UF IFAS Extension UNIVERSITY of FLORIDA

EENY-531

Polyphemus Moth *Antheraea polyphemus* (Cramer) (Insecta: Lepidoptera: Saturniidae: Saturniinae)[1]

Donald W. Hall[2]

The Featured Creatures collection provides in-depth profiles of insects, nematodes, arachnids, and other organisms relevant to Florida. These profiles are intended for the use of interested laypersons with some knowledge of biology as well as academic audiences.

Introduction

The polyphemus moth, *Antheraea polyphemus* (Cramer), is one of our largest and most beautiful silk moths. It is named after Polyphemus, the giant cyclops from Greek mythology who had a single large, round eye in the middle of his forehead (Himmelman 2002). The name is because of the large eyespots in the middle of the moth's hind wings. The polyphemus moth also has been known by the genus name *Telea,* but it and the Old World species in the genus *Antheraea* are not considered to be sufficiently different to warrant different generic names. Because the name *Antheraea* has been used more often in the literature, Ferguson (1972) recommended using that name rather than *Telea* to avoid confusion. Both genus names were published in the same year. For a historical account of the polyphemus moth's taxonomy see Ferguson (1972) or Tuskes et al. (1996).

The family name Saturniidae is based on the eyespots of some members of the family that contain concentric rings reminiscent of the planet Saturn (Powell 2003). Because of their ease of rearing (Collins and Weast 1961, Villiard 1975) and large size, polyphemus moths are often reared by amateur enthusiasts and also have been used for numerous physiological studies—particularly for studies on molecular mechanisms of sex pheromone action.

Distribution

Polyphemus moths are our most widely distributed large silk moths. They are found from southern Canada down into Mexico and in all of the lower 48 states, except for Arizona and Nevada (Tuskes et al. 1996).

Description

Adults

The adult wingspan is 10 to 15 cm (approximately 4 to 6 inches) (Covell 2005). The upper surface of the wings is various shades of reddish brown, gray, light brown, or yellow-brown with transparent eyespots. There is considerable variation in color of the wings even in specimens from the same locality (Holland 1968). The large hind wing eyespots are ringed with prominent yellow, white (partial), and black rings. On the upper surface, there are pink-edged white ante-medial and post-medial lines on the forewing and a pinkish white-edged, black post-medial line on the hind wing. The undersides of the wings have areas with pinkish-white and others with various shades of brown.

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Figure 1. Adult male polyphemus moth, *Antheraea polyphemus* (Cramer dorsal view).
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Figure 2. Adult male polyphemus moth, *Antheraea polyphemus* (Cramer ventral view).
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Figure 3. Adult female polyphemus moth, *Antheraea polyphemus* (Cramer dorsal view).
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Figure 4. Adult female polyphemus moth, *Antheraea polyphemus* (Cramer ventral).
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Polyphemus antennae are quadripectinate (comb-like on four sides) with those of males being larger than those of females.

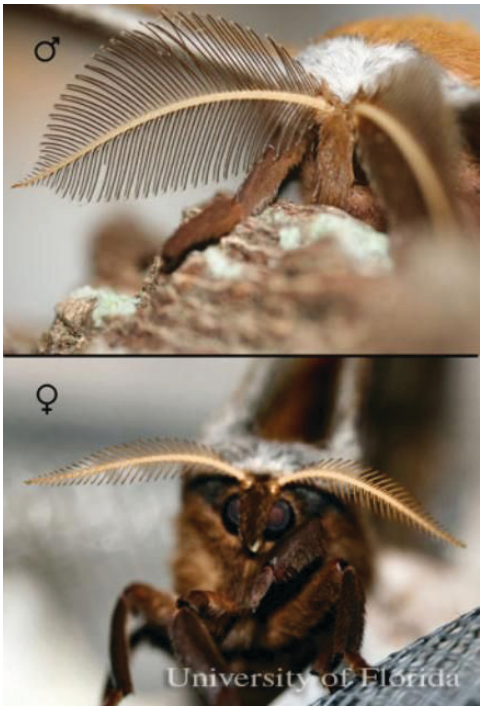

Figure 5. Male and female polyphemus moth, *Antheraea polyphemus* (Cramer) antennae.
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Eggs

The slightly oval flattened eggs are white with two broad brown rings and are cemented to the substrate with a dark brown adhesive. Maximum reported dimensions in millimeters are 2.4 × 2 × 1.52 (length × width × height) (Peterson 1965).

