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DISTRIBUTION AND DRY-SEASON ECOLOGY OF PFRIMER'S CONURE *PYRRHURA PFRIMERI*, WITH A REAPPRAISAL OF BRAZILIAN *PYRRHURA "LEUCOTIS"*

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Resumo. Pyrrhura pfrimeri é uma espécie pouco conhecida pertencente ao grupo *leucotis*, endêmica das florestas secas decíduas que crescem em solos derivados de calcário e maciços rochosos em uma área limitada a oeste da Serra Geral, Brasil Central. A espécie tem uma das menores distribuições geográficas entre os psitacídeos neotropicais. Durante o início da estação seca os periquitos alimentam-se principalmente de flores e sementes, utilizando figos no final da estação. A reprodução parece ocorrer no final da estação seca. Devido à sua distribuição restrita e à destruição rápida de seu habitat a espécie deve ser considerada ameaçada de extinção. As diferenças morfológicas e ecológicas, bem como as distribuições alopátricas dos três taxa brasileiros classificados como *Pyrrhura leucotis* são marcantes o suficiente para lhes dar status específico pleno.

Abstract. Pfrimer's Conure *Pyrrhura pfrimeri* is a poorly known taxon belonging to the *leucotis* species group. The species is endemic to central Brazil, where it is locally common, but restricted to dry, deciduous forests growing on limestone-derived soil patches and rocky massifs west of the Serra Geral, giving it one of the smallest distributions among Neotropical parrots. During the early dry season, the conures feed heavily on flowers and seeds, switching to figs later in the year. Breeding seems to occur in the early rainy season. Owing to its limited distribution and the rate of habitat destruction, *P. pfrimeri* should be considered threatened with extinction. The morphological and ecological differences and allopatric distributions of three Brazilian taxa grouped under *Pyrrhura "leucotis"* are marked enough to give them full specific status. *Accepted 20 March 1997.*

INTRODUCTION

Pfrimer's Conure *Pyrrhura pfrimeri* was described by Miranda-Ribeiro (1920), based on an undesignated type from Santa Maria de Taguatinga, present-day Taguatinga do Tocantins (12°26'S,45°40'W), central Brazil. Later, Berla (1946) designated the lectotype and paralectotypes of the taxon and treated it as a subspecies of *Pyrrhura leucotis*. This treatment was challenged by da Silva (1989, 1995), who considered the form sufficiently distinct and geographically isolated to warrant full specific status; he considered it one of the endemic species of the dry deciduous forests growing between the São Francisco and Araguaia rivers in Brazil. Nothing has been reported on the ecology of *P. pfrimeri* and even its distribution is poorly understood, as most authors (Vriends 1979, Forshaw & Cooper 1989, Arndt 1993) consider it known only from the type locality, evidently ignoring Pinto (1938), who listed specimens from localities other than the typical one. Here we describe the distribution and habitat of Pfrimer's Conure, provide the first observations on its ecology and comment on its taxonomical status and relationship with other endemic Brazilian taxa grouped with *Pyrrhura leucotis*.

METHODS

Localities where *P. pfrimeri* was known to occur or to have occurred, as documented by collected specimens housed in the Museu de Zoologia da Universidade de São Paulo (MZUSP) and by da Silva (1989), plus intervening areas of suitable habitat, were visited in 14–23 June and 27 October – 03 November 1995. More time was spent at two localities, Nova Roma and São Domingos (Fig. 1) to obtain ecological data. In each locality, searches for conures were made by walking along transects through natural vegetation patches and adjacent anthropogenic habitats. Every conure observed or heard was recorded, as was additional data including group size and habitat type (dry forest, riverine forest, *cerrado*, pasture, disturbed

areas). Habitat categories followed RADAMBRASIL (1989). Whenever a group of parrots was observed perched or feeding, plant food species, part eaten (flower, seed, fruit pulp or whole fruit), presence and number of juveniles and general behavior were recorded.

Each time a group of conures was found eating we recorded a feeding bout. Different groups congregating at a food source could generally be told apart as they arrived or departed, because they did not mingle while flying (despite doing so while feeding); in this case we recorded one feeding bout for each group. We attempted to infere habitat preferences and relative abundances of the conures by censusing them along line transects. Transects in each habitat were walked at least twice; total distances covered, as recorded with the aid of a pedometer, were 45.7 km in June and 57.5 km in October–November. Of these, 29.8 km were in areas where *P. pfrimeri* did not occur, and they are excluded from analyses. In all, 50.8 km were walked through dry forest, 19.3 km along a mosaic of pasture and small forest fragments, and 3.5 km along selectively logged riverine forest (the only area of this habitat we could find). To calculate relative population densities, we considered transect width to be 60 m in dry forest and more open areas and 20 m at the vine-tangled riverine forest.

We assessed the species' geographical distribution by visiting localities where it had not been previously recorded but with the seemingly suitable habitat type, based on the localities where we observed the conures. We also visited adjacent areas harboring different plant communities. We examined the area from Iaciara north to Campos Belos along the western foothills of the Serra Geral (Fig. 1), plus a exploratory visit to dry forests between Barreiras and Formosa do Rio Preto on the eastern side.

