NOTES ON THE DIET OF THE ENDEMIC RED-EARED PARAKEET *PYRRHURA HOEMATOTIS* AND OTHER VENEZUELAN MONTANE PARROTS

NOTAS SOBRE LA DIETA DE LA ENDÉMICA COTORRA COLIRROJA *PYRRHURA HOEMATOTIS* Y OTROS LOROS MONTANOS DE VENEZUELA

Galo BUITRÓN-JURADO[1] * and VIRGINIA SANZ[1]

SUMMARY.—Information on the diet of some species of tropical parrots is still scarce. We present data on the feeding ecology of the red-eared parakeet *Pyrrhura hoematotis*, an endemic and poorly known species of Venezuelan montane forests. Additionally, we describe other observations on the diet of the Venezuelan parakeet *Pyrrhura emma*, scarlet-fronted parakeet *Psittacara wagleri* and lilac-tailed parrotlet *Touit batavicus*. Red-eared parakeets used thirteen species of plants and their diet consisted principally of arillate seeds, but also included fleshy fruits and flowers. Tree species of Euphorbiaceae were main items in the diet of red-eared and scarlet-fronted parakeets. Leaves and resin of *Clusia alata* trees are reported for the first time in the diet of the lilac-tailed parrotlet. Our results add basic natural history data that can be useful for the conservation of these restricted distribution parrot species that are threatened by the habitat loss.

Key words: cloud forests, diet, Psittacidae, seed predators, South America, Yacambú National Park.

RESUMEN.—Información acerca de la dieta de algunas especies de loros tropicales es aún deficiente. Presentamos datos sobre la dieta de la cotorra colirroja *Pyrrhura hoematotis*, una especie endémica y pobremente conocida de los bosques montanos venezolanos. Adicionalmente, describimos otras observaciones sobre la dieta de la cotorra de Emma *Pyrrhura emma*, aratinga de Wagler *Psittacara wagleri* y cotorrita siete colores *Touit batavicus*. La cotorra colirroja utilizó trece especies de plantas y su dieta consistió principalmente en semillas ariladas, aunque también incluyó frutos carnosos y flores. Especies arbóreas de la familia Euphorbiaceae fueron los ítems principales tanto en la dieta de la cotorra colirroja como en la aratinga de Wagler. Las hojas y resina de árboles de *Clusia alata* son reportadas por primera vez en la dieta de la cotorrita siete colores. Nuestros resultados añaden datos básicos de historia natural que pueden ser útiles para la conservación de estas especies de loros que tienen una distribución restringida y están amenazados por la pérdida de hábitat.

Palabras clave: bosques nebulosos, depredadores de semillas, dieta, Parque Nacional Yacambú, Psittacidae, Sudamérica.

[1]　Laboratorio de Biología de Organismos, Centro de Ecología, Instituto Venezolano de Investigaciones Científicas (IVIC), Caracas 1020-A, Apartado 2032, Venezuela.

*　Corresponding author: galobuitronj@yahoo.es

INTRODUCTION

The natural history of many tropical parrot species is still poorly known, although this information is essential for their conservation (Mack and Wright, 1998; Botero-Delgadillo *et al*., 2010). Detailed data on habitats and diets of several tropical parrots are still needed to assess their vulnerability to habitat loss and global climatic change, especially for endemic species facing a greater risk of extinction related to the synergistic effects of narrow ecological niches and limited ranges (Walker, 2006; Slatyer *et al*., 2013). Diet data are also important to understand the parrots' role in the functioning and persistence of ecosystems. Parrots form large feeding flocks and are important pre-dispersal seed predators, probably affecting the recruitment patterns of tropical tree species due to their high removal and consumption rates (Pizo *et al*., 1995; Villaseñor-Sánchez *et al*., 2010). Conversely, some parrot species pollinate several plant species (Vicentini and Fischer, 1999; Hingston *et al*., 2004).

Venezuela accommodates 47 native species of parrots, parakeets and macaws (BirdLife, 2014). The biology of many of these is poorly known, especially of those, such as the endemic red-eared parakeet *Pyrrhura hoematotis,* that inhabit humid montane forests. This parakeet inhabits montane forests from 600 to 2400 m.a.s.l., although it is found mainly between 1000 to 2000 m.a.s.l. (Hilty, 2003). Two subspecies are recognised on the basis of differences in plumage coloration and geographic distribution. *P. h. hoematotis* is found along the western part of the Coastal Cordillera between Aragua and Miranda states, including Macarao, San Esteban and Henri Pittier national parks. *P. h. inmarginata* is only known from a very limited area on Cubiro, Lara State (Hilty, 2003; Restall *et al*., 2006; Juniper and Parr, 2010).

