

By the time the home of this blue macaw was finally traced in 1978 it numbered only some 60 birds in the wild, restricted to two cliff-nesting colonies in the Raso da Catarina in north-eastern Bahia, Brazil, where without considerable intervention it faces extinction in the fairly near term from the destruction and disturbance of its feeding habitat (licuri palm stands) compounded by hunting for food and for trade.

DISTRIBUTION Lear's (or Indigo) Macaw (see Remarks 1) is confined to the middle course of the rio Vaza-Barris south of the Raso da Catarina plateau, north-eastern Bahia, Brazil, in an area of probably no more than 8,000 km² (see below). However, for more than a century European and American zoos had occasionally received specimens (see Remarks 2) in consignments of Hyacinth Macaws *Anodorhynchus hyacinthinus* originating from Pará (probably Belém), Bahia (Salvador), Santos and Rio de Janeiro, but the provenance of the rarer, smaller macaws could not be established beyond "probably some part of Brazil" (Salvadori 1891, Astley 1907, Peters 1937). This situation of ignorance prevailed until Pinto (1950c), visiting Santo Antônio municipality in Pernambuco, was shown a captive specimen that had come from Juazeiro, a town on the right bank of the rio São Francisco in Bahia (a locality also noted for Spix's Macaw *Cyanopsitta spixii*: see relevant account). However, successive expeditions – to north-western Bahia and southern Piauí in 1958 (Pinto and de Camargo 1961), central Goiás in 1956 (Stager 1961), northern Bahia and Ceará in 1964 (Sick *et al.* 1987), again north-western Bahia in 1974 and 1976 (Sick 1979b,c) and north-western Bahia and southern Piauí and Maranhão in 1977 (Sick *et al.* 1987) – failed to find the species in the wild: no macaws were found around Juazeiro either in 1964 or in 1977 (Sick *et al.* 1979, Sick and Teixeira 1980) and it was evident that the captive specimen had been transported there, possibly along the rio São Francisco (King 1978-1979, Ridgely 1981a; see Remarks 3); thus in the year of its rediscovery the range of the species was given as "north-eastern Brazil, in the region of the lower rio São Francisco" (Pinto 1978).

The home of Lear's Macaw was finally traced in December 1978 to the area given above, although the rio Vaza-Barris flows directly into the Atlantic and is not part of the São Francisco basin (Sick 1979b,c, 1981, Sick *et al.* 1979, 1987, Sick and Teixeira 1980, 1983, also Freud 1980; popular recent account in Seitre 1990). The species is apparently restricted to that area, although formerly it was somewhat wider spread, probably reaching the rio São Francisco to the north near the town of Paulo Afonso (Sick *et al.* 1987); similar canyons north of Raso da Catarina, said by local people to have been used as roosts, were surveyed in 1978/1979 with no positive result (LPG). The species now occurs in two colonies (roosting sites, and probably for both also breeding sites) either side of the Vaza-Barris, one at Toca Velha, the other at Serra Branca; its feeding grounds extend south-west to Monte Santo and Euclides da Cunha (Sick *et al.* 1987). Its present range has been estimated to occupy an area of 15,000 km² (Yamashita 1987), but no recent records are known from outside an area of approximately only 8,000 km² (LPG), and indeed the evidence of recent work (see Ecology) is that birds forage within an area of only 450 km².

It is naturally not impossible that other small populations exist but, given the fairly intensive surveys of the interior of north-east Brazil in the past 10 years for this and two other blue macaws, Spix's and Hyacinth (see relevant accounts), the chances are very small; nevertheless, searches in northern Bahia in 1991 for possible additional populations of Spix's Macaw resulted in convincing reports of Lear's Macaw from several new areas (details withheld) that require follow-up (F. B. Pontual *in litt.* 1992; see also Remarks 4).

