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Colony breeding of the Pacific Parakeet *Aratinga strenua* Ridgway 1915 in the Volcán Masaya National Park, Nicaragua

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A colony of Pacific Parakeet *Aratinga strenua* Ridgway 1915 was studied at Volcán Masaya National Park in Nicaragua from 1993 to 1994. The parakeets nested in two craters of the Nindirí Volcano. They excavated their nests in the soft dirt of volcano wall. The parakeets started to roost in the volcano at the end of the dry season. They nested once a year, in the rainy season, and gradually left the volcano towards the end of that season as their young fledged. A good method for estimating the population would be simultaneous direct counts carried out at fixed points along the parakeets' flight paths into the volcano in June, when the birds have returned to their breeding grounds but have not yet started to lay eggs. All of the parakeets leave the volcano in the morning and can be counted in the afternoon when they come back from their feeding grounds.

KEY WORDS: Pacific parakeet, *Aratinga strenua*, Nicaragua, nesting, roosting, census.

INTRODUCTION

The Pacific Parakeet *Aratinga strenua* Ridgway 1915 ranges along the Pacific slopes of Central America from Oaxaca, Mexico, to southwest Nicaragua (SIBLEY & MONROE 1990). Psittaciformes is a very homogeneous group, and parrots have always proven difficult to classify. SIBLEY & MONROE (1990) treat the Pacific Parakeet as a separate species, while FORSHAW (1989) considers it a subspecies of the Green Parakeet *Aratinga holochlora* Sclater 1959. The Pacific Parakeet has nested in two craters of an active volcano in Volcán Masaya National Park since at least the 16th

Century (SALAS et al. 1992). In Nicaragua, the birds feed on fruit pulp and seeds and, to a lesser extent, on flowers as well (WERMUNDSEN 1997).

No details of the nesting and roosting behaviour nor of population sizes of the Pacific Parakeet have been recorded. The species is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and data are required on its populations, density and productivity to ensure that trade remains sustainable (WIJNSTEKERS 1995). International trade threatens many neotropical parrot populations, but the lack of information on the population ecology of most of the species has made it impossible to set reasonable export quotas (THOMPSEN & MULLIKEN 1992). It is important to design methods to estimate psittacid populations, but this task is difficult because many species range widely in their daily activities and occur in large flocks. Indirect methods based on number of flocks seen (average encounter rate) and mean flock size have been applied, but, unfortunately, both measures can vary daily (CANNON 1984, CHAPMAN et al. 1989, BLAKE 1992). Furthermore, the numbers of psittacids fluctuate according to the availability of food resources (THERBORG et al. 1990). SNYDER et al. (1982) and GNAM & BURCHSTED (1991) have used direct counts to estimate population sizes of the Bahama Parrot *Amazona leucocephala* Linnaeus 1758. The present study provides new information on the nesting and roosting behaviour of the Pacific Parakeet and suggests a technique for measuring the size of its population.

STUDY AREA AND METHODS

The study was carried out at Volcán Masaya National Park (12.0°N, 86.2°W) in Nicaragua between May 1993 and March 1994. The park is situated in a caldera, a roughly oval, steep-walled basin 6 to 12 km in diameter. Calderas originate through the collapse of a volcanic cone following eruption and the partial emptying of a magma chamber (SKINNER & PORTER 1992). The Nindirí Volcano, where the Pacific Parakeet nests, is situated in the middle of the caldera. The volcano is active and emits gases. The principal gas coming from a volcano is water vapour; together with carbon dioxide, it accounts for more than 98% of all volcanic gases. Other gases emitted include nitrogen, chlorine, sulfur, and argon, which are rarely present in amounts exceeding 1% (SKINNER & PORTER 1992). At times, Nindirí emits large amounts of sulfur dioxide gas. The area is tropical dry forest surrounded by agricultural land. Some areas of the park are barren because of earlier lava eruptions and volcanic gases. The climate of the region is characterized by two distinct seasons: a wet season from May to October and a dry season from November to April when most trees lose their leaves. Annual rainfall averages 1500 mm (SALAS et al. 1992).

