Fishing spiders in the hanging stomachs of Borneo

Dr. Simon D. Pollard • Curator of Invertebrate Zoology at Canterbury Museum & Adjunct Professor of Science Communication • University of Canterbury • Christchurch • New Zealand • simon.pollard@canterbury.ac.nz

Keywords: Field studies: Borneo, spiders, ants, *Nepenthes gracilis*, *Misumenops nepenthicola*, *Oecophylla smaragdina*.

Desperate for a drink, the famous naturalist Alfred Wallace drank the liquid from a group of pitcher plants while exploring Malaysia. Although the fluid was full of dead insects and looked "uninviting", he wrote in 1890 that he and his friends "found it very palatable, though rather warm, and we all quenched our thirst from these natural jugs". They must have been almost delirious with dehydration to have quaffed a few pitchers, as one local name for these plants translates to "the place where rats pee", probably because of the urine-like smell from decomposing insects. While I have drunk the fluid from unopened pitchers of *Nepenthes gracilis* (slightly sweet and slimy), when it smells like a rat urinal, and comes from a vessel often called a "hanging stomach", it does not sound like a drink that will improve with age.

In many ways the pitchers are like the stomachs of animals. Although not bubbling cauldrons of flesh-dissolving digestive fluid, they do contain bacteria and antioxidants that break the insects down. One animal that often ends up with pitcher-plant food in its own stomach is the crab spider *Misumenops nepenthicola*. It spends almost its entire life living within the pitcher and captures insects lured to the plant's nectar, as well as aquatic larvae living in the pitcher-plant fluid.

Misumenops not only lives with a number of Asian species of *Nepenthes* and steals their food,

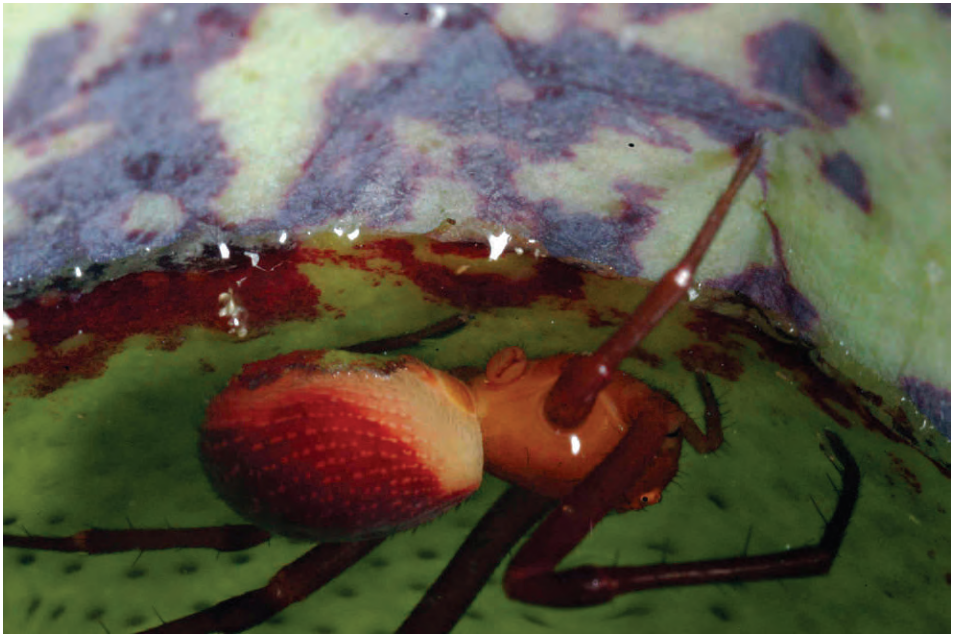

Figure 1: *Misumenops* with air bubble.

Figure 2: *Misumenops* dragging ant.

Figure 3: *Misumenops* and larva.

but it even uses the plant's insect trap to defend itself. When I first started peering into the pitchers of *Nepenthes gracilis* in Bako National Park in Sarawak on the island of Borneo, I was sure I sometimes caught a flash of red. This turned out to be the spider leaping from the walls or lip of the jug into the fluid. And predators a lot smaller than me have the same effect. The footsteps of large nectar-loving ants, three to four times the size of the spider, are enough to make the spider take the plunge. Fortunately for the spider, no underwater wrestling ensues, as these ants are somehow able to avoid the pitfalls of a slippery lip. *Misumenops* does not end up permanently in the pitcher because it leaves draglines of silk hanging from the lip of the pitcher down to the fluid and even below its surface. It uses these to move very quickly around the slippery walls of the pitcher and when it emerges from the fluid, it just grabs a silken line to help it get to the dry pitcher wall.

