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A non-biting midge (Diptera: Chironomidae) of horticultural significance

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Abstract

Sporadic previous reports of chironomid larvae feeding on roots of horticultural plants are reviewed and related to the growing recognition that a particular parthenogenetic species can damage severely indoor horticultural crops, particularly lettuce and young tomatoes. The taxonomy of the pest, *Bryophaenocladius furcatus* (Kieffer), is assessed, new synonymy proposed and a neotype and lectotype designated. The species is redescribed from the larva, pupa and adult female.

Introduction

Larvae of the dipterous family Chironomidae live in a geographically and ecologically broad range of predominantly aquatic habitats (Pinder, 1986). However, a minority of Orthocladiinae have semi-terrestrial, and fewer still terrestrial, immature stages. Sporadic reports refer to larval chironomids causing sub-soil damage in commercial horticulture or to stored crops, although the scale of the problem, and which species have been involved, is unclear. Recently, larvae of chironomid midges have been implicated as glasshouse crop pests. Unfortunately, in every recent case, the pest midges have been destroyed, along with the crop, before detailed observations on their bionomics and true agricultural significance could be made. Therefore, this study seeks to expose the problem, elucidate the number of species and identity of the insects involved, and survey the limited information on their pest status.

Taxonomic background

Chironomidae were first reported as causing an agricultural nuisance when Patch (1917) observed mining in growing potatoes in Maine, USA, by larvae that she was unable to rear. Johannsen (1937), describing the immature stages of a chironomid found in potted plants in American greenhouses, suggested identity with those of Patch. Johannsen identified the species as *Spaniotoma (Orthocladius) furcata* (Kieffer), Group *Bryophaenocladius* Thienemann. *Dactylocladius furcatus* had been named by Kieffer (*in* Thienemann & Kieffer, 1916) for an unreared female midge with unusual forked antennal sensillae. Although the rest of Kieffer's description is inadequate for recognition, Edwards (1929) believed he could recognize *furcatus* and used the name for female midges reared from several species of cultivated plants. Although Johannsen and Edwards observed no males and Johannsen saw females oviposit, neither author suggested in print that the species was parthenogenetic. Subsequently, Thienemann (*in* Thienemann & Strenzke, 1940) described the larva and female of a parthenogenetic species, *B. virgo*, living in

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terrestrial moss, and compared it with *furcatus* and other female midges recognized as belonging also to *Bryophaenocladius*.

Abbreviations

Repositories are abreviated in the text as follows:

BMNH Entomology Department, British Museum (Natural History), London;
CUC Cornell University Collections, Ithaca, New York State, USA (Dr J. Leibherr);
ZSM Zoologische Staatssammlung, Munich, German Federal Republic (Dr F. Reiss).
MAFF Ministry of Agriculture, Fisheries and Food, UK.

Systematics

As with many species described by Kieffer, no original material remains (type or otherwise) of *D. furcatus*. Interpretation of the species rests with Edwards (1929), who examined reared material but retained and described only adult females. These dry, pinned females have been slide-mounted, compared with and found to be conspecific with '*furcatus*' from the USA and with *B. virgo* types in the ZSM. Thus, there appears to be but a single parthenogenetic plant-damaging species of *Bryophaenocladius*. Thienemann & Strenzke's (1940) cited differences between *furcatus* and *virgo* appear groundless or insubstantial and do not allow separation of the specimens examined.

Bryophaenocladius furcatus (Kieffer)

Dactylocladius furcatus Kieffer in Thienemann & Kieffer, 1916: 535. **Neotype** (here designated): Lectotype of *Bryophaenocladius virgo* Thienemann, GERMAN FEDERAL REPUBLIC: Walkoppel [Examined].

Spaniotoma (Orthocladius) furcata (Kieffer); Edwards, 1929: 341.

