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EFFECTS OF APRONS ON PITFALL TRAP CATCHES OF CARABID BEETLES IN FORESTS AND FIELDS[1]

Marc E. Epstein and Herbert M. Kulman[2]

ABSTRACT

This study compared the efficacy of three types of pitfall traps in four forest and two field habitats. Two traps had aprons and one did not. The two apron traps were the same except for a gap between the trap and the plywood-apron, allowing captures from above or below. Traps were placed in a split-plot design and had three replicates of the three trap types per habitat. The traps were emptied each week from May to September. ANOVA's were performed on 12 trapped species separately over habitats, weeks, and the interactions between them. The nonapron trap captured over 40% more individuals than either apron trap, though apron traps tended to be more effective in fields for species found in both habitats. Habitat-trap interactions were only significant in two species. Trap-week interactions were significant in four species.

Pitfall traps are used for studying surface-dwelling arthropods, earthworms, and small vertebrates. Traps consist of a container sunk in the ground, with the open end flush with the ground surface. Specimens fall in and are unable to escape. Common additions include raincovers, barriers, aprons, funnels and, in removal studies, preservatives.

There is disagreement whether or not pitfall traps may be used to estimate either population densities or relative species abundances within a habitat or between communities. Greenslade (1964) stated that pitfall traps are of little use in this regard. This is because the number of trap captures is influenced by factors other than population size. However, Baars (1979) showed evidence that continuous pitfall trapping over the entire season for two carabid species gives a reliable measure of populations. Reviews of pitfall traps in ecological studies are found in Southwood (1978), Uetz and Unzicker (1976), and Durkis and Reeves (1982).

Greenslade (1964) found that traps whose perimeters were cleared of vegetation or litter had consistently higher catches. This type of trap was also intended to reduce the variation in catches due to local differences in trap location (e.g., obstacles such as grass tussocks and minor irregularities of the ground surface). The apron (a board or piece of metal surrounding the top rim of the trap) has a similar function as well as reducing the variability of the ground surface around the traps (i.e., soil and moisture differences). Cutler et al. (1975) compared catches of dionychious spiders with and without aprons in *Populus* stands. The apron traps caught nearly twice as many of the spiders as the nonapron type. Aprons have also been used by Houseweart et al. (1979) along with large capacity pitfall traps and by Uetz and Unzicher (1976) for wandering spiders.

Carabids are known to commonly occur under stones, logs, or other material. Nocturnal and diurnal species find refuge under such objects during periods of inactivity (Lindroth 1969). Fuller (in Allen 1979) found that 0.6 by 1.2-m rectangles of various materials all had significantly greater numbers of carabids than bare ground of the same size.

Using traps similar to Cutler et al. (1975), except for a gap between the trap and apron, we often found carabids under aprons. This raised the possibility that perhaps a harboring

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effect increased catches. The purpose of this study is to compare the field efficacy of (1) apron and nonapron pitfall traps, (2) apron traps of two types, and (3) all three traps. Species, habitats, weeks, and interactions were considered.

MATERIALS AND METHODS

Apron traps were similar to those with an apron used by Cutler et al. (1975) (an illustration of the three trap designs is found in Fig. 1). Directly above the can, on the ground surface, was the apron. It was a 0.09 m^2 by 0.6-cm-thick, brown-painted piece of plywood with a hole the same diameter as the can. A 12 cm^2 by 1.5-mm-thick plastic square with a 9-cm diameter hole was affixed to the top surface of the apron over the hole, creating an overhang above the can. On apron trap I (trap I) the hole was aligned with the top rim of the can, though not directly connected to it, and held in place by thin wood stakes on three sides of the apron. Apron trap II (trap II) was the same as trap I except the can was connected and sealed directly to the hole in the apron with caulking. The nonapron trap (trap III) was cleared of litter or turf around the can of the same dimensions as the apron in the other traps.

All traps had a circular metal can without a bottom, 9.5 cm by 12 cm deep, and a 0.47-l (16-oz) plastic cup which hung suspended 2 cm from the top of the can. The bottom ¼ of the cup was filled with a solution of 50% ethylene glycol (commercial anti-freeze) and water. Inside the cup was an insert (Morrill 1975) made from the bottom half of a cup the same size with fine mesh screen bottom. This allowed the fluid to drain into the cup when removing specimens. Each trap had a plywood rain cover, with a chicken wire skirt (2.5-cm mesh) to exclude vertebrates. The rain cover was bolted in three places to the platform in the apron traps, and to three wooden stakes in the nonapron trap. There was a gap of 5 cm between the rain cover and the ground or apron.