The red-eared parakeet is currently regarded as a 'Least concern' species in global

and national red lists, despite the lack of data on diet and population size, and a probable recent decline due to habitat loss within its limited distributional range (Rodríguez and Rojas-Suárez, 2008; IUCN, 2014). Here we present data on the diet of this parakeet from Yacambú National Park, Venezuela. We also describe a few observations on habitats and diets of other scarcely known South American parrot species: the Venezuelan parakeet *Pyrrhura emma*, scarlet-fronted *Psittacara wagleri* parakeet and lilac-tailed parrotlet *Touit batavicus*, obtained in Yacambú National Park and in a montane forest remnant in Altos de Pipe, in the Venezuelan Coastal Cordillera.

MATERIAL AND METHODS

Study area

Observations were done at two montane forest sites in Venezuela. The first area was the montane forests around El Blanquito, within the Yacambú National Park (10° 24' N 66° 55' W, 1650 m) in the Andes, Lara State. Yacambú National Park covers ca. 27,000 ha and the climate is humid with a mean annual temperature of 20 °C and an estimated annual rainfall of over 2000 mm with two peaks, in May-July and in October (Goodwin and Lentino, 1990). Lower montane rainforests cover most of the park. It is considered an Important Bird Area (IBA) due to the species richness (255) and the presence of several threatened species such as the helmeted curassow *Pauxi pauxi*, wattled guan *Aburria aburri* and rusty-flanked rail *Laterallus levraudi* (Lentino and Esclasans, 2005).

The second site was an isolated forest fragment (300 ha) in Altos de Pipe (10° 24' N 66° 55' W, 1600 m), a summit of an internal branch of the Coastal Cordillera, Miranda State. The climate is humid and rainy with an annual rainfall of 1063 mm and a mean

annual temperature of 17 °C; the site is covered by mist during several months of the year (Casañas and Jauregui, 2011). The vegetation is also classified as lower montane rainforest, although a variety of habitats are found due to the different successional stages of the vegetation resulting from the past 50 years of land conversion.

Field surveys

Observations were performed in five 1-ha plots in mature and old secondary forests within both survey sites, at elevations ranging from 1500 to 1700 m. We observed the parrots during eleven surveys of eight days each, nine carried out monthly from January to October 2011. Two additional surveys were done in Yacambú in November 2010 and February 2012. Parrot observations were performed in the morning from 06:30 to 12:00, and in the afternoon, from 15:00 to 17:00, avoiding heavy rain or mist, yielding a total of 280 sampling hours in each study area. Parrots were located using visual and aural clues in both study areas. Basic data such as date, time, flock size, habitat, and behaviour were recorded for each encounter. When parrots were observed foraging, we also recorded the plant species and part eaten (i.e. fruit pulp, seeds, or flowers), foraging height and technique (gleaning, reaching, and hanging) (Galetti, 1997; Kristoch and Marcondes-Machado, 2001). A feeding bout was defined as an observation of one or more individuals feeding on a food source (Renton, 2006). In the latter case, the behaviour was recorded for a single, randomly chosen individual and was assumed to be representative of the entire flock, to avoid problems related to lack of independence of sequential observations (Renton, 2006; Walker, 2006). If the birds moved to another plant and started feeding, this was considered as a new feeding bout (Kristoch and Marcondes-

Machado, 2001). The number of fruits removed either by swallowing or carrying away by a single individual during each observation was used to determine the removal rate. The diameter of the smallest and largest axis (measured with calipers to the nearest mm) of a sample of at least five fruits and seeds of the plant species consumed was recorded in the field to determine the size range of items consumed. Specimens of food plants were collected and identified by comparison with samples in the National Herbarium of Venezuela. These data permitted us to calculate the overall dietary breadth for red-eared parakeets using the standardised Levins niche breadth index (Levins, 1968), where values close to zero indicate dietary specialisation and values close to one indicate a broad diet (Krebs, 1999). The index was not calculated for the other three species since too few records were obtained.