Four nests were visited every second day in the Nindirí Volcano using technical climbing gear, ladders and a flashlight. When nestlings were 10 to 14 days of age, four nests were observed from 06:00 hr (before the parakeets woke up) until 13:00 hr and from 13:00 hr until 19:00 hr (after the parakeets started to roost). A total of 132 hr of observations were carried out.

The parakeets flew into the Nindirí Volcano through four permanent entrances and were counted simultaneously at fixed points near these entrances (Fig. 1). At each station, observers recorded the number of parakeets seen, the direction of their flight and the time of their detection. As in most gregarious parrot species, pairs and family groups were easily discernible within flocks since they flew very close to each other. The numbers of single birds in flocks were recorded. Parakeets were counted from 14:00 hr until sunset, with observations totalling 115 hr. One observer monitored the volcano from 06:00 hr to determine if the parakeets visited the volcano in the daytime. Comparisons of the numbers of roosting parakeets were carried out using a Mann-Whitney U-test, because the data were not normally distributed.

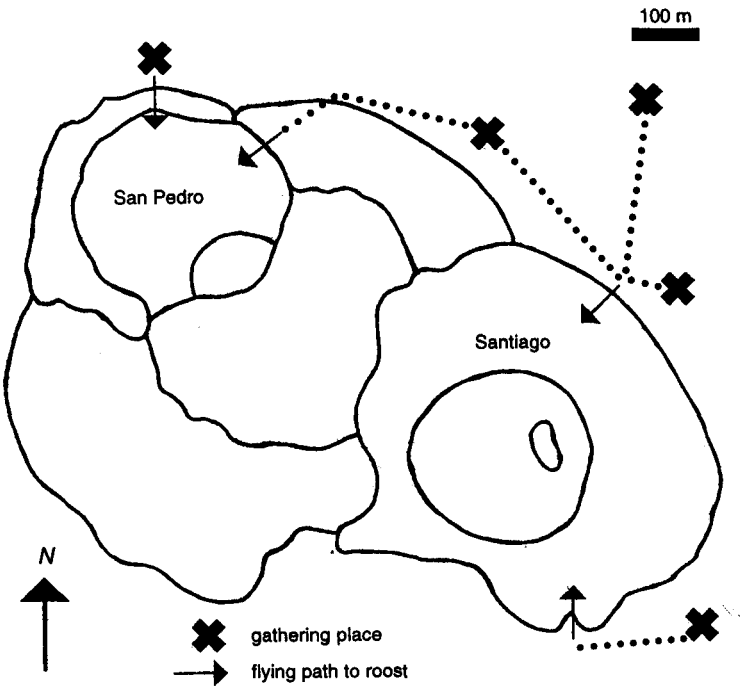

Fig. 1. — Parakeets usually landed on a tree or a group of trees before continuing into the craters. These assembly points were situated close to the volcano. Each crater had two permanent entrances.

RESULTS

The number of parakeets roosting in the Nindirí Volcano varied from 0 to 2231 (Fig. 2). Fig. 3 shows the events in the Pacific Parakeet year. From October to June, parakeets left the craters in the morning and came back in late afternoon. In the daytime there were no parakeets in the volcano. From May to June the number of parakeets counted was 2022 ± 115 (n = 6) (Fig. 2).

The parakeets nested in the rainy season. Egg-laying took place in July, when the number of birds counted decreased (Fig. 2). From July to September the number of birds counted was 1543 ± 169 (n = 7), a figure significantly less than that for May and June (Mann-Whitney U test, $\chi^2 = 9.0248$, df = 1, $P = 0.0027$). The percentages of single birds in flocks (Fig. 4) were significantly higher ($\chi^2 = 7.5342$, df = 1, $P = 0.0061$) in July and August ($\bar{x} = 10.6 \pm 1.9$, n = 5) than in May and June ($\bar{x} = 5.5 \pm 1.0$, n = 6). Further, from July to September, the parakeets visited the craters throughout the day.

