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Nesting of the Common Diuca Finch in the central Chilean scrub.—The Common Diuca Finch (*Diuca diuca*) is abundant in central Chile (Cody 1970), but its nesting behavior is poorly known. Goodall et al. (1946) reported that Diuca Finches build an open nest made of grass and roots and place their nest in various species of shrubs and trees. However, occasional observations indicate that Diuca Finches exhibit more varied nesting behavior. In some cases the nest is camouflaged and in others the nest is conspicuous. In this paper, we examine the selection of nest site and nest lining by Diuca Finches in the scrub zone of central Chile and discuss the possible role of predation.

Methods.—The study area was located in San Carlos de Apoquindo, 20 km E of Santiago (33°24′S, 70°30′W). This locality was vegetated by a scrub formation named matorral, with dominant associations of evergreen shrubs such as quillay (*Quillaja saponaria*) and litre (*Lithrea caustica*), both with an average height of 6 m. Summer deciduous shrubs were represented by trevo (*Trevoa trinervis*), crucero (*Colletia spinossisima*), espino (*Acacia caven*), and colliguay (*Colliguaja odorifera*) (average height was 3 m). The climate was of Mediterranean type, with winter rains and summer drought (di Castri and Hajek 1976).

The nests of Diuca Finches were located by observing the behavior of adult birds during the reproductive period (October 1987 to February 1988) and by examining all plants in a 3.1 ha area. We determined plant species, presence or absence of thorns, foliage density, height of nest, nest lining material (smooth or thorny twigs, average diameter 1.5 mm), and presence of eggs and chicks. We computed a periphery index as the ratio of trunk-to-nest distance divided by the canopy radius at nest height. Shrubs used by finches for nest sites were either thorny and low leaf density (Crucero, Trevo, and Espino) or thornless and high leaf density (Quillay).

We estimated the canopy-projected cover of shrubs and trees with the line intercept method (Armesto and Gutierrez 1980), along a 500-m transect.

We checked whether the selection of nest sites was random by comparing expected with observed frequencies by means of a χ^2 test (Sokal and Rohlf 1981). The expected number of nests was calculated by applying the proportion of plant cover in which Diuca Finches nested. To determine whether dependence existed between selection of nesting material and nesting sites, we analyzed the relative frequencies of nests built with smooth or thorny material by means of χ^2 test (Sokal and Rohlf 1981) for nests located in thornless and high leaf density plant structure. The expected number of nest types was calculated by applying the proportion of plant cover of all plants that could supply smooth or thorny material. When the expected number of nests with thorny or smooth nest lining material was less than five, Fisher's exact test (Sokal and Rohlf 1981) was used.

Eleven nestling Diuca Finches (occupying five different nests) were watched from the egg stage until fledgling stage every five days, in order to estimate their mortality up to the moment of nest abandonment. Nesting parents did not appear unduly disturbed by our observations and none deserted the nest.

Results.—4.05% of the shrubs examined were used for nesting by Diuca Finches (Table 1). Diuca Finches nested on four of the nine shrub species present, which together represented 57.8% of the plant cover available (Table 1).

Diuca Finches appeared to prefer building their nests in canopies with both high leaf density and no thorns ($\chi^2 = 11.39$, df = 1, $P < 0.005$), especially in quillay (Table 1). In this case, there was no apparent selection of nest lining material ($\chi^2 = 0.007$, df = 1, $P < 0.9$).

TABLE 1

PLANT CHARACTERISTICS IN THE STUDY (3.1 HA), NUMBER OF DIUCA FINCH NESTS, AND TYPES OF NEST LINING ON EACH PLANT SPECIES

Plant species	Number of shrubs	Relative cover (%)	Number of *Diuca* nests	Nest lining	
				Thorny	Smooth
Quillaja saponaria[a]	93	18.8	16	6	10
Colletia spinossisima[b]	39	14.2	4	4	0
Trevoa trinervis[b]	123	23.4	3	2	1
Acacia caven[b]	10	1.4	2	2	0
Lithrea caustica[a]	82	13.1	0		
Colliguaja odorifera[a]	88	12.4	0		
Baccharis linearis[a]	177	15.5	0		
Azara dentata[a]	4	1.2	0		
Talguenea quinquinervia[b]	2	0.2	0		
Total	618	100	25	14	11

[a] Thornless and high leaf density.
[b] Thorny and low leaf density.

Diuca Finches chose thorny nest lining material (Fisher's exact test, $P < 0.001$) when they nested in shrubs with thorns and low leaf density. However, they seemed to avoid nesting in these types of shrubs in spite of the large availability of this plant type (39% of total relative cover). In the latter case, birds chose thorny material (Table 1) for lining their nests. The periphery index indicates that there were no significant differences in location of nests between the two types of plant structures recognized (Student's *t*-test, not significant), one with thorns and low leaf density (average PI = 0.44, SD = 0.11) and the other thornless and high leaf density (average PI = 0.66, SD = 0.066).

Observations of birds from egg through fledgling stage indicated that mortality before leaving the nest was 82% (Fig. 1). During the study period, we noted picked eggs, missing eggs, and chicks. Feathers of a raptor, the Chimango Caracara (*Milvago chimango*), were found inside one Diuca Finch nest where two eggs had disappeared.

