HYACINTH MACAW *Anodorhynchus hyacinthinus* **V/R**[10]

The Hyacinth Macaw has been seriously reduced by massive, illegal trade to an estimated 3,000 birds divided between three main areas of Brazil: the eastern Amazonian region (chiefly Pará), where it lives in várzeas and savannas adjacent to tropical forest; the Gerais of the north-east, where it is a bird of cerrado and palm stands; and the pantanals of Mato Grosso (and marginally western Bolivia and north-eastern Paraguay). In all areas it exploits hard palm fruits and nests in either tree-holes or, in the Gerais, cliffs; strict enforcement of legal bans on trade, and various related action, is needed to save the species in each of its three known main areas, but further surveys should determine whether populations exist elsewhere.

DISTRIBUTION The Hyacinth Macaw is found chiefly in the centre of Brazil, south of the Amazon, but is also recorded from the extreme north-west of Paraguay and eastern Bolivia (see Remarks 1). The report in Niles (1981) of the species being present but "not plentiful" in Guyana is assumed to be an error. A specimen from Argentina is irrelevant (see Remarks 2).

Brazil On the basis of all the evidence available, the species is known from the Tapajós River in Pará east through Maranhão to Piauí and the rio São Francisco in Bahia and Minas Gerais, south through Tocantins and Goiás to Mato Grosso and Mato Grosso do Sul. On the basis of their own and other "recent" evidence, Munn *et al*. (1987, 1989) identified three distinct regions within this range into which the species has now retreated, one in the north focused on the Serra dos Carajás and the Amazon tributaries that drain from and round it, one in the east in the "Gerais" region where four states (Tocantins, Maranhão, Piauí and Bahia) meet, and one in the pantanal region of the south where three countries meet.

Munn *et al*. (1989) thought it "likely that the species originally ranged from just south of the Amazon in Pará to the drainage of the Paraná and Paraguay rivers in Paraguay and southern Brazil", implying full occupation of the intervening lands, as represented on the map in Forshaw (1989), which incorporates almost the entire states of Pará and Mato Grosso in the species's range. In fact, however, the records, both ancient and modern, indicate no occurrence west of the rio Xingu and the rio das Mortes between 4 and 15°S, so that the known range forms a broad arc that only covers the far east and south of Mato Grosso. The barrier that constrains the species in the west is presumably the eastern frontier of continuous Amazonian rainforest (see Ecology), so that in fact many populations, albeit at low density, may yet be found to exist in areas west of the rios Xingu and das Mortes where savannas and other more open formations occur naturally (the record from as far west as Alta Floresta bears this out). Equally, it is possible that the reports of the species from north of the Amazon even into Amazonas state reflect its ability to penetrate along rivers in várzea and into natural patches of savanna.

Amapá In October 1895 the species was common (though reportedly a dry season immigrant) on the rio Cunaní above and below Cunaní town, and at Lago do Tralhoto just to the north of Cunaní, where birds were breeding (Goeldi 1897). These observations (it is not clear if the area has ever been revisited) remain unique for the state (Novaes 1978a), although Vielliard (1979) speculated that the species might be or have been found as far as the frontiers with the Guyanas, and indeed J.-L. Dujardin (verbally 1991) had met hunters from Amapá who report the species there, while Smith (1991c), without indicating his source, casually mentioned his intention to survey a population there that is "less disturbed" than that in the Pantanal.

Amazonas Silva (1989a) referred to "a recent sighting of a group north of Manaus", and J. B. Thomsen (verbally 1991) also has a trapper's report of the species between Manaus and Roraima; until further information these records are best treated as provisional.

Pará Although Meyer de Schauensee (1966, 1982) and Pinto (1978) excluded the north bank of the Amazon from the species's range, a flock of seven near Breves, flying towards Ilha de Marajó on 17 January 1984, and others on 8 January 1984 flying towards north bank of the Amazon somewhere between Almeirim and Prainha, indicate the contrary, at least temporarily (da Silva and Willis 1986). These records give substance to specimen evidence from Monte Alegre on the north bank (Snethlage 1914), although Monte Cussari on the opposite south bank was probably the source of the skin (Novaes 1978a). Silva (1989a) had a dubious report of the species from Ilha de Marajó at the mouth of the Amazon.

Other localities in the state include (west to east, north of 4°S) rio Cuparí (Bates 1863), Tauari (Griscom and Greenway 1941), and Caxiricatuba (i.e. near Belterra: Pinto 1945) (specimen in MZUSP), all on the lower Tapajós; Diamantina, near Santarem, 1880s (Riker and Chapman 1890-1891); Trans-Amazonian Highway, east and west of Altamira (da Silva and Willis 1986), in the east as far as the

headwaters of the Curuá-Una (Sick 1985), specifically Prainha on the Curuá-tinga (three specimens in MNRJ); rio Iriri (possibly therefore at Altamira) (specimens in MNRJ and MPEG), and at its confluence with the Xingu, apparently the highest concentration of the species in the state (Silva 1989a), with sight records from 3°39'S 52°22'W in August/September 1986 (Graves and Zusi 1990); Patos (now Nazaré dos Patos just below the Tucuruí Dam), on the Tocantins, and up- but not downriver from there (Wallace 1853a, Bates 1863); the Tucuruí area itself in the mid-1980s (Johns 1986); and along a considerable length (its entire east-north-east course downriver of present-day Pindobal) of the rio Capim (Goeldi 1903); for rio Gurupi see Maranhão. South of 4°S, records (all recent) are from three general areas, the Serra dos Carajás, the Gorotire–Kayapo lands, and an area south of the rio Pau d'Arco near Redenção (Munn *et al*. 1987); the second of these lies on the upper Xingu, an area previously identified, apparently from hearsay, by Wallace (1853a).

