

DISTRIBUTION, HABITATS, AND CONSERVATION OF THE CAIMANS (ALLIGATORIDAE) OF PARAGUAY

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ABSTRACT

Three species of crocodylians occur in Paraguay. *Caiman yacare* is common through central and western Paraguay to the limits of permanent water; it is absent from the Paraná River drainage of eastern Paraguay and from the dry northwest. *Caiman latirostris* is sparsely distributed throughout eastern Paraguay and the southern half of the Chaco of western Paraguay. It is sympatric with *C. yacare* in many areas. *Paleosuchus palpebrosus*, recorded here for the first time from Paraguay, lives in the Apa River and probably a few other streams and rivers of the extreme northeastern corner of the country. Museum specimens of *Crocodylus acutus* labelled Paraguay and accounts of *Melanosuchus niger* in the country are erroneous. In Paraguay, *C. yacare* characteristically inhabits large rivers and adjacent marshes, while *C. latirostris* often lives in more ephemeral habitats such as stock tanks and seasonal marshes. This species seems to more aggressively colonize new water sources than *C. yacare*. Young and adult *C. yacare* occur in the same habitats, but adult *C. latirostris* are often found living in different areas than juveniles. Caimans in Paraguay have been subject to varying degrees of exploitation for their hides. *Caiman latirostris* has been most severely overexploited. However, populations have rarely been exterminated and they should recoup their numbers if protected from uncontrolled harvest.

RESUMEN

Tres especies de aligatridos se distribuyen en el Paraguay. *Caiman yacare* es común en el centro y al oeste de Paraguay hasta el límite de aguas permanentes; no se la encuentra en la cuenca del río Paraná al este del país y en la zona seca del noroeste. La distribución de *C. latirostris* es esparcida entre el este y el Chaco sur de Paraguay; y en varias partes se encuentra en simpatria con la especie *C. yacare*. *Paleosuchus palpebrosus*, con el primer registro para Paraguay mencionado en este trabajo, vive en el río Apa y probablemente otros arroyos y ríos en el extremo nordeste del país. Especímenes de museo de *Crocodylus acutus* y relatos sobre la existencia de *Melanosuchus niger* en el país son datos erróneos. En Paraguay, *C. yacare* habita grandes ríos y los pantanos contiguos a éstos, mientras que *C. latirostris* frecuentemente vive en habitats más temporales, como por ejemplo estanques y pantanos que se forman en la época de lluvia. Esta especie parece ser más agresiva en la colonización de nuevas fuentes de agua. Los juveniles y adultos de la especie *C. yacare* viven juntos en el mismo habitat, pero adultos de *C. latirostris* con frecuencia son encontrados en áreas diferentes a los juveniles. Los caimanes en Paraguay han sido expuestos a varios grados de explotación de sus pieles, afectando especialmente a *C. latirostris*. Sin embargo, en muchas partes las poblaciones no han sido exterminadas y podrían recuperarse bajo el control de su caza.

Precise information on the crocodylian fauna of the Southern Cone of South America and, specifically, Paraguay, has been slow in accumulating. Early naturalists gave no specific information and frequently confused species (Medem, 1983). The first published record for any crocodylian from a precise locality in Paraguay is found in Schenkel (1902), who records a *Caiman latirostris* from Villarica, department of Guairá (Fig. 1). Schmidt (1928) was the first to summarize crocodylian distributions in the region which includes Argentina, Paraguay, Uruguay, and southern Brazil. He did not cite specific localities within Paraguay, but he mapped *Caiman yacare* on its borders in the Pilcomayo and Paraguay rivers, and *C. latirostris* in the Paraná and lower Pilcomayo rivers. Müller and Hellmich (1936) collected a series of *C. yacare* from six localities along the Paraguay River and associated floodplains, but these important records from the Gran Chaco Expedition of 1925 were largely overlooked. Medem (1960) later reviewed the range of *C. yacare*, but gave no specific records for Paraguay. Freiberg and de Carvalho (1965) summarized the distribution of *C. latirostris* but gave no specific localities in the interior of Paraguay. Later authors such as Neill (1971), Guggisberg (1972), Brazaitis (1974), da Rocha e Silva

(1981), and Groombridge (1982, 1987) mapped or described the distributions of *C. latirostris* and *C. yacare*, but added no new specific information for either species in Paraguay. Scott and Lovett (1975) recorded the first *C. yacare* specifically cited for Paraguay since the work of Müller and Hellmich (1936).

