AARK EX SITU MANAGEMENT GUIDELINES:

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BIOLOGY AND FIELD DATA

Taxonomy:

Order: Anura
Family: Dendrobatidae
Subfamily: Aromobatinae
Genus: Mannophryne
Species: collaris
Common names: Merida's collared frog

Comments: The family is considered as Aromobatidae by some authors. Boulenger's (1895) *Phyllobates trinitatis* is probably the earliest reference to Mannophryne collaris. The only material accessioned prior to 1895 as *P. trinitatis* in the BMNH, and coming from Venezuela, is a series of adults and tadpoles from "Andes of Venezuela" purchased from E. Hartert (Grandison, in litt.). These specimens can of course represent *Mannophryne collaris* or any other Venezuelan Andean collared frog. The species was for a long time known as *Colostethus collaris*, until La Marca (1992) assigned it to a new genus he created for the whole group.

Description:

Size: SVL (Snout-to-Vent length): Adult males 25 mm, Adult females 30 mm
Coloration: Adult females with dorsum pale brown bearing dark irregular spots (occasionally greenish brown or uniformly brown with fine black stippling); flanks brown with yellow inguinal stripe (yellow coloration more intense near groin) usually extending close to level of shoulders; dorsolateral pale and dark bands absent; pale longitudinal femoral stripe absent; dark canthal band surrounding head; a pale lo real stripe from eye to eye, sometimes not clearly defined on tip of snout; a not well-defined pale stripe from posterior part of eye to base of arm, covering obliquely the lower part of tympanum; dark stripe on upper lip absent; loreal region dusted or flecked with dark: brown; throat yellow; collar black or dark brown (may occasionally possess pale flecks within the collar; the collar is usually absent, or obscured by the ventral dark coloration in males); venter white; ventral surfaces of limbs uncolored or violet. Extremities cross-barred, conspicuously in adult females, inconspicuously in males and juveniles of both sexes; a dark: stripe on anterior part of arm; pale cross-bars wider or equal to dark ones. Adult males with blackened dorsum; inguinal region pale gray with yellow spots; throat gray, paler than venter; venter dark gray. Some adult males, less than 24.0 mm SVL, possess yellow throats and whitish venter. Juvenile males and females with black collar, yellow throat and white venter. Some juvenile males lack conspicuous markings on dorsum. A juvenile male, about 15.0 mm SVL, had a white throat and venter. Ventral surfaces of shanks cream with dark emarginations, in both sexes.
Morphological characters: Head slightly wider than long; interorbital area smooth; interorbital distance about 1.5 times greater than upper eyelid width; canthus rostralis not well- defined, almost straight; nares not elevated, directed laterally; nares closer to tip of snout than to eye; loreal region flat, nearly vertical, descending abruptly to lips; snout subovoid in dorsal view; tip of snout broadly rounded in dorsal view, protruding beyond lower jaw and acutely rounded in lateral view; length of eye about 1.4 times eye-to-nares distance; internarial distance about 1.6 times eye-to-nostril distance; tympanum inconspicuous, about 1/3 length of eye, separated from eye about 1/2 its horizontal length;

supratympanic fold absent; a single, rather large tubercle at rictus; tongue rounded, entire. Posterior 1/2 not adherent to floor of mouth; choanae rounded, almost completely concealed by palatal shelf of maxillary arch; maxilla and premaxilla toothed; teeth short.