Maranhão There is a specimen in ANSP from the rio Gurupi, forming the border with Pará, from 1928. The text and map in Snethlage (1927-1928) indicate records of the species on the Maranhão side of the Parnaíba south of Uruçuí, i.e. roughly from 7°30'S. Reiser (1926) found the species at Barra do Galiota (Galeota) across the Parnaíba from Piauí, somewhat south of 8°S (also a specimen in AMNH). However, Munn *et al*. (1987) mapped in the entire southernmost part of the state, south of Carolina and Balsas, based on recent field reports.

Piauí Reiser (1926) recorded the species regularly in June and July 1903 on the upper Parnaíba, extending from Gilbués north to São Estevão at roughly 8°S (a Lagoa Estevão is at 7°32'S 45°03'W in OG 1963b), an intervening locality being "Xingu, near Santa Maria"; a pair from this river in Piauí are mentioned by Hellmayr (1908) as being in BMNH, but cannot now be found there. Corrente (or Correntes), south of Gilbués, is a further locality (Pinto and de Camargo 1961). Munn *et al*. (1987) mapped the area of extreme south-west Piauí in which all these places lie as the only part of the state from which recent records exist, without reference to that from Picos, on the eastern border of the rio Parnaíba basin, apparently in the 1970s, and evidently the north-easternmost record of all for the species (Vielliard 1979).

Bahia In 1903 Reiser (1926) saw captive birds from the rio Preto in the far north-west; and in 1940 birds were "seen frequently" on the rio Grande, near Barreiras (Aguirre and Aldrighi 1983). Munn *et al*. (1987) included the first area within their "Gerais" centre, and mapped a large area south-west of the second (not therefore covering the rio Grande itself) as one from which the species has now disappeared.

Tocantins Sick (1985) referred to the northern part of Goiás, i.e. what is now Tocantins, in the region of the rio Tocantins, as especially important; yet the evidence seems remarkably tenuous. Stager (1961) observed and collected the species between the Serra Dourada and Peixe, i.e. in the southernmost part of the state, but Munn *et al*. (1987) indicated the population there to be extinct. However, Munn *et al*. (1987) reported the species present in Araguaia National Park, in the northernmost part of Ilha do Bananal (they treated this as the south-easternmost extension of the Amazonian Brazil centre, the only area outside the state of Pará), and they mapped a large area of the north-east of the state, from Filadélfia south through the Chapada das Mangabeiras to Dianópolis (mentioning that the western limits of the species's range in this area include Santa Teresa de Tocantins and Ponte Alta do Tocantins), as part of the "Gerais" centre. However, the centre evidently extends further south into the south-eastern corner of the state, given specimens (in MNRJ) from Taguatinga, rio da Palma and Arraias. It is worth noting that von Spix (1824) recorded the species from "Goyaz province near the community of Santa Maria" ("Provinciae Goyatazes prope pagum St. Mariae"), this presumably being the present-day Santa Maria do Tocantins, lying at the western edge of the "Gerais" centre.

Goiás Older records are from the north-west quarter of the state at Crixás (des Murs 1855, Pinto 1938), Pilar de Goiás (specimen in MZUSP), Uruaçu (Aguirre and Aldrighi 1983) and the lower rio das Almas at Fazenda Formiga (Pinto 1936, 1938); the single area in the state mapped by Munn *et al*. (1987) to indicate modern records covers precisely these four sites, although it is described as "near Mozarlândia". Less specifically the Araguaia at or near Registro do Araguaia was a locality for the species in 1823 (von Pelzeln 1868-1871), with two females collected on the river in June 1906 (Hellmayr 1908), while the Araguaia between Aruanã and Ilha do Bananal was a source of repeated sightings in 1932 (Fleming 1933); indeed, Hellmayr (1908) commented that "the Araguaya seems to be one of the principal hunting-grounds of this beautiful bird".

Mato Grosso The last record under Goiás applies equally to Mato Grosso, since the Araguaia divides the two states; and the species was collected across the river from Dumbá (close to Aruanã), which

is on the right (Goiás) bank of the Araguaia (Pinto and de Camargo 1952). In this south-east region of the state there are also records from Garapú, on rio Sete de Setembro (specimen in MPEG); Chavantina (Xavantina) and Pindaíba, both on the rio das Mortes (Pinto and de Camargo 1948, 1952, Sick 1955). All these records were omitted from the map in Munn *et al*. (1987), presumably because none is more recent than 1952, although one from 12°54'S 51°52'W in August–September 1968 (Fry 1970) is also omitted.

