

**LIFE HISTORY AND DESCRIPTION OF IMMATURE STAGES OF  
*TRUPANEA PSEUDOVICINA* HERING (DIPTERA: TEPHTRITIDAE) ON  
*POROPHYLLUM GRACILE* BENTHAM IN SOUTHERN CALIFORNIA**

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*Abstract.*—*Trupanea pseudovicina* Hering is a monophagous, univoltine fruit fly (Diptera: Tephritidae) infesting flower heads of *Porophyllum gracile* Benth (Asteraceae) in southern California, but may be oligophagous on still-unknown hosts in other southwestern United States. The egg, first-third instar larvae, and puparia are described and figured for the first time. The immature stages of *T. pseudovicina* are similar to those of five other California congeners described to date, with only the lateral spiracular complex of the third instars differing among these six species. The life cycle is of the aggregative type in southern California. The adults are long lived and comprise the over-summering and over-wintering stage that returns in spring to oviposit in the preblossom flower heads of *P. gracile*. An average of 2.5 (range: 1–7) eggs were oviposited, mostly singly or side-by-side in pairs, but also in packets of up to five, by one or more females in preblossom flower heads. First and early-second instars feed mostly on florets and ovules in preblossom heads. Late-second and third instars feed on soft achenes, not pitting the receptacles. Pupariation occurs in the open flower heads, within which an average of 30% of the florets/soft achenes were destroyed in heads containing puparia. Five species of chalcidoid Hymenoptera were reared from individual puparia and mature flower heads bearing *T. pseudovicina* puparia as solitary, larval-pupal endoparasitoids: *Colotrechnus* sp. (Eulophidae), *Eurytoma* n. sp. nr. *levivultus* Bugbee, *Eurytoma* sp. (1 ♀) (Eurytomidae), *Halictoptera* sp. (Pteromalidae), and *Pteromalus* sp. (Pteromalidae).

*Key Words:* Insecta, *Trupanea*, Asteraceae, nonfrugivorous Tephritidae, biology, taxonomy of immature stages, flower-head feeding, monophagy, host-plant range, parasitoids

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*Trupanea pseudovicina* Hering (Diptera: Tephritidae) is a monophagous species in one of the larger and more widespread genera of nonfrugivorous fruit flies in North America and California (Foote and Blanc 1963, Foote et al. 1993). Being of little or no economic importance, most species of *Trupanea* remain little known (Foote 1960, Foote et al. 1993), except for seven species of *Trupanea* from southern California for

which we have published detailed life histories (Cavender and Goeden 1982, Goeden 1987, 1988, Goeden and Teerink 1997c, Goeden et al. 1998, Headrick and Goeden 1991, Knio et al. 1996b), along with descriptions of the immature stages of five of these species (Cavender and Goeden 1982, Goeden and Teerink 1997c, Goeden et al. 1998, Headrick and Goeden 1991, Knio et al. 1996a). This paper describes the life his-

tory of an eighth species, *T. pseudovicina*, and its immature stages.

#### MATERIALS AND METHODS

This study was based in large part on dissections of subsamples of flower heads of *Porophyllum gracile* Benth (Asteraceae) infested by *T. pseudovicina* from samples collected during 1991–1994 in the low-elevation Colorado (northern Sonoran) Desert and high-elevation, eastern Mojave Desert in southern California in the manner described by Goeden (1985, 1992). The principal study site in the Colorado Desert was in Valliceto Valley at the mouth of Smugglers Canyon, 440-m elevation, San Diego Co. One-liter samples of excised, immature and mature flower heads containing eggs, larvae, and puparia were transported in cold-chests in an air-conditioned vehicle to the laboratory and stored under refrigeration for subsequent dissection, photography, description, and measurement. Six eggs, 14 first-, 10 second-, and 10 third-instar larvae, and 6 puparia dissected from flower heads were preserved in 70% EtOH for scanning electron microscopy (SEM). Additional puparia were placed in separate, glass shell vials stoppered with absorbant cotton and held in humidity chambers at room temperature for adult and parasitoid emergence. Specimens for SEM were hydrated to distilled water in a decreasing series of acidulated EtOH. They were osmicated for 24 h, dehydrated through an increasing series of acidulated EtOH and two, 1-h immersions in Hexamethyldisilazane (HMDS), mounted on stubs, sputter-coated with a gold-palladium alloy, and studied with a JEOL JSM C-35 SEM in the Department of Nematology, University of California, Riverside.

Most adults reared from isolated puparia were individually caged in 850-ml, clear-plastic, screened-top cages with a cotton wick and basal water reservoir and provisioned with a strip of paper toweling impregnated with yeast hydrolyzate and sucrose. These cages were used for longevity

studies in the insectary of the Department of Entomology, University of California, Riverside, at  $25 \pm 1^\circ\text{C}$ , and 14/10 (L/D) photoperiod.

Plant names used in this paper follow Hickman (1993) and Bremer (1994); tephritid names and adult terminology follow Foote et al. (1993). Terminology and telegraphic format used to describe the immature stages follow Knio et al. (1996a), Goeden and Teerink (1997a, b, c), and Goeden et al. (1998) and our earlier works cited therein. Means  $\pm$ SE are used throughout this paper. Voucher specimens of *T. pseudovicina* and its parasitoids reside in the research collections of RDG; preserved specimens of eggs, larvae and puparia are stored in a separate collection of immature Tephritidae maintained by JAT.

#### RESULTS AND DISCUSSION

##### TAXONOMY

Adult.—*Trupanea pseudovicina* was first described by Hering (1942) as *Trypanea texana*, which was preoccupied by *texana* Malloch. It was renamed *Trypanea pseudovicina* by Hering (1947). Foote (1960), Foote and Blanc (1963), and Foote et al. (1993) pictured the wing patterns of the female and male, which unlike some *Trupanea* spp., e.g. *T. bisetosa* (Coquillett), *T. imperfecta* (Coquillett), *T. jonesi* Curran, and *T. nigricornis* (Coquillett), are not sexually dimorphic.