Specimens of *Pyrrhura leucotis* ssp. (7 *pfrimeri*, 15 *leucotis*, and 12 *griseipectus*, Appendix 1) housed in the Museu de Zoologia da Universidade de São Paulo (MZUSP) were examined and measured with calipers to the nearest mm. Because of the small sample size sexes were pooled. We measured wing and tail length, bill length from tip to the joint of the upper maxilla, bill width at its base, and mandibular height at the base. During analyses we discarded tail measurements from the analyses because of the large number of tail-damaged specimens in the sample.

RESULTS AND DISCUSSION

Habitat and Distribution. Pyrrhura pfrimeri is restricted to semi-deciduous (riverine) or deciduous (dry) forests growing on limestone outcrops or limestone-derived soil patches from Taguatinga de Goias south to Iaciara, a stretch about 300 km long and, at some points, only 30 km wide along the foothills west of the Serra Geral massif (Fig. 1, 2). This limestone patch, pre-Cambrian in age, was exposed by the erosion of the more recent sandstone and quartzite deposits that covered it and of which the Serra Geral and the Chapada dos Veadeiros are examples (RADAMBRASIL 1989). The climate in the region is seasonal, with a dry season extending from May to September and an average annual precipitation around 1,300 mm (RADAMBRASIL 1989). During 1994 a pronounced drought affected all of Brazil; the rains began 3—4 months later than usual, while in 1995 the rains were also late, with no substantial precipitation being recorded up to early November. Whereas most of central Brazil is covered by *cerrado* (savanna) vegetation, the more fertile limestone-derived soils support forests presenting an almost continuous canopy 15—20 m high. That canopy is dominated by *Tabebuia impetiginosa* (Bignoniaceae), *Astronium urundeuva* (Anacardiacea), *Pseudobombax grandiflorum., Chorisia venticosa, Cavallinesia arborea* (Bombacaceae), *Caesalpinea ferrea, Enterolobium contortisiliquum, Copaifera langsdorfii, Piptadenia* sp. (Leguminosae), with occasional emergents 25 m or more high (mostly *Cavallinesia arborea.*). A dense undergrowth of lianas and, in some areas, bamboo (*Actinocladum* or *Guadua* spp.) occurs in the more disturbed patches. On rocky outcrops several species of columnar cacti and terrestrial bromeliads occur, in an association much like that found in semi-arid northeastern Brazil (see Ratter *et al.* 1978, RADAMBRASIL 1989). In fact, Ratter *et al.* (1978) considered similar forests on the eastern side of the Serra Geral as representing an arboreal type of *caatinga*, the xeric deciduous formation endemic to northeastern Brazil (Rizzini 1979). The habitat of *Pyrrhura pfrimeri* (Fig. 3) represents a *caatinga* forest island amid the *cerrado*, a con-

clusion supported by the presence there, but not in surrounding cerrado, of bird species endemic to the caatinga, e.g., Great Xenops (*Megaxenops parnaguae*), Scarlet-throated Tanager (*Compsothraupis loricata*), and White-naped Jay (*Cyanocorax cyanopogon*) (pers. obs.). These dry forests are quite distinct from the surrounding savanna (for a description of cerrado see Eiten 1972, 1982), their presence on the limestone patches probably arising from a combination of more fertile soils

