TOHOKU UNIVERSITY

Effect of environmental stress on biochemical and physiological features in cultured fish

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Famous *Samurai*
Mr. Masamune Date
He is a first feudal lord of Sendai area.

Research Interest

Fish are often exposed to a complex of stresses derived from both global and local stressors (in both nature and artificial conditions).

In addition, the temperature of ocean has been gradually increasing by global warming.

We should study on the stress response and on relationship between stress and health in fish.

- Today's topics -

1. Definition of stress
2. Stress responses in fish
3. Eustress and distress

Our former Amamiya campus (Fac. Agric., Tohoku Univ.)


What is a stress?
Hirose River, Sendai, Japan

Definition of stress

"Like a rubber ball"

Stressor: a pressure caused by finger (external factor)

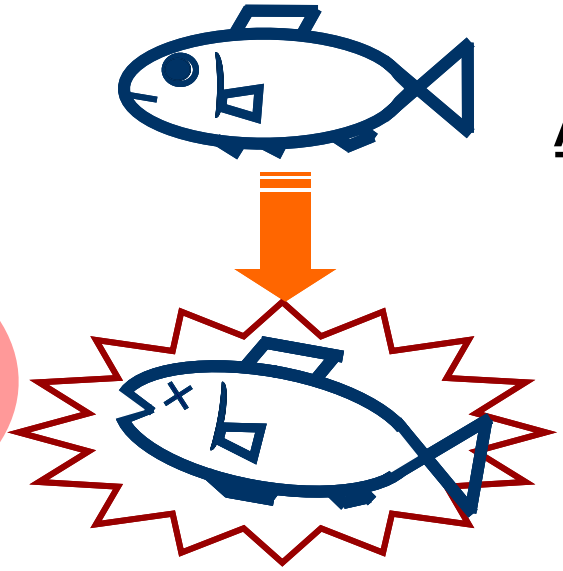
Hand model: our master course student Rika Okada

Stress state: a situation of battered (depressed) rubber ball

External and internal stimuli which cause many kinds of biochemical and physiological responses in body

Many types of stress (stressors)

Fish are surrounded by many kinds of stress



Physical stress

- Temperature
- Salinity
- Radiation, etc.

Artificial condition

- Handling
- Density, etc.

Chemical (Contaminants) stress

- Chemicals
- Heavy metal, etc.

Physiological stress

- Infection
- Nutrition, etc.

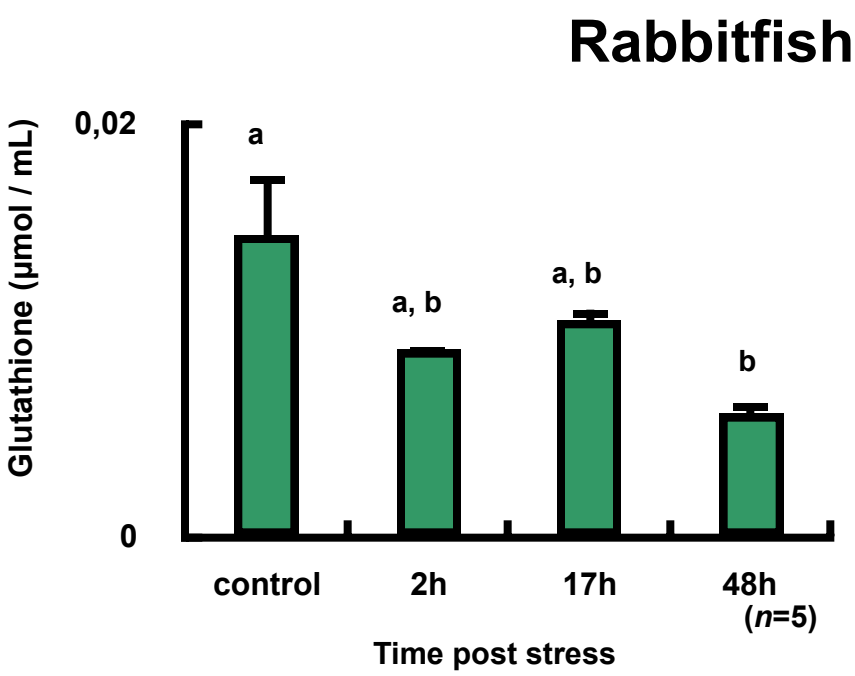
Differences in thermal stress responses of two fish species, temperate coho salmon *O. kisutch* and tropical rabbitfish *S. guttatus*