Bryophaenocladius virgo Thienemann in Thienemann & Strenzke, 1940: 24. **Lectotype** (here designated): GERMAN FEDERAL REPUBLIC: Walkoppel [Examined]. **Syn. n.**

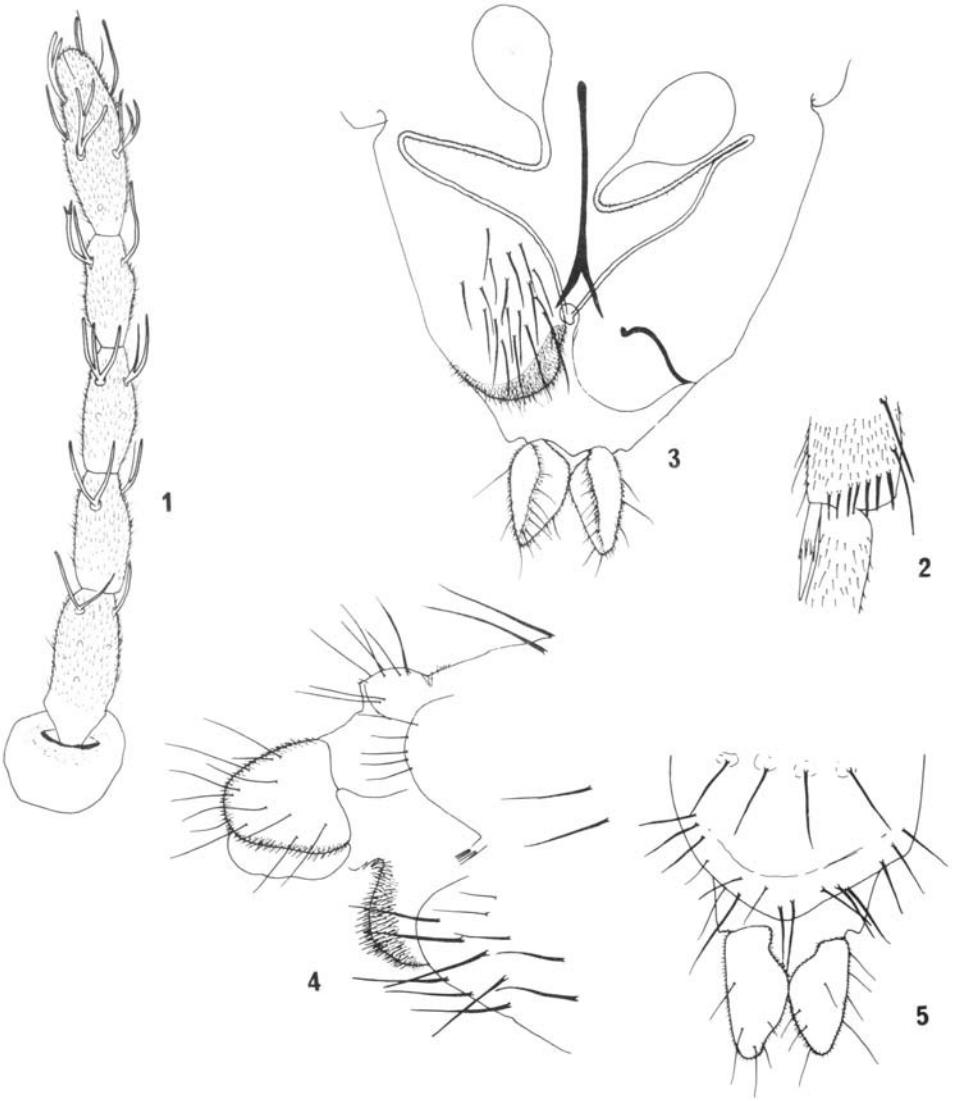
B. furcatus conforms to the generic diagnosis for *Bryophaenocladius* larvae (Cranston *et al.*, 1983), pupae (except for the presence of setae on the prefrons; Coffman *et al.*, 1986) and adult female (Saether, 1977; Pinder & Armitage, 1986).