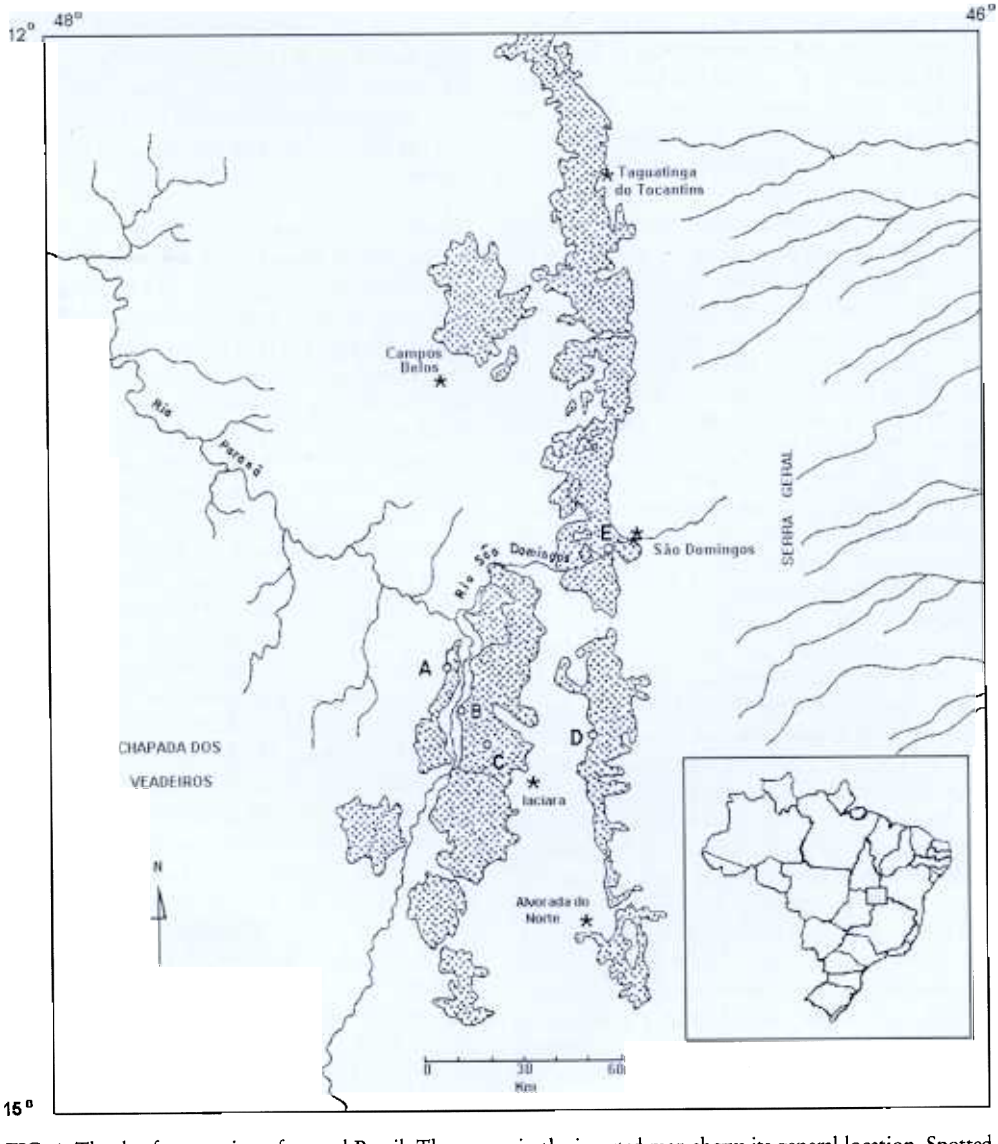

FIG. 1. The dry forest region of central Brazil. The square in the inserted map shows its general location. Spotted areas represent the original extent of forest, now greatly reduced, at the foothills of the Serra Geral. Dots represent localities where *Pyrrhura pfrimeri* has been observed: A) Nova Roma (13°50'S, 46°52'W); B) Riverine forests of the rio Paranã (13°55'S, 47°00'W); C) Fazenda Salobro (14°05S, 46°47W); D) Guarani de Goiás (14°01'S, 46°31'W); E) Fazenda Floresta (13°27'S, 46°29'W).

and, perhaps, more efficient drainage patterns (Ratter *et al.* 1978).

During the two periods we visited the area, both in the dry season, most trees had shed their leaves, except for the uncommon *Ficus* and some species of legume. A few tree species were in flower. This was especially evident in June, when the purple flowers of the abundant *Tabebuia impetiginosa* tinged whole stretches of forest and could be used as a visual aid to locate dry forest patches. This contrast is striking in the São Domingos region, where the forested limestone hills raise quite abruptly from the surrounding *cerrado*-covered plain.

Pyrrhura pfrimeri was found in every patch of dry forest we surveyed (Fig. 1), even in some quite degraded patches near Nova Roma and São Domingos, and it is probable that its distribution is continuous wherever forest survives. In surveys made in the surrounding *cerrado* and east of the Serra Geral, between Barreiras (12°S, 45°W) and Formosa do Rio Preto (10°57'S, 45°05'W), where a somewhat different kind of dry forest occurs, we failed to find the species, despite walking 23.6 km of transects. The only similar-sized parrots found in these areas were the Peach-fronted Conure (*Aratinga aurea*), widespread all over the *cerrado* and also in forest near Formosa do Rio Preto, and the Cactus Conure (*A. cactorum*) found only east of the Serra Geral in lower and drier vegetation. Apparently *Aratinga aurea* avoids areas of continuous dry forest, entering only fragmented and disturbed patches, thereby suggesting a degree of ecological segregation between this species and *P. pfrimeri*.

The dry forests east of the Serra Geral from Minas Gerais to Bahia have been ornithologically explored, starting with Spix in the last century, but no *Pyrrhura* has been found there (da Silva 1989). That is puzzling considering that the taxon geographically, closest to *P. pfrimeri* is *P. leucotis* from eastern Brazil's coastal forests (see below) and some related taxa linking them would be expected to occur in the intervening area east of the Serra Geral, especially with the similarities between the forests there and to the west.

At Nova Roma dry forest and dense *cerrado* vegetation meet in a quite abrupt transition, with *cerrado* growing atop a quartzite massif and dry forest on the foothills and surrounding plain. We did not observed *P. pfrimeri* in the *cerrado*, despite that representing a flying distance of less than one kilometer. In addition, many cultivated fruiting mango trees atop the massif attracted hundreds of Canary-winged Parakeets (*Brotogeris versicolorus*) that came from the forest during the morning and spent the whole day feeding there. *Pyrrhura pfrimeri*'s reluctance to come to these trees was all the more surprising because during the period (November) the forest was almost completely dry and there were few fruiting trees, and the species does feed on cultivated crops (see below).

Group Size and Population Densities. Group size in June ranged from 2 to 32, with a mean of 12.6 (SD = 6.93, n=36 sightings). The largest groups may have resulted from the fusion of smaller groups, as observed in a large agregation of over 50 conures, not included in our analyses, that were feeding on cultivated rice (see below). In October–November group size ranged from 2 to 33 (mean=12, SD = 8.09, n=26), not being statistically different from the previous period ($t=0.759$, $P>0.05$). Fledglings (begging youngsters) were observed only in June.

