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MANEJO DE LOS CROCODILIDOS VENEZOLANOS

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A REVIEW OF THE CONSERVATION AND MANAGEMENT  
OF VENEZUELA'S CROCODILIANS.

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## ABSTRACT

There are notable gaps in the knowledge required for the conservation and management of Venezuela's crocodilians. The taxonomic status of the sub-species of Caiman crocodilus is not clear. About 72% of the country lacks records for any crocodilian species. In general, the censusing methods that are being employed are of doubtful validity and do not permit inter-species or inter-habitat comparisons to be made. No long-term monitoring of crocodilian populations have yet been carried out in Venezuela. Research into factors that may affect the population biology of crocodilians has tended to be descriptive and intuitive, rather than comparative and experimental. The recent change in public opinion towards a positive view of crocodilians has about as much scientific basis as the previous negative view.

The conservation programs with Crocodylus intermedius have been unsuccessful so far. The two main proposals for the management of Caiman crocodilus are the harvesting of wild populations and captive rearing. These proposals are potentially conflictive.

Recommendations are made for: a national project on the taxonomic status of Caiman crocodilus; a national survey of crocodilians; research into censusing methods; long-term monitoring of crocodilian populations that will not be under hunting pressure; basic research into crocodilian biology; the quantification of illegal hunting; research publications; the conservation of Crocodylus intermedius; and the management of Caiman crocodilus.

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## 1. INTRODUCTION.

Whether a country wishes to protect an endangered species of crocodilian or to manage a species that is considered to be relatively common, during the course of their development both plans of action will produce the following questions:

- a) Which species exist in that country?
- b) Where?
- c) How many?
- d) Are those numbers stable, declining or increasing?
- e) What are the factors that influence population trends?

These five basic questions can only be answered with good data bases with regard to:

- a) taxonomy.
- b) geographical distribution.
- c) censuses.
- d) monitoring.
- and e) the factors (both natural and man-induced) that affect populations.

During the 7th Working Meeting of the IUCN/SSC Crocodile Specialist Group that was held in Caracas during 1984, a series of eight papers were given (Gorzula and Paolillo, 1984; Mago de Perez, 1984; Medina, 1984; Quero de Peña, 1984; Ramo and Busto, 1984; Rivero Blanco and D'Andria, 1984a; Seijas 1984a and 1984b) that summarized much of the present knowledge and status of Venezuela's crocodilians. This paper will use that information in order to highlight what are the major gaps in our knowledge with regard to the five areas outlined above, and will then critically review the existing programs for protection and management. Finally, a series of suggestions will be made as to which areas of study could be given priority by the institutions that are involved in crocodilian research in Venezuela. The analysis of the case-history of Venezuela is intended to provide insights that will be applicable to similar problems that are being confronted by other countries.

## 2. THE MAJOR GAPS IN KNOWLEDGE.

### 2.1. Taxonomy.

At the present time there are considered to be five species of crocodylians represented in the fauna of Venezuela: Caiman crocodilus, Paleosuchus palpebrosus, Paleosuchus trigonatus, Crocodylus acutus, and Crocodylus intermedius. In addition, two sub-species of Caiman crocodilus (C. c. crocodilus and C. c. fuscus) are recognized (Medem, 1983). It is rather surprising to note that, up to the time of writing this paper, no taxonomic studies have been made of venezuelan crocodylians at a regional level. There are, however, two species that apparently warrant attention.

In the case of Caiman crocodilus it is assumed that the sub-species Caiman c. fuscus inhabits the northwestern part of the country in the Maracaibo basin and in the states of Yaracuy and Falcón. This sub-species is "replaced" by Caiman c. crocodilus in the rest of the territory. In fact, it is pure speculation as to where and whether there is a zone of intergradation between these sub-species or if some geographical barrier such as the venezuelan Andes and the coastal range separate them. Furthermore, the sub-specific status of Caiman c. crocodilus in Venezuela is not at all clear. The ecological studies of populations of Caiman crocodilus in the western Llanos of Venezuela (Ayarzagüena, 1980; Godshalk, 1976; Maness, 1976; Marcellini, 1979; Staton and Dixon, 1975 and 1977) when compared to the study that was carried out in the savanna lagoon systems of southeastern Venezuela (Gorzula, 1978) illustrate differences in general behaviour, in population structure and dynamics, and also in the average maximum size reached by adults in these two areas. There is also anecdotal information from commercial hunters that the hides of Caiman crocodilus from the Orinoco Delta were of less value than hides from the western Llanos, because they were smaller, more ossified and had more "buttons". The basis for these differences is open to speculation.

The Orinoco crocodile, Crocodylus intermedius, has likewise been reported as presenting various "phases". Medem (1981) describes and illustrates three color phases from Colombia. These are the mariposo with a grey or grey/green dorsum and black patches, the amarillo with light brown or sand

colored dorsum and flanks and a few dark patches, and the negro with dark grey or black dorsum and flanks. Medem notes that a captive male of the negro phase changed to the amarillo phase over a two year period of captivity. Possibly, a similar situation exists (or existed) in Venezuela. Lopez Corcuera (1984) reports that there were three varieties of Orinoco crocodile recognized by hide hunters in Venezuela: the green (caimán verde) of the Orinoco, the yellow (caimán amarillo) of the western Llanos, and the "tiger" (caimán tigrito) that was apparently shorter, fatter and stronger than the other two varieties and in addition had very distinct round black markings along the flanks. As with the previous species no studies have been carried out that would permit an interpretation of these apparent differences between populations or individuals.

## 2.2. Geographical Distribution.

In order to evaluate the present state of knowledge for the five species (Figures 1, 2, 3, 4, and 5) recorded from Venezuela the known distribution of each species has been plotted using a grid of 0.5 degrees of latitude by 0.5 degrees of longitude. Each square of the grid covers a little less than 3,000 km<sup>2</sup>, there being a total of 354 squares that cover continental Venezuela and the island of Margarita. The Venezuelan Esequibo Territory has not been included in this analysis. Shaded squares represent the existence of one or more localities within that square for the species under consideration.

Data for Caiman crocodilus (Figure 1) was compiled from Ayarzagüena, 1980; Gorzula and Paolillo, 1984; Medem, 1983; Ramos, Danielewski and Colomine, 1981; Riveño Blanco and D'Andria, 1984b, Rodriguez and Robinson, 1984; Seijas 1984b and 1984c; and Staton and Dixon, 1975. Distribution data for Paleosuchus palpebrosus (Figure 2) and Paleosuchus trigonatus (Figure 3) is based on Gorzula and Paolillo (1984). In the case of the two species of Crocodylus records prior to 1974 have not been included. The distribution of Crocodylus acutus is based on Seijas (1984a) and that of Crocodylus intermedius is based on information from Blohm, 1982; Franz, Reid and Puckett, (unpublished m/s without date); Godshalk, 1982; Godshalk and Sosa, 1978; Novoa, unpublished communication without date; and Ramo and Busto, 1984.

All five species show a marked discontinuity of known localities within the probable range of each.