Immature stages.—The immature stages of *T. pseudovicina* heretofore have neither been described nor illustrated.

*Egg*: Forty three eggs of *T. pseudovicina* dissected from heads of *Porophyllum gracile* were white, opaque, smooth; elongate-ellipsoidal,  $0.61 \pm 0.005$  (range, 0.54–0.66) mm long,  $0.16 \pm 0.002$  (range, 0.14–0.18) mm wide, smoothly rounded at tapered basal end (Fig. 1A), pedicel 0.02 mm long, with a single row of aeropyles (Fig. 1B).

The egg of *T. pseudovicina* is similar in shape to the eggs of other *Trupanea* species previously described, larger in width and

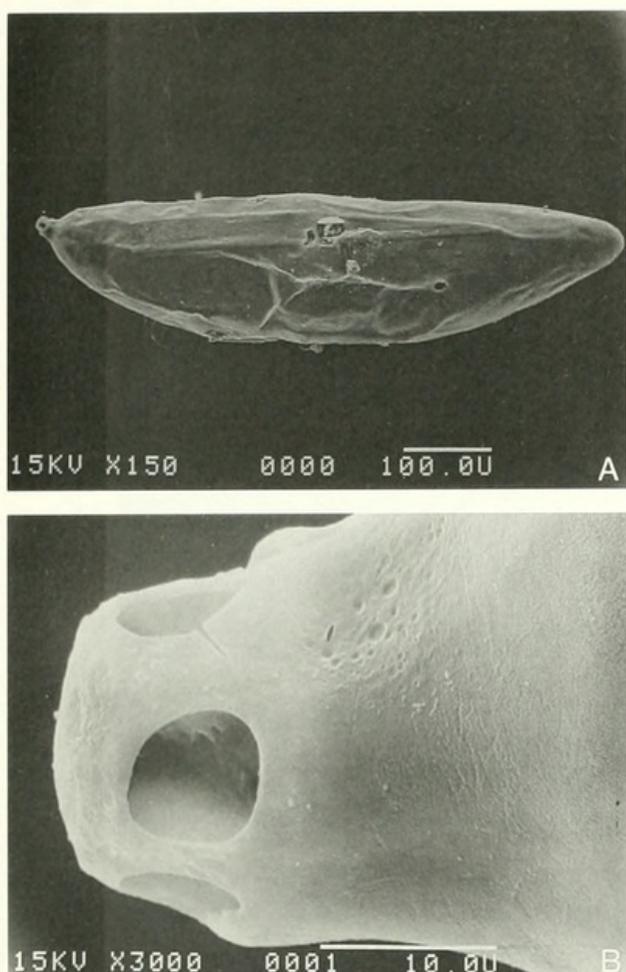


Fig. 1. Egg of *Trupanea pseudovicina*: (A) habitus, anterior to left; (B) pedicel.

length than *T. californica* Malloch, but shorter than *T. bisetosa*, *T. conjuncta* (Adams), *T. imperfecta*, *T. jonesi*, *T. nigricornis*, and *T. signata* Foote (Goeden 1987, 1988, Headrick and Goeden 1991, Knio et al. 1996a, Goeden and Teerink 1997c). As in *T. pseudovicina*, a single row of aeropyles circumscribes the pedicel of *T. nigricornis*, *T. signata*, and *T. jonesi* (Goeden and Teerink 1997c, Goeden et al. 1998); whereas, *T. bisetosa* has 1–2 rows of aeropyles (Knio et al. 1996a).

**Third instar:** White, elongate-cylindrical, tapering anteriorly, rounded posteriorly, minute acanthae circumscribe thoracic and abdominal intersegmental lines (Fig. 2A); gnathocephalon conical, with rugose pads dorsally and laterally (Fig. 2B), rugose pads laterad of mouth lumen serrated on ventral margin (Fig. 2B-1, C-1); dorsal sensory or-

gan a single, dome-shaped papilla (Fig. 2B-2, C-2); subdorsal sensilla laterad of dorsal sensory organ (Fig. 2C-3); anterior sensory lobe (Fig. 2B-3) bears terminal sensory organ (Fig. 2C-4), pit sensory organ (Fig. 2C-5), lateral sensory organ (Fig. 2C-6) and supralateral sensory organ (Fig. 2C-7); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 2C-8, D-1); mouth hooks tridentate (Fig. 2D-2); median oral lobe laterally flattened, tapered anteriorly (Fig. 2D-3); labial lobe attached to median oral lobe, with two pore sensilla (Fig. 2D-4); ventrolateral sensillum laterad of labial lobe (Fig. 2D-5); prothorax circumscribed anteriorly by minute acanthae (Fig. 2E-1), rugose pads (Fig. 2E-2) and single row of verruciform sensilla, with additional sensilla dorsad (Fig. 2E-3); single stelex sensillum located dorsomedially on prothorax; anterior thoracic spiracles on posterior margin of prothorax bear four rounded papillae (Fig. 2E-4, F); metathoracic lateral spiracular complex consists of spiracle, stelex sensillum, and verruciform sensillum; abdominal lateral spiracular complexes consist of spiracle only; caudal segment circumscribed by minute acanthae (Fig. 2G-1), and stelex sensilla (Fig. 2G-2); posterior spiracular plates with three ovoid rimae, ca. 0.038 mm in length (Fig. 2G-3), and four interspiracular processes with 5–6 branches, longest measuring 0.016 mm (Fig. 2G-4); intermediate sensory complex ventrad of posterior spiracular plates, consists of stelex sensillum (Fig. 2H-1) and medusoid sensillum (Fig. 2H-2).

