

## SCIENTIFIC NOTE

# AN AQUATIC LIGHT TRAP DESIGNED FOR LIVE CAPTURE OF PREDATORY *TROPISTERNUS* SP. (COLEOPTERA: HYDROPHILIDAE) LARVAE IN ARKANSAS RICE FIELDS<sup>1,2</sup>

JAMES A. DENNETT<sup>3</sup> AND MAX V. MEISCH<sup>3</sup>

Department of Entomology, University of Arkansas, Fayetteville, AR 72701

**ABSTRACT.** Construction of an aquatic light trap developed for the live capture of 3rd-stage larvae of predatory *Tropisternus* sp. for use in laboratory bioassays against larvae of *Anopheles quadrimaculatus* and *Psorophora columbiae* is described. On 10 occasions, an average of 5.2 traps was used per evening, resulting in 52 trap-nights that accumulated 106.7 h of trapping time, or an average of 10.6 h per trap. Use of 2 heavy-duty alkaline D-sized batteries and appropriate in-circuit resistance effectively increased bulb life and trap operating time, ranging from 22 to 36 h. During both seasons, approximately 3 wk after permanent flooding of large rice fields was the most productive period in which to capture larvae of *Tropisternus* sp. Live trapping worked well and provided numerous larvae of *Tropisternus* sp. for use in laboratory predation bioassays with *An. quadrimaculatus* and *Ps. columbiae* larvae. Six hundred fifteen 3rd-stage larvae of *Tropisternus* sp. and 740 adult *Tropisternus lateralis* were captured in aquatic light traps in 1999 and 2000. Of traps containing larval *Tropisternus* sp. and adult *T. lateralis*, average numbers of 15.3 and 19.4 were captured per trap, respectively. Among all traps, the largest nightly captures of larval *Tropisternus* sp. and adult *T. lateralis* consisted of 263 and 404 specimens, respectively. The largest single trap captures for larval *Tropisternus* sp. and adult *T. lateralis* were 94 and 184, respectively. Additionally, 478 rice water weevils (*Lissorhoptrus oryzophilus*) also were captured. Rice water weevils averaged 36.7 per trap, with the largest single trap capture of 102 weevils on an evening where 287 weevils were captured among all traps. Other predatory insect species were captured infrequently, consisting primarily of 3rd-stage larvae of *Hydrophilus triangularis* and adult belostomatids, dytiscids, and notonectids. Predatory larvae of *H. triangularis* may have been attracted to the traps by the presence of larval *Tropisternus* sp. Larval *Tropisternus* sp. may have been attracted by the light source and prey items that entered the trap, such as chironomid larvae.

**KEY WORDS** *Anopheles quadrimaculatus*, *Psorophora columbiae*, *Tropisternus lateralis*, predation, biological control, aquatic light trap

Before conducting laboratory research on the predatory impact of larvae of *Tropisternus* sp. (Coleoptera: Hydrophilidae) against larvae of *Anopheles quadrimaculatus* Say and *Psorophora columbiae* (Dyar and Knab), a collection method was needed to obtain large numbers of live 3rd-stage larvae of *Tropisternus* sp. Sampling both adult and larval beetles can be performed by using dippers or aquatic nets, but such sampling is labor intensive, whereas light trapping has been proven efficacious in the past.

During a quantitative sampling study performed in California, Washino and Hokama (1968) used aquatic traps containing an incandescent light source that were vertically submerged in rice fields 1 night per week from June to September. Over this period, 860 larval and 1,790 adult *Tropisternus* spp.

were collected with 6 traps 1 night per week. These traps collected large numbers of hemipterans and coleopterans, but were designed to kill any insects captured.

Zalom et al. (1980) placed similar traps at distances of 1, 5, and 30 m away from rice levees to determine relative densities of adult and larval hydrophilids in California. Bimodal trap catches of adult *Tropisternus lateralis* (Fabricius) were made, with peaks occurring during May and July. Most adults and larvae of *T. lateralis* were trapped closer to levees, but some were found at all distances monitored. In a similar study, Zalom (1981) used aquatic light traps to collect aquatic invertebrates weekly in California rice fields. Stepwise multiple regression analysis revealed that populations of *T. lateralis* were influenced positively by availability of chironomid larvae prey, and negatively by the presence of predatory dytiscid adults and larvae of *Hydrophilus triangularis* Say.

