

Vegetation Refuges of a Sand Lizard Assemblage in Temperate Coastal Sand Dunes

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ABSTRACT.—Natural refuges constitute a fundamental resource in the habitat of any given species. Consequently, the knowledge of those elements that are used as protection from predators is a priority for conservation. We studied the antipredatory mechanisms of an assemblage of sand dune lizards, determining whether refuge sites are random or whether particular types are chosen depending on their availability. We also compared the frequencies of the use of refuge sites with the use of perch sites by individuals at initial detection. *Liolaemus multimaculatus* used sites under rocks, either as refuges or as perches, and sites under sub-shrubs (*Senecio bergii*) and clump herbs (*Spartina ciliata*) as refuge only. *Liolaemus gracilis* used sites under creeping herbs (almost exclusively *Panicum racemosum*) and sub-shrubs (*Senecio bergii*) as refuge and perch sites more frequently than expected. *Liolaemus wiegmanni* only used sub-shrubs (mainly *Melilotus indicus* but also *Achyrocline satureioides* and *Senecio bergii*) both as refuge and perch sites. We show that lizards of Costa Bonita select certain types of native psammophytic grassland plants as refuge. Most of the plants used as refuge are also used as perch sites.

RESUMEN.—Los refugios naturales constituyen un recurso fundamental del hábitat de una especie. En consecuencia, el conocimiento de aquellos elementos utilizados como protección ante los depredadores, constituye una medida prioritaria para su conservación. Estudiamos los mecanismos antidepredatorios en un ensamble de lagartijas arenícolas, explorando si el uso de los refugios es al azar o si hay una selección de determinados tipos dependiendo de su disponibilidad. También se comparó la frecuencia de uso de sitios de refugio con los sitios de percha donde los individuos fueron detectados inicialmente. *Liolaemus multimaculatus* utilizó los sitios bajo roca, ya sea como refugio o como percha y sólo como refugio a sitios bajo subarbustos (*Senecio bergii*) e hierbas en mata (*Spartina ciliata*). *Liolaemus gracilis* utilizó más frecuentemente a lo esperado como sitios de refugio y percha a aquellos bajo hierbas rastreras (casi exclusivamente *Panicum racemosum*) y subarbustos (*Senecio bergii*). *Liolaemus wiegmanni* sólo utilizó subarbustos, tanto como sitios de refugio como de percha (principalmente *Melilotus indicus* pero también *Achyrocline satureioides* y *Senecio bergii*). Este trabajo demuestra que las lagartijas de Costa Bonita seleccionan determinados tipos de plantas del pastizal psamofítico nativo para reducir los riesgos de ser capturadas. La mayoría de estas plantas son sus principales sitios de percha.

Defensive strategies in animals fall into two main categories: primary and secondary defenses (Edmunds, 1974). Primary defense includes behavioral and morphological features operating regardless of the presence of a potential predator, which decrease the chance of the prey being perceived or discovered. Secondary defense includes those mechanisms (behavioral responses) used by the prey when it has been discovered by a predator (Edmunds, 1974). The use of rocks, burrows, and plants is a common antipredatory mechanism in animals. They are used as primary or as secondary defenses. Lizards have antipredatory mechanisms that range from a combination of cryptic coloration and immobility to the implementation of high running speeds, aggressive displays, and caudal autonomy (Pianka and Vitt, 2003). Moreover, many species reduce the risk of predation using particular habitats where the availability of refuges serves as physical barriers between prey and predators (Smith and Ballinger, 2001). Refuge use by lizards has been studied in different contexts: in relation to their escape behavior (Cooper, 1998; Cooper and Whiting, 2007); in the selection and permanence in terms of body condition and thermal costs to the individuals (Amo et al., 2007a; Cooper and Wilson, 2008); and in relation to the choice of particular attributes such as size, shape, and temperature (Schlesinger and Shine, 1994; Cooper et al., 1999; Cruz et al., 2005). Although vegetation has been recognized as an important palliative against predation of lizards (Stamps, 1983; Martín and López, 1995, 1998; Rocha et al., 2004), the use of different vegetation types as a secondary defense has been little explored.