*Trupanea pseudovicina* differs from previously described *Trupanea* species in being more elongate-cylindrical than barrel-shaped (Headrick and Goeden 1991, Knio et al. 1996a, Goeden and Teerink 1997c, Goeden et al. 1998). The serrated rugose pads laterad of the mouth lumen are similar to those on *T. nigricornis*, *T. signata* and *T. jonesi* (Knio et al. 1996a, Goeden and Teerink 1997c, Goeden et al. 1998). The subdorsal sensilla are similar to those found on *T. bisetosa* and *T. jonesi* (Knio et al. 1996a,

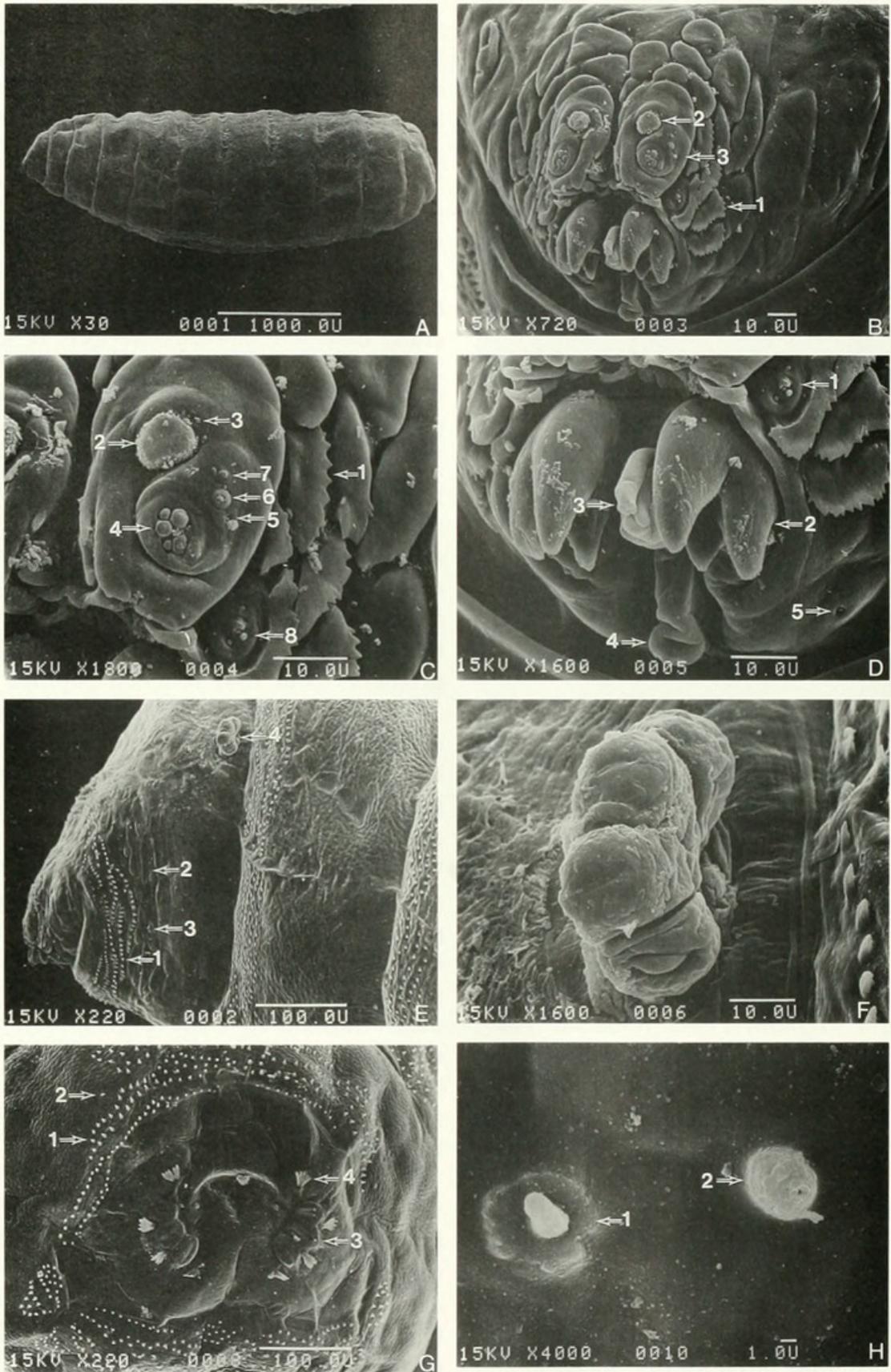


Fig. 2. Third instar of *Trupanea pseudovicina*: (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—serrated rugose pads, 2—dorsal sensory organ, 3—anterior sensory lobe; (C) anterior sensory lobe, 1—serrated rugose pads, 2—dorsal sensory organ, 3—subdorsal sensilla, 4—terminal sensory organ, 5—pit sensory organ, 6—lateral sensory organ, 7—supralateral sensory organ, 8—stomal sense organ; (D) gnathocephalon, anterior view, 1—stomal sense organ, 2—mouth hook, 3—median oral lobe, 4—labial lobe, 5—ventro-

Goeden et al. 1998). The lateral spiracular complex in each *Trupanea* species previously examined has differed slightly in the number or type of sensilla present (Headrick and Goeden 1991, Knio et al. 1996a, Goeden and Teerink 1997c, Goeden et al. 1998). The metathoracic lateral spiracular complex in *T. pseudovicina* is similar to that in *T. jonesi*, but the abdominal lateral spiracular complex is different; *T. jonesi* bears one placoid sensillum (Goeden et al. 1998); whereas, *T. pseudovicina* has no sensilla.