If the pitcher had only recently opened for business and was not full of drowned victims being broken down into plant nutrients, I could see the spider clearly beneath the fluid. When the pitcher was a murky mass of bodies (or "necromass"), the spider would scuttle crab-like beneath the corpses in their watery grave and later emerge, zombie-like, with its body cloaked in the partially digested bodies of ants and other insects.

How does this spider manage to breathe underwater? Unlike some aquatic spiders, which trap a bubble of air over their entire body, adult and large juvenile *Misumenops* trap only a small air bubble over a pit on the anterior ventral abdomen next to the book lungs, which are used for breathing (see Fig. 1). The pit is covered in water-repellent hairs that help push the air bubble against the sides of the pit and keep it in place. This elaborate mechanism is to overcome a property of the pitcher-plant fluid that encourages drowning rather than breathing. Pitcher plants produce a surfactant or wetting

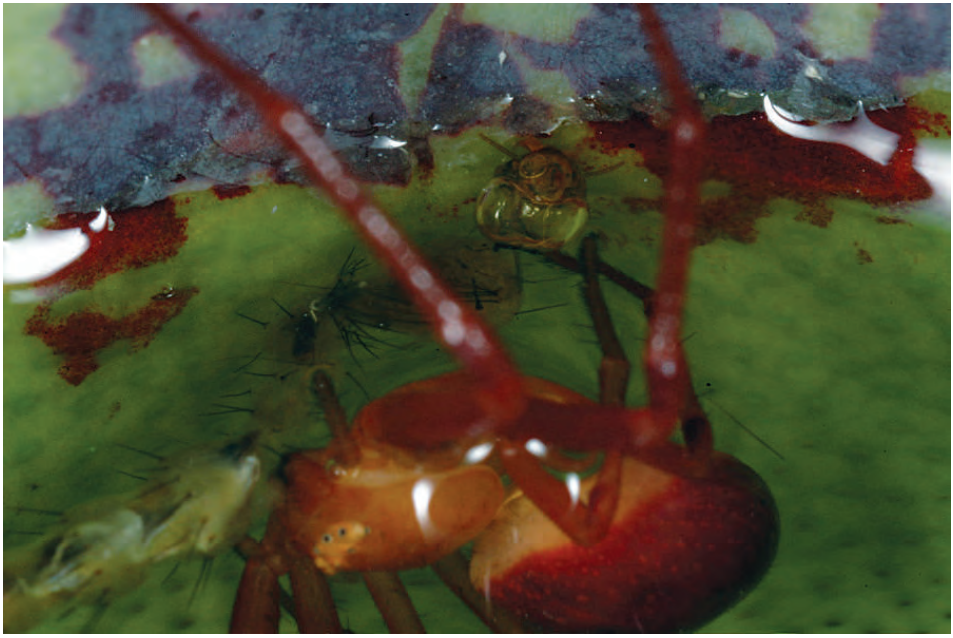

Figure 4: *Misumenops* underwater with larvae.

agent (hence the liquid's slimy feel when I drank it) that reduces the surface tension on the fluid's surface. This facilitates the smooth transition from air to liquid for plummeting insects. Obviously, pitcher plants want their food *inside* their stomachs, not skating around on the surface breathing tiny sighs of relief! However, for a plummeting spider, low surface tension also makes it more difficult to trap an air bubble; hence the hairy pit.

With an air bubble attached, the spider can stay underwater for about 40 minutes. If it needs to come up for a breather it can just raise its hairy pit above the surface and take down another bubble of air. *Misumenops* does not have a water-repellent cuticle, like some aquatic spiders, and so it emerges from the fluid looking like the proverbial drowned rat. Although the fluid only digests the dead, the spider carefully grooms itself dry, before deciding its next move.

Just how does *Misumenops* steal sweet-toothed insects from the jug? For insects like flies and beetles, *Misumenops* is a rather malevolent lifeguard as it saves some of them that have just fallen in, from drowning, by hauling them out of the fluid. The kiss of death rather than the kiss of life follows the rescue and the spider then sucks its victim dry. Many other species of crab spiders also exploit the attractiveness of nectar by living on flowers and ambushing pollinating insects.