Authors are divided as to whether or not the taxon *yacare* is a distinct species or a subspecies of *Caiman crocodylus*. Schmidt (1928) and Medem (1983), using several morphological and coloration characters, showed that *yacare* is usually distinguishable from *crocodylus*. However, most recent authors of systematic lists have used the trinomial (Fuchs, 1974; Wermuth and Fuchs, 1978, 1983; Wermuth and Mertens, 1961). We will use the binomial, *C. yacare*.

Fuchs (1974) described two new subspecies that are supposed to occur in Paraguay: *C. crocodylus paraguayensis* and *C. c. matogrossiensis*; he considered *yacare* to be another subspecies of *C. crocodylus*. The original descriptions, based on commercial hides of uncertain provenance, disregarded several recommendations of the International Code of Zoological Nomenclature (ICZN, 1985), here paraphrased: 73A. A holotype should be designated; 73C. Data on the holotype, including size, locality, date, sex, age, col-

lector's name, collection in which it resides, collection number, and elevation should be given; and 73D. Paratypes should be labelled (ICZN, 1985). Because of these deficiencies we cannot evaluate the validity of the taxa, nor use the descriptions to classify specimens.

The ranges of the new subspecies as mapped by Wermuth and Fuchs (1978) partially overlap and completely divide the range of *C. c. yacare* into two widely separated units. This situation is not biologically realistic. Later, the same authors redefine the distributions of the taxa *paraguayensis*, *matogrossiensis*, *yacare*, and *crocodilus* so that they do not overlap (Wermuth and Fuchs, 1983), but the mapped ranges of *yacare* and *crocodilus*, at least, do not resemble those of any other recent author (e.g., Medem, 1983). For these reasons, we concur with Medem (1983) that the subspecific epithets *paraguayensis* and *matogrossiensis* should not be used until they are proven to be valid biological entities based on museum specimens from known localities.

Medem (1983) summarized the known distribution of Paraguayan caimans and added observations of his own from a 1973 trip of Paraguay. However, most of his additional information was derived from interviews and not firsthand knowledge. Several of his records are doubtful, especially those for *C. latirostris* northwest of Pozo Colorado and the records for *Melanosuchus niger* discussed below.

Waller (1987) published the collected records for Argentinian and Uruguayan caimans, including several localities near the Paraguayan border. This work precisely defines the southern limits of *C. latirostris* and *C. yacare*. The author was careful to include only well documented records, a practice that is often lacking in studies of crocodylian distributions.

In 1980, a biological inventory of Paraguay was initiated by the combined efforts of the Servicio Forestal of the Ministerio de Agricultura y Ganadería (MAG) and the Instituto de Ciencias Básicas of the Universidad de Asunción from Paraguay, the Fish and Wildlife Service (FWS) and Peace Corps of the United States, and the World Wildlife Fund (WWF). At the same time, the Museo Nacional de Historia Natural de Paraguay (MNHNP) was created to receive the collections resulting from the project. Subsequent fieldwork has contributed a large amount of information concerning the distribution and abundance of Paraguayan organisms, including caimans (Foster, 1983).

During the period October 1986 to January 1987, a team of biologists surveyed the crocodylian fauna of Paraguay. The survey was sponsored by the Inventario Biológico Nacional of the Ministerio de Agricultura y Ganadería, Paraguay, and CITES as part of a larger study on the systematics, biology, and population status of crocodylians in Paraguay, Bolivia (King and Videz Roca, 1989), and the Pantanal of Brazil (Brazaitis, 1989).

This paper summarizes records of specimens in the MNHNP and major U.S. museums and the literature on the distribution of caimans in Paraguay, and records our observations of their habitat use in Paraguay.

METHODS

The CITES-sponsored team was composed of three to six people from the U.S. Fish and Wildlife Service, U.S.A.; the Inventario Biológico Nacional of the Ministerio de Agricultura y Ganadería, Paraguay; the Department of Biology, University of New Mexico, U.S.A.; and locally hired help. Techniques of the survey included aerial surveys of the Paraguayan Chaco; diurnal and nocturnal searches on foot, from boats, and from a jeep; the use of guides familiar with the local fauna and terrain; and interviews with local residents, hunters, and hide dealers.

Data collection was opportunistic given the diverse ecological and logistic situations encountered. Usually the team set up a base camp at a large ranch (*estancia*) and then traveled about the local area, examining habitats and capturing caimans where possible. Local residents were interviewed. Where caimans were scarce or otherwise difficult to secure by hunting, skins were obtained from hunters or hide dealers or skulls were salvaged from butchering sites.

