fungal strains were grown at room temperature (18°–22°C) on a water agar plate in which a small piece of agar (~10 × 10 mm) from an old culture was inoculated on the fresh water agar plate at intervals of ~2 weeks. At each time of fungus inoculation, nematodes (*Rhabditis* sp.) that were multiplied at room temperature on SA agar (= 'Saikawa & Aoki's agar': KNO<sub>3</sub>, 0.2 g; MgSO<sub>4</sub>·7H<sub>2</sub>O, 0.02 g; KH<sub>2</sub>PO<sub>4</sub>, 0.1 g; K<sub>2</sub>HPO<sub>4</sub>, 0.3 g; NaHCO<sub>3</sub>, 0.02 g; Na<sub>2</sub>SiO<sub>3</sub>, 0.02 g; agar, 20 g; distilled water, 1 l. The unadjusted pH was 7.8) were added to the plate (Saikawa and Kadowaki 2002). For time-lapse photomicrography, a portion ~7 × 7 mm containing the fungal mycelium and nematodes was removed from the agar plate and placed on a glass slide. The agar piece was then covered with a coverslip (18 × 18 mm) and observed using a microscope (Zeiss Axioscop) equipped with interference contrast.

In the TGU strain of *A. dactyloides*, the three curved cells that composed a ring trap inflated suddenly when a nematode entered the lumen of the ring (Fig. 1). At initiation of formation of a ring, a hyphal branch extended that resembled a hook in appearance (Figs. 2, 3), and a basal portion of the branch developed a bud (Figs. 4, 5) right before fusion with the advancing tip of the hook (Figs. 6, 7). The dimension of the bud was almost similar in morphology to that in the same species observed by Higgins and Pramer (1967) and in *Dactylel. aphrobrocha* (Drechsler 1950). After closure, the resulting ring was always supported by a two-celled short stalk, 7–14 μm long and 4.0–5.0 μm wide (Fig. 7).

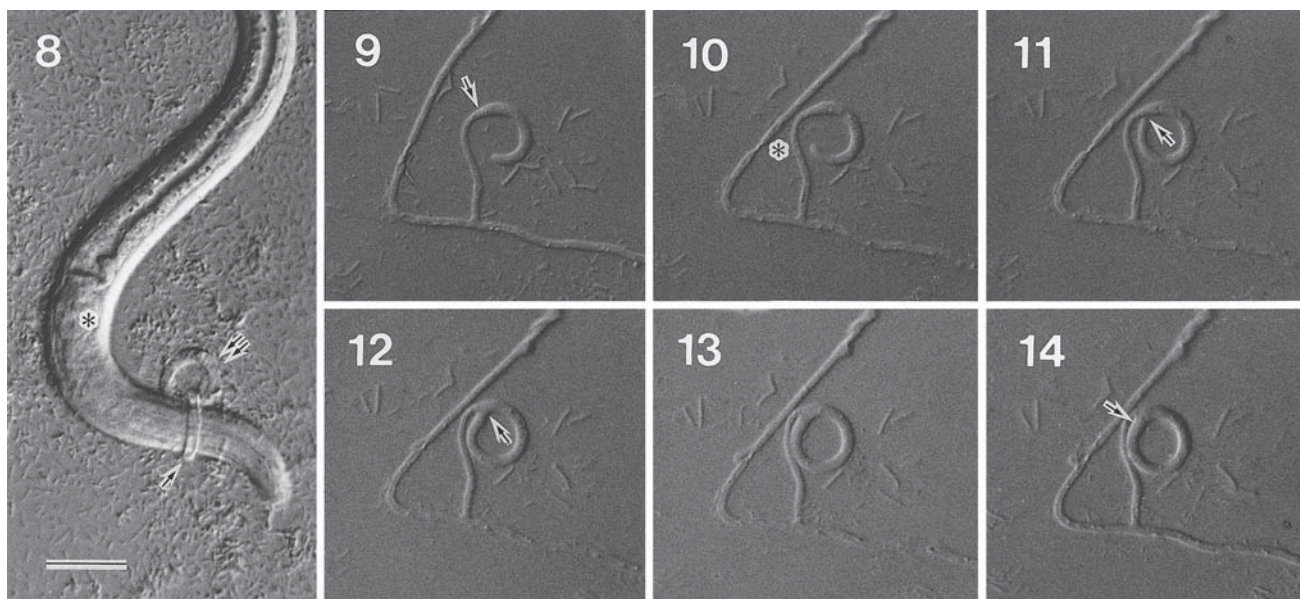
On the other hand, none of the three curved cells of a nonconstricting ring inflated at all when a nematode entered the ring lumen of either *Dactylel. leptospora* (Fig. 8) or *Dactylar. candida*. Saikawa (1985) ascertained by electron micrographs that the ring cells of the former fungus exuded adhesive similar to that of cells of the adhesive network in *Arthrobotrys oligospora* Fres. (Nordbring-Hertz and Stålhammar-Carlemalm 1978). In ring formation in *Dactylel. leptospora* and *Dactylar. candida*, the narrow hy-