*Second instar:* White, elongate-cylindrical, tapering slightly anteriorly, rounded posteriorly, minute acanthae circumscribe thoracic and abdominal intersegmental lines (Fig. 3A); gnathocephalon conical (Fig. 3B, D); rugose pads laterad of mouth lumen serrated on ventral margin (Fig. 3B-1, D-1); dorsal sensory organ a single, dome-shaped papilla (Fig. 3B-2, C-1); subdorsal sensilla laterad of dorsal sensory organ (Fig. 3C-2); anterior sensory lobe bears all four sensory organs (Fig. 3B-3); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 3C-3, D-2); mouth hooks bidentate (Fig. 3B-4, D-3); median oral lobe laterally flattened, tapered anteriorly (Fig. 3B-5, D-4); prothorax circumscribed anteriorly by minute acanthae (Fig. 3D-5) and verruciform sensilla (Fig. 3D-6); anterior thoracic spiracles bear four rounded papillae (Fig. 3E); metathoracic lateral spiracular complex consists of spiracle (Fig. 3F-1), stelex sensillum (Fig. 3F-2), and verruciform sensillum (Fig. 3F-3); abdominal lateral spiracular complexes consist of spiracle only (Fig. 3G); caudal segment bears posterior spiracular plates (Fig. 3H); posterior spiracular plates consist of three ovoid rimae, ca. 0.016 mm in length (Fig. 3H-1), and four interspirac-

ular processes, each with 4–5 branches, longest measuring 0.013 mm (Fig. 3H-2); intermediate sensory complex consists of stelex sensillum and medusoid sensillum.

The second instar is very similar to the third instar in general habitus and sensory structures, but lacks the rugose pads that circumscribe the prothorax in the third instar. Also, the mouth hooks are bidentate in the second instar, and the posterior spiracular plates differ slightly in the size of the rimae and the number of branches in the interspiracular processes. *Trupanea jonesi* differs from *T. pseudovicina* in that the rugose pads near the mouth lumen are not serrated, and the prothorax is circumscribed by rugose pads (Goeden et al. 1998). *Trupanea bisetosa* and *T. nigricornis* second instars have tridentate mouth hooks and the ventral margin of the ventral lobe is papillate (Knio et al. 1996a).

*First instar:* White, elongate-cylindrical, rounded anteriorly and posteriorly, minute acanthae circumscribe meso-, metathoracic and abdominal intersegmental lines (Fig. 4A); gnathocephalon conical, lacking rugose pads (Fig. 4B); dorsal sensory organ a single, dome-shaped papilla (Fig. 4B-1); subdorsal sensillum laterad of dorsal sensory organ (Fig. 4B-2); anterior sensory lobe with four sensory organs (Fig. 4B-3); stomal sense organs reduced (Fig. 4B-4); mouth hooks bidentate (Fig. 4B-5); median oral lobe laterally flattened (Fig. 4B-6); prothorax with minute acanthae ventrally, thoracic segments circumscribed by single row of verruciform sensilla; anterior thoracic spiracles not present; lateral spiracular complex not seen; caudal segment smooth, lacking minute acanthae (Fig. 4C), circumscribed by stelex sensilla in a 2-dorsal, 4-ventral arrangement (Fig. 4C-1); posterior

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lateral sensillum; (E) prothorax, lateral view, 1—minute acanthae, 2—rugose pads, 3—verruciform sensillum, 4—anterior thoracic spiracle; (F) anterior thoracic spiracle; (G) caudal segment, 1—minute acanthae, 2—stelex sensillum, 3—rima, 4—interspiracular process; (H) intermediate sensory complex, 1—stelex sensillum, 2—medusoid sensillum.