With rare exceptions, we did not make quantitative density estimates. The habitats visited included a wide variety of types, from large, open rivers and lakes to overgrown marshes and cattle tanks; and we often did not make a complete census of the area or body of water. Therefore, our descriptions of population densities are only expressed in relative adjectives. "Low" densities mean that fewer than 10 caiman were seen by each investigator during a night's reconnaissance; "high" densities or "dense" populations mean that many caiman were seen in a night's work. The latter densities were probably between 50% and 100% of the carrying capacity of the habitat.

Caimans were collected by harpooning, noosing, or grasping. A series of external measurements were taken, stomach contents and parasites were preserved, and tissue samples for biochemical analysis were saved. Most specimens were preserved whole in 10% formalin, but some, including the largest, were saved as a preserved skin with skull and a dried skeleton. Skeletons of a few small specimens were also prepared.

To facilitate further examination, specimens are located temporarily at the Florida State Museum (UF), but ultimately they will be divided among the UF, the U.S. National Museum, and the MNHNP.

A low level aerial survey made at the end of the dry season in October enabled us to determine which areas of the Chaco (western Paraguay) held water even in the depths of the long dry season. These observations were supplemented by wet season (December) flights at higher altitudes.

Statistical analyses of habitat use were made with goodness-of-fit tests. Juveniles were animals less than 500 mm total length, subadults were from 500 mm to 1,200 mm total length, and adults were larger. Probability values of less than 0.05 were considered to indicate significant differences.

DESCRIPTION OF THE STUDY AREA

Paraguay west of the Paraguay River is called the Chaco, although several different xerophytic zones are included. The entire area, with the exception of isolated Cerro León in the northwest, is a flat plain dissected by occasional river courses. Most areas are subject to seasonal flooding. The southern third is flooded for longer periods and the predominant vegetation is a palm (*Copernicia australis*) savannah. Areas that are rarely inundated are covered with a dense, botanically complex thornscrub. In the dry season, surface waters are present only in some of the larger river courses, in artificial impoundments, or in cattle tanks.

East of the Paraguay River, the land is uplifted to moderate elevations (300-500 m), and streams and low mountain ranges (to 800 m) provide variety to the landscape. Surface waters are usually found in streams and rivers, and marshes are found in each river valley. Especially extensive marshes are found near the confluence of the Paraguay and Paraná rivers in the departments of Ñeembucú and Misiones.

Rainfall in Paraguay decreases in a smooth gradient from greater than 1,700 mm/year in the southeast to less than 500 mm/year in the northwest. The Paraguay River, which bisects the country, receives between 1,000 and 1,300 mm of rainfall yearly.

RESULTS

Distribution of Persistent Surface Water

During October, water was generally present in rivers, oxbows, natural permanent water holes (lagoons), and cattle tanks in the southwestern Chaco (department of Presidente Hayes), but it was increasingly scarce towards the north and northwest (Fig. 1). The Paraguay River and its oxbows formed a wet corridor 10-50 km wide along the eastern edge of the Chaco, and the Pilcomayo River contained water at least as far as the border between the departments of Presidente Hayes and Boquerón. Numerous easterly flowing rivers in the departments of Presidente Hayes and southern Alto Paraguay contained water in deeper parts, but only the southernmost were flowing and only a few were continuous. There is a belt of deep lagoons across the center of the department of Alto Paraguay, but north of there the tanks and oxbows were generally dry, except near the Paraguay River.

There were several large, shallow lagoons with water near the Bolivian border in the departments of Alto Para-



FIGURE 1. Map of Paraguay showing the locations of departments and other geographic features mentioned in the text.

guay and Chaco, but these were the results of September rains, according to the residents of Palmar de las Islas. There do not appear to be any permanent natural waters in the department of Chaco. There was water in the deeper pools of two rivers in northeastern Nueva Asunción, but the rest of the department appeared to be dry. The only water visible in the region of Filadelfia in northern Boquerón was in a few cattle tanks. Based on other trips, we know that interior Boquerón is very dry, and the only permanent water is in the Pilcomayo River and perhaps in a few oxbow lagoons along its course.

Species Accounts

Caiman latirostris (Daudin, 1802)

Caiman latirostris is the southernmost crocodylian in the New World, reaching 33°S latitude in Argentina and Uruguay (Waller, 1987). Its latitudinal distribution mirrors that of the American alligator (*Alligator mississippiensis*), as does its broad snout, terrestriality, and vertebrate-eating proclivities.