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**Figs. 1–7.** *Arthrobotrys dactyloides*. **1** Closure of constricting ring by sudden inflation (*arrow*) of three cells making up the ring, in which only two cells are visible in this figure. The nematode (*asterisk*) had just been captured. **2–7** Formation of a constricting ring. **2, 3** Hyphal branch

resembling a hook. **4, 5** Basal portion of the branch developing a bud (*arrows*) right before completion of ring formation. **6, 7** Fusion of bud with tip of advancing curved branch to make a ring. *Bar 1* 50 $\mu$ m for **1–7**



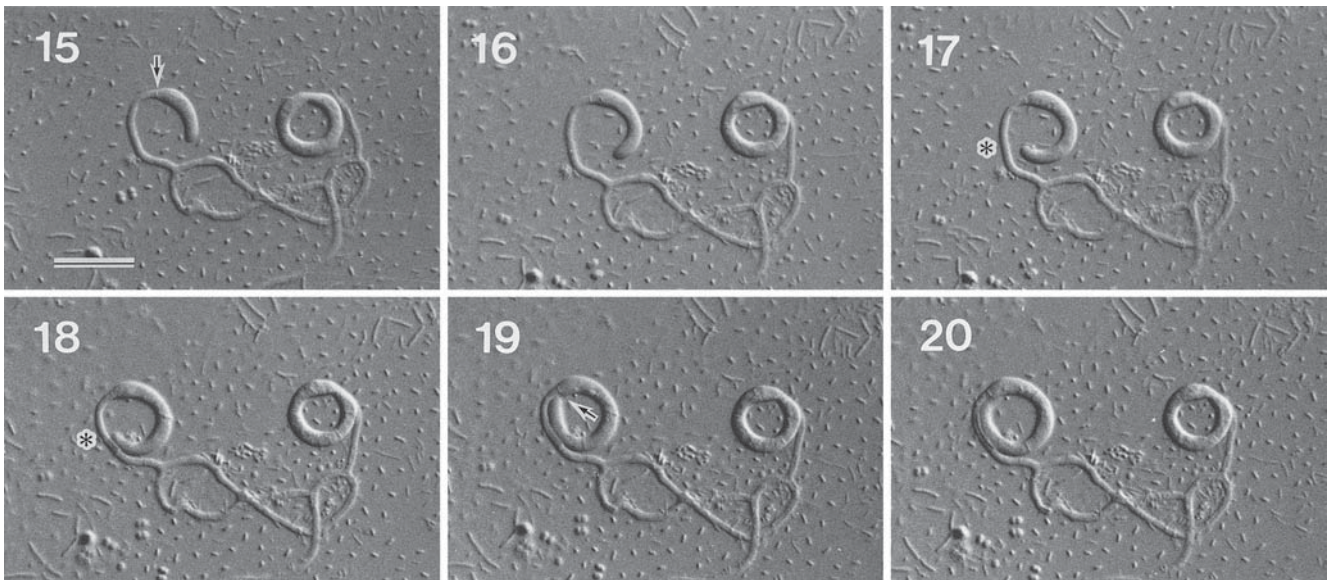
**Figs. 8–14.** *Dactylella leptospora*. **8** A nonconstricting ring (*arrow*) is capturing a nematode (*asterisk*) before capture. **9–14** Formation of a nonconstricting ring. **9** Narrow hyphal branch developing a thick hypha resembles a hook. *Arrow* shows portion of the septum, although it is obscure in this figure. **10** Tip of elongating hyphal branch is close to portion (*asterisk*) of the branch

behind the tip. This portion, however, does not develop a bud in opposition to the advancing hypha. **11, 12** Tip right before fusion with portion at septum (*arrow*) without development of a bud. **13, 14** Completion of a ring. *Arrow* in **14** shows a septum between two ring cells. *Bar 8* 50 $\mu$ m for **8–14**

phal branch, 1.2–2.0 $\mu$ m and 1.2–1.8 $\mu$ m wide in each species, developed a thick hypha (1.7–4.0 $\mu$ m and 2.0–4.0 $\mu$ m wide, respectively) that resembled a hook (Figs. 9, 15, 16). Unlike in *A. dactyloides*, however, from no portion of the branch did a bud arise in opposition to the advancing tip of the

curved hyphal branch, although the tip came very close to the branch (Figs. 10–12, 17–19). The tip eventually fused to make a ring at the septum between the narrow branch and the basal portion of the hook (Figs. 13, 14, 20). The stalk of the nonconstricting ring in both *Dactylella leptospora* and





**Figs. 15–20.** Formation of a nonconstricting ring in *Dactylaria candida*. **15, 16** Extending branch resembles a hook. *Arrow* in **15** shows septum. **17, 18** Tip of the extending hypha is close to its basal portion (*asterisk*) of the branch. Unlike constricting-ring formation, a bud does not arise from this portion of the branch in opposition to the advancing curved

hypha. **19** Tip right before fusion with portion at septum of branch (*arrow*) that does not develop a bud. **20** Completion of a ring. At the right-hand side in each figure, a ring that has already been completed is seen. *Bar 15* 50  $\mu\text{m}$  for **15–20**

*Dactylar. candida* was quite varied in length, 4–45  $\mu\text{m}$  and 10–35  $\mu\text{m}$  long in each species.

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