Flight activity of certain carrion beetles: Silpha noveboracensis, Staphylinidae, Histeridae

Paul P. Shubeck
Biology Department, Monclair State College, Upper Montclair, NJ 07043

Shubeck, Paul P. (Biol. Dept., Montclair State College, Upper Montclair, N.J. 07043). Flight activity of certain carrion beetles: *Silpha noveboracensis*, Staphylinidae, Histeridae. Hutcheson Mem. Forest Bull. 3:40-43. 1975. The influences of temperature, relative humidity and light intensity on the flight activity of *Silpha noveboracensis*, Staphylinidae and Histeridae, that were attracted to carrion, were examined. The typical lower threshold temperature of flight activity for *S. noveboracensis* was 23°C, and 30°C was probably at or near the upper threshold temperature. The upper threshold level of relativity humidity for this species appears to be about 85% and a light intensity of about 5 FC, at the end of the diurnal period, appears to inhibit further flight. Although 97% of the Staphylinidae taken were captured at temperatures of 23°-30°C, a few were taken at temperatures of 18°-22°C and the highest recorded temperature of 30°C did not appear to inhibit flight activity. Relative humidity readings from 36% to 100% were recorded and Staphylinidae were not inhibited at any level within this range. The degree of light intensity appeared to have little influence on the flight activity of this taxon. More than 99% of Histeridae captured were taken within a temperature range of 24°-30°C but the upper temperature had no limiting effect on their flight activity. Although this taxon was taken within a wide range of relative humidity, 36%-100%, 84% of the total was captured within a range of 56%-83%. This taxon did not appear to be affected by low light intensities.

In a recent study to determine the diel periodicities of certain carrion beetles it was found that *Silpha noveboracensis* Forst., *Silpha americana* L., *Silpha inaequalis* Fab. and *Nicrophorus tomentosus* Web. were either exclusively or primarily diurnal (Shubeck 1971). These species are members of family Silphidae, the Carrion Beetles. Certain individuals from three other families of beetles were also attracted to the the carrion-baited traps used in the study. These beetles, from families Leptodiridae, Staphylinidae and Histeridae, were also either exclusively or primarily diurnal.

Since the evidence given in the study above seemed to be reasonably conclusive, it was decided to investigate further and to attempt to determine either that portion of the diurnal period during which carrion beetles are most active, and/or which factors of the environment, i.e. relative humidity, light intensity, and temperature serve as a stimulus to flight activity. In a study on the effect of temperature on insects in flight, Taylor (1963) suggested "... that the lower temperature threshold is, in temperate climates, an important climatic factor determining insect flight and that it can be clearly and simply measured by trap catches."

Data were collected during brief periods of the summers of 1971, 1972 and 1973. The carrion-baited traps were placed in Hutcheson Memorial Forest (hereafter referred to as HMF) near East Millstone, Somerset County, New Jersey and also in a similar forest at the Great Swamp Wildlife Refuge, near Meyersville, Morris County, New Jersey. Data from the two sites are lumped.

Methods

Several days for collecting were scheduled during each of the summers in 1971, 1972 and 1973. A day for collecting was not scheduled unless it was possible to stay in the field to empty traps and take relative humidity, temperature, and light intensity readings every hour, on the hour from 8:00 A.M. to 7:00 P.M. in order to adequately cover the diurnal period. Due to the fact that not a single individual of *Silpha noveboracensis* had been captured by 4:00 P.M. on 26 May 1971 (apparently because of temperatures below 23°C), further collecting was discontinued for the day. On 29 June 1973 not one individual of this taxon was taken up to 6:00 P.M. (apparently because the relative humidity had ranged from 95% to 100%), so further collecting was again discontinued. Data in this study, therefore, is based on 117 hours of collecting. The meteorological data were actually taken and recorded during the 5-10 minutes preceding the hour, and the beetles collected during the 5-10 minutes that followed the hour. The relative humidity was determined by the use of a Taylor® hand sling psychrometer. A Taylor® laboratory thermometer was placed on the leaf litter, in the shade, and the temperature recorded. The light intensity reading was determined by the use of a General Electric® photography light meter. The instrument was held at a 45° angle to the leaf litter at a