In dry forest areas conure relative densities (pooled data from June and October–November totaling 602 individual sightings) averaged 197.66 individuals/km^2 (11.9 individuals/walked km), wheres in nearby pasture-isolated forest it was only 23.4 individuals/km^2 (1.4 individuals/walked km, or only 27 recorded individuals), and all conures were observed on the few remaining forest blocks left on the pasture. We think results for the dry forest censuses are somewhat of an overestimate, because in June one of the main food plants of the conures was a ruderal that grew mostly along the tracks used as transect line. In October–November most, if not all, of the conures at Nova Roma (where all the censuses were conducted in the period) were gathering to feed in a sole fig tree (*Ficus gomeleira*) near the track. Although those facts probably induced errors in absolute population estimates because the conures congregated along the transect tracks, the data is useful to compare the relative densities among habitats and show that conures are far less common in fragmented habitat. In the riverine forest we found only one

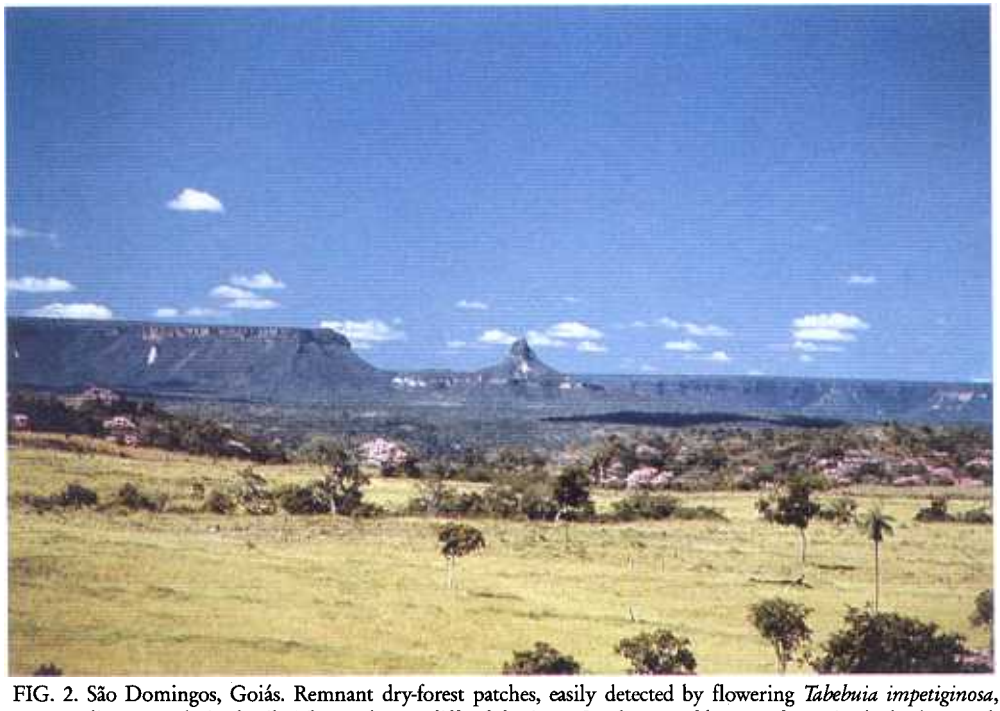

FIG. 2. São Domingos, Goiás. Remnant dry-forest patches, easily detected by flowering *Tabebuia impetiginosa*, grow on limestone-derived soils. The sandstone cliffs of the Serra Geral, covered by *cerrado*, are in the background.

group with 11 conures, sampling being too small for comparisons.

Censusing conure groups at Nova Roma as they flew from their feeding trees to roost on the limestone hills during sunset produced a probable total population of 120—150 individuals for the whole area (around 2 km² of forest) or 60—75 individuals/km², probably a more accurate figure than the estimate from the transects.

Overall, *Pyrrhura pfrimeri* is fairly easily found wherever dry forest persists, and, in fact, it is the commonest parrot in this habitat, being observed even in disturbed and fragmented forest patches. Our observations suggest that Pfrimer's Conure is able to persist and even breed in small forest fragments, although in very reduced numbers. But considering that widespread deforestation is a recent phenomenon in its area of occurence it is possible such isolated groups will be unable to persist in the long term, especially as such remnants are vulnerable to fire and continue to be selectively logged (see Conservation).

Food Habits and Behavior. A total of 46 feeding bouts were recorded in June, plus 25 in October–November. We noted striking differences in food plants eaten in the two periods. The flowers of *Tabebuia impetiginosa* were eaten in 43 % of all feeding bouts observed. The conures spent hours picking one flower at a time, chewing around its base, discarding it and repeating the process, usually ignoring the approach of an observer right to the base of the food tree. The second most important item (33 %) were the immature seeds of *Hyptis* sp. (Labiatae), an introduced ruderal herb very common along the dirt roads and tracks. The conures came to the ground to feed on *Hyptis*. Other food items during the period were the catkins of *Cecropia* sp. (Cecropiaceae), the fruits of *Ficus gomeleira* (Moraceae) and *Psidium guajava* (Myrtaceae), and the flowers of a *Bauhinia* sp. (Leguminosae), each accounting for 6 % of the feeding bouts. All figs we opened were heavily infested by Agaonidae wasps, and these probably contributed protein to the diet in a season when the birds had

dependent fledglings. This also suggests that the record of a *Pyrrhura leucotis* with a crop full of insects (Schubart *et al.* 1965) may represent a case of deliberate, rather than accidental, ingestion (see also Martuscelli 1994 for another instance of insect-eating).

Pyrrhura pfrimeri came to the vicinity of human habitations to feed on the fruit pulp of cultivated Guava (*Psidium guajava*) but the seeds were discarded. Our calculations did not include the observation of c. 50 conures feeding on cultivated rice *Oryza sativa* because we could not be sure of how many different groups gathered there. As when feeding on *Hyptis*, the conures came to the ground to feed on the mature seeds, while several sentinels kept watch in the nearby trees and shrubs.

