BÖHME, W., BISCHOFF, W. & T. ZIEGLER (eds.): HERPETOLOGIA BONNENSIS, 1997: 207-213

Monitoring of declines in Venezuelan *Atelopus* (Amphibia: Anura: Bufonidae)

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Introduction

Amphibians world wide seem to be experiencing population declines and range reductions that are raising concern about their conservation status. The phenomenon, mainly noticed for frogs and toads, has been placed in the framework of a so-called "biodiversity crisis". It had its first public "boom" in 1990, mainly after a workshop called "Declining Amphibian Populations – A Global Phenomenon?" that took place in Irvine, California, USA (e.g. BARINAGA 1990, BLAUSTEIN & WAKE 1990, HAYES & JENNINGS 1990, PHILLIPS 1990, TYLER 1991, VITT et al. 1990, WYMAN 1990). Reports from different parts of the world have followed. Later on, the International Union for the Conservation of Nature (IUCN) established a "Declining Amphibian Population Task Force" to organise a global monitoring program dealing with the problem. The results are being divulged through the newsletter "Froglog". Although most reports indicate human impacts as causes of the declines, they are still a matter of controversy (e.g. see discussion in Herpetologica (1994), Lafayette, **50**(1): 65-108).

Among the amphibians apparently affected are several species of the Neotropical toad genus *Atelopus*, usually referred to as "harlequin frogs". It constitutes a speciose group among the Bufonidae of more than 65, often attractively coloured animals, with a Central and South American distribution ranging from Costa Rica to Bolivia (e.g. LÖTTERS 1996). Declines have been documented for local populations of *A. varius* in Costa Rica (POUNDS & CRUMP 1994), as well as several Ecuadorian species, among which the *A. ignescens* complex seems to be the most affected (e.g. LÖTTERS 1996: 90). Apparent declines have been detected for several Venezuelan *Atelopus*, too (LA MARCA & REINTHALER 1991).

Seven species of *Atelopus* are known to occur in Venezuela (e.g. LA MARCA 1992, LÖTTERS 1996). All of them occur in mountainous regions in the Andes as well as the Caribbean Coastal Range. Except for the most recently described, *A. tamaense*, reports suggest that their populations are diminishing in number, though their habitats appear not to be affected by direct human intervention. Having all of them more or less restricted distributions, it is not surprising that the first Venezuelan amphibian to be considered endangered was *A. cruciger* (FERNÁNDEZ BADILLO 1990); even though already in 1983 *A. sorianoi* was suggested to be of vulnerable status by LA MARCA. LA MARCA & REINTHALER (1991) documented apparent declines for *A. carbonerensis*, *A. mucubajiensis*, *A. oxyrhynchus*, *A. pinangoi*, *A.*

sorianoi and *Atelopus* sp. After these findings, for several of the Venezuelan populations have been proposed different status classifications. VIAL & SAYLOR (1993) listed *A. carbonerensis*, *A. mucubajiensis*, *A. oxyrhynchus* and three additional *Atelopus* (without name indication) from the "Andes de Mérida", as threatened/endangered. LA MARCA (1994) proposed the category of "vulnerable" for *A. carbonerensis*, *A. mucubajiensis*, *A. oxyrhynchus*, *A. pinangoi* and *A. sorianoi*; the author recommended them to be included in the "Venezuelan Red Book of Animals". In this paper we summarise our monitoring surveys on populations of the *Atelopus* species that occur in Venezuela (except *A. tamaense*).