A highly significant new record is of a low-density population near Alta Floresta in the central-north of the state, west of the rio Teles Pires, late 1989 (TAP). This extends the range westwards in the state by some 600-700 km, and indicates how lack of ornithological exploration may have seriously biased assessments of the species's status not only in the state but globally. It would appear very likely that populations occur throughout the entire north-western quarter of the state.

In the south of the state, below 15°S, the species evidently occurs patchily across pantanal habitat. Published or specimen localities are extremely scarce, four being Fazenda de Cima and rio (ribeirão) das Flechas (von Pelzeln 1868-1871) (both these being south-west of Cuiabá), Poconé (Forshaw 1989) and Bocaina de Descalvados (or Descalvado) (Naumburg 1930), 8 km and 18 km south, 1931 (Stone and Roberts 1935). Nevertheless, Munn *et al*. (1987) delineated an area encompassing both these sites south-west of Cuiabá in the upper Paraguai basin, and representing 12 sites for recent records. They also mapped as a separate entity the region that straddles the Bolivian border from below San Matías (Bolivia) south to Lagoa Uberaba; and they demarcated the general area of pantanal north-east from Porto Jofre up to and around Rondonópolis as one of unknown possible significance, although one apparently in which no known food-plants grow. However, in July 1988 up to six were present 35 km north of Porto Jofre and seven roosted in palms at Porto Jofre (M. Pearman, S. G. D. Cook *in litt.* 1988).

Mato Grosso do Sul The general area of pantanal delineated for Mato Grosso (see immediately above) by Munn *et al*. (1987) extends south-east from Porto Jofre into the upper Taquari and the rio Coxim – there are 10 specimens from Coxim (in MCZ, MNRJ and MZUSP; also Pinto 1938) despite the reported absence from the central Pantanal of known food-plants. Munn *et al.* (1987) indicated four other semi-discrete areas, (1) astride the Bolivian border north of Corumbá as far as the state border, (2) in the Pantanal do Rio Negro, (3) north of Miranda and (4) in the south-west corner adjacent to Porto Murtinho (whence six specimens in MNRJ and MZUSP taken at Salobra: see Pinto 1945). These account for almost all previous records from the state (including, e.g., Dubs 1983, Ridgely 1983), but there are specimens in FMNH from Piraputanga (OG 1963b gives two adjacent sites, west of Campo Grande), although they were taken in 1926.

Minas Gerais In the nineteenth century the species was reported from Contendas (18°03'S 47°21'W in OG 1963b) (see Pinto 1952), and from the São Francisco basin, notably at the confluence of the rio das Velhas, i.e. near Pirapora (Burmeister 1856). Sick (1985) also mentioned "middle rio São Francisco" but it is assumed this is a repetition of Burmeister. Modern records are from Paracatu, Arinos, Formoso and Buritis in the north-west (M. A. de Andrade *in litt.* 1986), and these seem to have been overlooked by Munn *et al*. (1987).

São Paulo The listing of the species for the extreme western part of the state in the lower rio Tietê, rio Paraná (Pinto 1978), is based on a century-old report in von Ihering (1898) that referred particularly to Itapura (a locality for, among others, Golden-capped Parakeet *Aratinga auricapilla*: see relevant account); however, absence of a specimen led von Ihering (1905a) to reject the species for the state and the record is today regarded as totally unreliable (C. Yamashita *in litt.* 1990).

Bolivia The species occurs in the far east of Santa Cruz, south and south-west of San Matías (Remsen and Ridgely 1980, Ridgely 1981a, 1989), and astride the border with Brazil (Munn *et al*. 1987). A second area bordering Brazil, just north of Corumbá, may hold the species (Munn *et al*. 1987). López (in press) had a second-hand report of up to five birds in Noel Kempff Mercado National Park, which would represent a substantial range extension.

Paraguay Historically, Finsch (1867-1868) referred to the southern limit of the species as being formed by the Paraguayan settlement named Albuquerque, although this has not been traced. The species is apparently now found, at least seasonally, in extreme north-eastern Paraguay, where in August 1977 along the río Apa it was well known to hunters, who said it crosses over at times from adjacent Mato Grosso (Ridgely 1981a). Although in 1987 only one resident pair was reported to be present in the entire country,

in the río Apa region (Munn *et al*. 1987), there have been records in the period 1988-1989 from Concepción department (Estancias Centurión, San Luis de la Sierra, Reyes Cué, Mirabeaud and Satí, as far as Loma Porá to the south of San Luis de la Sierra) which suggest a small resident population there (López in press; see Remarks 3). Nores and Yzurieta (1984b) considered it present in Canindeyú department, but the basis for this is not clear. A flock of six birds crossed the río Paraguay into the country at 21°37'S (Puerto María, Alto Paraguay department) on 11 August 1988 (Hayes *et al*. 1990, F. E. Hayes *in litt.* 1991).

