

## An empirical study of fish breeding and biotechnology: Evidence from Indonesia

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### Abstract

This exact review analyzes the utilization of fish reproducing and biotechnology inside the setting of hydroponics in Indonesia. With its quickly developing populace and expanding interest for fish, Indonesia faces huge difficulties in addressing protein needs while guaranteeing feasible natural practices. Accordingly, this examination explores the effect of fish rearing and biotechnology on upgrading fish creation, further developing species quality, and moderating natural worries. Using quantitative information and subjective experiences accumulated from reviews and meetings with fish ranchers, reproducing specialists, and policymakers, this study reveals insight into the present status of fish-rearing practices and the reception of biotechnological progressions across various locales of Indonesia. The findings feature the different ways to deal with fish rearing, including specific rearing, hereditary alteration, and high-level conceptive procedures, and evaluate their suggestions for creation yields, disease opposition, and asset protection. By orchestrating observational proof, this study adds to the comprehension of the job of biotechnology in molding the fate of hydroponics in Indonesia and gives significant proposals to policymakers and partners to advance maintainable and strong fish-rearing practices in the country.

**Keywords:** Fish Breeding (FB), Biotechnology (BT), Indonesia (I), Theoretical analysis.

**Citation:** Yulfiperius et al. 2023. An empirical study of fish breeding and biotechnology: Evidence from Indonesia. *FishTaxa* 28: 1-9.

### Introduction

In the present era, there is a surge in the demand for fish. natural fish harvesting methods are now unable to meet the ever-increasing demand for fish. increased natural harvesting methods have little efficacy in fulling the fish demand of the world. this problem is overcome by introducing artificial methods to increase fish production. aquaculture is one of the methodologies used for improving the quality and quantity of required fish. The improvement in the methodologies of aquaculture can be achieved through the help of biotechnology-based techniques (R Sulistijowati, Yuliati, & Komariyah, 2023). The animals produced through aquacultures are well developed to be used for various biotechnological experiments. the fertilization process of animals developed in aquaculture can be altered using various hormones that ease the biotechnology-based experimental processes. The main reason behind using biotechnology in aquaculture is to produce advanced-quality aquatic products. In recent years, biotechnology has provided remarkable applications in the field of fishery and has resulted in the production of improved livestock using biotechnological-based tools (Rieny Sulistijowati, Yuliati, Komariyah, & Musaiyaroh, 2023). the areas in aquaculture that have benefited from biotechnological techniques include; using synthetic-based hormones for inducing the breeding process, mono sex production, development of uniparental as well as polyploid species, production of transgenic fish, improved production of feed and natural marine-based products development.

The production of aquatic organisms in a controlled environment under suitable conditions is done in aquacultures. all the activities related to aquatic production growth, development, and fertilization are

controlled in aquaculture. In aquacultures aquatic development and death factors are under control. The aquacultures have improved the production of fisheries to a great extent and have doubled the fish population (Setiyowati, Nugroho, & Halik, 2023). The statistic obtained by the Ministry of marine affairs and Fisheries in 2018 declared that the production of aquatic organisms by aquacultures has increased from seventy to seventy-four percent. This data shows that in the present world, most of the fish production is from aquaculture. The increase in population has resulted in increased demand for fish-based marine products. The economic sustainability of most countries of the world demands marine product production as these products play an important role in maintaining economic sustainability. Using biotechnology-based techniques in aquacultures can enhance the marine product production of any economy for carrying out the fish breeding process. The biotechnology-based hormonal product is used in aquacultures. The gonadotrophin-releasing hormone is a hormone produced through biotechnology tools that improve the process of fish breeding (Marsasi, 2023). This hormone plays a role in the regulation and initiation of the reproductive process in vertebrates. The GnRH is an important hormone as it holds critical importance under the name Ovaprim and is used in fish breeding processes all over the world. The economically significant fishes do not breed until induced by the GnRH factor. Through the advancement of biotechnology tools, the production of GnRH has been increased successfully (Burrichter, Chen, & Marco, 2022).