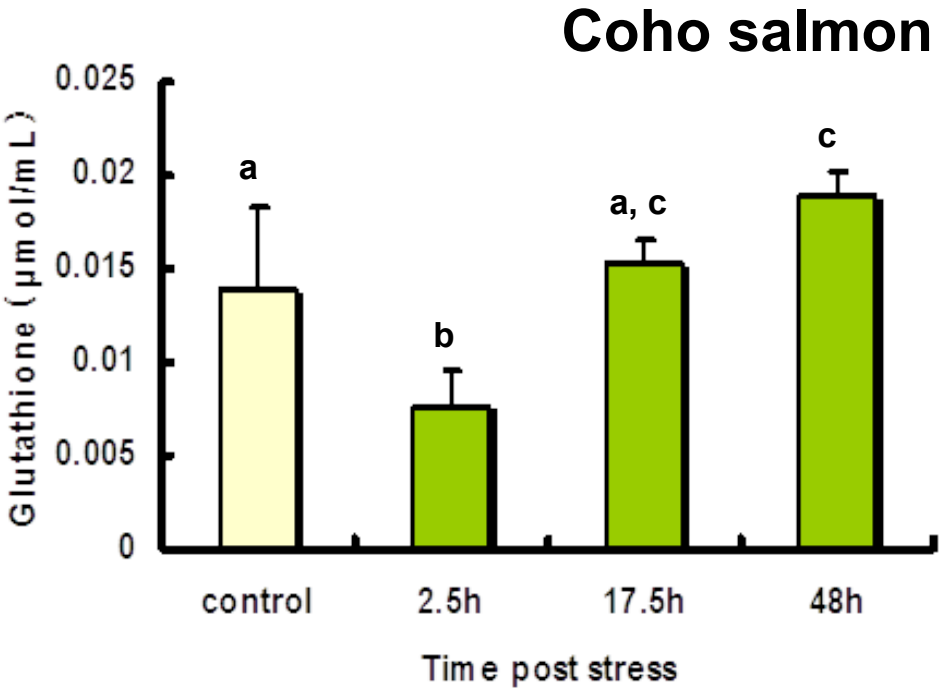
Rabbitfish, *S. guttatus*

Sesoko Marine Station,
Univ. Ryukyus, Okinawa, Japan

Thermal stress affected plasma glutathione level

Optimum temp.+11℃ for 2 h

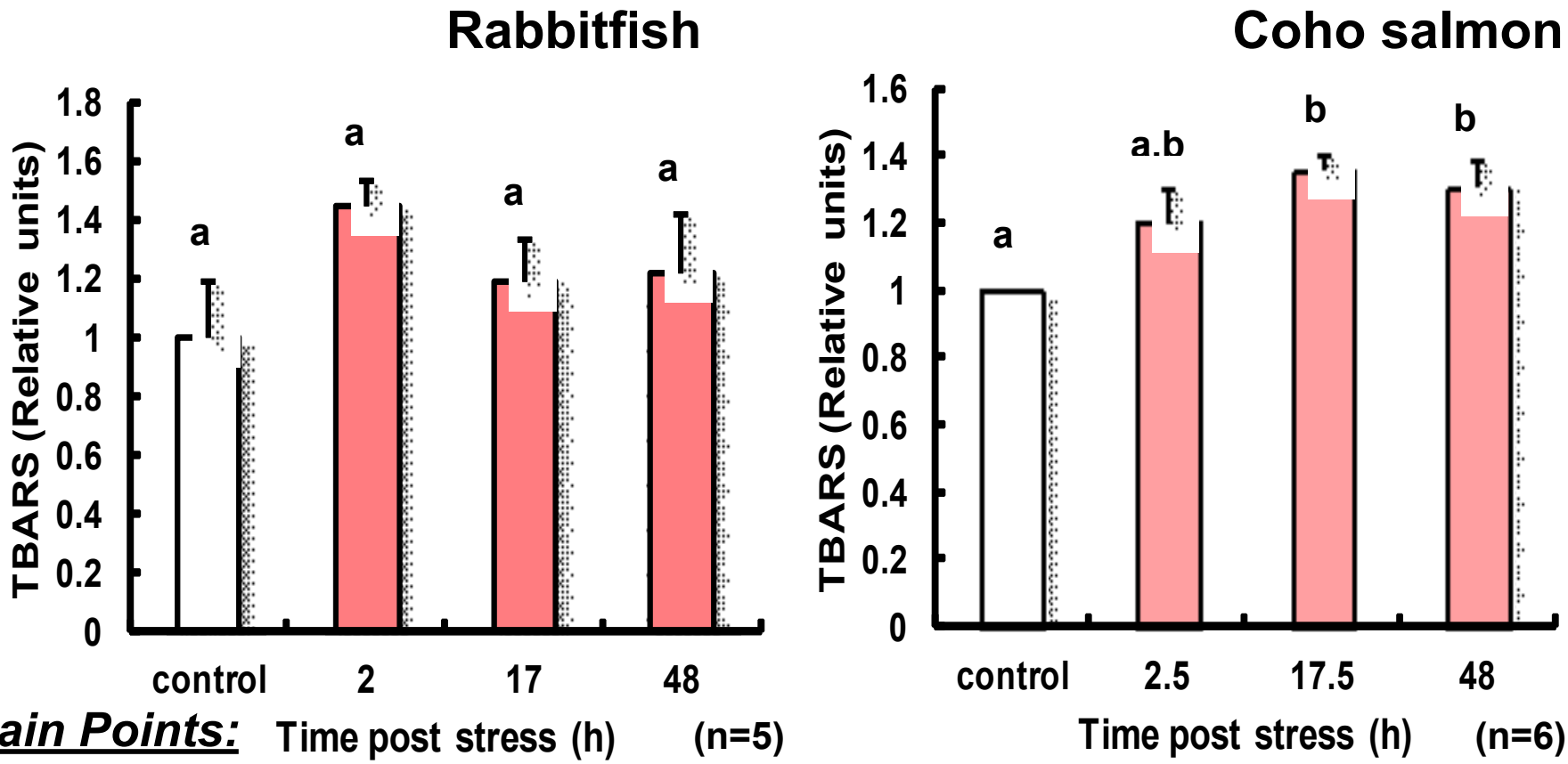




Main Points:

1. In rabbitfish, glutathione (GSH) decreased gradually and reached its lowest value at 48 h post stress.
2. On the other hand, GSH in coho salmon decreased tentatively at 2 h post stress after which it then increased.