POPULATION Munn *et al*. (1989) put a range of between 100,000 and three million for the numbers prior to the advent of Amerindians. However, owing to the species's large but even now patchily known (and perhaps truly patchy) range, an idea of an original population size, say at the beginning of the last century when the Hyacinth Macaw was first described, is unapproachable. A few fragments of qualitative evidence exist, such as that on the Tocantins above Patos it was "very abundant" in 1848 (Wallace 1853a), in one part of Amapá the species was common at the end of the last century (see Distribution), in many parts of Mato Grosso in the 1910s it was abundant (Naumburg 1930), and in the pantanal of the state in 1931 it was frequent, several groups containing from one to eight pairs (Stone and Roberts 1935), while in one area of the Gerais up to 50 were seen apparently feeding on a burnt area in what was considered the richest area for the species in the upper Parnaíba (Reiser 1926), in another (near Gilbués) "hundreds" were startled from a roost in a swamp (Naumburg 1928), and in yet another (Peixe, in central Goiás) in 1956 small flocks of from three to six individuals were seen (Stager 1961). Despite indications of a great decline in numbers and the fragmentation of the species's range wrought by trade since the early 1970s, neither Ridgely (1981a) nor Sick (1985) considered it "truly rare" in the early 1980s. However, in early 1987 the first attempt at a comprehensive review and survey of the species (Munn *et al*. 1987, 1989) estimated the then world population at 3,000 individuals, with a range of 2,500 to 5,000; of the three main known areas for the species, around 750 were judged to survive in Amazonian Brazil (following, amongst other things, a reported 70% decline since 1974 of numbers at Carajás), 1,500 survived in the pantanals (of which some 200 were inside Bolivia and just two inside Paraguay), and 1,000 existed in the Gerais (mostly in Tocantins; only 100 were believed left in Piauí, following the extirpation of the species from around Corrente and Gilbués, where 10-15 years before it was common). There are no figures for Minas Gerais, except that in 1986 26 birds were confiscated that had been trapped in the state (M. A. de Andrade *in litt*. 1988). Munn *et al*. (1989) argued that each of the three main populations needs to be managed as a separate biological entity whose numbers do not sink below 500. The world's population of captive specimens is now certainly bigger than that in the wild, many thousands being held in zoos and private collections (C. Yamashita *in litt*. 1988).

ECOLOGY As a species of the seasonally drier forests of the eastern Amazon and the drainages south and east of the Amazon basin, but with the ability to exploit different types of food in different parts of its range, the Hyacinth Macaw occurs in habitats with very different topography, vegetation and climate (Munn *et al*. 1989). In the Amazonian part of its range it occupies seasonally moist forest with a broken canopy of brazil-nut trees *Bertholletia excelsa* and an understorey of low trees and bamboo (Munn *et al*. 1987, 1989) and at Tucuruí it was recently found in tall terra firme forest, even foraging within selectively logged areas (Johns 1986), although other evidence is of palm-rich várzea as the preferred habitat there (da Silva and Willis 1986; also Riker and Chapman 1890-1891, Sick 1985). Wallace (1853a), noting its absence from alluvial lowlands, considered that the distribution of the species's food-plants must be influenced by geological factors, and Goeldi (1903) characterized it tentatively as an inhabitant of the upper part of rivers in "Lower Amazonia", particularly in the vicinity of rapids; while it seems always to shun continuous humid forest (Ridgely 1981a), it occurs at its edge and flies over it in search of foraging habitat (Roth 1988c, 1989a). In the south-west pantanals it occupies moist palm groves interspersed with grassy marshes and gallery forests (Munn *et al*. 1987, 1989), and its (virtual) absence west of the río Paraguay is explained by the lack of this combination there (Ridgely 1983). In the Gerais region of north-east Brazil it is a bird of open dry forest in rocky valleys and plateaus (Munn *et al*. 1987, 1989): in the upper reaches of various rivers and their tributaries in this region there are wet areas called "brejos", either with gallery forest or buriti *Mauritia vinifera* palm stands, often in cliff-sided valleys cutting through the plateaus, and the combination of cerrado across the plateaus and in the valleys (where the birds forage), buriti stands (where they loaf and sometimes breed: but see Threats), and cliffs (where they breed), proves

ideal (Roth 1988c, 1989a; also Snethlage 1927-1928: 477-478, 510-511, Stager 1961, Sick 1965). In central Goiás in 1934 the species appeared wholly allied to buriti palm stands, the birds coming daily in small groups to tall trunks of burnt specimens to explore and expand cavities in them (Pinto 1936; see also Sick 1955). The roost-site in one instance was buriti palms on a river bank (Reiser 1926), but another study has indicated that the nest-cavity may be used by one of the pair for roosting throughout the year (C. L. Paiva *in litt*. 1989).