Dorsum, flanks and venter smooth; palmar tubercle single, rounded, about 4 times size of thenar; thenar tubercle oval, about 1.5 times longer than wide; no supernumerary tubercles; subarticular tubercles rounded, elevated; moderate-sized pads; largest pad on third finger, almost covering tympanum when placed on it; pads wider than long, pad on third finger about 1.6 times wider than adjacent phalanx; fingers free; second and third finger bearing conspicuous lateral fringes; a keel runs along outer and inner lateral parts of fourth finger; first finger equal in length to second: third finger not swollen in males. Cloacal opening at about midlevel of thighs, directed ventrally, covered by a short and thick vent fold; free margin of vent fold scalloped; shanks, thighs and tarsi smooth above and below; strong tarsal fold from base of pad on first toe, running along outer part of that toe and then obliquely to midline on tarsus; tarsal fold not ending in tubercle, not flattened at the end; outer metatarsal tubercle rounded when viewed from above, subconical in lateral view; inner metatarsal tubercle oval, 1.5 to 2.0 times longer than wide, about twice as large as outer; no supernumerary tubercles; distal subarticular tubercles rounded, proximal oval; subarticular tubercles flattened; foot web formula: 12.0-l.Oll2.0- l.Olli2.0-1.5IV2.0-2.0V; toes with flap-like lateral fringes; flap-like fringe along outer edge of fifth toe from base of pad to middle of metatarsus; pads wider than long; largest pad on fourth toe, about 1.3 times wider than pad on third finger, about l. 7 times wider than adjacent phalanx; heels do not touch when thighs are held at right angles to body axis, reaching to anterior corner of eye when legs are adpressed forward.

Note: Development of the collar that is distinctive in this species initiates in the late stages of the tadpole' s ontogeny. The melanophores that usually are widespread throughout the venter of younger tadpoles become restricted in late stages to the throat and chest. This fine dark stippling becomes more evident as a collar once metamorphosis is completed. The juveniles of both sexes bear this character. The collar of juveniles is solid,

Longevity:

No records of longevity are known from wild animals. Captive frogs have been kept for up to 3 years, being already adults when captured, suggesting they may reach an age of four or more years in nature.

Zoogeography/ecology:

Distribution: The range of distribution of the species is restricted to the Andes of Estado Mérida, Venezuela. Main range of distribution is along the terrace where the city of Merida is located.

Habitat: *Mannophryne collaris* is a diurnal and terrestrial frog that lives along cascading but also in slow water streams under seasonal semideciduous montane forests. This type of humid mountain forest is characterized by an annual average precipitation between 1100- 2200 mm, and an average annual temperature between 18- 24°C, parameters that could be used as useful predictors of the occurrence of collated frogs in places previously not collected.

Population: There is not a current estimate of numbers of the putative remaining populations, which must be at is lowest value ever. When present, it is a locally abundant, but it is in decline in most parts of its range. The main threat to the species is habitat destruction and alteration, due primarily to agriculture (for both crops and livestock), infrastructure development for human settlement within and in the vicinity of the city of Merida, as well as for tourism development. In addition, pollution may also

be contributing to the observed declines.

Status: Endangered B1ab(iii,iv,v)+2ab(iii,iv,v). Listed as Endangered, because its Extent of Occurrence is less than 5,000 km2 and its area of occupancy is less than 500 km2, its distribution is severely fragmented, and there is continuing decline in the extent and quality of its habitat, and in the number of mature individuals.

Diet:

There is not a single research on the preferred food items of the species in the wild, but it is suspected to feed on different kind of small arthropods and their larvae.

Reproduction:

Sexual maturity/age at first breeding: In captivity, it appears to be at least two years. After a year of hatched from eggs, individuals are immature juveniles, although changes in coloration indicate they are already males or females.

Seasonality: Frogs start to breed at the beginning of the rainy season, both in the wild and in captivity. In captivity they appear to bread all year round, although there is no breeding activity at the climax of the dry season.

Eggs/oviposition/clutch size/ development: Eggs are laid on land and the male protects them. When hatched, male carries the larvae on his back to water where they develop further. Clucth size ranged from 9 to 20 eggs. Development takes about two weeks from eggs to free swimming tadpoles; and about two months to complete development into small froglets.

Tadpoles. Once hatched from the eggs, tadpoles are carried on top of a male specimen; the male then carried them to a nearby water body. In the literatures there is only a single report of total number of transported larvae: a male that was carrying 3 tadpoles on dorsum. We have seen males with 7 transported larvae.