The number of roosting parakeets dropped gradually towards the end of the year, when the birds began to roost in trees outside the park area, and no parakeets were observed roosting in the volcano. At the beginning of the year, the number of roosting parakeets gradually started to raise (Fig. 2).

Some parakeets left the volcano and flew westwards at sunset (Fig. 5). Before leaving, the group flew in a circle within the volcano and called loudly, attracting more birds to join the group. More than 90% of these parakeets were paired in every count.

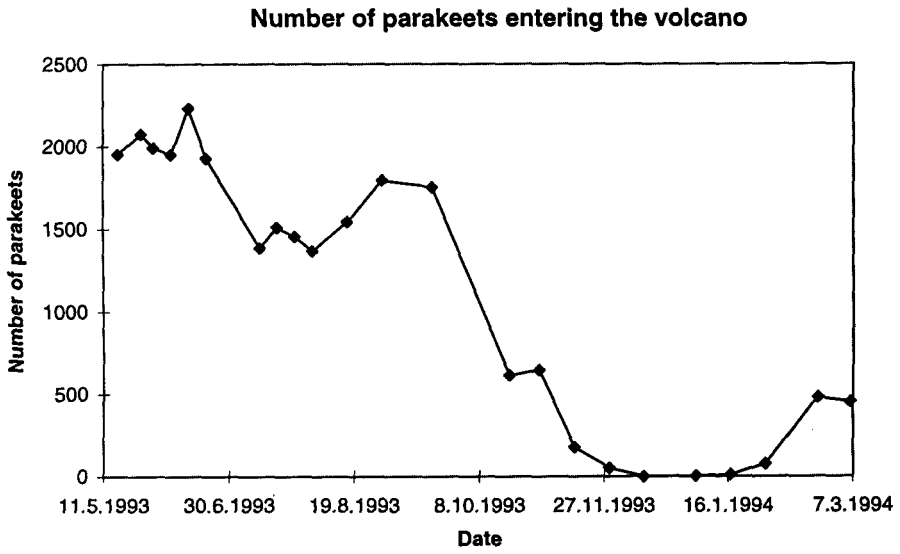

Fig. 2. — The number of Pacific Parakeets in each count. Pacific Parakeets were counted along their flight paths into the craters.

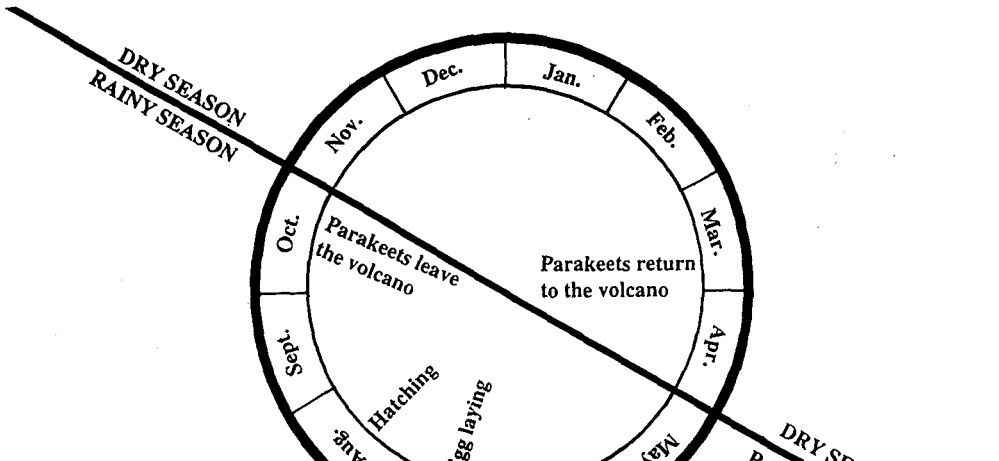

Fig. 3. — A year in the life of the Pacific Parakeet. Parakeets occupied the volcano in the rainy season but were absent in the dry season.

