A Winter Spider

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I brought in some wood from an unheated garage and a little spider 'emerged' from the pile. Here in eastern Canada the garage has been way below freezing for a couple of months, possibly even getting down to -20C. Unfortunately the spider died within an hour – heat shock? Rather than discard the little fellow I decided to photograph it.

Figure 1 shows the form (habitus) of the spider after death. I did manage to get a shot of the face of the spider soon after it died which shows the disproportionally large chelicerae beneath the 8 eyes (Fig. 2).

Fig. 1. Dorsal view (Nikon 105mm MF Micro Nikkor).

Fig. 2. Face view showing huge chelicerae below the 8 eyes (4x Nikon CF N Plan Achromat objective).

Technique.
The dead spider was initially placed in 70% alcohol and then into 100% alcohol. When throughly dehydrated it was cleared in cedarwood oil. All subsequent images are of the spider in this oil. The advantage of not permanently mounting the specimen in, for example, Canada balsam is that it can be manipulated to photograph at different angles. For my first close-up of the body (Fig. 3) I placed the spider on my vertical macro-stand and used a 4x Nikon CF N Plan Achromat objective on a bellows. This set-up allows for 'stated' magnification, *i.e.*, 4x. With my Olympus BH2 microscope I use a 2.5x Olympus NFK relay lens to project the image, from the objective, onto a camera's sensor. That set-up gives a 10x magnification with a 4x objective – sometimes desirable, sometimes not.

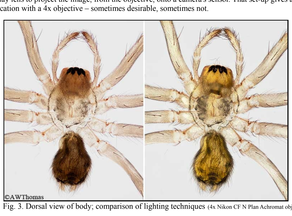

Fig. 3. Dorsal view of body; comparison of lighting techniques (4x Nikon CF N Plan Achromat objective).

For thin reasonably transparent objects light from beneath the subject (transmitted light) works well on my vertical set-up. For thicker subjects with surface detail light from above (reflected light) works best. This spider has a pair of thin pale pedipalps and 8 pairs of thin pale legs well suited for transmitted lighting (Fig. 3, left). However, the main body, anterior cephalothorax (prosoma) including the eyes and posterior abdomen (opisthosoma), was too dense to show detail with transmitted light. With a combination of transmitted and reflective lighting the pedipalp and leg details remain visible and more detail can be seen in the dorsal surfaces of the body including the eyes (Fig. 3, right).

The dual lighting was obtained by positioning a flash at the level of the spider (on a microscope slide) such that half of the flash's light reflected off the dorsal surface of the spider and half of the light illuminated a shiny white sheet placed beneath the spider. Figure 4 shows the vertical set-up with a Nikon 105mm micro lens attached to bellows; and Figure 5 shows the specimen-holding area in more detail.

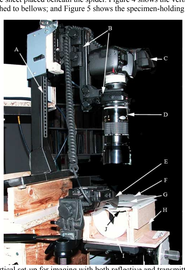

Fig. 4. Vertical set-up for imaging with both reflective and transmitted light.
A old enlarger stand; B bellows; C control for remote flash; D 105mm lens; E flash at level of plate F; F translucent plate; G specimen; H false stage attached to stage of a BH2 microscope; J arm of microscope with objective holder and eyepiece removed; the hole in J allows light reflected from the white curved paper to illuminate the subject from below.

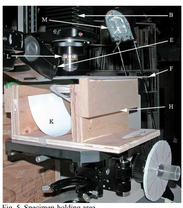

Fig. 5. Specimen-holding area.
Labels as in Fig. 4 plus: K white reflective sheet; L 10x Nikon CF N Plan Achromat objective; M focusing lamp.

Cephalothorax or Prosoma.
This anterior part of the body is formed by a fusion of the head and the thorax and is covered dorsally by a shield, the carapace (Fig. 6). The 8 simple eyes are located on the leading edge of the carapace with 2 facing upward, 2 facing laterally and 4 facing forward (Figs. 2, 6, 7). Each eye is 'simple' in the sense that each has only one lens; it contrasts with the complex eyes of insects that have many lenses in each eye. Being predators, spider's eyes are excellent for recognizing and stalking prey. Their is nothing 'simple' in their ability to see. The yellow/orange blocks beneath and posterior to the eyes are the huge chelicerae situated ventrally and vertically.

Fig. 6. Cephalothorax or Prosoma (10x Nikon CF N Plan Achromat objective).

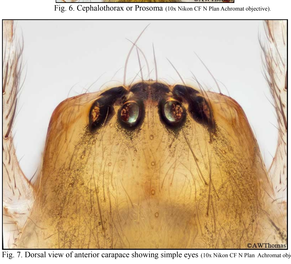

Fig. 7. Dorsal view of anterior carapace showing simple eyes (10x Nikon CF N Plan Achromat objective).

Each chelicera consists of a stout basal segment with sharp triangular teeth and a distal fang-like segment. These chelicerae are held vertically beneath the eyes (Fig. 8) with the fangs 'closed'. The fangs 'open' when prey is attacked (Fig. 9). I suspect the splayed basal segments in Fig. 9 is a consequence of slight flattening under the coverglass on the microscope slide.

Fig. 8. Chelicerae with fangs in 'closed' position (10x Nikon CF N Plan Achromat objective).