The free swimming tadpoles have an oval body and a relatively slender caudal musculature. The spiracle is sinistral and the cloacal opening is dextral. The denticle row formula is 2/3; the second upper row and the first lower row are medially interrupted; the upper lips have a wide diastema; the lips usually bear a single row of alternating papillae. Labial papillae are small. The beaks vary from poorly to well keratinized and usually bear small serrations on the edges. Mannophryne neblina has minute crenulate serrations giving a first impression of a smooth beak.

Activity and other notable behaviour:

The most elaborate behavioral patterns of dendrobatid frogs occur in members of the genus Mannophryne, and M. collaris is not an exception. Courtship and aggressive behavior have been reported for the species, and it is already known that females are more aggressive than males.

Aggressive Behavior. Females of *Mannophryne collaris* are known to be highly aggressive and more territorial than males, a situation common to other *Manophryne* but quite unlike of that seen in many other dendrobatid frogs (which is the reverse case). It has been hypothesized that parental care may be related to the behavior of females being more aggressive than males. Since transport of tadpoles in these collared frogs is carried out exclusively by males, females may engage more freely in close contact attacks that could otherwise be harmful for transported larvae. In the wild, females usually

occupy shores or elevated positions on rocks in a stream. The number of adult females on a rock seems to be in direct correlation to the number of crevices in the rock. Such crevices usually enable juveniles to escape aggressive contact with adults, but the latter may also use the crevices when disturbed or to avoid predation. These observations are helpful when trying to imitate the natural conditions in ex-situ captivity facilities. Females may defend fixed territories for months, as suggested by similar behavior in *M. trinitatis* (more than a month) and *M. herminae* (at least two months).
Estimated female's territory size in *M. collaris* has been stated to be no more than 0.30-0.40 m in diameter. Females usually attack any individual intruding their territories. The aggressive behavioral display starts with the female facing the intruder, adopting an upright posture and slowly pulsating the bright yellow throat. The intruder frequently retreats after this challenge. lf the intruder does not retreat, the resident female hops to the intruder and repeats the throat challenge. lf this also fails, the resident female jump at the intruder, landing directly on the opponent's head. lf the intruder still resists, the resident female engages in a brief pushing match or wrestling bout, in which both the resident and the intruder stand on their hind legs, leaning against and attempting to push each other off the rock. The opponents may also engage in wrestling bouts, in which both the resident and the intruder stand on their hind legs, leaning against and attempting to push each other off the rock. The opponents may use the forelegs for grappling, while engaging in these upright fighting, stiffening their forelegs. Wrestling bouts involving just female-female interactions have not been observed in *M. collaris*. Female opponents of the species may engage in wrestling involving clasping the other around the head. Wrestling bouts between males have not been reported for *M. collaris*, but in similar species male-male encounters are usually started with some kind of threat by one of the males, although in most male-male encounters the resident male attacks intruders without any preliminary threat. Males do not seem to pulsate the throats in the manner characteristic of females. Males also appear to be less aggressive than females, and it has been suggested that males do not fight to defend territories against all intruders but rather fight with potential reproductive competitors, because it is unlikely that a parent frog transporting larvae can defend a territory. Males seem to use rapid color change, from brown to black, for visual communication. Brown coloration in males seems to deter attack by black males, as evidenced by the little incidence of aggression from black males to juveniles, and the apparent inhibition of agonistic behavior when black males tum brown after a given encounter. In this context, it is interesting to note that tadpole-carrying males are invariable paler than any other males.

Courtship Behavior. Courtship behavior is well known for M. collaris. The males of this species usually select high calling-places on rocks, logs, or floating vegetation near the female' s territories. The males usually attract females by jumping up and down, in a courtship that also involves vocalizations accompanied by visual displays (change of color from brown to black). Males may run quickly in a sideways motion along a rock or log. The males may raise their bodies on all four legs in an exaggerated pushup. The males slowly approach the female, stopping frequently every 5-8 cm, sitting and calling for 10-15 seconds. Then, they lower their heads and body to an almost horizontal position, crawling backwards a few steps and jumping upwards. A variant of this behavior is to assume the exaggerated pushup position after calling, then moving backwards a few steps while turning slightly laterally and then jumping. The males maintain a bipedal position for a few seconds, taking one or two steps towards the female before returning to the sitting position. In some instances, a second jump may follow after the sitting position was reassumed. These visual displays are usually made at a distance from the female, although a male may follow a female that moves away, eventually making contact with her.