Nine traps, three of each design, were placed in six sites, for a total of 54 traps at the Twin Cities Army Ammunition Plant, New Brighton, Minnesota. Each site, a subunit of a larger habitat pitfall trapped for carabids the previous year, had relatively homogeneous soils, moisture, and vegetation. There were three blocks in each habitat, each consisting of the three trap types arranged in a triangle 3 m apart (locations for the three trap designs

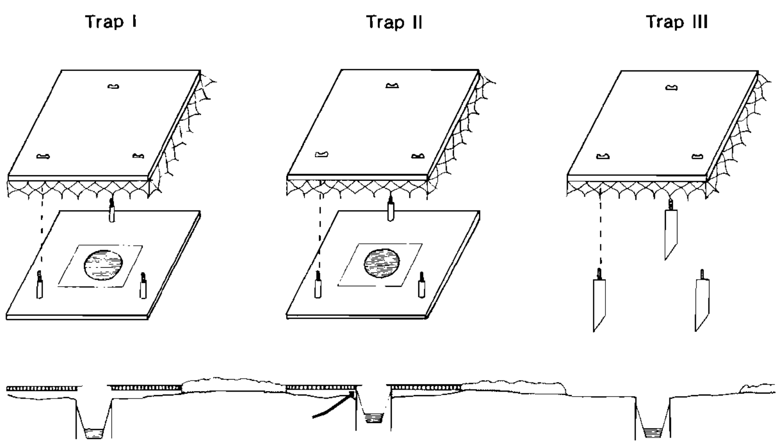

Fig. 1. Diagrams of apron and non-apron pitfall traps. The bottom illustration is in cross section, excluding the rain cover. The arrow shows that there is no gap between the trap and the apron.

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were selected from three numbered stakes by rolling a die). The distance between blocks ranged from 5 to 15 m depending on the size of the microhabitat. The habitats included a dry and a moist old field (OF1 and OF2), a mesic oak stand (Oak), a hygric and a mesic cottonwood stand (CW1 and CW2), and a cottonwood-box elder stand on the slope of a kame deposit (HCW) (Epstein 1982). Traps were emptied at weekly intervals from 2 May to 22 September 1981.

The procedure for setting out the apron traps differed depending on habitat. In the forest, leaf litter was cleared from around the can with the apron placed so the top of the litter was flush with its upper surface. In fields, a piece of turf equal in size to the apron was removed so the apron was flush with the base of the turf.

Split-plot ANOVA, with data transformed to square root, was performed to test the efficacy of the three trap designs on 12 common species. Species were tested individually to remove the bias caused by species with relatively large catches and to look at how susceptibility to being trapped differs among them. Linear contrasts (Snedecor and Cochran 1967) were used to compare all combinations of trap designs. A two-way ANOVA used the proportion of a trap type within a block summed over the season to analyse habitat-trap interactions within species. The data were transformed to square root. This removed bias caused by large differences in the numbers of individuals trapped between habitats. Only data from habitats in which a species was trapped at least 10 times were used in both analyses.

Specimens were identified by Epstein using the keys in Lindroth (1969) and verified or corrected by authorities on Carabidae (see Acknowledgments).

RESULTS

Overall, the nonapron trap (trap III) captured over 40% more specimens of Carabidae than either apron traps; 1015 versus 600 (trap I) and 606 (trap II). This inequality was found primarily in forest habitats (Fig. 2).

Species which showed the largest catch difference between trap designs in the split-plot ANOVA included *Calathus gregarius* Say, *Pterostichus pensylvanicus* LeConte, *Cymindus americana* Dejean, and *Platynus decentis* Say ($P < 0.005$). The first three species were captured significantly more in trap III compared to either trap I or trap II. *P. decentis* was caught more in trap III versus trap II ($P < 0.005$) than compared to trap I ($P < 0.025$). *Synuchus impunctatus* Say showed less overall difference between traps ($P < 0.025$) with the only significant difference being more captured in trap III than trap I ($P < 0.005$).