Discussion.—Nilsson (1986), Moller (1987), and Martin and Roper (1988) have indicated that nest-site characteristics and nest-building material are determined mostly by differential predation on nests which differ in such characteristics. Birds appear to have the capability of responding behaviorally to reduce predation effects (Nilsson 1986, Jaksić and Simonetti 1987, Graham 1988). Our results indicate that Diuca Finches are subject to high mortality before leaving the nest. According to Ricklefs (1969), predation is the most important factor of mortality in eggs and chicks among several orders of birds, including Passeriformes.

Predation may be a factor in the high mortality observed in Diuca Finches. Jiménez and Jaksić (1989) showed that the Austral Pygmy-Owl (*Glaucidium nanum*) is an important predator of Diuca Finches (eggs and nestlings). Núñez (pers. comm.) has seen mouse-opossums (*Marmosa elegans*), racerunners (*Callopistes palluma*), and snakes (*Philodryas chamissonis*) eating eggs and chicks of Diuca Finches.

The nesting pattern observed among Diuca Finches could thus be related to avoidance of predation through selection of plant structures with high leaf density that provide crypsis against predators to the nests (Nilsson 1986). Or alternatively, in the case of conspicuous nests built in plants with thorns and low leaf density, the selection of thorny material for the nest lining could be favored and would counteract predators' efficiency. The alternative

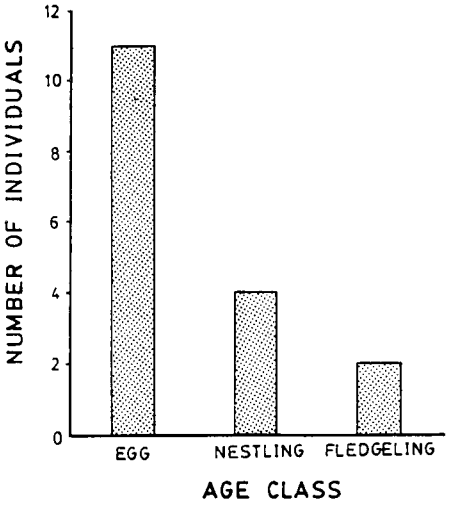

FIG. 1. Survival of *Diuca* Finch eggs, nestlings and fledglings in the nest.

hypothesis that nest lining material is collected near the nest cannot explain the random selection of nest lining material in both thornless and high leaf density plant structure. In addition, the authors observed Diuca Finches collecting nest lining material in an area 50 m around the nests.

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The proximate costs and benefits of polygyny to male Northern Shrikes.—Trivers (1972) defined parental investment as any investment by a parent in an offspring that increases the offspring's chance of surviving at the cost of committing resources to other offspring. Wittenberger (1981) modified this definition to apply to entire clutches or broods of offspring. An exact definition of parental investment has been disputed for some time, and even today the debate continues. Discussions of mating strategies typically deal with the benefits and cost of a behavior to females (e.g., Orians 1969, Alatalo et al. 1986). The consequences for males, however, are less often addressed. For example, polygyny has obvious benefits over monogamy for males because a polygynous male has a greater reproductive potential during a single breeding season. However, polygyny may also impose higher costs to the male if he contributes to the care of offspring. If there is a cost of polygyny to the male it is ultimately paid for in reduced survivorship, which unfortunately is difficult to measure because it requires large sample sizes and long-term studies. But, even proximate measures of cost, such as the time involved in feeding and defending additional young, may be informative because time spent in parental care probably exposes the male to additional hazards of predation and injury (Reid and Sealy 1986). Proximate costs to males might also be relevant to mate selection. In fact, some theories of mate selection assume that females choose among males on the basis of the male's ability to incur proximate costs (Slagsvold 1986, Alatalo et al. 1986).

We investigated some of the proximate costs of polygyny to male Northern Shrikes (*Lanius excubitor*). In Israel, male Northern Shrikes reside permanently in breeding territories. Females are not permanent residents and leave the breeding area immediately after their broods fledge. Seven male Northern Shrikes were observed during the 1987 breeding season, from January to June, at Sede Boqer (34°47′N, 30°52′E, 475 m ASL), in the Negev Desert highlands of Israel. The study area is a flat loessal plain. The plateau supports a sparse dwarf shrub community dominated by *Hammada scoparia, Zygophyllum dumosum, Reaumuria hirtella, Anabasis syriacus,* and *Artemesia herba-alba.* The major woody species are *Tamarix nilotica, Atriplex halimus, Retama raetam,* and *Thymelaea hirsuta.* Regional flora includes a large variety of herbs and geophytes (Danin et al. 1975).

Two of the seven males we observed had polygynous relationships (Yosef and Pinshow 1988b); the first two documented cases of polygyny in this species. Following this discovery, time-budgets were constructed for all seven pairs under observation. The birds' diurnal behavior was divided into the following categories: (1) perching, (2) flying (usually to or from collecting prey, or chasing conspecifics or heterospecifics from the area, or changing lookout points), (3) handling prey (recorded from the instant the shrike landed on or near the prey and attacked it until the prey was impaled or consumed), and (4) preening.