Finally, the information for all five species has been pooled and placed on a single map (Figure 6). A simple calculation of dividing the number of blank squares by the total number of squares of the grid indicates that for 72% of the territory of Venezuela there are no records of any species of crocodilian.

A relatively large tract of land (some 20,000 km<sup>2</sup>) that merits attention is the Orinoco Delta. Large crocodilians are seen in that area from time to time. Whether these are Crocodylus acutus, Crocodylus intermedius, or even Melanosuchus niger is not known. During the intensive hide hunting period of the 1930's and 1940's skins of Melanosuchus niger were sold in San Fernando de Apure (Lopez Corcuera, 1984), but it is not known if they originated in Venezuela.

### 2.3. Censuses.

At present in Venezuela there are four regional surveys that are being carried out in order to estimate the densities of crocodilian populations.

The first, and certainly the most intensive, is being carried out by the National Wildlife Service of the Ministry of the Environment and Renewable Natural Resources (MARNR) in the western Llanos with Caiman crocodilus. The results of the first year of this project have been published by Seijas (1984c). The object of the censuses is to calculate the extraction level for Caiman crocodilus in ranches that have applied for licences for commercial hunting. The basic methodology has been direct counts of Caiman crocodilus by means of spot-light (night-time) surveys of lagoons where the caimans are concentrated during the dry season.

The same institution is carrying out surveys of Crocodylus acutus along the northern coast of Venezuela (Seijas, 1984a) and as an incidental result of this project is obtaining counts of Caiman crocodilus in the same habitats (Seijas, 1984b). In this case the methodology consists of spot-light surveys, apparently at any time of the year, that express the counts made as individuals/km of river or as individuals/km of shore-line of lake.



The Universidad Nacional Experimental de los Llanos Occidentales "Ezequiel Zamora" (UNELLEZ) is surveying populations of Crocodylus intermedius in the western Llanos (Ramo and Busto, 1984). This survey has been by means of direct counts of crocodiles from a light aircraft and has also quantified the changes in the observed numbers of crocodiles with respect to the hour at which the survey was made.

Finally the División de Cuencas e Hidrología of the state-owned company C.V.G. Electrificación del Caroní (EDELCA), which is responsible for the hydro-electric development of the Caroní River in southern Venezuela, has been carrying out censuses of Caiman crocodilus, Paleosuchus palpebrosus and P. trigonatus (Gorzula and Paolillo, 1984) as part of a general inventory of terrestrial and aquatic ecosystems of the Caroní River basin. The densities have been expressed as numbers of individuals observed/km of shore-line, and were based on spot-light surveys.

Of these four surveys, the MARNR's of Caiman crocodilus in the western Llanos is perhaps the most reliable. Its methodology was designed on a series of broad-based ecological studies that have been made in that area. The works of Ayarzagüena (1980), Godshalk (1976), Maness (1976), Marcellini (1979), and Staton and Dixon (1975) have all contributed to the establishment of the following generalities with regard to Caiman crocodilus in the western Llanos:

- a) Due to a marked dry season in that area, virtually all the Caiman crocodilus concentrate in refuge lagoons during the months of March and April.
- b) Due to the characteristics of these lagoons, which are usually devoid of vegetation and with relatively clear banks, the spot-light counts will give a direct count of about 90% of the real population in any one body of water.
- c) The counts do not detect hatchlings and thus represent a close approximation of the total number of juveniles, sub-adults and adults.
- d) The size structure of these concentrations of caimans is relatively constant.

The personnel of the National Wildlife Service also studied the relationship between diurnal and nocturnal counts and arrived at the following formula for the estimation of the total population of non-hatchling Caiman crocodilus of a given ranch. The equation is as follows:

$$P = [N + (D \times 3.29)] / 0.9$$

where P = the estimated population for the ranch

N = the number of caimans counted during spot-light surveys

D = the number of caimans counted in lagoons only  
visited during the day

3.29 = the correction factor for converting day counts to  
night counts

and 0.90 = the correction factor for converting observed counts  
to estimated real numbers.

With the other three censusing programs the situation is very far from arriving at formulae that may permit the estimation of the real numbers of the crocodilian species under study. Some of the problems inherent to the surveying of crocodilians have been touched upon recently by Gorzula (1984) and Magnusson (1984) in the IUCN/SSC Crocodile Specialist Group Newsletter. Those problems which relate specifically to the programs being carried out in Venezuela are outlined below:

- a) In the case of riverine and coastal species it is not known if the counts are of static populations or whether they are of partially or totally migratory populations that move between the rivers and adjacent marshes and streams during the course of the year.
- b) In general, for night-time surveys, the planning of these with regard to factors such as the state of the tide, the general weather conditions, the hour at which the survey starts, whether there is moonlight etc, is based on the experience and educated guess-work of individual workers.
- c) Most workers are in agreement that for each species there are behavioural differences between individuals and between populations that result in different responses to the approach of an observer on foot, in a launch with an out-board motor, paddling a canoe, in a helicopter, or in an aeroplane. These

- differences are sometimes the result of previous hunting pressure, but not invariably.
- d) In the case of Caiman crocodilus, which inhabits a wide variety of habitats there is no single expression of measurement that permits interhabitat comparisons to be made. For riverine habitats and large lakes densities are usually expressed as numbers of individuals/km of shore-line. However, in narrow rivers and streams a caiman may be using both banks. In shallow lagoons and marshes it is open to discussion as to whether the density should be expressed as a function of the length of shore-line or as a function of the surface area of the body of water or both.
  - e) During extensive surveys in areas where it is unlikely that a return visit will be made it is very difficult to project what would be the conditions of a lacustrine or riverine habitat during the other seasons of the year.
  - f) It is not known what the effect of fragmentation of aquatic habitats could have on crocodilian densities. Would a series of twenty half hectare ponds hold more caimans than a single 10 hectare lagoon? If so, how should habitat fragmentation be measured?
  - g) Finally, the majority of crocodilian workers in Venezuela report densities and numbers of non-hatchlings, and seldom take into account the size- or age-structure of populations.

#### 2.4 Monitoring of Populations.

The hunting to virtual extinction of both Crocodylus acutus and Crocodylus intermedius during the 1930's and 1940's followed by a very intense hunting pressure on Caiman crocodilus during the 1950's and 1960's has been well documented by Lopez Corcuera (1984), Medem (1983), Mondolfi (1965), and Rivero Blanco (1974). Although there are no records of population densities for this period, it is estimated that literally millions of individuals of these species were killed in Venezuela. In 1974 a total ban on the hunting of crocodilians was imposed. In recent years

isolated populations and individuals of Crocodylus acutus (Seijas, 1984a) and Crocodylus intermedius (Blohm, 1982; Franz, Reid and Puckett unpublished m/s; Godshalk, 1982; Godshalk and Sosa, 1978; Novoa unpublished communication; and Ramo and Busto, 1984) have been reported within their respective historical ranges. Whether these reports are heralding the recuperation of either species or are simply relict populations that are stable or on the decline is not known.