The most common victim of *Nepenthes gracilis* in Bako National Park are green weaver ants (*Oecophylla smaragdina*) and *Misumenops* has a very clever way of catching them. The ants are far too dangerous for the spider to catch on its own, so it lets the plant do most of the work. At times, the spider will detect the splash of a green weaver ant as it falls in. After a minute or two the ant sinks and drowns in the fluid. Out of sight but not out of mind, the spider waits about ten minutes before submerging and retrieving the freshly-dead and harmless ant (see Fig. 2).

Misumenops also goes fishing for aquatic larvae that are living in the pitcher fluid (see Fig. 3). It will stick its long front legs into the fluid and grab larvae as they come to the surface to breathe, or it will drop into the fluid and catch them underwater (see Fig. 4). It will even crawl into the necromass,

throw a little spider tantrum by thrashing around, and flush out larvae which are hiding there. As the larvae swim away from the disturbed necromass they are captured by the spider.

Female *Misumenops* build an egg sac just above the pitcher's fluid line, and when the baby spiders emerge they disperse around the dry walls inside the pitcher. Just like their parents, the babies also leap into the fluid when disturbed. The sight of 50-odd spiderlings making tiny splashes as they submerge reminds me of an arachnid version of "Titanic"! Because the spiderlings are so small, they can trap an air bubble over their entire abdomen, and will stay submerged for as long as the adults. Ironically, while the lower surface tension makes it more difficult for the adults to trap a bubble of air, the babies actually benefit from the surfactant, as it allows their small bodies to slip underwater more easily. When I saw the babies jump into regular water, a number got stuck on the surface "skin". Eventually the spiderlings leave their nursery to find their own pitchers.

What does the carnivorous plant get out of having a free-loading carnivore living in its insect trap? Well, probably nothing, except the spider at least uses the pitcher as a gigantic toilet and returns some of what it stole from the plant. This makes me feel even less like following Wallace's "line"; but if I ever had to, it would be one cocktail I would neither shake nor stir.

Carnivorous plant cultivar names registered in 2011

Dionaea 'Fondue' G.Bily, Carniv.Pl.Newslett.40:95 (2011)	20 Oct.
Dionaea 'JA1' J.A.Gonzalez Dominguez, Carniv.Pl.Newslett.40:140 (2011)	30 Dec.
Drosera 'Ambrosia' B.Barnes, Carniv.Pl.Newslett.40:25 (2011)	3 Apr.
Drosera 'Dreamsicle' B.Barnes, Carniv.Pl.Newslett.40:25 (2011)	3 Apr.
Drosera 'Golden Dew' S.Fretwell, G.Bourke & S.Spence, Vic.Carniv.Pl.Soc.101:5 (2011)	20 Oct.
Drosera 'Leo Bourke' G.Bourke, Carniflora Australis 7(3):4 (2010)	29 Jun.
Drosera 'Woolly Beast' B.Barnes, Carniv.Pl.Newslett.40:26 (2011)	3 Apr.
Drosera 'Woolly Red' B.Barnes, Carniv.Pl.Newslett.40:26 (2011)	3 Apr.
Nepenthes 'Fat Boy' G.Bourke, Carniflora Australis 7(3):5 (2010)	29 Jun.
Nepenthes 'Red Rocket' G.Bourke, Carniflora Australis 7(3):5 (2010)	29 Jun.
Sarracenia 'Blood Sweat & Tears' P.Wilson, Carniv.Pl.Soc.J.(UK) 33:52 (2011)	7 Nov.
Sarracenia 'Deep Throat' P.D'Amato, Carniv.Pl.Newslett.40:138 (2011)	30 Dec.
Sarracenia 'Godzuki' P.D'Amato, Carniv.Pl.Newslett.40:96 (2011)	20 Oct.
Sarracenia 'Gorey' J.Lechtman, Carniv.Pl.Newslett.40:136 (2011)	30 Dec.
Sarracenia 'Leo Song' P.D'Amato, Carniv.Pl.Newslett.40:137 (2011)	30 Dec.
Sarracenia 'Red and White' P.D'Amato, Savage Garden:82 (1998)	30 Dec.
Sarracenia 'Seurat' J.Lechtman, Carniv.Pl.Newslett.40:136 (2011)	30 Dec.
Utricularia 'Allure' G.Bourke, Captive Exotics Newslett.1(4):7 (2011)	29 Jun.
Utricularia 'Irene' G.Bourke, Carniflora Australis 7(3):7 (2010)	29 Jun.
Utricularia 'Merrie Heart' P.D'Amato, Carniv.Pl.Newslett.40:97 (2011)	20 Oct.