POPULATION Lear's Macaw "was common" in north-east Bahia 60-100 years ago, old people in the area remembering "large flocks... flying overhead" (Hart 1991). However, the current total population is not known to be more than 60 individuals living in two colonies (Yamashita 1987), and at best the total population consists of far less than 200 birds (Yamashita 1987); the statement that "there are possibly some hundreds of specimens left, living in several colonies" (Sick *et al.* 1987; also Sick and Teixeira 1983) must therefore now be regarded with caution, and the earlier view that the Raso da Catarina population probably numbers no more than 100 birds, perhaps fewer (Ridgely 1981a), allowed to prevail. Indeed in four consecutive simultaneous counts (May, July, August and November 1989) at the two roost

sites, although the numbers at each always varied, the total came to 61 (Machado and Brandt 1990). In July 1990 the total was 66 (D. S. Gardner *in litt.* 1990). On 24 September 1991 a concentration of 46 birds was observed c.45 km east of Canudos, and a local man reported that a second, smaller population lived some 15 km to the west, and that in his view the total number stood between 50 and 100 birds (B. M. Whitney *in litt.* 1991).

ECOLOGY The range of Lear's Macaw is within the "caatinga" (thorn scrub) region of north-east Brazil at altitudes from about 380 to 800 m, with daily temperatures varying between 15 and 45°C (Yamashita 1987); the birds roost in sandstone cliffs or canyons (locally known as "talhados" or "serras": Sick *et al.* 1979, 1987) that vary in height from 30 to 60 m, using fairly small weathered holes which are often within 0.5 m of one another in the top third of the cliff faces; as many as four use a single hole; some birds roost outside the holes, clinging to the cliff or on narrow ledges (Yamashita 1987). Individuals leave their roosting places before dawn for the feeding grounds, arriving at them between 06h00 and 07h00 (in a later study 05h00 and 06h00, although as late as 10h00 or more in August, after ranging more widely for food); they leave for the roosts between 16h00 and 18h00 and arrive back around dusk (Sick and Teixeira 1980, Sick *et al.* 1987, Yamashita 1987, Brandt and Machado 1990, Machado and Brandt 1990).

The view that the chief food of the species is nuts of mucujá *Acrocomia lasiospatha* and tucuma *Astrocaryum tucuma* (Finsch 1867-1868) was a guess based on what was known of the food of Hyacinth Macaw (see Ecology in relevant account and that also of Glaucous Macaw *Anodorhynchus glaucus*). In fact Lear's Macaw feeds principally on the hard nuts of licuri *Syagrus coronata* palm trees found in the caatinga and pastures cleared for cattle-grazing (Yamashita 1987); these palms grow on top of the Raso da Catarina plateau and on crystalline soils in the surrounding lower lands; within the macaw's range they are particularly abundant in the municipality of Euclides da Cunha, being less common on the plateau's sandy soils (Sick *et al.* 1987). Studies in 1988 showed that birds from the Toca Velha roost were feeding in eight discrete areas (between 20 and 32 km distant) scattered over some 140 km², these areas ranging from 10 to 440 ha and containing 150-600 licuri palms; birds from the Serra Branca roost were known to use only a single site (12 km distant) of 400 ha containing around 1,000 licuri palms that were so productive as to render foraging elsewhere unnecessary (Brandt and Machado 1990). Studies in 1989 raised the number of feeding areas for the Toca Velha birds to 15, covering 300 km², and for the Serra Branca birds to eight (see Remarks 5), covering 150 km² and ranging from six to 14 km from the roost site (Machado and Brandt 1990). Feeding activity occurs mainly between 06h00 and 09h00 and between 14h00 and 16h00 (Brandt and Machado 1990). The birds feed in trees in small subgroups of two or three (maximum four) individuals or search for fallen nuts on the ground (also those deposited by cattle), taking turns at keeping watch (Sick and Teixeira 1980, Sick *et al.* 1987, Yamashita 1987, Brandt and Machado 1990, Machado and Brandt 1990). Up to five palms may be visited in a feeding period, birds preferring near-ripe fruits and each consuming around 350 licuri palm nuts per day, a figure which suggests that this food resource is a main factor (direct and indirect) limiting population growth (Brandt and Machado 1990; see Threats, also Remarks 6). Other foods indicated by local people are the fruits of pinhão *Jatropha pohliana*, umbu *Spondias tuberosa* and mucunã *Dioclea* (Sick *et al.* 1987); the first two of these (both unripe) were noted by Brandt and Machado (1990) and Machado and Brandt (1990), who otherwise saw sisal flowers *Agave* sp. (apparently nectar) being used once, braúna *Melanoxylon* sp. seeds being taken from July to September 1989 (licuri then being largely unavailable), and maize *Zea mays* being taken extensively in July 1988. There is a report that birds forage on "*Cocos schizophylla*" nuts (P. Roth in Silva 1989a; see Remarks 7). Adults may return to the same palm trees on consecutive days, a fact exploited by hunters (Sick *et al.* 1987).

