6-2012

Effectiveness of Pan Trapping as a Rapid Bioinventory Method of Freshwater Shoreline Insects of Subtropical Texas

Frank J. Dirrigl Jr.

Effectiveness of Pan Trapping as a Rapid Bioinventory Method of Freshwater Shoreline Insects of Subtropical Texas

Frank J. Dirrigl, Jr.

Department of Biology, University of Texas-Pan American,
1201 West University Drive, Edinburg, TX 78539

Abstract. Pan trapping proves to be an effective method for field surveying insects, especially Diptera. This manuscript examines the effectiveness of the method for the rapid bioinventory of freshwater shoreline insects. Pan traps at ground level, above ground, and elevated and of different colors were evaluated for their ability to attract and capture insects. Abundance (n), taxonomic richness (T), and hierarchical diversity indices (H′) allowed for the determination of efficacy among methods. Yellow pan (n = 141, T = 10, H′ = 1.15) and elevated yellow pan traps (n = 113, T = 5, H′ = 1.18) were most effective at capturing the highest diversity of insects. Blue (n = 12, H′ = 1.18) and green (n = 51, H′ = 0.74) traps had similar richness (T = 4); however differed in the total insects captured and diversity. The results provide entomologists in South Texas and other subtropical environments with information to assist them with planning surveys in the field and with further study potentially developing pollution tolerance values for different insect taxa.

Introduction

Freshwater shorelines of streams, rivers, irrigation canals, reservoirs, ponds, and lakes are dynamic habitats experiencing, but not limited to, episodic drying, flooding, erosion, and deposition of wrack consisting of inorganic (e.g., litter debris) and organic (e.g., decayed plants) material. Ecologically, the insect fauna of these shorelines are pollinators, omnivores, predators, detritivores, scavengers, herbivores, phytophagous, and even malachophagous (Kirk 1984, Aguiar and Sharkov 1997, Mathis and Zatwarnicki 2005). Studies of freshwater shoreline insects more often focus on the biology of a particular order (e.g., Plecoptera) rather than habitat (e.g., freshwater shoreline) or tropic (e.g., predator) guild (Kirk 1984, Maredia et al. 1992, Gibb and Hochuliges 2002, Campbell and Hanula 2007). However, data on pan trapping of trophic groups and populations can be useful for assessing pest management strategies, biological control, and even ecological restoration (Mattoni et al. 2000, Metz 2004, Laubertiel et al. 2006).

Pan trapping or water trapping uses colored shallow pans or bowls partially filled with water and a nonfragrant detergent to increase surface adhesion, which traps the insect. A preservative, such as glycerin or salt, may be added if traps are left unattended for periods longer than a week (Masner n.d.; Laubertiel et al. 2006). Insect orders, families, and guilds attract differentially to color pan traps (Capinera and Walmsley 1978), most likely because they reflect colors similar to flowers or leafy parts of plants or algae, and round bowls can imitate flower shape (Dafini et al. 1990, Aguair and Sharkov 1997, Campbell and Hanula 2007).

The freshwater shoreline insect fauna of subtropical Texas is seldom studied. The purpose of this study was not to provide an exhaustive review of pan trapping techniques but to focus on the ability of the method to provide a target survey for freshwater shoreline insects as a habitat guild and bioindicators of environmental health and water quality in the region. The findings of this study may provide entomologists with information to assist them with planning similar surveys in the field.

Materials and Methods

Modified from Disney et al. (1982) and Ausden (1996), pan traps consisted of translucent colored (yellow, green, red, and blue) plastic round, sloping bowls with 21.5-cm top and 11-cm bottom diameters, and approximate depth of 4 cm. Pans filled with 2 cm of water and 0.5 ml of nonfragrant dishwashing detergent were placed as two sample groups:

1. Green, red, and blue traps at ground level; and
2. Yellow traps in-ground (i.e., as a pitfall trap), ground level, and elevated. The selection of yellow to examine height differences follows the affinity of the color to attract numerous insect taxa (Masner n.d., Disney et al. 1982, Laubertiel et al. 2006, Namaghi and Husseini 2009).

Elevated traps were attached using drywall screws and washers to a 0.82-m wooden stake. Each trap consisted of two bowls held together with a binder clip to ease transferring insects caught in the water through a funnel and into a plastic bottle for transporting back to a laboratory.