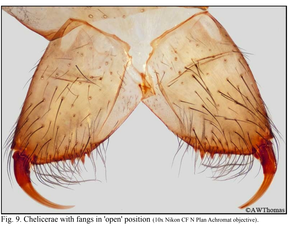

Fig. 9. Chelicerae with fangs in 'open' position (10x Nikon CF N Plan Achromat objective).

In ventral view the components of the prosoma, head and thorax, are distinctly recognizable. Anteriorly the massive chelicerae dominate the head. Immediately posterior to the chelicerae is the mouth surrounded laterally by the basal segments of the pedipalps which act as crushing jaws (Fig. 10).

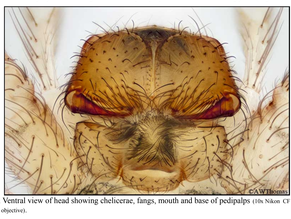

Fig. 10. Ventral view of head showing chelicerae, fangs, mouth and base of pedipalps (10x Nikon CF N Plan Achromat objective).

Each of the 8 legs terminates in a pair of claws plus a smaller single central claw. The larger claws have a row of smaller claws along much of their inner surface (Fig. 11). Also present on this lower tarsal segment are long sensory hairs, trichobothria, which themselves are 'hairy' (Fig. 11).

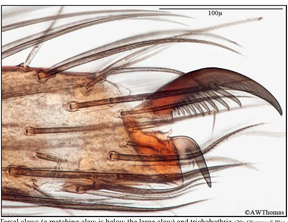

Fig. 11. Tarsal claws (a matching claw is below the large claw) and trichobothria (20x Olympus S Plan objective + 2.5x relay lens).

All the above images are with 'normal' flash illumination while the following images are with polarized light on an Olympus BH2 microscope.

On the lower surface of the carapace in the midline and about 2/3rds towards the posterior is a thickened ridge, visible as a brown line in Fig. 6. Looking at this spider under polarized light revealed some interesting details. The carapace ridge becomes more obvious (Fig. 12, circled) and muscle rays (blue) can be seen anchored to it. The ridge and the muscles are shown in close-up in Fig. 13 as blue and orange fibers.

Fig. 12. Dorsal view of prosoma showing internal ridge and muscles attached (Olympus S Plan FL2 objective + 1.25x intermediate lens + 2.5x relay lens).

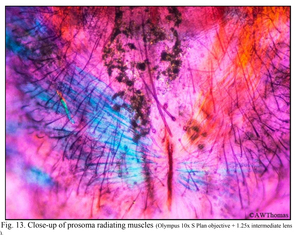

Fig. 13. Close-up of prosoma radiating muscles (Olympus 10x S Plan objective + 1.25x intermediate lens + 2.5x relay lens).

Also visible in Fig. 12 are the muscles in the basal leg segments, especially the green muscles in the long femurs of the legs.

Under polarized light the chelicerae show details of the internal muscles (Fig. 14). Especially interesting are the different sized muscles in the basal segment. The smaller single protractor muscle (PM) attaches directly to a condyl on the outer side of the fang and serves to pull open the fang – not much energy required. Unlike the situation with the protractor muscles, the huge retractor muscles do not attach directly to the fang. Instead they connect to a sclerite (SC) which connects to a condyle on the inner side of the fang with, what appears to me to be, a block of resilin; visible as small green blocks between the sclerites and the fangs (Fig. 14). Resilin is an elastomeric protein that can store much of the energy (97% in a locust leg) required to deform it. Thus the muscle energy required to open the fangs, before a strike on a prey animal, deforms the resilin blocks on the inner surfaces of the fangs. When the retractor muscles are contracted the stored energy in the resilin is released and the fangs are pulled inwards with a force greater than that obtained from the retractor muscles alone. In other words, the spider is using much of the energy used to open the fangs to close the fangs and to pierce the integument of prey animals.

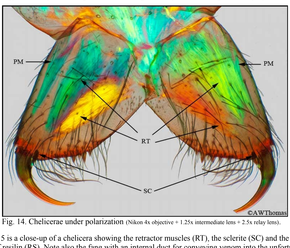

Fig. 14. Chelicerae under polarization (Nikon 4x objective + 1.25x intermediate lens + 2.5x relay lens).

Figure 15 is a close-up of a chelicera showing the retractor muscles (RT), the sclerite (SC) and the small block of resilin (RS). Note also the fang with an internal duct for conveying venom into the unfortunate victim, seen in more detail in Fig. 16.

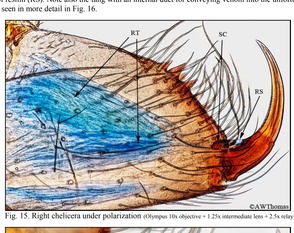

Fig. 15. Right chelicera under polarization (Olympus 10x objective + 1.25x intermediate lens + 2.5x relay lens).

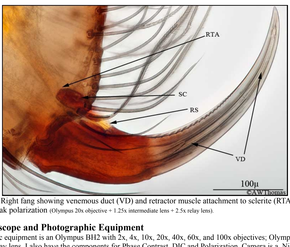

Fig. 16. Right fang showing venemous duct (VD) and retractor muscle attachment to sclerite (RTA) under very weak polarization (Olympus 20x objective + 1.25x intermediate lens + 2.5x relay lens).

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.

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