

Do diurnal carrion beetles use sight, as an aid to olfaction, in locating carrion?

Paul P. Shubeck, Biology Department, Montclair State College, Upper Montclair, N.J. 07043

Shubeck, Paul P. (Biol. Dept., Montclair State College, Upper Montclair, N.J. 07043). Do diurnal carrion beetles use sight, as an aid to olfaction, in locating carrion? *Hutcheson Mem. Forest Bull.* 3:36-39. 1975. — Diurnal species of Silphidae were trapped in equal numbers in visually exposed carrion traps and in concealed carrion traps. This seems to indicate lack of discrimination between locating exposed and locating concealed carrion and implies that sight is not involved. Individuals of family Histeridae attracted to carrion acted similarly, apparently depending on olfaction alone. Families Staphylinidae and Leptodiridae, however, were captured in much greater numbers in the visually exposed carrion traps, indicating the probable use of their eyes in addition to their olfactory organs. Carrion seeking members from the last three families are known to be diurnal in Hutcheson Memorial Forest.

Ecological field studies that are carefully planned and faithfully conducted often lead to meaningful results. Just as often, however, they lead to new questions and thus to new field studies. Such has seemed to be the case with ecological studies of carrion beetles in H M F during the past 14 years. In one of the original projects it was found that seven species of Silphidae (Carrion Beetles), and certain unidentified species of Leptodiridae (Small Carrion Beetles), Histeridae (Hister Beetles), and Staphylinidae (Rove Beetles) were capable of locating carrion placed in one-gallon cans that were sunk into the soil. These beetles were *not* collected in similar cans that were empty or that held non-carrion baits. All can openings were flush with the surface of the soil but concealed from view (Shubeck, 1968). In a later study (Shubeck, 1970) it was found that when given a choice of carrion-baited ground cans versus carrion-baited air cans, four species of Silphidae manifested strong preferences for one type or the other, apparently indicating differences among species in efficient "clueing in" on carrion.

A study of diel periodicities of certain carrion beetles in HMF (Shubeck, 1971) showed that four species of Silphidae were completely or primarily diurnal in finding carrion and two species of this family were nocturnal. Also primarily diurnal were individuals of families Leptodiridae, Staphylinidae, and Histeridae that were attracted to the carrion traps. The results of this study were especially intriguing since Abbot (1927), and Milne and Milne (1944) had written about the typical nocturnal or crepuscular activities of carrion beetles and Kuhnelt (1961) referred to Silphidae as blind beetles (European studies).

Since it was obvious from these studies that some carrion beetles were nocturnal but that most were diurnal; and further, that the work in HMF was based on concealed carrion, whether suspended in the air or sunk in the ground; and also that not all species were attracted similarly to different traps — it was decided that an attempt should be made to determine if carrion beetles use their eyes to help them to locate carrion, or to determine that their orientation to carrion is based on olfaction

alone. All data were collected during the summer of 1974 and the trapping station was located within H M F about 40 meters from its northern edge.

Methods

Eight carrion-baited traps were placed along the arc of a circle which was approximately 22 meters in diameter. The four box-type traps (Fig. 1) were situated so that one of each was located at compass points N, E, S, and W from the center of the circle, and the battery jar-type traps (Fig. 1) were arranged so that one of each was located at points NE, SE, SW, and NW from the center of the circle. As a result, individual traps containing carrion concealed from view, and individual traps containing carrion exposed to view were alternately situated along the arc of the circle and each trap was about 8.5 meters from each neighboring trap. Chicken drumsticks were readily available at most supermarkets so they were used as carrion.

A fresh chicken drumstick was placed in each of the eight traps on 22 June, and collections made on 29 and 30 June and on 1 July. The decomposing drumsticks were replaced on the latter date with fresh ones and collections then made on 4, 5, and 6 July. A third sequence was prepared on the latter date and collections were made on 9, 10, and 11 July. The traps were similarly baited on 5 August and a single collection made on 10 August. Most collecting was conducted around 18:00 although a few collections were taken several hours earlier.

All data were recorded at the trapping circle. Beetles were identified to family, and all but two individuals of the family Silphidae were identified to species. Accuracy of identification and recording of data were facilitated by having one worker remove and identify beetles from the traps and having a second worker record the data. The vast majority of Silphidae were then released about 50 meters from the trapping circle but many representatives of the Staphylinidae, Histeridae, Leptodiridae, and Scarabaeidae were preserved in 70% alcohol for eventual identification to species.

