

Descriptions of the Egg and Mature Larva of the Bee *Chelostoma* (*Prochelostoma*) *philadelphia* with Additional Notes on Nesting Biology (Hymenoptera: Megachilidae: Megachilinae: Osmiini)

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ABSTRACT

The egg of *Chelostoma* (*Prochelostoma*) *philadelphia* (Robertson) and its last larval instar, which had been preserved while defecating, are described and illustrated. The egg was collected from nests constructed in frass-filled burrows of the beetle *Xylobiops basilaris* (Say) in a dead branch of *Ficus carica* L. Nests consisting of a short linear arrangement of cells are described as is the provisioning behavior of the bee. Although distinguishable, the last stage larva is similar to that of another species belonging to a different subgenus of *Chelostoma*. The two larvae will be compared in a subsequent publication.

INTRODUCTION

The following describes the mature larva and egg of *Chelostoma* (*Prochelostoma*) *philadelphia* (Robertson), a small, slender bee that nests in the narrow confines of vacated beetle galleries in dead trees. Krombein (1967) reported on its nest and nesting biology and briefly described the egg. Parker (1988) presented information on the biology of several other species of *Chelostoma* and cites the works of others who contributed to our present understanding of the genus. We also add here additional biological observations. The egg was recovered by H.H.G. from the nest site, and the larva was collected by Krombein in 1959.

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OBSERVATIONS

H.H.G. first discovered and observed male *C. philadelphia* visiting and feeding on the flowers of blackberries (*Rubus* sp., Rosaceae) (fig. 1) at her home in Clifton, Passaic County, New Jersey, on May 16–22, 2015, but observed no females there. On May 26, 2015, she found females (figs. 2, 3) nesting in a dead fig tree branch (*Ficus carica* L.) approximately 65 feet from the blackberries. The tree, about seven feet tall, consisted of a multitrunk system that divided into a series of large branches just above ground level. At neither place did she see females and males together, nor did she learn the source of the pollen that females used for nest provisions. Females entered circular beetle holes, 2.0 mm in diameter, which peppered the length of the dead branch, roughly 8 cm in diameter at the base. The holes had been made by adults of the beetle *Xylobiops basilaris* (Say) (Bostrichidae). Females of this well-known beetle (see Bugguide, 2012) construct tunnels through the bark and across the wood grain and deposit their eggs at intervals along the way. After hatching, larvae burrow into the soft sapwood, thereby making tunnels that extend with the wood grain at right angles to the entrance tunnel. After the beetle larvae mature, they depart. Females of *C. philadelphia* appropriated the vacated beetle larvae's feeding tunnels for their nest tunnels. Approximately 3.0 mm in diameter, almost all of these tunnels were solidly packed with caked, nearly white powder (fig. 14), the beetle frass, which the female bees removed (figs. 4, 5). No bostrichid larvae were encountered when we disassembled the tree branch, although several dead adults were found.

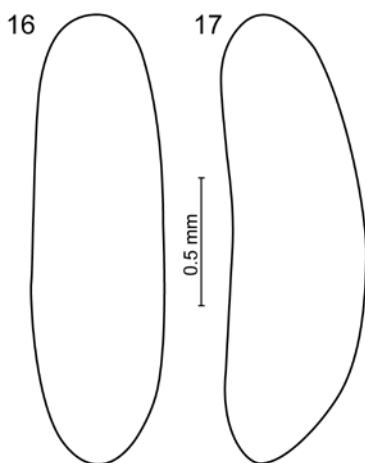
Over a period of six days H.H.G. was able to make observations on the adult activities of these bees at the nesting site. Although several branches of the tree exhibited the beetle holes up to five feet above the ground, those used by the bees were restricted to the lower two feet, perhaps because of the limited thickness of the tapering branches. Females often visited a number of these holes before selecting one. After finding a suitable nesting hole, she removed the beetle frass and other debris (figs. 4, 5) before starting to forage for pollen and nectar. When foraging, returning females invariably entered nest entrances headfirst (fig. 6), presumably regurgitated nectar, briefly exited (fig. 7) to turn themselves around, and reentered tailfirst to unload pollen from their abdominal scopas (fig. 8). It is uncertain when they manipulate the pollen and nectar to mix and shape the provisions. Departing females exit entrances rapidly without delay. One provisioning female was noted returning on May 26 at 8:00 P.M., only 16 minutes before sunset. After depositing pollen, she exited to turn around, reentering headfirst, and remained in the nest overnight.