Note: The female's lack of receptivity is expressed in the form of threat displays, or chases with or without contact, in the manner described above for agonistic encounters. The female following the

mate once he turns away after performing calls and dancing shows the female's receptivity. The male leads the female to a site to deposit eggs (usually a rolled dead leaf, although it may be under rocks or moss. Displacements to the ovipositing site may cover more than 1 m. A single example is known for *M. collaris* in which a male lead a female for more than 7 m before reaching the place to deposit the egg mass. Once the female began to follow the male, the leading mate performs no further calling or dancing.

MAINTENANCE IN CAPTIVITY

Accommodation

Adult animals:

Newly metamorphs and juveniles are kept in small plastic containers that are provided with permanent water and a paper substrate upon which a small hiding receptacle (like a half cut coconut shell) is provided.

Larvae:

Tadpoles are kept in plastic or glass containers filled with pebbles, rocks, aquatic plants and a permanent aeration supply. Rocks are provided to facilitate the metamorphosing tadpoles climbing to higher places. Once the tail is reabsorbed, specimens are moved to plastic containers with a small patch of water and relatively dry parts with hiding places.
Up to 20 tadpoles are kept in plastic 'larvaria'; once development is reached, they are moved to small-size vivaria.

Life-support details:

Facilities are designed to provide captive frogs conditions closely resembling those found in nature. Reproductive parents are kept in large terraria with abundant vegetation and hiding places, as well as running water and simulated rain periods. An isolated room is devoted to raising a variety of food items to the froglets and adult frogs. The invertebrate food-supply' facility provide a reliable and varied live-food items for all stages of the species, and are complemented with vitamins and mineral supplements.

Diet

Food items:

Adult: Fruit flies (*Drosophila melanogaster*), cricquets (*Acheta domestica*), wax moths larvae (*Galleria melonella*), mealworms (*Tenebrio molitor*), weevils (*Sitophilus* spp.), juvenile pill-bug (*Armadillidium vulgare*), Californian earthworm *Eisenia foetida*),

Recent metamorphs and juveniles: Fruit flies (*Drosophila melanogaster*).

Larvae: commercial droplets food for tadpoles, and commercial fish flake's food.

Feeding method:

Adults: invertebrates are placed in shallow plastic lids within the terraria, in numbers according to size of prey item and size of the adult frogs, in enough quantities to be eaten within 24 hours.

Larvae: food is provided daily, in enough quantity not to make the water turbid (usually to be eaten within 12 hours or less).

Reproduction

Social structure:

Large terraria maintain 3 pairs (3 males, 3 females) of adult reproductive frogs.

Courtship and spawning

Courtship and spawning take place within the large terraria. There is plenty of hiding places for the frogs, and they are left unsupervised for about 18 hours, reason why we have not been able to see these events. Spawning almost always (>80%) takes place below coconut halves provided as shelters, and the rest under decaying leaves that have been placed within terraria on purpose. The terraria are supervised every other day for egg masses.

Care of eggs and larvae:

Eggs: egg masses are taken away from the terraria were reproductive pairs inhabit in order to avoid damage. Eggs are then placed on top of a flat rock that is placed inclined towards (and in touch with) a small water deposit (kind of a small pond). They are covered with humid decaying leaves that are not in touch with the egg mass.

Larvae: Once hatched from the eggs, larvae are placed in a separate plastic container (we call the "larvaria") with shallow water that is oxygenated with an aquarium air pump. The bottom of these larvaria are free from objects, or are filled with small rounded peebles.

Other details:

Handling and transport:

Specimens are caught with hand nets and plastic gloves. Transport in done within plastic containers.