Shoreline insects were collected at an artificial, stormwater detention lake in the Edinburg Municipal Park, Edinburg, Hidalgo County, Texas. Collection occurred for 7 days with two samples gathered in March 2010. Insects caught were either pinned or preserved in 70% ethanol for identification to family using Triplehorn and Johnson (2005) and Merritt et al. (2008). Comparisons of efficacy of pans for trapping families of insects (see Kitching et al. 2004) considered color and elevation using the total number of insect taxa (richness) and hierarchical diversity (Shannon) of insects captured (Osborne et al. 1980).

Results

Pan trapping (Table 1) for 7 days along the freshwater shoreline of the park resulted in 379 identifiable specimens in 17 taxa of Coleoptera, Lepidoptera, Diptera, and Hymenoptera. The greatest numbers of insects collected were dipterans, particularly the Ephydridae and Chironomidae. Eight families were represented by a single specimen.

Overall, the greatest abundance of insects was collected using yellow, attracting almost twice the abundance of blue traps (Table 1). Red and green traps had similar abundances. Regarding richness, yellow also yielded greater values, whereas blue and green were similar in the number of taxa captured. Most insect diversity was found in yellow or green traps, with blue and red traps attracting similar but less diversity.

Eight taxa not selected for by other trap schemes were collected from yellow traps. Although insect abundance in red and green traps approximated each other,

Table 1. Collection Rates of Freshwater Shoreline Insects by Trapping Method

			Pantrap (*n*)				Elevated pantrap (*n*)	Pitfall (*n*)
Order	Family	Total (*n*)	Red	Green	Blue	Yellow	Yellow	Yellow
Coleoptera	Byturidae	8	0	0	0	6	0	2
	Melyridae	1	0	1	0	0	0	0
Lepidoptera	Unidentified	1	0	0	0	1	0	0
Diptera	Calliphoridae	1	0	0	0	1	0	0
	Cecidomyiidae	1	0	0	0	1	0	0
	Ceratopogonidae	1	0	0	0	0	1	0
	Chironomidae	126	8	8	40	31	33	6
	Culicidae	3	1	0	2	0	0	0
	Dolichopodidae	1	0	0	0	1	0	0
	Ephydridae	200	0	0	4	79	70	47
	Psychodidae	1	0	1	0	0	0	0
	Psychodinae	10	2	2	5	0	0	1
	Simuliidae	3	0	0	0	0	3	0
	Tipulidae	1	0	0	0	0	1	0
Hymenoptera	Ichneumonidae	1	0	0	0	1	0	0
	Sphecidae	6	0	0	0	6	0	0
	Solenopsis	14	0	0	0	14	0	0
Total		379	11	12	51	141	113	57
Taxa		17	3	4	4	10	5	4
Shannon		n/a	0.76	1.18	0.74	1.15	1.18	0.66

it differed in Culicidae (red) and Psychodidae (green). Green and blue pan traps were most effective for attracting Coleoptera. Green attracted a single unique coleopteran (Melyridae) not found in any other trap. Blue and red pan trap were most effective for attracting Culicidae. Chironomidae were attracted to all colors and traps; however, they were most abundant in blue pan traps.

Yellow pan traps attracted more insects than did yellow elevated traps and more than twice the number of insects as did yellow pitfall traps (Table 1). However, yellow pan and elevated traps approximated each other in richness and hierarchical diversity of insects.

Differences among the yellow trap schemes existed regarding taxa collected. Yellow pan traps captured seven species of insects not found in elevated or pitfall traps and shared three taxa (Byturidae, Chironomindae, and Ephydridae) among schemes. However, yellow elevated traps collected three taxa (Ceratopogonidae, Simulidae, Tipulidae) not found in yellow pan or pitfall traps. Yellow elevated traps attracted slightly more Chironomidae than did the yellow pan, but more than five times that of pitfall traps. More Ephydridae were found in yellow pan and yellow elevated traps than in pitfall traps.

Discussion

In this study, the influence of different trapping schemes of color and height on quick, target collection of shoreline insect orders and families was investigated. The results demonstrated, not surprisingly, that various colors and elevations of pan traps selected for different insect taxa and diversity. Similar to Disney et al. (1982), yellow pan traps attracted the most diversity and families of insects and were the most effective at collecting dipterans. Ephidridae are not restricted to low heights and can be found 0.6 to 2.13 m above ground (Steyskal 1972); thus, they were found in elevated yellow pan traps. However, the presence of water may be more important than color or trap height. Whereas Campbell and Hanula (2007) found Hymenoptera to prefer blue traps, along the shoreline I found them to prefer yellow, similar to Leong and Thorp (1999; however, their study focused on bees, and I recovered ants and sawflies).

