David vs. Goliath

Anthony Thomas (Canada)

Details of a tiny parasitoid wasp (2.6 mm) that kills a much larger moth caterpillar (length 80 mm).

The Moth Caterpillar

All moth caterpillars are parasitized by the larvae, maggots, of wasps and flies. This type of parasitism results in the death of the host and thus it is really a predation. However, rather than an immediate death as with most predation, death is delayed by a few weeks as the maggots feed on the internal tissues/organs of the live caterpillar. As parasites rarely cause death of a host, these wasps and flies cannot be called parasites and so have been called parasitoids.

I saw this **Laurel Sphinx Moth** (*Sphinx kalmiae*) caterpillar with its dorsal surface festooned with the silken cocoons of a parasitoid Braconid Wasp. Phographed in nature (Fig. 1) and then collected so as to photograph the wasps after they emerged.

Fig.1. Caterpillar of Laurel Sphinx moth with cocoons of a parasitoid wasp.

The Wasp.

The wasp is in the Order: Hymenoptera, Family Braconidae, and is possibly *Cotesia congregata*.

In Fig. 1 the caps, which 'pop-open' to let the wasp emerge, can be seen at the tops of some of the cocoons; seen more clearly in Fig. 2. I measured the length of one cocoon at 3.52 mm. Also seen in Fig. 2 are the orange spiracles, through which air passes into the caterpillar, visible on the lower part of the body. The dark brown spot are holes chewed by the wasp maggots and through which they emerged, the maggots then moved to the dorsal surface to spin cocoons.

Fig. 2. Close-up of caterpillar showing wasp cocoons with caps, exit holes made by the wasp maggots, and the orange spiracles of the caterpillar.

After the wasp emerges from its cocoon the cocoon often drops off the caterpillar host. Fig. 3 shows empty cocoons some with lids 'missing' and a couple with lids still attached. The brown stains are excretory products from the metabolism of the pupae which have been voided by the adult.

Fig. 3. Empty cocoons, with and without caps.

The wasps are tiny, length 2.6 mm excluding antennae, with long antennae. The wings have a very reduced venation and the female has a short egg-laying spike, ovipositor, with which she inserts eggs beneath the skin of caterpillars. Fig. 4 is a lateral view of a female whose downward pointing ovipositior at the posterior end of the body is unfortunatey partially hidden by a middle leg.

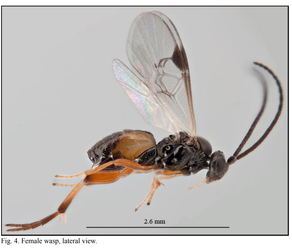

Fig. 4. Female wasp, lateral view.

Figure 5 is a close-up lateral view of the thorax and abdomen and clearly shows the short ovipositor.

Fig. 5. Thorax and abdomen showing short ovipositor.

Wings.

As with most insects there are two pairs of wings but they are unusual in that they have a few number of veins (Fig. 6). Although the forewing and hindwing of each pair are independent they function as a single unit. The leading edge of the hindwing has a series of three hooks on a stiffend bar (Fig. 6) that project dorsally and lock onto a stiffened rod on the trailing edge of the forewing (Fig. 6).

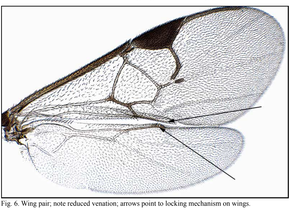

Fig. 6. Wing pair; note reduced venation; arrows point to locking mechanism on wings.

Figure 7 shows the thickened bar on the trailing edge of the forewing at about 25x, while Figure 8 shows the corresponding hooks on the leading edge of the hindwing at about 100x.

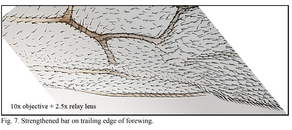

Fig. 7. Strengthened bar on trailing edge of forewing.

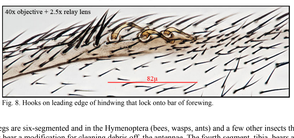

Fig. 8. Hooks on leading edge of hindwing that lock onto bar of forewing.

Legs.

Insect legs are six-segmented and in the Hymenoptera (bees, wasps, ants) and a few other insects the forelegs bear a modification for cleaning debris off the antennae. The fourth segment, tibia, bears a modified spine, fibula (Fig. 9 f; Fig. 10) that extends down from the tip of the tibia. This spine has stiff spines on its inner surface (Fig. 10). The first tarsomere, metatarsus (Fig. 9 mt), of the fifth segment bears a shallow groove lined on its inner surface with stiff hairs (Fig. 10). The base of an antenna can be fitted within the pocket created by flexing the metatarsus against the spine of the tibia; as the antenna is pulled through this pocket it is swept clean of debris. The antennae, being a major sensory organ, have to be kept clean.

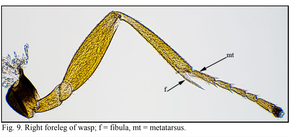

Fig. 9. Right foreleg of wasp; f = fibula, mt = metatarsus.