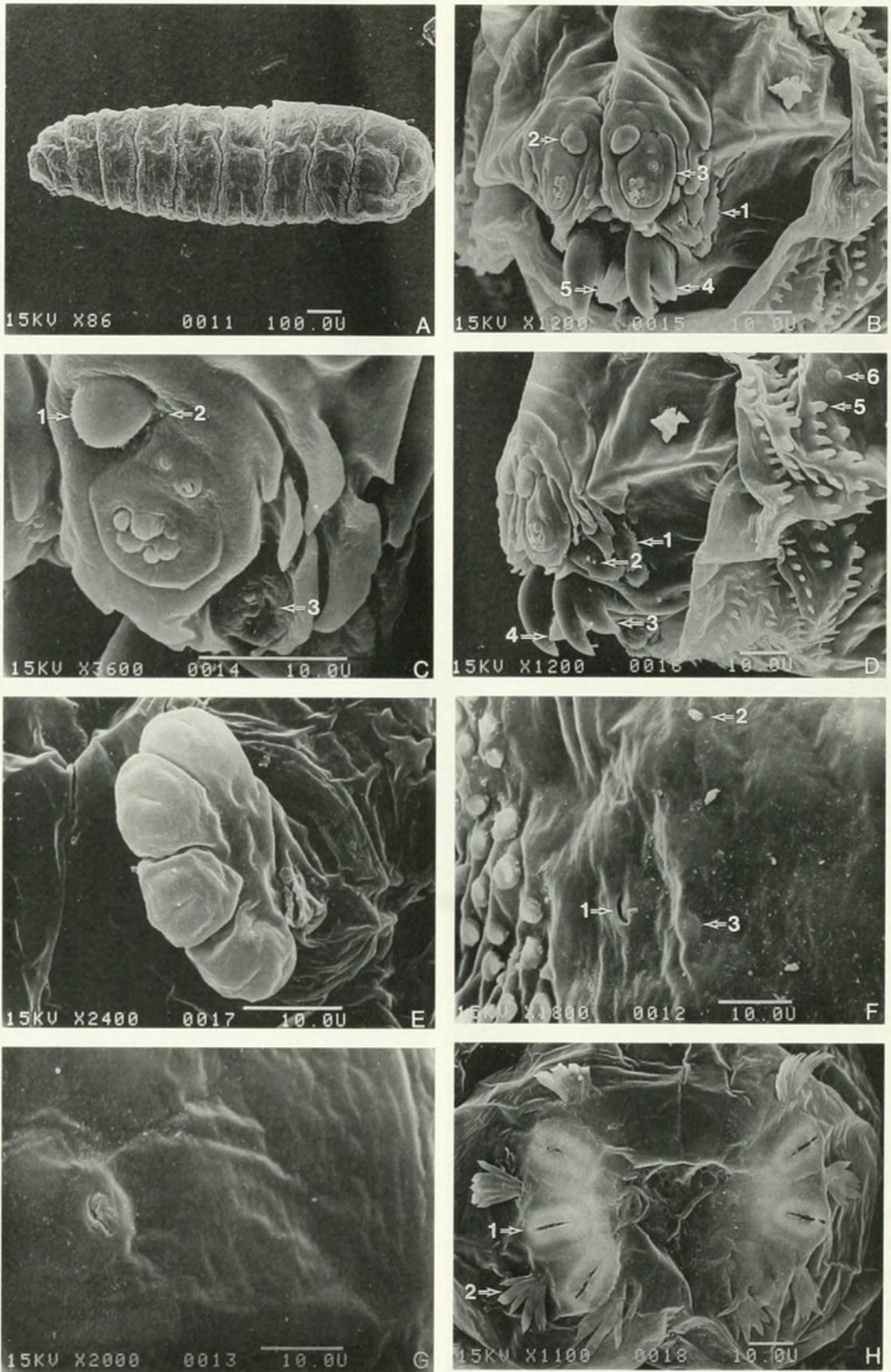


Fig. 3. Second instar of *Trupanea pseudovicina*: (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—serrated rugose pads, 2—dorsal sensory organ, 3—anterior sensory lobe, 4—mouth hook, 5—median oral lobe; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—subdorsal sensilla, 3—stomal sense organ; (D) gnathocephalon, lateral view, 1—serrated rugose pads, 2—stomal sense organ, 3—mouth hook, 4—median oral lobe, 5—minute acanthae, 6—verruciform sensillum; (E) anterior thoracic spiracle; (F) metathoracic lateral

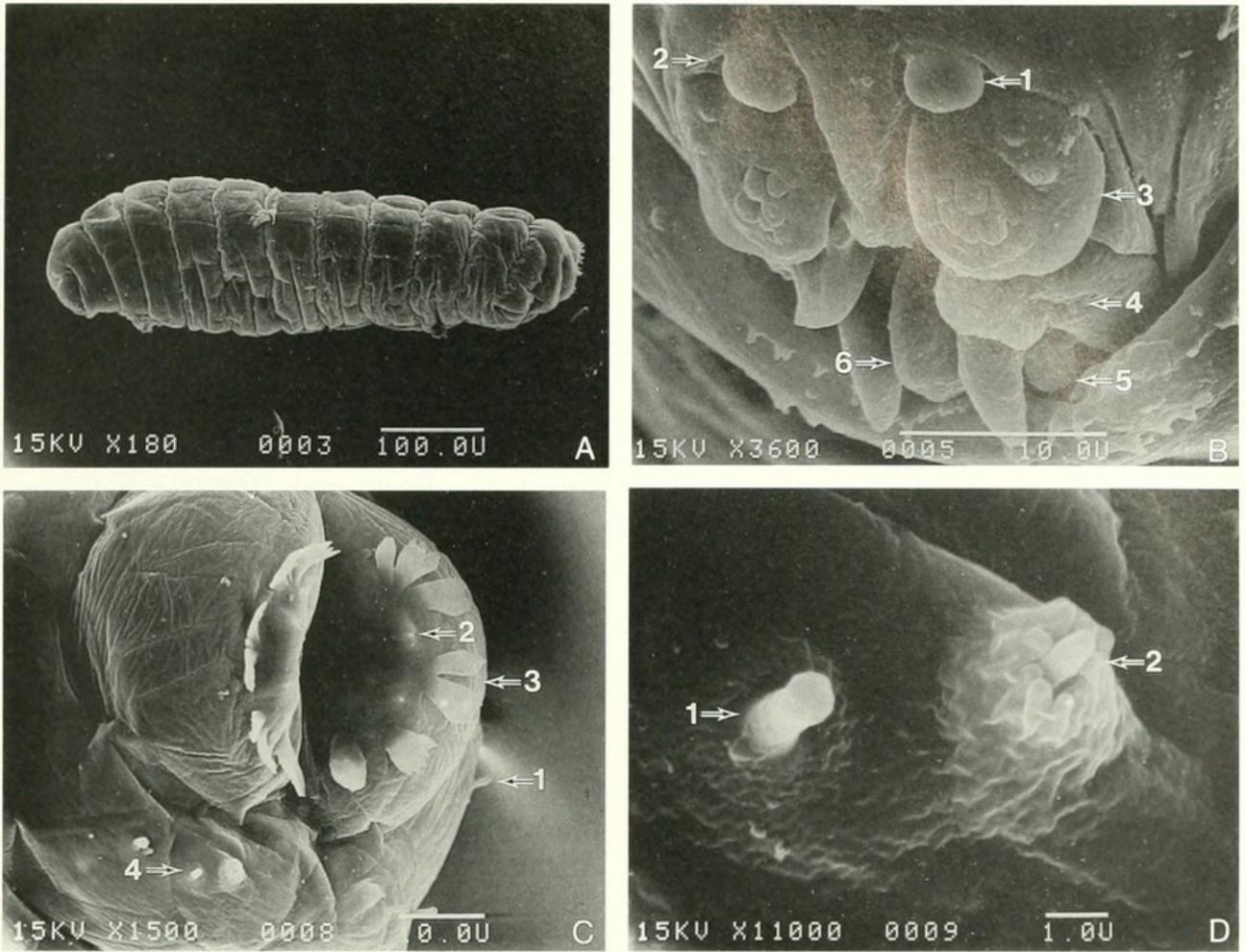


Fig. 4. First instar of *Trupanea pseudovicina*: (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—dorsal sensory organ, 2—subdorsal sensillum, 3—anterior sensory lobe, 4—stomal sense organ, 5—mouth hook, 6—median oral lobe; (C) caudal segment, 1—stelex sensillum, 2—rima, 3—interspiracular process, 4—intermediate sensory complex; (D) intermediate sensory complex, 1—stelex sensillum, 2—medusoid sensillum.

spiracular plates with two ovoid rimae, ca. 0.007 mm in length (Fig. 4C-2), and four interspiracular processes, each with 1–3 branches, longest measuring 0.006 mm (Fig. 4C-3); intermediate sensory complex (Fig. 4C-4), with stelex sensillum (Fig. 4D-1) and medusoid sensillum (Fig. 4D-2).

