Popular Article

TRENDS IN AGRICULTURE SCIENCE

Vol.3 Issue 06 June 2024, Page: 1974-1978

Genetics and Management of Wild and Captive Fish Populations

Subramaniyan Manikandan[1], Shiv Kumar Yadav[2], Suresh Eswaran[3]

[1&2] PG Scholar, [3] Assistant Professor & Head, Department of Fish Genetics and Breeding , TNJFU-Institute of Fisheries Post Graduate Studies Vaniyanchavadi, Chennai, Tamil Nadu, India - 603103.

https://doi.org/10.5281/zenodo.12594296

Abstract

Humans have intruded into the natural environment for a long time to meet their ever-growing needs. Human intervention along with environmental effects has created an imbalance in the natural ecosystem. This has increased the demand for conservation of the wild and captive populations of flora and fauna. Management strategies have to be designed in such a way that it helps in maintaining the natural gene pool. Genetics is playing an important role in managing the wild and captive populations. Application of quantitative genetics in conservation has revolutionized this approach. Thus, this study discusses on the role of genetics in management of wild and captive fish population.

Keywords: Conservation, Wild and Captive fish population,Genetics

Introduction

A group of individuals of a species living in a particular geographical area are able to interbreed to form a population of the species. All the species had their population only in the wild in the initial days. They interacted amongst themselves and with other populations in the wild. Nature is dynamic and evolving continuously. Hence, in practical, the populations are not in equilibrium. The equilibrium of the population is interrupted often by environmental (drought, flood, immigration, emigration, tectonic movements etc.) and anthropogenic activities (deforestation, pollution, mining, agriculture and industrial waste, invasive species etc.). This leads to the loss of potential individuals contributing to the gene pool. To compensate and overcome this loss, new conservation strategies were initiated which led to the development of captive population. Populations maintained in confined environments and monitored by human beings are referred to as captive population. They are reserved stocks maintained to prevent extinction of species. In order to maintain healthy stocks, the genetic variation amongst the individuals of the populations must be maintained. Genetic variation increases the fitness of the individual. This in turn helps the population to adapt to the changing ecosystem and increases the survival rate. Effective selection of individuals and careful evaluation of various genetic parameters will help in best conservation and management practise.

Genetic Diversity – The real conservation

Genetic diversity can be viewed at two levels: Intraspecific and Interspecific diversity. Intraspecific diversity is within species and further divided into interpopulation (between populations) and intrapopulation (within population, between individuals). Interspecific diversity includes all the different species of animals and plants present in an ecosystem. Preserving this diversity is crucial for maintaining the integrity of food webs and overall ecosystem health.

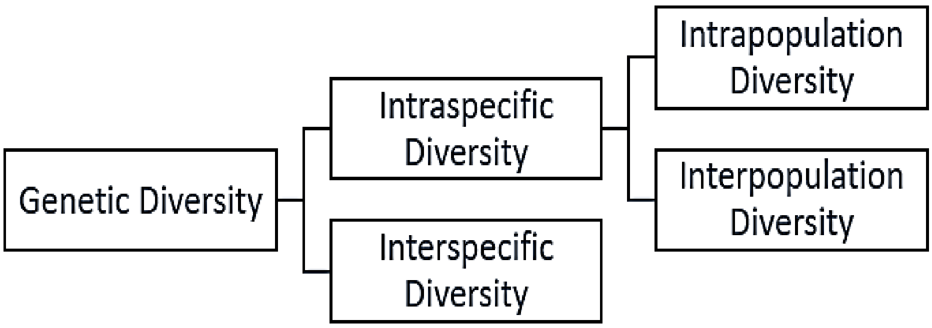

Fig 1: Flow chart on different levels of Genetic Diversity

Fish is the only source of animal protein that is still captured wildly to a greater extent. The marine capture fisheries were all time high in 2018 with 84.5 million tonnes (FAO - SOFIA 2022). Increase in the capture fisheries refers to the removal of individuals of a population which in turn affects the genetic composition of the organism. Wild populations are characterized by normal allele at a genetic locus in contrast to the mutant allele found in its counterparts. They may be found as a single large population inhabiting a specific geographical location as Peruvian anchovy found in off coast of Peru and Chile (Castillo and Plaza, 2016) or as small isolated populations spread out over spatial locations as low-mobility river blackfish (*Gadopsis marmoratus*) (Coleman, R. A., *et,al* , 2016) found across freshwater streams of Australia. With natural selection playing its role in wild populations the heterozygosity is always high. When a species has a lot of differences in its DNA, it is said its genetic diversity is high (Frankham, R., 2002). This increases the fitness of the individual and helps in its survival by adapting to the changing environmental parameters. But with increase in wild capture, intensified climate change and encroachment of aquatic bodies for developmental activities it has led to loss of genetic diversity. With reduction in genetic diversity the species becomes more susceptible to small changes in the environment.

In captivity, genetic diversity reduces and genetic changes occur due to controlled environmental conditions. Captive populations are affected by founder's effect. The limited number of individuals contributing to the next generation do not represent the whole set of alleles present in the population. Captive breeding programs can increase the number of organisms but cannot assure the increase in genetic diversity of the organism. The latter requires careful identification of prevailing genetic diversity using nuclear, mitochondrial DNA or STRs (short tandem repeats) also known as microsatellites. Microsatellites are short sequences of DNA which are repeated variable number of times and are found throughout the genome. They are used to determine the number of times a repeat is found in a locus which differs in between individuals of the population. This gives the level of genetic diversity prevailing in the population. The evaluation of genetic diversity of the population helps in appropriate planning of conservative programmes, identifying and differentiating of various species and helps know the inbreeding levels of the species.