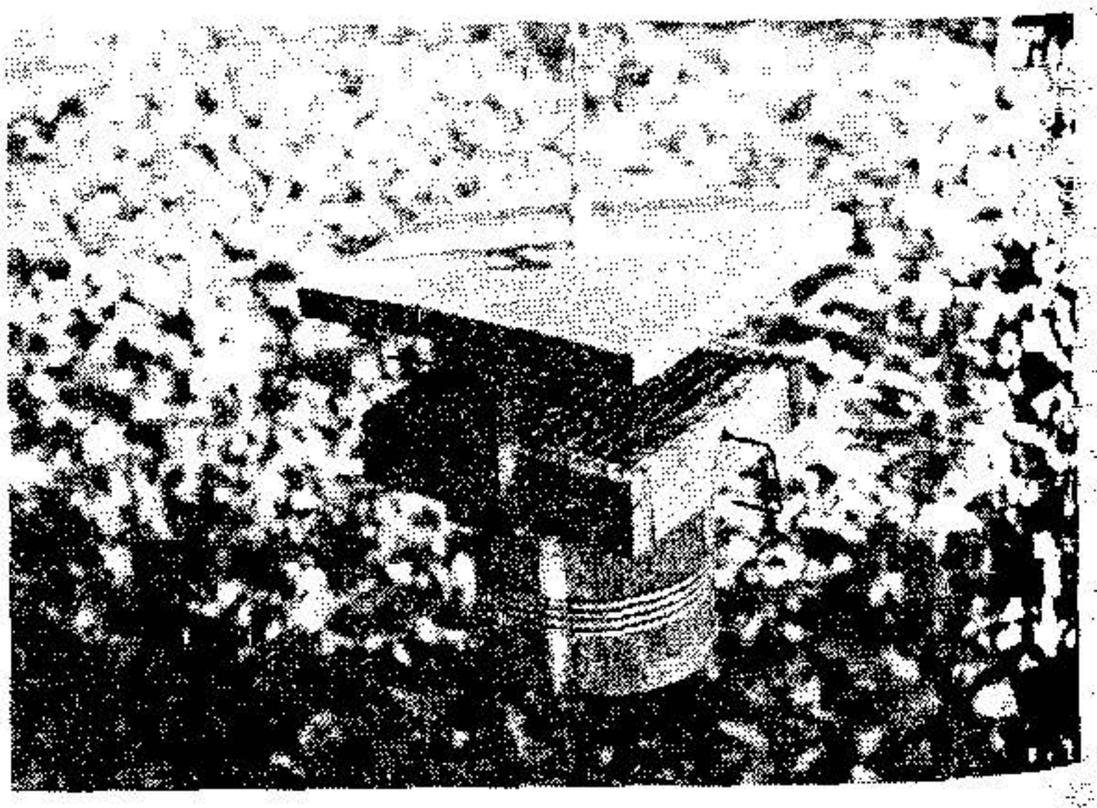

Figure 1. Suspended carrion-baited trap first used in Great Swamp Wildlife Refuge. Photograph by Thomas Shubeck.

distance of about 10 centimeters. In an attempt to be consistent the recorder always kept his back to the sun and held the light meter over shaded leaf litter when recording light intensity.

Data were recorded in HMF on the following dates in 1971: 26 May; 17, 24 and 25 June; and 3 July. Four one-gallon cans in wooden boxes were suspended above the ground so that the ½ inch wire mesh covering the can opening was ¾ meter above the ground (Shubeck 1971). A fresh chicken leg was placed in each trap 3 to 7 days before each of the collecting days.