Materials and methods

A monitoring program has been established focusing on the type localities of the different species of Venezuelan *Atelopus*. The main technique are diurnal visual encounter surveys (compare HEYER et al. 1994: 84). Specimen identification is by hand-made drawings of individual dorsal patterns and other morphological characteristics (i.e. body size, deformed body portions). Field investigations were distributed as follows: between March and November 1990, 34 trips with more than 300 hours of searching, and between 1991 and 1993, 35 days with more than 150 hours of searching. Since 1994 we have concentrated on *A. mucubajiensis*, conducting several-days-per-week searches from February to May 1994, and one-day-monthly searches thereafter, respectively. Since 1994, we have visually searched in four opportunities for *A. cruciger* in the Henri Pittier National Park which involves large portions of the Caribbean Coastal Range. Moreover, between 1987 and 1993 a survey with drift fences and pitfall traps (see HEYER et al. 1994: 109) aiming at this species in the Henri Pittier National Park was carried out by JESÚS MANZANILLA. Studies are being conducted for *Atelopus* sp. in Trujillo State, with a two-days-per-month visual searching that has started in September 1994. Additionally, we examined and noted total numbers of individuals of Venezuelan *Atelopus* in several museums in Venezuela, Germany and the USA (AMNH, BYU, CM, CVULA, FMNH, KU, LACM, TCWC, ULABG, UPR-M, USNM, UTMNH, ZFMK [for abbreviations see FROST 1985: 663-669]).

Data about climate and habitat conditions were recorded sporadically.

Account of results and species status

Atelopus carbonerensis RIVERO, 1974

The "yellow little toad of La Carbonera" is a cloud forest species that is nearly endemic to its type locality (e.g. LA MARCA 1992). Information on its commonness date back to the 1920s. At that time M. A. CARRIKER (an ornithologist from the Museum of Zoology of the University of Michigan) noticed that this toad was locally abundant (unpubl. field notes). When RIVERO (1974) first recognized the "yellow little toad of La Carbonera" as a distinct taxon (i.e. a subspecies of *A. oxyrhynchus*), he (p. 605) stated that at least a hundred specimens could be collected in a short period of time and that dozens of them were found killed on road. More detailed, 154 specimens were indicated as paratypes (but see LA MARCA 1992: 13 for inconsistencies about this figure) and were compared for variation with "100

odd specimens seen but not captured" (RIVERO 1974: 604). Furthermore, the author (p. 605) reported that, during the rainy months of May and June, this toad "come[s] out to the roads in enormous numbers", and that "out of the breeding season it stays in the darker parts of the temperate forests where it exists in such great abundance that a hundred can be collected in less than an hour". An ecological study carried out by DOLE & DURANT (1974) yielded 750 marked (toe-clipped) and released individuals. Two of these were recaptured eight and ten years later by LA MARCA (1984). Besides these records, further information on former abundance is only available from data of museum collections in which this taxon is the Venezuelan *Atelopus* species which is the best represented. We recognised more than 400 individuals.

Recent searches do not span the suggested population turn over time. The increasingly downward trend in number makes us think it may be endangered in places where in the 1970s this *A. carbonerensis* was extremely common. Since the beginning of our monitoring in 1990, we have only found two specimens, in January and October 1990, respectively. The only recent recognition of this species is a sight of a single animal by PEDRO DÁVILA (pers. comm.) in Las Cruces, near La Carbonera (State of Mérida), in January 1995.

Populations of *A. carbonerensis* live in places that do not have any legal protection status. Forest destruction, introduction of exotic conifers (*Pinus* spp.) and cattle farming are probably major threats for this species. Drought as a result of deforestation can also be another factor to account for the observed declines.

Atelopus cruciger (LICHTENSTEIN & MARTENS, 1856) [1]

The "sapito rayado" is the only member of the genus found outside the Cordillera de Mérida. Once it was abundant in cloud forests of the central part of the Caribbean Coastal Range (e.g. LA MARCA 1992) Reports of former abundance date back to the 1930s (MÜLLER 1934). MONDOLFI (1976: 131) indicated that this species was relatively common in the montane forests of the Coastal Range. In 1966 the Rancho Grande Biological Station in the Henri Pittier National Park was founded. Since then the "sapito rayado" was abundant around the station for more than twenty years. But after the late 1980s it was drastically decreasing in number, and thus was considered the first endangered anuran species in Venezuela by FERNÁNDEZ BADILLO (1990, pers. comm.). Systematic searching for this species involves pitfall traps (efforts led by JESÚS MANZANILLA between 1987 and 1993 [pers. comm.]), as well as visual searches by us since 1994. None of these have revealed the presence of this toad. Special attention to small streams in which *Atelopus* tadpoles usually occur (e.g. LÖTTERS 1996) did not even reveal the presence of *A. cruciger* larvae.

