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SCIENTIFIC NOTE

Collecting Insects Associated with Wetland Vegetation: An Improved Design for a Floating Pitfall Trap

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Collecting insects in wetlands with dense vegetation is difficult at best due to standing water and high structural complexity. Almost as many sampling methods are available for sampling insects in aquatic habitats as there are types of water bodies (Cummings 1962). Merritt *et al.* (2008) provided the most recent comprehensive guide to aquatic sampling methods and listed over 30 different methods to collect arthropods in and around aquatic and emergent macrophytes. The number and type of taxa collected in an aquatic sampling program depends on the type of collection strategy used and types of local vegetation (Turner and Trexler 1997).

Using pitfall traps for insect collection has a well-established history in entomology and is commonly used in terrestrial systems for biodiversity studies (Triplehorn and Johnson 2005; Aguilar Julio 2010). Pitfall traps operate continuously, are inexpensive and easy to use, and result in large species-rich samples (Clark and Blom 1992). Forests and agricultural areas are most commonly sampled with pitfall traps, but they are rarely used in areas that could potentially be flooded (Mertens *et al.* 2007). A handful of floating pitfall type designs are scattered in the literature, but none are addressed in Merritt *et al.* (2008). Floating pitfall traps have been used to sample amphibians (Jones 1986) and spiders (Renner 1986; Graham *et al.* 2003), but rarely for insects.

Grigarick (1959) provided the first description of a floating trap that was designed to sample *Hydrellia* sp. (Diptera: Ephydridae) in rice fields. The design consisted of a round 20.3-cm diameter by 3.2 cm deep aluminum pan inserted into a piece of wood. The trap was non-selective and caught a wide variety of insects as well as animals, and due to the shallow design was swamped easily by water movement. Additional published designs consisted of a 0.4-L small pot (unspecified type) weighted with wax and lead, and inserted into a 20.0-cm × 12.0-cm piece of cork (Ruzicka 1982) and a 3.5-cm × 8.0-cm vial inserted into a 12-cm square board (Renner 1986). Graham *et al.* (2003) constructed a floating pitfall trap with a double cup, the smaller cup for collecting fluid nested inside of a larger outer cup (10 cm diameter) weighted with mud and rocks. The doubled cup was then inserted into a 15-cm piece of square styrofoam.

We constructed and tested each of the published trap designs in the field before beginning to create our own. Traps based on Grigarick (1959) were quickly sunk by turtles at our field site. Those constructed according to Renner (1986) would not stay level with the water's surface and the openings were easily blocked by debris. The design from Ruzicka (1982) fared slightly better, but the cork used for the float degraded quickly in the water, and Louisiana's high summer temperatures melted the wax, fouling samples. The design of Graham *et al.* (2003) accumulated water between the nested cups, resulting in the inner cup floating with the top several centimeters above the water's surface. We also had problems with the styrofoam float disintegrating and degrading in the heat. We aimed to design an inexpensive, robust trapping system to effectively sample insects associated with emergent and floating macrophytes, and could be deployed in the field for long periods of time without maintenance.

Pitfall traps in terrestrial systems consist of two major parts: a base that includes the trapping container and a cover. Our trap design includes those features as well as an anchoring stake with tether as an additional component (Fig. 1). The floating base consists of a Ball® (Daleville, IN) standard mouth, 236.5-ml glass canning jar with 85 g of lead fishing weights placed in the bottom. The weights were encased in FloraCraft® (Ludington, MI) liquid acrylic resin, poured over the weights to cover them in the bottom of the jar in order to prevent lead contamination in the environment. These jars were hot glued into a 15 × 15-cm piece of 2.5 cm thick black polyethylene packaging foam with a 6.7 cm diameter hole cut in the center. Trial traps were built with several thicknesses of foam and several types of glues to evaluate and ensure proper placement at the surface and longevity in the field (see floating trap in Fig. 2). The rod ends of four K'nex®

