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Natural history of the Tamarugo conebill *(Conirostrum tamarugense)* during the breeding period: diet and habitat preferences

Historia natural del comesebo de los tamarugales *(Conirostrum tamarugense)* durante el período reproductivo: dieta y preferencia de hábitat

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ABSTRACT

The Tamarugo conebill *(Conirostrum tamarugense)* is a rare bird, endemic of the desert of northern Chile and southern Perú. Information about its basic natural history, including its distribution and behavior is isolated and scarce. The objective of this work was to study the food preferences and habitat selection of *C. tamarugense*, during the breeding period. The study was conducted at the "Pampa del Tamarugal" National Reserve in the Tarapacá province, Chile. Diet, apparent digestibility and daily food requirements are described. Food availability and bird density were also studied in five zones within the reserve. Tamarugo conebill is insectivorous and specialist, consuming preferentially larvae of *Leptotes trigemmatus* (Lycaenidae). Based on allometric relationships, we found that daily food requirement was similar to the expected value for a 10 g passerine. The five recognized forest zones present significant differences in foliage volume, leptotes's larvae abundance and bird. Birds preferred more profitable zones, with mature and unmanaged trees, probably because food resources are more abundant and search costs are low. Apparently, population dynamics of *C. tamarugense* is associated with the Tamarugo forest history. We pointed that the conservation status of this species depends on the Tamarugo forests and associated insects.

Key words: Tamarugo conebill, breeding period, food preferences, *Prosopis tamarugo*.

RESUMEN

El comesebo de los tamarugales *(Conirostrum tamarugense)* es un ave rara, endémica de la zona desértica del Norte de Chile y Sur del Perú. Información sobre su historia natural, incluyendo distribución y conducta, es escasa y fragmentada. El objetivo de este trabajo fue estudiar, durante el período reproductivo, las preferencias tróficas y de hábitat de *C. tamarugense*. El estudio se realizó en la Reserva Nacional "Pampa del Tamarugal", provincia de Tarapacá, Chile. Se describe su dieta y estima digestibilidad aparente y requerimientos tróficos diarios. Se reconocieron cinco zonas de bosque en el área de estudio, en ellas se determinó el volumen foliar, la oferta de alimento y densidad de *C. tamarugense*. El comesebo de los tamarugales es un ave insectívora y especialista que consume casi exclusivamente larvas de *Leptotes trigemmatus* (Lycaenidae). Los requerimientos tróficos diaros del comesebo de los tamarugales son similares a los esperados para un ave paserina de 10 g. Las cinco zonas de bosque reconocidas presentaron diferencias significativas en volumen foliar, abundancia de larvas y densidad de aves. Las aves seleccionan las zonas caracterizadas por árboles maduros y sin manejo forestal, probablemente por ser las zonas con mayor abundancia y concentración de recursos tróficos, lo que reduciría los costos de búsqueda. La dinámica poblacional de *C. tamarugense* está asociada a la historia del bosque de tamarugos. El estado de conservación de esta especie depende de la preservación del bosque y de los insectos asociados.

Palabras clave: Comesebo de los tamarugales, período reproductivo, preferencias tróficas, *Prosopis tamarugo*.

INTRODUCTION

The Tamarugo conebill (*Conirostrum tamarugense* Johnson & Millie) is an endemic bird inhabiting deserts of Northern Chile and Southern Perú (Johnson & Millie 1972, Mayr & Vuilleumier 1983, Collar et al. 1992). Data concerning general information about its biology and distribution are scarce, based mainly on sparse observation (see Johnson & Millie 1972, McFarlane 1975, McFarlane & Loo 1974, Schulenberg 1987, Tallman et al.

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1978). The species conservation status was defined as vulnerable (Rottmann & López-Calleja 1992, Collar et al. 1992). Recently, their breeding area was identified (Estades & López-Calleja 1995), being characterized as reintroduced plantations of *Prosopis tamarugo* (Tamarugo) in the Atacama desert (Chile). Present-day plantations (14,600 ha) are located in similar areas where the original tamarugo savannas were before their commercial exploitation during the last century. The population of *P. tamarugo* exhibits different age classes according to its year of plantation and management (Aguirre & Wrann 1985). Estades & López-Calleja (1995) document a significant bird concentration in forests zones with old and without forestry management trees of *P. tamarugo*.

Considering that trophic resources are one of the main factors determining habitat preferences as well as populations dynamics in birds (Cody 1981, Wiens 1984), the objective of this work was to report basic aspects of natural history of this species through studies of diet and food requirement, and its trophic resources distribution in different Tamarugo's forest zones. We document also the effects on the Tamarugo conebill's habitat preferences and population movements.