The first instar differs from the second instar in possessing fewer rows of acanthae circumscribing the intersegmental lines, and the prothorax is not circumscribed by acanthae. The gnathocephalon is smooth, lacking rugose pads, and the stomal sense or-

gans are reduced and nearly indistinct. The posterior spiracular plates differ in bearing two rimae and the interspiracular processes have fewer branches than the second instar. The interspiracular processes differ slightly among the first instars of previously studied *Trupanea* species (Knio et al. 1996a, Goeden et al. 1998). *Trupanea pseudovicina* and *T. bisetosa* interspiracular processes are very similar, with 1–4 branches, either blade-like or broad with dentate margins; however, *T. nigricornis* has four, broad branches with dentate margins in each in-

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spiracular complex, 1—spiracle, 2—stelex sensillum, 3—verruciform sensillum; (G) seventh abdominal lateral spiracular complex, spiracle; (H) posterior spiracular plates, 1—rima, 2—interspiracular process.

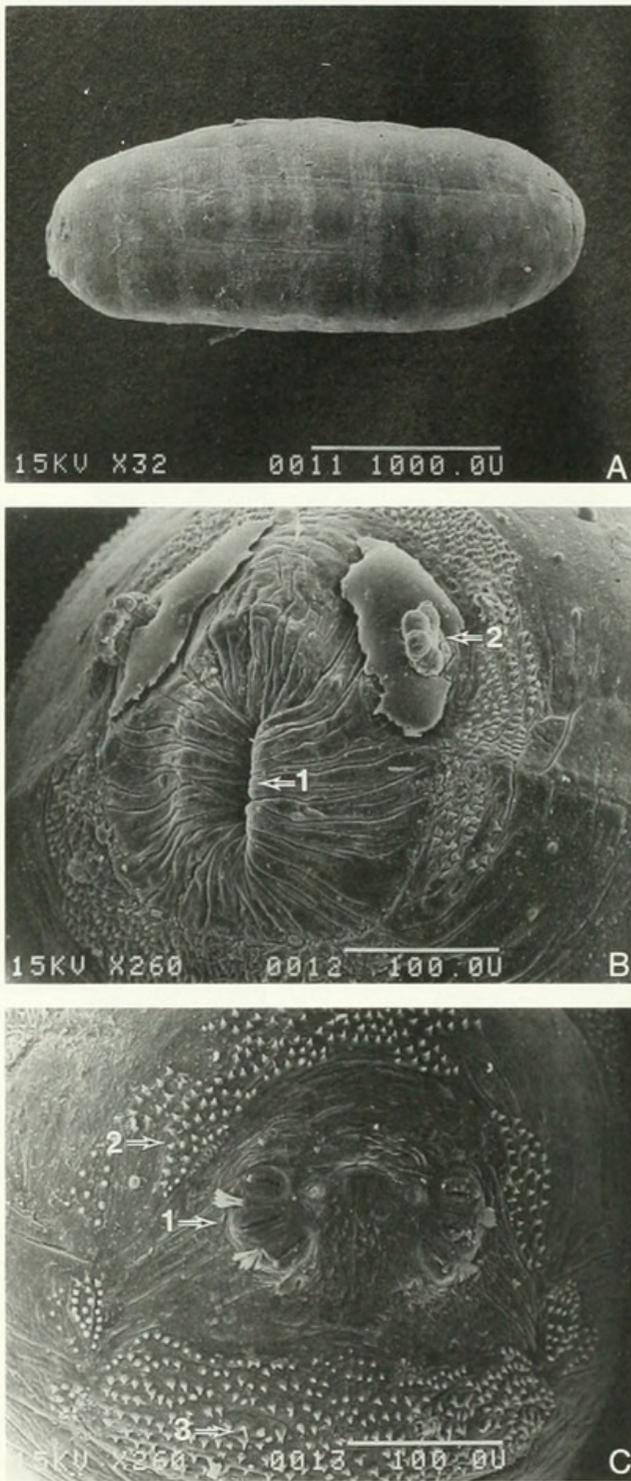


Fig. 5. Puparium of *Trupanea pseudovicina*: (A) habitus, anterior to left; (B) anterior end, 1—invagination scar, 2—anterior thoracic spiracle; (C) caudal segment, 1—posterior spiracular plates, 2—minute acanthae, 3—intermediate sensory complex.

terspiracular process, and *T. jonesi* has very reduced interspiracular processes (Knio et al. 1996a, Goeden et al. 1998).

**Puparium:** Black, elongate-ellipsoidal (Fig. 5A); anterior end bears invagination

scar (Fig. 5B-1) and anterior thoracic spiracles (Fig. 5B-2); caudal segment bears posterior spiracular plates (Fig. 5C-1), band of minute acanthae (Fig. 5C-2) and the intermediate sensory complex (Fig. 5C-3). One hundred-seventy-six puparia averaged  $2.75 \pm 0.02$  (range, 2.13–3.35) mm in length;  $1.12 \pm 0.01$  (range, 0.70–1.38) mm in width.

#### DISTRIBUTION AND HOSTS

The distribution of *T. pseudovicina* mapped by Foote et al. (1993) included several locations each in Arizona, California, New Mexico, and Texas, and single locations in Colorado, Kansas, and Nevada.

