

Caloric Density Preference of Cave Crickets, *Hadenocetus*
subterraneus

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As with all feeding habit studies concerning insects, it is essential to understand the efficiency of food utilization. Woodring, et al. (1979) reported that efficiency of food utilization for adult house crickets increased with increased quality of food, and that efficiency parameters would vary in some species with specific events in the life cycle. Levy (1976), attempted to demonstrate a relationship between food odor and the cave crickets' ability to differentiate among food sources. Levy suggested that small crickets were less selective when foraging than medium or large crickets and that small crickets stopped and ate at the first available food source, whereas larger crickets were attracted to foodstuffs with the strongest odor. Odor seemed to be correlated with caloric density in Levy's studies so she could not assess whether crickets had a preference for caloric density per se.

MATERIALS AND METHODS

Caloric density preference studies for cave crickets were conducted during the final week of February, 1988, in Marion Avenue, Sophy's Avenue, Frozen Niagara, and White Cave in Mammoth Cave National Park (MCNP), Kentucky. Studies were also performed in Walnut Hill Cave outside MCNP. Initial studies used mixtures of peanut oil:cornstarch and lard:cornstarch, in 10:90, 50:50, and 90:10 (w/w) ratios. In further studies, three mixtures of smooth peanut butter and cornstarch, at 100:0, 50:50, and 0:100 (w/w) were used. These latter mixtures have known caloric densities (5.9, 5.0, and 4.1 Kcal/gm, respectively; Watt and Merrill, 1963). Each mixture was placed in a covered 100 x 15 mm plastic Petri dish under a separate live trap on the cave floor. The three traps with three different mixtures were aligned at intervals of about one meter with the order assigned randomly. Resident roosting crickets had equal access to each mixture and could opt between lower or higher caloric density foodstuffs.

Live traps were constructed of wooden embroidery hoops having diameters of 31 cm and widths 1.3 cm. Upper hoops consisted of an inner and an outer ring that jointly serve to bind a piece of plastic screen cloth in place as the top enclosing surface of the trap. Each double upper hoop was

then placed directly above a single lower hoop. Upper and lower hoops were spaced 1 cm apart at four equal intervals around the diameter of the hoops using plastic squares measuring 1 cm per side. Hoops were connected using a continuous strip of duct tape spanning both inner surfaces. Each hoop was propped up by a single rectangle, 3 x 1.2 x 17.5 cm, cut out of plywood. Each rectangle had a 1.5 x 0.6 cm notch cut in its top end. The edge of the hoop sits in the notch. Props served as triggering supports for the hoop traps, and each prop was connected to 15.25 m of heavy gauge string through a 0.4 cm diameter hole drilled near the bottom end.

Individual traps were propped over each food mixture, Petri dishes were uncovered, and traps were allowed to stand undisturbed for approximately one hour. All traps were then activated simultaneously by pulling the taut threads attached to the support props.

The number of male and female crickets captured by each trap was recorded, and hind femur length (HFL) of each cricket was measured to the nearest 0.1 cm using dividers and recorded. Crickets were released at their capture sites after measurements were taken. Data collected were statistically analyzed using the χ^2 (chi-square) test of independence to determine if there was selection for food related to caloric density, and if it related to gender and/or size (i.e., age).

RESULTS

The chi-square test of independence was applied to the total number of crickets that were attracted to each foodstuff in all caves. These results pertain to peanut butter:cornstarch mixtures whereas the peanut oil:cornstarch and lard:cornstarch mixtures yielded insignificant data. Table 1 represents experimental data for all crickets captured (separated by size) in all caves. Crickets were not evenly distributed among the foodstuffs ($\chi^2 = 15.1$, $df=2$, $p<0.001$). Sexable, large crickets ($HFL>10$ mm) were not evenly distributed among the three food sources ($\chi^2 = 29.54286$, $df=5$, $p<0.001$), but non-sexable, small crickets ($HFL<10$ mm) were. Total crickets for all caves were categorized further into three size groupings; large ($HFL>20$ mm), medium (HFL 10-19 mm), and small ($HFL<10$ mm), also shown in Table 1. Large and medium crickets were not evenly distributed among the foodstuffs but small crickets were ($\chi^2 = 37.94286$, $df=8$, $p<0.001$).