Female (n = 10) (Figs. 1–5). Body length 2·4–3·9 mm, wing length 1·6–2·1 mm. Medium to dark brown, vittae not significantly darker. Head: antenna (Fig. 1) with five flagellomeres of lengths 86–100; 59–72; 63–76; 53–76; 95–112 μm; each flagellomere 1–4 bearing subapically a pair of long, partially or completely bifid or trifid sensilla trichodea; flagellomere 5 with four pairs of simple or partially or completely bifid *ca.* 50-μm-long sensilla trichodea. Antennal ratio 0·33–0·40 (exceptionally 0·30 in an asymmetrical specimen with antennal ratio of 0·39 on opposite antenna). Temporal setae consist of 5–7 uniserial outer verticals running into postorbitals. Clypeus with 5–7 setae. Eye bare. Palp with segment lengths (2–5) 33–49; 76–102; 56–83; 100–122 μm; third segment without finger-like extension, bearing subapically a group of 5–6 *ca.* 20-μm-long sensillae, not lying in discrete pit.

Thorax with moderately developed antepronotum bearing 3–6 lateral setae; 8–13 long decumbent acrostichals, 9–13 uniserial dorsocentrals arising from pale areas, 3–5 prealars and 4–10 uniserial scutellars.

Wing moderately to strongly punctate (microtrichia visible at 40× magnification); costa extended about 100 μm beyond apex of R_{4+5}. *Cu* weakly curved apically. Vein *R* with 9–13 setae, R_1 with 5–8, R_{4+5} with 6–11, excluding 2–3 on costal extension. Squama with 3–9 setae. Venarum ratio 1·12–1·22.

Legs with fine pseudospurs subapically on tarsomeres 1 and 2 on mid- and hind legs, lacking sensilla chaetica and pulvilli. Foreleg spur 45–55, midleg spurs 55–60 and 0–15, hind leg spurs 60–75 and 25–35 μm long; tarsal comb (Fig. 2) with only 4–6 spines. Beard ratio less than 1 on all legs. Lengths and proportions of legs are given in Table I.



Figs 1–5.—*Bryophaenocladius furcatus* (Kieffer), adult female; 1, antenna; 2, apex of hind tibia with spur and comb; 3–5, genitalia; 3, ventral; 4, lateral; 5, dorsal.

TABLE I. *Leg lengths and ratios*

	Femur	Tibia	Leg ratio
Foreleg	615–715	680–830	0·60–0·67
Mid-leg	630–805	700–910	0·39–0·45
Hind leg	665–855	830–1055	0·50–0·56

	Tarsomeres				
	1	2	3	4	5
Foreleg	455–540	275–310	175–225	110–135	85–115
Mid-leg	315–370	165–205	100–150	90–110	85–110
Hind leg	455–560	250–300	200–230	100–135	90–110

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Genitalia (Figs. 3–5). Tergite IX (Fig. 5) undivided, broad but with narrower caudal band of heavier sclerotization bearing the 12–16 setae. Gonocoxite IX weak with few setae (Fig. 4). Ventrolateral lobe of gonapophysis VIII large, rounded, with lobes virtually contiguous medially, covering scarcely defined dorsomesal and apodeme lobes (Fig. 3). *Spermatheca 90–122 μm long by 75–85 μm wide, somewhat pear-shaped, with distinct* neck; duct with single convolution, ending separately without bulb.

Pupa (n = 8) (Figs. 12 & 13). Total length 3·1–3·8 mm, unpigmented.

Cephalothorax. Two pairs of short, stout frontal setae about 20 μm long, on ventral prefrons (perhaps more ventral pair are medially located postorbitals). Ocular and postorbital setae absent. Cephalic area smooth; antennal bases without pearl row.

Thorax (Fig. 12) with antepronotal sheath dorsally nodose with some posteriorly directed spinules not extending laterad of ventral-most antepronotal setae; remainder of thorax and wing sheaths smooth. Usually two, sometimes three, stout antepronotal setae; dorsal seta longest (50–65 μm) the others shorter (28–35 μm). Three precorneal setae (uniquely, an asymmetric specimen has 2) either subequal at 35–38 μm, or pc 2 slightly longer than pc1 or 3. Three spine-like, subequal lengthed 35–45 μm long dorsocentrals, dc1 separated from proximate dc2 and 3.