Nest closures were constructed with mud and pebbles, and cell partitions were made from mud alone. On May 31 H.H.G. noted that a female bee made more than 20 trips to gather mud and pebbles over a two-hour period to construct a single nest closure. Exterior to the hole, the female positioned herself with head at the hole while the rest of her body pointed away in line with

FIGURES 1–15. Views of the bee *Chelostoma* (*Prochelostoma*) *philadelphia* illustrating its behavior. 1. Male on blackberry flower. 2. Female approaching hole made by the beetle *Xylobiops basilaris* in dead fig tree. 3. Branch of fig tree, showing beetle holes; those that had been appropriated by female *C. philadelphia* for nesting are circled. 4, 5. Female removing white beetle frass in nest preparation. 6. Female *C. philadelphia* with pollen carried by abdominal scopa entering nest. 7, 8. After nectar regurgitation, female emerging from nest in order



to reenter tailfirst to discharge pollen as in figure 8. **9, 10.** Nest closures made from mud with small pebbles added to outer surface. **11.** Nest closure viewed from side, showing depth. **12, 13.** Live egg of *C. philadelphia* on provisions in cell of nest built into vacated beetle gallery and close-up of egg. **14.** Cell with front end partly hidden constructed at branching of beetle gallery, with branch on left frass filled. Cell holding large, moist provision loaf with intermediate stage larva (arrow); note pollen coated cell partition behind provisions. **15.** Cell partition removed from nest, showing thin layer of seemingly dry pollen covering rear surface, as seen in cross section in figure 14 (arrow).



FIGURES 16, 17. Diagram of egg of *C. philadelphia*, apical end toward top, dorsal/ventral view and lateral view, respectively.

the radius of the hole. She applied mud along the outer edge of the hole as she circled her body around it. She gradually filled in the hole, incorporating small stones with mud in the final seal (figs. 9, 10). The nest closure plug extended 5 mm into the tunnel (fig. 11). Toward the end of plug construction and afterward, the entrance was repeatedly visited by small ants presumably attracted by the odor of the mud. This suggests that the bee uses nectar to moisten the closure mortar.

Knowing of J.G.R.'s interest in, and research on, osmiine nesting biology, she and her husband (Mike Zeidan) cut the dead branch on the weekend of May 31. They brought the sample for J.G.R. to examine (fig. 3), about 20 cm long containing roughly 20 beetle holes, four or five of which had been appropriated by females of *C. philadelphia* as nest burrows. The wood was extremely tough and grainy, making dissections of the tunnels difficult to reach without a good deal of chopping and splitting with chisels and hammer, possibly distorting and modifying nest contents.

Each of the five nests uncovered consisted of two or three cells in linear series (fig. 12). Each cell partition consisted of a thin (less than 0.5 mm), waferlike, circular sheet of dried mud (fig. 15) with a slightly concave surface facing the front of the nest and a slightly convex rear surface. Provisions (figs. 12–14) consisted of an oval loaf of a sticky mixture of nectar and yellow pollen, one of which was 2.5 mm in diameter and 4.5 mm in length. However, some masses were extremely elongate, probably distorted by the shock waves associated with our trying to penetrate the wood. While the mass had a sticky consistency when pierced with forceps or probe, it did not adhere to the cell wall or rear surface in that the rear of the cell as well as the cell wall near the rear was coated with a thin layer of dry pollen. Unexplained is why the sticky surface of the provisions did not adhere to this seemingly dry layer of pollen.

Also unexplained is why, among all provisioned cells, only two immatures were found, an egg and an intermediate-stage larva. Although the disruption created by our trying to find cells might have ruptured tissue of immatures, no remains were detected. The egg was discovered partly inserted on the side of the front end of a provision mass (fig. 12) and the larva adhered in the front end of another mass (fig. 14) presumably close to where it had been deposited as an egg. Cast larval skins were recovered from the provisions that had accumulated under the larva as is usually the case with megachilid larvae.