Some species of sand-dwelling lizards of coastal dunes are vulnerable to human activities that destroy specific patches of native vegetation, causing the decline in population numbers at regional and local levels (Rocha and Bergallo, 1992; Vega et al., 2000). This decline may occur when thermoregulatory and foraging patches of vegetation decrease, and at the same time, predatory risk increases (Amo et al., 2007b). In rigorous environments such as sand dunes, the low vegetation cover can be of crucial importance in the survival of sand lizards, either as a safeguard against high temperatures (Rocha, 1988, 1995) or by moderating predatory pressure.

Along psammophytic grasslands of the southern dune barrier of the Atlantic coast of Argentina (Isla, 1998), three small species of arenicolous *Liolaemus* lizards (Liolaemidae) coexist in sympatry in structurally different microhabitats (Vega, 2001). The primary defense mechanisms of these species include immersion under the sand using this substrate as a retreat during the autumn–winter period of inactivity and as refuge during spring–summer nights (Halloy et al., 1998). *Liolaemus multimaculatus* is a small (up to 70 mm snout–vent length, SVL) and strictly arenicolous lizard. The dorsal color pattern matches the texture and color of the sandy substrate. Sexual dichromatism is only evident on the ventral surface; females possess an immaculate venter, whereas males have small, isolated brown spots on throat and abdomen. This species shows sexual size dimorphism, with males attaining larger sizes than females (Vega, 1997). It is an endemic species of the coastal dune ecosystem with a vulnerable conservation status (Lavilla et al., 2000) and inhabits microhabitats of pioneer vegetation within a matrix of open spaces in foredunes and distal beaches. As a secondary defense, the lizards usually run to take refuge at the base of shrubs or clumps of vegetation, remaining motionless,

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and on some occasions hiding under the sand displaying a characteristic sand-burying behavior (Etheridge, 2000).

Liolaemus gracilis is a small (up to 55 mm SVL) and slender lizard with a long tail. The dorsal color pattern is gray, yellowish-brown, sometimes with a fine blackish vertebral line and two narrow light stripes on the sides, bordered by a dark thin stripe. Below these stripes, there are two broad reddish-brown bands, sometimes with dark spots. This species shows no sexual dimorphism in size or in color (Vega and Bellagamba, 2005). These lizards frequently use the vegetation of the slopes of hummocky dunes in foredunes and in blowouts. As a secondary defense, they generally escape by climbing steep slopes of the dunes under vegetation cover (Block and Vega, 2008).

Liolaemus wiegmanni is a small lizard (up to 64 mm SVL). The background of the dorsal color pattern is tan or brown, and there are dark brown spots edged in white, with longitudinal stripes that are light-cream or yellow (Etheridge, 2000). Adult males acquire an orange-yellow throat, and females are darker than males (Scolaro, 2006). This species shows no sexual dimorphism in size (Vega, 1999). These lizards frequently use vegetation cover of semifixed dunes, usually far away from open spaces and beaches. As a secondary defense, they run to sites under shrubs or clumps of vegetation using small burrows in the sand as occasional refuges (Etheridge, 2000).

As in other regions of the world, grasslands of coastal dunes of Buenos Aires province in Argentina have undergone diverse degrees of degradation and fragmentation caused mainly by urbanization and tourism activities but also by other habitat-modifying activities such as forestation and cultivation of exotic invasive plant species (Gómez and Toresani, 1999). In the southern dune barrier of this province, human impact is lower than in the eastern dune barrier in the north (Celsi and Monserrat, 2008); hence, we considered these environments appropriate to assess the habitat requirements of sand-dwelling lizards. The aim was to study antipredatory mechanisms of a *Liolaemus* sand-dune assemblage identifying the abiotic and vegetation components of the microhabitat they use as refuges to avoid being caught. We explored in the microhabitat of each species to determine whether they use refuges in a random manner or select particular ones. In addition, refuge sites used as a secondary defense were compared with perch sites on which individuals were initially detected. Knowledge of animal-plant interactions is of utmost importance to understand ecosystem complexity (Bortolus et al., 2002). This study represents the first contribution in characterizing the usage of vegetation types of coastal dunes as refuges by a lizard assemblage.

