PHOTO CONTEST – 1997

BUTTERFLIES

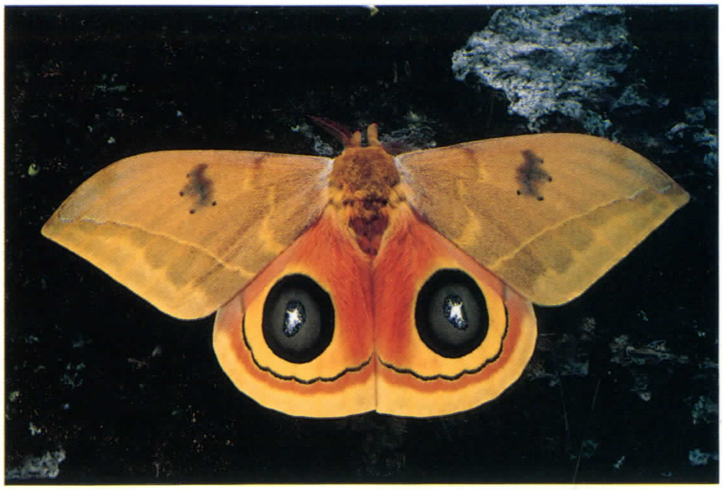
First Prize: *Tomares romanovi* (Lycaenidae), Armenia (A. Sourakov) (see *Holarctic Lepid.*, 3(2), 1996).
Second Prize: *Delias hyparete hierte* (Pieridae), Hong Kong (J. J. Young) (above).
Third Prize: *Hypolycaena* sp. (Lycaenidae), Ghana (A. Sourakov).
Parnassius hardwickii (Papilionidae), India (Himalayas) (N. Hishikawa) (see *Holarctic Lepid.*, 4(1), 1997).

IMMATURES

First Prize: *Automeris larra* (Saturniidae), French Guiana (K. L. Wolfe) (back cover).
Second Prize: *Otherone verana* (Saturniidae), Mexico (C. Conlan) (next page, bottom right).
Third Prize: *Acherontia atropos* (Sphingidae), England (C. Conlan) (see *Holarctic Lepid.*, 4(1), 1997).

MOTHS

First Prize: *Automeris rubrescens* (Saturniidae), Mexico (C. Conlan) (next page, top left).
Second Prize: *Automeris tridens* (Saturniidae), Costa Rica (C. Conlan) (next page, top right).
Third Prize: *Automeris io draudtiana* (Saturniidae), Mexico (C. Conlan) (next page, center left).
Dirphia crassifurca (Saturniidae), Colombia (K. L. Wolfe) (next page, bottom left).



HONORABLE MENTIONS - 1997

Lamproptera meges akirai
(Papilionidae)
Indonesia (Sulawesi) (J. J. Young)

Myscellus amystis
(Hesperiidae)
Brazil (Rondonia) (J. P. Brock)

ALSO:
Copiopteryx semiramis banghaasi (Saturniidae), Guatemala (K. L. Wolfe): back cover (inside)

Heliconius hecale (Nymphalidae: Heliconiinae), South America (J. Kuhn): front cover (inside)

TROPICAL LEPIDOPTERA, 8(1): 1-4

AN OPTIMIZED PORTABLE BAIT TRAP FOR QUANTITATIVE SAMPLING OF BUTTERFLIES

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ABSTRACT.– A bait trap for butterflies which is optimized for butterfly capture, catch retention and durability is discussed. In addition, sources of between-trap sampling variation are discussed and strategies for reducing differences in trap performance under field conditions are presented.

KEY WORDS: bait trapping, biocriteria, Nymphalidae, Rhopalocera, sampling protocols, techniques.

Two recent papers (Austin and Riley, 1995; Sourakov and Emmel, 1995) decribed many of the advantages and shortcomings of using commercial and/or homemade bait traps for inventorying butterflies in the tropics. These papers highlighted shortcomings such as the poor performance of commercially available traps and the problems associated with transporting bulky traps. The simple solutions offered by Austin and Riley (1995) emphasize ease of construction relative to duplicating complex commercial traps or trap designs with internal cone baffles (Platt, 1969), as well as portability and ease of use under field conditions.