Results and discussion

A total of 3066 beetles were captured during the 1974 summer study. Table 1 shows the taxa, as recorded, and the breakdown of each taxon into the number captured in concealed traps versus the number captured in the visually exposed traps. The four most abundant families were Silphidae, 39.47% of the total; Staphylinidae, 43.54%; Histeridae, 9.07%; and Leptodiridae, 5.84%.

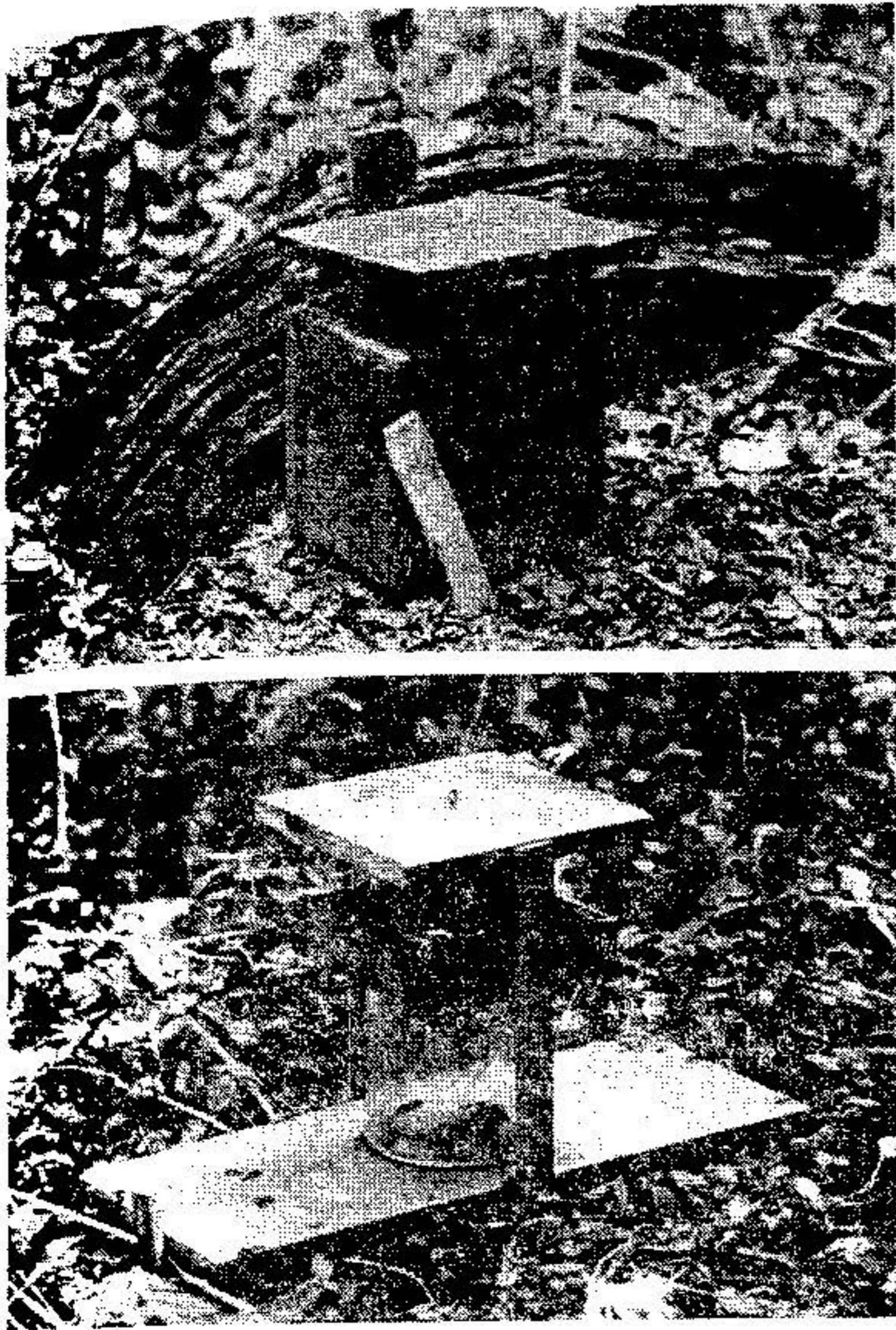


Figure 1. Upper photograph shows box-type trap in which carrion was concealed from view. Lower photograph shows battery jar-type trap in which carrion was exposed to view. Photographs by Thomas P. Shubeck.