METHODS

The study was conducted at the "Pampa del Tamarugal" National Reserve (20°24' S, 69° 44' W), at Tarapacá province (I Region, Chile), between late October and early November 1993. This area has an extreme desertic climate, with a mean annual rainfall of 0.3 mm (di Castri & Hajek 1976). Both the temperature and relative humidity undergo large daily variations (Sudzuky 1985). After a preliminary survey of the reserve, five sampling zones (Fig. 1) were recognized, according to the year of plantation, management status and degree of isolation.

Diet characterization was carried out using fecal samples (Ralph et al. 1985). Individuals were mist-nested and maintained in individual cages during one hour to obtain a fecal sample. In the laboratory different items were identified, insects were compared with a reference collection. For estimating the daily consumption rate, apparent digestibility and daily food requirement (FR), a total of six individuals were maintained for two days in individual cages. During the first day of acclimation, animals were maintained with food *(L. trigemmatusís larvae)*. On the second day, between 7:00 to 20: 00 h, 5 g of larvae were offered to each bird. Water was maintained ad libitum during two days. Excreta and orts were collected at the end of the experiment. At the laboratory, the collected excreta was weighed and dried at 55° C. Energy content of food and excreta were determined using a Parr 1261 computerized calorimeter. Apparent digestibility was defined as the coefficent of matter (AMC*) or energy (MEC*) consumed that is absorbed (Karasov 1990), and was calculated as $\{Q_i - Q_e\}/ Q_i$. Where Q_i = daily rate of food intake, and Q_e = daily rate of excreta's production. Digestibility is termed "apparent" because this method underestimates digestive efficiency by the contribution of metabolic wastes (Karasov 1990). The food requirement (FR) was estimated as:

$$FR\ (g/d) = FMR\ (kJ/d) / \{Q_{prey}\ (kJ/g) \cdot MEC^*\},$$

were FMR = Field metabolic Rate, estimated from Nagy (1987) and Q_{prey} = Caloric value of food (see Bozinovic & Medel 1988).

To characterize conebill's habitat, in the five sectors assessed, the mean Tamarugo foliage volume per ha were used. A total of 24 transects were stablished at different zones in the Reserve, each transect contained 20 trees. Foliage volume was estimated by assimilating the tree to the solid drawn ($Vol = (d/2)^2 \cdot \pi \cdot 7/9h$). Then the dimensions estimated for each tree were height (h) and crown diameter (d). The absence of the lower third of the foliage was registered as management status (pruned). Density of *C. tamarugense* was estimated by the linear transect method on a predertermined area (Emlen 1971); in each sector and during two days, six daily transects were performed. Considering that initial survey of insect distribution to reveal that larvae of *L. trigemmatus* are concentrated in inflorescence of Tamarugo trees, the abundance of leptotes larvae was estimated through direct observation