In October–November the conures were observed to feed mainly on the fruits of *Ficus gomeleira* (72 %), but also on the fruit pulp of a *Pouteria* sp. (Sapotaceae, 12 %) and the inflorescences of *Maclura tinctoria* (Moraceae, 8 %). Odd items were young leaves of *Astronium urundeuva* and shoots of a *Psittacanthus* sp. (Loranthaceae, 4 and 8 % respectively). Over 120 conures would congregate in the area's sole fruiting fig tree, spending most of the day in its vicinity. Figs were the most important resource during this period, with all conures in the area feeding from a single tree. Like other *Pyrrhura* (Roth 1984, Forshaw & Cooper 1989, Pizo *et al.* 1996), *P. pfrimeri* uses abundant food resources clumped both in time and space, with different groups congregating to share the resource, and showing a preference for soft items. Flowers, mainly large ones with abundant nectar, have been recorded as a food item of some importance for the rainforest *Pyrrhura picta*, & *P. perlata* (Roth 1984) and *P. albipectus* (Krabbe & Sornoza 1994), and as making 25 % of the diet of *P. frontalis* (Pizo *et al.* 1996), but were absent from the diet of *P. leucotis* in the lowland humid forests of Espirito Santo, where it was found to feed only on soft fruit and seeds, especially *Cecropia* spp. (Simão *et al.* 1998), suggesting an interesting ecological difference between *leucotis* and *pfrimeri*.

Although there are few quantitative data on the importance of flowers for Neotropical parrots, this resource may be critical to species or populations inhabiting seasonal forests with a marked dry season (Galetti, pers. com.). In the case of *Pyrrhura pfrimeri* it is clear that flowers are important in a season when there are few alternative food sources, accounting for 53 % of feeding bouts in June, much as has been shown for *Pionus maximiliani* living in semi-deciduous forests in southeastern Brazil (Galetti 1993). Besides *Tabebuia impetiginosa*, some of the most common trees in the dry forest, like *Pseudobombax grandiflorum*, *Chorisia venticosa*, and *Cavallinesia arborea*, flower gregariously in the dry season and present large and nectar-rich flowers, providing additional food sources after the flowering of *Tabebuia* has ended. The abundance of nectar-rich species that flower during the dry season and the presence of fig trees, resources that are absent from the surrounding cerrado vegetation, explain the existence of a conure belonging to a rainforest group inhabiting a seasonal, even xeric, habitat.

All feeding bouts were observed in forests growing over flatter ground; none was observed during transects in the limestone outcrops. At Nova Roma, where more extensive observations were made, the conures flew in early morning from the higher parts with exposed rock to the base of the hills and surrounding plain to feed, returning at dusk. This pattern was consistent and, coupled with the observation that forest on flatter ground is less xeric (Ratter *et al.* 1978) suggests that the combination of flatter ground and foothill forest may be critical for the survival of the conures.

The observations of *Pyrrhura pfrimeri* feeding at ground level are somewhat surprising, as most species in the genus are restricted to the canopy (Vriends 1979, Roth 1984, Forshaw 1989); feeding on the ground is similar to some small *Aratinga* conures like *A. cactorum* and *A. aurea* (pers. observ.). Feeding on the ground has obvious advantages in the seasonal dry forest, where the diversity of resources at any one time is limited.

Like other *Pyrrhura*, *P. pfrimeri* is a noisy bird and groups were usually first detected by their calls. In June, when fledglings were present, their continuous begging was the best clue to locate groups. *Pyrrhura pfrimeri* flies at or below canopy level, dashing among the trees, and perching both in the crowns and at lower levels. We observed groups perched on very exposed dry small trees amid pasture, the conures flying

comparatively low (3—6 m) over such open areas. Conures feeding on the ground or at low levels displayed an evident sentinel system, one or more conures always being positioned atop a nearby tree. Sentinels gave alarm calls, causing the group to fly, as soon any possible threat was detected. The conures were also observed to flee after a group of Jandaya Conures (*Aratinga jandaya*) distressed by a soaring Black-and-White Hawk-eagle (*Spizastur melanoleucus*) gave alarm calls. Another conure group with young fled from approaching White-naped Jays (*Cyanocorax cyanopogon*).

Mating was observed in June. A pair was engaged in allopreening when the male embraced the female with his left wing and leg and half-mounted her; the female lowered its body and raised and twisted her tail out of the way of the male's vent. The male did not grab the female with his bill. The remainder of the group kept feeding with no overt notice of the copulation. The presence of several individuals with worn tails in October–November suggests that they could be nesting during that period. Nest sites were not found but because the conures always flew towards exposed limestone outcrops during sunset and one male collected in July (MZUSP 15765) shows a worn tail with encrusted soil, it is possible this conure nests in rock cavities, which are very common in the area (pers. observ.).

We were unable to find the exact spots the conures spent the night and therefore were unable to assess if the whole group sleeps in a cavity, as *Pyrrhura picta* (Roth 1984) and *P. leucotis griseipectus* (pers. observ.), but from their behavior at sunset we believe it is likely.