During the summer of 1972 data were collected in HMF, in the same traps, on 1 July. On dates 18, 19 and 20 July, however, data were collected in the Great Swamp Wildlife Refuge using traps of a slightly modified design (Fig. 1). Six of the latter were suspended ¾ meter above the ground and arranged in a straight line. The traps were spaced about 3 meters apart from each other, and baited with fresh chicken legs 4 to 6 days before collections were made. Data were collected in HMF on two days in 1973: 28 and 29 June. Two of the modified traps used in the Great Swamp were added to the 4 can-box traps that had been used (and left) in HMF the previous summers. These traps were situated about 10 meters from the original four. Two fresh chicken legs were placed into each trap 3 days before the first collecting day.

All beetles collected in carrion traps were identified to 4 major taxa — Silphidae, Staphylinidae, Histeridae, Leptodiridae — and "other beetles." In a previous study in HMF it had been found that about 90% of all beetles attracted to carrion-baited traps were members of these 4 families (Shubeck 1969). Individuals of family Silphidae were identified to species. All beetles captured in HMF were released at the end of each collecting day, about 40 meters from the traps. Beetles collected in Great Swamp were preserved in 70% alcohol for possible future study.

Although data were recorded for 4 species of Silphidae, and 3 other "carrion beetle" families, it was deemed advisable not to attempt to analyse data for species of Silphidae other than *Silpha noveboracensis*, or for the taxon Leptodiridae, because of the very small numbers of individuals taken from these taxa during the period of study.

Table 1. Carrion-bait captures of *Silpha noveboracensis* at given temperatures (modified after Taylor 1963).

°C	A	B	C	D
30	5	2	11	2.2
29	11	7	43	3.9
28	16	12	46	3.8
27	10	7	38	3.8
26	10	9	47	4.7
25	14	11	139	9.9
24	21	10	55	2.6
23	11	7	19	1.7
22	4	0	0	.0
21	7	0	0	.0
20	3	1	1	.3
19	4	0	0	.0
18	1	0	0	.0

A = Number of times (hours) the temperature occurred.
B = Number of times a capture occurred at this temperature.
C = Total numbers of *Silpha noveboracensis* captured at given temperature during course of study.
D = Average number of beetles captured per hour (C/A).

Results and discussion

Of 399 individuals of *Silpha noveboracensis* collected during the course of the study, all but 1 were captured at temperatures 23° through 30°C (Table 1). The individual exception was taken at 20°C although 19 hours of data had been recorded when the temperatures ranged from 18° through 22°C. It would appear that 23°C was the typical lower threshold temperature for flight activity by *S. noveboracensis*. Unfortunately, no temperature above 30°C was ever recorded during the study, so it was not possible to state unequivocally that 30°C was the upper threshold temperature for flight activity. On the other hand, Table 1 shows that the 11 beetles collected at 30°C represented only about 25% of the numbers collected at each of the temperatures, 26° through 29°C. Also, captures at 30°C were made on but 2 of 5 collecting periods. The evidence suggests that 30°C is at, or near the upper threshold temperature level. Also evident is the fact that although the normal temperature range of flight activity was 23°C to about 30°C, a very pronounced peak of activity was present at 25°C, and this might be considered to be the optimum temperature for flight activity (Fig. 2).

