DIFFERENTIAL OWL PREDATION ON WHITE AND AGOUTI *MUS MUSCULUS*

DONALD W. KAUFMAN

DICE (1947) demonstrated selection against conspicuous phenotypes of mice (*Peromyscus maniculatus*) by owls. His experiments were conducted in a laboratory room with either a Barn Owl (*Tyto alba*) or a Long-eared Owl (*Asio wilsonianus*) as predators. Vegetation was simulated by a latticework of boards. Subsequently Kaufman (1974) found that Barn Owls and Screech Owls (*Otus asio*) selected against conspicuous phenotypes of old-field mice (*Peromyscus polionotus*) in field enclosures with natural vegetation. It then became of interest to examine the effectiveness of selection against conspicuous prey whose conspicuousness was greatly increased; this was done by using white and agouti house mice (*Mus musculus*). In field experiments white mice (*Mus musculus*) disappeared faster than agouti mice during 3- and 6-day periods in a 1-acre enclosure (Kaufman and Wagner 1973). Under similar vegetation conditions, wild Loggerhead Shrikes (*Lanius ludovicianus*), diurnal predators, captured more white than agouti *Mus* released in pairs near the birds (Kaufman 1973a). Here, I report the results of a study designed to test the effectiveness of nocturnal predators, Barn Owls and Screech Owls, in capturing the conspicuous phenotype with white and agouti *Mus* used as prey. Effect of the amount of vegetation and changes in illumination on effectiveness of owls are also discussed.

MATERIALS AND METHODS

Pairs of house mice (*Mus musculus*) of the same sex, one white and one agouti, were simultaneously placed in experimental enclosures with a background of either light or dark brown soil with natural vegetation (3.6 × 9.0 × 3.9 m, described in Kaufman 1971). The phenotype of the first mouse captured and time elapsed from release to capture were recorded. The second mouse was removed from the enclosure. Both mice were removed when owls failed to capture a mouse within 15 minutes. Trials were repeated each evening until each owl stopped preying on the mice. Four Barn Owls and seven Screech Owls were used during the experiments.

Owls were maintained on a varied diet of live and dead white, agouti, and light brown house mice, light and dark brown old-field mice, and beef heart to reduce complications caused by a specific searching image (concept defined in Tinbergen 1960) for one type of mice.

Illumination during trials was measured with an International Light IL 600/IL 660 Low Level Photometer connected to a single channel recorder. Intensity of night light varied from 2.8×10^{-6} to 8.5×10^{-3} lm·ft^2. Light intensity was arbitrarily divided into three classes (1) 2.8×10^{-4} to 8.5×10^{-3} lm·ft^2, (2) 2.8×10^{-5} to 2.8×10^{-4} lm·ft^2, and (3) 2.8×10^{-6} to 2.8×10^{-5} lm·ft^2 for analysis of the effect of light intensity on owl predation. In general terms, light class 1 represented

TABLE 1

NUMBERS OF CAPTURES BY OWLS AND SELECTION INDICES DURING PREDATION EXPERIMENTS WITH WHITE (W) AND AGOUTI (A) *MUS*

	Dark sparse		Light sparse		Light dense	
Barn Owls	5A:27W	−0.688[1]	24A:30W	−0.111	11A:34W	−0.511[1]
Screech Owls	5A:25W	−0.667[1]	13A:13W	0.000	9A:30W	−0.539[1]

[1] Associated Chi-square value significant at $P < 0.01$.

clear nights (no cloud cover) with one-half to full moon, class 2 represented clear nights with less than one-half moon or with moon near the horizon, and class 3 represented nights with starlight and no moon or with heavy cloud cover reducing the moonlight and starlight.

Coloration of soils and the dorsal pelage of mice was measured with a Bausch and Lomb Spectronic 505 Recording Spectrophotometer (Smith et al. 1969; Kaufman 1974). Reflectance measurements were made from 400–700 mμ. Brightness values were calculated from the reflectance spectrum using the selected ordinate method (Hardy 1936). Brightness values using this method range from 0.0 for pure black to 100.0 for pure white. Brightness was used to compare mice and soils as experiments were conducted at night and intensities of reflected light are more important than color. Average brightness values ($\overline{B}$) were 71.5 for 10 white mice, 7.4 for seven agouti mice, 23.6 for four samples of light brown soil, and 8.8 for four samples of dark brown soil. Comparison of values for brightness of soils and mice demonstrated the greater conspicuousness of white over agouti on both soils. In fact, the dark soil and dark mice were approximately the same brightness. White mice will be considered the conspicuous prey and agouti mice the matching prey in this paper, although both are conspicuous to some degree on both soils.

