Conservation of *Telmatobius* Species:

T. *scrocchii* and T. *culeus*

Introduction: The *Telmatobius* Family

Telmatobius frogs are endemic to South America's Andes mountain range, distributed across Argentina, Bolivia, Ecuador, Chile, and Peru (Angulo, 2008) (Fig 1 & 2). Many species are purely aquatic and live in small streams or lakes. Others can be partially terrestrial as adults, but their eggs and larvae are completely dependent on aquatic conditions. Their clutch can be 80 to 500 eggs, however they tend to have low reproduction rates. Eggs are laid on rocks with in the water but little is known about their development. Adults tend to live hidden in debris and vegetation, under rocks, and within natural muddy cavities. Though adults may be found resting on rock during the day, most adults are most active at night (Barrionuevo, 2008).

Along with their endemism and aquatic lifestyles, Telmatobius species can be found in high altitude habitats. This gives rise to evolutionary adaptations in low oxygen environments. The T.*culeus* has been a focus of studies observing unique oxygen exchange techniques and will be described further within this paper.

Figure 1: Map of Argentina
Provided by Emily the Blogger

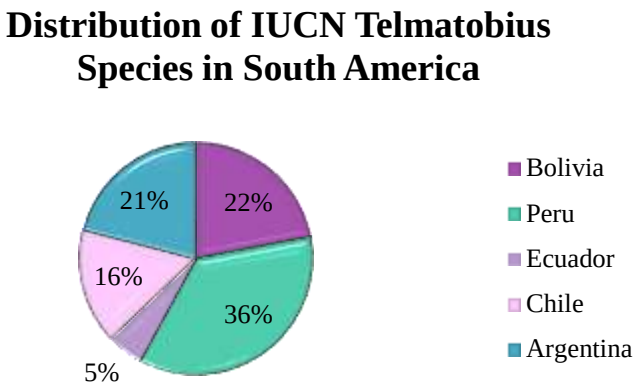

Figure 2: Pie chart of distribution of *Telmatobius* species
Based on information given by IUCN

Herpetologists are concerned for *Telmatobius* for a variety of reasons. Firstly, populations are considerably vulnerable due to their endemism, small populations, low fecundity, and aquatic mode of life (Barrionuevo, 2008). Small aquatic populations can be vulnerable to floods and many are affected by human caused events. Among these events are habitat loss, pollution, harvesting, and introduction of invasive species (Angulo, 2008). Local mining and agriculture are polluting waters and quickly eroding lands, destroying small water bodies (Barrionuevo, 2008). In some cases, local harvesting have impacted small populations of *Telmatobius* species, such as T. *culeus* (Angulo, 2008). To help local fishing, the Rainbow trout, *Salmo gardnier*, was introduced to Tucuman Providence in the beginning of the 20th century. This exotic species became a new predator for *Telmatobius* species and have declined populations of T.*ceiorum* and T. *laticep*s .

In addition, there has been a rapid decline of amphibians across South America due to chytridiomycosis, a fungal disease caused by *Batrachochytrium dendrobatidis* (Fig. 3). This disease hardens the skin of amphibians and amphibians primarily use their skin to breathe. Therefore, chytridiomycosis interferes with oxygen exchange, resulting in death. This disease is quickly spreading and has been found in some *Telmatobius* species such as the T. *marmoratus* in Peru (Barrionuevo, 2008). Climate change has been theorized to contribute to the swift spread, however there is limited evidence available (Angulo, 2008).

Figure 3: Midwive mass mortalities (Alytes obstetricans) due to chytridiomycosis in the French Pyrenees, 2010.
Photo by Matt Fisher. Published in Frog Log , Volume 100

The small populations are unable to recover from such events resulting rapid declines. There are more than 50 species of the Tematobius described and 58 are listed by International Union for Conservation of Nature (Barrionuevo, 2008 and IUCN).

Argentina's *Telmatobius* spescies: T. *Scrocchii*

Argentina is home to thirteen *Telmatobius* species, all of which are listed by the IUCN. 61% of Argentina's *Telmatobius* species are considered as endangered or critically endangered and 23% as data deficient (Fig. 4). Among these species is the *Telmatobius scrocchii,* commonly named the andalgala water frog. T.scrocchii is one of the most unknown species of America (Levilla, 2014). There are no known photos of living T. *scrocchii*, however a collected specimen photograph was provided (Fig. 5). This shows the body being about 5mm in length and 2.5mm in width (Lavilla, 2005). It also shows having nuptial pads which can be inferred to assist with breeding. Amphibian nuptial pads are dermal sex glands dominantly in males that secret sex hormones. It has been theorized that normal function of these nuptial pads are damaged by chemical pollutants in the environment (van Wyk, 2003). There have been no studies on population trends and ecological roles.