One of the largest archipelagic countries around the globe is Indonesia which has numerous fishery resources. The magnitude of the marine sea of Indonesia is 5.8 million km<sup>2</sup>. The data from various studies of the past predicts that Indonesia holds the second position in producing seaweed and fourth in aquaculture-based productions. Indonesia uses marine biotechnology techniques for developing open-water fisheries systems and for improving the quality of their marine ecosystem (Purnomo, Yulianto, Mahdiannur, & Subekti, 2023). Indonesian fisheries include the process of cultivation and production of fisheries resources for marine-based product development. The process of marine marketing is performed under the Indonesian fisheries project. The data obtained through the central statistical agency predicts that in Indonesia aquaculture fish production is more compared to captured fish production (Belleggia & Osimani, 2023). This increased production of the fish population by Indonesian aquacultures leads to an improvement in income resources for fish farmers. Moreover, seaweed farming is carried out in Indonesia through fisheries farmers. Due to the low cost of seaweeds, they are used by rural communities in their farming techniques. In Indonesia, seaweed farming provides a lot of financial benefits to the rural people. Through proper policy-making processes, seaweed farming in Indonesia can benefit the development of quality products (Friedman & Fernández-Gimenez, 2023). Also, the increased fishing pressure has resulted due to the increase in the population of the world. To overcome the fishing pressure the seaweed farming technique is used by farmers in remote areas. This technique provides great benefits to improve the economic stability factor as it is a low-investment technique. Economic and social benefits are achieved through the use of seaweed farming for producing improved products (Veeragurunathan, Vijay Anand, Ghosh, Gurumoorthy, & Gwen Grace, 2023). Indonesian economic sustainability greatly depends on seaweed farming as it provides improved livelihood opportunities to the farmers associated with seaweed farming programs.

A genetically developed species known as the African catfish is found in Indonesia and holds great food-supporting value. Indonesia's food security is fulfilled through the food-supporting value of African catfish. To save the catfish population from declining the African catfish breeding program has been established in Indonesia. The use of biotechnology techniques for improving catfish breed helped increase the production rate of African catfish. Genetic diversity obtained in African catfish shows that using biotechnology-based genetic techniques for producing this fish species holds great importance in improving the food security factor of Indonesia (Mohammad). One benefit of using genetic engineering technology for producing the breed of

African catfish was to get catfish having improved genetic traits. the implementation of African catfish breeding programs resulted in the spread of this specie all over Indonesia .this breeding program holds tremendous importance in Indonesia as it helped fish farmers save the African catfish population and provide economic stability to the country through its use for food security purposes (Ertör, 2023) .furthermore, in most of the countries a large part of income depends on marine industries and its products. by improving the growth and reproduction process of aquatic life, better aquatic and marine products can be obtained. using biotechnology techniques in aquaculture and seaweed framing can improve the fish breeding process and can provide numerous benefits to marine industries (Zhang & Sun, 2022).

### **Research objectives:**

This research paper aims at explaining the importance of fish breeding. The improvement in fish breeding using biotechnology techniques has also been discussed in the article moreover, the role of fish breeding techniques in improving Indonesia's economic sustainability has been discussed here.

### **Fish breeding:**

The process of breeding different species of fish for the production of fish with improved genetic traits is termed fish breeding. in this process, the fish species are transferred from one water body to another. The maintenance of the fish population and increase in fish-based resources is achieved through the fish breeding process. mostly the fish breeding process is highly complex as well as expensive. This process requires the maintenance of fish species using hormones that induces the fish's growth and developmental process. The fish breeding programs help in maintaining the fish population as well as increasing fish production. All the fish breeding programs work with the approval of the Ministry of Agriculture and Fishery. To carry out fish breeding three critical steps are important (Rachman et al., 2022). The first step includes the selection of parent fish. the second step is to develop favorable conditions for the fish breeding process. the third step is to protect the fish species that are taken for breeding purposes. various fish breeding techniques are used for improving the production value of marine products. The below-mentioned techniques are biotechnology-based and improve the fish breeding process.