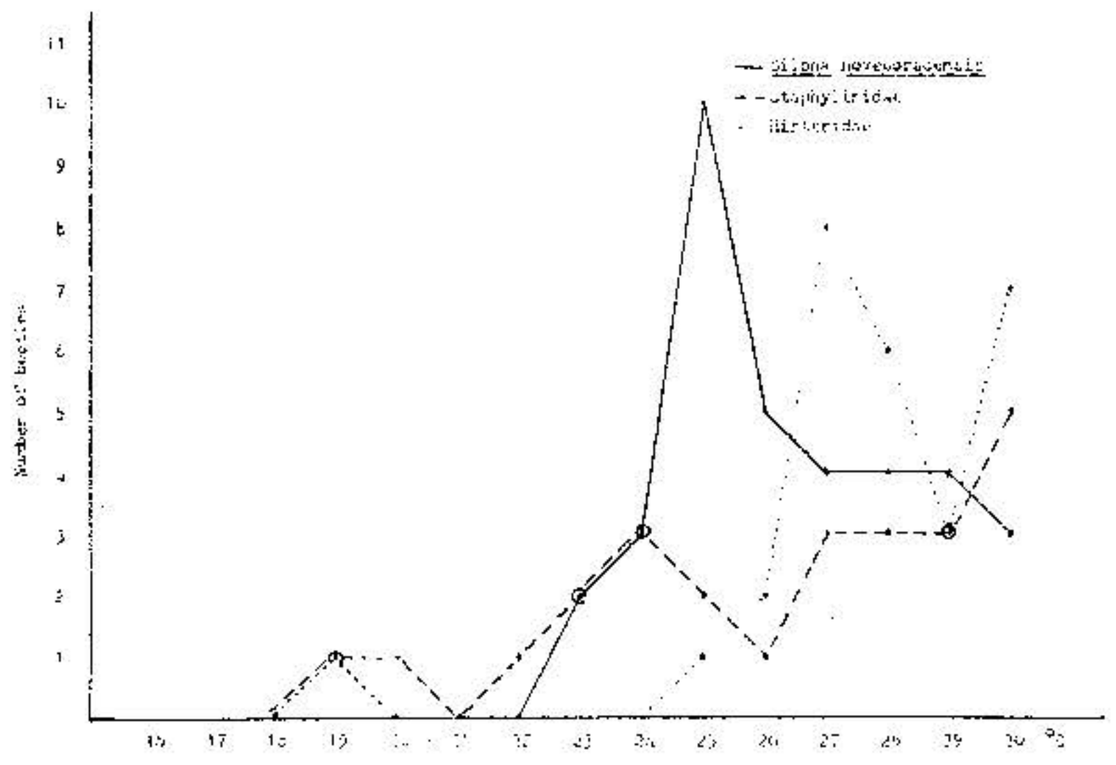

Figure 2. Average number of beetles captured per hour. Data taken from column D, Tables 1 & 3. Fractions are rounded out to whole numbers.