Wasbauer (1972) reported *T. pseudovicina* from *Porophyllum gracile* and *Bebbia juncea* (Benth) Greene. The former host-plant belongs to the subtribe Pectidinae in the tribe Helenieae of the Asteraceae (Hickman 1993, Bremer 1994), and is the only validated host of this tephritid in North America (Goeden 1985, 1989, 1992). On the other hand, *B. juncea* belongs to the subtribe Galinsoginae in a different tribe, Heliantheae (Hickman 1993, Bremer 1994), and *T. pseudovicina* was not recorded in the insect fauna of this desert shrub when surveyed by Goeden and Ricker (1989); consequently, this additional information now strongly indicates that the record for *B. juncea* in Wasbauer (1972) is erroneous, not representing the rare host earlier suggested in explanation by Goeden (1985) (Foote et al. 1993). Accordingly, *T. pseudovicina* may be either a true monophage (one host-plant species) in North America north of Mexico or a near-monophage (one host-plant genus) on *P. gracile* and has not yet been reported from *P. ruderale* (Jacquin) R. Johnson, *P. scoparium* Gray, or *P. greggii* Gray, the other congeners in the southwestern United States (Arizona, New Mexico, Texas) or on additional species of *Porophyllum* in the Sonoran Desert and other parts of Mexico (Shreve and Wiggins 1964, Johnson 1969, Hickman 1993). Alternatively, if identifications and records for *T. pseu-*

*dovicina* in Foote et al. (1993) are correct for Nebraska and Oklahoma, where *P. gracile* does not occur according to Johnson (1969), this instead is an oligophagous tephritid that reproduces in flower heads of a still-to-be-reported, additional host genus or genera. Like several other tephritid species that we have studied, e.g. *Trupanea conjuncta* (Goeden 1987), *Tomoplagia cressoni* Aczél (Goeden and Headrick 1991), *Zonosemata vittigera* (Coquillett) (Goeden and Ricker 1971), *Trupanea pseudovicina* represents a native southern California tephritid closely associated with a native host-plant, which along with its congeners, is primarily distributed in Mexico and southward, where they remain little known.

#### BIOLOGY

**Egg.**—In 28 closed, preblossom, immature flower heads, 85 eggs were inserted pedicel-last between the tips of the phyllaries, and most were deposited perpendicular to the receptacle ( $n = 83$ , 98%; Fig. 6A, B) and inserted among the florets ( $n = 57$ , 67%, Fig. 6A). Only a single egg each was found deposited at an angle to the long axis of the head or parallel to the receptacle. Twenty eight of the 85 eggs (33%) were deposited loosely above or upon the closed florets (Fig. 6B) in the space beneath the appressed distal parts of the phyllaries. Only three of the 85 eggs (4%) were inserted partially into a floret. The diameters of the receptacles of 23 flower heads containing eggs averaged  $1.8 \pm 0.1$  (range, 1.1–2.6) mm, and 28 infested heads contained an average of  $2.5 \pm 0.3$  (range, 1–7) eggs oviposited mostly singly (Fig. 6B) or side-by-side in pairs, but also in packets (Fig. 6A) of up to five, by one or more females.

**Larva.**—Upon eclosion, first instars tunneled into or fed externally on one or more unelongated floral tubes of the immature florets (Fig. 6C). An average of  $2.7 \pm 0.5$  (range, 1–7) first instars was found feeding within 14 closed, preblossom flower heads. The receptacles of these heads averaged  $1.8$

$\pm 0.7$  (range, 1.1–2.3) mm in diameter with an average of  $27 \pm 7$  (range, 23–30) florets, of which an average of only  $1.5 \pm 0.4$  (range, 0–6) floral tubes, or 6% (range, 0–21%), were damaged. No ovules or receptacles within these 14 infested flower heads were pitted by first instar feeding.

Second instars fed mainly in floral tubes and ovules of preblossom flower heads or soft achenes of open heads (Fig. 6D). Most second instars fed with their mouthparts directed towards the receptacles within individual floral tubes/ovules (Fig. 6D), but two, even three, early second instars occasionally were found within a single floret. A few second instars were found tunneling through several ovules/soft achenes parallel to, but well above the receptacles (Fig. 6D). Receptacles of 17 flower heads containing second instars were undamaged and averaged  $2.3 \pm 0.1$  (range, 2.0–3.3) mm in diameter. These flower heads contained an average of  $3.2 \pm 0.3$  (range, 1–5) second instars that had destroyed an average of  $5.1 \pm 1.0$  (range, 1–15) ovules/soft achenes, or 17.3% (range, 3.8–50%) of an average total of  $29 \pm 0.7$  (range, 24–34) ovules/soft achenes.

Most third instars confined their feeding to soft achenes and florets at the margins, and less commonly to the centers, of open or postblossom heads (Fig. 6E). Heavily infested preblossom flower heads never opened and were completely excavated (Fig. 6F). In 49 flower heads averaging  $2.2 \pm 0.4$  (range, 1.5–2.7) mm in diameter and containing an average of  $2.2 \pm 0.2$  (range, 1–8) third instars, an average of  $7.8 \pm 1.0$  (range 1–26) soft achenes/florets were damaged, or 29% (range, 5–100%). Most third instars fed with their long axes oriented perpendicular to and mouthparts directed towards the receptacles (Fig. 6E), within the lower parts of the floral tubes and upper parts of the soft achenes, well above the receptacles. No receptacles were pitted in the 49 flower heads that contained third instars, even in heavily infested, totally excavated heads (Fig. 6F). Upon completing