We found *C. latirostris* to be scarce throughout most of its range in Paraguay (Fig. 2). This species' skin is less bony and more valuable than that of *C. yacare*. The species still persists in small populations in most of its former range, even in Lake Ypacaraí which is in a suburb of Asunción. This is the only species in much of eastern Paraguay. Here it lives in streams, cattle tanks, and marshes in rolling hills

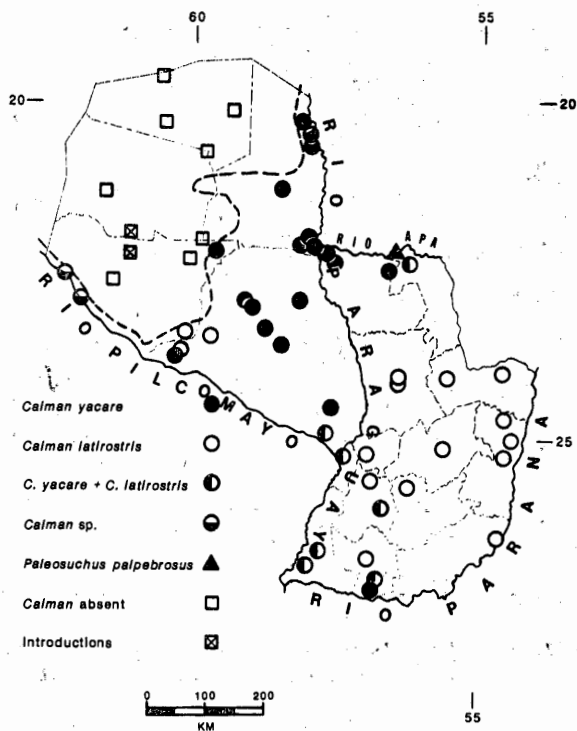


FIGURE 2. Distribution of crocodilians in Paraguay. The dashed line marks the northern and western limit of natural surface waters at the end of the dry season. Sites recording *Caiman* sp. are based on sight records; it was not possible to determine which species.

and small valleys. Further west along the Paraguay River and in the southern Chaco, it is in broad contact with *C. yacare*, in some places existing in microsympatry, especially during the dry season. We found six sympatric sites during our study, and there are old museum specimens of both species labelled as originating in Asunción.

Although populations of *C. latirostris* have been greatly reduced almost throughout its Paraguayan range, they would probably recover under effective protection. However, several factors may delay the recovery of *C. latirostris*, even with protection. Populations of *C. latirostris* are low and scattered, much of the habitat in the western half of its Paraguayan range is ephemeral and perhaps stressful, and several hunters told us that *C. yacare* now lived in some places where *C. latirostris* had formerly occurred.

Both this species and *C. yacare* have been introduced into artificial tanks on at least two Chaco ranches in an area where surface waters ordinarily disappear before the end of the dry season (Fig. 2). One of the introduced *C. latirostris* populations is spreading throughout at least 20 km along the intermittent Mbiguá River in cattle tanks supported by deep wells.

Caiman yacare (Daudin, 1802)

Caiman yacare persists in good numbers in many parts of Paraguay. It occurs throughout the Chaco of western Paraguay wherever there are permanent water refuges during the dry season. The species is associated with the Paraguay River and its larger tributaries and associated marshes, but, based on our observations and museum records, it is probably absent from the Paraná River drainage above the marshes at the confluence of the Paraná with the Paraguay. As noted, it is sympatric with *C. latirostris* at several sites.

Although in many places *C. yacare* is subjected to intense hunting pressure, both for hides and for meat, it usually manages to persist in low numbers. Where protected, populations may be dense. We counted about 500 animals, most subadults and adults, in a 2-ha dry-season pond. These are similar to dry-season densities of *C. crocodilus* in the Venezuelan llanos (Seijas, 1986) and a little less than *C. yacare* in the Brazilian pantanal (Schaller and Crawshaw, 1982).

Paleosuchus palpebrosus (Cuvier, 1807)

This species is recorded from Paraguayan waters for the first time, based on a whole-mount specimen, now in the MNHNP. The specimen was collected in 1973 by a local taxidermist from the Apa River which forms part of the northwestern border between Paraguay and Brazil (Fig. 2). Searches by us in the area failed to produce any new definite records, but three wary caimans seen during a 50-km nocturnal canoe trip on the Arroyo Estrella might have been this species. A local resident, who recognized all three species, said that *Paleosuchus* was the only caiman in the stream. *Paleosuchus* was also reported by a local hunter from the Arroyo Chacalolina, about 60 km south-southwest of Bella Vista, but the few caiman that we saw there were all *C. yacare*. The mounted specimen of *P. palpebrosus* extends the range of the species about 360 km south-southeast of Urucum near Corumbá, Mato Grosso, and 940 km west-southwest of Ituberava, São Paulo, Brazil, the two nearest known localities (Luederwaldt, 1926; Medem, 1983; Peracca, 1904). The Paraguayan locality is also the southernmost record for the genus.