#### **1) Chromosomal Engineering:**

To improve the production of cultural fish, the chromosomal sex manipulation technique is used that improves the chromosomal inheritance process of uniparental and polyploid chromosomes (Sardjono, Christian, Juwitasary, & Putra, 2019). The chromosomal manipulation techniques hold immense importance in enhancing the breeding process and improving hybrid variability factor as well as sex control. most diploid vertebrates consist of two sets of chromosomes while in polyploid species they have one additional chromosome set along with two sets of chromosomes.in triploid species, the number of chromosomes set is three. The triploid method is the most effectively used method for developing sterile fish species. the sterile fish species are used in aquacultures and fisheries management ecosystems to improve the fish breeding process. By using biotechnology techniques in aquaculture, the crossbreeding between teraponids and diploid fish species induces the production of triploid fish species. another technique of chromosomal engineering is gynogenesis this process is involved in developing animals having whole maternal inheritance features .producing gynogenetic individuals improves the fish breeding process as it induces the interbreeding process in a single generation (Djufry, 2022). For determining the sex of fish, the gynogenesis process is used in fish breeding as it produces female fish species in the population having female homogeneity. combining the gynogenesis process with the hormonal sex inversion method helps in developing species for aquaculture.

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Another process based on the chromosomal engineering principle is androgenesis which produces progeny without any female genetic contribution. The progeny produced through androgenesis produces a male population of fish that holds great commercial value in aquaculture. The sex manipulation technique, gynogenesis, and androgenesis are chromosomal engineering-based fish breeding techniques that improve the production quality of fish in aquaculture (Ghelichkhan, Eun, Christensen, Stott, & MacAdam, 2018).

### **Material and Methods:**

Writing concentrated has been finished in setting up this paper. All information and data utilized were gathered in light of accessible distribution connecting with the over wide time status of *Clarias* cultivating inside the nation and abroad. The information and data acquired were then developed to orchestrate the plan of *Clarias* cultivating in Indonesia. Along with late development innovations, investigations to see the practicality of use were likewise considered to choose or propose systems about challenges, obliges, and issues faced.

### **2) Sex Control Technique**

Sex control is another fish breeding technique that helps in improving the characteristic of teleost species. improvement in teleost species enhances the production value associated with aquacultures. Sex control is a technique that improves the mono-sex production by the process of sex manipulation. This process is more useful in species in which one sex is potentially useful in comparison to the other sex. Two processes are involved in sex manipulation. the first is hormonal control in which the sex steroids are given to fish in the developing stage when sex differentiation starts (Marinus et al., 2018). The appropriate dose of sex steroids at a liable time causes the inversion of phenotypic genetic expression of a female into a male fish. While the genetic expression of males remains the same. also, molecular-based genetic methods help in the process of sex differentiation. Environmental factors like temperature can influence the sex determination process. through the sex determination process, the fish breeding process becomes easier and improved quality of fish breeds are obtained in aquacultures.

### **3) Transgenesis Process**

This is a biotechnology-based technique used for introducing the DNA into the genome of a host for the maintenance and expression of genes. this technology-based technique holds importance in modifying the genetic characteristic of commercial fish species .in Salmonoid growth enhancement feature is observed using the transgenesis technology. For improving the quality of the transgenic process sterile species are preferred. the sterile spices reduce the risk of mixing transgenic stocks (Chivenge, Sharma, Bunquin, & Hellin, 2021). The sterile fishes are produced through the inducible promoters that make species sterile to be used in the transgenesis process. This process helps in maintaining the growth and reproduction of transgenic species present in the transgenic stock. Any specie that escapes the transgenic stock becomes unable to perform breeding in aquaculture. an important factor that disturbs the fish transgenic fish stock is cold temperature. The temperature of most aquaculture is cold and many fish species die because of this temperature before the start of the transgenesis process. various methods and techniques have been employed to maintain commercialized aquaculture for the production of fish species having commercial importance. These techniques include; the use of mass gene transfer-based technology, the use of appropriate promoters for ensuring the optimum developmental stage, the use of desirable genes, information about the physiological, nutritional as well as environmental factors of aquaculture, and the maintenance of transgenic fish safety.

1. **Introduction of DNA into the Genome:** Transgenesis involves inserting foreign DNA, often containing desired genes, into the genome of a host organism. This DNA can be from the same species or from a

different species, depending on the goals of the genetic modification.