Phenological data on the presence and absence of fleshy fruits of 42 tree species in Yacambú were available as part of a concomitant study of frugivorous birds in both areas (Buitrón-Jurado, 2012). Fruit-bearing trees ≥ 10 cm in diameter at breast height (DBH) were registered within each 1-ha plot and recorded as an edible source when any frugivorous birds were observed eating them. Data on the fruit crops of two tree species, *Cecropia angustifolia* and *Tetrorchidium rubrivenium* were also recorded. Ten mature trees of both species with a trunk diameter greater than 10 cm were monitored for nine months to determine the number and ripeness of fruits. To visually estimate the number of fruits in a tree, fruits were counted on ten branches and the total number of fruiting branches was counted for each tree to calculate the total number of fruits on each individual (Chapman *et al*., 1992). These data were used to explore whether monthly parrot abundance was related to fruit availability, using Spearman rank correlations. Data are shown as means ± S. E.
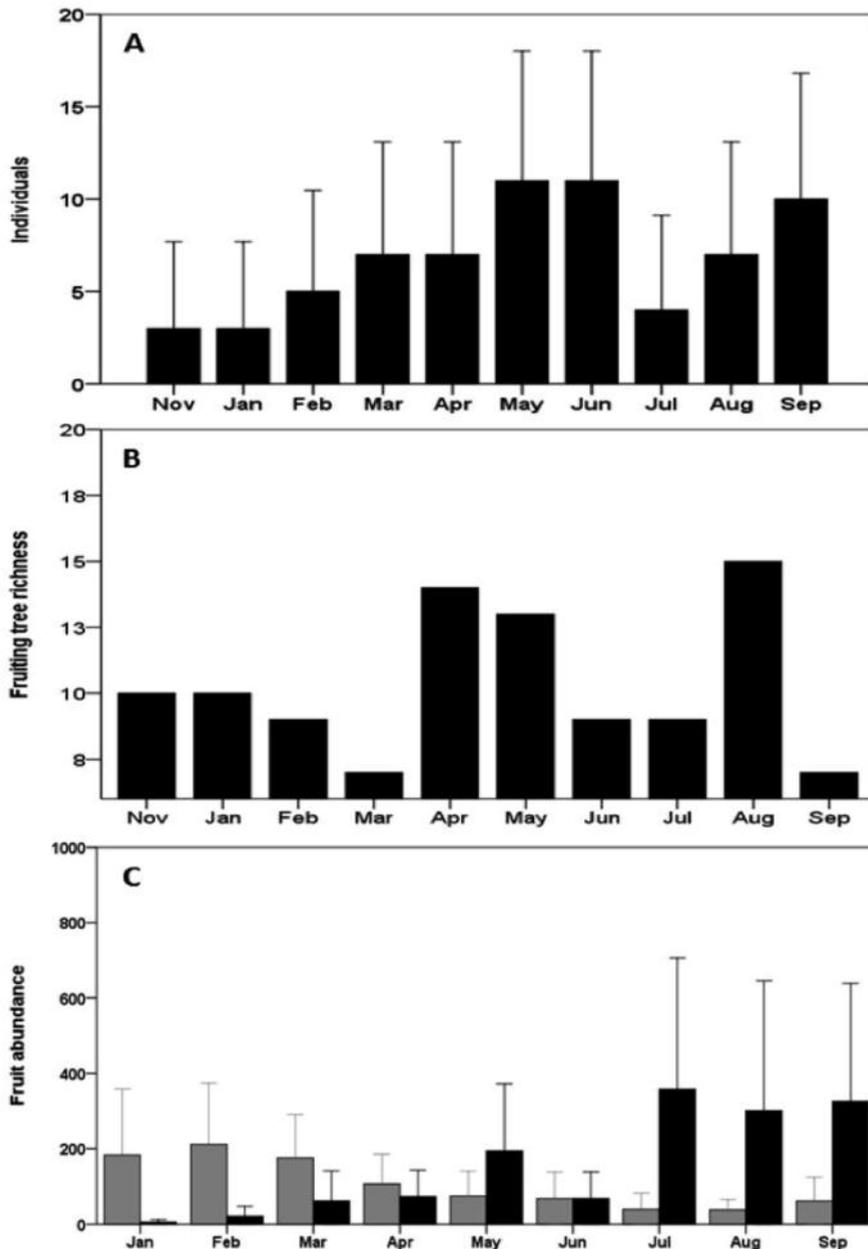
FIG. 1.—A) Monthly number of sightings (means ± S. E.) of red-eared parakeets *Pyrrhura hoematotis*; B) Number of fruiting tree species; C) Crop size of ten trees *Tetrorchidium rubrivenium* (black) and *Cecropia angustifolia* (grey) during 2011 in El Blanquito, Yacambú National Park, Venezuela.
[A) Número de observaciones mensuales (media ± S. E.) de la cotorra colirroja Pyrrhura hoematotis*; B) número de especies de árboles con frutos; C) tamaño de la cosecha de frutos de 10 árboles de* Tetrorchidium rubrivenium *(negro) y* Cecropia angustifolia *(gris) durante el año 2011 en El Blanquito, Parque Nacional Yacambú, Venezuela.]*

Results

Red-eared parakeet

Flock size and habitat. Red-eared parakeets were observed only in the Yacambú National Park during all surveys, although they were more frequently recorded in May, June, and September (fig. 1A). Parakeets were generally observed flying or perching during the early morning in flocks of 1-25 individuals (4 ± 0.6, N = 50). Flocks flew fast and generally close to the forest canopy. At midday, groups were observed resting in the canopy of tall trees. Most records (n = 28) were obtained in tall secondary forest dominated by trees of *Myrcia acuminata*, *Alchornea triplinervia* and the exotic *Eucalyptus,* in plots at low altitude in our survey area. In this area, we observed also a pair copulating for a few seconds in June 2011. Parakeets were also observed (N = 25) on the edges of tall mature forests at 1700 m, these dominated by tree species such as *Pouteria baehniana, Cecropia angustifolia*, *Calatola costaricensis* and the palm *Wettinia praemorsa*.

