Biosciences, Biotech. Research Asia Volume **01**, No. (**2**) 9-13 (2004)

THE RELEVANCE OF GENETICS IN THE DEVELOPMENT OF FISHERY TECHNOLOGY IN NIGERIA

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(Received, October 28, 2003)

ABSTRACT

In this review I present the relevance of genetics in the development of fishery technology in Nigeria. Genetic principles such as identification and classification of fish, selection, inbreeding, hybridization, production of polyploids, disease-resistant fish, conservation of wild stock and control of sexual maturation applied to fish in various areas are discussed. Consideration is given to problems which militate against the rapid application of these principles.

INTRODUCTION

Fish framing, an encouraged industry in many parts of Nigeria continuously looks towards scientific and technological motivation for further development. Modern genetics (the science dealing with heredity) though a product of 20th century, has made immense progress in biotechnological advancement of many countries particularly the developed ones. This is because most of the expressed characteristics of organisms have underlying genetic origins which make their utilization in biotechnology possible, easy and fast[1]. The possibilities for genetic manipulation of stocks are limited while aquatic organisms remain largely undomesticated, but, with increased in the establishment of large companies or organization of specialist suppliers of stock genetics then stands a good tool which possesses a great potential of considerably improve fishery.

Modern genetics having made almost explosive progress since its discovery is relatively young in fish culture chiefly in low technology, high labour-intensive aquaculture areas such as Nigeria. Indeed, the idea and attempts of applying genetic principles to fish culture were unrecognized as far back as 1960s[2,3]. The knowledge and acceptance of applied genetics in fishery gained fundamental significance with the arrival of large establishments of specialist stock suppliers[4].

Genetics serves as a basis for selection and other artificial or experimental breeding programmes amied at improving fish for use in controlled production systems. This has been noted to contribute in no small measure, to the development of fishery technology, mainly in the improvement of quantity and quality of fish produced for specific purpose. In Nigeria, not much appreciable progress in fishery is recorded. This is associated with little emphasis laid on fish genetics. Infact various measures of improving farmed fish performance (suitable feeding, management and prophylatic means etc.) save genetic have been used in Nigerian fishery but they do not produce the adequate anticipated effect. In the present investigation, the relevance of genetics in the development of fishery technology in Nigeria is discussed.

APPLICATION OF GENETICS

Genetic principles are applied to fish in the following areas viz.

Identification and Classification of Fish

Genetics is important to identify and classify fish. Morphological and behavioral parameters are insufficient to properly name and group fish. The correct identification of fish allows several management decisions to be made, which could save time and money[6]. With the introduction of genetics in fishery, adequate identification has been achieved. Genetics is seen as aiding the characterization of the diverse wild populations of commercial and related species[7]. This is vital to assist in the selection of best-adapted populations for specific reasons and environments. Gjedrem *et al*.[8] studied the chromosome number of some salmonids and their hybrids in an attempt to differentiate them. Tilapia stock was identified using electrophoretic genetic markers[6].

Selection:

This is the common genetic tool available to breeder for stock improvement and the most powerful factor capable of altering genetic structure of a population[5]. Also natural selection in the absence of genetic technology will not necessarily benefit the breeder[7]. Fish are selected for desirable economic important traits such as growth, colour, carcass yield, pigmentation, synthesis of vital food components-protein, vitamins, oils, etc. For any selective breeding to succeed, there must be a good genetic variance for the traits to be selected.

Population differ significantly in quality and quantity of genes associated with the characteristics[9]. Amateur breeders have produced a variety of forms and colour in many fish species by selection[4]. Donalson and Olson[10] recorded striking improvement in the selection of rainbow trouts for some characteristics, although the genetic validity could not assessed then[4]. Most commercial traits are inherited as large number of genes each with considerable small individual effects. Successful, properly conducted genetics selection programmes have been documented by some researchers.

During the period between 1950 and 1978 in China, there was an increased production of kelp from 60 to 200,000 metric tons[11,12]. This was attributed to improved strains obtained through genetic manipulation by mutation in breeding and selection. In addition, it was recorded that the new breed produced have higher temperature tolerance, faster growth and higher alginate and iodine contents. Also, several generations of selection in atlantic salmon and rainbow trout have resulted to genetic gain of 3-4% per year for growth rate in Norway. Positive response of atlantic salmon to natural selection for age at sexual maturity was reported[13]. Similarly, the production of atlantic salmon smoltifying at one year of age was genetically selected among others[14].

Inbreeding

Inbreeding in commonly associated with general lowering of fitness especially with fast reproducing fish[4]. Genetic plays a vital role in inbreeding particularly in a closed breeding cycle. The restricted outcome of some breeding programme is due to limited individuals of too few a gene pool, the extremity of which may result to deleterious inbreeding depression of fitness[7]. Few of genetic techniques applied to circumvent the problems of inbreeding depression are :

The maintenance of inbred lines for use as parents to produce F-1 hybrids offsprings for production lines. This will increase the gene pool in the breeding system[4]. Production of new inbred lines by a special parthogenesis. In this case eggs are fertilized with genetically inert spermatozoa and cold shock immediately to double the number of maternal chromosomes[15,16].