Abdomen with tergites, most pleura and posterior three sternites covered with spinules, except for muscle marks, with sternal spinules finer than tergal, except on segment IX. Conjunctives bare. All setae short, with 2 L setae, 2 D setae and at least 1 V seta, 0 setae absent.

Tergite IX (Fig. 13) not developed as an anal lobe, densely spinose, apically rounded, bearing two setae on dorsal surface but lacking macrosetae.

Fourth-(final)-instar larva (n = 7) (Figs. 6–11).—Body (Fig. 6) length 4·8–5·4 mm, yellow-green with dark brown head capsule. Head capsule setae S1–10 stout and short. Frontoclypeal apotome (Fig. 11) anteriorly narrowed posterior to S3 setae, protruding to a point within labral sternite.

Antenna (Fig. 9) five-segmented, half mandible length, segment lengths 41–45; 25–31; 4–5; 4–5; 2 μm. Antennal ratio 1·0–1·2. Antennal blade 37–49 μm, slightly overreaching tip of antenna. Lauterborn organs absent.

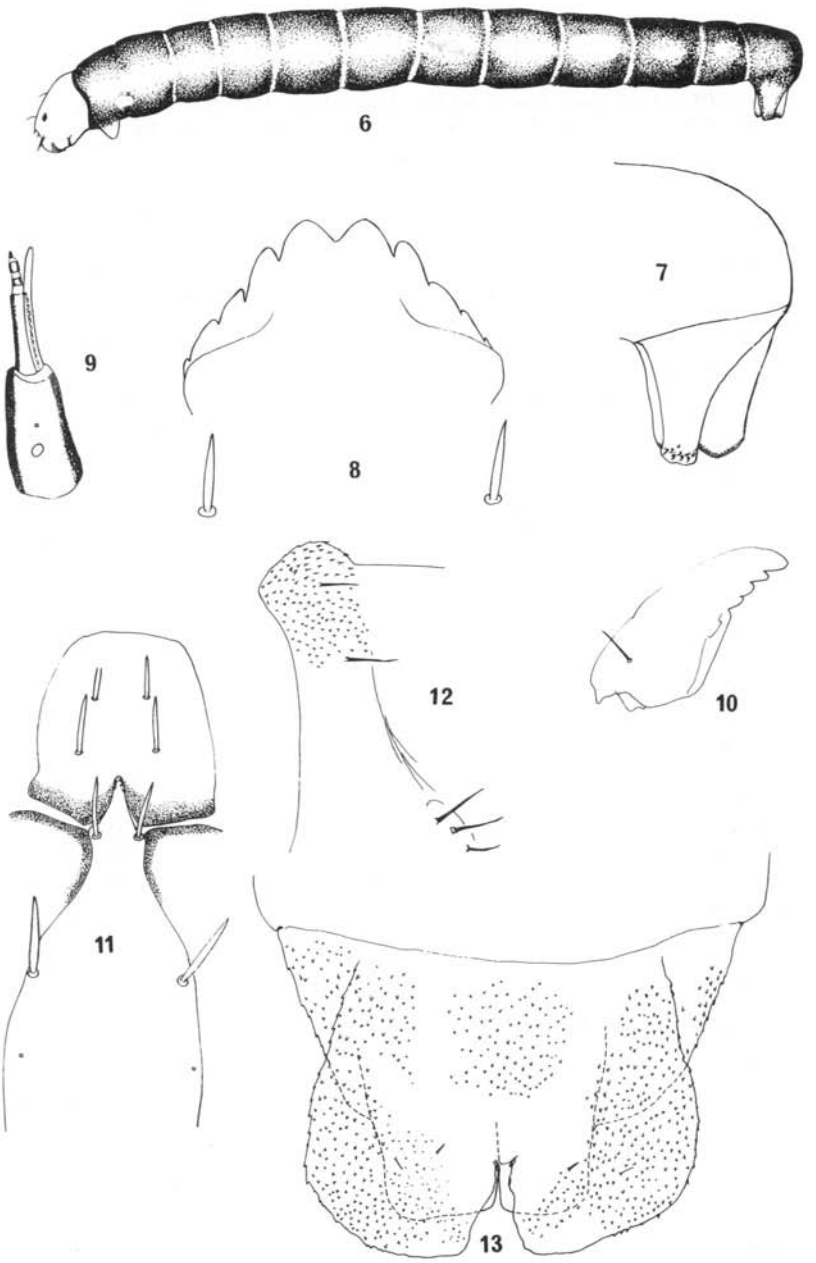
Labrum with SI, SII and SIII simple, broadly lanceolate, SIV small, peg-like. Pecten epipharyngis of three scales; ungula small. Premandible 76–93 μm long, with dark apical tooth and two broad inner teeth contrasting with yellow ground colour; without brush.