The local name, *jacaré itá*, means rock-caiman in the Guaraní language. The Paraguayan hunters who use this term believe that the name describes the habitat, because in this area it lives in small, often rocky, streams. Another interpretation is that the name refers to the exceptionally bony skin that is hard enough to deflect a harpoon.

Melanosuchus niger (Spix, 1825)

Medem (1983) and Plotkin et al. (1983) summarized the known historic range of the black caiman. The distribution was basically Amazonian with the exception of populations near the coast in the Guianas, the Araguaia-Tocantins river system of Brazil that shares the Amazon delta, and Bolivian localities in the Paraguay River drainage near the headwa-

ters of an Amazonian tributary, the Guaporé. These authors also listed localities in the marshes of southern Paraguay along the Paraguay River. However, we do not believe that *Melanosuchus* comes any closer to Paraguay than Corumbá on the Paraguay River in Brazil.

The Paraguayan accounts are based on interviews by Medem (1983) with a government official and a professional hunter. The informants said that they had seen or killed caiman that were as long as 5 m. The hunter also described the ventral color as being pure white. Medem (1983) compared these size estimates and the color description with *C. yacare*, which is thought to reach a total length of a little more than 2.5 m and has an ivory to yellow belly. He concluded that the descriptions were not applicable to *C. yacare* and had to be *Melanosuchus*.

During our study we interviewed government officials, a commercial hunter in the area where *Melanosuchus* was supposed to occur, and the most important crocodylian skin dealer in Paraguay. All concurred in the belief that there were two species of caiman in the area and their descriptions were referable to *C. latirostris* and *C. yacare*. The hide dealer knew *Melanosuchus*, but all of the skins came from Bolivia or the Mato Grosso of Brazil. We talked to a Chamococo Indian in northern Paraguay that had seen a huge black and white caiman on a hunting expedition to Bolivia; it was so large that he was afraid to shoot it. He had never heard of this species (called *caimán*) in Paraguay.

Although it is possible that a *Melanosuchus*, possibly a young one, floated on water hyacinths down the Paraguay River more than 1,000 km from the Laguna de Cáceres in Bolivia to southern Paraguay, it seems unlikely. It is more probable that the animals in the stories from southern Paraguay had grown a bit with repeated telling. At one time, *C. latirostris* possibly attained lengths of 3 to 3.5 m (Medem, 1983), and especially large males of this species may be the basis for the Paraguayan *Melanosuchus* reports.

Crocodylus acutus Cuvier, 1807

There are three specimens of juvenile *Crocodylus acutus* in the U.S. National Museum of Natural History that were supposedly collected by Captain Thomas J. Page in Paraguay in the 1850s. Since there are no other records for the species south of the Orinoco River delta in Venezuela (Medem, 1983), we assume that these specimens have incorrect data.

Caiman Habitats

Medem (1983) compared the habitats of *C. latirostris* and *C. yacare*. He concluded that the former lives in quieter waters usually covered with floating and emergent vegetation, while the latter inhabits open waters that may or may not be flowing. Our data show a somewhat different pattern. The distribution of caiman species among habitat types is

shown in Table 1. A goodness-of-fit analysis of the occupied habitats (lumping rivers plus streams, and tanks plus temporary ponds) showed no significant association between species and habitat type ($n = 62$; $P > 0.10$). Nor was there a significant difference between the species' occurrence at sites with or without floating vegetation ($P > 0.30$). Six of 21 sites where *C. latirostris* occurred had enough floating vegetation that most of the animals were hiding in it, as did 16 of 41 sites for *C. yacare*.

Several reasons could help explain the discrepancies between our observations and Medem's (1983). Most of his information seems to have come from areas of sympatry, where habitat segregation might occur. Where we found the two species in the same area, *C. latirostris* was in more ephemeral habitats, and *C. yacare* inhabited permanent water. At Estancia Tinfunque in the Chaco, *C. yacare* was abundant in the main streams and surrounding marshes of the Pilcomayo and Montelindo rivers, albeit concentrated because of the dry conditions. Several fish species were migrating up the Montelindo and the caiman taken there were fat and full of food.

Caiman latirostris, in contrast, was present in cattle tanks, shallow marshes, and temporary ponds in the nearby uplands. Two adjacent tanks approximately 6 years old that were several kilometers from the other caiman habitats were inhabited by *C. latirostris*. One tank covered with the floating aroid *Pistia* contained about 50 young *C. latirostris* in 1- and 2-year-old cohorts, and the other that was bare of vegetation contained an adult *C. latirostris* protecting a creche of 20 yearlings. Neither tank contained fish nor ampullariid snails, although frogs (*Pseudis* and *Lysapsus*) were abundant in the vegetated tank. The juveniles were eating beetles, hemipterans, and diplopods, but the adult diets are not known. Subadults in temporary ponds in the area were eating frogs (Aquino, 1988).