Diet. We observed 23 feeding bouts (90 individuals). Red-eared parakeets foraged in the sub-canopy (12 ± 0.8 m, N = 22) and they fed on thirteen plant species from nine families during the study period (table 1). The main items consumed, based on the number of feeding bouts, were arillate seeds of Euphorbiaceae, from mature fruits of *Tetrorchidium rubrivenium* and *Alchornea triplinervia,* and immature fruits of *Sapium stylare*. Capsules of these tree species were less than 10 mm in diameter and contained one to three arillate seeds that turned red when ripe. Other items eaten were seeds of *Croton gossypifolius* (Euphorbiaceae), flowers of *Erythrina* and *Ocotea*, and fleshy fruits of *Geonoma undata* (Arecaceae), *Cecropia angustifolia* (Urticaceae) and *Guettarda crispiflora* (Rubiaceae). Red-eared parakeets also included *Inga oerstediana* pods in their diet; a group of three was observed consuming these fruits on November 2010. Levins' niche breadth value was 0.65, and the fruit removal rate varied according to food plant, ranging from 2 to 24 items min^{-1} (9.7 ± 2.4, N = 23) (table 1). The sizes of the consumed items ranged from 1.6 to 9.6 mm (7.5 ± 0.5, N = 20). Foraging behaviour included gleaning and acrobatic techniques such as hanging down or reaching out to fruits. Parakeets also took fruits with the foot and bit off pieces, on two occasions.

Parakeet abundance and fruit availability. Most tree species were observed carrying fruits in April, May, and August in Yacambú, including almost all the species consumed by the red-eared parakeet, with the exception of *Heliocarpus americanus*, which was observed with dry indehiscent fruits in March. Nevertheless, we found no association between the number of tree species carrying fruits (figure 1B) and the number of parakeets (r_s = 0.06, N = 10, P = 0.8). Neither was there an association between parakeet abundance and the number of fruits of *Cecropia angustifolia* (r_s = −0.46, N = 9, P = 0.21) nor *Tetrorchidium rubrivenium* (r = 0.45, N= 9, P = 0.2). The fruit abundance of both tree species is showed in fig. 1C.

Venezuelan parakeet

We obtained three records of this species, all in Altos de Pipe where it seems to be scarce. The first was on 20 February 2011: a group of three individuals were observed perched at the top of a tree of *Clethra lanata* (Clethraceae) during the morning. A group of three individuals was also recorded on 23 March 2011 resting on branches of a tree of *Alchornea triplinervia*. Finally, four individuals were observed at 20 m at the top of a tree of *Eschweilera tenax* (Lecythidaceae) on 17 June 2011. All our observations were

TABLE 1

Food plants and frequency of consume by the red-eared parakeet *Pyrrhura hoematotis* in Yacambú National Park, Venezuela. Data on removal rates are shown as means ± S. E.

[*Alimento vegetal y frecuencia de consumo por la cotorra colirroja* Pyrrhura hoematotis *en el Parque Nacional Yacambú, Venezuela. Datos de tasas de remoción presentados como promedio ± S. E.*]

Family	Species	Plant part eaten	Feeding bouts	Number of parakeets	Removal Rate fruits min^{-1}	Date
Arecaceae	*Geonoma undata*	Fruits	1	4	1.8	Jul 2011
Asteraceae	*Piptocoma* sp.	Seeds	1	7	13.0	Apr 2011
Euphorbiaceae	*Alchornea triplinervia*	Seeds	3	9	23.7 ± 9	Mar, Apr 2011
	Croton gossypiifolius	Seeds	1	20	3.4	May 2011
	Sapium stylare	Seeds	1	5	12.1	Oct 2011
	Tetrorchidium rubrivenium	Seeds	7	13	4.4 ± 1	Nov 2010, Jun, Jul 2011
Fabaceae	*Eryhrina poepiggiana*	Flowers	1	5	3.8	Feb 2012
	Inga oerstediana	Pods	1	3		Nov 2010
Lauraceae	*Ocotea* sp.	Flowers	1	7	22.6	Feb 2011
Malvaceae	*Heliocarpus americanus*	Seeds	2	2	11.4	March 2011
Myrtaceae	*Eucalyptus citridora*	Capsules	1	3	2.5	Sep 2011
Rubiaceae	*Guettarda crispiflora*	Fruits	2	8	4.2	Nov 2010, Sep 2011
Urticaceae	*Cecropia angustifolia*	Fruits	1	4	8.0	June 2011
			23	90	9.7 ± 2.4	

made in mature forest where common tree species included *Nectandra laurel* (Lauraceae), *Matayba longipes* (Celastraceae), *Graffenrieda latifolia* (Melastomataceae) and the palm *Wettinia praemorsa* (Arecaceae). A single feeding bout was recorded on 17 June 2011 when one parakeet consumed the ripe fruits of *Cecropia angustifolia*, 10 m up in the crown.