The combined numbers accounted for 97.92% of all beetles collected. It is interesting to note that in 1961 these four families made up 97% of the total beetle captures and in 1963, 89% (Shubeck, 1969). The vast majority of the remaining individuals were dung beetles (Scarabaeidae) and their numbers, when added to the numbers of the most abundant families, brought the total to 99.84%.

Preliminary examination of Silphid species attracted to concealed carrion versus visually exposed carrion showed little, if any, discrimination between the two groups. This was somewhat puzzling since four of the species are diurnal (Shubeck, 1971) and they could be expected to utilize vision, along with olfaction, when searching for carrion. In order to obtain statistical support for the apparent evidence that four diurnal species of Silphidae depend on olfaction, and not olfaction and vision, to locate carrion — each of these species was subjected to hypothesis testing (Dixon and Massey, 1957).

H_0 : We want to test if the proportion of beetles using vision along with olfaction = .5 = p .

$$\hat{p} = \frac{\# \text{ beetles captured at visually exposed traps}}{\# \text{ beetles captured at all traps}}$$

Z has a normal distribution with a mean 0, and a standard deviation of 1.

If $\alpha = .01$, the probability (rejecting H_0 / H_0 is true) = α .

Reject if $Z < -2.57$ or $> +2.57$.

(1) *Silpha noveboracensis*, where $\hat{p} = \frac{340}{734} = .46$

Fail to reject H_0 ,
 $Z = -1.96$ * $P < .05$

(2) *S. inaequalis*, where $\hat{p} = \frac{55}{118} = .47$

Fail to reject H_0 ,
 $Z = -.65$ $P < .26$

(3) *S. americana*, where $\hat{p} = \frac{33}{75} = .44$

Fail to reject H_0 ,
 $Z = -.93$ $P < .18$

(4) *Nicrophorus tomentosus*, where $\hat{p} = \frac{37}{68} = .54$

Fail to reject H_0 ,
 $Z = .61$ $P < .27$

It is obvious from the statistical treatment above that the proportion of beetles (within each species) attracted to the visually exposed carrion is not significantly different from the proportion attracted to concealed carrion.

The remaining two species of Silphidae are known to be nocturnal in H M F (Shubeck, 1971), and one, *N. orbicollis*, was taken in sufficient numbers to convincingly show that virtually equal numbers were attracted to visually exposed carrion (102 beetles) and to concealed carrion (109 beetles). Statistical treatment indicated $Z = -.41$ and $P < .34$. This species served as a fine control since nocturnal, carrion-feeding insects might be expected to depend on olfaction alone to locate food and further, eyes would be of little use in the dark. This gives added support to the evidence indicating that diurnal Silphid species in H M F do not use sight but rely on olfaction to locate carrion.

The next taxon that was examined was Staphylinidae. Of 1335 individuals collected, 1052 were taken at visually exposed carrion traps. Rove beetles are predators of other arthropods and sight is undoubtedly of assistance in (1) locating carrion, and (2) locating the prey present upon this microhabitat. Statistical treatment indicated that the proportion of individuals attracted to visually exposed carrion was not $p = .5$, and the hypothesis was rejected. Staphylinidae, in other words, were very significantly attracted to visually exposed carrion.

(5) Staphylinidae, where $\hat{p} = \frac{1052}{1335} = .79$

Reject H_0 ,
 $Z = 3.19$ $P < .0007$

* P = the confidence level that would cause us to reject H_0 for the observed data. (The smaller the P the stronger our conviction.)

Table 1. Cumulative numbers of beetles attracted to concealed and visually exposed carrion. The month and day of the collection and the number of days after the bait was set, for that collection, is given above each column. In addition to the taxa and numbers shown, 56 Scarabaeidae, 2 Elateridae, 2 *Nicrophorus* sp., and 3 unknown beetles were taken.