Captures of conspicuous (white) and matching (agouti) mice were compared using the selection index, *SI* (Dice 1947). $SI = (a - b)/(a + b)$; a = number of matching mice captured and b = number of conspicuous mice captured. The index ranges from +1.0 when all mice captured are matching to −1.0 when all mice captured are conspicuous. $SI = 0.0$ when equal number of both phenotypes are captured.

RESULTS AND DISCUSSION

Barn Owls and Screech Owls captured more white than agouti mice during each of the six experiments except for Screech Owls hunting on light soil with sparse vegetation (Table 1). Owls were equally effective at capturing the conspicuous prey on dark soil and on light soil with dense vegetation (2×2 contingency table; $\chi^2 = 0.72$, $P > 0.05$ for Barn Owls; $\chi^2 = 0.43$, $P > 0.05$ for Screech Owls). But the owls were more effective on dark soil and light soil with dense vegetation than on light soil with sparse vegetation (2×3 contingency table; $\chi^2 = 9.06$, $P < 0.05$ for Barn Owls; $\chi^2 = 8.55$, $P < 0.05$ for Screech Owls).

Ratios of white to agouti mice captured by Barn Owls and Screech Owls on each of the three substrates were not different (Chi-square

TABLE 2

NUMBER OF WHITE (W) AND AGOUTI (A) *MUS* CAPTURED BY OWLS[1]

Light class	Dark sparse		Light sparse		Light dense	
1	3A: 6W	−0.333	2A: 7W	−0.556	9A:18W	−0.333
2	7A:36W	−0.674[2]	22A:19W	+0.073	7A:32W	−0.641[2]
3	0A:10W	−1.000[2]	13A:17W	−0.129	4A:13W	−0.529

[1] Barn Owls and Screech Owls combined. Selection indices are given. Illumination for light classes is given in the text.
[2] Associated Chi-square value significant at $P < 0.01$.

analysis) among the three light classes or two time periods (0–2 and 2–15 minutes after release). Therefore, captures by both predator species were combined. Effectiveness of capture by owls was not different among light classes on any of the three substrates (Table 2). Effectiveness of capture of the white mice during the first 2 minutes after release of mice was not different from the effectiveness of capture after the first 2 minutes for either light soil with dense vegetation or dark soil (Table 3). Ratios of white-agouti captures by the owls were significantly different between the two time periods on light soil with sparse vegetation (Table 3) with more agouti than white mice captured in the 2–15 minute time period. No difference was noted in predator effectiveness between the prey sexes.

Captures of white and agouti mice or no mice during the first trial of each owl each evening are given for Barn Owls and Screech Owls in Table 4. Barn Owls were more effective at capturing a mouse on soils with sparse vegetation than with dense vegetation ($\chi^2 = 4.86$, $P < 0.05$) but Screech Owls were equally effective in capture in both sparse and dense vegetation ($\chi^2 = 1.54$, $P > 0.05$).

Selection against conspicuous white prey (Table 1) agrees with the general results of experiments with *Peromyscus* (Dice 1947; Kaufman 1974) although the owls were more effective against white *Mus* than conspicuous forms of *Peromyscus*. Selection indices were –0.24 to –0.29

TABLE 3

NUMBER OF WHITE (W) AND AGOUTI (A) *MUS* CAPTURED BY OWLS[1]

Time period	Dark sparse		Light sparse[2]		Light dense	
0–2	4A:16W	−0.600[3]	15A:26W	−0.268	4A:31W	−0.771[4]
2–15	16A:48W	−0.500[4]	27A:17W	+0.227	6A:21W	−0.556[4]

[1] Barn Owls and Screech Owls combined for two time periods (0–2 minutes and 2–15 minutes after release). Selection indices are given.
[2] Ratio of W:A is significantly different between time periods ($\chi^2 = 5.21$, $df = 1$, $P < 0.05$).
[3] Associated Chi-square value significant at $P < 0.05$.
[4] Associated Chi-square value significant at $P < 0.01$.