Considerations of Pan Trapping. Although an effective, passive method, pan trapping can influence studies of dipteran diversity (cf., Ausden 1996):

- Pan trapping resulted in loss of antennae and leg parts important in identification. Heads also became detached. For example, a specimen of Psychodidae lost most wing margin hairs.
- Specimen lost color and desiccated quickly within 2 days. Selected specimens of all captured taxa had decay of the thorax and abdomen. In the subtropical climate of South Texas, preservative should be used. Glycerin could be used because of its insect adherence, clarity, and lack of smell. It may also prevent water loss from evaporation, and any potential effects could be tested easily by including traps without any preservative.
- The use of colored bowls encouraged vandalism to traps at the study site, which was a public-access area. Bilingual (Mexican-Spanish) signage did not prevent trap losses. Studies may need to be in restricted or fenced areas if they can be viewed by the public.

Pan Trapping Recommendations. My data confirm Disney et al. (1982) by demonstrating the effectiveness of yellow pan trapping and the differences in representation among taxa, although a different color scheme was used. Based on the abundance and diversity of insect taxa from this preliminary study, I recommend, although my suggestions are not necessarily novel:

- Complimentary yellow pan and yellow elevated pan traps should be used to maximize collection.
- To compare shore-restricted to open-water (i.e., entirely aquatic) insects, floating pan traps also could be used (see Grigarick 1959).
- To increase or compare collection efficacies, pan trapping may be combined with pitfall trapping (Mattoni et al. 2000) and should include net sweeping (Evans and Bailey 1993, Cane et al. 2000, Stephen and Rao 2007) to maximize the diversity recovered.
- Placing traps closed for at least a week before beginning collection would help avoid "digging-in" or the tendency of captures to be higher, at first, and slow down as insects become familiar to traps (Greenslade 1973).
- Similar to Russo et al (2011), color combinations rather than use of a single color may result in finding more insects.

Developing larvae of aquatic insects reside along shores or are periaquatic in the substrates of littoral zones. This quality makes shoreline insects candidates for biomonitoring water quality, and pan trapping is an efficient survey method for this habitat guild. Assuming the occurrence of adult shoreline insects indicates the successful development of their larval aquatic stages, the presence and absence of specific taxa (e.g., Dolichopodidae found in yellow pan traps and having a pollution tolerance of 4 based on Klemm et al. 1990) can indicate water quality or management needs (Keiper and Walton 2002). Ancillary to this study, aquatic benthic insects in sediments adjacent to the study shoreline will be collected to determine any differences in the occurrence of adult and larval stages. Because, regional pollution tolerance values are unavailable for South Texas, researchers using freshwater macroinvertebrates as indicators of water quality are dependent on the Hilsenhoff's family-level values for the US Environmental Protection Agency Southeast, Midwest, and Upper Midwest regions (Klemm et al. 1990: Appendix B). As information on shoreline and adjacent benthic insect fauna is gathered and water quality (e.g., alkalinity, ammonia, nitrite/nitrate, pH, and phosphorus) of sites is tested, reference sites and pollution tolerance values can be developed. The abundance of Ephydridae identified to species shows promise for this purposes.

Acknowledgment

This research was funded by The University of Texas-Pan American Faculty Research Council Grant. Gratitude is expressed to John Brush, Edwin Quintero, and Carolyn Sanchez for their assistance in the field and laboratory in carrying out this study. I thank K. Rod Summy (UTPA) and an anonymous reviewer for their suggestions at improving this manuscript.

References Cited

Aguiar, A. P., and A. Sharkov. 1997. Blue pan traps as a potential method for collecting Stephanidae (Hymenoptera). J. Hymenoptera Res. 6: 422-423.

Ausden, M. 1996. Invertebrates, pp. 139-177. *In* W. J. Sutherland [ed.], Ecological Census Methods: A Handbook. Cambridge University Press, Cambridge, UK.

