Trichogramma nubilale New Species (Hymenoptera: Trichogrammatidae), an Egg Parasite of *Ostrinia nubilalis* (Hübner)[1,2]

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ABSTRACT

Trichogramma nubilale, n. sp., is described from laboratory-reared, 5th-generation specimens of a colony originating from material collected at the University of Delaware Substation near Georgetown (Del. Rt. 28), Sussex Co., Del., 19 September 1972 (coll. C. P. Davis), ex eggs of the European corn borer, *Ostrinia nubilalis* (Hübner), laid on sweet corn. Biological characteristics and field observations are noted.

Although the European corn borer, *Ostrinia nubilalis* (Hübner), is among the most destructive pests of corn in the United States, effective biological controls are lacking. Several authors (Baker et al. 1949, Caffrey and Worthley 1927, Jones et al. 1939, and Schread 1936) reported natural parasitism of European corn borer egg masses by *Trichogramma* in the United States. However, the percentage of parasitized egg masses varied considerably, from 0.5 to 70% during a year, and the parasitism of eggs in a single mass was small, from 0.5 to 20%. Attempts to increase parasitism by the release of laboratory-reared *Trichogramma minutum* Riley or *T. pretiosum* Riley (Baker et al. 1949, Marlatt 1931, and Schread 1936) were inconclusive or failed.

In 1971, intensive searches for *Trichogramma* parasitism of European corn borer eggs in Delaware revealed a new species of *Trichogramma* in eggs from dockweed (*Rumex* spp.), sweet pepper (*Capsicum annuum* L.), and both field and sweet corn (*Zea mays* L.) at the University of Delaware Substation near Georgetown. Parasitism by this new species on sweet corn ranged from ca. 5% in June to ca. 70% in September. In addition, and of more importance, 100% of the eggs were parasitized in ca. 90% of the field-collected (1971–72) egg masses parasitized by the new species.

The following description is based on the 5th-generation progeny from specimens collected in 1972. The laboratory colony was maintained on eggs of *O. nubilalis* with fluctuating light (15 L:9 D) and temperature (13 h at 28±1.25°C, 11 h at 20±1.25°C), 40–60% RH, and a constant supply of dilute honey (5–10%). Structural measurements and ranges are based on 50 randomly selected paratype specimens. "Runt" males and females were discarded because of their morphological abnormalities. The mounting and clearing techniques were similar to those described by Wirth and Marston (1968). The specific name of the new species is derived from the specific name of the host. The gender of the specific name as published in Davis and Burbutis (1974) is incorrect, but the species studied is identical.

Trichogramma nubilale, n. sp.

Male.—Body dark brown to blacklish-brown; abdominal sterna lighter brown. Head with 6 equal ocellar bristles, a series of 3–4 strong fronto-orbital hairs, and 1 post-ocular bristle with 2–3 orbital hairs. Eye hairs scattered, long, and finely tapered. Dorsal margin of oral cavity broad; dorsolateral corners rounded; lateral margins slightly convergent. Antennae (Fig. 5) brown; club darker; antennal hair strong, stout (not tapered), and sharp; length of antennal hair 2.04 (1.83–2.48) times greatest width of club; greatest length of club 4.76 (3.67–5.71) times width of club, length of club 1.32 (1.16–1.47) times length of basal antennal segments. Scutal and scutellar bristles equal; scutellar hairs short and fine; scutellar clear spot not in line with scutellar hair and bristle; scutellar bristle closer to margin than scutellar hair; scutellum with distinct median ridge with anterior half pronounced; anterior scutal bristle closer to margin than posterior scutal bristle; posterior scutal bristle centrally located between median line, lateral and posterior margins; sculptured cells on scutum distinctly elongated along median line. Hind tibia (Fig. 2) with 7–8 spurs (1 large ventral—4–5 small medial—2 small dorsal); equal to or slightly greater than length of genitalic capsule and aedeagus. Wing with 14 distinct hair rows (9 on dorsal surface and 5 on ventral surface); ventral surface with greater number of adventitious hairs than dorsal surface; length of tornus bristles 2.10 (1.90–2.32) times greatest length of costal fringe; length of longest marginal wing fringe 1.01 (0.95–1.13) times greatest length of tornus bristles; width of wing 6.31 (5.36–7.02) times greatest length of tornus bristles; length of wing 1.92 (1.84–2.08) times greatest width of wing. Abdomen with 2 dorsolateral hairs on 5th tergum; 3–4 strong medioventral hairs on 3rd–5th sterna; 2 dorsal hairs on 6th tergum; sparse but strong dorsoventral hair series on 6th and 7th abdominal segments; 4–6 ventrolateral teeth on 1st abdominal segment.