The traps recommended by Austin and Riley (1995) are essentially straight tubes. Butterflies are attracted to baits and fly upwards into the trap as they leave the bait. The traps retain their catch by virtue of each individual butterfly's behavior. Butterflies fly upward and rest in upper portions of the trap where they can be easily collected. While these simple traps are ideal for species inventory, they are less useful for quantitative studies.

Using butterfly traps to generate quantitative data is problematic, to say the least. Inherent variation in catch due to trap placement and the attractiveness of different baits influence individual trap performance. In this paper I provide an overview of a trap designed to optimize catch, optimize catch retention and maximize trap durability, as well as to standardize performance between traps. Recently, I have spent many hours simply watching traps work, noting how they capture butterflies and how butterflies avoid or escape capture. These observations have heavily influenced my design, as well as how I employ traps as quantitative tools.

OPTIMIZING BUTTERFLY CATCH

Several factors are likely to influence whether or not a butterfly enters a trap when leaving the bait. Most butterflies, when presented with some obstacle that they must negotiate, fly towards light (presumably because light is associated with open space). Thus, to work effectively a trap should visually guide butterflies upwards from the trap base and into the trap barrel using light. Sourakov and Emmel's (1995) observations regarding the very poor performance of commercially available traps made from dark heavy-weight netting exemplify this and are probably representative for how most butterflies react to dark trap interiors. The heavy, dark netting of most commercially available traps creates a trap barrel that is dark and shaded. In my experience, when leaving the bait in such a trap, butterflies simply follow the same route they entered—they fly out into the open space between the trap base and the barrel.

The key to solving this particular problem is to minimize the contrast in light intensity between the entry route butterflies take to access the bait and the barrel of the trap itself. This makes it less likely that butterflies leaving the bait will automatically move towards the open gap between the base and the trap itself. I have accomplished this by modifying the typical trap designs in five subtle ways:

1) The trap body should be as transparent as is possible. I recommend using a very sheer, light colored netting. All of my traps are made of inexpensive sheer curtain material, usually white or tan. Curtain material has the advantage of being UV-light resistant, water-proof, very snag-resistant and very light weight. The primary disadvantage is that these traps are not camouflaged. My traps are very conspicuous and are used exclusively in areas with very limited public access.
2) The trap base should be as dark as is possible. I spray-paint the upper surface of my bases flat black. This presents the butterflies with two starkly contrasting directions in which to fly, upwards into light, or downwards into darkness.
3) The light that enters the trap via the gap between the bottom of the trap barrel and the base should be minimized. I use a narrow, 1 inch gap (Fig. 1). This, in conjunction with the next two items, minimizes the visual image this escape route presents to a butterfly. To most collectors, this gap will seem to be too narrow, but in Belize, I capture large nymphalid genera on a daily basis, including *Morpho, Archeoprepona, Prepona, Historis,* and *Taygetis*. There seems to be a general misconception about how butterflies access the bait in a trap. Large and medium sized butterflies do not fly directly to the bait, but rather walk into the trap either along the base or more often from the barrel of the trap itself. Thus, large butterflies (4-6 inch wing span) can easily maneuver their wings

through a fairly narrow gap. In watching individual butterflies, this maneuver can take seconds or tens-of-minutes to figure out, and a few butterflies never do get in. But I feel that the number of butterflies that don't enter the trap because of the small gap is far less than the number that escape traps with wider gaps.

4) Raise the bait 2 inches (5cm) above the trap base. I use half pint freezer containers. This accomplishes two things. Most obviously, it places feeding butterflies inside the trap barrel and away from escape routes. Second, it alters the butterfly's field of view, further minimizing the width of unfiltered light they see between the trap base and barrel (Fig. 2). The bait container itself should be secured into place using a 1 inch square of velcro to attach it to the trap base. This ensures that the bait always sits directly under the barrel cone opening, and does not shift during routine thunderstorms.

5) The trap base is circular and should be at least 1 inch (2.5cm) larger in diameter than is the trap barrel. This in conjunction with #4 above further reduces the butterfly's view of a potential escape route.