In the case of Caiman crocodilus it is generally assumed that the wild populations have recovered since the hunting ban was imposed. This assumption is based on the fact that large numbers of Caiman crocodilus can be found in the Llanos today. In 1982 a National Wildlife Service team counted a total of 44,797 Caiman crocodilus in 16 ranches (total area 2,338 km<sup>2</sup>) and estimated the population of non-hatchling caimans to be 55,072 (Seijas, 1984c) Unfortunately there is no data of population levels prior to the start of commercial hunting or even prior to the implementation of the hunting ban. Some workers have even speculated that the present day populations of Caiman crocodilus are above the historical levels because this species has expanded into the vacant niche left by Crocodylus intermedius. Gorzula and Paolillo (1984) suggest that populations of Caiman crocodilus have increased in southern Venezuela during this century due to the creation of new habitats (dams, cattle ponds and borrow pits) by the activities of man.

However, apart from the plans of the MARNR to monitor populations of Caiman crocodilus in those ranches where hunting was carried out in 1983 and 1984, no long-term or even short-term monitoring of a population of any species of crocodylian has yet been carried out in Venezuela.

## 2.5. Factors that Affect Crocodylian Population Dynamics.

### 2.5.1. Natural Factors.

The majority of the studies of wild populations of crocodylians in Venezuela have been of a descriptive nature (Ayarzagüena, 1980; Blohm, 1948; Castroviejo, Ibañez and Braza, 1976 and 1977; Godshalk, 1976; Gorzula, 1978; Maness, 1976; Marcellini, 1979; Ramos, Danielewski and Colomine, 1981; Rivero Blanco, 1974; Staton and Dixon, 1975 and 1977; Seijas, 1979; and Seijas and Ramos, 1980). Apart from Blohm's (1948) paper on Crocodylus intermedius all of the others have dealt with Caiman crocodilus. All of these

studies have tended to have been restricted to a single locality, and a single season or a single year. Some authors have recognized that there do exist differences in the ecology of Caiman crocodilus populations at both a national and international level, but rarely (if ever) attempt to explain them.

The only study that has examined the effect of environmental factors on the population dynamics of a crocodylian species in Venezuela has been that of Staton (1976). In this paper Staton compared the clutch size and mean egg size in nests of Caiman crocodilus at two distinct localities in the western Llanos in two separate years (1973 and 1976) and related differences to the amount of flooding at the two study sites, the amount of rainfall, and the time at which nesting occurred during the breeding season.

#### 2.5.2. Man-induced Factors.

Illegal commercial hunting of crocodylians is known to exist in Venezuela. It is generally assumed to be most prevalent in the southwestern Llanos and the Orinoco Delta, from where the hides are exported (as contraband) to Colombia and Guyana and Trinidad respectively. The hunting pressure is also assumed to be principally upon Caiman crocodilus. However, no concrete data that would permit a critical evaluation of illegal commercial hunting in Venezuela appears to exist.

Likewise, subsistence hunting for food (eggs and meat) and for the supposed curative properties of teeth (Lopez Corcuera, 1984) and eggs (Gorzula and Paolillo, 1984) has only been briefly examined for the Alligatoridae in southern Venezuela by Gorzula and Paolillo (1984).

The few data that do exist with respect to habitat modification by the activities of man have stressed the overall positive effect on populations of Caiman crocodilus in the western Llanos (Ramos, Danielewski and Colomine, 1981) and in southern Venezuela (Gorzula and Paolillo, 1984).

#### 2.5.3. Education.

In the long-term the survival of crocodylians in Venezuela will depend on the attitude of the general public and their politicians, rather than on the views of a few dozen biologists. The attitudes quite often depend on "mental images" which may be very far from reality (Gould and White,

1974). Lopez Corcuera (1984) has summarized some of the popular views that existed with respect to crocodilians when they were abundant.

Humboldt stated:

" It is improbable that the day will arrive to liberate from crocodiles a country in which the labyrinth of rivers without number bring every day fresh hoards from the eastern drainage of the Andes, by means of the Meta and Apure to the coasts of Spanish Guayana. All that will be brought with the progress of civilization will make these animals more timid and help with the task of putting them to flight."

The naturalist Father Gumilla wrote:

" What definition could be found that would adequately embrace the frightful ugliness of the Caimán? It is the very same ferocity and the clumsy abortion of the greatest monstrosity, the horror of all living beings; so formidable, that if the Caimán looked at itself in a mirror, it would run away trembling. The most life-like fantasy could not paint a more appropriate Satan than by portraying itself with those characteristics of the Caimán."

A poem in a reading primer for children read:

" Ferocious, warty and ugly  
sleeping on the beach he shows  
his two rows of teeth.  
And everytime I see him  
stretched out and sun bathing  
with chills I think  
of the innocent beings  
that this monster has eaten  
by the river side."

A school textbook taught the following about natural history:

" LESSON 25 - the piranhas

The Llanos are beautiful.

But in the Llanos harmful animals abound.

In some rivers are found the piranhas.

LESSON 26 - the electric eel and the caiman

In the Llanos live other dangerous animals.

They are savage animals, like the electric eel, the caimán, the jaguar and the snake.

The Llanos are beautiful but....."

Beliefs such as those above probably resulted in the general view that commercial hunting to extinction of crocodilians would be a service to public safety. Today public opinion seems to be moving to the other extreme and the "old myths" are being replaced by "new myths". These new myths find their ways into films, popular books, and even grant proposals and scientific publications. They should be regarded as myths, not only because there is no scientific information to support them, but also because in the context in which they are used they are meant to express something totally different. Five of the most frequently used new myths and the implications behind them are outlined below:

- a) The Orinoco crocodile is exclusively a fish-eater..... implying that crocodiles are not usually dangerous to man and therefore we can repopulate rivers with them with no danger to the local inhabitants.
- b) The Orinoco crocodile was very important in maintaining river courses in the Llanos because their movements aided the movement of sediments.....implying that flash-floods in the Llanos is the repayment for the overkill of crocodilians.
- c) The Orinoco crocodile and the spectacled caiman were very important in controlling populations of piranhas, the latter being the principal predator of fishes that are of commercial value.....implying that abundant crocodilians go hand in hand with the development of commercial fisheries.

- d) The Orinoco crocodile maintained the ecological balance of the populations of fishes, birds mammals in the Llanos.....this vague statement implies that the reduction of crocodiles has resulted in a negative alteration of the Llanos ecosystems.
- e) The Orinoco crocodile's excrement was very important for the primary productivity of the Lanos ecosystems.....implying that the biological productivity of the Llanos was degraded with the extermination of crocodiles.

When and where these beliefs started is not known. (b) and (c) seem to have some basis with phenomena observed by the inhabitants of one or more specific areas of the Llanos, and (e) seems to have been borrowed from Fittkau's (1970) hypothesis on the role of caimans in the nutrient regime of the mouth-lakes of Amazon affluents.

Finally, it should be mentioned that the crocodilian workers who are responsible for divulging the knowledge about Venezuela's crocodilians tend to publish much of their reasearch as internal manuscripts of universities and other organizations. These publications are difficult to obtain and therefore underused.