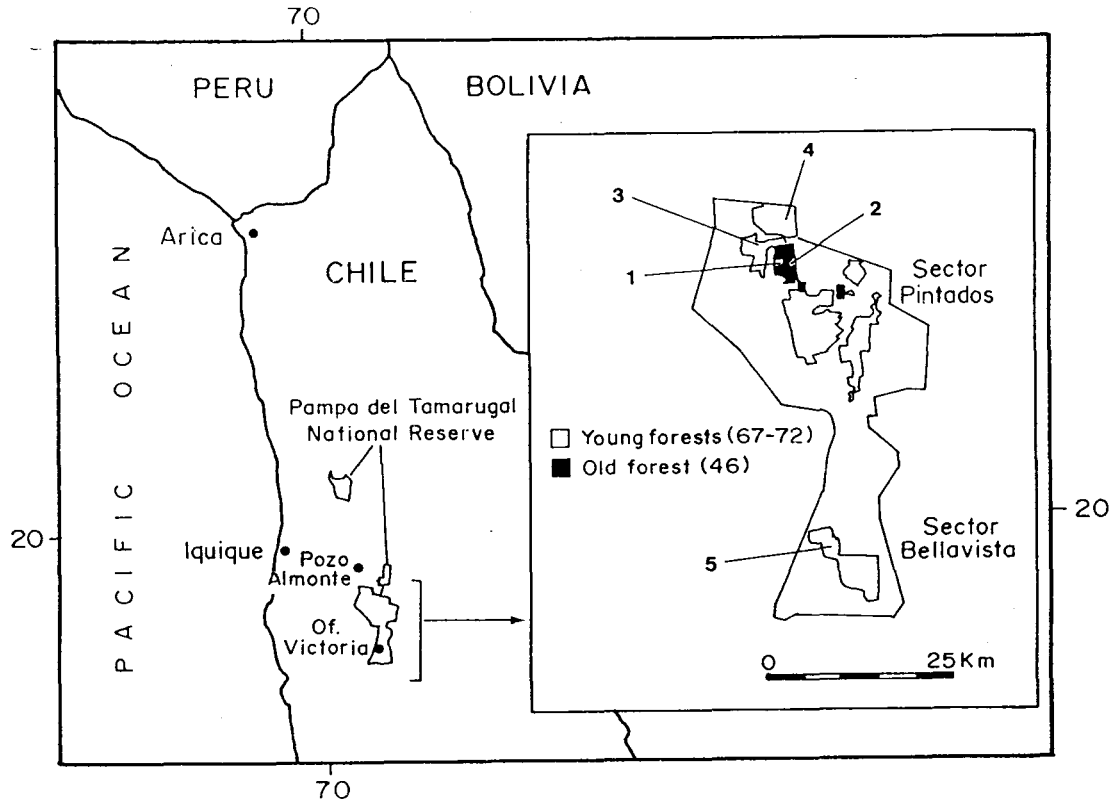

Fig. 1: Study area "Pampa del Tamarugal" National Reserve. Specificating the location of different Tamarugo zones recogniced in these study. See Table 1 for zone caracterization.

(Area de estudio Reserva Nacional "Pampa del Tamarugal". Se especifica la ubicación de las diferentes zonas de Tamarugo reconocidas en este estudio. Ver Tabla 1 para caracterización de las zonas).

(Cooper & Whitmore 1990), counting the number of larvae in 10 inflorescences for tree, and in 20 to 30 trees for sector.

Results are given as means ± SD. The non parametrical Kruskall-Wallis test was used for comparisons between Tamarugo zones (Sokal & Rohlf 1981), and a posteriori test for determined homogeneous group. Correlations were conducted using the Spearman rank coefficient (Steel & Torrie 1985).

RESULTS

Diet

Conirostrum tamarugense feed mainly on larvae of *Leptotes trigematus* (Lycaenidae). These larvae are present in all the bird's samples (n = 12), representing a 88% of all consumed preys. The other 12% are represented by three items: Carabidae, 6.4%, Formicidae, 3.7% and Microhimenopteran, 2.0%, and are present in few samples (4, 3, and 2 respectively). Pieces of inflorescences were observed in 75% of the samples. Foraging observation were done during a transect run (20 h total). We detected that *C. tamarugense* forages exclusively at the foliage near the inflorescences. The species was never observed foraging on the ground under or between the trees.

Tamarugo conebill maintains body mass during captivity (m_b = 9.88 (1.14 g). Daily consumption was 260.5 (± 6.30) larvae/d, or 2.56 (± 0.62) g/d (dry weight). The AMC* was 0.67 (± 0.35) and MEC* was 0.76 (± 0.31). Considering that FMR for a 10 g passerine is 49.07 kJ/d according Nagy (1987), and the larvae of *L. trigemmatus* caloric value is 23.36 kJ/g, the expected FR was 2.78 g/d. This estimation is in the range to the observed value (outliers test, $p > 0.1$).

Habitat characterization

The Tamarugo's foliage volume was different in the five zones recognized in this work (Table 1). The zone 1 (oldest zone) presents significantly more foliage volume than younger areas (zone 3, 4, and 5), as well as those of similar age but pruned zone 2. Only zone 5 was isolated from the rest (Fig. 1). It did not present significant differences in foliage volume with a similar age zone 4 (Table 1).

Food abundance

The abundance of *L. trigemmatus* is related to Tamarugo's age and silvicultural management (Table 1). Older trees (zone 1) exhibited significantly more larvae than younger trees (zone 4 and 5), and zone 3 exhibited intermediate abundance. The effect of pruning did not change larval's abundance at similar age trees (zone 1 and 2). Isolated trees (zone 5) presented significantly few larvae when compared with all other zones. Probably, the dispersal capacities of *L. trigemmatus* are limited being unable to travel to the isolated area.

Bird density

Density of *C. tamarugense* changes significantly among different zones, forming three different groups (Table 1). The first group formed by the older plantation (zone 1) which presents more birds than all the other zones. The second group included zone 2,3 and 4 (Fig. 1), and present medium bird densities. Finally, the isolated zone 5 presented less than 1 bird/ha.

DISCUSSION

Conirostrum tamarugense is an insectivorous bird with a narrow trophic niche, consuming preferentially larvae of *L. trigemmatus*. The species do not forage on the ground under the foliage, probably because larvae of *L. trigematus* are scarce there, and due to the presence of a potential predator lizard *(Microlophus atacamensis)*. We postulated that Tamarugo conebills preferred to forage near the inflorescences because the maximun concentration of *L. trigemmatus* in the Tamarugo foliage was found in this area (Toro et al 1993). The high presence of inflorescence's rest at the tamarugo conebills excreta samples confirms this proposal. The only information available about *C. tamarugense*'s food preferences is provided by McFarlane & Loo (1974), based on the stomach contents of two conebills captured at the Azapa Valley, near Arica. The main items consumed by these individuals were homopterans, lepidopteran larvae, aphids, dipterans and hymenopterans.