Table 2 shows all crickets captured in all caves separated by sex. Neither male nor female crickets were evenly distributed among the food sources, ($\chi^2 = 38.36986$, $df=5$, $p<0.001$). Both male and female crickets tended to be attracted to foodstuffs containing peanut butter.

DISCUSSION

Table 1 shows that total crickets captured in all caves were not evenly distributed among the food sources (peanut butter:cornstarch mixtures), suggesting that crickets have the ability to differentiate among foods of different caloric density. However, crickets were not attracted to peanut oil:cornstarch mixtures, which proposes that something other than the volatile fats of the peanut butter attracted the crickets, therefore, peanut butter's odor is caused by a different compound. Table 1 also shows medium and large crickets were not distributed evenly among all foodstuffs ($p < 0.001$) but were distributed nearly equally between the two highest caloric density foodstuffs. Small crickets were evenly dispersed among total food types. This size-related distribution suggests that small crickets do not optimally forage, i.e., they stop and feed at the first possible energy source no matter what its energy value. These results also suggest that large crickets forage for higher caloric density foodstuffs but only do so by odor, since odor is generally correlated with caloric density (Levy, 1976), and cannot differentiate between foods of different but high caloric content.

Table 2 shows that sexable crickets (HFL > 10 mm) were not equally distributed among the foodstuffs. The majority of sexable crickets were attracted to food sources containing peanut butter while very few were attracted to

pure cornstarch. However, equal numbers of sexable crickets were attracted to 100 percent PB and to 50 percent PB, and the number of males and females were attracted to those two food sources. This suggests that sexable crickets, i.e., adults and sub-adults, differentiate between food sources of differing caloric densities but only by odor. This also suggests that neither males nor females have different abilities in locating and differentiating among high caloric density foodstuffs.

Table 1. Total number of crickets captured in all caves.

L=large crickets (HFL>20mm) M=medium crickets (HFL 10-19mm)
S=small crickets (HFL<10mm). Baits used were combinations of peanut butter (PB) and corn starch. Data were collected from 23-27 February 1988.

Table 2. Number of crickets with HFL>10mm by sex attracted to each bait for all caves. M=male, F=female. Baits used were combinations of peanut butter (PB) and cornstarch. Data were collected from 23-27 February 1988.

Table 1. Total numbers of crickets captured in all caves. L= large crickets (HFL $\geq$ 20mm) M= medium crickets (HFL 10-19mm) S= small crickets (HFL<10mm). Baits used were combinations of peanut butter (PB) and corn starch. Data were collected from 23-27 February 1988.

Location.Date.Run	100% PB			50%PB			0%PB		
	L	M	S	L	M	S	L	M	S
Marion Ave 23.1	2	0	2	3	1	0	0	0	3
Marion Ave 23.2	0	2	6	4	1	1	0	0	2
Marion Ave 23.3	2	0	0	3	2	3	1	1	2
Sophy's Ave 23.1	1	1	2	1	4	2	1	0	3
Frozen Niagara 23.1	0	1	0	0	2	2	0	0	3
Walnut Hill 24.1	4	7	2	1	6	8	0	0	2
Marion Ave 24.4	4	0	4	0	2	2	0	0	2
Sophy's Ave 24.2	2	3	2	0	2	3	0	0	5
Marion Ave 26.5	3	1	3	1	1	1	0	0	0
White Cave 27.1	0	2	1	0	1	1	0	0	0
Subtotal	18	17	22	13	22	23	2	1	22
Total	57			58			25		

Table 2. Number of crickets with HFL $\geq$ 10mm by sex attracted to each bait for all caves. M=male, F=female. Baits used were combinations of peanut butter (PB) and cornstarch. Data were collected from 23-27 February 1988.

Location.Date.Run	100%PB		50%PB		0%PB	
	M	F	M	F	M	F
Marion Ave 23.1	1	1	3	1	0	0
Marion Ave 23.2	2	0	4	1	0	0
Marion Ave 23.3	1	1	3	2	1	1
Sophy's Ave 23.1	1	1	3	2	0	1
Frozen Niagara 23.1	1	0	1	1	0	0
Walnut Hill 24.1	7	4	6	1	0	0
Marion Ave 24.4	3	1	1	1	0	0
Sophy's Ave 24.2	4	1	0	2	0	0
Marion Ave 26.5	2	2	1	1	0	0
White Cave 27.1	2	0	0	1	0	0
Subtotal	24	11	22	13	1	2
Total	35		35		3	