Habitat segregation might also take place during the wet season. Most of our observations were made in the dry season while both species were concentrated, but there was some evidence that *C. latirostris* moved out of the dry season refuges into upland habitats more quickly than *C. yacare*. We found *C. latirostris* in several isolated temporary ponds only 2 days after they had filled with rain.

Local residents at many places told us that *C. yacare* was aggressive toward *C. latirostris* and would displace it when they came in contact. Given that *C. latirostris* has been subjected to more intense hunting pressure, the observations of the replacement of *C. latirostris* by *C. yacare* could be the result of a disproportionate reduction of the former by hide hunters. We saw mixed species groups of all age classes during our survey. *Caiman yacare* was always the more common species in the mixed groups. Where *C. latirostris* occurred by itself, it seemed to inhabit a wider range of habitats than it did when it occurred in sympatry with *C. yacare*. However, whether or not *C. yacare* really excludes

TABLE 1. Occurrences of different size classes of two species of caiman in Paraguay. Totals represent the number of sites in each habitat type where the species, and size classes within species, were observed. For instance, *Caiman yacare* was present in 15 lakes. In 12 of these, juveniles were present; in 14, subadults; and in 13, adults.

	River >20 m wide	Stream 2-10 m wide	Lake	Stock Tank	Temporary Pond	Marsh
<i>Caiman latirostris</i>	2	2	3	6	2	6
juveniles	—	1	1	2	—	4
subadults	—	—	2	2	2	4
adults	2	2	2	2	—	—
<i>Caiman yacare</i>	5	3	15	5	2	11
juveniles	2	3	12	3	—	11
subadults	3	2	14	2	2	2
adults	5	1	13	4	1	3

C. latirostris from using parts of the habitat is an open question.

Juvenile and subadult habitats did not differ from adult habitats in *C. yacare* ($n = 62$; $P > 0.20$, Table 1). About 40% of the sites had large areas of floating vegetation that were used by all size classes. Young *C. yacare* congregated in shallow water near the shore, while large individuals often stayed offshore in deeper water. The same pattern was documented for *C. crocodilus* in the Venezuelan llanos (Fitzgerald, 1988).

Juvenile and subadult *C. latirostris* appeared to live in different habitats than the adults ($n = 24$; $P < 0.02$). A large proportion of the juveniles and subadults was found in cattle tanks, temporary ponds, and shallow marshes, whereas adults were more often found in rivers, streams, and lakes, especially in areas where *C. yacare* was absent.

We did not identify any *Paleosuchus* in the field. Local hunters said they occurred in rivers and streams, often with rocks and strong currents.

SUMMARY OF HABITATS, DISTRIBUTIONS, AND STATUS OF POPULATIONS BY REGION

Southern Chaco

The flat, seasonally inundated lands west of the Paraguay River provide the largest block of essentially continuous habitat for caimans in Paraguay (Fig. 1). Contrary to Medem (1983), populations of *C. latirostris* and *C. yacare* occur in the south along the entire length of the Paraguayan Pilcomayo River, judging from records for both species from Salta Province, Argentina, near the intersection of Argentina, Paraguay, and Bolivia (Waller, 1987). Populations are reduced in some of these areas, but most of the region is quite inaccessible and caimans are protected on many of the ranches. As in all other localities subject to hunting, populations of *C. latirostris* are more likely to be decimated than those of *C. yacare*.

Moving north from the Pilcomayo, *C. latirostris* stops at about the Tropic of Capricorn. Here in the interior of the southern Chaco, access by road is easier and caiman population levels tend to vary, depending on the local hunting pressure. However, both species seem to persist at least in low numbers in most suitable habitats.

Northern Chaco

North of the Tropic line, *C. yacare* occurs to the limits of semi-permanent surface water (Fig. 2). Here, too, populations persist in all suitable habitats. In this region, hunting is most intense along the few major highways and in the marshes and oxbows along the Paraguay River. Populations are dense in more remote areas.

The absence of *C. latirostris* in the northern Chaco is not easy to explain (Fig. 2). In this area, dry season habitat is limited and *C. yacare* concentrates in dense groups in a few remaining bodies of water. Perhaps *C. latirostris* does not tolerate these conditions. The small ponds and cattle tanks inhabited by *C. latirostris* in the southern Chaco are scarce or absent in the northern Chaco.