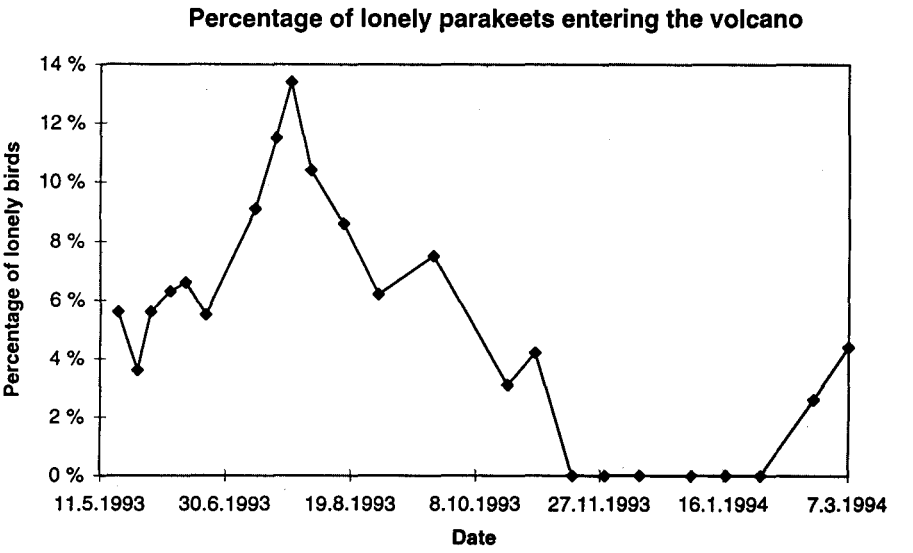

Fig. 4. — The percentage of single birds entering the volcano. Pairs, family groups and single birds were easily discernible within the Pacific Parakeet flocks. In flocks of gregarious parrots, members of pairs and family groups fly very close to each other.

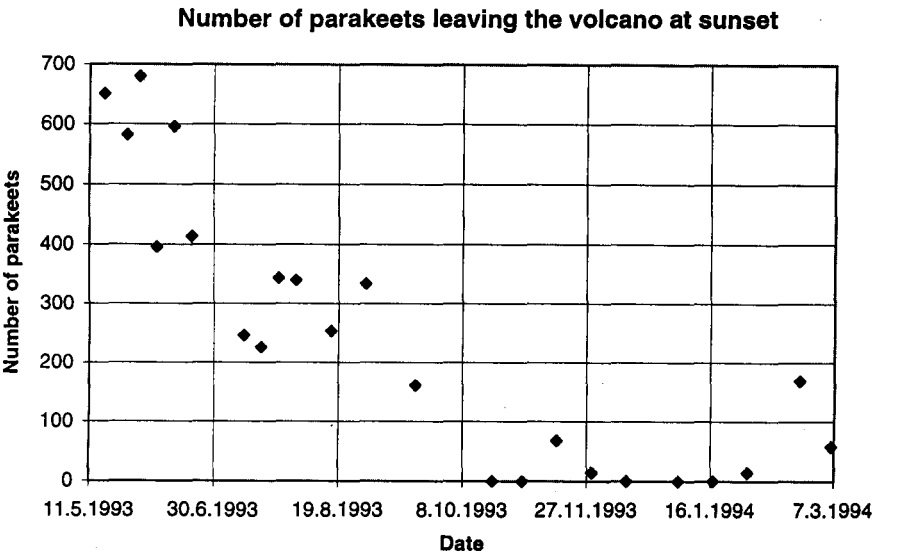

Fig. 5. — Just before sunset, some parakeets left the volcano and flew westwards.

The parakeets dug their roosting/nesting holes in the soft dirt of the volcano wall. Nests were tunnels, 120 to 300 cm in length, that terminated in a nesting chamber (Table 1). The nesting pairs that were observed used holes dug in previous seasons but they enlarged the holes by 42 ± 39 cm (range = 15-100 cm, n = 4) after hatching. Each tunnel was occupied by a single pair. The parakeets did not use nesting material but, rather, deposited their eggs in a hole in the ground. With the exception of one pair, the eggs were not visible from the nest entrance. Eggs hatched

in August (range = 9 August-18 August, n = 10). The development of the nests is reported in Table 1. Chicks fledged in late September and in early October (range = 29 September-2 October). Fledging occurred 51 ± 2 (range = 50-54, n = 5) days after hatching. In Nicaragua, the Pacific Parakeet also nested in crevices among rocks, holes in banks and, on rare occasions, in hollows in trees. One individual, recognizable because of yellow feathers on its head, occupied the same tunnel in 1993 and 1994 with its mate.