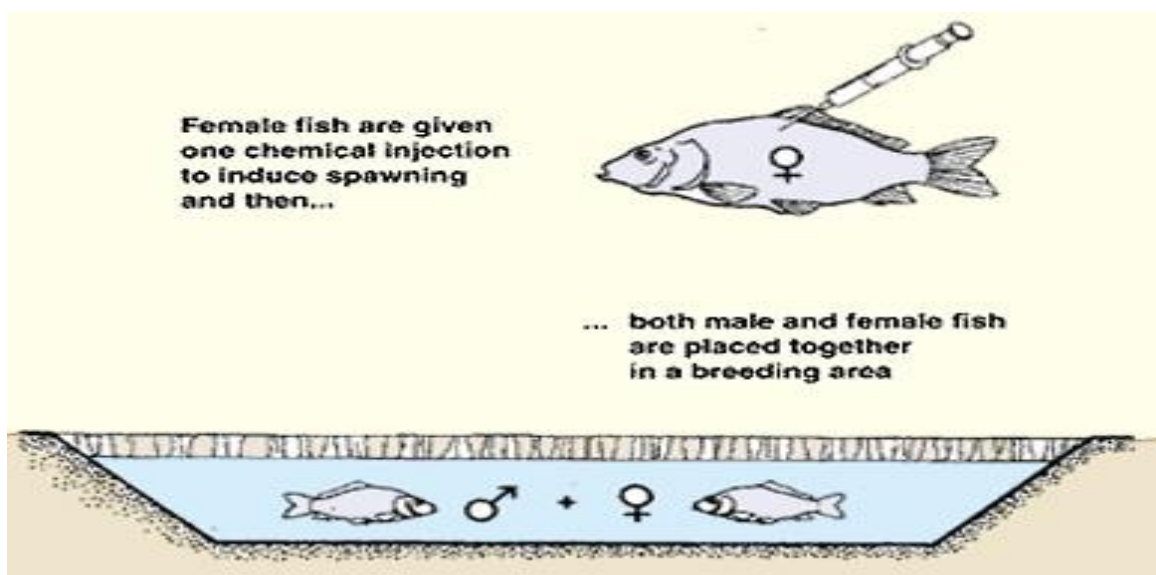
2. **Commercial Fish Species Modification:** Transgenesis is commonly used to modify commercial fish species, such as salmonoids, to enhance specific traits like growth rate. By introducing genes that promote faster growth, scientists can potentially create fish with higher yields for aquaculture.
3. **Sterile Species:** To prevent unintended crossbreeding between transgenic and wild fish populations, sterile species are preferred for transgenesis. These sterile fish are typically produced using inducible promoters that render them unable to reproduce.
4. **Inducible Promoters:** Inducible promoters are DNA sequences that regulate gene expression. In this case, they can be used to control the fertility of the fish, ensuring that transgenic fish do not contribute to the natural population.
5. **Cold Temperature Challenges:** Cold temperatures in aquaculture settings can be problematic for fish, especially those undergoing transgenesis. Selecting fish species that are better adapted to the local temperature conditions can help mitigate losses.
6. **Methods and Techniques for Commercialization:** To successfully commercialize transgenic fish, several factors need to be considered:
  - **Mass Gene Transfer:** Efficient methods of introducing the foreign DNA into fish embryos or cells need to be developed.
  - **Promoter Selection:** Using appropriate promoters ensures that the introduced genes are active during the desired developmental stages.
  - **Desirable Genes:** Genes with known benefits, such as growth enhancement or disease resistance, are selected for insertion.
  - **Understanding Factors:** Knowledge of the fish species' physiology, nutrition, and environmental needs is crucial for successful aquaculture.
  - **Safety Measures:** Ensuring the safety of transgenic fish in terms of their impact on ecosystems and human consumption is important.



#### 4) Nutritional Value of Aquaculture:

The advancement of the aquaculture industry has increased in the last few years. developing countries of the