Our objective was to develop an effective method for capturing live 3rd-stage larvae of *Tropisternus* sp. from Arkansas rice fields without having to waste valuable field time in collecting predators with aquatic nets. A self-contained aquatic light

<sup>1</sup> Mention of commercial products does not imply a recommendation for use or sale by the University of Arkansas.

<sup>2</sup> Approved for publication by the Director of the Arkansas Agricultural Experiment Station.

<sup>3</sup> Former Graduate Assistant and University Professor, respectively, Department of Entomology, University of Arkansas, Fayetteville, AR 72701.

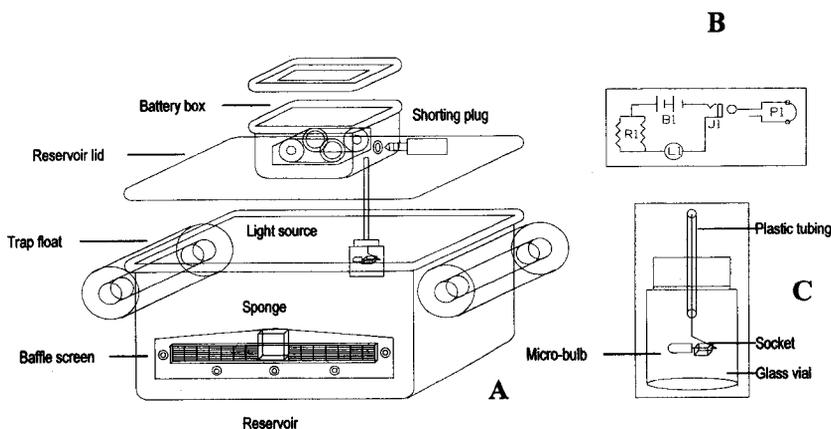


Fig. 1. Diagram of an aquatic light trap designed for the capture of 3rd-stage larvae of *Tropisternus* sp., illustrating basic trap configuration (A), wiring schematic (B), and close-up of light source (C).

trap that would permit live capture of hydrophilid larvae and possibly other aquatic insect species could benefit research with these and other organisms. To our knowledge, no aquatic light trap has been designed specifically for the live capture of larvae of *Tropisternus* sp. beetles. Therefore, we designed a trap particularly for this purpose. In designing the trap, special consideration was given to the larval *Tropisternus* sp. because larvae drown readily without some means of flotation and are cannibalistic when crowded (Plague 1996).

The aquatic light trap was fabricated from 1 Rubbermaid® 5.6-liter clear plastic shoe box (model 2217, Rubbermaid Inc., Wooster, OH), which served as the main trap body, and 1 Rubbermaid Servin' Saver® 0.75-liter sandwich box (model 3870), which housed trap electronics. Two trap floats, consisting of two 24.1-cm lengths of 1.9-cm-diameter schedule 40 polyvinyl chloride (PVC) pipe covered with 17.7-cm lengths of 0.95-cm-thick polyethylene foam pipe insulation, were permanently sealed against water entry by hot gluing 1.9-cm PVC pipe caps to the pipe ends (Fig. 1A). Each float was tightly attached to the trap body under a lid catch on opposing ends with 20.3-cm black cable ties in such a manner as to not interfere with lid closure. After attaching both floats, a narrow slit measuring 0.6 cm wide  $\times$  22.8 cm long was cut into only 1 side of the trap body, about 2.5 cm from the bottom edge and sanded smooth to remove sharp edges. Next, a trap baffle was constructed from a section of aluminum window screen (15 squares/2.5 cm) measuring 7.6 cm wide  $\times$  25.4 cm long folded in half. Stray edges of the screen were carefully tucked in to yield a smooth surface that would not injure insects, before attaching a 2.5-cm<sup>2</sup> section of cellulose sponge, centered and even with the upper uncut screen edge, with hot glue. The completed baffle was centered over the slit and riveted at 5 predrilled points, each located about 1.5 cm from the edge of the slit, inside the trap body.

The baffle formed a barrier that was permanently positioned away from the trap's inside wall. Aluminum rivets (0.31-cm diameter) and washers added strength to both surfaces being joined and prevented corrosion during immersion (Fig. 1A).