Food consists of seeds, nuts, fruits and vegetable matter (Forshaw 1989). Munn *et al*. (1987, 1989) indicated that the Hyacinth Macaw is dependent on about eight species of palm (see Remarks 4, 5), two or three in each of its three known main areas: thus in the Amazonian region it utilizes inajá *Maximiliana regia*, babaçú *Orbignya martiana* and tucuman *Astrocaryum* sp. (reports of its eating brazil nuts being unpersuasive); in the pantanals acuri *Scheelea phalerata* and bocaiúva *Acrocomia* sp. (but also occasionally *Copernicia australis*: Silva 1989a); and in the Gerais piaçava *Attalea funifera* and catolé *Syagrus coronata*, although also occasionally (not as a major food, *contra* Pinto 1936) buriti (also Ribeiro 1920, Aguirre 1958, A. Studer verbally 1987). The endosperm and/or mesocarp of fruits of these species are obtained through the exceptional power of the bill and jaw of this parrot, the largest of its kind in the world (Munn *et al*. 1989). In the Gerais, the two main food-plants have no stem, and birds therefore forage from the ground (Sick 1985, Roth 1989a); they gather on burnt areas, as foraging is then rendered much easier (Reiser 1926, Snethlage 1927-1928, Roth 1989a), and similarly, in the pantanals, flocks come regularly to paddocks and around ranch buildings where cattle congregate, to feed on the palm nuts eaten but not digested by the cattle (Ridgely 1989, Munn *et al.* 1991). There is a report that at Poconé the local population of c.30-40 birds eat oil palm nuts (presumably *Elaeis guineensis*) from the plantations along the roadside (A. Whittaker *in litt*. 1991). Other foods may be taken, though in much smaller proportions: thus while the crop and stomach contents of one specimen collected in Mato Grosso do Sul comprised crushed palm nuts, another taken at the same locality held three fruits (Myrtaceae), possibly *Ficus* sp. (Schubart *et al*. 1965); the species "appreciates coconut palm buds" (Sick 1985); and four birds in flooded terrain were once witnessed eating *Pomacea* snails (Roth 1989a). Birds are presumed to take minerals from exposed clay near rivers (Silva 1989a); and have been seen to take salt from blocks laid out for cattle (C. L. Paiva *in litt*. 1989, Silva 1989a, Clark 1991).

It has been speculated that in the lower Amazon seasonal movements may take place over large distances, possibly related to the phenology of some plants (da Silva and Willis 1986). Certainly in Amapá the species was reported to be a dry season breeding immigrant, absent during certain months (Goeldi 1897). Wallace (1853a) recorded its absence from alluvial lowlands, but in the same account mentioned its presence at "the sea-coast" and "sometimes close up to the banks of the Amazon", which suggests that movements must occur: indeed while Sclater and Salvin (1867), working on Wallace's collection and presumably his notes also, wrote that it is "not found in the Amazons valley proper, and appears to be restricted to the slightly elevated plateau south of the Lower Amazons", Wallace (1853b) himself indicated that the food-plants later identified by Bates (1863; see above) were present throughout the alluvial lowlands. Snethlage (1927-1928) indicated movements into burnt areas of savanna in the Gerais at the end of the dry season, but also only recorded the species after reaching the plateau. Flights between roosting or nesting sites and feeding areas are often over long distances and at great heights (Forshaw 1989). The species is most active in the morning and late afternoon, flying normally in groups of 2-8 to and from its feeding grounds (Roth 1989a); feeding can begin as early as 05h00 (Clark 1991), while high daytime temperatures appear to inhibit foraging activity (da Silva *et al.* 1991).

Throughout its range the Hyacinth Macaw nests in holes in trees, but in the Gerais it also uses holes in cliffs, at one stage in equal proportion to tree holes, although in more recent years, with the destruction of trees to obtain young, almost exclusively in cliffs (Munn *et al.* 1987, 1989, Roth 1989a). The extent to which the cliff holes are excavated by the birds, as claimed by Descourtilz (1854-1856), is unknown. At Carajás the brazil-nut tree provides nest-sites (Munn *et al*. 1987, 1989, Roth 1989a), although elsewhere in Amazonian Brazil the birds' preference for várzea forest is equally for the palms' roosting and nesting sites as for their food (Sick 1985); breeding there appears to occur in the dry season, starting in July (Roth 1989a), while nesting in "miritý [= buriti] palms" was recorded in October, Amapá (Goeldi 1897). In the pantanals the nest-tree is almost always either manduvi *Sterculia striata*, chimbuva *Enterolobium contortisiliquum* or angelim *Torresea cearensis*, the only species that reach sufficient diameter for nesting (Munn *et al*. 1987, 1989, C. L. Paiva *in litt*. 1989). Of 21 nests, 1990-1991, 20 were in *S. striata*, which were commonest in small patches of vegetation dominated by acuri palms, cavity