Eastern Paraguay, Paraguay River Drainage

The rolling hills of eastern Paraguay break up the caiman habitat into isolated streams and river valleys, with their associated marshes and oxbows. Both *C. latirostris* and *C. yacare* inhabit the region and *P. palpebrosus* occurs in the streams of the extreme north. The lack of *C. yacare* records immediately east of the Paraguay River is probably an artifact of collecting. Local people said that they occur there and we see no reasons to doubt them.

Access is good and human population density is relatively high in this region and we know of no dense populations of caiman. However, both species still occur throughout the area, and populations should recover if protected. Because caimans are scarce, hunting per se does not seem

to be the most serious threat at this time; casual plinking by nocturnal fishermen appears to be an important mortality factor.

Eastern Paraguay, Paraná River Drainage

Caiman latirostris seems to be the only species of caiman in the Alto Paraná region. Habitats are almost entirely streams and rivers with the exception of several large reservoirs formed by the damming of the large rivers. Caiman populations are generally accessible and they have been hunted to low levels throughout the area, and current levels of hunting will eventually exterminate them in many places. *Caiman latirostris* in this region are often taken by baited hook, a practice that seems to have come with the recent influx of Brazilian immigrants. This method is deadly because even the most wary caimans can be taken this way.

Southern Paraguay, Marshes of Misiones and Neembucú

The extensive marshes at the confluence of the Paraguay and Paraná rivers are in many ways an extension of the wetlands of the southern Chaco. They coalesce with the extensive marshes of the Esteros del Yberá in Argentina. Both *C. latirostris* and *C. yacare* exist here in sympatry. Much of the area is accessible by road or boat, and hunting has been intense. The region is so large, however, that both species persist throughout in low numbers.

CONSERVATION PROGNOSIS

Until recently, the exploitation for hides of caimans in Paraguay was almost uncontrolled, and many populations were decimated. However, the prognosis for the future of Paraguayan caiman populations is improving for most areas because of a series of local and international efforts. The fact that small residual populations persist in almost all of the areas we visited indicates that caimans should be able to repopulate any area where they and their habitat are protected.

The most important instrument for the conservation of wildlife in general, and caimans in particular, has been, and continues to be, enlightened landowners. The national parks of Paraguay do not contain much caiman habitat, and time and again we found the most dense caiman populations on private ranches in areas where caiman were otherwise reduced to scattered individuals. The ranches Tinfunque, La Golondrina, Juan de Zalazar, Pozo Azul, and Viente-seis were especially noteworthy. The development of water sources for cattle has increased the dry season habitat for caiman. These have especially favored *C. latirostris*. However, the ranches are under increasing pressures from

poachers as a result of constantly improving transportation systems, human population growth, and a large influx of Brazilian immigrants. The largest ranches are the most effective at protecting caiman. Ranches are large in the Chaco and in the south but relatively small in eastern Paraguay.

Although caiman hides are still the basis for a large illegal market in Paraguay (Gaski and Hemley, 1988), there are indications that this traffic is diminishing more rapidly than the caiman populations. The international hide market is now under much tighter control, and prices have dropped considerably. At the time of our fieldwork, hunters received the equivalent of US\$1.50-\$4.00 per hide. Apparently the risks of fines and confiscation of skins are now high enough that skin trafficking is no longer good business. Prices were higher where the market was well organized, but in most places hunters sold skins to local general stores, where they were held for the chance visits of itinerant hide buyers.

Paraguay is signatory to CITES and does not issue export permits for commercially exploited wildlife. Although caiman skins are still smuggled, progress is being made; the largest tannery processing wildlife skins in Asunción has recently closed down. The combination of increased difficulty in marketing hides, increased awareness of conservation needs, reduced caiman populations, reduced prices, and increased action by governmental and international agencies has temporarily relieved some of the pressure on caimans. However, increased human populations, improved access to wildlands, habitat conversion to agriculture, and the construction of hydroelectric projects guarantee that the pressure will not only continue but has every likelihood of increasing again.

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APPENDIX 1. PARAGUAYAN SPECIMENS

Acronyms in parentheses list collections as designated by Leviton et al. (1985), plus the following: MCNI = Museo de Ciencias Naturales de Itaipú, Puerto Stroessner, Alto Paraná, Paraguay; and CITES = collections made during the present study, now temporarily housed at the Florida State Museum, Gainesville. The number following the collection designation is the number of specimens in the collection.