MATERIALS AND METHODS

This study was conducted during the spring-summer (September to March) of 2006–07. The study area encompassed approximately 40 ha in Costa Bonita (38.56056°S, 58.62944°W, Datum: WGS84), Necochea, Buenos Aires province, Argentina. Costa Bonita is located at the southern barrier of coastal dunes, a grassland area of important biodiversity in the province (Bilenca and Miñarro, 2004). Small isolated patches of introduced plant species also occur, such as *Tamarix gallica* ("tamarisco"), *Carpobrotus edulis* ("uña de gato"), *Acacia longifolia* ("acacia"), and *Myoporum laetum* ("transparente"), which were cultivated around the residences of the small tourist village for the purpose of fixing dunes.

The use of microhabitat components was estimated in random walks through the different habitats of the dunes on the basis of individual responses of lizards to a human predator. The same human performed all random walks to avoid affecting the perception of risk by the lizards. Surveys were performed between 0900 and 1700 h, and total effort-hours were 196. Each time that an individual lizard was detected, the species was identified, and the initial location of sighting (INI) and the site of refuge where the individual ended its flight (REF), were marked with narrow reeds painted red. At both sites, we recorded the type of abiotic component (sand or rock) or plant species the lizard used and recorded their escape behavior (crypsis, burying in sand, hiding in burrows, locomotive modes). Data were recorded for adults or subadults that were very close to the minimum size at maturity (*L. multimaculatus* SVL > 47 mm, Vega, 1997; *L. gracilis* SVL > 40 mm, Vega and Bellagamba, 2005; *L. wiegmanni* SVL > 42 mm, Martori and Aun, 1997). Data from juveniles and hatchlings were not recorded. Component availability in each microhabitat (AVA) was estimated at random points within the home range of individuals to ensure that these components were actually available for individuals (Castilla and Bauwens, 1991). The home range is defined here as the area traversed by the individual in its normal activities of food gathering, mating, and caring for young (Burt, 1943). In other words, avoiding these random points would signify an individual lizard had moved far from its preferred microhabitat. We selected random points within realistic distances of displacement of lizard individuals such that random points represented sites potentially used by these individuals. The estimation of random sites was carried out by obtaining a number from 1 to 36 by means of a roulette pocket, which, multiplied by 10, indicated the direction or degree of divergence from the north of a compass located in the INI. By obtaining a second number, the distance or number of steps away from INI was estimated. Because the stride length was about 0.6 m, the random site could only be, at most, 21.6 m (36 × 0.6 m) from the sighting location. This value is just above the maximum distance of displacement recorded for individuals of *L. multimaculatus* (Kacolis et al., 2009), *L. wiegmanni* (C. Block, O. A. Stellatelli, and L. E. Vega, unpubl. data), and *Liolaemus lutzae* (Rocha, 1999), the latter being an arenicolous species that is similar in size to those species studied here.

Microhabitat components were categorized into two physical types (sand and rocks) and into five biological types of plants: (1) erect stems herbs (ESH); (2) creeping herbs (CH); (3) clump herbs (CLH); (4) sub-shrubs (SS); and (5) shrubs (SH) (sensu Zuloaga and Morrone, 1996, 1999). *Panicum racemosum*, which adopted different physiognomies at different stages of its life cycle, was classified as CH in the microhabitat of *L. gracilis* and as ESH in the microhabitats of *L. multimaculatus* and *L. wiegmanni*. Plants were identified to species (Cabrera and Zardini, 1978).

Usage frequency of the microhabitat components was analyzed using a Chi-square test ($\alpha = 0.05$), assessing the general hypothesis that microhabitat components were used in the same frequency as they were available (AVA). We compared: (1) used refuge sites (REF) versus their availability in the microhabitat (AVA); (2) initial detection sites or perch sites (INI) versus availability in the microhabitat (AVA); and (3) perch sites (expected) versus used refuge sites (observed). When Chi-square test results were significantly different, Bonferroni intervals were constructed ($\alpha = 0.05$) to find out which of the seven microhabitat categories contributed to the difference (Neu

TABLE 1. Frequency of use of microhabitat components by *Liolaemus* species: refuge site (REF), initial detection site (INI). Proportion of available components (AVA). Letters in parentheses indicate the origin of plants. N: native, E: endemic, I: introduced, A: adventitia. *N* = number of observations.

