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Transgenic fish resistant to infectious diseases, their risk and prevention of escape into the environment and future candidate genes for disease transgene manipulation

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Abstract

Transgenic fish have been produced that have improved growth, disease resistance, survival in cold and body composition, have altered color, that can act as bioindicators for estrogenic pollutants and that can produce pharmaceutical proteins. The largest amount of transgenic research has focused on growth hormone transfer. A relatively small amount of research has focused on enhancing disease resistance, but significant enhancement has been accomplished. Pleiotropic effects from the transfer of other transgenes, particularly growth hormone gene can alter disease resistance in both positive and negative ways. Most negative effects for all transgenes appear to lower fitness traits, which is positive for biological containment. Transgenic fish appear to pose little environmental risk, but this research is not fully conclusive. To expedite commercialization and minimize environmental risk, transgenic sterilization research is underway. A large amount of functional genomics research has resulted in a much better understanding of gene expression when fish are experiencing disease epizootics. This information may allow the future design of more effective transgenic approaches to address disease resistance.

Keywords: Transgenic fish; Pleiotropic effects; Disease resistance; Gene expression; Environment; Sterilization

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Résumé

Des poissons transgéniques ont été préparés pour améliorer leur croissance, leur résistance aux maladies, leur survie dans le froid et leur composition corporelle, pour modifier leur couleur et pour être utilisés comme bioindicateurs permettant de détecter des polluants oestrogéniques ainsi que pour produire des protéines d'intérêt pharmaceutique. La plus grande partie des études appliquées mettant en œuvre des poissons transgéniques s'est focalisée sur le transfert du gène de l'hormone de croissance. Une partie plus modeste des recherches porte sur la lutte contre les maladies, qui ont permis des progrès substantiels. Des effets pléiotropiques résultant du transfert d'autres gènes et en particulier du gène d'hormone de croissance, peuvent modifier la résistance aux maladies dans un sens positif ou négatif. La plupart des effets négatifs de tous les transgènes semble diminuer l'aptitude des poissons à s'adapter au milieu sauvage ce qui contribue à renforcer l'efficacité du confinement biologique. Les poissons transgéniques semblent poser peu de problèmes environnementaux mais les recherches dans ce domaine ne sont pas pleinement concluantes. Pour accélérer la commercialisation des poissons transgéniques et minimiser les risques environnementaux, des recherches sont actuellement conduites dans le but de stériliser les animaux. De nombreuses études de génomique fonctionnelle ont permis de mieux comprendre l'expression des gènes quand les poissons souffrent de maladies épizootiques. Ces informations permettent d'envisager des protocoles nouveaux basés sur des approches transgéniques plus efficaces pour aborder la résistance aux maladies.

Mots clés : Poisons transgéniques ; Effets pléiotropiques ; Résistance aux maladies ; Expression de gènes ; Environnement ; Stérilisation

1. Introduction

One of the greatest future potential benefits of gene transfer in fish will be enhancement of disease resistance. Diseases are the greatest problem facing aquaculture and damaging its profitability. Disease resistance is also an animal welfare issue. Transgenic fish with enhanced disease resistance would increase profitability, production, efficiency and the welfare of the cultured fish.

Research to date indicates great promise for success of this approach for enhancing disease resistance. Genetic gain is also possible through traditional selective breeding, but it appears that the rate of genetic improvement and the consistency of genetic improvement may be greater with the transgenic approach [1,2]. Selective breeding may also have the drawback that the disease organisms may well respond to selective forces as well, negating some of the selection response in the fish.

2. Trangenesis for disease resistance

2.1. Viral diseases

Anderson et al. [3] provided the first evidence of the potential for transgenic enhancement of a fish resistance when they used the expression of viral coat protein genes or antisense of viral early genes to improve viral resistance in rainbow trout (*Oncorhynchus mykiss*). Shrimp