Caiman yacare

PARAGUAY: (USNM 4). ALTO PARAGUAY: Puerto Ramos, 7 km S Bahía Negra (MNHNP 10, CITES 27); Estancia Doña Julia, 1 km SE Puerto Caballo (MNHNP 2, CITES 22); Estancia Capitán Carmelo Peralta, Río Negro, 15 km N Puerto Caballo (CITES 6); Laguna General Díaz (CITES 15). AMAMBAY: 15 km S Bella Vista (CITES 1); Arroyo Chacalalina 4 km above mouth, 60 km SSW Bella Vista (CITES 2). BOQUERÓN: Estancia Pozo Azul, 60 km ENE Filadelfia (MNHNP 3). MISIONES: Villa Permanente de Yacyretá (MNHNP 1); Estancia Sarandy, 15 km SSW Santiago (CITES 8). ÑEEMBUCÚ: Estero Cambá near San Juan (MNHNP 22); Estancia Viente-seis, 8 km NE Tacuara (CITES 9). PARAGUARÍ 5 km E Mbuyapey (CITES 3). PRESIDENTE HAYES: Estancia Tinfunque, 20 km S Avalos Sánchez (MNHNP 9, CITES 17); Trans-Chaco Highway Km 45 (MNHNP 2); Estancia La Golondrina, 30 km NW Villa Hayes (MNHNP 2, CITES 6); Riacho Negro, 44 km W Concepción (MNHNP 4); Río Montelindo, near Trans-Chaco Highway (CITES 2); Estancia Juan de Zalazar, 2 km N Río Verde (MNHNP 26, UCM 3 [Scott and Lovett, 1975r]); Pozo Colorado (UCM 1).

Caiman latirostris

ALTO PARANÁ: Arroyo Parapá-cuá, 12 km N Limoy (CITES 1); Río Acaray, 2.5 km N Highway 7 (MNHNP 1); Río Itabó, 40 km N Puerto Stroessner (MCNI 3). AMAMBAY: Laguna Sununú, 15 km S Bella Vista (MNHNP 1). BOQUERÓN: Estancia Tinfunque, 8.5 km NW Avalos Sánchez (CITES 10); Estancia Tinfunque, 5 km NW Avalos Sánchez (CITES 1). CAAGUAZÚ: Yuque River (= Arroyo Yuquyry ?, MCZ 1); Río Yguazú, 6 km W Colonia Caacupé (CITES 3). CANENDIYU: Jejuí-guazú, 33 km N Curuguaty (MNHNP 1); Piratíy, 30 km N Puente Kyjhá (CITES 2). CENTRAL: Asunción (AMNH 2). CORDILERA: Lago Ypacaraí near San Bernardino (CITES 1). ITAPUA: Río Paraná, 11.9 km E Puerto San Rafael (UMMZ 1). MISIONES: Cabaña Guaviray, San Ignacio (MNHNP 1). ÑEEMBUCÚ: Estero Cambá near San Juan (MNHNP 2); Estancia Viente-seis, 8 km NE Tacuara (CITES 1). PRESIDENTE HAYES: Estancia la Golondrina, 30 km NW Villa Hayes (MNHNP 3). SAN PEDRO: Estancia Sanguina-cue, 10 km N Río Jejuí-guazú on High-

way 3 (CITES 1); Estancia Santa María, 17 km SSW Lima (CITES 2).

Paleosuchus palpebrosus

AMAMBAY: Río Apa at mouth of Arroyo Piri-pucú, 30 km SW Bella Vista (MNHNP 1).

Crocodylus acutus

PARAGUAY: (USNM 3).

Literature, Photographs, and Sight Records

The sight records and photographs were seen and confirmed by at least one of the authors. The literature records have not been confirmed by us.

Caiman yacare

ALTO PARAGUAY: Km 40, Riacho Mosquito; Puerto Casilda; Puerto Sastre (Müller and Hellmich, 1936). CENTRAL: Asunción (ANSP 2 in Medem, 1983). CONCEPCIÓN: Centurión; Estrella (Müller and Hellmich, 1936). PRESIDENTE HAYES: Estancia Rincón Charrúa, Trans-Chaco Highway Km 275 (P.W. Myers, transparency). DEPARTMENT NOT SPECIFIED: Northern Chaco (Müller and Hellmich, 1936).

Caiman latirostris

GUAIRÁ: Villarrica (Schenkel, 1902). MISIONES: Estancia Sarandy, 15 km SSW Santiago (sight record). PARAGUARÍ: César Barrientos (MNHNP, photograph); 5 km E Mbuyapey (skin seen). PRESIDENTE HAYES: 100 km W Pozo Colorado (carcass seen); Estancia Tinfunque, Avalos Sánchez (sight records).

Caiman sp.

BOQUERÓN: Estancia La Dorada, 40 km SE Pedro P. Peña (J.F. Facetti, Jr., photograph); Pedro P. Peña (sight record).