entrances were on average 8 m from the ground, and 67% were in the main trunk (Guedes 1991, Guedes and Harper 1991); of 25 nests at another site in the same period, 23 were in *S. striata*, the other two being in *E. contortisiliquum* and *Andira cuiabensis*, the average distance between active nests was 3.64 km, and density over the 50,000 km^2 ranch was 0.027 nests per km^2 (Munn *et al.* 1991); of six nests at a third site, one was in an isolated tree by the roadside while the others were all inside forest patches (C. L. Paiva *in litt*. 1989). Roth (1989a) reported that buriti palms are also used there, and that breeding is from the end of the dry season in September; C. Yamashita (*in litt*. 1988) found nesting there from late August to January at the beginning of the rainy season (see also Dubs 1983, Clark 1991). In the Gerais large dead or dying buriti palms are or at least were used (Sick 1985, Munn *et al*. 1987, 1989, Roth 1989a); local reports in Piauí of eggs being laid in December (Reiser 1926) are supported by the find of a cliff-nest in that month in 1979, c.100 km from Formosa do Rio Preto (A. Studer verbally 1987), although Roth (1989a) saw a pair acting as if with eggs or young in August, and Snethlage (1927-1928) reported cliff-nests occupied in September–October. In captivity, the incubation period is 27 days (Low 1991d), or 28-30 days, with the fledging period approximately three months (Forshaw 1989). The clutch-size is normally two, sometimes three, and occasionally as many as three fledge from one nest, though usually only one (Roth 1989a). However, possibly only 15-30% of the population, at least in the pantanals, attempt to breed each year: so 50 pairs may produce as few as 10-30 or even 7-25 offspring per year in natural conditions (Munn *et al*. 1987, 1989). Certainly breeding success appears highly variable between years (possibly influenced by success in the preceding year): Smith (1991c) claimed that only one chick per nest is raised (and thought that only three young were likely to fledge from ten nests during an investigation of his own), Munn *et al.* (1991) also considered one young to be the rule (of four nests whose outcome was certain, three failed entirely and one fledged one young, while in three other nests only one young was present), Guedes and Harper (1991) found that of five active nests in early 1991 one fledged two young and the others one each, while Clark (1991) reported obvious success of birds in June 1989, when half the pairs seen had offspring, and of these latter pairs half had one and half had two offspring, whereas in the following year at the same site he saw no evidence of any breeding success at all. Nestling growth may be slowed by the very high temperatures, humidity and insolation that inhibits daytime foraging by parents (da Silva *et al.* 1991). Immatures appear to remain with adults for almost a year (Clark 1991). Sexual maturity is only reached, in captive individuals, at four years (Silva 1989a).

THREATS The Hyacinth Macaw is especially vulnerable to capture, shooting and habitat destruction because it is so noisy, intrinsically fearless, curious, sedentary, predictable, and extremely specialized on only one or two species of palm in each part of its range (Munn *et al*. 1987). Following this generalization, it is important to stress that the cardinal cause of the species's decline is trapping for the cagebird trade, as widely agreed (Ridgely 1981a, Munn *et al*. 1987, 1989, Forshaw 1989, Roth 1989a, Silva 1989a, Smith 1991c).

Trade Quantification of trade figures in the past two decades remains unreliable, owing to the amount of smuggling, routing through non-CITES countries, and internal consumption in South America; nevertheless, Munn *et al*. (1989) noted that while CITES declarations indicate 702 birds imported into the U.S.A. during 1981-1984, quarantine sources show a figure of 1,382, suggesting that CITES declarations may have revealed only a fraction even of the then "legal" trade in the species. At this time each bird was selling for around $2,000 in the U.S.A. (Ridgely 1983), although $5,000-7,000 was the figure given in Inskipp *et al.* (1988) (which see for a breakdown of trade figures in the early 1980s).

To develop some impression of the impact of trapping for trade it is worth taking note of three extraordinary sets of figures provided by aviculturists: first, as an example of the difficulty of keeping young birds alive (a reason why trade in adults, which affects populations much more seriously, prevails), Silva (1989a: 153-154) recorded a Paraguayan dealer receiving 300 unfeathered young in 1972 and losing all but three (a 99% mortality); second, he reported a trapper once working an area for three years, with one assistant, from which he was collecting 200-300 Hyacinth Macaws a month (though clearly only in certain seasons, unless a total catch of 7,200-10,800 is seriously being proposed); third, Smith (1991c) reported a trapper who caught a thousand in one year (1980), who knew of two other teams operating at similar levels, and who suggested a minimum 10,000 were taken from the wild during the 1980s.

Concentration on trapping adult birds, because young survive so poorly (see above), has depleted populations much more rapidly (Munn *et al*. 1987, 1989, Roth 1989a); while in the Gerais young were (nevertheless) taken by felling nest-trees (see above), this could equally have had the effect of removing

adults, if no other nest-sites were available in the region. Trapping methods for adults include liming perches at traditional roost-sites and using clap-nets on baited areas, both of which can lead very rapidly to the extermination of a local population, since the species is so extremely site-faithful (Ridgely 1981a, Munn *et al*. 1987, 1989, Roth 1989a, C. Yamashita *in litt*. 1987, 1988).

Transportation and smuggling are obviously well organized, for even birds from the Gerais leave Brazil through Paraguay and Bolivia (P. Roth *in litt*. 1985), chiefly by plane from private airstrips on estates in Mato Grosso do Sul, or via Corumbá, whence either to Santa Cruz in Bolivia (the largest exporting centre in that country) or down the Paraguay River to Asunción or Concepción, and thence abroad (Ridgely 1981a, 1983, J. V. Remsen *in litt*. 1986, Munn *et al*. 1987, 1989): of the 1,113 birds that entered the U.S.A. between 1975 and 1982, 1,089 were exported from Bolivia, 16 from Paraguay and only two from Brazil (Nores and Yzurieta 1984b). Listing on Appendix I of CITES (see Measures Taken) in 1987 appears only to have enhanced the rarity value of the species and fuelled the illegal market, for from August 1987 to November 1988 no fewer than 700 birds are known to have been trapped and traded (Munn *et al*. 1989). The internal market for the species in Brazil and adjacent countries is unknown but probably large; it appears sporadically in the illegal market in Rio de Janeiro in lots of up to four birds (C. E. Carvalho *in litt*. 1987).