Microhabitat components	Height (cm)	<i>Liolaemus multimaculatus</i>			<i>Liolaemus gracilis</i>			<i>Liolaemus wiegmanni</i>		
		REF %	INI %	AVA %	REF %	INI %	AVA %	REF %	INI %	AVA %
Rocks		20.93	22.09	5.81	0	0	0	1.15	0	1.15
Sand		4.65	8.14	34.88	1.59	1.59	30.16	1.15	1.15	4.60
Erect stems herbs										
<i>Oenothera mollisima</i> (N)	30–100	2.33	0	1.16	4.76	6.35	1.59	3.45	0	6.90
<i>Lagurus ovatus</i> (N)	30–50	0	0	3.49	0	0	6.35	1.15	0	20.69
<i>Poa</i> spp. (N)	30–60	3.49	3.49	8.14	0	0	6.35	8.05	10.35	22.99
<i>Solidago chilensis</i> (N)	100	0	0	2.33	0	0	1.59	1.15	0	2.30
<i>Panicum racemosum</i> (N)	50–100	24.42	39.54	22.09	–	–	–	3.45	3.45	12.64
Creeping herbs										
<i>Carpobrotus edulis</i> (I)	10–30	1.16	2.33	1.16	15.87	9.52	11.11	0	0	0
<i>Panicum racemosum</i> (N)	50–100	–	–	–	46.03	60.32	26.98	–	–	–
<i>Adesmia incana</i> (N)	80	0	0	1.16	0	0	1.59	0	2.30	10.35
<i>Hydrocotyle bonaerensis</i> (N)	10–15	0	0	1.16	1.59	0	1.59	0	0	0
<i>Calystegia soldanella</i> (N)	10–20	0	0	5.81	1.59	1.59	3.18	0	0	0
Clump herbs										
<i>Spartina ciliata</i> (N)	100–160	13.95	10.47	3.49	0	0	1.59	0	0	0
Sub-shrubs										
<i>Senecio bergii</i> (E)	80–100	12.79	1.16	2.33	20.63	15.87	3.18	13.79	2.30	5.75
<i>Margyricarpus pinnatus</i> (N)	15–30	0	0	0	0	0	0	4.60	3.45	4.60
<i>Achyrocline satureioides</i> (N)	30–50	0	0	2.33	0	0	1.59	8.05	16.09	1.15
<i>Melilotus indicus</i> (A)	80	2.33	2.33	1.16	1.59	1.59	1.59	54.02	60.92	6.90
Shrubs										
<i>Tamarix gallica</i> (I)	150–250	13.95	10.47	3.49	6.35	3.18	1.59	0	0	0
<i>N</i>		86	86	86	63	63	63	87	87	87

et al., 1974; Byers and Steinhorst, 1984). If a component in REF or INI had its expected proportion (AVA) included in the confidence interval for its observed proportion, that component was considered as not selected; otherwise, the analysis indicated that the component was selected, either positively (preferred) or negatively (avoided).

Predators of lizards present in the study area were the Chimango Caracara (*Milvago chimango*) (Yañez et al., 1982), the Burrowing Owl (*Athene cunicularia*), the Guira Cuckoo (*Guira guira*), and the Great Kiskadee (*Pitangus sulphuratus*). We observed the Burrowing Owl and the Great Kiskadee.

RESULTS

Most of the individuals (89.8%, 212 of 236; *L. multimaculatus*, 72, *L. gracilis*, 53, and *L. wiegmanni*, 87) used patches of native plant species and only a small proportion (10.2%, 25 of 236; *L. multimaculatus* 14 individuals, *L. gracilis*, 10 individuals) was detected in patches of introduced vegetation of *Tamarix gallica* and *Carpobrotus edulis* (Table 1). The Chi-square test revealed significant differences in the frequency of use of microhabitat components by each species, both as refuge sites as well as perch sites (Table 2). *Liolaemus multimaculatus* used rocks more

frequently than expected either as refuge or as perch sites, and this lizard species used shrubs and clump herbs as refuge sites more frequently than expected (Table 3, Fig. 1). Results also indicated that this species avoided the sites found in exposed open sand and sites under creeping herbs. *Spartina ciliata*, the only clump herb available in its microhabitat, was the preferred refuge site of this species. After escaping, some individuals ran toward the back side of *Spartina* and remained motionless staring at the attacker having a physical barrier between them and predators. After a sustained persecution (two or three intensive searches within the plant), 40.5% of the individuals (*N* = 86) submerged into the sand, whereas 59.5% remained in the same plant or ran to another. This species also hid first under the outer branches of *Tamarix gallica* but ran to the interior of this bush if predator threat continued.