Table 1.
Pacific Parakeet nests.

Nest	Length (cm)	Entrance		Chamber		Number of eggs	Number of chicks	Number of fledglings
		Width (cm)	Height (cm)	Width (cm)	Height (cm)			
1	300	40	10	60	15	2	2	2
2	228	50	10	55	19	2	2	0, no renesting
3	120	23	10	40	20	3	3	3
4	168	30	25	40	30	4	3	0, no renesting

The males and the females searched for food and visited their nests together 5 times a day 10 to 14 days after the eggs had hatched. Between 06:00 hr and 13:00 hr nests were visited 3 times (SD = 0, totalling 84 hr at four nests) and between 13:00 hr and 19:00 hr twice (SD = 0, totalling 48 hr at four nests). On average, parents stayed in the nest 23 ± 16 min (range = 7-55, n = 30). Between 6:00 hr and 13:00 hr flights averaged 118 ± 32 min (range = 68-169 min, n = 24). The day's fourth flight was long, averaging 251 ± 13 min (range = 235-267, n = 8); the last flight of the day was short, lasting 42 ± 9 min (range = 31-55, n = 8).

American Kestrels *Falco sparverius* Linnaeus 1758 and Black Vultures *Coragyps atratus* Bechstein 1783 were mobbed by the parakeets in the volcano area during the breeding season. Outside the breeding season, American Kestrels and Grey Hawks *Asturina plagiata* Schlegel 1862 attacked adult parakeets, causing mass flight from the craters.

CONCLUSIONS

The Pacific Parakeet nests in a toxic environment of volcanic gases, but the volcanic walls provide soft dirt in which the birds can easily dig their nesting tunnels. Landslides frequently cause the nest entrances to collapse, and the parakeets must continuously enlarge their tunnels.

The Pacific Parakeet excavates nests which penetrate up to 3 m into the soft dirt of the volcano wall and terminate in a nesting chamber like those dug by the Patagonian Conure *Cyanoliseus patagonus* Vieillot 1818 (Forshaw 1989). However, there were no interconnections between different nests. The Pacific Parakeet nested once a year, in the rainy season. The entire breeding population occupied the craters 2 months before laying eggs and left the breeding site gradually, as the young fledged. This behaviour is similar to that of the Patagonian Conure (Bucher et al. 1987). The

Pacific Parakeets fed their young regularly — 5 times a day — unlike the Green-rumped Parrotlet *Forpus passerinus* Linnaeus 1758 (WALTMAN & BEISSINGER 1992).

Like some other birds nesting in colonies, e.g. the Common Starling *Sturnus vulgaris* Linnaeus 1758, the Silvery-Cheeked Hornbill *Ceratogymna brevis* Friedmann 1929, and the Asian Glossy Starling *Aplonis panayensis* Scopoli 1783 (WARD & ZAHAVI 1973), the parakeets in the present study gathered in a tree or a group of trees before entering the volcano. At sunset, some of the birds left the craters. CHAPMAN et al. (1989) have recorded that some mixed-species parrot flocks in Costa Rica leave their roosting site in a similar way. It seems that not all the Pacific Parakeet pairs were nesting, since more than 90% of the birds leaving were paired in each count. Many parrot species, for example macaws (MUNN 1992), do not nest yearly.

As the Pacific Parakeets have permanent entrances to the craters, a good method for estimating the size of their population would be simultaneous direct counts at fixed points along these flight paths. The best season in which to estimate the Pacific Parakeet populations in Nicaragua would be in June; at that time the parakeets have returned to their breeding grounds but have not yet started to lay eggs, and all of the birds leave the volcano in the morning and come back in late afternoon. The best time to count parakeets would be from afternoon till sunset, when the birds come back from their feeding grounds.

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