TABLE 4

NUMBER OF TRIALS IN WHICH WHITE, AGOUTI, AND NO MICE WERE CAPTURED DURING THE FIRST TRIAL PER OWL PER NIGHT[1]

Substrate	Barn Owls[2]			Screech Owls		
	White mice	Agouti mice	No mice	White mice	Agouti mice	No mice
Dark sparse	14 (87.5)	1 (6.3)	1 (6.3)	17 (65.4)	3 (11.5)	6 (23.1)
Light sparse	8 (50.0)	7 (43.8)	1 (6.3)	10 (47.6)	7 (33.3)	4 (19.1)
Light dense	34 (56.7)	11 (18.3)	15 (25.0)	31 (52.5)	9 (15.3)	19 (32.2)
All	56 (60.9)	19 (20.7)	17 (18.5)	58 (54.7)	19 (17.9)	29 (27.4)

[1] Substrates were dark soil with sparse vegetation and light soil with sparse and dense vegetation. Percent of trials in parentheses.
[2] Barn Owls captured a greater proportion of mice in sparse vegetation than dense vegetation ($P < 0.05$).

in laboratory experiments with *P. maniculatus* (Dice 1947) and –0.19 to –0.43 in field experiments with sparse vegetation with *P. polionotus* (Kaufman 1974). Payne (1971) reported that Barn Owls can capture prey using only auditory signals under very low light conditions. Thus results could be attributed to differences in activity between phenotypes of prey as white mice were conspicuous in all experiments. Differences in effectiveness of capture on light sparse and dark sparse substrate (Table 1) indicate that coloration was the important variable as the selection indices would not be different if the owls were cueing on auditory signals.

White mice were more conspicuous on dark soil than light soil as agouti mice were almost the same brightness as the dark soil but much darker and more obvious on the light soil. From consideration of the relative conspicuousness of the prey on light and dark soil, owls should be more effective on the dark soil; this was supported by the results as seen in Table 1.

Lack of differences in the owls' effectiveness among light classes contrast to the differences in effectiveness using two phenotypes of *Peromyscus polionotus* on both light and dark soil (Kaufman 1974). Changes in effectiveness against conspicuous prey under different light conditions are also suggested by Dice's (1947) data. Lack of any demonstrable effect of light on owl predation was probably due to the greater conspicuousness of the white *Mus* relative to agouti *Mus* and soils used irregardless of light conditions during these experiments.

Selection against the conspicuous prey by nocturnal predators in dense vegetation (Barn Owls, $SI = -0.511$; Screech Owls, $SI = -0.539$) was nearly as great as the effectiveness of the diurnal Loggerhead Shrike ($SI = -0.625$, Kaufman 1973a) against white *Mus* in similar vegetation

conditions. Effectiveness of capture of white mice on soils with sparse vegetation was quite different between Loggerhead Shrikes (SI = +0.652, Kaufman 1973a) and owls (SI = –0.688 to 0.000, Table 1). Both mice in sparse vegetation near the predator during the day are very obvious and selection against the conspicuous prey was apparently affected by the specific searching image of the shrikes (Kaufman 1973a). Mueller (1971) using both white and grey *Mus* reported that conspicuousness of prey was less important than oddity and specific searching image in prey selection by hawks (cf. Kaufman 1973b), but his laboratory experiments are not strictly comparable to the present experiments with owls.

The overall effect of both owls and shrikes would be to select against white mice under natural field conditions. Although, the time required would be much greater than indicated by these values of SI because most prey losses would be random with respect to coloration under field conditions. Selection against the conspicuous prey in a 1-acre enclosure demonstrates this reduction (SI = –0.147 and –0.077 for 3- and 6-day intervals, respectively) (Kaufman and Wagner 1973).

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Summary

Differential predation on white and agouti house mice by Barn Owls and Screech Owls was examined. Experiments were conducted in field enclosures using three different substrates. Owls selected against the conspicuous, white prey in all three experiments. Owls were more effective in capturing the conspicuous prey in dense vegetation than in sparse vegetation. No differences in effectiveness of selection across illumination conditions were demonstrated.

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Department of Zoology, University of Texas, Austin, Texas 78712. Present address: Savannah River Ecology Laboratory, Drawer E, Aiken, South Carolina 29809. Accepted 22 June 1973.