Liolaemus gracilis used refuge and perch sites in creeping herbs and sub-shrubs more frequently than expected and avoided open sites and erect herbs in both cases (Table 4, Fig. 1). This lizard showed almost exclusive preference for the creeping herb *Panicum racemosum*, and among sub-shrubs, the lizard's first choice was *Senecio bergii* (Table 1). A single individual took refuge in a small burrow in the sand under *P. racemosum*.

TABLE 2. Chi-square test ($\alpha = 0.05$) results for the microhabitat component usage by *Liolaemus* species. REF: refuge site, INI: initial detection site, AVA: available components. *N* = number of observations.

	REF vs. AVA			INI vs. AVA			<i>N</i>
	χ^2	df	<i>P</i>	χ^2	df	<i>P</i>	
<i>Liolaemus multimaculatus</i>	130.38	6	< 0.001	86.91	6	< 0.001	86
<i>Liolaemus gracilis</i>	62.99	5	< 0.001	45.22	5	< 0.001	63
<i>Liolaemus wiegmanni</i>	224.45	4	< 0.001	240.22	4	< 0.001	87

TABLE 3. Bonferroni confidence intervals ($\alpha = 0.05$) for components in the microhabitat of *Liolaemus multimaculatus*. F: frequency, P: proportion.

	Refuge			Initial			Available	
	F	P	Intervals	F	P	Intervals	F	P
Rocks	18	0.209	0.091, 0.327 ^a	19	0.221	0.101, 0.341 ^a	5	0.058
Sand	4	0.047	-0.015, 0.108 ^a	7	0.081	0.002, 0.161 ^a	30	0.349
Erect stems herbs	26	0.302	0.169, 0.436	37	0.430	0.287, 0.574	32	0.372
Creeping herbs	1	0.012	-0.019, 0.043 ^a	2	0.023	-0.020, 0.067 ^a	8	0.093
Clump herbs	12	0.140	0.039, 0.240 ^a	9	0.105	0.016, 0.193	3	0.035
Sub-shrubs	13	0.151	0.047, 0.255 ^b	3	0.035	-0.018, 0.088	5	0.058
Shrubs	12	0.140	0.039, 0.240 ^a	9	0.105	0.016, 0.193	3	0.035

^aSignificant differences between Initial/Refuge and Available.

^bSignificant differences between Initial and Refuge.

Liolaemus wiegmannii used only sub-shrubs, both as refuge and as perch sites. This lizard preferred *Melilotus indicus* but also used *Achyrocline satureioides* and *Senecio bergii* (Table 5, Fig. 1). Sites in open sand, under stem-erect herbs (*Poa* spp. and *Lagurus ovatus*), and under creeping herbs (*Adesmia incana*) were avoided by this species. A single individual escaped to a burrow in the sand under a sub-shrub.

Liolaemus gracilis and *L. wiegmannii* showed no significant differences between plant types selected as a secondary defense and those used as perches (*L. gracilis*: $\chi^2 = 3.42$, df = 4; $P < 0.489$, $N = 63$; *L. wiegmannii*: $\chi^2 = 2.81$, df = 4; $P < 0.591$, $N = 87$) (Tables 4 and 5). *Liolaemus multimaculatus* was the only species that used a sub-shrub component (*Senecio bergii*) more as a refuge than as a perch ($\chi^2 = 40.44$, df = 6; $P < 0.001$, $N = 86$) (Table 3).

DISCUSSION

Secondary defense mechanisms against predation of the *Liolaemus* assemblage of Costa Bonita included selection of sites under certain plant types that, in general, were not significantly different from sites selected as perches. These species showed a marked tendency to select refuge in vegetation as an anti-predatory tactic despite cryptic coloration or mimicry with immobility predominating as a primary defense mechanism in *Liolaemus* species that inhabit exposed habitats (Schulte et al., 2004).