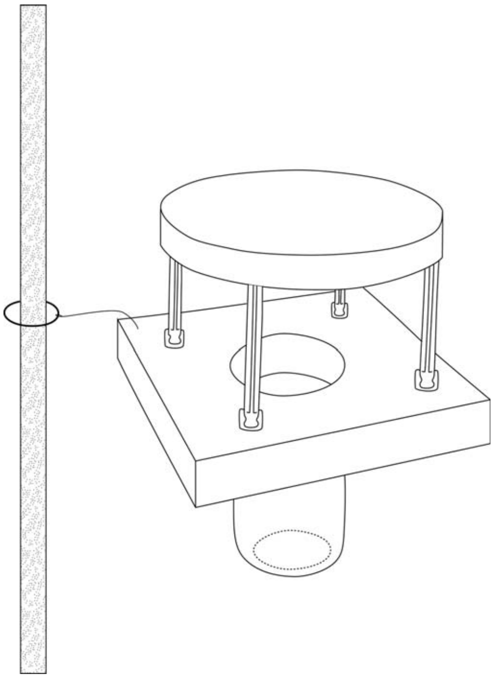

Fig. 1. Line drawing depicting our design for an improved floating pitfall trap (with gardening stake at left). Lead weights are not depicted in the jar.

(Hatfield, PA) "Standard Black Rod/Connectors" (Part #90914) were hot glued into the foam, rod down, 3.7 cm from the hole of the jar. These served to connect the cover to the base. The cover was made from a Fisher® (Hampton, NH) clear polystyrene Petri dish (15 mm ×150 mm) with four K'nex® "Standard Yellow Rods $3^{7}/_{16}$" (Part #90953) spaced evenly on the inside of the edge of the Petri dish and hot glued in place. While covers do not appear to affect the composition of trap catches in terrestrial systems (Buchholz and Hannig 2009), we chose to use a clear cover to reduce debris in the trap and potential bias. A 2.5-cm key ring was attached to one corner of the foam with a 30-cm piece of 49-strand nylon-covered steel jewelry wire. The ring was placed over a Gardener's Blue Ribbon® (Lititz, PA) 2-m Plastic-Coated Steel Landscape Stake, preventing horizontal drift but allowing vertical movement with changes in water level.

Our floating pitfall trap cost approximately US$9 to build (including the landscaping anchor stakes) and was constructed in the laboratory. The assembly of a complete trap from beginning to end took less than an hour (not including time for the acrylic to set). Traps that failed in the field were found to have a variety of problems including animals eating the foam, falling branches, and turtles using them as a platform. Traps that became submerged stayed buoyant at the water's surface and still collected

Fig. 2. Trap *in situ,* approximately 0.5 m deep water with surface covered by aquatic macrophytes and debris.

insects, even after the jar became flooded. Less than 50 individual trap catches out of 1,300 were lost due to being overturned or fully submerged. After a year of environmental exposure, the foam on some traps began to lose buoyancy and was replaced in preparation for an additional field season.

Evaluation of collection methods and designing a robust collecting program in wetlands with heavy vegetation requires knowledge of the target taxa, sampling characteristics of the method(s) selected, and the amount of time required to process the catch (Turner and Trexler 1997). Both dipnets and core samplers have been commonly used to take whole plant samples in other studies looking at arthropods associated with aquatic macrophytes (Bennett 1966; Forno and Bourne 1984; Herrera *et al.* 2000; Poi de Neiff and Neiff 2006; Albertoni and Palma-Silva 2006). Unfortunately, vegetated dipnet and core samples can take 2–5 hrs per sample to process (Meyer *et al.* 2011). In comparison, our field team of four people serviced 100 traps in the field in 3–4 hrs, and later sorted the catches in the laboratory. Each trap collection required an average total processing time of 20 min invested per trap for each service date, which allowed us to take and process a higher number of samples than if we had taken whole plant samples. Our trap design provides an easy and efficient way for collecting insects associated with floating and emergent macrophytes for a wide variety of both taxonomic and ecological studies. Use of these traps does not require the removal of vegetation or disturbance to the local community and allows for repeated sampling in the same physical location.

Utilization of different collection methods in wetlands results in very different taxa (Meyer *et al.* 2011). Floating pitfall traps allow collection of specimens missed by other types of aquatic sampling, partially due to the long collecting period. Highly mobile or nocturnal groups that are using the aquatic vegetation would easily be missed using the commonly used net and core based sampling methods. As in terrestrial ecosystems, biases in the design of the floating pitfall traps surely exist (Work *et al.* 2002) and should be evaluated in future investigations. Pitfall traps in terrestrial systems depend on movement of individuals and collect based on activity and density (Topping and Sunderland 1992), so potential biases in a floating pitfall trap include a positive bias to mobile species that frequent the surface and are associated with floating and emergent macrophytes, while under sampling taxa that are restricted to the water column. While we designed these traps specifically to collect insects associated with wetland vegetation, these traps could easily be implemented as part of a larger wetland sampling regime to complement other collection methods.

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