Figure 6. Eggs of polyphemus moth, *Antheraea polyphemus* (Cramer).
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Larvae

Packard (1914) provided detailed descriptions of the eggs and each of the five larval instars and color drawings of instars 1 to 4. He gave the following lengths for the five instars: 1st instar: 5 to 6 mm (~¼ in), 2nd instar: 14 to 15 mm (~⅔ in), 3rd instar: 20 to 25 mm (~1 in), 4th instar: 40 to 45 mm (~1½-1¾ in), 5th instar: 60 mm (2⅓ in). First instar larvae are white with two black transverse bars on the tops and sides of each segment.

Figure 7. First instar larva of polyphemus moth, *Antheraea polyphemus* (Cramer).
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Older instars are yellow-green, and the setae become relatively less prominent with each molt. The translucent yellowish-green to green, full-grown (fifth instar) caterpillars are 60 to 75 mm (2⅓–3 in) in length (Godfrey et al. 1987). They have yellow mid-segmental lines that run from the sub-dorsal scoli (setae-bearing, wart-like bumps) touching the spiracles and to the lateral scoli on abdominal segments 2 to 7. The scoli are orange to red, and the lateral aspects of the dorsal and sub-dorsal scoli are silver. The dark area of the anal plate extends as a line part way across abdominal segment nine. Fifth instars have a yellow band that extends around the dorsal and lateral areas directly behind the head, yellow bands laterally at the bases of the thoracic legs, and a yellow mid-ventral line that extends the length of the abdomen. Fifth instar male larvae can be differentiated from female larvae by the presence of a black pit on the ventral aspect of the ninth abdominal segment of males that is lacking in females (Miller and Machotka 1980).

Figure 8. Late instar larva of polyphemus moth, *Antheraea polyphemus* (Cramer).
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Figure 9. Fifth instar larva of polyphemus moth, *Antheraea polyphemus* (Cramer).
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Cocoon and Pupa

The single-layered cocoon is thicker and more elliptical than the cocoon of the luna moth (Wagner 2005).

Figure 10. Cocoon of polyphemus moth, *Antheraea polyphemus* (Cramer).
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The pupa is obtect (wings and appendages are appressed to the body). Female pupae may be distinguished from males by the presence of a longitudinal notch on the ventral surface of the fourth totally exposed abdominal segment. This notch is lacking in males. Also, the much larger developing antennae of male pupae touch each other at the mid-ventral line, while those of female pupae do not.

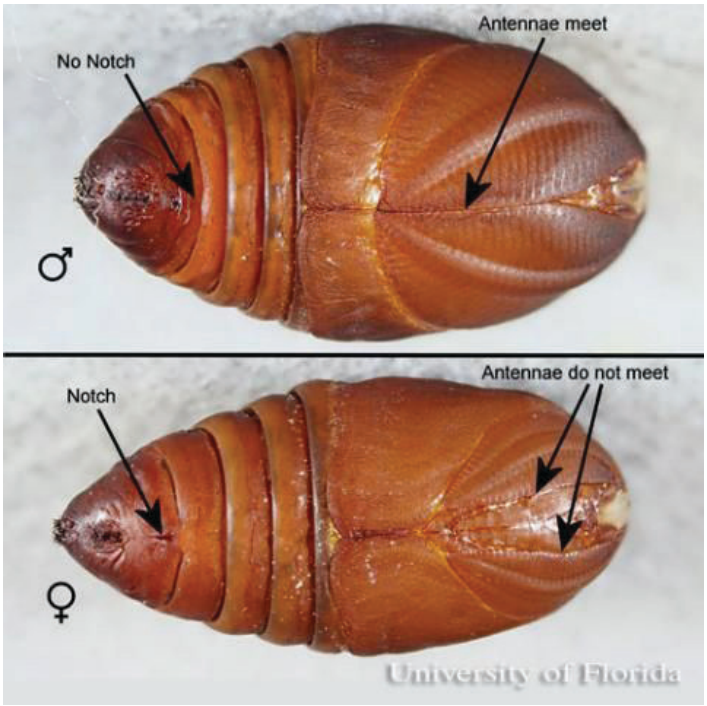

Figure 11. Male and female pupae of polyphemus moth, *Antheraea polyphemus* (Cramer).
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The pupa is anchored to a loosely spun pad of silk at the rear of the cocoon by a cremaster (spines at the tip of the abdomen) that facilitates emergence of the adult from the pupal exoskeleton.