In different microhabitats, the three species coincided in selecting sub-shrubs, specifically *Senecio bergii*, which is an endemic plant of the coastal grasslands in a vulnerable status of conservation (Delucchi, 2006). These species avoided stem-erect and creeping herbs as refuges. Sub-shrubs have large canopies that hinder visibility of aerial predators and allow prey movements while maintaining their positions. These physiognomic attributes of plants that provide concealment opportunities could be recognized by these lizards. Some species can discriminate among suitable sites in rocks (Schlesinger and Shine, 1994; Cooper et al., 1999; Cruz et al., 2005; Aguilar and Cruz, 2010) and plants (Kerr et al., 2003) that provide them with survival advantages. Some species of *Anolis* recognize structural characteristics of vegetation (Kiestler et al., 1975), and *Tiliqua rugosa* can discriminate visual cues (shape and color) during spatial orientation (Zuri and Bull, 2000) and detect shrubs in visual perception ranges less than 20 m (Auburn et al., 2009).

Liolaemus multimaculatus chose a wider range of refuges than the other two species including rocks from the abrasion platform on the beach, clump-herbs, and an exotic shrub species on the fixed foredunes. This may be, in part, because in exposed microhabitats, greater distance between refuges could favor more opportunistic selection behavior of lizards. When faced with a threat, they may use the closest refuge and, therefore, be less selective than the other species. The antipredator strategies of *L. multimaculatus* resembled those of *Liolaemus lutzae* from the open microhabitats of coastal dunes of southern Brazil, which displays a wide set of secondary mechanisms of defense, including immersion into the sand (Rocha, 1993). *Liolaemus gracilis* predominantly used sites under *Panicum racemosum*. This herb is unusual in that it grows hanging above the slopes of dunes in a tangled web that makes access difficult for predators. Its structure also allows lizards to sprint and climb during escape. In a more diverse microhabitat, *L. wiegmannii* selected refuge sites only under sub-shrubs, primarily *Melilotus indicus* (an introduced species) and *Achyrocline satureioides* plants.

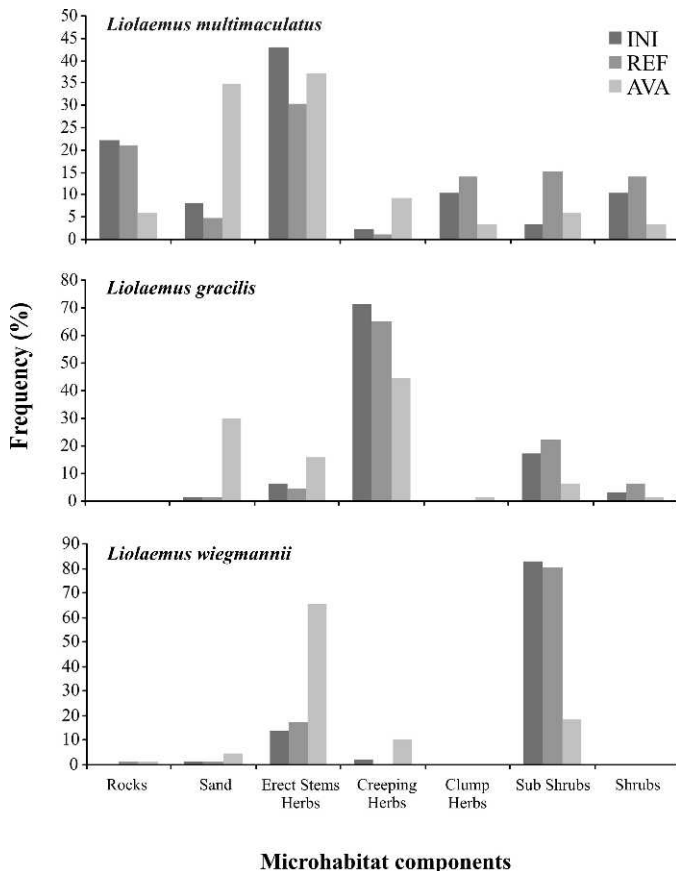


FIG. 1. Availability (AVA) and frequency of use of environmental components in the microhabitat of each species of lizard. Initial detection site (INI), refuge site (REF).

TABLE 4. Bonferroni confidence intervals ($\alpha = 0.05$) for microhabitat components of *Liolaemus gracilis*. F: frequency, P: proportion.