EGG OF *CHELOSTOMA* (*PROCHELOSTOMA*) *PHILADELPHI* (ROBERTSON)

Figures 12, 13, 16–20

After being illustrated, the single egg of this species was prepared for SEM examination. Although preparation severely wrinkled the chorion, the micropyle was identified at the anterior end of the egg (fig. 18, arrow).

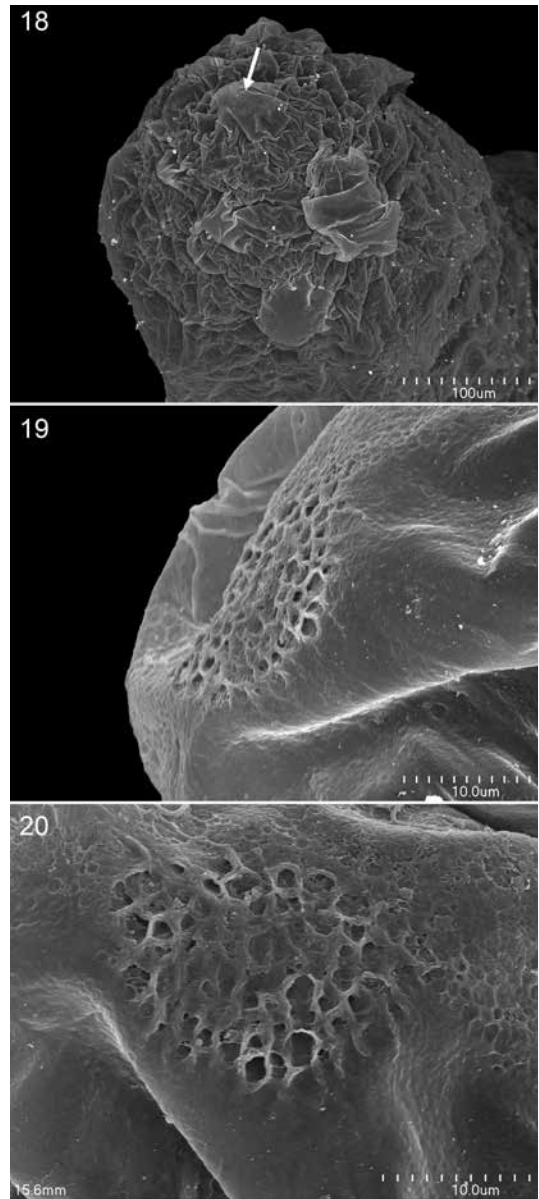
DESCRIPTION: Egg shape elongate (length 1.725 mm), nearly parallel sided in dorsal or ventral view (fig. 16) but with maximum width (0.5 mm) shortly posterior to midbody, rounded at front end and more narrowly rounded at posterior end. In lateral view (fig. 17), egg slightly curved with posterior half of body appearing more enlarged than in dorsal or ventral views. When viewed with stereomicroscope, chorion semitransparent, smooth, embryo white, micropyle not visible. With SEM examination, micropyle found to be very small cluster of pores on anterior end of egg (figs. 5–7).

MATURE LARVA OF
CHELOSTOMA
(*PROCHELOSTOMA*)
PHILADELPHI (ROBERTSON)

Figure 21

DIAGNOSIS: The larva of this species will also be treated in a manuscript by Rozen and Praz (in prep.) wherein characters differentiating it from other osmiine larvae will be more fully presented. There can be little question that the postdefecating larva of this species, when found, will be quite similar to that of *Chelostoma (Gyrodromella) rapunculi* (Lepeletier) described in that manuscript, not only because of general body shape but also because of the extremely small head size relative to body size of both species. These two species can be distinguished by the presence of spicules on the atrial wall of *C. philadelphia* and their complete absence in *C. rapunculi*.

The specimen described here was almost certainly defecating at the time of preservation. The hind gut was completely filled with pollen, and the mid intestine still retained a considerable amount. As might be expected when clearing with an aqueous solution of sodium hydroxide, cuticular pigmentation was consid-



FIGURES 18–20. SEM micrographs of apical end of egg. **18.** Position of micropyle (arrow). **19, 20.** Close-up of micropyle, oblique view and full view, respectively.

erably reduced at the end of treatment.