Scarlet-fronted parakeet

The scarlet-fronted parakeet was only recorded in Yacambú where it seemed to be a seasonal visitant. Flocks of 3-50 individuals (15 ± 3.3, N = 13) were observed, first in November 2010 and between September to November 2011 at 1700 m. Their presence coincided with the fruiting of species of Euphorbiaceae such as *Sapium stylare* and *Tetrochidium rubrivenium*. These flocks remained perched and feeding for 10 to 30 minutes in emergent trees of *Sapium stylare*. The forest was tall, as described for the red-eared parakeet.

We observed 16 feeding bouts (129 individuals) in Yacambú only, all of them on immature fruits of *Sapium stylare*. During feeding, birds were noisily cracking fruits and giving frequent calls that can be described as "*kleea, kleea, kleeaa*" (record XC131795, available at http://www.xeno-canto.org). The parakeets took the capsules directly from the branches (90 %), although some hanging manoeuvres were also observed. Fruit removal rates ranged from 2 to 11 fruits min^{-1} (7 ± 0.7, N = 16).

Lilac-tailed parrotlet

This species was only recorded in Altos de Pipe, where we observed a single group. Six individuals were observed on 7 October 2010 at 07:45 hrs on the margin of secondary forest while feeding among the lower branches (3-5 m up) in a tree of *Clusia alata* (Clusiaceae; 5 m high, 19.4 cm diameter). Their foraging behaviour was remarkable because at least three individuals consumed the sap of the tree. They scratched the green twigs of the branch-tips to remove the bark gently, especially at the base of fresh young leaves, from where they licked the emerging sap. One of the individuals also broke a leaf petiole and ate the lamina. A young bud was eaten by another bird, which responded aggressively to another approaching individual. The birds remained silent while feeding, holding on to the branches with both feet while pecking at the leaf bases from below. The group chewed and broke four leaves during the thirty minutes that they remained perched in the tree. Three individuals moved to eat the young capsules of a neighbouring *Clusia* tree and remained there for another five minutes before flying away.

Our study provides information on the habitat and foraging ecology of four tropical parrot species and is the first detailed study of the diet of the endemic red-eared parakeet. Previous accounts of the ecology of the red-eared parakeet indicate that it inhabits tall mature forests in Rancho Grande in the Venezuelan Coastal Cordillera, where flocks are seen all year round close to the canopy and in the forest edges (Lentino and Portas, 1994). Our findings accord with these previous observations, since red-eared parakeets were observed in tall mature and secondary forests. Nevertheless, the tree species composition in Yacambú differs and the vegetation is of lesser stature than the montane forests in Rancho Grande (GBJ pers. obs.).

To date, only fleshy fruits of *Psidium sp*. (Myrtaceae) had been recorded as consumed by the red-eared parakeet (Fernández-Badillo *et al*., 1994, GBJ pers. obs.). We found, however, that the red-eared parakeet fed on a diversity of food resources, including the fleshy fruits, flowers, and seeds of several tree species, as do other *Pyrrhura* species (Toyne *et al*., 1992; Ragusa-Netto,

2007; Botero-Delgadillo *et al.*, 2010, 2013). The diet of red-eared parakeets included tree genera with fleshy fruits such as *Cecropia* as well as tree species producing large crops of arillate seeds, such as *Alchornea triplinervia, Sapium stylare* and *Tetrochidium rubrivenium*. These food items have been recorded previously in the diet of other Andean *Pyrrhura* species, including the white-breasted *P. albipectus* and the rose-fronted *P. rhodocephala* parakeets (Toyne, 1992; Aguilar, 1996*)*. Nevertheless, none of the Andean species have been reported consuming palm fruits, as does the red-eared parakeet (Toyne, 1992; Aguilar, 1996; Botero-Delgadillo *et al.*, 2010, 2013). The dietary breadth of the *inmarginata* form of the red-eared parakeet was similar to values reported with comparable sampling efforts for other restricted-range Neotropical parakeets, such as the Santa Marta *P. viridicata* and Todd's *P. caeruleiceps* parakeets (Botero-Delgadillo *et al.*, 2010, 2013). Nevertheless, in the view of the separate distributions of the two red-eared parakeet subspecies, it is possible that differences in their diet occur and this requires further study.

We did not find any correlations between parrot occurrence and the number of fruiting tree species nor with the two tree species for which fruit crop data were available. This suggests that red-eared parakeets do not show a strong association with the crops of these tree species, and probably the abundance of other food resources (e. g. dry seeds) needs to be taken in account. The absence of such correlation, however, could be also associated with the small sample size of our study or from factors unrelated to feeding resources, such as the availability of nesting cavities (Brightsmith, 2005).