### 3. THE CONSERVATION AND PROTECTION OF CROCODILIANS IN VENEZUELA.

Although two endangered species of crocodilian, Crocodylus acutus and Crocodylus intermedius, are found in Venezuela and given a general umbrella protection by the law, specific conservation programs only exist with Crocodylus intermedius.

On the positive side it has been amply demonstrated in Venezuela that Orinoco crocodiles not only survive but also breed in captivity. The two female crocodiles in the Parque Loefling (Ramirez, Castillo and Gorzula, 1977) produced nests with fertile eggs in 1981, with 56 and 36 eggs respectively, showing that females over twenty five years of age are still fertile. There are also motivated people (notably Tomás Blohm, Pedro Trebbau, Robert Godshalk, Evelio Sosa, and Iván Darío Maldonado) who have worked for the conservation of this species over the years.



Unfortunately, although the population of captive Crocodylus intermedius in the UNELLEZ, the Parque Loeffling, the Hato El Frío, the MARNR field station in Puerto Ayacucho, the Parque del Este (Caracas), the Parque El Pinar (Caracas), the Parque Zoológico Bararida (Barquisimeto), the private installations of Tomás Blohm, and the private installations of Evelio Sosa has fluctuated from 1974 to 1984 between 40 to 60 adults and sub-adults, and although during these ten years at least 24 nest were produced, of which 14 were known to have been fertile, there has been no significant production of young crocodiles. It is also interesting to note that, inspite of what would appear to be ideal material for research by students and crocodilian workers, the only document that has been produced to date that deals with the husbandry of Orinoco crocodiles and provides first-hand data is that of Blohm (1982).

A variety of the problems that have contributed to the failure of a national captive breeding program are outlined below:

- a) Most of the crocodiles are kept as "curiosities" in concrete tanks where nesting would be impossible.
- b) The majority of captive crocodiles have not even been marked, measured and sexed.
- c) Where crocodiles have been paired and given adequate space for nesting, the material available is usually construction sand rather than river washed sand. This has contributed to mortality by water-logging killing embryos, and by it being virtually impossible for the hatchlings that do survive to get out of the nest.
- d) Hatchlings that do manage to survive the nest are frequently left to the care of inexperienced labourers who do not know how to feed them.
- e) Crocodiles in general are inadequately fed. Those in one zoological park have been fed for ten years on a diet of raw beef lung. In this case the sub-adults have been examined and the majority show growth deformities including curved snouts, shortened mandibles, and in three cases an apparent resorption of the base of the tail resulting in hunched lower backs.

- f) In the case of the Parque Loeffling there was a reasonable production of hatchlings during 1974 and 1976. The 24 individuals that were reported in 1977 (Ramírez, Castillo and Gorzula, 1977) had dropped to 6 by 1980. Apparently there was competition in both age classes that resulted in the establishment of one or two dominant individuals that prevented others from feeding. Figure 7 shows the size data that exists for 14 of the Crocodylus intermedius that were in the Parque Loeffling, compared to the growth rate of a captive Melanosuchus niger (Dowling and Brazaitis, 1966). The wide range of lengths for any one year-class of Crocodylus intermedius illustrates the variability of individual growth rates in this group of animals.
- g) Finally, the level of education of the people in charge of captive crocodiles in some institutions leaves much to be desired. In one place the vet in charge donated the eggs of two nests to his family and friends (as food!). In another, a crocodile that was kept in a pen was shot by persons unknown and its teeth removed. And in yet another instance there is a breeding female that is totally blind because the keepers constantly throw sticks and stones at her head, so as to make her move for the visitors.

#### 4. MANAGEMENT PROGRAMS IN VENEZUELA.

That Venezuela's crocodylians are potentially a valuable renewable natural resource is not a new idea. Over the years a series of publications (Blohm, 1973; Brazaitis and Watanabe, 1982; MARNR, 1982; Rivero Blanco, 1968 and 1973) have put forward proposals for crocodylian management. These in turn have apparently stimulated a number of research projects that have investigated aspects of crocodylian biology and/or ecology with a view to contributing to future management plans (Belda, in preparation; D'Andria, 1980; Gutiérrez, in preparation; Ramos, 1975; Rivero Blanco, 1974; Rodríguez, in preparation; and Rodríguez and Robinson, 1984). Although it is implicit in some of these studies that Crocodylus intermedius could theoretically be subject to management in the distant future, the species emphasized by all of them is Caiman crocodilus. At the present time there

are three schools of thought with regard to the management of Caiman crocodilus:

#### 4.1. Proponents of Harvesting of Wild Populations.

In 1982 Venezuela began an experimental program for the commercial harvesting of Caiman crocodilus (Quero de Peña, 1984). This program was extensively discussed during the 7th Working Meeting of the IUCN/SSC Crocodile Specialist Group. The general consensus of opinion of the crocodilian workers at this meeting was that the scientific basis for calculating extraction levels is sound, but that the monitoring of hunted populations and strict controls are essential to the plan in order to prevent abuses. The main criticism of the program is related to whether it is applicable to other areas of Venezuela. The management plan is designed, on the basis of studies made in the western Llanos, to harvest 50% of the "surplus males" (i.e. those bigger than a total length of 1.80 m) in any one population. However, Gorzula (1978) when reporting the size structure of a population in southeastern Venezuela did not indicate the existence of any individuals of that size. In fact, only 4 individuals out of 137 captures were longer than 1.50 m. Subsequent work by Gorzula and Paolillo (unpublished data) has yet to discover the presence of Caiman crocodilus that would be even near to the minimum legal size established for commercial hunting.

#### 4.2. Proponents of Captive Rearing for Commercial Purposes.

The supporters of this form of management oppose the hunting of wild populations with the argument that there is not yet enough information about the biology of wild populations of Caiman crocodilus to permit a scientifically sound management plan to be designed, nor could one ever be adequately controlled. They believe that captive rearing would enable not only farmers, but also the national and international organizations involved in the trade of crocodilian products, to exert a very tight control over this resource. Critics of this alternative state that it is doubtful whether the captive rearing of a low-quality and slow-growing crocodilian would ever make a profit.

#### 4.3. Opponents to Commercial Management of Crocodilians.

Medem (1983) stated:

" Whilst subsistence hunting and fishing by indians and colonists is not a determining factor in the extinction of animals, as soon as commerce appears the situation changes, and in a relatively short period of time, this strong negative impact obliterates the species and degenerates into the ecological disequilibrium of the ecosystem."

There is a genuine fear among some wildlife workers, both within and outside Venezuela, that management programs (whether the harvesting of wild populations or captive rearing programs) may be a Pandora's box in those areas where "commercially recuperated species" and endangered species are sympatric. They believe that with more crocodilian products going on the international market, the more consumer demand will be stimulated, and that this in turn will stimulate poaching and contraband.