That young were observed in June suggests that breeding occurs in the late rainy season to early dry season (April–May). Nevertheless, 1994 and 1995 were drought years in Brazil, with the rains being late by several months and causing most bird species either to forgo breeding or to breed later than usual (pers. observ.). The same probably happened with *P. pfrimeri*. The observations of birds with worn tails in November, just when the very first rains, late by two months, were falling, support the view that the birds adjust their breeding cycle to the rain patterns.

FIG. 3. A pair of *Pyrrhura pfrimeri* feeding on cultivated guava *Psidium guajava* at Fazenda Floresta. Notice the absence of the auricular patch and the extent of blue in the head.

Most pairs that bred produced two fledglings, as observed in June, but we also observed pairs with three young. Overall, fledglings made up only 20.6 % of the individuals of the 6 groups we could positively identify and count them, suggesting most pairs had not bred or were unsuccessful during the 1994—1995 breeding season.

Conservation. The greatest, and most pressing, threat to the survival of *Pyrrhura pfrimeri* is habitat destruction, as limited trade or persecution has been detected. Few Brazilian aviculturists have the species in their collections, and few conures are in captivity. The conures reportedly have been bought from bird dealers based at Brasília, the country's capital (N. Kawall, pers. com.). If trading continues at this low level it is unlikely to be a source of concern in the short-term. That can change, nevertheless,

if the species comes into fashion among aviculturists, thereby increasing the demand.

The total area covered by dry forest west of the Serra Geral was estimated to be around 6,750 km² in the middle 1980's (RADAMBRASIL 1989), that representing roughly 75 % of the original forested area. The dry forest patches have been cleared for pasture and explored by loggers, since woods like *Astronium urundeuva* and *Tabebuia impetiginosa*, prized for their endurance, are in great demand for the making of fence poles. Comparing vegetation maps in RADAMBRASIL (1989) with what we observed in the area, we can attest that all forest around Alvorada do Norte is gone, as well as most of the large forested area that once existed between Iaciara and the Rio Paranã (Fig. 1). Judging from our experience in the region only 40 % of the forest remain, and most of it continues to be logged.

In October–November we were impressed by the changes observed around Nova Roma since June. Two forest fragments isolated amid pasture where we had observed *Pyrrhura pfrimeri* had vanished and a third had been badly damaged by fire. Signs of forest burning were widespread and, upon investigating, we discovered that most fires had originated from logging camps and from attempts to improve the local poor pasture. In addition to burning the forest, the loggers were removing all *Tabebuia* trees over 50 cm dbh, effectively depleting the conure's food supply. Fire also killed all saplings and damaged thin-barked species like fig trees.

The largest remnants of dry forest we observed are around Guarani de Goiás, where an extensive tract with over 50 km² was being quickly logged in June. Further north, towards São Domingos and Campos Belos, forest remains only on limestone outcrops too steep and rocky to be of any use, and in a few properties that have not been completely colonized, like Fazenda Floresta, some of them being fairly extensive (over 50 km²). We found most, if not all, forest on the flatter areas has been destroyed and that the remnants are being selectively logged. All of the riverine forests we visited were badly damaged, and are now dominated by bamboo, second growth and liana-covered trees. Although *Pyrrhura pfrimeri* seems to withstand a fairly high degree of habitat disturbance, its ecological needs are incompletely known, especially with regard to the use of forest on flatter ground below the limestone outcrops. As these forests are fast disappearing, so may be a critcal resource for the species. Also, although forest on the limestone outcrops are usually spared, the proximity of a major developing center at the country's capital at Brasília makes one wonder how long it will take for a cement company to become established in the area.

It is difficult to produce a population estimate for *Pyrrhura pfrimeri* because the actual extent of remnant habitat is unknown, and the population densities obtained from transects may be an overestimate. Supposing that 40 % of the forest existing in the middle 80's persists and conure densities are around the lower estimates we made for the Nova Roma region (60—75 individuals/km²), the total conure population may be around 162,000—202,500 individuals. On the other hand, it is important to note that whereas Nova Roma still had forest on flatter ground adjacent to rocky outcrops, all of these has been cleared over most of São Domingos north to Campos Belos, so densities are probably not the same. Considering the limited extent of its habitat, that habitat's quick destruction and fragmentation, and probable simultaneous decline in overall numbers of conures, we feel *Pyrrhura pfrimeri* deserves at least vulnerable status, following the criteria adopted by the IUCN (1995).

A proposal to create a national park at São Domingos, mostly to protected a cave-rich karst formation, has been under consideration by Brazilian federal authorities for almost a decade. That would also protect a sizeable patch of dry forest and populations of *Pyrrhura pfrimeri*, albeit of unknown size. More recently, after lobbying by local NGO's, the Goiás state government agreed to establish a 50,000 ha state park in the same area as an "environmental compensation" for the area to be flooded by a hydroelectric project on the headwaters of the Tocantins river, west of the Chapada dos Veadeiros. Terra Ronca State Park had its limits decreed in November 1996, and the first 15,000 ha of the park are already scheduled to be bought. This is the first action ever to be taken to protect a dry-forest area. The park reaches the Serra Geral, including the many rivers that drain into the karst area, protecting significat areas of cerrado besides some of the best remnant dry forests

(K. Ramos Alves, pers. com.). The effective protection of the state park at São Domingos will also benefit a population of the near-threatened Brazilian Black-tyrant *Knipolegus franciscanus* and other dry-forest endemics (see da Silva & Oren 1992), a welcome measure that could be complemented by a second reserve at Guarani de Goiás, where the extent and condition of the dry forests make the area worth conserving.