Data on the habitats and diets of the other three parrot species observed are extremely scarce. There are no detailed accounts of plant species or parts included in the diet of the Venezuelan parakeet. Anecdotal observations indicate that the Venezuelan parakeet

feeds on fruits, seeds and flowers and it has been observed eating flowers of *Erythrina* (Fabaceae), seeds of *Heliocarpus* (Tilliaceae) and fleshy fruits of *Turpinia occidentalis* (Staphyleaceae) (Juniper and Parr, 2010; M. González, pers. comm.; GBJ, pers. obs.). The same applies to the scarlet-fronted parakeet whose diet has been reported to include flowers, fruits and seeds, especially maize (Juniper and Parr, 2010). It has been observed eating guavas *Psidium guajaba* and *Erythrina fusca* in Colombia (Rodríguez-Mahecha and Hernández Camacho, 2002). Our observation on the diet of the scarlet-fronted parakeet in Yacambú showed a heavy consumption of immature and mature fruits of *Sapium stylare*.

Touit species are among the least known parrots in South America. Data on the diet of the lilac-tailed parrotlet and blue-fronted parrotlet *Touit dilectissima* indicate the consumption of *Clusia* fruits in Colombia and Ecuador, respectively (Troncoso *et al.*, 1995; Olaciregui and Ureña, 2011; Liu and Lyons, 2012). Our observation corroborated the use of Clusiaceae by the lilac-tailed parrotlet, and shows that *Clusia* trees also could provide additional feeding resources to these parrotlets such as sap, flowers and leaves. All these resources are consumed by only a few Neotropical parrot species. Nectar has been recorded in the diet of the golden-winged *Brotogeris chrysopterus*, yellow-chevroned *B. chiriri* and white-eyed parakeets *Psittacara leucophtalmus* and the green-thighed parrot *Pionites leucogaster* (Vicentini and Fischer, 1999). Sap has been previously recorded in the diet of the military macaw *Ara militaris* which also includes leaves, as the diets of the reddish-bellied and Todd's parakeets (Pizo *et al.*, 1995; Kristoch and Marcondes-Machado, 2001; Contreras-González *et al.*, 2009). Further studies are needed, however, to corroborate if the consumption of sap, a particular reward for pollinators in *Clusia* species (Martins *et al.*, 2007), and leaves is frequent among *Touit* parrotlets.

The considerable use of arillate fruits of Euphorbiaceae and Clusiaceae among our parrot species is probably related to the greater nutritional value of such fruits relative to fleshy and juicy fruits, which are richer in carbohydrates and water but poorer in protein and fat (Galetti *et al*., 2000; Gilardi and Toft, 2012). Our observations of the feeding ecology of the four parrot species also suggest that they act as pre-dispersal seed predators as do other Psittacidae (Pizo *et al*., 1995; Villaseñor-Sánchez *et al*., 2010). All four species included seeds in their diets, some of them obtained from immature fruits. Nevertheless, the red-eared and Venezuelan parakeets could in addition act as endozoochorous seed dispersers for small-seeded tree species such as *Cecropia angustifolia* and *Guettarda crispiflora,* or may disperse them by epizoochory (Tella *et al*., 2015).

It has been suggested that the limited areas of occupancy of some endemic bird species in Venezuela are related to specific habitats or to resources available in montane areas near the coast (Boesman, 1998). The abundance of tree species with arillate seeds and heavy fruit crops, such as *Sapium stylare*, *Alchornea triplinervia* and *Tetrorchidium rubrivenium*, could be a factor influencing the distribution or movements of the scarlet-fronted parakeet in a similar manner to that seen in other South American parrots that are known to wander over large areas seeking patches of abundant and ephemeral feeding resources (Galetti, 1997; Renton, 2001; Ragusa-Netto, 2004). In Yacambú, our data indicated also that sympatric species of parakeets, such as the red-eared and scarlet fronted parakeets, may show different responses to fruit availability. Further studies of the relationship between feeding resource availability and the seasonal movements of Venezuelan parakeets are needed to elucidate their vulnerability to habitat loss.

Red-eared and Venezuelan parakeets are considered 'Least concern' species even though knowledge about their habitats, breeding requirements and populations is deficient. These species may be at greater extinction risk than the scarlet-fronted parakeet, which has been recently uplisted to 'Near-threatened' (IUCN, 2014). The two endemic species of *Pyrrhura* parakeets occur in mature montane forests, although they have a more restricted area of occupancy than the scarlet-fronted parakeet and are less abundant than in the past when flocks of 100 individuals were recorded (Fernández-Badillo *et al*., 1994). Red-eared and Venezuelan parakeets face important conservation issues due to habitat loss. They require urgent population assessments to determine their extinction risk, especially the red-eared parakeet which seems to be less tolerant of habitat fragmentation and was not recorded in Altos de Pipe. Further field efforts should focus on assessing the population sizes of parrots within Yacambú National Park and the importance of other feeding resources (e.g. dry seeds) on their abundance, as well as on confirming the presence of red-eared parakeets in nearby national parks that harbour montane forests, such as El Guache and Terepaima.

BIBLIOGRAPHY

AGUILAR, H. F. 1996. Algunas notas sobre el Perico Cabeza Roja, *Pyrrhura rhodocephala* Sclater y Salvin, 1871 (Aves: Psittacidae) de los Andes venezolanos. *Zoocriaderos*, 1: 33-48.