The holes in the cliff faces are said by local people to serve also for nesting (Sick and Teixeira 1980), but to date nesting has only been recorded from adjacent cliffs (see below). The breeding season was said to coincide with Lent and with the period of licuri harvest (i.e. maximum production), from February to April (Sick *et al.* 1987), and copulation has been recorded in September (B. M. Whitney *in litt.* 1991) and November (Brandt and Machado 1990), with nesting activity in December (C. Yamashita *in litt.* 1987): thus indeed breeding may be timed so that the period of maximum food availability (January, in 1989; Brandt and Machado 1990) coincides with the period of maximum consumption (Hart 1991

related timing of breeding to the rainy season, starting between December and February and lasting till April/May). The nesting pair observed in 1986 occupied an isolated cliff near the rest of the colony (C. Yamashita *in litt.* 1987). In another account of possibly the same event, communal roosting at a traditional cliff was disrupted by the increasing territorialism of a pair “intending to nest in one of the deep burrows in the traditional roosting cliffs”, the non-breeding birds scattering in small groups to roost in other cliffs instead; two or three breeding pairs tolerated each other in the same area, although their burrows were not in sight of each other and trips to and from feeding areas involved noisy challenges from each pair (Hart 1991). In July–October 1988 two young were observed (Brandt and Machado 1990). In May 1989 five young were produced by three pairs (one pair with one, two with two) (Machado and Brandt 1990). Thus there has been clear evidence of breeding, albeit with low productivity, in three out of four years, 1986–1989. Young birds take almost twice as long as adults to open nuts, and their diet is supplemented by relatives throughout their first year of life (Brandt and Machado 1990). Breeding has occurred in captivity but few details have been published; it took 13 weeks (87 days in Hart 1991) from hatching for a young bird to be fully feathered and flying, and another three weeks to be self-sufficient (see Bish 1985, Silva 1989a).

THREATS The distribution of Lear's Macaw certainly appears relictual, and the species could even be declining owing to natural causes. The general disturbance of the area is, however, testimony to the prevalence of human pressures in the region: two heavily travelled roads cross the range of the macaw, the area has been densely populated since the late eighteenth century (or “since 1870”: Hart 1991), and there are many foot and donkey trails that provide wide access (Yamashita 1987). Hart (1991) attributed this general level of disturbance to (a) the opening up of the region 25 years ago by Petrobrás, the Brazilian oil company, whose new roads into the region were immediately used by settlers and hunters, and (b) the relocation of many families in the region by government agency; she added that if indeed oil is found in the immediate area the species will soon become extinct.

Trade The species may now be more at risk than ever, simply because its precise whereabouts are now well known: even in the late 1970s it was recognized that the area would need to be rigorously protected from bird trappers (Ridgely 1981a), a situation which still applies: between 1983 and April 1988, three birds are known to have been offered for sale in the markets at Jeremoabo, all apparently young taken from the colony (Toca Velha) just south of the Raso da Catarina, two in 1986 and one in 1988 (C. Yamashita *in litt.* 1988). There was, moreover, the incident reported under Measures Taken.