Population management:

The reproduction and rearing of Mannophryne collaris counted with an abundant and helpful literature on captive breeding of dendrobatid frogs. In spite of the low production of eggs, in every single reproductive event per mating pair, there is a high percentage or survivorship within each group. Specimens are kept apart taken into account the provenance place. Each phylogenetic line is maintained as a separated entity, following standard record-keeping protocols to avoid risks of interbreeding and minimize the risks of loss of genetic diversity.
Once the F1 specimens attain large juvenile and adult sizes, they are released in the field following strict protocols for re-introductions.

References

Unpublished reports and bibliography:

Amphibian Ark. 2008. A guide to biosecurity and husbandry standards require for the safe and responsible management of ex situ populations of amphibians. Standards based upon CBSG/WAZA Amphibian Ex Situ Conservation Planning Workshop, El Valle, Panama, 12-15th February 2006- 2006.

Boulenger G. A.1912. Descriptions of new batrachians from the Andes of South America, preserved in

the British Museum. Ann. Mag. Nat. Hist., ser. 8, 10(56):185-191.

Dole, J., and P. Durant. 1974. Courtship behavior in Colostethus collaris (Dendrobatidae). Copeia, 1974(4):988-990.

Durant, P., and J. W. Dole. 1975. Aggressive behavior in Colostethus (=Prostherapsis) collaris (Anura: Dendrobatidae). Herpetologica, 31:23-26.

La Marca, E. 1984. A taxonomic and systematic revision of the frogs of the Colostethus collaris group (Anura: Leptodactylidae: Dendrobatinae). M. Se. Thesis. Univ. Nebraska. 256 pp.

La Marca, E. 1992. Catálogo Taxonómico, Biogeográfico y Bibliográfico de las Ranas de Venezuela. Cuadernos Geográficos (Universidad de Los Andes, Mérida) 9:1-197.

La Marca, E. 1994. Taxonomy of the frogs of the genus Mannophryne (Amphibia: Anura: Dendrobatidae). Publicaciones de la Asociación Amigos de Doñana 4:1-75.

La Marca, E. 1995. Biological and systematic synopsis of a genus of frogs from northern mountains of South America (Anura: Dendrobatidae: Mannophryne). Bulletin of the Maryland Herpetological Society 31:40-75.

La Marca, E. 1995. Crisis de biodiversidad en anfibios de Venezuela: estudio de casos. Pp. 47-70 In M.E. Alonso (ed.). La Biodiversidad Neotropical y la Amenaza de las Extinciones. Cuadernos de Química Ecológica 4. Universidad de Los Andes, Mérida. 160 pp. DOI: 10.13140/2.1.5075.7760.

La Marca, E. 1996. Frogs of the genus Mannophryne. British Dendrobatid Group Newsletter 27("26"): 9-11.

La Marca, E. 2004. Decline of high Andean frogs of Venezuela. Reptilia 36:26-30.

La Marca, E. 2007 ("2005"). Estatus de poblaciones de ranas de la familia Dendrobatidae (Amphibia: Anura) en sus localidades tipo en los Andes de Venezuela. Herpetotropicos 2(2):73-86.

La Marca, E. 2009. Estatus poblacional de las ranas de la familia Dendrobatidae en los Andes de Venezuela. Pp. 182 In D. Giraldo, F. Rojas.Suárez & V. Romero (eds.). Una Mano a la Naturaleza: Conservando las Especies Amenazadas Venezolanas. Provita & Shell Venezuela, S.A. Caracas, Venezuela.

Manzanilla, J., E. La Marca & M. García-París. 2009. Phylogenetic patterns of diversification in a clade of neotropical frogs (Anura: Aromobatidae: Mannophryne). Biological Journal of the Linnaean Society 97:135-199.

Lötters, S., K. H. Jungfer, F.-W. Henkel y W.Schmidt. 2007. Poison Frogs. Biology, Species & Captive Husbandry. Frankfurt am Main (Edition Chimaira), 668 pp., 828 illustrations.

Sánchez, R. 2010. Mannophryne collaris. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Downloaded on 15 May 2015.