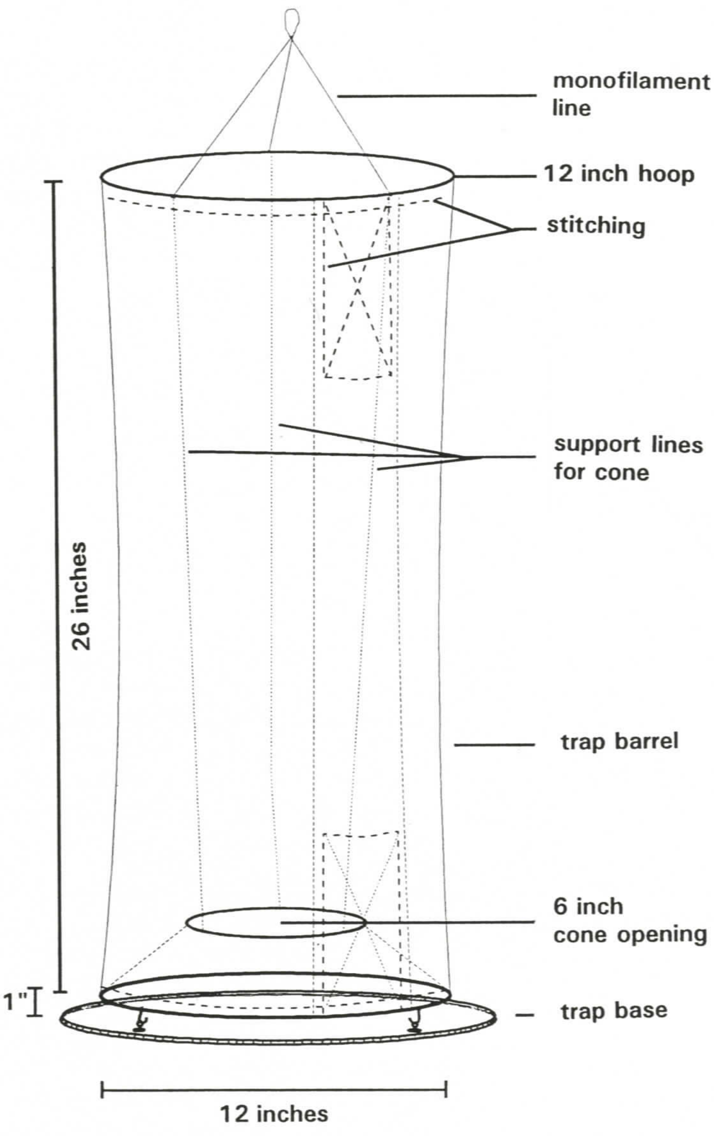

Fig. 1. An overview of the trap design.

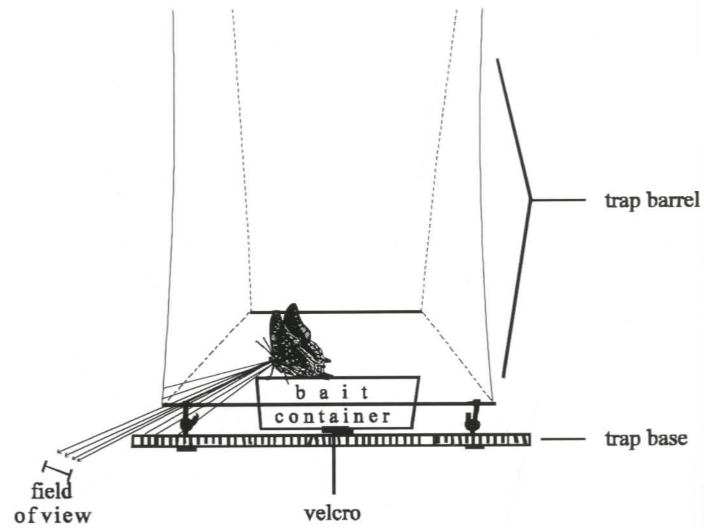

Fig. 2. Detail of the trap base showing the restricted line of sight a butterfly has when leaving the bait.

OPTIMIZING CATCH RETENTION

Once butterflies enter the trap, the key for quantitative sampling is to keep them there until the sample is collected. Losses from quantitative samples are not acceptable. While no trap can be escape-proof, there are ways to minimize sample loss.