Most portions of the area inhabited by *A. cruciger* lie within non-destroyed, protected national parks (i.e. Henri Pittier, San Eusebio). Thus, no explanation has been forwarded for the apparent declines. Possibly, increasing drought effects are involved since the forests outside the protected areas drastically diminished. Acid rain has been detected in the Henri Pittier National Park (J. MANZANILLA pers. comm.), but the scope of its influence has not been assessed.

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[1] The taxonomic status of *Atelopus cruciger vogli* MÜLLER, 1934 is unclear; it probably represents a junior synonym of *A. cruciger* (LICHTENSTEIN & MARTENS, 1856).

Atelopus mucubajiensis RIVERO, 1974

The "yellow little toad of Mucubajf" occurs in paramo habitats of the central part of the Cordillera de Mérida (e.g. LA MARCA 1992). Literature reports since the 1960s (see LÖTTERS 1996: 36) indicate that it formerly was abundant at its type locality. "Numerous" specimens squashed on road were reported by RIVERO (1974: 611). Museum collections hold more than 140 individuals. Since 1990 when our monitoring has started, we have just seen one living specimen in that year, as well as one dead specimen in water and six living tadpoles in 1994 (LA MARCA & REINTHALER 1991, LÖTTERS 1996: 90).

Populations are located within a protected national park (i.e. Sierra Nevada). The presence of trout (*Salmo* sp., *Oncorhynchus* sp.) in some streams where the "yellow little toad of Mucubajf" spawns may pose a potential threat. Furthermore, exotic conifers (*Pinus* spp.) have been introduced in some places of the distribution area. LA MARCA & REINTHALER (1991) hypothesis that these could contribute to a humidity deficit by high evapotranspiration rates. Recently, we detected burns in natural vegetation.

Atelopus oxyrhynchus BOULENGER, 1903

"Mérida's yellow toad" lives in cloud forests in the vicinities of Mérida City and at La Carbonera (State of Mérida). It is the most widely distributed Andean *Atelopus* species in Venezuela (e.g. LA MARCA 1992). Museum holdings total more than 160 specimens. About 50 individuals were noticed by one of us (ELM) on a rainy day in June 1978. A total of 28 specimens was captured by PIÑERO (1985), 10 of them on a single day in June. Since then, just one individual observed in 1994 has come to our attention.

Droughts over the last several years, may have caused the declining of this toad. Some populations may be gone because of forest destruction, although at least one population occurs in the protected Sierra Nevada National Park. Environment pollution and human settlements in the high Mucujún Valley (State of Mérida) may have been a cause of the observed declines in that area. LA MARCA & REINTHALER (1991) indicated that the use of chemicals as DDT, Parathion and others that are banned in "developed countries", could be a threat to this toad. Droughts during the breeding season over the last several years may have caused the disappearance of a population in the Monte Zerpa forest, near the city of Mérida. Occasional heavy rains may have acted as triggers for reproduction, but reproduction effort may have been lost when immediate long dry periods, recorded within the last decade, followed again.

Atelopus pinangoi RIVERO, 1980

The "green and red venter harlequin toad", occurs near Piñango, State of Mérida (e.g. LA MARCA 1992). According to local people, it once was abundant and occasionally seen walking, on rainy days, in the dirty streets of this village. Formerly, it was only known from the type's description. Our searching, by 1988 only, has revealed two populations in isolated cloud forests near Piñango. Due to forest destruction, consequent habitat fragmentation and because of the introduction of trout (*Salmo* sp., *Oncorhynchus* sp.), that probably preys upon *Atelopus* larvae, recolonisation of former habitats by this toad may be impossible.

Atelopus sorianoi LA MARCA, 1983

The "scarlet harlequin toad" is the *Atelopus* species with the most restricted distribution so far known (e.g. LA MARCA 1992): a short transect by a small stream in a relictual patch of cloud forest near the town of Guaraque (State of Mérida), in the Venezuelan Andes. In the original description, LA MARCA (1983) alerted about the impact that may have forest destruction upon survival of this species. Nevertheless, about 100 specimens were seen in June 1988, nearly 50 % of them squashed on the road. Since 1990 when two specimens of *A. sorianoi* were observed it has not been found by us.