The insect diversity is low in the Tamarugo forest (Cogollor et al. 1985), and larvae of *L. trigemmatus* are the most abundant resource in the foliage samples during the main blooming period (September to December) of *P. tamarugo* (Toro et al.1993). Probably Tamarugo Conebills select the more abundant and profitable items and consume others only in casual encounters. In two visits during the non-breeding period (February and July 1994) few inflorecences and absence of leptotes's larva in all the Tamarugo forest were detected. We postulate that bird population fluctation at the reserve are asociated to the Leptotes trigematus's life cicle, specifically with larvae appearance.

Since the studied population migrated to the preandean zone between North of Chile and South of Perú (Estades, unpub. data), we suspect that the amplitude of the trophic niche during this period increased asociated to an increment at vegetation and insect diversity in preAndean zones, as stated the observations of McFarlane & Loo (1974). Information of food preferences and resources availability during the non breeding period in these areas may be necessary to confirm this.

Conirostrum tamarugense presents an AMC* and MEC* similar to than expected for an insectivorous bird (Karasov 1990), and an experimental daily food consumption similar to the predicted for a 10 g paserine bird (Nagy 1987). Extrapoling the densities information (Table 1) at the Pintados areas (Fig. 1, excluding Bellavistas zone 5), the population density of Tamarugo Conebill are 34,404 ind, and their daily requirement is near 9 million larvae/day. Information about

TABLE 1

Variation in foliage volume, larva abundance and *C. tamarugense* density in five different study zones. The values are average ± 1 SD, Kruskal-Wallis P significant level are presented, * : homogeneous group, a posteriori non parametric test.

Variación del volumen foliar, densidad de larvas y densidad de *C. tamarugense* en las diferentes zonas de estudio. Se presentan promedios ± 1DE, el nivel de significancia p (Kruskall-Wallis). *: grupos homogéneos según prueba a posteriori.

Zone	Year of Plantation	Surface of Plantation (ha)	Foliage volume *P. tamarugo* (m^3 /ha)	Larvae abundance *L. trigemmatus* (larva/inflorescence)	Density of *C. tamarugense* (ind/ha)
1	1948	964	15,505 ± 2,220 *	4.33 ± 1.38 *	9.27 ± 2.86 *
2	1948 pruned		4,962 ± 2,613 *	3.93 ± 1.83 *	3.50 ± 2.06 *
3	1967	2,881	7,852 ± 4,579 *	3.43 ± 0.47**	4.84 ± 2.24 *
4	1973	4,833	4,002 ± 1,276 *	2.05 ± 0.37 *	2.38 ± 3.39 *
5	1973 isolated	2,109	7,905 ± 1,222 *	0.05 ± 0.05 *	0.33 ± 1.49 *
	p		6.80×10^{-3}	5.79×10^{-10}	1.84×10^{-3}

abundance of larvae in different areas will permit to determine the real effect of *C. tammarugense* predation upon this Lycaenidae.

Conirostrum tamarugense population density is not correlated with larvae abundance ($r_s = 0.90$, $p = 0.07$) or foliage volume ($r_s = 0.40$, $p = 0.42$). The densities of Tamarugo conebill, however, are correlated with both variables combined as foliage volume • larvae/inflorescences ($r_s = 0.99$, $p < 0.001$). Both factors determined that an older and dense tree should show more inflorescences and then more larvae abundance than a young or pruned tree. Our work confirms this idea; trees with denser foliage present significantly more density of Tamarugo conebills than pruned or younger trees during breeding period. Considering that *C. tamarugense* needs an average of 261 larvae/day, one bird would need to visit 60 inflorescences in zone 1 to achive its daily energy requirement, 127 in zone 4 and 5,210 at isolated zone 5 (if all larvae/ inflorescence are detected). Then *C. tamarugense* appears to select the more profitable patches, were the number of inflorescences are sufficient to supply their FR with minimum travel.

Human exploitation of Tamarugo's savanas determined their extreme reduction (Aguirre & Wrann 1985). The Chilean government initiated a reforestation program in this area, starting in 1938-48. This forestation is concomitant with the first observation and description of *C. tamarugense* (Johnson & Millie 1972), when the first trees were 35-22 year old. Recent nesting records of the species in a mature forest (Estades & López-Calleja, 1995) is coincident too. The preference for mature forest, were their food is sufficient to supply their energetic requirement confirms the hypothesis that trophic resources availability is an important factor in determining habitat selection in this species. Probably, *C. tamarugense* density have been increasing during last decade due to the conservation of mature *P. tamarugo* forests.

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