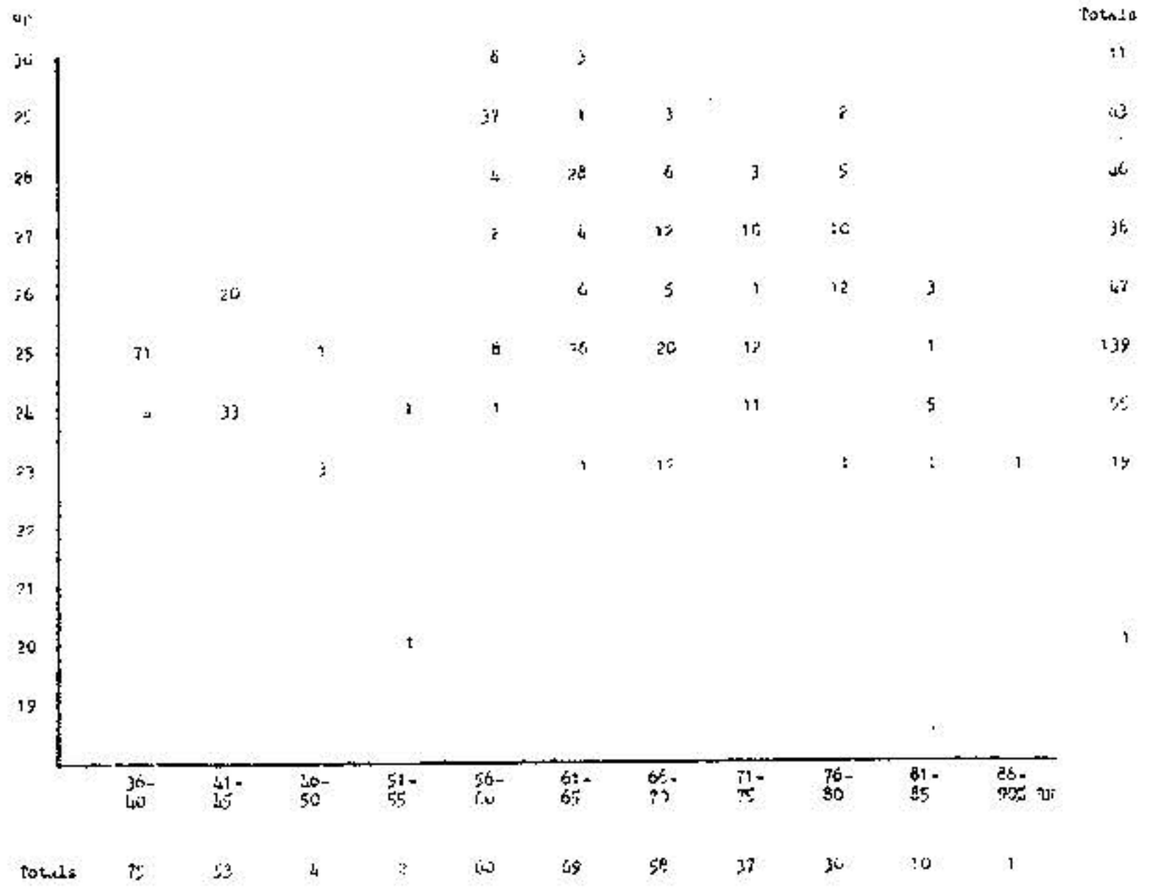

Figure 3. Total numbers of *S. noveboracensis* showing temperature and relative humidity at time of capture.

Table 2. *Silpha noveboracensis* capture data. Each number to the right of a given temperature represents the number of individuals collected at an hourly collection. The number below the capture number is the % RH recorded when the collection was made, and the third number down indicates time of collection (9 for 9 A.M., 13 for 1 P.M., etc.).

°C											
30	8	0	0	0	3						
	59	60	65	64	64						
	13	14	16	17	18						
29	11	2	0	0	2	24	0	0	1	1	2
	59	56	56	62	66	59	77	77	70	64	77
	13	14	15	16	17	12	14	15	16	15	19
28	3	0	24	0	1	1	4	1	3	2	1	1	0	2	0	3
	74	69	61	73	69	66	59	70	76	76	64	70	73	69	69	65
	11	18	11	14	15	16	18	12	13	18	13	12	13	14	15	17
27	12	2	10	0	3	2	0	0	8	1						
	69	56	76	73	63	72	76	76	72	65						
	12	17	11	17	12	11	14	15	13	16						
26	1	5	0	20	5	3	1	2	1	9						
	72	68	61	42	65	84	65	76	76	79						
	19	10	19	17	10	19	10	11	10	12						
25	1	3	9	5	17	20	25	18	28	0	1	0	0	12		
	48	59	63	60	64	68	38	39	36	91	83	96	100	75		
	13	14	14	15	16	17	14	15	16	9	9	16	17	11		
24	0	1	1	1	0	10	4	0	4	17	15	0	0	0	1	1	0	0	0	0	0
	47	45	51	59	86	71	82	45	39	41	44	100	100	91	82	75	84	100	100	100	95
	12	15	16	17	10	18	19	11	12	13	18	18	19	9	10	18	19	13	14	16	17
23	0	1	1	1	4	8	3	1	0	0	0										
	57	62	82	77	66	70	46	87	95	95	100										
	11	18	9	11	12	13	19	9	12	15	18										
22	0	0	0	0																	
	47	95	100	100																	
	13	9	10	11																	
21	0	0	0	0	0	0	0														
	45	51	72	69	90	90	48														
	12	15	10	19	9	10	10														
20	0	0	1																		
	51	58	54																		
	11	16	9																		
19	0	0	0	0																	
	59	50	84	90																	
	10	14	9	9																	
18	0																				
	66																				
	9																				

In so far as relative humidity was concerned, the overwhelming majority of these beetles were taken within a range of 36%-84% (Fig. 3). Only 1 individual was taken at 87% RH. Relative humidities of 91%-100% were recorded 3 times at 23°C, 7 times at 24°C, and 3 times at 25°C. Not one individual of *Silpha noveboracensis* was ever taken at this upper range of relative humidity even though the temperatures were suitable for flight (Table 2). It must be noted that 36% RH can not be declared the lower threshold for flight activity (there having been no lower RH recorded at sampling times), particularly so in view of the fact that the highest capture (28) in any one collection occurred at 36% RH (Table 2, 25°).

