Vol. 39, No. 3, September 1994
Made in United States of America

COLOR PREFERENCE OF THE ISLAND ENDEMIC LIZARD *UTA PALMERI* IN RELATION TO RAT ERADICATION CAMPAIGNS

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Rats (*Rattus* spp.) introduced to islands are responsible for an estimated 21% of all recorded avian extinctions (King, 1981, 1985), and have caused the extirpation of many burrow-nesting seabirds from islands throughout the world (Atkinson, 1989). The eradication of rats and other introduced mammals on islands is a first step in the restoration of island ecosystems, and has recently been proposed for several islands of northwestern México (Harrison, 1993).

Bait poisoned with the anticoagulant brodifacoum is the most effective tool for eradicating rats from islands without native mammals (Taylor and Thomas, 1989; Veitch and Bell, 1990). Although a necessary conservation tool, there is some potential for direct poisoning of endemic species or native populations with locally adapted gene pools when using brodifacoum-laced bait on islands. If such poisoning results in mortality which is significant at the population level, the net effect of rat eradication could be negative.

One way to avoid poisoning non-target animals is to carefully choose a bait and form of presentation which are attractive to rats, but minimize the potential for poisoning of non-target species. Dyeing poisoned bait may decrease consumption by birds and lizards, which respond differentially to colors, without affecting consumption by rats, which do not have color vision. Although several studies have examined the influence of different color on bait consumption by birds (Pank, 1976; Brunner and Coman, 1983), we were unable to find similar studies on lizards.

In this study we tested the response of San Pedro Mártir Island's endemic *Uta palmeri* to colored plastic chips to determine which color was least attractive. *Uta palmeri* is attracted to almost any novel object (pers. obser.) and eats a wide variety of foods including seabird excrement, insects, carrion, and vegetation (Wilcox, 1980; Hews, 1990). Thus, *U. palmeri* may consume poisoned bait, if the bait is not carefully selected.

Research was conducted from 1–14 July 1991 on San Pedro Mártir Island, Gulf of California, México (28°23′N; 112°20′W), a 3-km² rocky desert island most of which is covered with a thin layer of white seabird guano. *Uta palmeri* is extremely abundant on the island, and very tame (Wilcox, 1980; Hews, 1990).

We tested the differential response of lizards to seven different colors by simultaneously presenting two plastic chips (1 by 2 by 0.1 cm) of different colors (Table 1). We used a red plastic chip to test the motivation of lizards to respond, because from our observations and from a study designed to test color perception in *U. palmeri* (Hews and Dickhaut, 1989) we knew that *U. palmeri* was most attracted to red-colored objects.

For each trial we chose a lizard in an area where we had not previously conducted a test, approached to within 1 m, and simultaneously tossed two different colored chips 10–25 cm in front of the lizard. We then recorded which of the two colors the lizard first approached and touched with its snout or grasped in its mouth. If the lizard did not touch either of the chips within 30 s, we tested its motivation by tossing a red chip in front of the lizard. If the lizard touched or grasped the red chip within 30 s we assumed

TABLE 1—Colors tested on *Uta palmeri*, 1–14 July 1991, San Pedro Mártir Island, Gulf of California.

Color[1]	Hue[2]	Value[2]	Chroma[2]
Red	3.5R	3.8	10.6
Yellow	8.5Y	8.7	11.5
Purple	9.5P	3.8	5.3
Light Blue	2.5PB	6.9	4.5
Dark Blue	7.5PB	2.6	5.2
Brown	6.5YR	4.5	7.0
Grey		7.5	
White		9.1	

[1] Manufactured by Kleerdex Co., Bloomsburg, PA, USA.

[2] Based on Munsell Color system.

TABLE 2—Results of two-choice color response tests on *Uta palmeri*, 1–14 July 1991, San Pedro Mártir Island, Gulf of California.[1]

Series 1			
Colors	Yellow vs. Purple	Light blue vs. Dark blue	White vs. Brown
n	13 2	18 7	2 13
P	$P = 0.02$	$P = 0.05$	$P = 0.05$
Red only	0%	17%	6%
Series 2			
Colors	Grey vs. Purple		
n	18 7		
P	$P = 0.05$		
Red only	17%		
Series 3			
Colors		Purple vs. Dark blue	
n		14 1	
P		$P = 0.01$	
Red only		28%	
Series 4			
Colors		Dark blue vs. White	
n		2 13	
P		$P = 0.02$	
Red only		30%	

[1] n = number of lizards that touched each color first; P = significance level using a two-tailed binomial probability test; Red only = lizard did not touch either of the two colored chips, but indicated motivation by touching a red chip offered immediately after.

it was motivated but not attracted to either of the two other colors presented. If the lizard did not respond to the red chip, we excluded that trial from analysis. We tested each pair of colors until we recorded either 15 or 25 positive responses and eliminated the most attractive colors over four series of tests. We tested for significance using a two-tailed binomial test. To test for differences in the percentage of trials where the lizard did not respond to either of the two colors, but did respond to the red chip, we used the chi-square test in a 2 by 2 contingency table.

Dark blue was the least attractive color tested (Table 2). The percentage of trials where the lizard did not respond to either color, but did respond to a red chip, was highest in the dark blue versus purple and the dark blue versus white trials ($P < 0.04$ for all comparisons). This indicated that lizards most often (28 to 30% of trials) failed to respond to either test color of these two color pairs, even though their subsequent response to red indicated that they were motivated. For the lizards that did approach a color, there was a significant differential response to purple of the colors tested, dark blue was responded to least.

Although lizards may be less sensitive to brodifacoum than mammals, and brodifacoum-laced bait did not cause significant mortality of omnivorous lizards on Round Island, Mauritius (Merton, 1987), all practical precautions should be taken to avoid harming populations of native animals. Our data suggest that bait dyed dark blue would be less likely to be eaten by *U. palmeri* than bait dyed any of the other colors tested (although extrapolating from the colors tested to other apparently similar colors must be done with caution). This is fortunate, because dark blue also appears to be an unappealing color for many bird species (Pank, 1976; Brunner and Coman, 1983), and commercial bait preparations are often dyed dark blue.

Consumption of bait by lizards can be further minimized by conducting eradication campaigns during the winter when lizards are less active. This will also greatly diminish the probability of secondary poisoning to island snakes, some of them endemic, which could eat poisoned rats.

islands of northwestern Mexico, and all species in the genus are found on these islands (Wilcox, 1980; Case, 1983), the results of this study may be useful in planning rat eradication campaigns on other islands in addition to San Pedro Mártir.

Research was funded by the Conservation International Sea of Cortez Ecosystem Program. We thank the Secretaría de Desarrollo Urbana y Ecología for permission to conduct research on Isla San Pedro Mártir (permit # 00987), S. Brock of Kleerdex for providing colored plastic, and D. Hews, R. Powell, and two anonymous reviewers for providing constructive criticism of the manuscript.

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