Male Genitalia.—(Fig. 1) Length of genitalia 2.22 (1.89–2.43) times its width. Length of aedeagus (a) 0.99 (0.90–1.07) times length of hind tibia. Length

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of penis valve 0.93 (0.75–1.11) times length of apodemes (apo). Gonoforceps (gf) converging. Chelate structures (cs) anterior to gonoforceps and in line with median ventral projection (mvp) and dorsal extension of gonobase (degb). Median ventral projection strong, sharp but not strongly tapered, broad basally, strong along median line and meeting smoothly with median ventral ridge (mvr); apex in line with dorsal extension of gonobase and chelate structures; with 2 small (sometimes inconspicuous) basolateral projections just anterior to junction with ventral ridge. Ventral ridge weakly developed posterior to junction with median ventral projection, rounded. Anterior margin of genitalic capsule broad 0.88 (0.79–0.91) times greatest width of capsule. Gonobase (gb) with deep lateral clefts; internal margin of gonobase triangular; width of internal margin of gonobase (imgb) 1.74 (1.42–2.28) times its length; posterior apex of internal margin distinctly posterior to exterior cleft. Dorsal extension of gonobase with strongly developed basolateral wings; posterior apex strong, broad, blunt, and in line with apex of median ventral projection and chelate structures; length of dorsal extension of gonobase 1.33 (1.20–1.52) times length of gonobase. Length of median ventral projection 0.80 (0.69–1.00) times length of toe of dorsal extension of gonobase [toe distance equals imaginary distance between base of median ventral projection and anterior interior margin of dorsal extension of gonobase].

Female.—Body color similar to male; front light brown. Head with 7–9 (usually 8) ocellar bristles, 1–2 post-ocular bristles with 4–5 orbital hairs, 2 genal bristles with 4–5 fronto-orbital hairs, and scattered occipital hairs. Braces of antennal club narrow, 0.50 to 0.75 times length of club. Dorsal margin of oral cavity similar to male but narrowed. Hind tibia similar to male, but very short. Scutum and scutellum (Fig. 4) similar to male, except anterior scutal bristle shorter than posterior bristle, anterior scutal bristle equal to scutellar bristle; scutellar ridge uneven and stronger anteriorly; posterior-lateral scutellar margin extended ventrally. Length of wing 1.92 (1.84–1.98) times width; length of tornus bristles 2.21 (1.95–2.34) times greatest length of costal fringe; length of longest marginal wing fringe 1.10 (0.92–1.29) times greatest length of tornus bristles; width of wing 6.31 (5.88–6.69) times greatest length of tornus bristles. Abdomen similar to male, except field specimens with 7–8 ventrolateral teeth laboratory specimens with 4–6 (rarely 8) ventrolateral teeth.

Female Genitalia.—(Fig. 3) Broad, width of ovipositor 0.60 (0.55–0.63) times its length. Length of hind tibia (Fig. 2) 0.77 (0.73–0.82) times length of ovipositor.

Variation.—The number of orbital hairs, the development of the scutellar median ridge, the number of small median spurs on the hind tibia, and the wing trichiation of both sexes varies in direct proportion to adult size. The median scutellar ridge is reduced to an anterior knob in the smallest specimens. In large specimens, 5 small median spurs occur on the hind tibia. The general position and direction of the hair rows on the wing is constant, but the overall number of hairs varies considerably. Ca. 10–20% of the females examined have 8 lateral ocular bristles on one or both sides of the median ocellus. Field-collected females normally have 7–8 ventrolateral teeth on the 1st abdominal segment; laboratory-reared females have 4–6 teeth.

Types.—The holotype male (USNM #72693) and allotype female of *T. nubilale* have been deposited in the U.S. National Museum, Washington, D. C. Mounted and preserved paratype males and females have been deposited in the U. S. National Museum (25♀, 25♂), the British Museum (Natural History) (15♀, 15♂), London, England, the Institute of Ecology (15♀, 15♂), Warsaw, Poland, and the Commonwealth Institute of Biological Control (25♀, 25♂), Indian Station, Bangalore, India. The type specimens are the 5th-generation descendants of specimens emerging from parasitized eggs of the European corn borer collected from sweet corn at the University of Delaware Substation near Georgetown (Del. Rt. 28), Sussex Co., Del., 19 September 1972, by C. P. Davis.