Hunting Hunting both for food and for sale of wildlife products in regional markets represents a serious problem in the area (Yamashita 1987), but the extent to which it has affected the Lear's Macaw population is unclear; two birds are known to have been shot for food since the species's rediscovery (Sick *et al.* 1987, A. Brandt verbally 1988). The inability of the licuri palm stands to supply the birds' needs throughout the year forces them to forage more widely, notably in July, which renders them more vulnerable to hunters, especially if they take to eating cultivated maize (Brandt and Machado 1990).

Farming and tree use The local economy depends on subsistence agriculture and free-range cattle and goat-farming; cattle consumption of racemes and unripe fruit of licuri palms in the dry season may limit the supply of ripe nuts for macaws; although these birds prefer mature fruit and cattle prefer green fruit, many farmers believe that macaws compete with cattle for food (C. Yamashita *in litt.* 1988). Licuri palms are not regenerating in any areas used by livestock (Brandt and Machado 1990), and many adult plants in traditional feeding sites of the bird are now senescent (C. Yamashita *in litt.* 1988); it is already apparent that the existing areas of palm used by the species are inadequate at seasons of greater scarcity (see Brandt and Machado 1990), so this trend is extremely serious and will prove fatal to Lear's Macaw unless reversed. Burning to renew pastures compounds this problem (Ribeiro 1990b) and poses a further threat (see below). In July 1990 a main feeding area was actually being cleared of licuri palms (D. S. Gardner *in litt.* 1990). Moulded feathers showed fault bars indicating the occurrence of food privation (C. Yamashita *in litt.* 1986). The dependence of the birds on braúna seeds in winter 1989 reveals a further vulnerability, since braúna is prized as a building material, so although the trees are left standing when land is cleared for pasture this is merely so that they can be exploited at a later date (Machado and Brandt 1990). There are projects for reforestation with algarroba *Prosopis* in the area (C. Yamashita *in litt.* 1986),

this being promoted in north-east Brazil (principally Pernambuco) as a multiple-use miracle plant (see de Azevedo 1984) although its environmental impact appears to be unknown (LPG).

Disturbance The Toca Velha roosting site is subject to some disturbance owing to the proximity of the town of Canudos and the presence of some families living in the accesses to the canyon (Machado and Brandt 1990). Ribeiro (1990b) mentioned the impending development of a road close to a breeding area, resulting in more traffic and disturbance.

Fire Licuri palms are mostly situated in very dry, grassy pastures, winds are nearly constant in the region, and there is a local penchant for burning to clear areas: one major fire in the region could eradicate a major portion of the species's food-supply in a matter of days (B. M. Whitney *in litt.* 1991).

Natural causes Certain individuals in the two known colonies have been noted to have crossed tail-feathers, which may be evidence of inbreeding in the population (C. Yamashita *in litt.* 1986). The sandstone cliffs that are currently used as roosting sites by the macaws are fractured, and for unknown reasons birds roost in only a few canyons, although many others are seemingly available; high thermal variation from day to night produces slides in the cliffs (Yamashita 1987), as do torrential rainfalls (LPG), and a slide occurring at night or during nesting could have a disastrous effect on the population (Yamashita 1987). Sick and Teixeira (1980) and Sick (1981) refer to birds on cliffs defending themselves against dense swarms of flies, implying these might be problematic (mosquitoes may affect breeding success in Hyacinth Macaws: see Threats in relevant account).