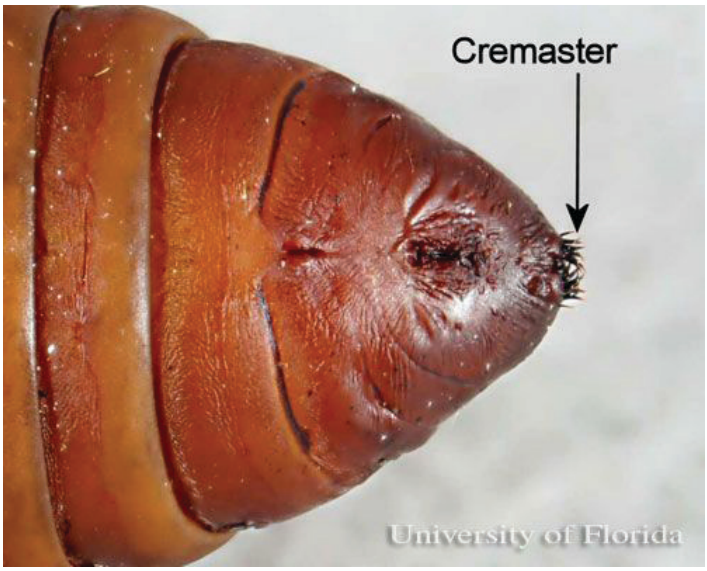

Figure 12. Cremaster on posterior end of pupa of polyphemus moth, *Antheraea polyphemus* (Cramer).
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Life Cycle

The polyphemus moth is univoltine (one brood per year) from Pennsylvania northward (Holland 1968) and bivoltine (two broods per year) from the Ohio Valley southward (Tuskes et al. 1996). However, due to staggered emergence, adults may be found during every month of the year in Florida (Heppner 2003).

The adult moth escapes the pupal case by splitting it at the anterior end and pushing the top up. Unlike the other large silk moths, the polyphemus and luna moths lack an escape "valve" in the cocoon to aid their emergence. Therefore, in order to escape their cocoons, they secrete a trypsin-like cocoonase enzyme to digest the sericin component of the silk at the anterior end of the cocoon to soften it (Kafatos and Williams 1964, Hruska et al. 1973). The cocoonase is produced and released from the highly modified maxillary galeae (the structures that form the tongue or proboscis of moths and butterflies that feed as adults). The moths then tear their way from the cocoon by the use of chitinous spurs on the thorax near the bases of the front wings while moving about the cocoon in a circular pattern (Hilton 1965). Actually, there are two spurs on each side—a large spur and a smaller spur immediately anterior to it (see photo).

Adult eclosion (emergence from pupa) typically occurs in the afternoon with males usually beginning emergence several days before females from the same brood.

Afternoon emergence allows time for expansion and drying of the wings prior to the evening flight period. Also, during the first day after emergence, the moth voids the liquid meconium, which is composed of the breakdown waste products of the old larval tissues.