After constructing the main trap body, a RadioShack® 2 D-cell battery holder (catalog no. 270-386A, Tandy Corporation, Fort Worth, TX) was modified by centering and attaching a 1.2-cm-wide  $\times$  2.5-cm-long piece of perforated phenolic board to the end of the battery holder bearing wire leads with a single rivet so that about 1.2 cm of the board protruded above the top of the battery holder. The modified holder was then centered and riveted to the sandwich box bottom at 2 predrilled points. The sandwich box was then centered and riveted to the top of the trap body lid at predrilled locations. Next, a 0.31-cm hole was drilled through the sandwich box and trap lid approximately 1.2 cm from the end of the battery holder bearing the wire leads to allow insertion of the light source wiring. A 2nd 0.31-cm hole was drilled about 2.5 cm from the bottom in the adjacent side of the sandwich box, perpendicular and in line with the light source wiring hole to permit electrical switch attachment. Drilling at these positions allowed for easier wiring connections (Fig. 1A).

A light source was constructed from a 20-ml glass scintillation vial with a 0.31-cm hole drilled in the screw cap, two 15.2-cm lengths of insulated single-strand 22-gauge copper wiring, one 15.2-cm length of 0.31-cm aquarium tubing, 1 small 2-socket connector cut from a 20-pin single in-line IC socket (catalog no. 276-1975, RadioShack), and a Rayovac® high-intensity miniature flashlight bulb (model 2-T1, Rayovac Corporation, Madison, WI; Fig. 1C).

Both wire strands were inserted into the plastic tubing and soldered to the socket connector. After soldering, the wiring opposite the socket end was inserted into the underside of the vial screw cap

and pulled through, positioning the socket at the vial center. Two cable ties were then used to position the wiring permanently in the vial by attaching 1 above the screw lid and 1 below. The miniature bulb was grasped with a paper towel and inserted into the socket connector, taking care not to contaminate the bulb surface. The wiring behind the socket was bent at approximately 45° with needle-nosed pliers to allow easier insertion of the bulb inside the vial. Before attaching the vial, a thin layer of rubber caulking was applied to the glass vial threads and to both the upper and lower edge of the vial cap. Wiring from the light source was pushed through the bottom of the trap lid and into the sandwich box. The light source was positioned so the bulb was facing, and even with, the upper edge of the baffle screen before permanently locking with 2 cable ties, 1 inside the sandwich box and 1 on the underside of the trap lid (Figs. 1A, 1C).

A 2-conductor 0.31-cm mini phone jack (catalog no. 274-251C, RadioShack) was inserted inside the sandwich box with the jack facing outward, fastened to the predrilled hole located on the side of the box with supplied hardware, and covered with a 2.5-cm piece of aluminum tape to prevent water entry. A 2-conductor 0.31-cm phone plug (catalog no. 274-286A, RadioShack) was used as a removable switch by soldering a small piece of wire across both leads and inserting a 10.1-cm length of nylon cord into the plug housing and filling with hot glue. This created a removable shorting plug that was tethered to the sandwich box by the cord threaded through a small hole positioned near the phone jack, which effectively prevented accidental activation of the traps and loss of the shorting plug in the field. Once the shorting plug was pushed through the aluminum tape, a water-resistant seal was formed (Fig. 1A).

Wiring inside the sandwich box was connected as follows. The positive (red) wire from the battery holder (B1) was soldered to 1 side of the PC board terminal inserted into the phenolic board with the screw terminals facing upward, and a wire from the light source (L1) was soldered to the other side of the PC board terminal. The other wire from the light source was soldered to 1 tab of the phone jack (J1), whereas the negative (black) wire from the battery holder was soldered to the remaining phone jack tab. Two 10-ohm (¼-watt) resistors (R1; catalog no. 271-1301, RadioShack) were placed in parallel within the PC board terminal to yield 5 ohms of circuit resistance. The shorting plug (P1) was simply pushed into the phone jack to activate the trap upon deployment in the rice field (Figs. 1A, 1B).

After testing 6 traps early in the season, the number of larval *Tropisternus* sp. captured was increased by adding a partially inflated 0.9-liter plastic freezer bag, which improved trap stability under windy conditions, and a sponge float, fabricated

from a scored cellulose sponge (11.9 × 7.6 × 1.5 cm) pushed over a small Rubbermaid Servin' Saver (118-ml, model 8344), which provided larvae additional harborage. Upon trap deployment, heavy rubber bands around the trap bodies kept the lids in place.