Hybridization

The production of individuals from genetically unlike parents is employed in hatchery to increase the genetic variability of endemic stock in a selection. With hybridization in fishery, desirable character can be combined in separated different form into one stock. This will encourage the production of desirable hybrids for market and also superior fish for traditional fishing can created. Refstie and Gjedrem[17] obtained interspecific hybrids of salmonids genetically. Similarly, Blanc and Chevassus[18] reported good hatchability and survival of some hybrids produced from salmoinds. The hybrids were noted to have better traits (increased growth rate, environmental tolerance, large egg size, etc) than their respective parents. Hybrids of small freshwater starlet, Acipenset ruthernus and the giant marine sturgeon, Huso huso have better growth rate and fresh water tolerance in comparison with their parents[19].The hybrids from plaice and flounder (Platichthys flesus) have large egg size and high environmental tolerance which make them suitable for hatchery enviorment[4]. Brem *et al*[20] obtained tilapia hybrids by transferring genes into tilapia (Oreochromis niloticus) using DNA fragment containing mouse metallothionein-1 promoter fused with the human gene for somatotropin. The transgenic tilapia survived up to 90 days after spawning. Transgenic salmon with Escherichna Coli β galactosidase gene was show to express the enzyme activity[21].

Production of Polyploids

The existence of more then the normal two sets of chromosomes in fish is genetically based and this has contributed to improved production in fishery. Polyploids are commonly produced by thermal shock. Rainbow trouts were produced by using heat shock treatment on fertilized egg[22]. Likewise, triploid plaice was produced by the application of cold to freshly fertilized egg[23]. Other means of making artificially duplicated chromosome sets of fish include the use of hydrostatic pressure and chemicals such as cytcochalasin-β[24,25].

Disease - resistant fish

Artificial breeding of disease-resistant fish to prevent the serious loss associated with reduced natural genetic resistance or general vigour is of considerable importance in fishery. Genetic resistance to diseases in cultured organisms occupy an important position in breeding generally. In agricultural animals however, little has been done to develop disease resistant varieties. This lag in not due to lack of genetic variability to disease resistance but reliance on prophylaxis[26].

Fish have genetic variation for disease resistance significantly adequate for exploitation in aquaculture. Hayford and Emboby[27] reported higher disease resistance with increased growth rate and average number of egg per female in the salvelinus frontinalis (Eastern brook trout). Wolf[28] noted the development of disease resistant strains of freshwater fish. Higher disease resistance in selectively bred fish Chinook salmon (Oncorhychus tsthrawytcscha) and Other freshwater fishes was also recorded by Donalson[29]. The heritability of survival of alevins in splake hybrids was attributed to genetic difference in susceptibility to blue sac diseases[30]. Furthermore, rive strains of atlantic salmon parr were estimated to vary significantly in resistance to vibrio disease[31]. Hines *et al.*[32] indicated genetic difference in susceptibility to Epidermal epithelioma disease and bladder inflammation among strains to common carps. They noted disease resistance in crossbreds between the two infected strains.

Conservation of wild stock

Conservation of wild genepools in important for future selection and breeding programmers that may be an integral part of the oncoming aquaculture. Genetic variation for aquaculture breeding can be drawn from the gene pool of natural populations. Equally, the reclamation of lost genes in hatchery selection is impossible expect reference is made to the wide stocks[7]. Inspite of the role played by wild stocks in fishery, it is difficult to artificially preserve natural genetic integrity of wild populations. However, processes such as hybridization and ecological competition are in use to successfully conserve wild gene pools for future needs.

Control of sexual maturation

Control of sexual maturation is useful for the rearing of sterile fish which in turn reduce cost and increase protein production with high quality flesh. The usual method employed in controlling sexual maturation and spawning is by the feeding of appropriate sex hormones to fish. Jensen and Shelton[33] used estrogen in the production of monosex genetic male tilapia. Monosex tilapia fry was produced by the application of androgen[34]. Pandian and Varadaraj[35] produced 100% male tilapia by applying endocrine and chromosomes manipulation techniques.

Conclusion

Genetics can be placed at the central core of fishery development. It has profoundly buttress the fishery technology of some countries. There exist scanty reported works on fish genetics in Nigeria. Some noticeable problems militating against the development and progress of fish genetics in the nation include the followings :

Life cycle of fish : The life cycle of an organism must be fully and easily controlled for good genetical study to be carried out. Most fishes have complex cycles which contribute to the set-back of fish genetics research in fish culture. This is the major problem militating against rapid development and expansion of aquaculture in the tropics generally. In Nigeria most species preferred by consumers such ar Chrysichythys nigrodigitatus (silver catfish), Clarias gariepinus (mud catfish), Lates niloticus (Nile perch), Heteropbronchus bidersalis (catfish) etc are difficult to breed. This necessitates specialized hatchery techniques which are difficult to combey.

Long-temr-result-obtainable-research in fish genetics due to complex nature of genetic systems in fish associated with lower rate of reproduction and fewer offsprings in comparison with prokaryotes. This factor is further complicated by unaviability of specific trained experts, appropriate laboratory equipment, spare parts and materials associated with insufficient fund.

Socio-economic problem:

Scientists are inadequately rewarded. Institutional constraints such as access to credit and land as well as the availability of surface and ground water which hinder the drastic expansion of aquaculture and the realization of the programme within the time frame of genetic research.

In order to develop fishery technology in Nigeria, there is the need to reduce or eliminate the above stated problems. This will encourage aquaculture systems to move beyond the present state of rearing invariably wild organism in hatcheries. Selective breeding programmes should be integrated into production systems to repose the present level of disease control, inbreeding, hybridization, production of polyploids, conservation of wild resources, etc. This information will be useful to set the pace for fish genetics research in the country.

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