Other threats: Amazonian Brazil The increased commercial sale of feather art by the Kayapo Indians of Gorotire (up to 10 Hyacinth Macaws are needed to make a single headdress) is of concern (Munn *et al*. 1987, 1989); meat-hunting by recent settlers also exists, e.g. along the Trans-Amazonian Highway (Munn *et al*. 1987, 1989; also Sick 1985), although Wallace's (1853a) evidence from the Tocantins indicates that this has been a chronic problem ("at almost every house feathers were on the ground, showing that this splendid bird is often shot for food"); habitat loss to hydroelectric power schemes on the rios Tocantins and Xingu has been significant (A. D. Johns *in litt*. 1986); habitat modification through human encroachment embraces the entire length of the rio Capim, according to the map in Wetterburg *et al*. (1981); and perhaps the current conversion of the region to cattle-ranching may yet prove the most irreversibly damaging influence (Munn *et al*. 1989).

Other threats: the pantanals Apart from trapping, the only real threat in this region is lack of nest-sites: although food-trees are left standing (they also provide food for cattle), nest-trees are cleared for the sake of cattle, sometimes because the cavities play host to vampire bats, sometimes because high-ground (i.e. dry) forest is cleared for wet-season pasture (Munn *et al*. 1987, 1989, 1991, da Silva *et al.* 1991); indeed, the most favoured nest-tree, manduvi, is characteristic of fertile soils, and hence many are lost to make way for pastures (Guedes 1991). However, in addition, Sick (1985) reported that the Hyacinth Macaw is killed in the region because eating bocaiúva buds makes the palm, which furnishes good wood for fence posts, die, and because it is accused of scaring away the cattle; and C. L. Paiva *in litt*. (1989) recorded poor regeneration of *Scheelea* food-trees owing to cattle-grazing, and serious competition for nest-cavities from African bees *Apis mellifera* (although some nests seem to enjoy or endure an association with these bees, without harm: Guedes 1990). Loss of eggs or chicks in nests was thought attributable to cold (if rain entered the cavity), predators (possibly coatis) or, most probably, moquitoes (Smith 1991c). Birds have been seen defending nests against Red-and-green Macaws *Ara chloroptera* (Guedes and Harper 1991).

Other threats: the Gerais In 1903 the species was little trapped but hunted for its feathers and meat (Reiser 1926). However, subsequent human movement into the region has led to an intensification of agriculture, as most of the cerrado, its preferred feeding habitat, makes very fertile farmland (Roth 1989a; also P. T. Z. Antas *in litt*. 1986); moreover, meat-hunting continues as the area is so poor that bush-meat of any kind is sought for its protein value (Munn *et al*. 1987, 1989).

MEASURES TAKEN The species is protected under Brazilian law (Bernardes *et al.* 1990), has been listed on Appendix I of CITES since 1987 (but see Threats) and is banned from export in all countries of origin (Inskipp *et al*. 1988, Munn *et al*. 1989). Singapore's accession to CITES is regarded as a major step towards closing down illegal trade in the species (Low 1991d). The Hyacinth Macaw occurs in only a few Brazilian national parks and reserves, e.g. the Cara-Cara Reserve (now the Pantanal National Park) in Mato Grosso and the Araguaia National Park in Goiás, neither of which are entirely secure (Ridgely 1981a); but only a small, low-density population exists in the latter, and only a few individuals if any exist in the extreme north of the former, the nearest area with a reasonable population of the species being 30 km north of its northern limit (C. Yamashita *in litt*. 1986, 1987). The ranch-owners in the pantanals

have become sensitized to the problem, and many no longer allow trappers on their properties; similar attitudes are developing in the Gerais (Munn *et al*. 1989). At Poconé the owners of many local fazendas protect the birds despite their use of oil palms (see Ecology) (A. Whittaker *in litt.* 1991).