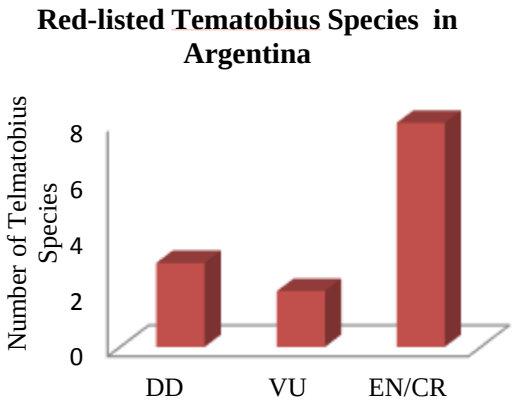

Figure 4: Information collected from IUCN. DD, Data Deficient. VU, Vulnerable. EN/CR, Endangered or Critically Endangered.

T. *scrocchii* is endemic to Argentina's rivers and streams in the Campo Arenal area of Catamarca Providence (Fig. 7). It has only been sighted in the El Ingenio stream and

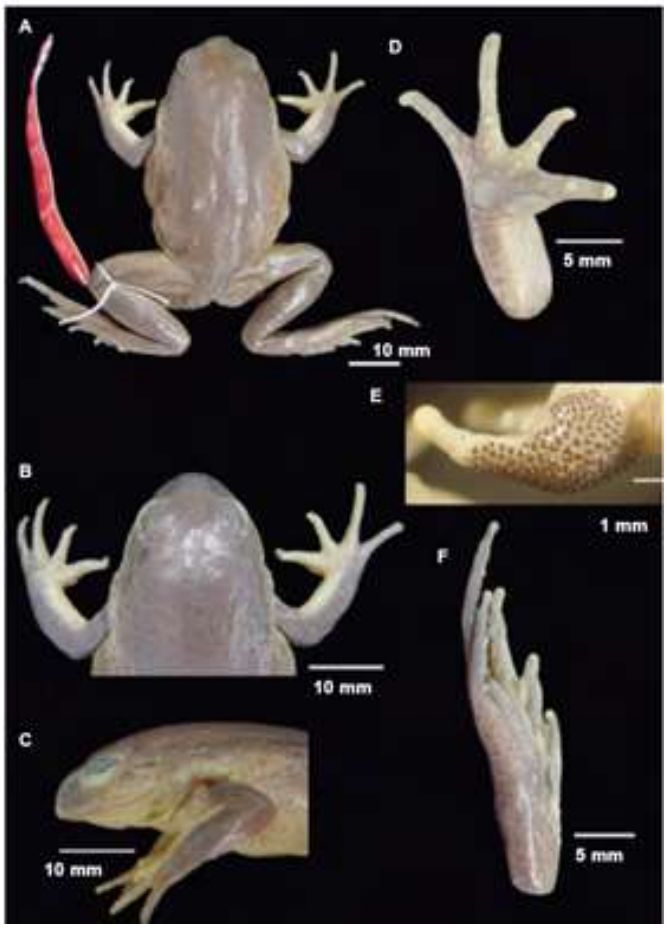

Figure 6: *Telmatobius scrocchii*. (A) Dorsal view. (B) Head in dorsal view. (C) Head in lateral view. (D) Palmar surface. (E) Detail of the nuptial pads. (F) Plantar surface. Provided by LAVILLA, EO & S. BARRIONUEVO. 2005 Gender *Telmatobius* in Argentina.

occasionally in connected waters, the Rio Arenal, Loma Redonda and Lio los Cerrillos (IUCN). Samples have been collected at 2800 to 3000 meters above sea level (Lavilla 2014).

In 1997 year a "catastrophic" flood raised El Ingenio's water levels seven meters above the normal, creating landslides and washed away all debris except large rock. The stream was minimized, destroying the T. *scrocchii* habitat (Lavilla, 2014). In 1997 to 2003, amphibian researchers worked at El Ingenio stream but could not find the T. *scrocchii*. But, researcher still have hope that the T. scrocchii is lost forever (Lavilla, 2014).

Argentina's *Telmatobius atacamensis*, was considered to be likely extinct by the Global Amphibian Assessment. However, a new population was discovered recently in a tributary of River San Antonio de los Cobres (Barrionuevo, 2008). There is urgency to survey nearby waters of El Ingenio for surviving T. *scrocchii* populations. Research and conservation efforts are critical to its recovery. Unfortunately, there have been no efforts to recover a metapopulation of T. *scrocchii* to this date (IUCN). The Argentina Amphibian species listeded T. *scrocchii a*s Vulnerable, IUNC listed as endangered in 2004 because it occupies such a small place with very few populations and individuals. Currently, many researchers are observing the many

Argentinian amphibian threats such as disease and agriculture while monitoring common amphibian habitats (Lavilla, 2012).