1) A cone baffle (with a 6 inch or 15cm opening) at the bottom of the trap prevents butterflies from simply flying or walking out of the trap. While Austin and Riley (1995) very correctly point out that this single design component adds to the assembly time and complexity of making a trap, it is a must for quantitative sampling. When in the field, I generally have enough time to service my traps only twice a day. Without this baffle I would have to service the traps on a more regular basis, detracting from other aspects of my work. In addition, lowering traps set at 5m or higher above ground excites the butterflies inside, and the cone baffle reduces the number of escapees to less than one specimen per trap on average per week.

2) I use a 21 inch diameter, string-pull closed bag to seal off the bottom of the trap when I empty it. This prevents excited butterflies from flying out the opening of the cone while I empty the trap. Just as often, carefully attaching this bag to the trap forces butterflies still feeding at the bait upwards and into the trap. Butterflies are removed from the trap through an unsecured 3 inch area of overlap of netting identical to Austin and Riley's (1995) trap design 1.

3) Ant predation of butterflies can be very severe in traps. While ants generally eat just the butterfly body and leave behind the wings, allowing inclusion of the devoured insect into a quantitative data set, it is nicer to have an entire specimen, especially if genitalic dissection is needed for determination. As recommended by Austin and Riley (1995), I use light-weight monofilament fish line to attach the hanger to the trap. Ants will not travel down monofilament line, and as long as the trap body itself is not touching foliage or tree limbs, ants cannot easily enter the traps. I have tested this directly by hanging traps in ant-supporting acacia trees with no ants entering the traps.

OPTIMIZING DURABILITY OF THE TRAP

1) The netting is UV and snag resistant. As mentioned previously, I use sheer curtain material to minimize cost.

2) The trap barrel is supported by a 12 inch diameter hoop made of two strands of 14 gauge galvanized wire. While wood embroidery

hoops are easier to use and less expensive (in the USA, at least), they can be exceedingly fragile and I have had significant breakage in transit. The galvanized wire is rust resistant, resists deformation, and simply will not break under ordinary circumstances.

3) The hooks that attach the base to the barrel of the trap are likewise made of galvanized 14 gauge wire. Hooks and fasteners are easily fashioned using needle-nosed pliers.
4) The trap base is corrugated plastic. This is lightweight and very resistant to wear from normal use.

OPTIMIZING BETWEEN TRAP PERFORMANCE

In quantitative studies, individual trap efficiency is not as critical as is the consistency of performance between traps. Differences in catch should reflect real differences in the butterfly community being sampled, not differential trap performance. Three primary factors influence trap performance in the field: uniformity of construction, trap location, and bait consistency.

Construction. It is essential that individual traps not differ from one another in any significant manner that would alter trap performance. Thus, while my trap design was created to maximize and retain catch, it was also designed to be fairly easy to construct in a consistent and uniform manner. In that light, I build my traps using an assembly-line approach, usually in batches of 10-14 traps at a time. For example, all of the metal hoops are cut and made at one time, then all of the net barrels are connected to the top hoop, then the bottom hoop is connected, and so on until the trap is completed. By making or assembling each part of the trap in mass, differences between parts are minimized. In addition, I construct more traps than I need for quantitative work, which allows me to reject some traps as below acceptable standards (these traps are fine for qualitative inventory use).

Trap Placement. Trap location influences which species are likely to be collected (DeVries, 1988; Shuey, unpublished data). If the goal of the trapping program is to examine differences between seasons at a sampling site, then it is imperative that the trap hang at exactly the same location for each sampling event. However, most sampling is implemented to look at differences between sites. Because habitat structure, especially in tropical forests near edges and light gaps, influences the species that are likely to visit the traps, using a single trap to quantitatively sample a butterfly community is almost impossible. For example, for a trap placed at the edge of a light gap 1m above the ground, the catch will be highly influenced by the amount of light that hits the trap. A trap located in heavy shade may collect many satyrids but hardly any *Memphis* species. If placed just a few feet away in more open sunlight, this pattern could easily be reversed.