Fig.10. Close-up of antenna-cleaning pocket of wasp formed by modification of two leg segments.

The antenna-cleaning pocket of this wasp is not as well-developed as a similar structure in one of our local ant species (Fig. 11).

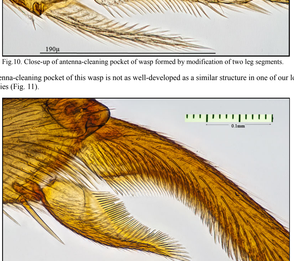

Fig. 11. Antenna-cleaning pocket on the foreleg of an ant.

Ovipositor.
The egg-laying apparatus of this braconid wasp is a complex structure, details of which are best seen after soaking the abdomen in 5% KOH, washing, dehydrating and clearing in cedarwood oil (Fig. 12)

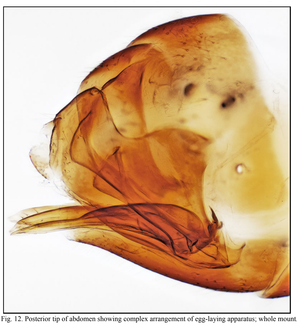

Fig. 12. Posterior tip of abdomen showing complex arrangement of egg-laying apparatus; whole mount.

As in all insects and most animals the body plan is bilaterally symmetrical about the dorsal-vertical longitudinal axis. The egg-laying apparatus thus consists of two sets of parts with the actual 'tube' (ovipositor), through which eggs are delivered beneath the outer cuticle, skin, of the host, formed by a very close association of the medial units. Figure 13 shows all the parts of the egg-laying apparatus dissected out of the abdomen and flattened on a slide. The most ventral pointed element contains the actual ovipositor tube.

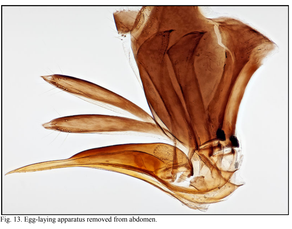

Fig. 13. Egg-laying apparatus removed from abdomen.

I have been unable to find a description of the various elements so cannot put names on them. However, I believe I can at least comment on the function of some of the elements. Normally, the ovipositor is held in the horizontal position as seen in Fig. 5. When the female lands on a host caterpillar she holds on with her legs and rotates the ovipositor 90 degrees downwards so that it is now in a vertical position above the host (position seen in Fig. 4). I'm guessing that such rotation is accomplished by muscles connected to the levers (Fig.14, lv) contracting and the articulation with the ovipositor (Fig.14, ar) causes the ovipositor to rotate vertically. Figure 14 shows the wasp's right-side of the paired egg-laying apparatus dissected out from the overlying body wall. Note that the most ventral element below the tip of what I believe to be the actual tube (ov) through which the eggs pass is a barbed spear (sp) which, with its conterpart on the left-side, most likely makes the entrace hole in the caterpillar's skin.

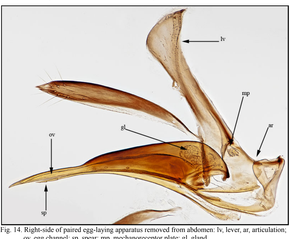

Fig. 14. Right-side of paired egg-laying apparatus removed from abdomen: lv, lever, ar, articulation; ov, egg channel; sp, spear; mp, mechanoreceptor plate; gl, gland.

At the base of the lever (lv) is a mechoreceptor plate (mp) housing about 30 trichoid sensilla. These sensilla have nerve connections and these "tell" the female the orientation of the oviposite. At the base of the ovipositor (ov) is a gland (gl) - function unknown; possibly for lubrication or even for local anethesia of the caterpillar. Figure 15 shows a close-up of the ovipositor and the barbed spear.

Fig. 15. Tip of ovipositor tube plus associates barbed spear.

And Fig. 16 shows a close-up of the mechanoreceptor plate with about 30 trichoid sensilla. Each sensillum consists of a hair-like projection of cuticle surrounded by a membranous socket. A nerve cell is asociated with each hair and the surrounding membrane allows the hair to move.

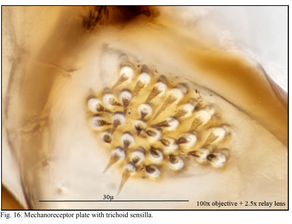

Fig. 16. Mechanoreceptor plate with trichoid sensilla.

Microscope and Photographic Equipment

My basic equipment is an Olympus BH2 with 2x, 4x, 10x, 20x, 40x, 60x, and 100x objectives; Olympus 2.5x NFK relay lens. I also have the components for Phase Contrast, DIC and Polarization. Camera is a Nikon D90 with Nikon PB-6 bellows; Nikon flash in place of Olympus' halogen lamp. For reflected light images I use Nikon CF objectives, El-Nikkor enlarging lenses, and a MF 105mm Micro Nikkor.
Most images are stacks of several frames processed by Zerene Stacker.

Contact author, email: mothman AT nbnet DOT nb DOT ca

Published in the September 2012 issue of Microscape Magazine, www.microscape.org.