Mandible (Fig. 10) 158–175 μm long with apical tooth shorter than combined lengths of inner three teeth. Mola rounded, not as deeply pigmented as teeth. Seta interna and seta subdentalis absent.

Mentum (Fig. 8) 100–135 μm long, with paired rounded median teeth and five pairs of laterals, the outermost very reduced, sometimes perhaps absent. Ventromental plates large, somewhat rounded at 'shoulder', slightly projecting beyond outer mental tooth on flattened mentum.

Abdomen (Fig. 7). Anterior parapods present, probably fused at least basally, carrying numerous very small fine spinules about 2 μm long and without true claws. Posterior parapods separate, bearing 10–14 claws of length 5–7 μm. Procercus absent, with no posterior setae. Anal tubules small, directed ventrally between posterior parapods. No distinct body setae.

Type material examined. *D. furcatus* was described from a female from southern Sweden; no type material has been found, and precedents suggest that Kieffer did not retain the specimen. Specimens here recognized as types of *B. virgo* from northern Germany exist in the ZSM. However, the name *furcatus* has been more widely used in the entomological literature than has *virgo*, particularly in relation to plant damage. Therefore, to maintain nomenclatural stability, the newly designated lectotype of *B. virgo* is designated as neotype of *furcatus*, rendering *virgo* an objective synonym of *furcatus*. Neotype and lectotype details: [GERMAN FEDERAL REPUBLIC: Plön] Waldkoppel. No further data. 1 Canada Balsam slide bearing 3 females beneath a single coverslip, with the



Figs 6–11.—*Bryophaenocladius furcatus* (Kieffer), larva; 6, whole body, lateral view; 7, posterior abdominal segments; 8, mentum; 9, antenna; 10, mandible; 11, frontoclypeal apotome. Figs 12–13.—*B. furcatus* (Kieffer), pupa; 12, anterior thorax, lateral view; 13, tergite IX, dorsal view.

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lectotype (the central of the three) ringed in ink on the coverslip. The slide bears two labels: one white with blue submargin bearing "Bryophaenocladius A virgo Waldkoppel" with "muscicola?" deleted, all in Thienemann's handwriting. A red Zoologische Staatssammlung label has been added indicating the lectotype and paralectotype designation of *virgo* and the neotype designation as *furcatus* by the present author. Deposited in ZSM.