#### 5. DISCUSSION AND RECOMMENDATIONS.

This review has limited itself to the gaps and problems in crocodilian research that are directly applicable to the conservation and management of Venezuela's crocodilians. It has also outlined some of the problems and areas of conflict in existing conservation and management programs. It should be noted that there is a National Commission of Crocodilian Workers in Venezuela, consisting of members from government agencies (such as the Ministry of the Environment and the National Guard), the universities, the zoological parks, and other organizations (such as EDELCA), which meet regularly under the coordination of the Fundación para la Defensa de la Naturaleza (FUDENA). This commission is well aware of the themes that have been covered in this manuscript, and has periodically discussed the following recommendations that arise from this review:

##### 5.1. A National Project on the Taxonomic Status of Caiman crocodilus.

This is essential for any management plans with this species. As a first approximation, a detailed morphometric and scale-count study should be designed and carried out with populations in at least the Maracaibo Basin, the western Llanos, the Orinoco Delta,

and the El Manteco Region. This project could form part of a larger project at a continental level.

5.2. A General National Survey of Crocodilians.

This should emphasize the areas of Venezuela for which there are no records. In those areas which are sparsely populated the logistics required would be expensive. Therefore, the survey would probably have to be a long-term project. It should include the collection of morphometric and scale-count data for all crocodilian species, but with emphasis on Caiman crocodilus, so as to provide additional information for the project outlined in 5.1.. This project should also establish which biotic and abiotic characteristics of crocodilian habitats are to be measured and/or recorded. For example, Paolini and Gorzula (unpublished information) recently carried out limnological analyses of 10 Caiman crocodilus and 5 Paleosuchus triconatus habitats in southern Venezuela. The range of values for conductivity, Chloride, Sodium, Potassium, and total cations fell into two distinct groupings according to the habitats of the two species. The values for temperature, pH, alkalinity, hardness, Calcium, and Magnesium overlapped only slightly for the habitats of the two species. Thus, in southern Venezuela the limnology of crocodilian habitats would appear to be an important component of a general survey.

5.3. Research into Censusing Methods.

Although the general survey proposed in 5.2. should routinely record the numbers of crocodilians seen in a given length or area of habitat, and detail the conditions under which the observations were made, separate research into censusing methods is needed. Some aspects of this research, such as the effect of the weather conditions, the time of night (or day), the state of the tide, and the phase of the moon on observed counts, could be the subjects for graduate theses of university students. In addition, research into practical methods for estimating the size or age-structure of populations is needed.

#### 5.4. Long-term Monitoring of Populations.

Although the monitoring of commercially-hunted populations of Caiman crocodilus has already been programmed by the National Wildlife Service of the MARNR, there is a need for the monitoring of both the absolute numbers and the size-structure of selected populations of crocodilians. These populations should be in areas which are unlikely to receive any significant hunting pressure during the monitoring period. This program must be designed to monitor the effects of natural factors, such as droughts, that could affect crocodilian population dynamics.

#### 5.5. Basic Research into Crocodilian Biology.

There is a need to establish, at a national level, what are the areas of crocodilian biology that need to be investigated with regard to the natural factors such as nest predation, egg survival, and hatchling survival that may affect population dynamics. This type of research must be orientated to both a comparative and experimental level.

#### 5.6. An Evaluation of Illegal Hunting of Crocodilians.

This could only be designed with a close cooperation between the Ministry of the Environment, the National Guard, and those international organizations that monitor trade in crocodilian products.

#### 5.7. Research Publications.

Of the 45 references cited in this paper that deal with venezuelan crocodilians, only 11 would be readily obtainable through the usual inter-library loan systems. Not only should the crocodilian workers in Venezuela make an effort to publish their research in obtainable national or international scientific journals, but it should also be considered whether the majority of the existing unpublished theses and reports could be gathered together and published as a special volume of "collected papers".

5.8. The Conservation of *Crocodylus intermedius*.

A single national conservation program, involving at least the MARNR and FUDENA, is long overdue. Since wildlife cannot be owned, either by institutions or by individuals, it would be feasible to confiscate those *Crocodylus intermedius* that are maintained in poor conditions and transfer them to places which are suitable.

5.9. The Management of *Caiman crocodilus*.

The harvesting of wild populations and the captive rearing for commercial purposes of this species are potentially competitive and probably mutually exclusive. It is therefore necessary that the venezuelan government establishes which form of management is to be implemented over the next decade. With this clarification research can be adapted to the needs of either one.