MEASURES TAKEN The species is protected under Brazilian law (Bernardes *et al.* 1990) and is listed on Appendix I of CITES. That the area where Lear's Macaw was rediscovered happened already to be part of an established federal reserve, the Raso da Catarina Ecological Station appeared to be good fortune (Sick *et al.* 1979; see Remarks 8). However, although 99,772 ha in size (Ribeiro 1990b) and having the Serra Branca cliff-site just inside its southern boundary (LPG), the station has no resident group of birds; cattle consume the unripe racemes there, so little food is available and the birds visit only sporadically (Yamashita 1987). Nevertheless, in fulfilment of an obvious need to protect the species from trapping (Ridgely 1981a), two guards were installed at Cocorobó (now Canudos) in 1980, and are still present (LPG). The movements of all strangers in the area are monitored, and their access to sensitive sites is denied (Hart 1991). On one occasion, a man believed to be working for a Rio de Janeiro bird-fancier was arrested while driving in the area with a large birdcage in the back of his truck (LPG). Landowners in the area have proved to be interested in protecting the macaws against the intrusions of hunters and trappers, and there has been much local liaison and education to promote regional interest in the conservation of the species; at one point this involved the publicizing of the shooting of a bird by a poor farmer and the exemplary (i.e. intended to be one-off) clemency shown him by police travelling eight hours to make the arrest (Hart 1991).

In fulfilment of other clear needs, namely a survey for further populations (Ridgely 1981a) and a study of the feeding biology of the birds and food production in the area (LPG and C. Yamashita verbally to WWF-U.S. 1985), fieldwork on both has taken place, funded largely by WWF-U.S. (see Sick *et al.* 1987 for the former, Brandt and Machado 1990, Machado and Brandt 1990 for the latter). Moreover, farmers growing corn have been promised compensation if they resist driving birds from their crops; a plan for the large-scale planting of licuri palm seedlings has been received with enthusiasm; and one landowner has bought up an area and allowed it to return to a natural state, with many young licuri palms now producing much fruit (Hart 1991).

MEASURES PROPOSED Continued research into the general biology of the species (proposed in Machado and Brandt 1990) is clearly of enormous importance for valid management, and must be undertaken. However, the view of Machado and Brandt (1990) that an on-site captive breeding programme could possibly accompany this research seems inappropriate: it would be an extremely expensive and necessarily risky option and at least should not be considered until the recommendations below have been successfully implemented (an increase in the stock of birds without an increase in the carrying capacity of the habitat would be of little value, while an increase in the latter could lead to an increase in the former without the trouble and expense of captive breeding).

The ecological station's enlargement to include more of the species's range was early hoped for (Sick *et al.* 1979, 1987), called for (in an ICBP Parrot Group resolution in April 1980: Ridgely 1981a) and, apparently, worked for (see Sick and Teixeira 1983), yet never implemented (LPG); it is important that roosting and nesting sites remain completely inaccessible to people (Sick and Teixeira 1980). However, nothing has yet been achieved in this regard, except the passing of a law in 1983 to establish the reserve officially (Machado and Brandt 1990), and the development (by Machado and Brandt 1990) of a detailed plan for land acquisition and/or the establishment of reserves, including the ecological station.

Meanwhile, a permanent food supply for the birds needs to be assured by fencing off key areas that hold licuri palms, and by planting seedlings chiefly of licuri palm but also of other native and introduced foodplants (mentioned under Ecology); in the longer term the creation of new feeding areas (identified in accordance with the results of the continuing programme of biological research) will be needed to compensate for intensifying disturbance from development near current feeding sites (Machado and Brandt 1990).

Education programmes will be necessary to achieve the support and sympathy of local communities for the conservation of the species and its habitats; in tandem with this should go a programme of wardening and liaison that extends current arrangements (Machado and Brandt 1990).

An investigation of the Cachoeira do Rio Preto region may be worthwhile in view of local claims of a second type of blue macaw there (see Remarks 4 and accompanying reservations). Sites in northern Bahia from which the species was reported or described during searches for Spix's Macaw by F. B. Pontual and M. A. Da-Ré in 1991 (see Distribution) need urgent investigation; IBAMA has been informed (M. G. Kelsey verbally 1992).