Additional Material Examined.—Sussex Co., Delaware: near Bridgeville, 24 May 71—70 mixed ♂ and ♀ ex *O. nubilalis* on dockweed, 19 Sept. 72—1 ♂ ex *O. nubilalis* on corn; near Georgetown (Substation), 10 June 71—5 ♂ and 44 ♀ ex *O. nubilalis* on corn, 11 June 71—4 ♂ and 20 ♀ ex *O. nubilalis* on corn, 14 June 71—4 ♂ and 17 ♀ ex *O. nubilalis* on corn, 31 Aug. 71—7 ♀ ex *O. nubilalis* on corn, 1 Sept. 71—1 ♂ and 3 ♀ ex *O. nubilalis* on corn, 13 Sept. 71—42 ♂ and 178 ♀ ex *O. nubilalis* on corn, 17 Sept. 71—7 ♂ and 54 ♀ ex *O. nubilalis* on pepper, 27 Sept. 71—many mixed ♂ and ♀ ex *O. nubilalis* on corn, 19 Sept. 72—2 ♂ and many ♀ ex *O. nubilalis* on corn. All specimens were collected by C. P. Davis and/or P. P. Burbutis.

Host and Associated Plant Species.—All collections of *T. nubilale* were from eggs (1300+ masses) of the European corn borer collected from corn, sweet pepper, and dockweed. Eggs of lady beetles, Coccinellidae (30+ masses), the saltmarsh caterpillar, *Estigmene acrea* (Drury) (50+ masses), the hornworm, *Manduca* spp. (200+), and Hemiptera (20+ masses) collected at the same times and locations and from the same host plants were not parasitized by *T. nubilale.* (A few saltmarsh caterpillar and hornworm eggs were parasitized by *T. pretiosum* Riley and *T. perkinsi* [Girault].)

Although some parasitism was obtained in the laboratory, attempts to rear *T. nubilale* on *Sitotroga cerealella* (Olivier), *Galleria mellonella* (L.), *Heliothis zea* (Boddie), and *Trichoplusia ni* (Hübner), which are readily accepted by most species of *Trichogramma,* failed. However, eggs of the southwestern corn borer, *Diatraea grandiosella* (Dyar), which are laid in masses similar in size and shape to those of the European corn borer, were parasitized by *T. nubilale* through 3 laboratory generations.

Habitat and Parasite Associations.—Since the initial collection in 1971, *T. nubilale* has been encoun-