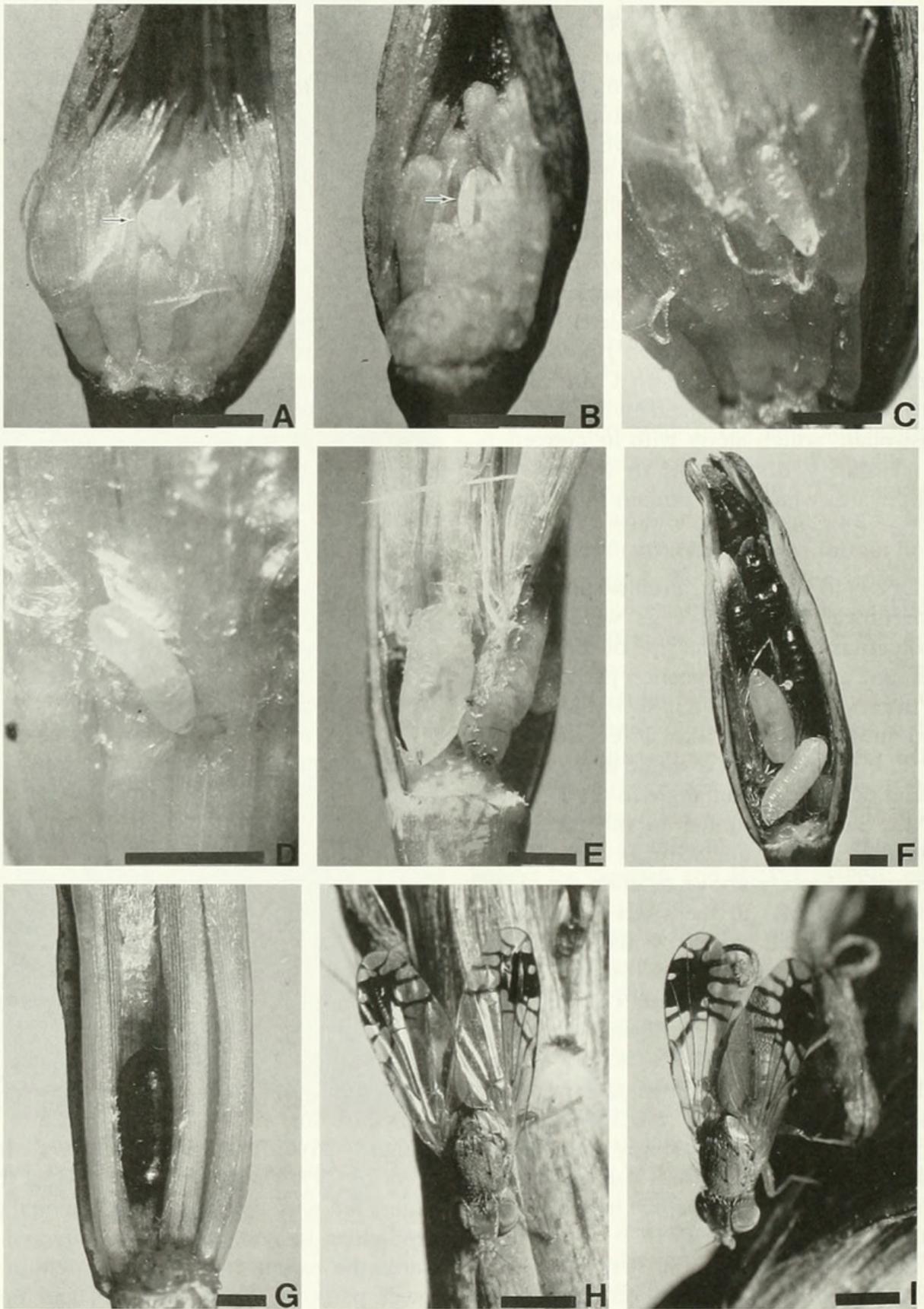


Fig. 6. Life stages of *Trupanea pseudovicina* in or on *Porophyllum gracile*: (A) three eggs (arrow) inserted among florets in closed, preblossom flower head; (B) egg (arrow) inserted atop florets in closed, preblossom flower head; (C) first instar tunneling in floret; (D) second instar feeding on soft achene at margin of open flower head; (E) third instar feeding on soft achene; (F) five puparia (top), prepuparium, and third instar (bottom) in completely excavated closed flower head; (G) single puparium between fully formed, undamaged achenes; (H) adult male on flower head; (I) adult female on flower head. Lines = 1 mm.

feeding, the larvae oriented with their anterior ends away from the receptacles, retracted their mouthparts, and pupariated (Fig. 6F).

**Pupa.**—Flower heads containing puparia (Fig. 6F, G) contained the greatest damage produced by the seed-feeding larvae of *T. pseudovicina* within flower heads sampled. The receptacles of 74 infested flower heads containing puparia averaged  $2.2 \pm 0.04$  (range, 1.4–3.2) mm in diameter and bore an average total of  $29.1 \pm 0.6$  (17–40) soft achenes/florets, of which an average of  $6.4 \pm 0.6$  (range, 2–27) soft achenes/florets or 30% (range, 6–100%) were damaged. Again, no receptacles were pitted. These heads contained an average of  $2.0 \pm 0.1$  (range, 1–6) puparia. Most puparia of *T. pseudovicina* were found alongside of the phyllaries at the margins of the flower heads, all had their anterior ends facing away from the receptacles, and their long axes were perpendicular to the receptacles (Fig. 6F, G).

**Adult.**—Adults emerged from mature flower heads, and were long-lived under insectary conditions, as 67 unmated males averaged  $95 \pm 4$  (range, 22–224) days, and 86 virgin females averaged  $112 \pm 5$  (range, 17–218) days. These flies are among the longest lived native species of nonfrugivorous Tephritidae from southern California in terms of average and maximum adult longevities that we have recorded. Such longevities are fully in accord with the aggregative type of life cycle ascribed below to this tephritid. The pre-mating and mating behaviors of *T. pseudovicina* were not studied in the field, and as with most congeners that we have studied, adults would not mate in petri dish arenas so useful with many other nonfrugivorous tephritid species (Headrick and Goeden 1994).

**Seasonal history.**—The life cycle of *T. pseudovicina* in southern California follows an aggregative pattern in which the long-lived adults, in reproductive diapause, overwinter and aggregate to mate on pre-blossom host plants in the spring (March–April)

(Headrick and Goeden 1994). They reproduce at first in the Colorado Desert, then in the Mojave Desert and on occasional host plants scattered in chaparral in the interior valleys (Munz 1974, Hickman 1993). A single generation is produced each year at each locale on *P. gracile*, and most of the life span of *T. pseudovicina* is spent as adults.

**Natural enemies.**—Five species of chalcidoid Hymenoptera were reared from individual puparia and mature flower heads bearing puparia of *T. pseudovicina* as solitary, larval-pupal endoparasitoids: *Colotrechnus* sp. (Eulophidae), *Eurytoma* n. sp. nr. *levivultus* Bugbee, *Eurytoma* sp. (1 ♀) (Eurytomidae), *Halticoptera* sp. (Pteromalidae), *Pteromalus* sp. (Pteromalidae).

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