Campbell, J. W., and J. L. Hanula. 2007. Efficiency of Malaise traps and colored pan traps for collecting flower visiting insects from three forested ecosystems. J. Insect Conserv. 11: 399-408.
Cane, J. H., R. L. Minckley, and L. J. Kervin. 2000. Sampling bees (Hymenoptera: Apiformes) for pollinator community studies: pitfalls of pan-trapping. J. Kans. Entomol. Soc. 73: 225-231.
Capinera, J. L., and M. R. Walmsley. 1978. Visual responses of some sugarbeet insects to sticky traps and water pan traps of various colors. J. Econ. Entomol. 71: 926-927.
Dafni, A., P. Bernhardt, A. Shmida, Y. Luri, S. Greenbaum, and C. O'Toole. 1990. Red bowl-shaped flowers: convergence for beetle pollination in the Mediterranean region. Israel J. Bot. 39: 81-92.
Disney, H. L., Y. Z. Erzinclioglu, D. J. de C. Henshaw, D. Howse, D. M. Unwin, P. Withers, and A. Woods. 1982. Collecting methods and the adequacy of attempted fauna surveys, with reference to the Diptera. Field Studies 5: 607-621.
Evans, E. W., and K. W. Bailey. 1993. Sampling grasshoppers (Orthoptera: Acrididae) in Utah grasslands: pan trapping versus sweep sampling. J. Kans. Entomol. Soc. 66: 214-222.
Greenslade, P. J. M. 1973. Sampling ants with pitfall traps: digging-in effects. Insectes Sociaux 20:343-353.
Grigarick, A. A. 1959. A floating pan trap for insects associated with the water surface. J. Econ. Entomol. 52: 348-349.
Keiper, J. B., and W. W. Walton. 2002. Effects of three vegetation management strategies on shore-flies (Diptera: Ephydridae) in newly constructed treatment wetlands. Ann. Entomol. Soc. Amer. 95: 560-576.
Kirk, W. D. J. 1984. Ecologically selective coloured traps. Ecol. Entomol. 9: 35-41.
Kitching, R. L., D. Bickel, A. C. Creagh, K. Hurley, and C. Symonds. 2004. The biodiversity of Diptera in Old World rain forest surveys: a comparative faunistic analysis. J. Biogeogr 31: 1185-1200.
Klemm, D. J., P. A. Lewis, F. Fulk, and J. M. Lazorchak. 1990. Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters. EPA/600/4-90/030, November 1990. US Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Cincinnati, OH.
Laubertiel, E. A., S. D. Wratten, and J. R. Sedcole. 2006. The role of odour and visual cues in the pan-trap catching of hoverflies (Diptera: Syrphidae). Ann. Appl. Biol. 148: 173-178.
Leong, J. M., and R. W. Thorp. 1999. Colour-coded sampling: the pan trap colour preferences of oligolectic and nonoligolectic bees associated with a vernal pool plant. Ecol. Entomol. 24: 329-335.
Maredia, K. M., S. H. Gage, D. A. Landis, and T. M. Wirth. 1992. Visual response of *Coccinella septempunctata* (L.), *Hippodamia parenthesis* (Say), (Coleoptera: Coccinellidae), and *Chrysoperla carnea* (Stephens), (Neuroptera: Chrysopidae) to colors. Biol. Con. 2: 253-256.
Masner, L. n.d. Pan Traps. Ecological Monitoring and Assessment Network, Environment Canada. http://www.eman-rese.ca/eman/reports/publications/sage/sage13.htm. Accessed 27 January 2010.

Mathis, W. N., and T. Zatwarnicki. 2005. Revision of New World species of shore fly genus *Discomyza meigen* (Diptera: Ephydridae). Ann. Entomol. Soc. Amer. 98: 431-443.
Mattoni, R., T. Longcore, and V. Novotny. 2000. Arthropod monitoring for fine-scale habitat analysis: a case study of the El Segundo sand dunes. Environ. Management 25: 445-452.
Merritt, R. W., K. W. Cummins, and M. A. Berg [eds.]. 2008. An Introduction to the Aquatic Insects of North America. 4th ed. Kendall/Hunt Publishing, Dubuque, IA.
Metz, M. A. 2004. Discovering the potential for natural control of arthropod pests on Christmas trees in Pennsylvania. Report submitted to the Pennsylvania Christmas Tree Growers Association, Harrisburg, PA.
Namaghi, H. S., and M. Husseini. 2009. The effects of collection methods on species diversity of family Syrphidae (Diptera) in Neyshabur, Iran. J. Agric. Sci. Tech 11: 521-526.
Osborne, L. L., R. W. Davies, and K. J. Linton. 1980. Use of hierarchical diversity indicies in lotic community analysis. J. Appl. Ecol. 17: 567-580.
Russo, L., R. Stehouwer, J. M. Heberling, and K. Shea. 2011. The composite insect trap: an innovative combination trap for biological diverse sampling. PLoS One 6: 1-7.
Stephen, W. P., and S. Rao. 2007. Sampling native bees in proximity to a highly competitive food resource (Hymenoptera: Apiformes). J. Kans. Entomol. Soc. 80: 369-376.
Steyskal, G. C. 1972. An unusual habit for a fly of the family Ephydridae. Proceedings Entomological Society of Washington 74: 129.
Triplehorn, C. A., and N. F. Johnson. 2005. Borror and DeLong's Introduction to the Study of Insects. 7th ed. Brooks/Cole, Belmont, CA.