Taxonomy. The *Pyrrhura leucotis* group comprises five taxa with disjunct distributions. Two of these (*P. leucotis emma* and *P. l. auricularis*) are restricted to rain and cloud-forests in the coastal ranges of northern Venezuela (Phelps & Phelps 1958, Meyer de Schauensee & Phelps 1978, Arndt 1993), and are isolated from the Brazilian populations by thousands of kilometers occupied by the several forms of the related *Pyrrhura picta* complex, a group with an Amazonian distribution (Arndt 1993). Whether this is another case of species or sibiling species with eastern Brazilian and northern Venezuelan ranges isolated by the bulk of the Amazonian forest (Willis 1992), or if the *leucotis* species group as currently known is poliphyletic, are contrasting hypothesis that deserve to be tested but are beyond the scope of this paper.

Pyrrhura leucotis is a bird of the lowland and foothill (under 500 m asl) forests east of the Brazilian coastal range from southern Bahia (c. 14°S), south through Espirito Santo to Sepetiba, just south of the city of Rio de Janeiro (Pelzeln 1871), including the adjacent lowland forests of eastern Minas Gerais. There is no record or specimen of the species from further south (Miranda-Ribeiro 1920, Pinto 1938, 1978; Pinto & Camargo 1961); the record of it occurring to São Paulo is in error (Sick 1993). The southernmost present-day locality is Serra do Tinguá, near Rio de Janeiro (22°36'S, 43°27'W; Scott & Brooke 1985). The available records show *Pyrrhura leucotis* to be a bird of the lowland forests of Amazonian affinities restricted to this stretch of eastern Brazil and adjacent foothill forests (see Rizzini 1979), being replaced by *Pyrrhura frontalis* at higher altitudes.

Pyrrhura griseipectus (treated as *Pyrrhura anaca* by Teixeira 1991) has been recorded from only three montane (above 500 m asl) evergreen to deciduous (at the lower altitudes) forest isolates in northeastern Brazil: Serra do Baturité and adjacent ranges (around 04°10'S, 38°50'W), Serra Negra (38°S, 08°40'W) and Murici (09°47'S, 36°50'W) (Yamashita & Coelho 1985, Teixeira *et al.* 1988). These widely dispersed localities represent natural forest islands isolated in regions otherwise covered by xeric vegetation (Baturité and Serra Negra) and the largest remaining montane forest tract remaining in the region (Murici). It is interesting that the lowland rainforests of this part of Brazil had been well explored (before being almost completely cut in the 1970—1980's to make room for sugarcane plantations) without the species being recorded (Pinto 1940, 1956; Pinto & Camargo 1961; Teixeira 1986, Teixeira *et al.* 1988).

The three Brazilian *Pyrrhura "leucotis"* have completely allopatric distributions, being effectively isolated from each other by thousands of kilometers. *P. pfrimeri* shows both the most extreme disjunction and distinctive habitat when compared to all other taxa of the group. It is the only species restricted to dry forests and to occurs outside the Atlantic forest domain (Rizzini 1979). *Pyrrhura pfrimeri* and *P. leucotis* are similar in size, with no significant differences in wing length ($t=0.937$, $P>0.1$, $df=20$), bill length ($t=0.173$, $P>0.5$, $df=20$) and mandibular height ($t=0.936$, $P>0.2$, $df=20$), but differ in color pattern, the most striking character being the absence of the white to light buffy auricular patch present in *leucotis* and *griseipectus*. It also has a pale blue forehead, crown, occiput, and nape, with this color spreading to the sides of the neck and throat before grading to green down to the breast. In contrast, *leucotis* has blue only on the forehead (sometimes also just above the eyes), crown and nape being buff or gray. Consistent, but minor, differences in color are the blackish external primaries (P10) of *pfrimeri*, with blue only along the raquis (mostly blue feathers in *leucotis* and *griseipectus*) and the almost complete lack of the dark narrow terminal band of the breast feathers. Nevertheless, in the living bird, the most striking characteristic of *Pyrrhura pfrimeri* is the contrast between the dark red face and the light blue head, and the absence of the auricular patch. These characters are probably important in species recognition and communication.

Although *Pyrrhura pfrimeri* is morphologically close to *leucotis*, the combined morphological differences, lack of intermediates or intervening populations that would allow gene flow between the two taxa, the very distinctive habitat, implying in significant ecological differences, are significant enough to warrant returning *Pyrrhura pfrimeri* to full specific status, as suggested by da Silva (1989, 1996).

Although both the Atlantic forest taxa may be thought to be closely related, based on geographical proximity, as suggested by Hellmayr (1929) and Pinto & Camargo (1961), *Pyrrhura griseipectus* in fact seem to be more divergent from *P. leucotis* than *P. pfrimeri*. Both are distinguished by differences of the periophthalmic ring (dark blue in *leucotis* and *pfrimeri*, white in *griseipectus*), auricular patch (cream to yellowish in *leucotis*, often with a buff tinge; pure white or cream in *griseipectus*, being noticiably larger in the latter), head color (front, nape and sides of neck suffused with blue in *leucotis*, with no blue in *griseipectus*) and breast feathers (green with a blue suffusion more intense near the neck and with a broad light grey or buff subterminal band and a narrow blackish terminal one in *leucotis*, dusky grey with a broad cream to light buff terminal band in *griseipectus*). *Pyrrhura griseipectus* is the same size as *leucotis*, as measured from their wing ($t=0.183$, $P>0.5$, $df=25$), but an important difference, previously noted by Hellmayr (1929), is the significantly longer bill of *griseipectus* ($t=4.75$, $P<0.001$, $df=25$), and its higher mandible ($t=3.49$, $P<0.01$, $df=25$), it looking proportionally larger-headed than the other Brazilian taxa, something anatomical studies may prove. Interestingly, there is no difference in bill width between *griseipectus* and *leucotis* ($t=0.000524$, $P>0.9$, $df=25$). As in the case of *P. pfrimeri*, the even more marked morphological differences, the geographycal isolation between the taxa, and different habitats may be evoked to assign full species status to *Pyrrhura griseipectus*, as proposed by da Silva (1989).