BIRDLIFE INTERNATIONAL. 2014. Species factsheet on-line: http://www.birdlife.org. Accessed on 14 February 2015.

BOESMAN, P. 1998. Some new information on the distribution of Venezuelan birds. *Cotinga*, 9: 27-39.

BOTERO-DELGADILLO, E., VERHELST, J. C. and PÁEZ, C. A. 2010. Ecología de forrajeo del Periquito de Santa Marta *Pyrrhura viridicata* en la cuchilla de San Lorenzo, Sierra Nevada de Santa Marta. *Ornitologia Neotropical*, 21: 463-477.

BOTERO-DELGADILLO, E., PÁEZ, C. A., SANABRIA-MEJÍA, J. and BAYLY, N. J. 2013. Insights into the natural history of Todd's Parakeet *Pyrrhura picta caeruleiceps* in Northeastern Colombia. *Ardeola*, 60: 377-383.

BRIGHTSMITH, D. J. 2005. Parrot nesting in southeastern Peru: seasonal patterns and keystone trees. *The Wilson Bulletin*, 117: 296-305.

BUITRÓN-JURADO, G. 2012. Diversidad de aves frugívoras y árboles, redes de interacción e identificación de árboles magnetos en dos bosques nublados de Venezuela con distintas condiciones de fragmentación. M. Sc. Tesis. Instituto Venezolano de Investigaciones Científicas. Caracas.

CASAÑAS, O. L. and JÁUREGUI, D. 2011. Morfoanatomía foliar de epífitas presentes en un bosque nublado, Altos de Pipe, Estado Miranda, Venezuela. *Acta Botanica Venezuelica*, 34: 153-175.

CHAPMAN, C. A., CHAPMAN, L. J., WANGHAM, R., HUNT, K., GEBO, D. and GARDNER, L. 1992. Estimators of fruit abundance of tropical trees. *Biotropica*, 24: 527-531.

CONTRERAS-GONZÁLEZ, A. M., RIVERA-ORTÍZ, F. A., SOBERANES-GONZÁLEZ, C., VALIENTE-BANUET, A. and ARIZMENDI, M. C. 2009. Feeding ecology of Military Macaw *Ara militaris* in a semi-arid region of central Mexico. *Wilson Journal Ornithology*, 121: 384-391.

FERNÁNDEZ-BADILLO, A., FERNÁNDEZ-BADILLO, E. and ULLOA, G. 1994. Psittácidos del Parque Nacional Henri Pittier, Venezuela. En, G. I. Morales, D. B. Novo, A. Luly and F. Rojas-Suárez (Eds.): *Biología y conservación de los psittácidos en Venezuela*, pp. 3-9. Gráficas Giavimar.

GALETTI, M. 1997. Seasonal abundance and feeding ecology of parrots and parakeets in a lowland Atlantic forest of Brazil. *Ararajuba*, 5: 115-126.

GALETTI, M., LAPS, R. and PIZO, M. A. 2000. Frugivory by toucans Ramphastidae at two altitudes in the Atlantic forest of Brazil. *Biotropica*, 32: 842-850.

GILARDI, J. D. and TOFT, C. A. 2012. Parrots eat nutritious foods despite toxins. *PloS one*, 7: e38293. DOI: 10.1371/journal.pone.0038293.

GOODWIN, M. L. and LENTINO, M. 1990. *Lista de las aves del Parque Nacional Yacambú. Estado Lara, Venezuela*. Sociedad Conservacionista Audubon. Caracas.

HILTY, S. L. 2003. *Birds of Venezuela*. 2nd edition. Princeton University Press. Princeton.

HINGSTON, A. B., GARTRELL, B. D. and PINCHBECK, G. 2004. How specialized is the plant-pollinator association between *Eucalyptus globulus* ssp. *globulus* and the swift parrot *Lathamus discolor*? *Austral Ecology*, 29: 624-630.

IUCN. 2014. Red list of threatened species. Version 2014.3. on-line: www.iucnredlist.org. Accessed on 14 February 2015.

JUNIPER, T. and PARR, T. 2010. *Parrots: a guide to parrots of the world*. Christopher Helm Publishers. London.

KREBS, C. J. 1999. Ecological Methodology, 2nd ed. Addison-Wesley Educational Publishers Inc. London

KRISTOCH, G. C. and MARCONDES-MACHADO, L. O. 2001. Diet and feeding behavior of the Reddish-bellied Parakeet *Pyrrhura frontalis* in an *Araucaria* forest in southeastern Brazil. *Ornitologia Neotropical*, 12: 215-223.

LENTINO, M. and PORTAS, C. 1994. Estacionalidad de los psitácidos en el uso del paso de Portachuelo, Parque Nacional Henry Pittier, edo. Aragua, Venezuela. In, G. I. Morales, D. B. Novo, A. Luy and F. Rojas-Suárez (Eds): *Biología y conservación de los psittácidos en Venezuela*, pp. 11-16. Graficas Gavimiar.