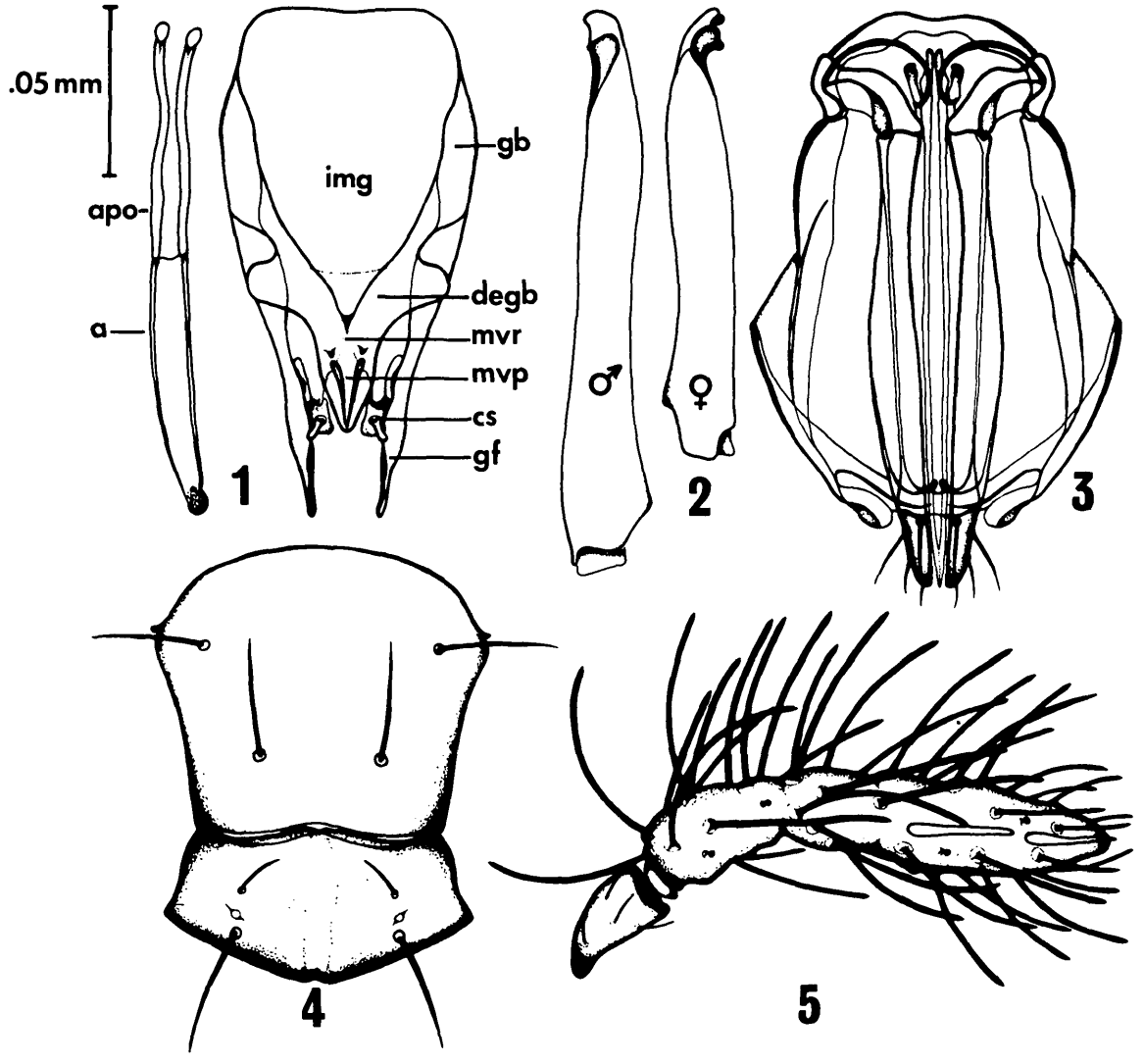

FIG. 1–5.—*Trichogramma nubilale*. 1, aedeagus and genitalia; 2, hind tibia; 3, ovipositor and supporting structures; 4, female scutum and scutellum; 5, apical segments male antenna (× 1.5). (a, aedeagus; apo, apodemes of penis valve; gb, gonobase; degb, dorsal extension gonobase; mvp, median ventral projection; img, internal margin gonobase; cs, chelate structure; gf, gonoforceps; mvr, median ventral ridge.)

tered at only 2 locations in Sussex Co., Del.; none has been found in other areas of the state. However, these collections from near Bridgeville and near Georgetown (Substation) in the spring, late summer, and early fall amounted to several hundred specimens from ca. 80 European corn borer egg masses.

Observations indicate that *T. nubilale* is a campestral species that parasitized eggs of European corn borers laid in commercial plantings of corn and sweet peppers and on dock in "weedy" areas surrounding these fields. Egg masses laid from just above ground level to as high as 5 ft above ground were parasitized by *T. nubilale*. *Trichogramma nubilale* was reared from field-collected and parasitized corn borer egg masses that also produced *T. minutum* R. and one other species, probably *T. perkinsi* (G.).

Bionomics.—In the laboratory, *T. nubilale* requires ca. 9–10 days to complete its development; the adults live ca. 9 days. An individual female is capable of laying ca. 60–75 eggs (determined by dissection). Each host egg (*O. nubilalis*) yields ca. 1.2 adult parasites in a 6 ♀ to 1 ♂ sex ratio.

Discussion.—*Trichogramma nubilale* is easily distinguished from all other known nearctic species by its black coloration (intensity is not affected by changes in temperature), the broad female genital capsule, and the morphological characters of the male genitalia. *Trichogramma evanescens* Westwood, recently established in the United States, is distinguished by its very long and finely tapered antennal hair, shorter median ventral projection, and the length of the female hind tibia to ovipositor ratio (1:1). In

Nagaraja and Nagarkatti (1973), *T. nubilale* keys to couplet 9a, *T. fasciatum* (Perkins).

The host specificity, efficiency of parasitism, and sex ratio of *T. nubilale* make it attractive as a potential biological control agent for control of the European corn borer.

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