Several individual birds and a few pairs exist in captivity in various places around the world: at the start of the 1980s one report claimed that 11 birds existed in the U.S.A. alone (Decoteau 1982); in 1987 there were at least 13 in total, namely one in Antwerp (this went to N. Kawall in Brazil), one in Mulhouse and one in Basle (these were united as a pair in Mulhouse, then loaned in 1992 to H. Sissen in the U.K.), one in Monaco (now dead), two in Bourton-on-the Water (U.K.) (both now dead, one after going to H. Sissen), one (with N. Kawall, now paired with the Antwerp bird) in São Paulo, one in Los Angeles (now dead), four in Tampa (at least one now dead) and one in Miami (R. Wirth *in litt.* 1987, with 1992 updates in brackets); in addition, there was one in Paris Zoo (this was in fact the same as the first bird held at Mulhouse: R. Wirth verbally 1992) and another in São Paulo Zoo (Silva 1989a), and more recently an assertion of one or more held in San Diego Zoo (incorrect: R. Wirth verbally 1992) and Vogelpark Walsrode (Lantermann and Schuster 1990), one in Yorkshire (U.K.) (this being the bird from Bourton-on-the-Water, now dead) and one male in South Africa (Barnicoat 1982, Sissons [*sic*, = Sissen] 1991), this last now in Yorkshire along with the two (senescent) birds loaned from Mulhouse (NJC). Although informed comment on the situation in the U.S.A., where a total of four birds (two of them captive-bred) existed in 1990, is that "aviculturists in the U.S. cannot do anything to save this species" (Clubb and Clubb 1991), there is clearly a case for seeking to determine the whereabouts of all captive stock, and to maximize its reproductive and genetic potential (and indeed that of the species) through the establishment of a consortium under the impartial aegis of the IUCN Captive Breeding Specialist Group, with the full support and involvement of the Brazilian authorities.

REMARKS (1) A modest suggestion – not, in the journalistic calumny of Ribeiro (1990b), an uncompromising insistence – that Lear's would prove to be a hybrid between Hyacinth and Glaucous Macaw (Voous 1965) was obviously discounted following the discovery of a wild population (King 1978-1979, Vielliard 1979). On the other hand, both Glaucous and Lear's could perhaps be regarded as vicariant forms of a single species, forming a superspecies with Hyacinth Macaw (Vielliard 1979, Forshaw 1989). (2) One such consignment, to Germany in 1893, apparently consisted of a fair number of birds (see Neunzig 1921), and Delacour (1939) possessed no fewer than seven in the late 1930s. (3) Juazeiro is only 150 km by road from the present centre of the species's range, so transportation by river would have been unnecessary. (4) During attempts to locate populations of Spix's Macaw in Bahia, Roth (1989b) reported that several people in a relatively small area of the upper rio Preto (Cachoeira do Rio Preto) distinguished two types of large blue macaw, although only Hyacinth Macaw was encountered. This needs to be treated

cautiously, however, as in that region Hyacinth Macaw is known as “arara-preta” (black macaw) and Blue-and-yellow Macaw *Ara ararauna* as “arara-azul” (blue macaw) (LPG; also Reinhardt 1870). (5) Machado and Brandt (1990) referred to seven feeding sites for the Serra Branca birds, but their table of these sites lists seven without including the major site used in their 1988 study (Brandt and Machado 1990), and it is presumed here that the total number of feeding sites is eight. (6) In view of the high rate of food consumption reported here, it is interesting to note that Tavistock (1926) reported the species “quite hardy, and I had a freshly imported one which went without food for two days and two nights on the top of an oak tree in the depth of winter”. (7) The scientific name should be *Syagrus schizophylla*, but in any case it appears this was a misidentification of *S. coronata* (LPG). (8) The view that because the species had so long gone undetected at the Raso da Catarina Ecological Station governmental presence there must have been slight (Ridgely 1981a) was mistaken, as the station had only just been established and indeed the first leaflet it issued (just before the species was rediscovered) mentioned the presence nearby of blue macaws (LPG).