LENTINO, M. and ESCLASANS, D. 2005. Áreas Importantes para la Conservación de las Aves en

Venezuela. In, K. Boyla and A. Estrada (Eds): *Áreas Importantes para la Conservación de las Aves en los Andes Tropicales: sitios prioritarios para la conservación de la biodiversidad,* pp. 621-730. BirdLife.

LEVINS, R. 1968. *Evolution in changing environments*. Princeton University Press. Princeton.

LIU, V. J. and LYONS, J. A. 2012. Notes on the feeding activity and diet of the Blue-fronted Parrotlet *Touit dilectissima* in north-west Ecuador. *Boletin SAO*, 21: 1-5.

MACK, A. L. and WRIGHT, D. D. 1998. The Vulturine Parrot, *Psittrichas fulgidus*, a threatened New Guinea endemic: notes on its biology and conservation. *Bird Conservation International*, 8: 185-194.

MARTINS, R. L., WENDT, T., MARGIS, R. and SCARANO, F. R. 2007. Reproductive biology. In, U. Lüttge (Ed.): *Clusia: a woody neotropical genus of remarkable plasticity and diversity. Ecological Studies,* 194, pp. 73-94. Springer-Verlag.

OLACIREGUI, C. and URUEÑA, L. E. 2011. First nesting record of Blue-fronted Parrotlet *Touit dilectissimus,* with some ecological notes. *Cotinga,* 33: 84-86.

PIZO, M. A., SIMÃO, I. and GALETTI, M. 1995. Diet and flock size of sympatric parrots in the Atlantic forest of Brazil. *Ornitologia Neotropical*, 6: 87-95.

RAGUSA-NETTO, J. 2004. Flowers, fruits, and the abundance of the Yellow-chevroned Parakeet *Brotogeris chiriri* at a gallery forest in the South Pantanal Brazil. *Brazilian Journal Biology*, 64: 867-877.

RAGUSA-NETTO, J. 2007. Feeding ecology of the Green-cheeked Parakeet *Pyrrhura molinae* in dry forests in western Brazil. *Brazilian Journal Biology*, 67: 243-249.

RENTON, K. 2001. Lilac-crowned Parrot diet and food resource availability: resource tracking by a parrot seed predator. *Condor*, 103: 62-69.

RENTON, K. 2006. Diet of adult and nestling Scarlet Macaws in Southwest Belize, Central America. *Biotropica*, 38: 280-283.

RESTALL, R., RODNER, C. and LENTINO, M. 2006. *Birds of Northern South America*. Christopher Helm and Yale University Press. London.

RODRÍGUEZ, J. P. and ROJAS-SUÁREZ, F. 2008. *Libro Rojo de la Fauna Venezolana,* 3rd Edition. Provita and Shell Venezuela S.A. Caracas.

RODRIGUEZ-MAHECHA, J. V. and HERNÁNDEZ-CAMACHO, J. I. 2002. *Loros de Colombia*. Tropical Field Guides Series. Conservación Internacional. Bogotá.

SLATYER, R. A., HIRST, M. and SEXTON, J. P. 2013. Niche breadth predicts geographical range size: a general ecological pattern. *Ecology Letters*, 16: 1104-1114.

TELLA, J. L., BAÑOS-VILLALBA, A., HERNÁNDEZ-BRITO, D., ROJAS, A., PACÍFICO, E., DÍAZ-LUQUE, J. A., CARRETE, M., BLANCO, G. and HIRALDO, F. 2015. Parrots as overlooked seed dispersers. *Frontiers in Ecology and the Environment*, 13: 338-339.

TOYNE, E. P., JEFFCOTE, M. T. and FLANAGAN, J. N. 1992. Status, distribution and ecology of the White-breasted Parakeet *Pyrrhura albipectus* in Podocarpus National Park, southern Ecuador. *Bird Conservation International*, 2: 327-339.

TRONCOSO, F., VAN DER WOLF, P. A. and AHUMADA, J. A. 1995. The Lilac-tailed Parrotlet *Touit batavica*, a new record for Colombia. *Caldasia*, 18: 147-148.

VICENTINI, A. and FISCHER, E. A. 1999. Pollination of *Moronobea coccinea* Clusiaceae by the Golden-Winged Parakeet in the Central Amazon. *Biotropica*, 31: 692-696.

VILLASEÑOR-SÁNCHEZ, E. I., DIRZO, R. and RENTON, K. 2010. Importance of the Lilac-crowned parrot in pre-dispersal seed predation of *Astronium graveolens* in a Mexican tropical dry forest. *Journal Tropical Ecology*, 26: 227-236.

WALKER, J. S. 2006. Resource use and rarity among frugivorous birds in a tropical rain forest on Sulawesi. *Biological Conservation*, 130: 60-69.

XENO-CANTO FOUNDATION. 2012. Xeno-canto America: Bird sounds for the Americas on-line: http://www.xeno-canto.org