DEVELOPMENTAL MALFORMATIONS: A SILENT KILLER OF AMPHIBIAN POPULATIONS?

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Having abnormalities is a normal condition in any population, and amphibians are no exception. Abnormal development often leads to permanent structural defects and these are termed malformations. Reports of malformed amphibians are not unheard of, with some reports dating back to the early 18th century. These observations, however, involved one or few individuals. The story took a sudden turn in 1995 when a group of middle school students from Minnesota, USA, discovered a small pond in which half the frogs had severe malformations, including missing and extra limbs [1]. This incident received immediate attention from both researchers and media since this was the time a "mass malformation" was reported.

Amphibians are considered as excellent bio indicators [2]. Unshelled eggs, aquatic tadpole stage, and permeable skin of tadpoles and adults make amphibians vulnerable to both aquatic and terrestrial hazards. This raised concerns over the causes and implications of amphibian malformations on human health and wildlife. Researchers in other places also began their studies to see if this incident was an isolated one, but it turned out that amphibian malformations was a widespread trend both in USA and other continents such as Europe, Asia and Australia [1].

What causes malformations?

In any population, a few individuals may have malformations resulting from trauma, genetic mutations or developmental disturbances, and this rate is usually below 5% and usually do not involve extreme malformations [3]. Recent surveys have shown that in many populations the frequency of malformations exceed 5% and sometimes reach 80% [3]. Generally malformations in limbs, especially in hind limbs are the commonest type observed in nature [1] (Figure 1). It is clear that this high prevalence of severe malformations could not be attributed to background levels of malformations. Intensive studies have identified chemical contaminants [4], exposure to UV-B radiation [5], and parasitic infections[6] as main causes of amphibian malformations. Interactions among above factors are also considered of great importance as no single factor alone can account for all types of malformations seen in nature [3].

Ecological Implications

Exposure to high levels of UV-B radiations, chemicals and trematode parasites often causes high rates of mortality in amphibian embryos and tadpoles [4-6]. Sub lethal exposure to these stressors results in development of malformations. In what ways can these malformations affect amphibians? Evidence suggests that malformations cause death of amphibians in direct and indirect ways. Malformed amphibians may survive well under laboratory conditions, but in nature they suffer reduced survivorship as malformations impair the locomotion [3]. Therefore, severely malformed ones are not likely to survive to adulthood and sexual maturity [3]. Not only the adults, but also tadpoles can experience adverse effects of malformations. Malformed larvae are known to experience greater mortality than normal larvae [7]. This is supported by the observation that larval amphibians show higher frequencies of malformations than that in adults from the same habitat [7]. Edemas and tail muscle malformations affect the swimming ability of the tadpoles making the tadpoles vulnerable to predation thereby causing indirect mortality [8]. Although some tail malformations disappear upon metamorphosis, edemas upon rupturing are often fatal and causes direct mortality of tadpoles [6]. Reduced activity of tadpoles resulting from malformations decreases the foraging activity while increasing the competition and predation risk. These mortalities might be a reason why we do not see such large number of malformed amphibians in nature although laboratory studies produce high frequencies of malformed individuals.

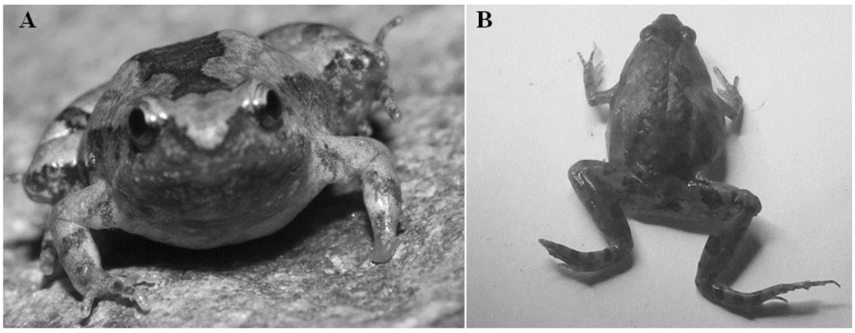

Figure 1: Malformed limbs of Microhyla ornata, collected during a field visit from Anuradhapura. A) apody (missing hand), B) brachydactyly (shorter toes)

Although long term data are not available to conclusively link malformations with amphibian declines, occasionally malformations are associated with declining populations [3]. It appears that mass malformations can eventually impact a larger portion of the amphibian population by causing death directly or indirectly, and are likely to contribute to the observed declines in amphibian populations [1].

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