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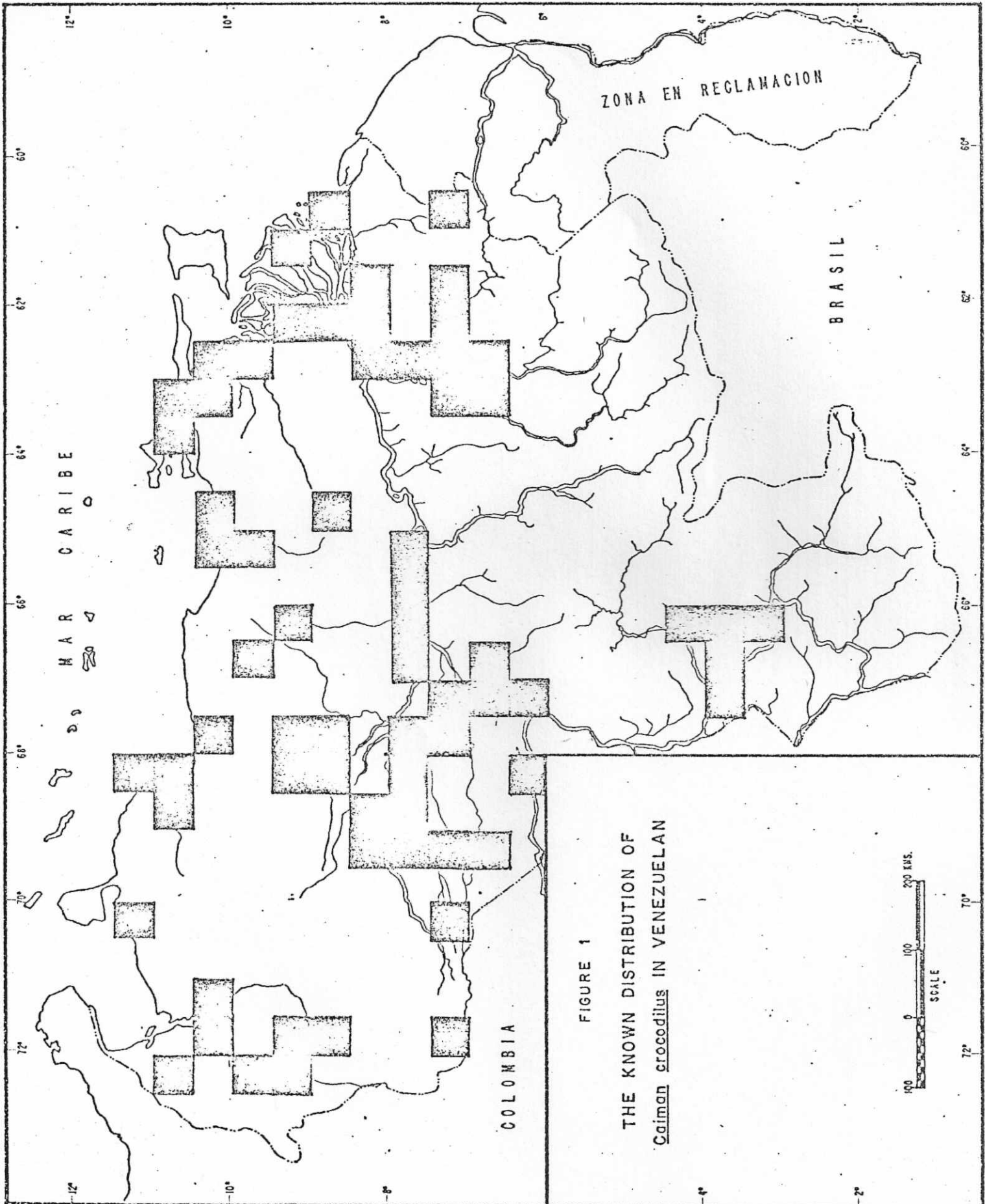
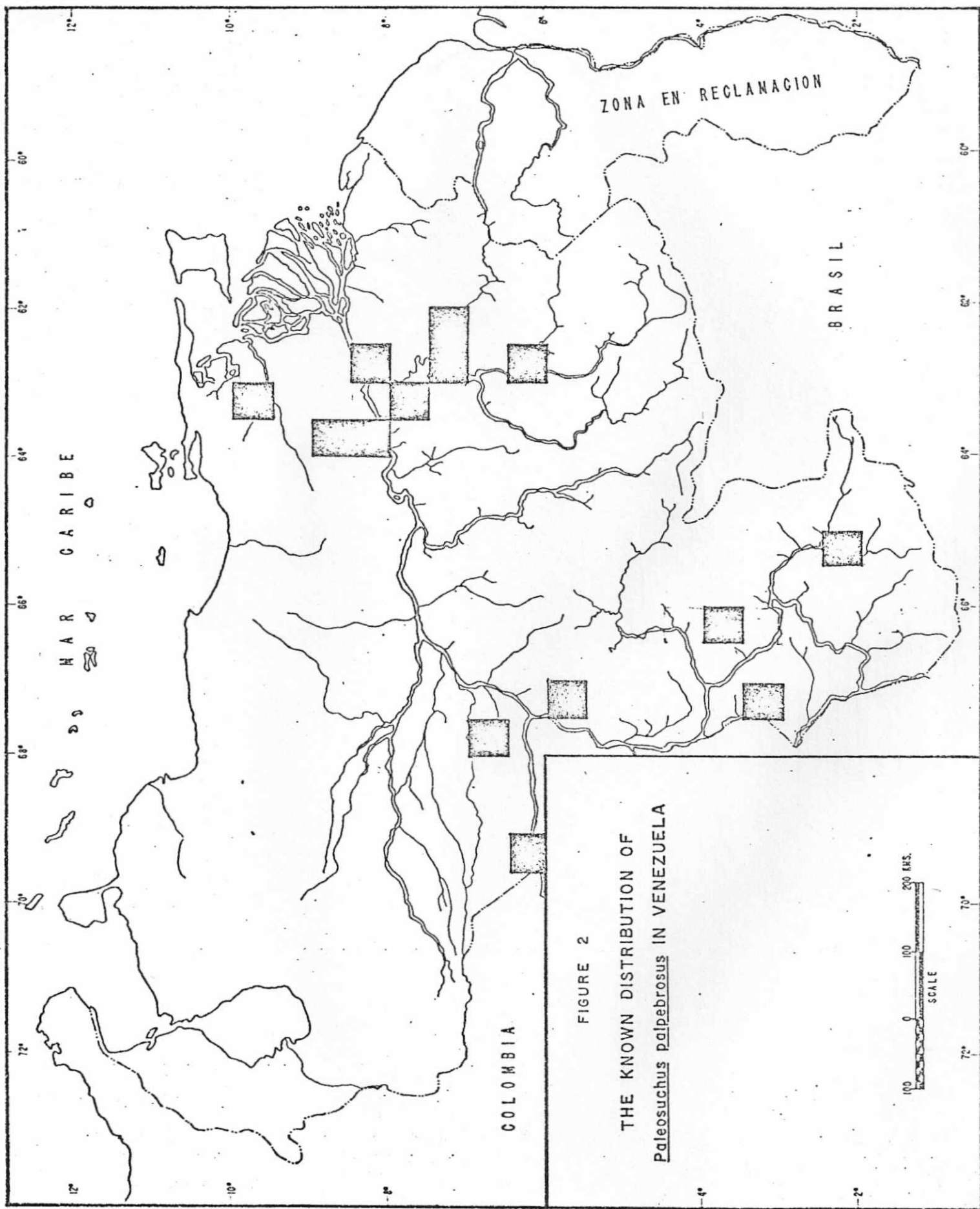
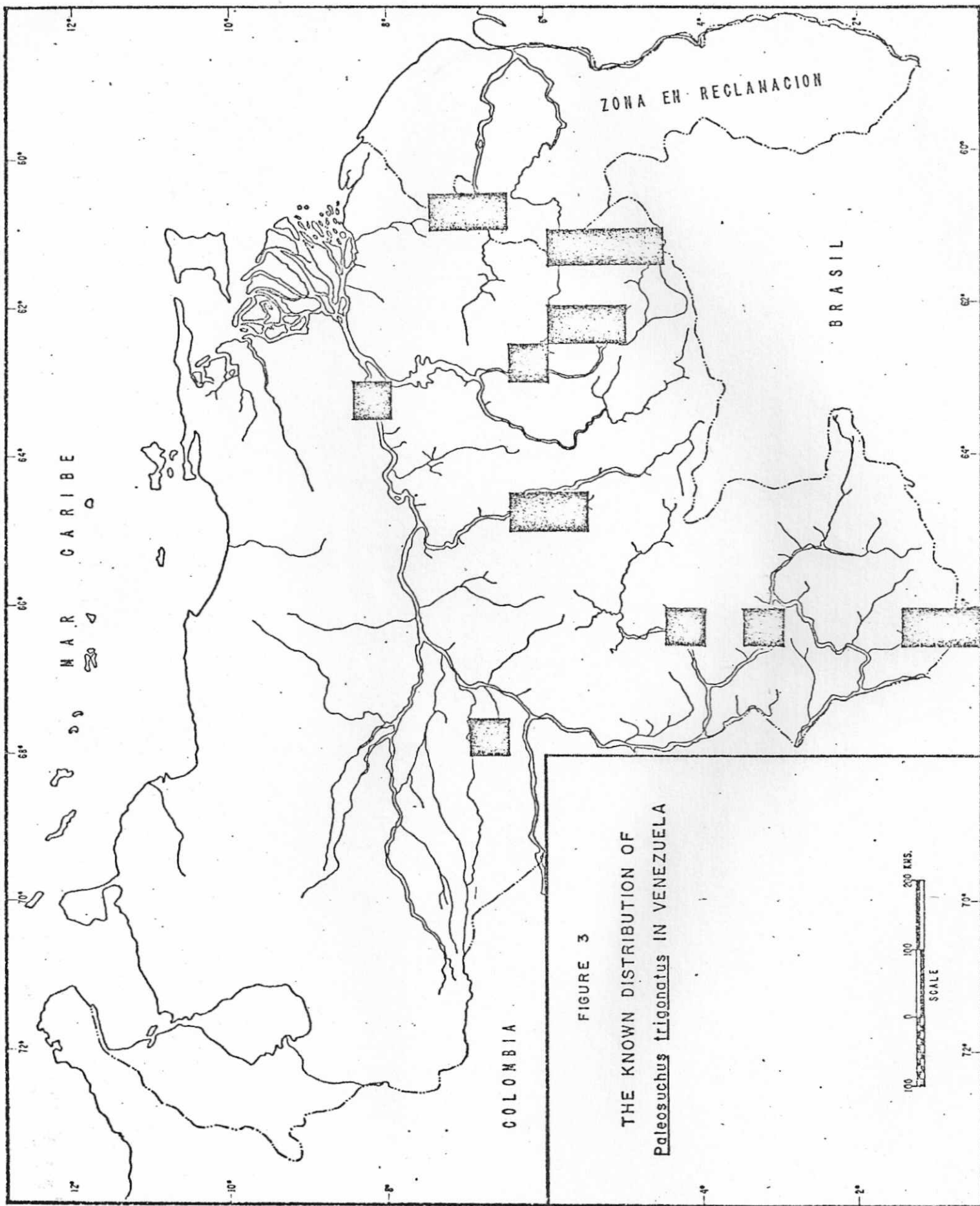