Data on species which were found in both forest and field (*C. gregarius*, *C. americana*, *Dicaelus sculptilis upioides* Ball, *Pterostichus novus* Straneo, and *Pterostichus lucublandus* Say) show that traps with aprons are often more effective than traps without them in field compared to forest habitats (Fig. 2). Habitat-trap interactions were significant only in the two-way ANOVA and for only *C. gregarius* and *S. impunctatus* (Table 1). Field-specialist species were captured in greater numbers in either traps II or III compared to trap I (Fig. 3).

P. novus ($P < 0.01$) and *P. decentis*, *C. gregarius*, and *C. americana* ($P < 0.005$) all had significant week-trap interactions in the split-plot ANOVA. Figure 4 shows the change in effectiveness between the three traps by week for *P. novus* and *C. americana*.

DISCUSSION

An apron around a pitfall trap may act as a barrier to forest dwelling carabids. Carabids moving about in leaf litter may follow the edge of the apron rather than moving on top or underneath it. Without an apron carabids reach a clearing on which they move about freely and become trapped. Aprons made of thin sheet metal like those used by Uetz and Unzicker (1976) should remedy this.

By contrast, in fields, where there is a greater amount of vertical resistance than in

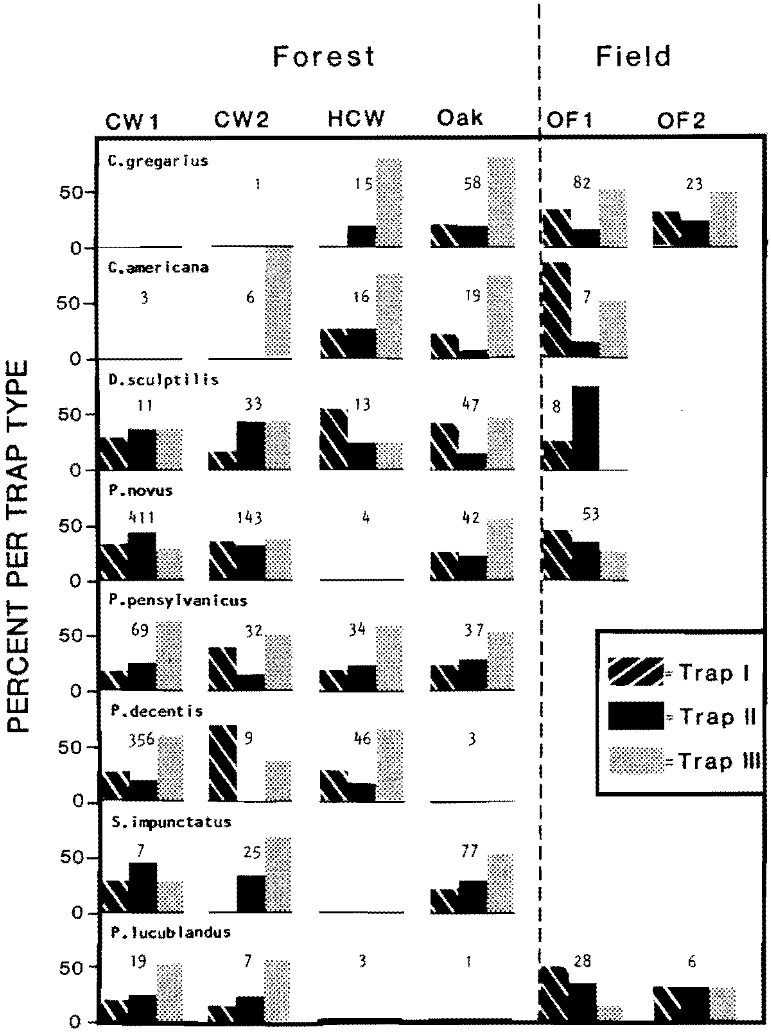

Fig. 2. Percent catches among three pitfall trap designs for eight species of Carabidae within each of six forest and field habitats. Numbers in each figure represent the total individuals trapped per site.

forest-litter habitats, carabids move at several levels. They more probably encounter an apron or a clearing around a non-apron trap from above. Thus, aprons may not act as much as barriers as they do in forest habitats.

There may be another reason why species that were found in both forests and fields were often trapped in greater numbers in apron trap I in fields (Fig. 2). Forest species that either seasonally or permanently expand into fields are more likely to seek cover under an apron, similar to the quality of cover available in forests, than field specialists. Field specialists *Calosoma calidum* Fabricius, *Pasimachus elongatus* LeConte, *Harpalus opacipennis* Haldeman, and *Evarthrus sodalis* LeConte, were captured in greater numbers in traps with less of a harboring effect; traps II and III (see further discussion below).