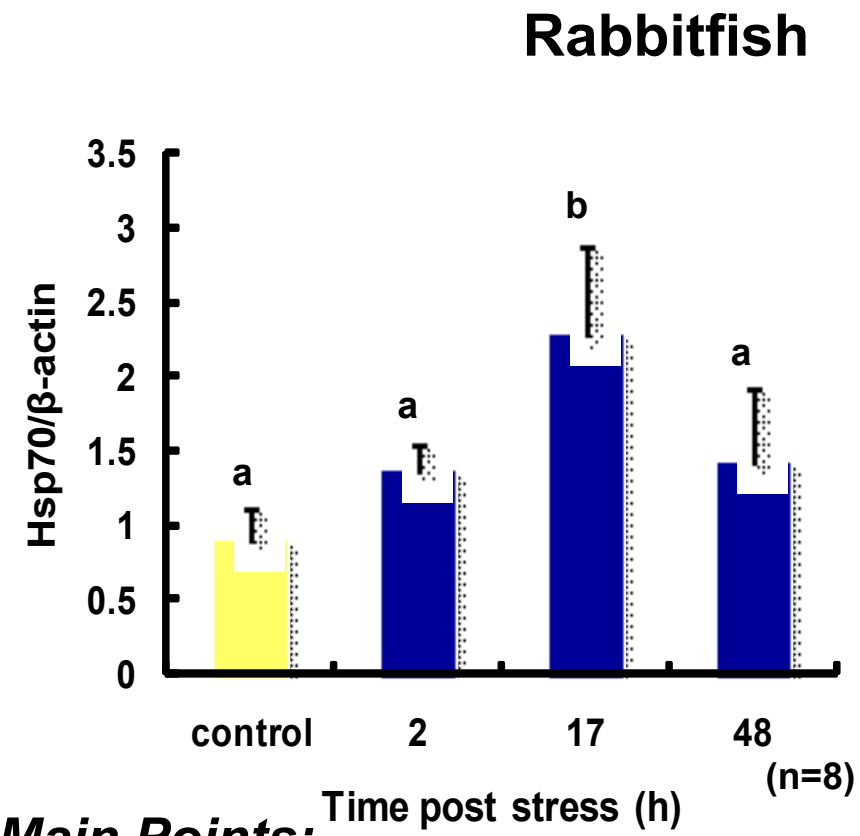
Thermal stress induced lipid peroxides in plasma

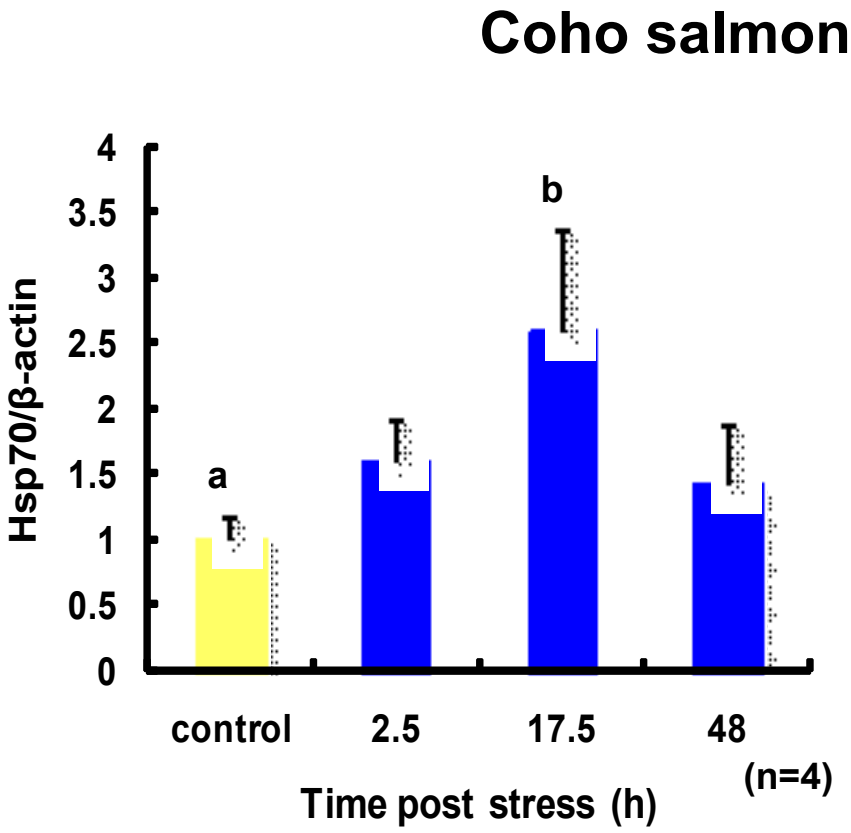


Main Points:

Although the plasma lipid peroxides (LPO) levels in rabbitfish were almost the same for all sampling periods, they increased significantly in coho salmon at both 17 h and 48 h post stress.