MEASURES PROPOSED Munn *et al*. (1987) called for a package of six measures of which (1), moving the species to Appendix I of CITES, was almost immediately implemented; the others were (2) to list the species as Endangered under the U.S. Endangered Species Act, for further protection in the U.S.A.; (3) to encourage a "media blitz" in Brazil against keeping the species and buying illegal birds, and in favour of stiffer penalties for law-breakers; (4) to break the network of smugglers in Brazil and adjacent countries through arrest and prosecution of key individuals, and an overall increase in IBAMA's enforcement competence and strength; (5) to create Bolivian and Paraguayan trade management authorities under presidential control (the former located in Santa Cruz); (6) to manage and replant the species's food-trees, erect nest-boxes as an experiment, and consider captive-breeding programmes at one site in the Pantanal and another in the Gerais. In respect of this last, however, the aviculturist Smith (1991c) remarked that "it is highly improbable that such a specialised feeder could ever be re-established as a wild bird from captive stock in which case aviary stock is absolutely irrelevant for the survival of this species". This may be valid, except that it takes no account of captive breeding's potential in supplying the market; the species used to be rare in captivity and very little bred (see Low 1972 for early successes) but it has in the past few years begun to be bred by a number of people (see Low 1991d) and with considerable sophistication (see Abramson 1991), so that a studbook now exists (Clubb and Clubb 1991). Meanwhile, Munn *et al*. (1989) have called for stricter international enforcement of the ban on trade in the species, and strong international pressure on those countries permitting the smuggling out or importation of birds. In the pantanals, the species could survive in good numbers if ranch-owners would leave standing all large actual and potential nest-trees and eliminate all trapping on their properties; and with the erection of nest-boxes, the fencing off of certain saplings and the planting of others, its long-term prospects would be further improved (da Silva *et al.* 1991).

Further important action must be to investigate the status of the species in areas not apparently addressed in the survey by Munn *et al*. (1987, 1989), for example (1) in the precise region of Amapá where it was common in the 1890s, (2) the middle reaches of the rio Capim in Pará, if not too seriously damaged since the 1890s, (3) the area of southern Piauí east of the main Gerais region as far as Picos, where birds were seen in the recent past, (4) north-western Minas Gerais where populations are scattered over a considerable area from the evidence under Distribution, but whose status is poorly known (M. A. de Andrade *in litt.* 1988), (5) the extensive region of south-eastern Mato Grosso from which rather old records derive but which appears to have been neglected ever since. Indeed, the entire question of the species's status and distribution at the vaguely perceived western edge of its range needs to be addressed by a vigorous combination of fieldwork (including plane flights) and the study of existing and currently planned vegetation and forest-cover maps (including those from satellite images). Following from this is the question of whether existing protected areas that hold the species can be supported, or whether they should be extended or even (for example in north-east Tocantins) created. Munn *et al*. (1989) also urged further studies of breeding biology in relation to such factors as nest-site shortage (with the erection of nest-boxes if the results indicate the need), and such studies are now beginning: hence Guedes and Harper (1991), Munn *et al.* (1991), da Silva *et al.* (1991), these last in turn calling for radio-telemetry studies to determine whether food shortages are causing problems. Munn *et al.* (1989) also called for the prevention of meat-hunting in the Gerais by improving local people's diet, and the prohibition of the sale of Indian feather art (although their traditional use of feathers should remain unchallenged).

REMARKS (1) Griscom and Greenway (1941) recognized subspecific difference between birds from Mato Grosso (race *maximiliani*) and the Lower Amazon. (2) A specimen (in MACN) was collected at 1,000 m on the río Caraparí in Orán department, Salta, in July 1930 (J. R. Navas *in litt.* 1991); the río Caraparí lies at around 22°08'S 63°43'W, rising in extreme north-central Salta and flowing north-west almost to the Bolivian border, where it meets another branch flowing south from Tarija and thus forms the Quebrada Macueta (Paynter 1985). This astonishing record must represent an escape, a straying bird or most likely a mislabelling. (3) Estancia Centurión is the source of a record of the near-threatened Bearded Tachuri *Polystictus pectoralis*, May 1989 (F. E. Hayes *in litt*. 1991), a piece of evidence that underscores the biological value of the site (see Remarks 4 under White-winged Nightjar *Caprimulgus candicans*). (4)

Palm nomenclature in various accounts reflects the unresolved taxonomy of the group: the *Attalea* was identified by Reiser (1926) as *A. compta*; the *Acrocomia* by Aguirre (1958) and C. Yamashita (*in litt*. 1988) as *A. sclerocarpa*, by Bates (1863) and Finsch (1867-1868) as *A. lasiospatha* (local name "mucujá"), by Hohenstein (1987) as *A. totai* and by C. L. Paiva (*in litt*. 1989) as *A. mokayayba*; the *Astrocaryum* by Bates (1863) and Finsch (1867-1868) as "*Astryocaryum*" *tucuma* (local name "tucumá"); and the *Syagrus* by Forshaw (1989) as *S. commosa*; moreover, Munn *et al*. (1987, 1989) referred to *Astrocaryum* as *Astocaryum* and *Atrocaryum* respectively, and various authors spell *Attalea Atalea*. Worse yet, *Scheelea phalerata* is sometimes placed in the genus *Attalea*, and the specific name *phalerata* is sometimes also given to *Orbignya martiana* (latter in Munn *et al*. 1987, former in Munn *et al*. 1989, Silva 1989a); finally, Munn *et al*. (1989) refer to acuri as "bacurí", while buriti is sometimes "miriti". (5) Bates (1863) recorded the species's use of *Astrocaryum* (tucumá) on the Tapajós, and of *Acrocomia* (mucujá) on the Tocantins; in the former case, all six of the specimens he collected had been eating the fruit, and in the latter, he made it clear that this was the most favoured of "several palms". It is curious that no-one else mentions *Acrocomia* as a food-plant in Amazonian Brazil.