The only known population of this toad was recently protected by its inclusion within the Batallón-La Negra National Park. Habitat destruction, however, continues to be a real threat. LA MARCA (1983) indicated that the very small geographical range of this highly endemic species places it as highly endangered if deforestation continues.

Atelopus tamaense LA MARCA, GARCÍA-PÉREZ & RENJIFO, 1990

No other data are available on the "harlequin frog of Tamá" than the original description based on specimens collected in August 1987 (see LÖTTERS 1996: 51). Nothing is known about its current population status. The type locality for this paramo species is situated within the Tamá National Park, Apure State, and has not been visited by us since then.

Atelopus spp.

Several specimens of an undescribed cloud forest toad from Trujillo State were collected by the senior author in December 1987. It is being monitored since 1994, and a few tadpoles were seen in November 1994 (but the searching efforts have not revealed metamorphosed nor adult individuals). Although the area in which it occurs lies within the Guaramacal National Park, we noted some deforestation in early 1995. A second undescribed Atelopus from a nearby site in Trujillo State could have suffered by severe floods in 1990.

Conclusions

As to conclude from our results, the Venezuelan *Atelopus* seem to undergo population declines. By the absence of data and knowledge we still cannot judge whether the observed declines are a part of normal cycles of population fluctuations (BLAUSTEIN et al. 1994) that are now at their lower peaks, or whether they are "unnormal" as a result of human impacts or natural causes, respectively.

The hypotheses of "unnormal" population downward trends in anurans has been forwarded strongly taking the available literature in account. Several reports (if not all) may account for the observed declines in Venezuelan *Atelopus*. In general these hypotheses fall into the categories of human impacts and natural causes. These include habitat destruction or fragmentation, water and land chemical pollution, acid precipitation, overcollecting, introduction of exotic species, increased ultraviolet radiation, pathogens as well as flood and droughts (e.g. ANDREWARTHA & BIRCH 1954, BLAUSTEIN & WAKE 1990, HAYES & JENNINGS 1990, PHILLIPS 1990, WYMAN 1990, LA MARCA & REINTHALER 1991, PECHMANN et al. 1991, CAREY 1993, BLAUSTEIN et al. 1994, PECHMANN & WILBUR 1994, POUNDS & CRUMP

1994). In spite of the high number of speculations about putative factors, supporting evidence is lacking for many.

Concerning the declines of the Venezuelan *Atelopus*, most data of their abundance appear to be anecdotal. However, these, associated with our more systematic monitorings in recent years, indicate that the apparent problem should be taken seriously. We recommend long-term documentations to understand population dynamics in *Atelopus* as well as strict protection and monitoring of the remaining populations and their environments.

Acknowledgements

The senior author thanks the Consejo de Desarrollo Científico Humanístico y Tecnológico de la Universidad de Los Andes (CDCHT-ULA), Mérida, and Fundacite-Mérida for financial support. Field work was carried out with grant CDCHT C-564-92 for the Project "Distribución Ecológica de la Mastofauna y Herpetofauna de la Región Andina". JESÚS MANZANILLA (Maracay, Venezuela), ALBERTO FERNÁNDEZ BADILLO (Maracay, Venezuela) and PEDRO DÁVILA (Mérida) shared with us their personal observations on certain *Atelopus* populations. The Instituto Nacional de Parques (InParques), Mérida, provided pertinent permits to carry out field work in the Páramo de Mucubají, Mérida State. ARNOLD G. KLUGE (University of Michigan, Museum of Zoology) generously provided information on the field notes of M. A. CARRIKER. KARL-HEINZ JUNGFER (Fichtenberg, Germany) and an anonymous reviewer made valuable comments on a previous version of the manuscript.

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Note added in proof

The second *Atelopus* sp. from Trujillo State referred to in this paper has recently been described as *A. chrysocorallus* by the senior author (LA MARCA, E. (1996 ["1994"]): Descripción de una nueva especie de *Atelopus* (Amphibia: Anura: Bufonidae) de selva nublada andina de Venezuela. – Mem. Soc. Cienc. Nat. La Salle, Caracas, **142**: 101-108).

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