Thermal stress induced HSP70 expression in the liver





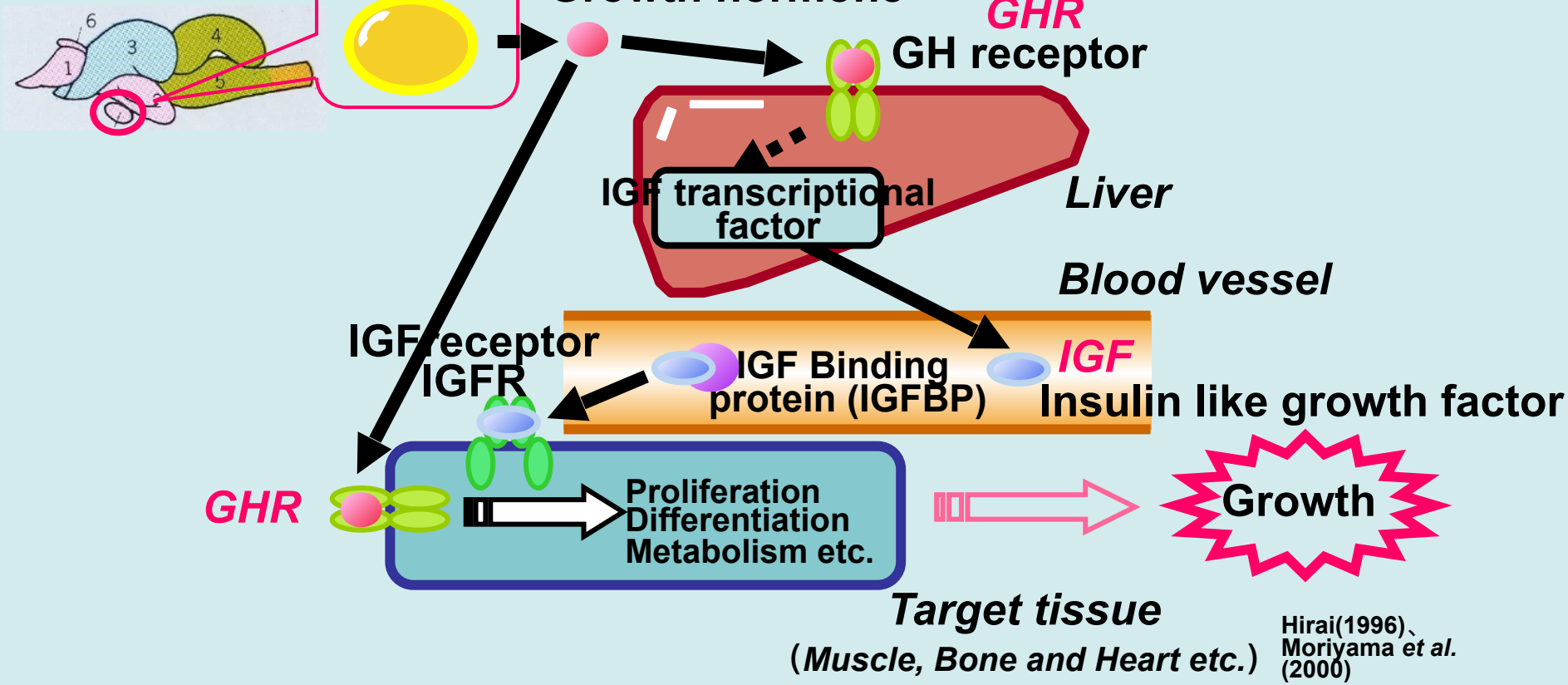
Main Points:

Hsp70 expression in the liver of both fish species increased at about 17 h post stress