		6-29	6-30	7-1	7-4	7-5	7-6	7-9	7-10	7-11	8-10
		7	8	9	3	4	5	3	4	5	5
Silphidae											
<i>Silpha noveboracensis</i>	Concealed	31	84	107	185	254	300	349	387	394	394
	Visual	39	73	98	181	221	254	304	329	340	340
<i>S. inaequalis</i>	Concealed	24	34	41	46	49	49	58	62	63	63
	Visual	14	19	21	29	36	38	53	54	55	55
<i>S. americana</i>	Concealed	7	8	8	20	29	31	42	42	42	42
	Visual	2	2	3	11	18	19	30	32	32	32
<i>Nicrodes surinamensis</i>	Concealed	0	1	1	1	1	1	1	1	1	1
	Visual	0	1	1	1	1	1	1	1	1	1
<i>Nicrophorus tomentosus</i>	Concealed	7	7	7	10	14	18	23	29	31	31
	Visual	3	4	6	10	15	16	24	32	34	37
<i>N. orbicollis</i>	Concealed	22	27	29	39	46	46	59	59	65	109
	Visual	15	18	18	27	33	33	44	45	47	102
Staphylinidae											
	Concealed	33	47	64	69	84	93	150	210	248	283
	Visual	104	161	193	311	370	381	652	788	898	1052
Histeridae											
	Concealed	1	1	2	13	24	38	73	147	153	156
	Visual	3	4	6	28	36	41	83	117	118	122
Leptodiridae											
	Concealed	0	4	6	6	17	20	22	28	55	68
	Visual	24	30	39	40	48	52	57	74	98	111

Individuals of family Histeridae were found to be approximately equally attracted to visual and concealed carrion and the statistical treatment supported the conclusion that sight had no positive influence on locating carrion.

$$(6) \text{ Histeridae, where } \hat{p} = \frac{122}{278} = .44$$

$$\text{Fail to reject } H_0, \\ Z = -1.99 \quad P < .0233$$

The last taxon examined statistically was Leptodiridae. This family, as was the case with Staphylinidae, had greater numbers of individuals attracted to the visually exposed carrion, so the proportion was not $p = .5$.

$$(7) \text{ Leptodiridae, where } \hat{p} = \frac{111}{179} = .62$$

$$\text{Reject } H_0, \\ Z = 3.23 \quad P < .0006$$

The fifth largest family of beetles captured was Scarabaeidae and the individuals attracted to the traps are commonly called dung beetles because of their practise of laying eggs in portions of dung which are subsequently rolled into little balls and buried. Dung beetles are not considered to be "carrion beetles" and their data was not treated statistically nor was it evaluated.

It seems clear then, that the diurnal species of Silphidae, active in H M F, do not discriminate between visually exposed and concealed carrion. They are attracted

to both kinds of carrion traps in very nearly equal numbers. The logical explanation appears to be that their ultimate location of carrion is based on their sense of olfaction. Similarly, Histeridae appear to locate carrion by means of olfaction and with no sight assistance. Staphylinidae and Leptodiridae, on the other hand, were captured in significantly higher numbers in the visually exposed carrion traps and thus appear to use their eyes, along with their olfactory nerve endings that detect odor.

Acknowledgments

I would like to thank the Hutcheson Memorial Forest Committee for encouraging me in my studies of carrion beetles in the Forest during the past 14 years. My son, Thomas Shubeck, provided many hours of field assistance. Special thanks are due Dr. Helen Roberts, of the Mathematics Department of Montclair State College, for completely revising, reworking, and finalizing the statistics used in the study.

Literature cited

- Abbott, C. E. 1927. Experimental data on the olfactory sense of Coleoptera, with special reference to the *Nicrophori*. *Ann. Entomol. Soc. Amer.* 20:207-216.
 Dixon, W. J. and F. J. Massey, Jr. 1957. *Introduction to statistical analysis*. McGraw-Hill Book Co., Inc. New York, 488 p.
 Kuhnelt, W. 1961. *Soil biology*. Faber and Faber, London, 397 p.

Milne, L. J., and M. J. Milne. 1944. Notes on the behavior of burying beetles (*Nicrophorus* spp.). J. N. Y. Entomol. Soc. 52:311-327.

Shubeck, P. P. 1968. Orientation of carrion beetles to carrion: random or non-random? J. N. Y. Entomol. Soc. 76:253-265.

_____. 1969. Ecological studies of carrion beet-

les in Hutcheson Memorial Forest. J. N. Y. Entomol. Soc. 77:138-151.

_____. 1970. Silphidae attraction to carrion-baited air cans versus carrion-baited ground cans. The Coleopterists Bull. 24:66-70.

_____. 1971. Diel periodicities of certain carrion beetles (Coleoptera: Silphidae). The Coleopterists Bull. 25:41-46.