Table 1. Trap effect and habitat-trap interactions for three pitfall trap designs for eight species of Carabidae.

Species	Mean%[a] trap I	trap II	trap III	Trap Effect[b]	Habitat-Trap Interaction[b]	Habitats[c] in Analysis
C. gregarius	17.8	17.8	64.5	A	A	1,2,3,4
D. sculptilis	29.4	30.4	40.2			3,4,5,6
P. pensylvanicus	24.9	19.6	55.5	A		3,4,5,6
P. novus	35.7	30.3	33.9			2,3,5,6
C. americana	17.4	6.4	76.2	A		3,4
P. decentis	30.9	11.9	57.1	A		3,6
P. lucublandus	22.4	26.4	51.2			2,6
S. impunctatus	9.4	37.3	53.3	B	C	3,5

[a] Mean proportion between trap designs within blocks; three replicates per habitat.
[b] A = Significant ($P < .001$), B = Significant ($P < .005$), C = Significant ($P < .05$).
[c] 1 = OF1, 2 = OF2, 3 = Oak, 4 = HCW, 5 = CW1, 6 = CW2.

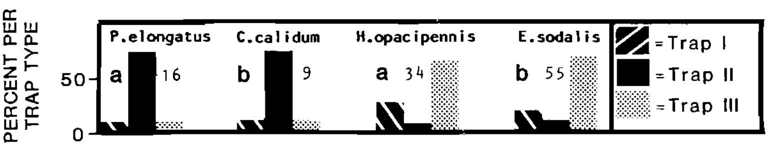

Fig. 3. Percent catches among three pitfall trap designs for four field-specialist species of Carabidae in two field habitats. Habitats are a = OF1 and b = OF2.

The harboring effect may also explain why larger numbers were caught in trap I than trap II. This was often true of *P. decentis, C. gregarius,* and *C. americana,* all species that are commonly found under logs or rocks (Lindroth 1969, Erwin 1981), though not statistically significant.

The greater captures of field species such as *P. elongatus* and *C. calidum* (Fig. 3) in trap II may represent the ability of larger species (> 20 mm length) to avoid capture by grasping the lip of the hole in the apron or the rim of the can with hind tarsi in traps I or III. A large carabid could span the distance between the hole in the apron and the rim of the can in trap I, whereas this would not be possible in trap II. Consistently fewer catches in trap I compared with trap II in a smaller species such as *S. impunctatus* (Fig. 2) may be due to the ability to crawl upside down under the apron without encountering the rim of the can.

Another attribute of trap II may have had an important influence on trap catches, especially in a wet habitat. This trap, with apron caulked to can, did not take in as much surface water during rainy periods. In CW1, traps I and III were filled with water nine and six times, whereas trap II only three times. Carabids which encounter the rim of a can filled with water, or fall in, are less probable captures because they can sense the presence of water or swim out. The large numbers of *P. novus* captured in trap II supports this hypothesis.

While trap design may not make much difference in the order of magnitude of captures of an abundant species such as *P. novus,* trap records for a less common species, *C. americana,* points to bias inherent in trap design. Data on *C. americana* show how