Figure 7: Map of T. scrocchii range, highlighted in yellow. Provided by IUCN

Telamtobius* Adaptations: T. *culeus

The most well researched *Telmatobius* is the T.*culeus*, commonly named the Lake Titicaca water frog. Lake Titicaca lies on the border of Peru and Bolivia, at a high elevation of 3,810 meters above sea level (Lee, 2010) (Fig. 8). T.*culeus* is a large frog and has a flat head with round snout and a thick, well developed dorsal disc; but its most distinct characteristic is its prominent skin folds (Benavides, 2002). When stressed it secretes a sticky, milky substance as a defense mechanism to predators. It does not to appear to be poisonous; rather, it is theorized to have an offensive taste. As a result, no birds are known to prey on the frog (Allen, 1922). T.*culeus* lives only in water only and is hardly seen at the water's surface (Allen, 1922). Though it reproduces at the lake's shoreline it prefers to stay at the bottom of Lake Titicaca feeding on amphipods, snails and aquatic insects (Lee, 2010). This amphibian was originally described in

1876 by Garman and continues to be studied in the field and out (Allen, 1922). Therefore, there is a far more information available than the T.scrocchii.

Figure 8: Map of T. *culeus* range, highlighted in yellow. Provided by IUCN

Biologists take interest in the T.*culeus* for its adaptation to a high altitude. It has one of the highest red blood cell counts reported for frog and toads. T.*celeus* has the lowest reported metabolic rate under normal oxygenated water conditions for any frogs, and one of the lowest of all amphibians. This is an advantage because it requires less oxygen to survive. Though T.*culeus* does have lungs, they are small and poorly vasculated. It relies primarily on the ability to remove oxygen from the water with its skin. It is highly vascularize and elaborately folded allowing it to function much like gills. Lake Titicaca's area has such high winds the water tends to be fairly oxygenated. Therefore, the frog can stay water, eliminating predators at the surface. However, if the water is not well oxygenated it will surface from the water to use its lungs. T.*culeus* also has adaptive behavior to efficiently obtain oxygen. If it cannot surface, the frog stretches out to maximize skin surface exposure and moves slowly in the water to obtain maximum oxygen from the water (Hutchison et al, 1976).

Lake Titicaca was established in 1978 to preserve natural resources, including the T. *culeus* habitat. Unfortunately, T.*celeus* is still declining at a rapid pace, 80% since 1998, and is considered critically endangered by IUCN since 2004. T. *celeus* continue to face common *Telmatobius* threats such as pollution, invasive species and susceptibility to chitridiomycosis In addition, adults are overharvested by locals who believe their consumption is an aphrodisiac (Lee, 2010).

Figure 9: T. culeus. Photographed by Arturo Munoz Saravia. Provided by Amazing Amphibia

Though Lake Titicaca is considered a reserve there has been little measures to maintaining suitable aquatic habitats. Other conservation efforts such as captive breeding programs have, so far, been unsuccessful (Lee, 2010).

Conclusion

Telmatobius species are vulnerable to many threats and are declining at an alarming pace. This is due to their high vulnerability and increasing threats. Conservation action is critical to their survival. Firstly, expansion of surveys are needed to find missing frogs, such as the T. scrocchii. For those found, extensive research must be done to learn ecological roles and population trends. To this date, the effects of declining amphibians on environments are unknown. Government legislation is required to regulate disposal of chemicals and waste

products and enforce prohibition of harvesting (Angulo, 2008). Local participation is also necessary to manage land erosion and over fertilization of crops (Barrionuevo, 2008). Conservation efforts will take time and many resources; however, it is the only way to prevent the extinction of many *Telmatobius* species.

Awknowlegements

A big thank you to Esteban Lavilla for his willingness to help provide information on T. *scrocchii*.

Bibliography

Allen, W. R. (1922). "Notes on the Andean Frog, *Telmatobius culeus* (Garman)." *Copeia*, (108), 52-54.

Angulo, A. (2008). "Conservation Needs of Batrachophyrynus and Tematobius Frogs of the Andes of Peru." Conservation and Society, 6(4), 328-333.

Barrionuevo, J. S., and Ponssa, M. L. (2008). "Decline of three species of the genus *Telmatobius* (Anura: Leptodactylidae) from Tucumán Province, Argentina." *Herpetologica*, 64(1), 47-62.

Hutchison, V. H., Haines, H. B., and Engbretson, G. (1976). "Aquatic life at high altitude: respiratory adaptations in the Lake Titicaca frog, *Telmatobius culeus*." *Respiration Physiology*, 27, 115-129.

Icochea, J., Reichle, S., De la Riva, I., Sinsch, U., and Köhler, J. (2004). "*Telmatobius culeus*." In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2

Lavilla, E. (2014). Re: Telmatobius scrocchii Inquiry [Electronic mailing list message].

Lavilla, E. (2012). "Argentina." *Frog Log*, 100, 20.

Lavilla, E. (2004). "*Telmatobius scrocchii*." In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2.

Lee, D. (2010) "Telmatobius culeus – Titicaca water frog" *Information on amphibian biology and conservation.* Berkeley, California: AmphibiaWeb.