world have the most advanced aquaculture-based industries that result in the increased importance of aquaculture products. aquaculture greatly improves the food security process (Friedman & Fernández-Gimenez, 2023). The most important factor for aquaculture maintenance is nutrition. the use of well-balanced and nutritional feed in aquacultures plays a pivotal role in the production of various species of fish. Using biotechnology improvised nutritional feed in aquaculture improves its productivity feature. Various exogenous and proleptic enzymes used in aquaculture feed improve its nutritional value. Thermostable enzyme used in aquaculture improves the quality of feed and makes it a growth enhancer feed for fish species. the environment of aquaculture based on external as well as internal microbial populations is enhanced using probiotics. for improving the shrimp culture in Indonesian aquaculture various probiotics are used in its feed (Mucharam, Rustiadi, & Fauzi). The use of probiotics in Indonesian aquaculture acts as an efficient tool for preventing the shrimp population from getting attacked by any viral substance. The importance of using commercial probiotics in aquaculture is that it improves the growth rate of indicus. Moreover, various aquaculture management have replaced the use of antibiotics with probiotics for making aquaculture safer for the shrimp population. Due to the immense use of probiotics in aquaculture, their demand has increased. the increasing demand for probiotics has increased their prices .moreover, using biotechnologically developed products in aquaculture improved the fish breeding process (Data, 2021). To achieve sustainable aquaculture various processes should be adopted by the aquaculture management system include: understanding the nutritional requirement of cultivable fish species, development of specific and improved diet for fish, understanding of nutrition requirement of the fish larval stage, enhancing the quality feed resources used in aquaculture, using biotechnology tool for a breakdown of complex products into simpler from, developing an appropriate and workable feeding strategy using biotechnology-based tools, etc. because of the tremendous benefits and application of biotechnology in aquaculture, it is believed that this technology will play a tremendous role in improving fish's nutritional value in the future.

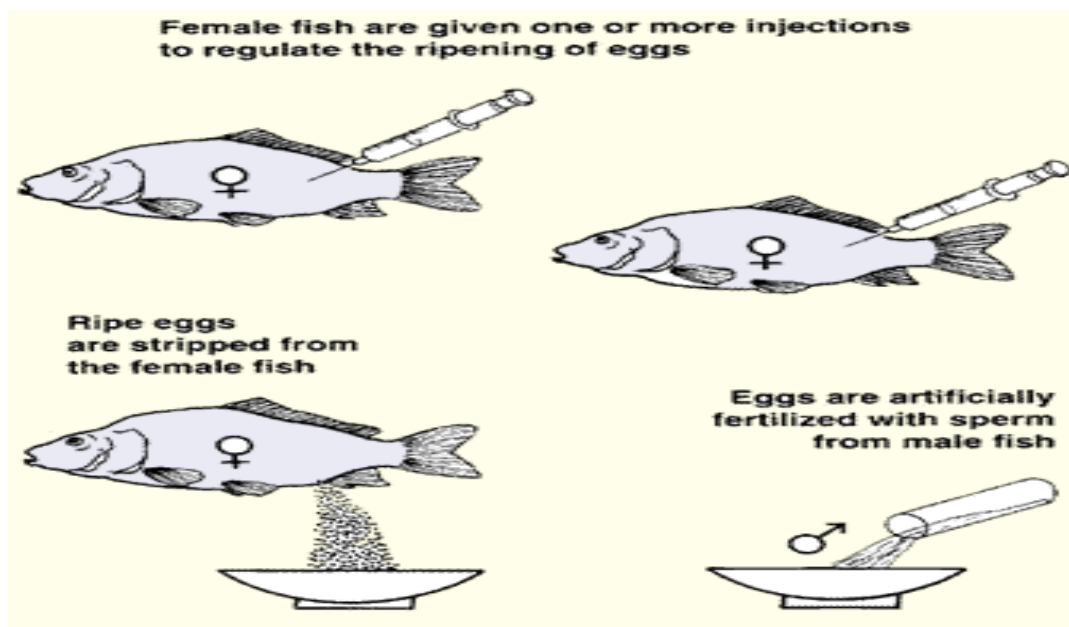


##### 5) Management of Fish Health Through Biotechnology;

The disease breakout among fish species hinders the developmental process of aquacultures. to solve this problem biotechnology-based tools and techniques are used for identifying any diseases in the fish population. vaccines use and molecular diagnostic tests are the biotechnology techniques used for diagnosing and treating various fish diseases. Pathogens are the main contributors to fish diseases. to avoid pathogens development in aquaculture vaccines help in minimizing the risk of disease development in fish species. the most important

biotechnological tool, PCR plays a significant role in detecting various fish diseases. This PCR method diagnosed various pathogens that cause fish diseases (Mardianto, Tjahjono, & Rifada, 2019). The use of vaccines in aquaculture kills pathogens and stops fish diseases from spreading. The new biotechnologically developed vaccines that provide immunization to fish against any pathogen attack. Moreover, for immunizing the shrimp's immune system, they are provided with biotechnologically developed products.