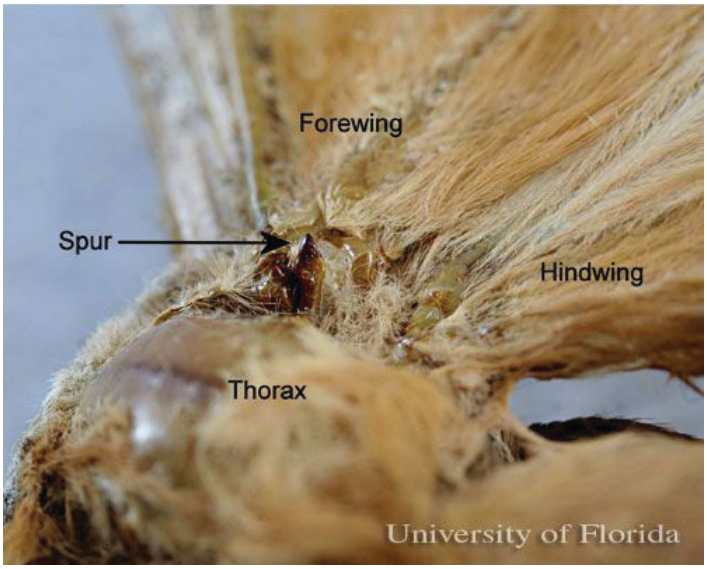

Figure 13. Thoracic spurs on thorax of polyphemus moth, *Antheraea polyphemus* (Cramer).
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The adults are strongly attracted to light—particularly UV wavelengths. There has been some concern that light pollution from man-made sources (particularly mercury vapor street lights) may deter silk moths from mating and have a negative impact on their populations in urban areas (Worth and Muller 1979). Fortunately, mercury vapor lamps are not used as commonly as they once were for street lights.

Females release a sex-attractant pheromone and may attract males from a distance beginning late evening of the day of emergence. The sex pheromone has been characterized as a 90:10 mixture, respectively, of trans-6, cis-11-hexadecadienyl acetate and trans-6, cis-11-hexadecadienal (Kochansky et al. 1975). While males are attracted all night long, maximal attractiveness is during the last two hours before sunrise (Kochansky et al. 1977). Mating pairs remain coupled throughout the day and separate at dusk. Either caged or tethered females can be used to attract wild males. Worth (1980) has designed a tether for this purpose that prevents the tethered moth from escaping or twisting the tethering line around its body.

Females begin laying eggs the evening after mating and continue for several nights. Eggs are laid singly or in groups of two or three on leaves of the host plant (Opler et al. 2012). In captivity, they will lay their eggs on any substrate. Adults have vestigial mouthparts and do not feed. Therefore, they are short-lived.

Figure 14. Cocoon of polyphemus moth, *Antheraea polyphemus* (Cramer) with emergence hole.
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Caterpillars are solitary and develop through five instars. Immediately after hatching, caterpillars eat their egg shells (Opler et al. 2012). Older instars eat whole leaves and then sever the petioles to drop them to the ground (Tuskes et al. 1996)—possibly to obscure their presence from predators. The presence of large larvae on branches overhead may often be detected by the presence of frass (caterpillar droppings) on pavement of driveways or parking lots.

Caterpillars exposed to short photoperiods (8-12 hours) produce diapausing (overwintering) pupae while those exposed to long photoperiods (>17 hours) produce non-diapausing pupae (Mansingh and Smallman 1967). Both induction and termination of diapause also may be influenced by temperature (Mansingh and Smallman 1971). Polyphemus caterpillars are polyphagous and have been reported in nature from over 50 species of broad-leaved plants (Ferguson 1972, Heppner 2003, Tietz 1972, Tuskes et al. 1996) and will feed on a wide variety of species in captivity. Polyphemus caterpillars use the full range of cocoon placement behaviors found in the subfamily Saturniinae as described by Wagner and Mayfield (1980):

1. Attached longitudinally and permanently to a twig so that the cocoon does not fall to the ground during the winter

2. Attached apically by a silk peduncle (occasionally by a double peduncle) to a twig. Peduncle may be weak allowing cocoon to fall to ground during winter or strong

so that cocoon remains on tree all winter. Attachment by a peduncle may be more common in the South (Wagner 2005)

3. Attached among leaves on trees but with no peduncle so that most fall to ground during winter

4. Spun on ground among fallen leaves, grasses or herbs

In the West, Native Americans sometimes fill the cocoons of polyphemus and other silk moths with sand or pebbles to make rattles by tying them to sticks or to their ankles for use as musical instruments (Himmelman 2002).

Figure 15. Frass (fecal pellets) of larva of polyphemus moth, *Antheraea polyphemus* (Cramer).
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Defenses and Natural Enemies

Polyphemus caterpillars are never sufficiently common to cause significant damage to their host trees except occasionally in California where they may be pests of commercial plums (Tuskes et al. 1996). Their populations are regulated by natural enemies—including insect parasitoids and generalist predators.