Although a range of light intensities of 7 through 20 foot candles was noted before morning activity began, the critical stimulus, virtually always, appeared to be a temperature level of 23°C (Table 2). On the other hand, light intensity was an important parameter at the end of the day since temperatures and relative humidities were usually suitable for flight during the last few hours of daylight. A few individuals were captured at light intensities of 4, 5 and 7 FC but the numbers taken at this time were much reduced.

The temperature range of flight activity for 97% of Staphylinidae taken was similar to that of *Silpha noveboracensis*, 23°-30°C. The lower threshold, however, did not appear to be so critical for Staphylinidae since 3.7% of the individuals taken were captured at temperatures below 23°C, i.e. 18°C through 22°C (Table 3). It was noted that a small but distinct peak of activity was present at 30°C when the numbers of *S. noveboracensis* dropped (Fig. 2). It would thus appear that some Staphylinidae can continue their flight activity in search of carrion at temperatures above 30°C.

Figure 4 clearly indicates that the flight activity of Staphylinidae is little affected by relative humidity

Table 3. Carrion-bait captures of Staphylinidae at given temperatures (modified after Taylor 1963). Comparable data for Histeridae are given in parentheses.

°C	A	B	C	D
30	5 (5)	5 (5)	23 (35)	4.6 (7.0)
29	11 (11)	11 (9)	36 (34)	3.2 (3.1)
28	16 (16)	15 (12)	47 (94)	2.9 (5.8)
27	10 (10)	9 (10)	29 (75)	2.9 (7.5)
26	10 (10)	7 (4)	14 (19)	1.4 (1.9)
25	14 (14)	11 (5)	32 (7)	2.2 (.5)
24	21 (21)	19 (4)	57 (9)	2.7 (.4)
23	11 (11)	8 (1)	21 (1)	1.9 (.1)
22	4 (4)	1 (0)	2 (0)	.5 (.0)
21	7 (7)	2 (0)	4 (0)	.5 (.0)
20	3 (3)	1 (0)	1 (0)	.3 (.0)
19	4 (4)	1 (0)	2 (0)	.5 (.0)
18	1 (1)	1 (1)	1 (1)	1.0 (1.0)

A = Number of times (hours) the temperature occurred.
B = Number of times a capture occurred at this temperature.
C = Total numbers of Staphylinidae captured at given temperature during course of study (Histeridae data in parentheses).
D = Average number of beetles captured per hour (C/A).

These beetles were captured over the entire range of relative humidity recorded from 36% to 100%. The degree of light intensity did not appear to be important as a stimulus to flight activity of Staphylinidae and one individual, in fact, was taken at a reading of "O" FC.

Although 1 Histerid beetle was taken at 18°C and another at 23°C, all of the others (273) were captured at a temperature range of 24°C through 30°C (Table 3). A primary peak of activity was evident at 27°C and a secondary peak of activity was evident at 30°C (Fig. 2). This latter fact probably indicates that Histeridae are capable of some flight activity above 30°C.