The avifaunas of eastern Brazilian forests from Espirito Santo to Ceará have a strong Amazonian influence (Pinto 1956, Pinto & Camargo 1961, Cracraft 1985, Sick 1993, Willis 1992, Gonzaga *et al.* 1995), with several species or subspecies being allopatric representatives of Amazonian taxa (Haffer 1974), e.g. the endemic Baturité Toucanet (*Selenidera gouldii baturitensis*) (Pinto & Camargo 1961). It is conceivable that both *leucotis* and *griseipectus* arose from ancestors of Amazonian origin related to *Pyrrhura picta* that colonized the forests of eastern Brazil when they were continuous with the Amazon forest, perhaps during one of the last climatic optimums 30—23,000 years BP (Ab'Saber 1990), and later populations became isolated as the forest shrank, especially the ones in northeastern Brazil.

Comparing *Pyrrhura griseipectus* with *Pyrrhura picta*, the subspecies that seems closest to it both in size and general morphology is *P. p. picta* from northern Brazil, which share most characteristics including the well-developed red bend of the wing (absent from other *P. picta* subspecies), narrow blue half-collar, and dusky to brownish grey breast feathers with broad grey or light buff terminal bands. Some *P. p. picta* from Amapá (but not all) differ from typical specimens in that they lack blue on the head, very like *griseipectus*, but this characteristic may be age-related. The most evident difference between *griseipectus* and nominate *picta* is the dark central pattern of the breast feathers, lanceolate in the latter and squarish in former, and the apparently even stronger mandible of *P. p. picta*.

Although the origin of the Atlantic forest taxa from Amazonian ancestors (not necessarily the same) seems plausible, the history of *Pyrrhura pfrimeri* presents difficulties. Its habitat is quite different from those of all other taxa in the *picta-leucotis* complex, including the similar *P. leucotis*, and the form of *Pyrrhura picta* geographically closest (*amazonum*) is too different in color pattern to be considered a near relative. The closest morphological similarity with *P. leucotis* suggest a colonization of the central Brazilian forests from the Atlantic forest, probably through the "Januária bridge" that connected the Paranã valley with the upper Doce river during wetter periods (Willis 1992). The existence of endemic birds of the Atlantic forest in the isolated mountains of Chapada Diamantina, central Bahia (Gonzaga *et al.* 1995) also point to the fact that, in northeastern Brazil, rainforest with Atlantic affinities was at one time much more extensive further inland than it is today and this may have been the source of the ancestral stock from which *P. pfrimeri* originated.

After the recent shrinking of the rainforests with the drying of the climate, only the flower and fig-bearing dry forests offered conditions for the survival of a population of *Pyrrhura* of the *leucotis* group west of the Serra Geral. The problem with this hypothesis is the absence of a *Pyrrhura* in the dry forests east of the Serra Geral, but the drier climate of this area (mean annual precipitation around 900—1,000 mm, opposed to 1,200—1,300 mm on the western slopes, RADAMBRASIL 1989) may be the clue to answer this question. The dry season is probably just too long for a forest *Pyrrhura* to live east of the Serra Geral, despite the presence of dry forest. The more modern techniques of molecular biology and DNA analyses may, one day, shed light on this subject, and on the relationships of the *Pyrrhura picta-leucotis* complex, one of the most interesting problems in Neotropical parrot taxonomy.

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APPENDIX

Pyrrhura pfrimeri. Brazil: Cana Brava, Nova Roma, Goiás: MZUSP 15766, 15768, 15770 (1♂, 2♀ ♀); Barra do rio São Domingos, Goiás: MZUSP 15765, 15767, 15769 (2♂, 1♀); Santa Maria de Taguatinga, Goiás: MZUSP 11333 (type specimen, unsexed).

Pyrrhura griseipectus. Brazil: Serra do Baturité, Ceará: MZUSP 33046, 33047, 41509, 41510, 41511, 41512, 41513, 41514, 41515, 41516, 41517 (8♂, 4♀).

Pyrrhura leucotis. Brazil: Rio Muriaé, Rio de Janeiro: MZUSP 27269, 27270 (1♂, 1♀); Rio Doce, Minas Gerais: MZUSP 6734, 24808, 24810, 24812, 24813, 24814, 24816, 24817 (4♂, 4♀), Itabuna, Bahia: MZUSP 10165 (1♂); Jequié, Serra do Palhão, Bahia: MZUSP 13989 (1♂); rio São José, Espírito Santo: MZUSP 28103 (1♂); rio Itaúnas, Espirito Santo: MZUSP 34495 (1♂).

Pyrrhura picta picta. Brazil: Mazagão, Amapá: MZUSP 42862 (1♀); British Guyana: MZUSP 6496 (1♂).