All the above-mentioned strategies are biotechnology-based and provide immense importance in developing excellent aquaculture for fish breeding and for producing various marine products. Using biotechnology techniques and tools in aquaculture greatly benefits the fish species in their growth and developmental phases and saves them from any attack from foreign pathogens. Also, several marine products can be obtained as a result of the fish breeding process. The production of pharmaceutical products, oils, and other pigments has been increased using biotechnologically modified techniques in marine aquaculture. Various marine organisms play a therapeutic role against several diseases. From the blood plasma of various marine organisms, novel compounds have been obtained that have the efficacy of destroying malignant cells, as well as stopping the growth of marine animals having high spermicidal ability or activity. Also, marine seaweeds are great commercial marine products having medicinal characteristics. The cells as well as tissue developed from seaweed have biological importance and are used in various unique drug development processes. Moreover, to efficiently use all the marine product biotechnology tools are used in most marine aquacultures. Various marine aquaculture management programs are used for improving the working of marine ecosystems. These programs ensure that the fish breeding process in aquaculture produces high-quality aquatic products for commercial use. Also, the marine products obtained through various biotechnology application used in the fish breeding process helps in improving the economic stability of the country.



Fish reproducing models in Indonesia have been utilized to develop fish creation and manageability in hydroponics further. Indonesia is a country with huge marine and freshwater assets, and hydroponics assumes a critical part in its economy and food security.

Some normal fish-rearing models and strategies that have been applied in Indonesia include:

1. **Specific reproducing:** Particular reproducing includes picking explicit people with helpful qualities, for example, development rate, illness opposition, and size, to be the guardians of the future. This cycle helps



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improve the general quality and efficiency of the fish populace.

2. **Crossbreeding:** Crossbreeding includes mating fish from various strains or species to consolidate their positive attributes. This strategy can prompt crossover power, bringing about superior development rates and other useful qualities.

3. **Monosex fish creation:** Some fish species show sexual dimorphism, where one sex becomes quicker and is more alluring for cultivating. Monosex fish creation includes delivering an all-male or all-female populace through hormonal control, further developing consistency and development rates.

4. **Polyculture and coordinated cultivating frameworks:** Polyculture includes raising numerous fish species together in similar lake or oceanic climate, exploiting their reciprocal natural specialties. Coordinated cultivating frameworks join fish with other cultivating rehearses like shrimp, poultry, or vegetables to make an economical and effective framework.

5. **Recycling hydroponics frameworks (RAS):** RAS is a concentrated hydroponics strategy that recycles and channels water to maintain high water quality, considering controlled and productive fish rearing in a shut climate.

### **Conclusion:**

Breeding technique is one of the most utilized strategies for sustainable seafood production since it adds to the conservation efforts for most aquatic species. Genetic improvement induces breeding and captive breeding are among of the known breeding procedures that have been employed to raise the output of aquatic species in coastal communities and other aquatic settings. It also delivers greater ecosystem services by boosting biodiversity and preventing species extinction through the development of breeding methods. More study is needed to explain additional breeding procedures with a goal to understanding their advantages and limitations after their application to diverse commercial aquatic species. Aquaculture operations are created with the presence of food security programs to boost fish consumption, enhance the farmers' welfare via business segmentation, and expand the prospects for various company scales by employing varied technology. Contextual analyses might exist where these reproducing models have been executed in unambiguous Indonesian areas, thinking about the nearby fish species, market requests, and ecological elements. The outcome of these models can fluctuate in view of elements like administration rehearses, foundation, specialized ability, and monetary circumstances. For more modern and definite contextual analyses, I suggest checking logical diaries, research papers, and reports from Indonesian agrarian and hydroponics establishments or talking with specialists in the field. Clarias catfish farming using diverse biotechnical techniques can preserve the sustainability of national catfish production. Only by employing the correct technology, the manufacturing system will be sustained. Production techniques in catfish farming can be utilized as a model for other aquaculture commodities. It is advisable to discover excellent catfish by leveraging the potential of local catfish species.

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