DESCRIPTION: Head: Head distinctly small in relation to body size (fig. 21); oriented slightly prognathously possibly because of elongate postmentum resulting in projecting labium. Salivary lips faintly pigmented; maxillary and labial palpi moderately pigmented. In lateral view, clypeus scarcely projecting beyond frons, antenna arising from only slight prominence, and labrum not extending

much beyond clypeus. Antennal papilla faintly pigmented, moderately large, tapering apically, and perhaps slightly longer than twice basal diameter. Labral sclerite transverse, well defined by pigmentation. Internal head ridges faintly pigmented except hypostomal ridge moderately pigmented; anterior tentorial pit darkly pigmented.

Mandibular apex darkly pigmented, approximately parallel sided in inner and outer views, with two apical teeth; ventral tooth longer than dorsal tooth; dorsal one narrowing to obliquely truncated apex with curved corners; ventral tooth curving to narrowly rounded apex; dorsal apical edge of apical tooth and ventral apical edge of ventral tooth jagged, uneven; apical concavity defined; cuspal area not projecting; outer mandibular surface with single long curved seta near base. Maxillary and labial palpi pigmented, about as long as antennal papilla but more parallel sided. Labial apex moderately narrow in frontal view; premental sclerite absent; postmentum nonsclerotized. Width of salivary lips slightly less than distance between bases of labial palpi.

Body (fig. 21): Body vestiture without spicules, consisting only of slender, pale setae, tapering to fine points, arising from small but distinct alveoli; these setae inconspicuous, moderate in length; setae moderately abundant on elevated dorsal surfaces of thorax and widely scattered on anterior ventral surface of thorax; some setae present on ventral surface of abdominal segments 8–10; lateral lobe of abdominal segment 8 (i.e., area below level of spiracle) clearly with some scattered setae of moderate length, but exact number undetermined because of opaque hind gut obstructing view on cleared specimens. Body form of postdefecating larva unknown but probably similar to that of *C. rapunculi* (see above); body form of defecating larva moderate in lateral outline between robust and slender; body segments gradually increasing in height with abdominal segments 3, 4, and 5 having greatest diameters; caudal annulets of most body segments projecting only faintly farther than cephalic annulets and surprisingly uniform in appearance; middorsal intersegmental tubercles totally absent. Spiracles unpigmented, subequal in diameter; atrium globular with width not much greater than depth, apparently projecting slightly above body wall, with rim; atrium appearing rather small; atrial inner surface ringed concentrically, spiculate; subatrium moderately to very long, tending to be nearly uniform in width.

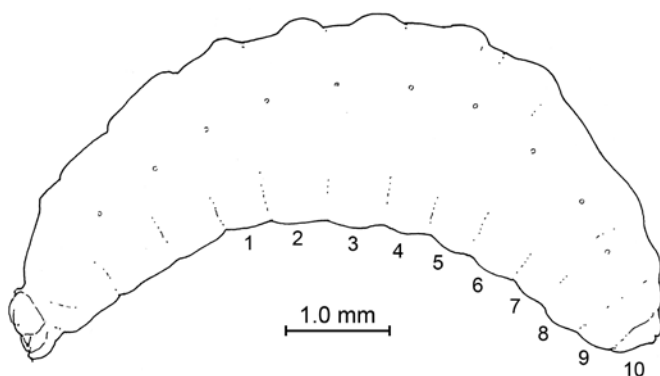


FIGURE 21. Diagram of mature larva of *C. philadelphia*, lateral view, with abdominal segments numbered.

MATERIAL STUDIED: One defecating last larval instar: VA: Arlington, VI-29-1959 (K.V. Krombein) A-14 3.

DISCUSSION

Nesting information on *Chelostoma* presented here follows closely that of previous accounts of the biology of the genus (Krombein, 1967; Parker, 1988; Westrich, 1989). None of the immature stages have been treated before (McGinley, 1989). Müller (2015) believes that the subgenus *Prochelostoma* consists of four species from the Old World (northern Asia) and a single one (*C. philadelphia*) from the New World (North America) on the basis of an investigation by Sedivy et al. (2008) dealing with ancestral state reconstruction and host-plant choice. The nesting biology of none of the Old World species is known.

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