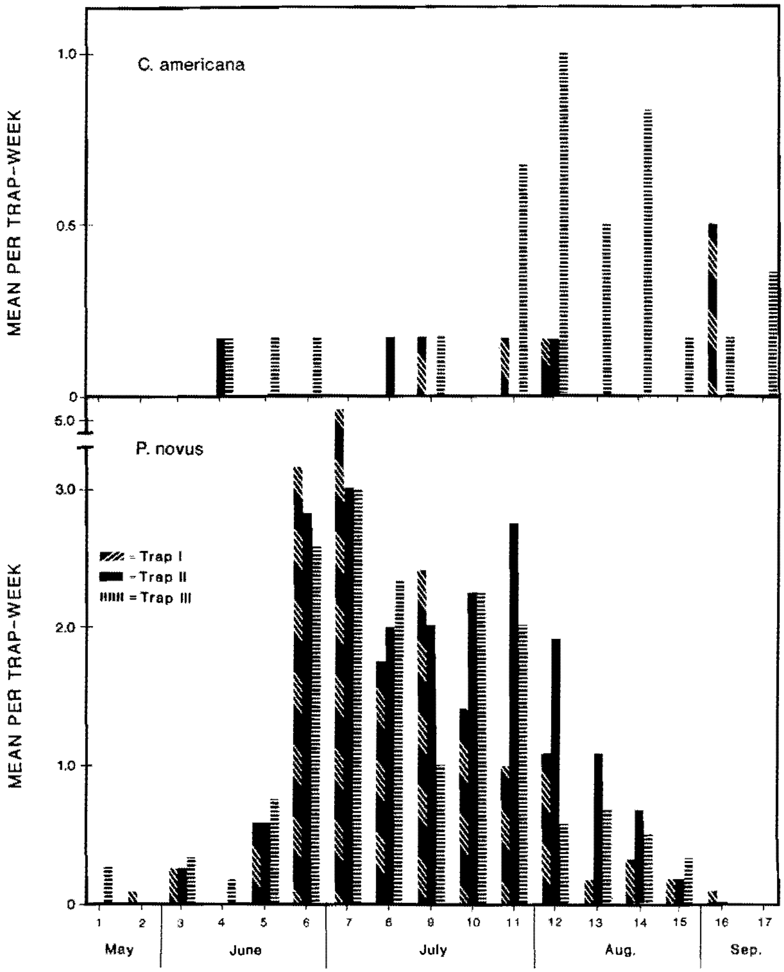

Fig. 4. Mean trap catches per week for *P. novus* and *C. americana*. Each trap replicated three times per habitat; *P. novus* from habitats OF2, NWO, CW1 and CW2, and *C. americana* from NWO and HCW.

certain pitfall trap designs may greatly underestimate the relative abundance of a species and that the efficacy of traps may not be constant throughout the season (Fig. 4). Traps I and II caught few or none most of the season, while trap III had initially small catches followed by a rough bell shape curve of catches.

We have shown that there are differences in how apron and nonapron pitfall traps perform in forest and field habitats. Though we may only infer the causes for these differences, our data illustrate the bias inherent even in traps similar in design. We recommend, therefore, that the use of several pitfall trap designs be considered for carabid surveys, including several habitats or within a single habitat, to better understand relative abundances and seasonal activities.

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LITERATURE CITED

Allen, R. T. 1979. The occurrence and importance of ground beetles in agricultural and surrounding habitats. p. 485–505 *in* Erwin, T. L., G. E. Ball, D. R. Whitehead, and A. L. Halpern (eds.). Carabid beetles: their evolution, natural history, and classification. W. Junk, Publ. The Hague.

Baars, M. A. 1979. Catches in pitfall traps in relation to mean densities of carabid beetles. Oecologia 41:25–46.

Cutler, B., L. H. Grim, and H. M. Kulman. 1975. A study in the summer phenology of dionychios spiders from northern Minnesota forests. Great Lakes Entomol. 8:99–104.

Durkis, T. J. and R. M. Reeves. 1982. Barriers increase efficiency of pitfall traps. Entomol. News. 93:8–12.

Epstein, M. E. 1982. Habitat and seasonal comparisons of ground beetles (Carabidae), M.S. Thesis. Univ. Minnesota. 70 p.

Erwin, T. L. 1981. Natural history of Plummers Island, Maryland. XXVI. The ground beetles of a temperate forest site. Bull. Biol. Soc. Washington 5:104–224.

Greenslade, P. J. M. 1964. Pitfall trapping as a method for studying populations of Carabidae (Coleoptera). J. Anim. Ecol. 33:301–310.

Houseweart, M. W., D. T. Jennings, and J. C. Rea. 1979. Large capacity pitfall trap. Entomol. News. 90:51–54.

Lindroth, C. H. 1969. The ground-beetles (Carabidae, excl. Cicindelinae) of Canada and Alaska. Part 1. Opuscula Entomologica; Suppl. 35:i–xlviii.

Morrill, W. L. 1975. Plastic pitfall trap. Environ. Entomol. 4:596.

Southwood, T. R. E. 1978. Ecological methods with particular reference to the study of insect populations. 2nd ed. 524 p. Chapman and Hall, New York.

Snedecor, G. W. and W. G. Cochran. 1967. Statistical methods. 6th ed. 593 p. Iowa State Univ. Press, Ames.

Uetz, G. and J. Unzicker. 1976. Pitfall trapping in ecological studies of wandering spiders. J. Arachnol. 3:101–111.