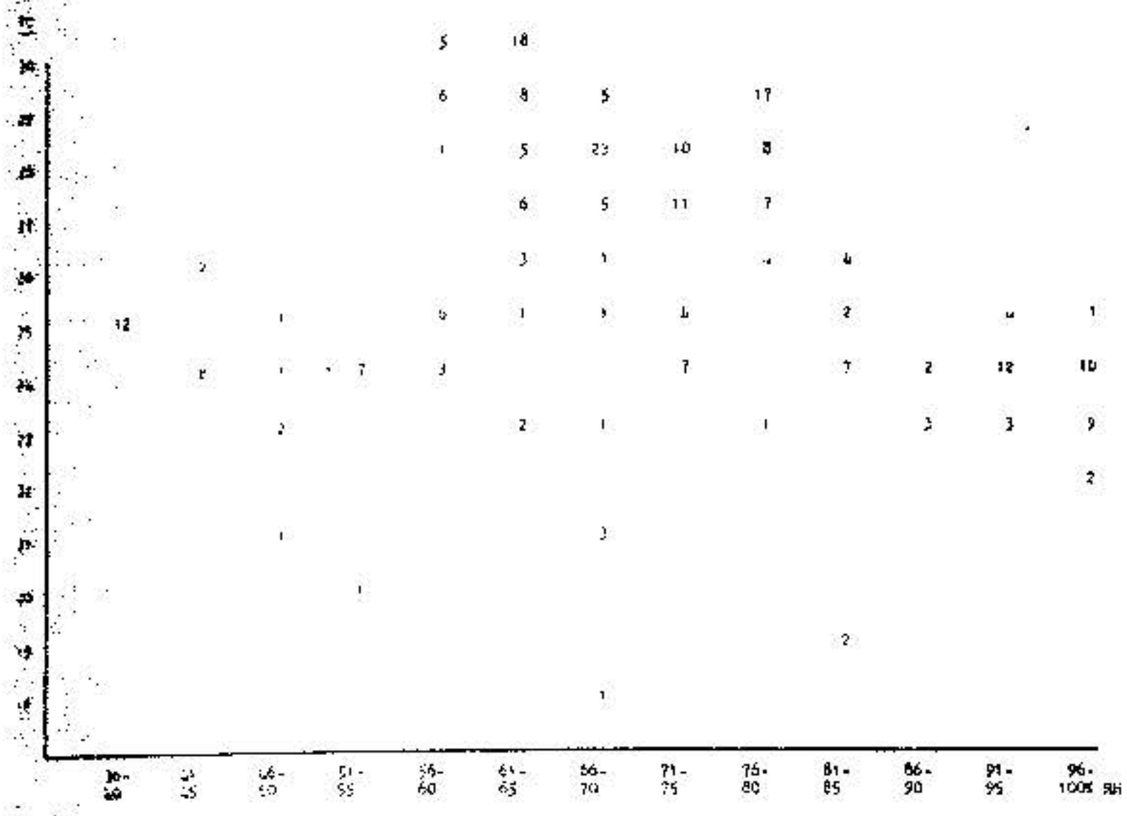

Figure 4. Total numbers of Staphylinidae showing temperature and relative humidity at time of capture.

In so far as relative humidity was concerned, 8 individuals were taken between 36% and 45% RH, and 8 individuals between 91% and 100% (Fig. 5). The remaining 259 (84%) were taken within a fairly compact range of relative humidity from 56% to 83%. It appears that Histeridae may have a preferred relative humidity range which is smaller than that of *Silpha noveboracensis* and Staphylinidae.

As with Staphylinidae, Histeridae did not appear to be limited by low light intensities and 1 Histerid was also taken at "O" FC.

As a result of a study on diurnal periodicity of flight by insects, mostly in Southern England, Lewis and Taylor (1965) came to a number of interesting conclusions. Two of them differ from findings in my study. In their study they found that . . . "Light intensity is the major factor controlling times of flight. . ." As has been shown in the N.J. study, after the onset of the diurnal period, temperature appears to be the major factor stimulating flight activity in the taxa studied; and high relative humidity appears to be a major factor inhibiting flight activity in *Silpha noveboracensis*.