Inbreeding – cause to conservation

Mating of closely related individuals results in inbreeding. Inbreeding accumulates homozygous alleles within the population and deletes several other useful alleles in the population. Deleterious recessive alleles get accumulated due to inbreeding resulting in poor survival of the species. In case of endangered organisms where the effective population (N_e), the number of reproducing individuals is very less, inbreeding and loss of genetic diversity is unavoidable (Frankham *et al*., 2002). Inbreeding stocks with less allozyme diversity caused severe problem in case of the homozygous endangered Sonoran topminnow fish (*Poeciliopsis occidentalis*). The population of Monkey Spring, Southern Arizona exhibited the highest mortality, the slowest growth rate, the poorest fecundity, and the weakest developmental stability. This strongly suggested inbreeding depression (Vrijenhoek,1994).

Isolation of a species due to habitat destruction, fragmentation from the main habitat also results in inbreeding due to bottle neck effect. The temporary reduction in the number of individuals increases the chances of inbreeding depression within the population. Inbreeding depression accumulates the deleterious alleles in the gene pool of the population which refers to the genetic burden or genetic load of the population.

The captive populations used for culture operations are more prone to inbreeding compared to wild stocks. The rate of accumulation of inbreeding is indeed high, particularly high for the three most desirable carp species. The directional selection of traits of individuals over the years has focused only on increasing the production levels. The other traits responsible for disease resistant, nutrient content and temperature tolerance have not been taken into account. This has ended up in species with high productivity but low survival levels. The aquaculture sector is facing sudden disease out breaks due to these activities of the past.

Role of genetics in conservation

Conservation genomics has become the recent trend in the field of conservation. Conservation these days not only focuses on increasing the number of organisms but increasing the genetic diversity amongst the existing population. Conservation can be *in-situ* (in the natural environment) or *ex-situ* (away from natural environment). *In-situ* conservation method is a cost-effective option compared to ex-situ methods. Protecting the natural environments to increase the wild population on its own is a very basic method. This method of conservation stands behind with increasing human population and illegal encroachment for livelihood opportunities. Population augmentation by translocation of individuals from elsewhere into place where it is declining is an alternative solution to this method. Out breeding depression and Genetic swamping (loss of identity of the original individual by the influence of the genotypes from the translocated ones) must be taken care while carrying out in-situ conservation methods. Establishment of zoos and gene banks focus on *ex-situ* method of conservation. Cryopreservation of sperms, ova and embryo are done to preserve them for use in future. A core collection consisting of carefully chosen representatives of all the various genetic variations of the population must be taken into mind while collecting and preserving specimens in GenBanks.

Conclusion

Biodiversity encompasses of genetic diversity, species diversity and ecosystem diversity. The first two are managed by genetics only. Maintaining genetic diversity is essential for the long-term survival of species. Strategies for managing wild and captive populations can help prevent inbreeding depression and loss of genetic diversity. Continued research and collaboration between conservation bodies and geneticist will be required to address the challenges of maintaining genetic diversity in the future. Genetics in common has an important role to play in conservation and management of wild and captive populations.

Reference

1. Bernos, Thais & Jeffries, Kenneth & Mandrak, Nicholas. (2020). Linking genomics and fish conservation decision making: a review. Reviews in Fish Biology and Fisheries.
2. Cerna, Francisco & Plaza, Guido. (2016). Daily growth patterns of juveniles and adults of the Peruvian anchovy (*Engraulis ringens*) in northern Chile. Marine and Freshwater Research. 67. 10.1071/MF15032.
3. Coleman, R. A., Gauffre, B., Pavlova, A., Beheregaray, L. B., Kearns, J., Lyon, J., Sasaki, M., Leblois, R., Sgro, C., & Sunnucks, P. (2018). Artificial barriers prevent genetic recovery of small isolated populations of a low-mobility freshwater fish. *Heredity*, *120*(6), 515–532.
4. FAO. 2022. The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO.

5. Frankham, Richard. (1995). Frankham R. Conservation genetics. Annual review of genetics. 29. 305-327
6. Michael K. Schwartz, Gordon Luikart and Robin S. Waples, (2007) Genetic monitoring as a promising tool for conservation and management. TRENDS in Ecology and Evolution Vol.22, Issue 1, Pages 25-33
7. Nils Ryman, Fred Utter and Linda Laikre (1995). protection of intraspecific biodiversity of exploited fishes. Reviews in fish biology and fisheries, 5,417- 5,446
8. Pinsky, Malin & Palumbi, Stephen. (2014). Meta-analysis reveals lower genetic diversity in overfished populations. Molecular ecology
9. Vrijenhoek, R.C. (1994). Genetic diversity and fitness in small populations. In: Loeschcke, V., Jain, S.K., Tomiuk, J. (eds) Conservation Genetics. EXS, vol 68. Birkhäuser, Basel.

Published: 28 June 2024
ISSN: 2583-7850