Polyphemus caterpillars gain protection from predators by their cryptic green coloration. When threatened they often rear the front part of the body in a "Sphinx" pose—possibly to make them less caterpillar-like to a predator. If attacked, polyphemus caterpillars, as well as those of many other bombycoid moths, make a clicking noise with the mandibles—sometimes as a prelude to or accompanied by defensive regurgitation of distasteful fluids. Brown et al. (2007) found that ants and mice were deterred by the regurgitant of the polyphemus caterpillars and suggested that the clicking is a warning of the impending regurgitation.

Cocoons hanging in trees are susceptible to attack by squirrels (Young 1982) and woodpeckers (Waldbauer 1970). Cocoons falling with the leaves in the fall or being spun among leaves or grasses on the ground may be more susceptible to attack by mice in the leaf litter, but Waldbauer (1996) believes that these cocoons gain protection from their random scattering in the litter and that the majority of cocoons that remain suspended in trees are attacked by woodpeckers.

Figure 16. Caterpillar of polyphemus moth, *Antheraea polyphemus* (Cramer) displaying the characteristic "Sphinx" pose.
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When threatened, adult polyphemus flip the front wings forward and also often flap the wings exposing the large hind wing eyespots—possibly to startle potential predators. Cryan (1973) reported an incident in which display of the eyespots appeared to protect a polyphemus in flight from blue jays.

Tuskes et al. (1996) listed the following insect parasitoids (with references) of polyphemus: ten species of tachinid flies (Arnaud 1978, O'Hara and Wood 2004), four species of chalcidoid wasps (Krombein et al. 1979, Peck 1963), one species of braconid wasp (Krombein et al. 1979), five species of ichneumonid wasps (Krombein et al. 1979, Townes 1944), and one species of proctotrupoid wasp (Collins and Weast 1961).

Old cocoons made by caterpillars that were parasitized by ichneumon wasps have an exit hole made by the wasp that is similar to that made by woodpeckers. However, they can be differentiated from cocoons attacked by woodpeckers by

the presence inside of the cocoon of the ichneumon and the cadaver of the polyphemus caterpillar.

Figure 17. Cocoon of polyphemus moth, *Antheraea polyphemus* (Cramer) with 2.0 mm diameter hole in top. The cocoon contained a hollow pupal exoskeleton with a hole of identical size, shape, and location as that in the cocoon. The hole is like those reported by Waldbauer et al. (1970) that were caused by hairy and downy woodpeckers.
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Figure 18. Cocoon of polyphemus moth, *Antheraea polyphemus* (Cramer) with exit hole made by an ichneumon wasp parasitoid. The cocoon contained an ichneumon wasp cocoon.
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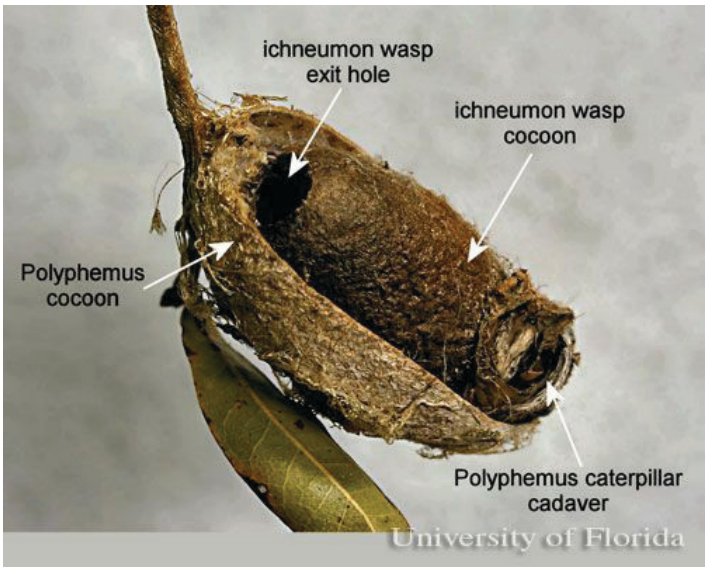

Figure 19. Cocoon of polyphemus moth, *Antheraea polyphemus* (Cramer) with an ichneumon wasp cocoon.
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