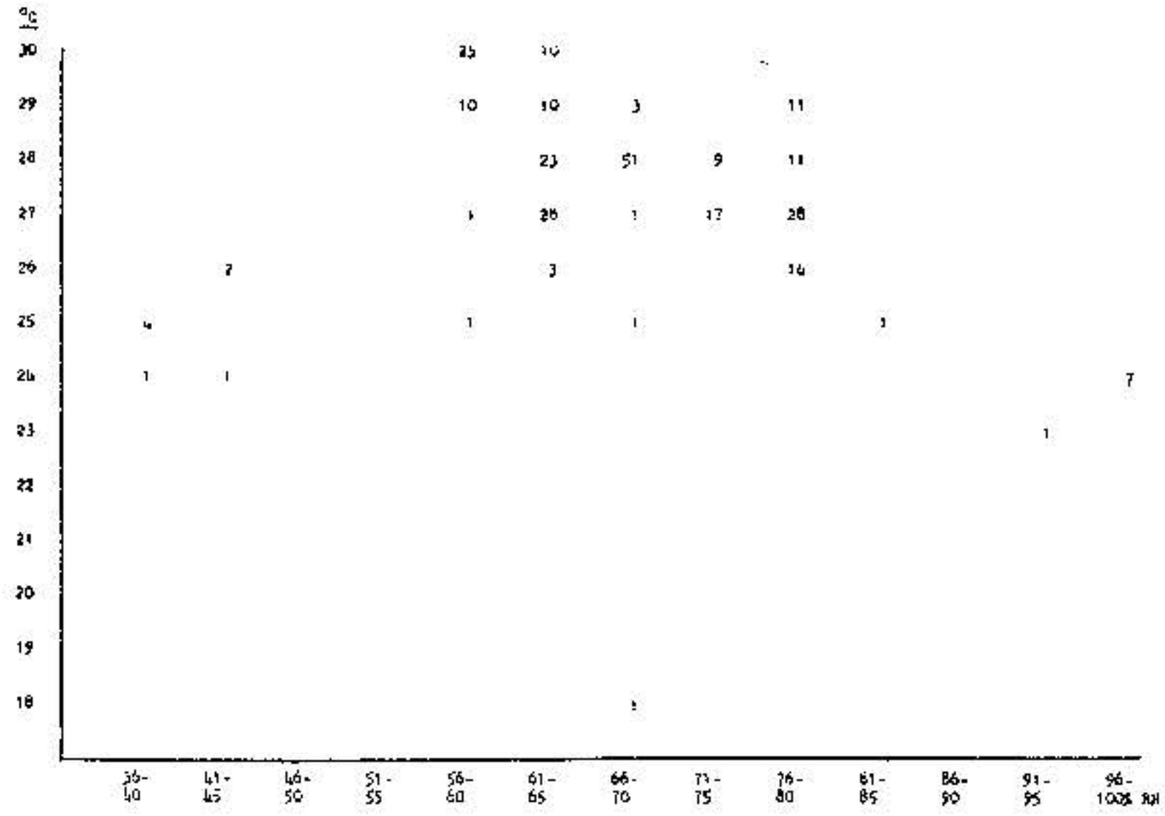

Figure 5. Total numbers of Histeridae showing temperature and relative humidity at time of capture.

Lewis and Taylor also stated that . . . "Insects feeding on decaying organic matter and fungi fly mainly in dim light, when sight may be less important than smell and when air is still and probably helps scent to be detected." In my study, the degree of light intensity, so long as it was at least 4-7 FC, was appearently of little significance. In fact, the majority of insects captured in New Jersey were taken during bright diurnal periods and not during crepuscular (dawn and dusk) periods.

I would like to thank the members of the Hutcheson Memorial Forest Committee of Rutgers University for giving me permission to work in the Forest, and the officials of the Great Swamp Wildlife Refuge for giving me permission to work in the Refuge.

Literature cited

Lewis, T., and L. R. Taylor. 1965. Diurnal periodicity of flight by insects. Trans. Royal Entomol. Soc. London 116: 393-476.

Shubeck, P. P. 1969. Ecological studies of carrion beetles in Hutcheson Memorial Forest. J.N.Y. Entomol. Soc. 77: 138-151.

Shubeck, P. P. 1971. Diel periodicities of certain carrion beetles (Coleoptera: Silphidae). Coleopterists Bull. 25(2): 41-46.

Taylor, L. R. 1963. Analysis of the effect of temperature on insects in flight. J. Anim. Ecol. 32: 99-117.