FIGURE 1  
 THE KNOWN DISTRIBUTION OF  
*Caiman crocodilus* IN VENEZUELAN

81







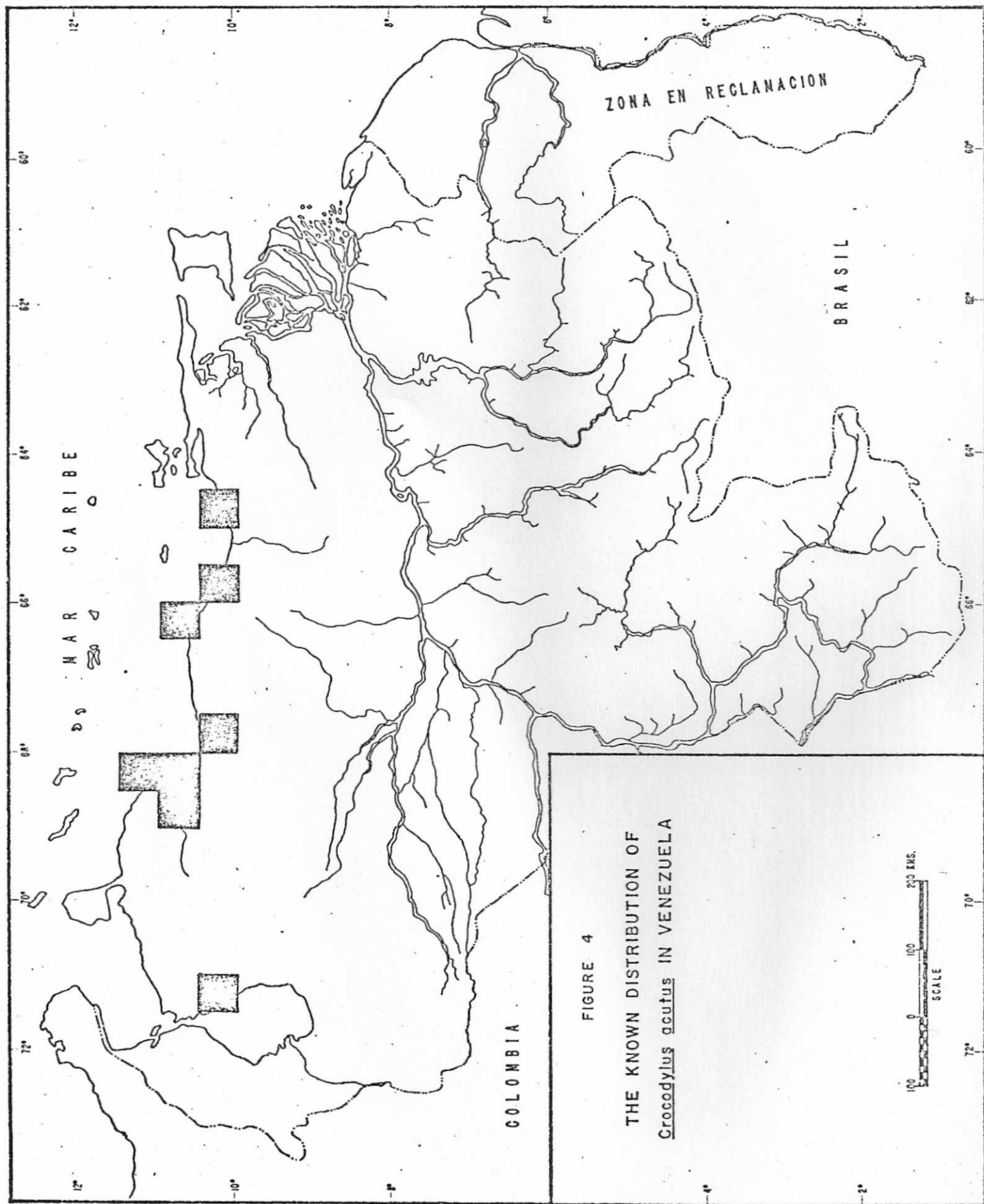


FIGURE 4  
 THE KNOWN DISTRIBUTION OF  
*Crocodylus acutus* IN VENEZUELA

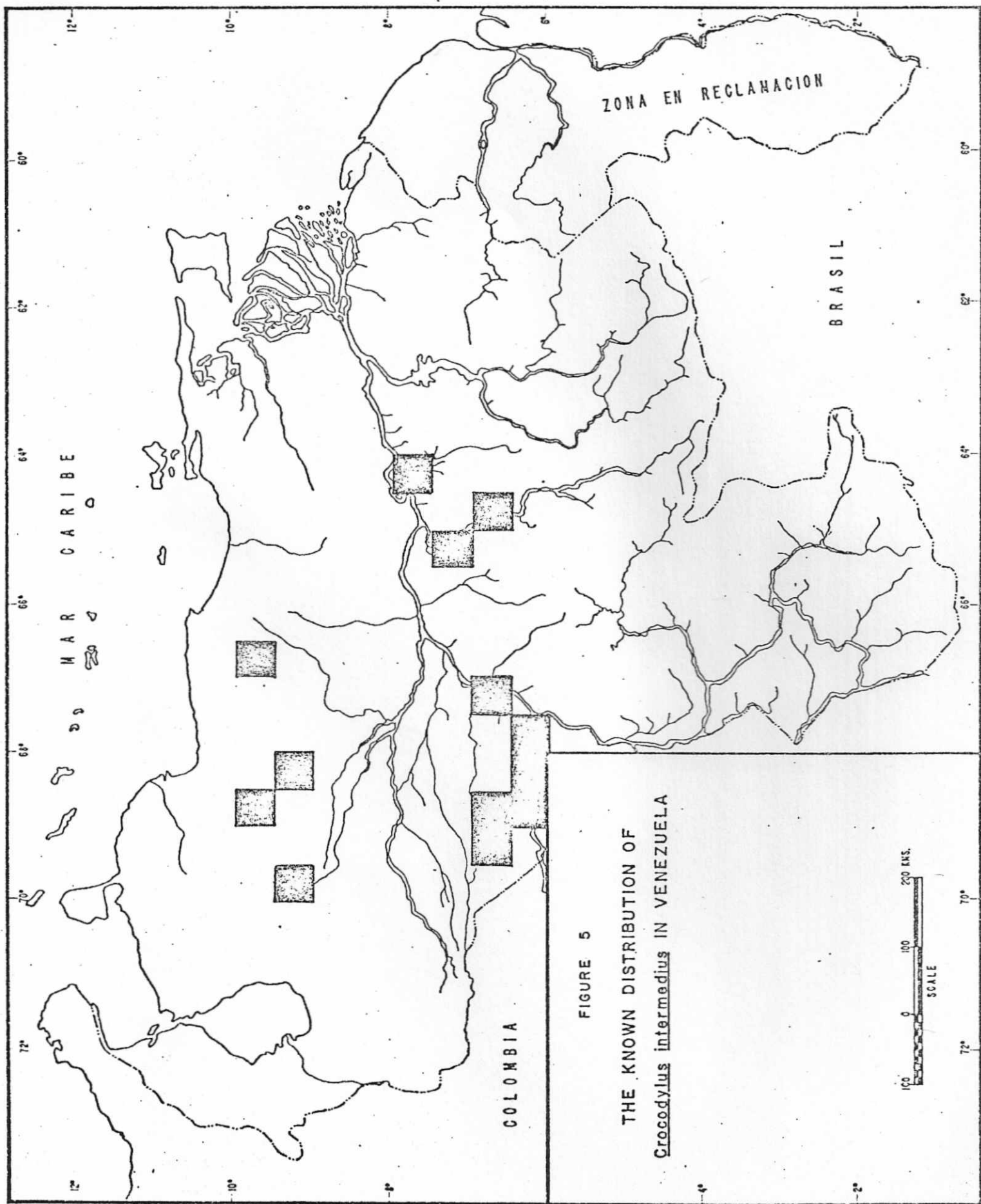


FIGURE 5  
 THE KNOWN DISTRIBUTION OF  
*Crocodylus intermedius* IN VENEZUELA

1982 = 752 *Pipra carolinensis* SB

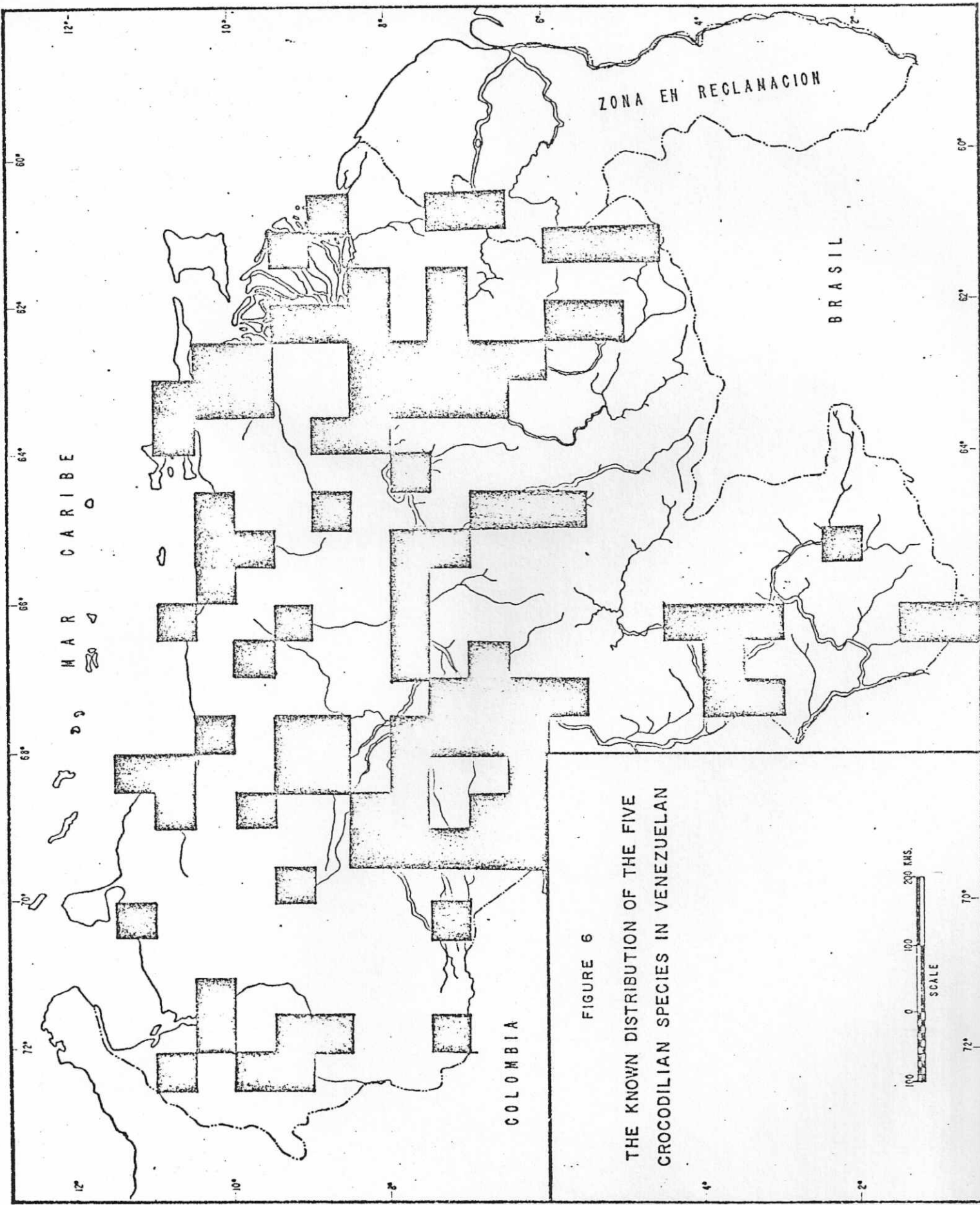
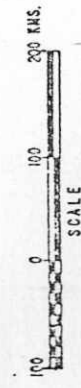


FIGURE 6  
THE KNOWN DISTRIBUTION OF THE FIVE  
CROCODILIAN SPECIES IN VENEZUELAN



6

Figure 7.

The Total Lengths at Different Ages of Fourteen Crocodylus intermedius in the Parque Loeffling, Ciudad Guayana, Venezuela, compared to the growth rate of a captive Melanosuchus niger (dotted line)(adapted from Dowling and Brazaitis, 1966).