	Refuge			Initial			Available	
	F	P	Intervals	F	P	Intervals	F	P
Sand	1	0.016	-0.026, 0.057 ^a	1	0.016	-0.026, 0.057 ^a	19	0.302
Erect stems herbs	3	0.048	-0.023, 0.118 ^a	3	0.063	-0.018, 0.145 ^a	10	0.159
Creeping herbs	41	0.651	0.492, 0.809 ^a	45	0.714	0.564, 0.864 ^a	28	0.444
Clump herbs	0	0	0	0	0	0	1	0.016
Sub-shrubs	14	0.222	0.084, 0.360 ^a	11	0.175	0.048, 0.301 ^a	4	0.063
Shrubs	4	0.063	-0.018, 0.145	2	0.032	-0.027, 0.090	1	0.016

^aSignificant differences between Refuge/Initial and Available.

Antipredatory advantages in using structural features of vegetation have been recognized in other studies (Stamps, 1983; Martín and López, 1995). Jaksic and Fuentes (1980), who analyzed predation in 12 species of *Liolaemus* in central Chile, showed that individuals using perches with reduced visibility to predators had fewer autotomized tails. Some experiments of increasing predation risks also demonstrated that lizards diminish their conspicuousness by increasing the use of shelters (Pérez-Tris et al., 2004). In this study *L. gracilis* and *L. wiegmanni* showed no differences between what was selected as refuge and perch sites. Unlike the cryptic advantage of *L. multimaculatus* in open sand, the greater conspicuousness of these species might have led them to use vegetation as refuge. Conspicuousness of *L. gracilis* in bare sand would be reduced by the coloration of the lizard, light brown dorsal coloration with yellow longitudinal stripes on the flanks that mimics the long yellowish-green leaves of the grass *Panicum racemosum*. In the case of *L. wiegmanni*, the yellow longitudinal lines and dark brown spots of its dorsal pattern are partially camouflaged with the shadows and filtered sunlight projected through the branches of sub-shrubs. Even though crypsis as primary defensive mechanism was strongly verified in *L. multimaculatus*, our results showed that this lizard avoided the full exposure in open sand areas and occupied sites in close proximity to vegetation and rocks. There could be a trade-off between exposure and safety. For example, Kacoliris et al. (2010) highlighted the use and selection by this lizard of the medium-sized clumps of *Spartina* of coastal sand dunes of Mar Chiquita in avoiding predation.

The use of burrowing was not a common strategy in these species. It is possible that, as it has been demonstrated for other species, the occurrence of thermal trade-offs involved in entering or staying in burrows during diurnal hours (Amo et al., 2007a; Cooper and Wilson, 2008) could have restricted the use of burrows as refuges, at least in the first stages of escape behavior.

Sand-dwelling lizards of Costa Bonita selected certain vegetation types presumably to reduce the risk of predation. We observed a correspondence between refuge and perch sites such that there could be a trade-off between exposure and

safety. Selection of vegetation refuges and the shared evolutionary history of these lizards and native grasses have strong implications in the conservation of these species. The characteristics of native vegetation used by these lizards should be taken into consideration when acquiring sites for conservation. At the same time, restoration/enhancement of coastal dune sites should consider the vegetation structure that is relevant to the individual species of lizards.

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TABLE 5. Bonferroni confidence intervals ($\alpha = 0.05$) for microhabitat components of *Liolaemus wiegmanni*. F: frequency, P: proportion.

	Refuge			Initial			Available	
	F	P	Intervals	F	P	Intervals	F	P
Rocks	1	0.011	-0.018, 0.041	0	0	0	1	0.011
Sand	1	0.011	-0.018, 0.041 ^a	1	0.011	-0.018, 0.041 ^a	4	0.046
Erect stems herbs	15	0.172	0.068, 0.277 ^a	12	0.138	0.043, 0.233 ^a	57	0.655
Creeping herbs	0	0	0 ^a	2	0.023	-0.018, 0.064 ^a	9	0.103
Sub-shrubs	70	0.805	0.695, 0.914 ^a	72	0.828	0.723, 0.932 ^a	16	0.184

^aSignificant differences between Refuge/Initial and Available.

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