I minimize the impact that individual trap placement can have by using an array of three traps at each sample location and then pooling the data from the traps. While trap placement at each sample station is still critical, by placing an array of three traps at each station the differences from individual trap placement is minimized. My arrays are always centered around light gaps and consist of a trap placed 1m above the forest floor in a moderately shaded area, a trap placed at 5m in partial shade, and a trap placed in partial shade at ½ to ⅔ of the height of the surrounding forest canopy.

Bait. Perhaps most critically, if catches between traps or trapping stations are to be consistent, the attractant must also be consistent. Butterflies are attracted to aromatic decomposition products from baits. If bait trapping is used as part of a quantitative sampling regime, the quality of bait used must be consistent throughout the sampling period as well as between sampling periods. I achieve this (as best as possible) by using only fruit-based baits, and then I control the fermentation process to the greatest extent possible by following this bait recipe:

1) To a ½ gallon (2 liter) container, add enough over-ripe plantains (1cm thick crosswise slices with the skin still on) to fill the container to the ⅔ level. Plantains decompose slowly and create a stable base to the bait that will last for over a week.
2) Fill the remainder of the container with ripe (not over-ripe) bananas sliced similarly.
3) Add two cups of unrefined (brown sugar).
4) Add a spoonful of baker's yeast.
5) Add enough tap water to the container to bring the water level up to the ⅔ mark. Make sure that the water is not chlorinated, as this will kill the yeast or at least slow the fermentation reaction.
6) Cap the container, shake well until ingredients are well mixed, and allow to sit for 24 hours.

After the initial fermentation period, the bait should smell very strongly of fruity alcohol and is ready to use. Because the nature of the bait changes with time, I keep a constant supply of fresh fermenting bait on hand. As I move my traps to new locations, I discard half of the old bait and refresh it with new bait to insure that the fermentation process has a constant supply of fruit and sugar upon which to work. In the tropics, never add processed fruit drinks or beer to baits, as these usually have enough preservative in them to completely wipe out ongoing fermentation in the bait.

This bait is very attractive, and I usually have interested butterflies circling the traps within the hour, sometimes in minutes. However, if there are abundant natural fruits fermenting in the immediate vicinity, no artificial bait is very productive. In these cases, trapping is not likely to be very worthwhile.

DISCUSSION

There is a recent burst of interest in using butterflies as indicators of ecological integrity (e.g., Panzer 1995, Kremen *et al.*, 1993, Sparrow *et al.*, 1994). The potential utility of tropical butterflies has been demonstrated by Kremen (1992) and a generic protocol for butterfly community sampling has even been developed (Sparrow *et al.*, 1994). However, if such methods are to be useful beyond site-specific monitoring, and applied through comparative studies to ecosystems throughout the tropics, then standardized sampling methods must be developed that can be uniformly implemented by people with diverse educational backgrounds as well as skill and motivational levels. Passive sampling offers a good opportunity to develop easily implemented standardized methods and analysis (Barbour *et al.*, 1994), and the trap and methods I have outlined represent one possible solution.

The trap design and sampling methods I have outlined are far from perfect for all applications. They represent a series of compromises intended to meet my sampling objectives as best as I see possible. Others will want to consider modifications that better suit their needs. For example, my traps miss selected crespuscular species. While the traps do well with *Taygetis* spp. and *Opisphanes cassina*, other common species such as *Opisphanes quiteria* are rarely captured. Similarly, in Belize I have repeatedly observed *Eryphanis aesacus* feeding at the bait inside my traps, but have only trapped this species once. *Caligo uranus* occurs throughout this study area but has never been trapped. It seems likely that my traps, which optimize capture of day-flying butterflies, do not work with some crespuscular species. These butterflies, which frequent heavily shaded areas even at sunset, may react oppositely than most species, and move towards deep shade when trying to avoid obstacles. Thus, the dark netting of commercially produced traps may optimize sampling for these species. Finally, this trap is fairly time-consuming to construct, especially compared to some of the trap designs from Austin and Riley (1995). It takes me about 20 hours to make 12 traps; sewing the cone accounts for at least half of this time. I personally would welcome designs which better streamline construction.

ACKNOWLEDGEMENTS

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