Other material examined (all slide-mounted in Euparal or Canada Balsam). A slide, presumed German Federal Republic but without locality data, labelled: "Bodenchironomiden No 10 Bryophaenocladius virgo" ("muscicola" scored out) contains 2 larvae under one coverslip, 1 pupa, 1 female and one female abdomen under another coverslip. Another slide is labelled "Strenzke 255 Bryophaenocladius A virgo Th" and contains 3 larvae under a single coverslip. Both slides in ZSM. UK: 2 ♀, Hereford, Evesham, 17.ii.1986, "damaging lettuce" (via MAFF); 2 ♀, Hertfordshire, Harpenden, 1931, "breeding in pot of soil" (*Barnes*); 7 larvae, 1 pupa, Lancashire, 29.iv.1984, "damaging young lettuce" (*D. I. Green* via MAFF, PC 86-009); 5 ♀, Surrey, Wisley, iv.1922, "larvae attacking *Primula* roots" (*G. Fox-Wilson*); 1 larva, 9 pupae, 1 ♀, no locality or date, via MAFF PC 86-028, "damaging rhododendron roots"; 1 larva, Yorkshire, Leeds, no further data, P-83-87, CIE A15038; all slides in BMNH. USA: Maine, 1 larva, injuring tomato seedlings in greenhouse, O.A.J. Lot 2487 (det. O. A. Johannsen); 1 larva, New York State, Binghampton, v.1928, "from soil in greenhouse", O.A.J. Lot 2028; 3 larvae, New York State, Selden, "boring tomato stems", 9.iv.1956 (*M. Semel*); slides in CUC.

Agricultural significance

The species recognized here as *B. furcatus* was first reported as larvae mining in growing potatoes in Maine, USA (Patch, 1917). When Johannsen (1937) reported on a chironomid found in potted plants in American greenhouses, he suggested they were identical to those of Patch, and although Patch's material has not been found, it is likely that Johannsen's view was correct.

As early as 1913, larvae were observed to cause damage to the roots of greenhouse plants in Sussex, England, and subsequent rearings confirmed that the species was quite widespread in horticultural situations (Edwards, 1929). Damage was mainly restricted to roots, although Edwards noted a larva mining in the stem of a seedling tomato. A previously unpublished handwritten note by Edwards in 1930 refers to considerable damage to young prothalli of *Adiantum* sp. at Kew Gardens, England. Johannsen's notebooks refer to larvae found in soil in pots in a greenhouse and to larvae injuring seedling tomatoes.

Occurrences in the past five years suggest that above-soil damage to horticultural crops is increasing in Britain. Most reports concern serious damage to glasshouse lettuce crops, often, but not exclusively, in the seedling stage. However, two cases concerned damage to the full grown lettuce, where initial damage to outer leaves trailing on the soil surface extended to the developing lettuce hearts. The level of damage in all cases has been sufficient to warrant destruction through ploughing-in of the crop. Tomato plants continue to be damaged by larvae of *B. furcatus*, although the level of destruction does not seem to match that to lettuce.

The species is clearly parthenogenetic; Johannsen, Edwards, MAFF entomologists and I have observed deposition of fertile eggs by unmated females. Development of the larvae beyond the early instars has not been attained in culture, but this appears to be due to poor rearing conditions rather than non-viability. Thienemann & Strenzke (1940) described the metamorphosis (under *B. virgo*). No males have emerged from reared larvae of *B. furcatus*, giving a strong indication that this is an obligate parthenogenetic species. Parthenogenesis occurs quite widely in the Chironomidae, particularly amongst pest species. Parthenogenesis may facilitate development of pest status by exclusion of the need for the male mating swarm, with associated possibilities of mating failure due to

inappropriate conditions for swarm formation in restricting environments such as glasshouses and polyethylene horticultural tunnels.

The decision presented in this paper that *B. furcatus* is the parthenogenetic species involved in damaging attacks inside glasshouses should not be taken to indicate that this is the only species of *Bryophaenocladius* involved in plant damage. *B. vernalis* (Goetghebuer) has been reared from larvae damaging rare mosses growing in chalk quarries in southern England. Other species in this predominantly terrestrial genus may yet be found to be phytophagous.

In addition to *Bryophaenocladius*, other larval Chironomidae have been suspected of damaging field crops, including winter wheat and maize. However, with the exception of documented disturbance and damage to aquatic rice seedlings, it is unclear if these larvae, including those of *Smittia* (especially *S. pratorum* (Goetghebuer) and *Limnophyes* species), actually cause damage or are secondary invaders following attack by invertebrate and fungal plant pathogens. More careful observations on damaged crops are necessary before the significance of other chironomid species can be determined.

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