During June and July of 1999 and 2000, 6 traps were deployed on 10 evenings in large foundation seed rice fields at the Rice Research and Extension Center, Stuttgart, AR. Traps were positioned approximately 50 m apart within levee ditches in 15–20 cm of water shortly before dark, and activated when ambient light levels decreased. Traps were operated throughout the night, and were retrieved early the following morning. Specimens captured were identified with appropriate keys (Peterson 1977, Merritt and Cummins 1984, Stehr 1991). Other invertebrates were retained for identification and included in trap counts, but were discarded afterwards. Within traps, larval *Tropisternus* sp. found refuge in cavities of flotation sponges, wire ties, the upper edge of the baffle screen, trap floats, the underside of the reservoir lid, and the top of the bulb housing.

Upon transport to the laboratory, larvae of *Tropisternus* sp. were gently removed from traps and separated to prevent cannibalism by placing each larva in a small 148-ml clear plastic drinking cup containing 74 ml of dechlorinated water and a small square (1.2–1.9 cm<sup>2</sup>) of cellulose sponge that served as anchorage for the larval *Tropisternus* sp. before conducting predation bioassays against larvae of *An. quadrimaculatus* and *Ps. columbiae* (Dennett and Meisch, unpublished data). Laboratory temperature and photoperiod were maintained at 75°F and 16:8 h light:dark during both seasons.

During the trapping effort, an average of 5.2 traps was used per evening, resulting in 52 trap-nights that accumulated 106.7 h of trapping time, or an average of 10.6 h per trap. Use of 2 heavy-duty alkaline D-sized batteries and appropriate in-circuit resistance effectively increased bulb life and trap operating time, ranging from 22 to 36 h before batteries were replaced.

Live trapping worked well and provided numerous larval *Tropisternus* sp. for use in laboratory predation bioassays. Six hundred fifteen 3rd-stage larvae of *Tropisternus* sp. and 740 adult *T. lateralis* were captured in aquatic light traps over both seasons. Of 40 traps containing larval *Tropisternus* sp., an average of 15.3 larvae was captured per trap. Among all traps for a given evening, the largest capture of *Tropisternus* sp. larvae was made on a rainy night, resulting in a total of 263 specimens with 94 in a single trap.

Thirty-eight traps captured an average of 19.4 *T. lateralis* adults per trap, whereas among all traps deployed on a given evening, the largest capture of adult *T. lateralis* contained 404 specimens, with 184 in 1 trap. Interestingly, 478 rice water weevils (*Lissorhoptrus oryzophilus* Kuschel) were captured

in 13 traps, which averaged 36.7 weevils per trap. The largest single trap capture contained 102 weevils, on an evening where 287 weevils were captured among all traps. Other larger insect species were captured infrequently, consisting primarily of predacious 3rd-stage larvae of *H. triangularis* and adult belostomatids, dytiscids, and notonectids. Predatory *H. triangularis* larvae may have been attracted to the traps by the presence of larval *Tropisternus* sp. Larvae of *Tropisternus* sp. may have been attracted not only by the light source, but also by prey items that entered the trap, such as chironomid larvae. Large numbers of chironomid larvae and odonate and ephemeropteran naiads were commonly caught early in the season. Approximately 3 wk after permanent flood of large rice fields was found to be the most productive period in which to capture larvae of *Tropisternus* sp. during both growing seasons.

#### REFERENCES CITED

- Merritt RW, Cummins KW. 1984. *An introduction to the aquatic insects of North America* 2nd ed. Dubuque, IA: Kendall/Hunt Publishing Company.
- Peterson A. 1977. *Larvae of insects, an introduction to Nearctic species, part II, Coleoptera, Diptera, Neuroptera, Siphonaptera, Mecoptera, Trichoptera* 6th ed. Ann Arbor, MI: Edwards Brothers.
- Plague GR. 1996. Examination of the feeding behavior of larval *Tropisternus* (Coleoptera: Hydrophilidae). *J Kans Entomol Soc* 69:104–107.
- Stehr FW. 1991. *Immature insects* Volume 2. Dubuque, IA: Kendall/Hunt Publishing Company.
- Washino RK, Hokama Y. 1968. Quantitative sampling of aquatic insects in a shallow-water habitat. *Ann Entomol Soc Am* 61:785–786.
- Zalom FG. 1981. Interactions potentially affecting the seasonal abundance of selected aquatic invertebrates in a rice field habitat. *Hydrobiologia* 80:251–255.
- Zalom FG, Grigarick AA, Way MO. 1980. Habits and relative population densities of some hydrophilids in California rice fields. *Hydrobiologia* 75:195–200.