Growth in vertebrate

GH/IGF-I Axis

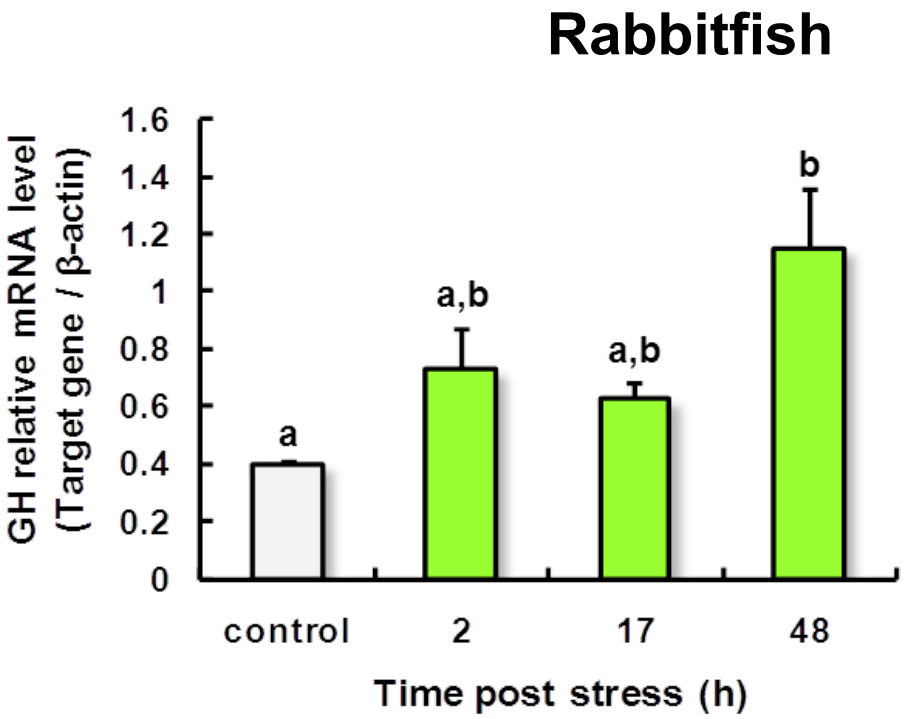
Growth is regulated by the growth hormone (GH) and insulin like growth factor (IGF) axis. Growth is influenced by a complex set of cellular, endocrine, and environmental factors.

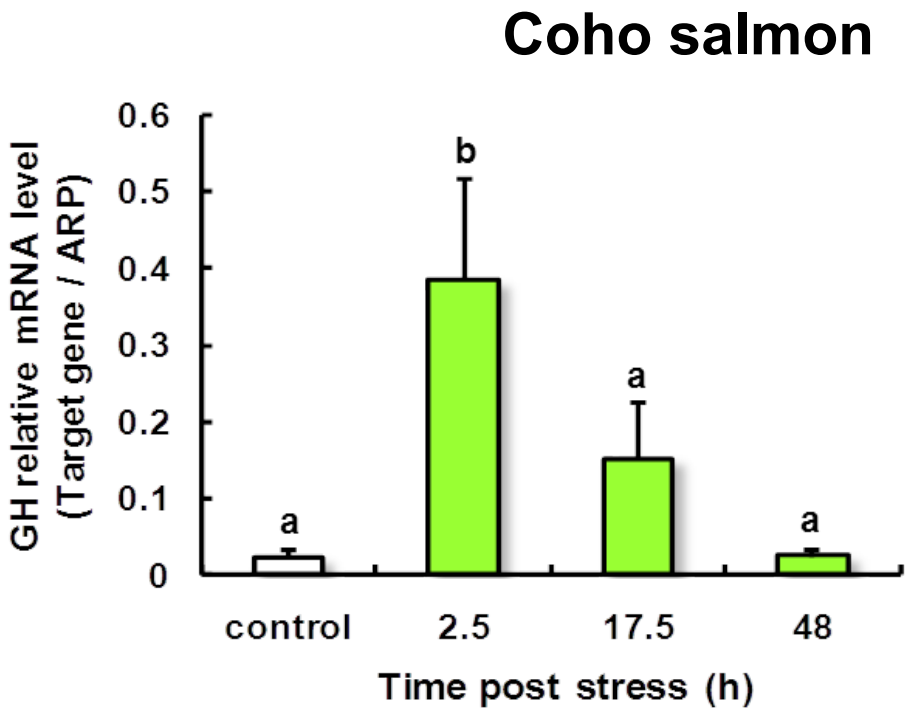


Hirai(1996)、Moriyama *et al.* (2000)

Thermal stress induced GH mRNA expression in the pituitary

Optimum temp.+11℃ for 2 h



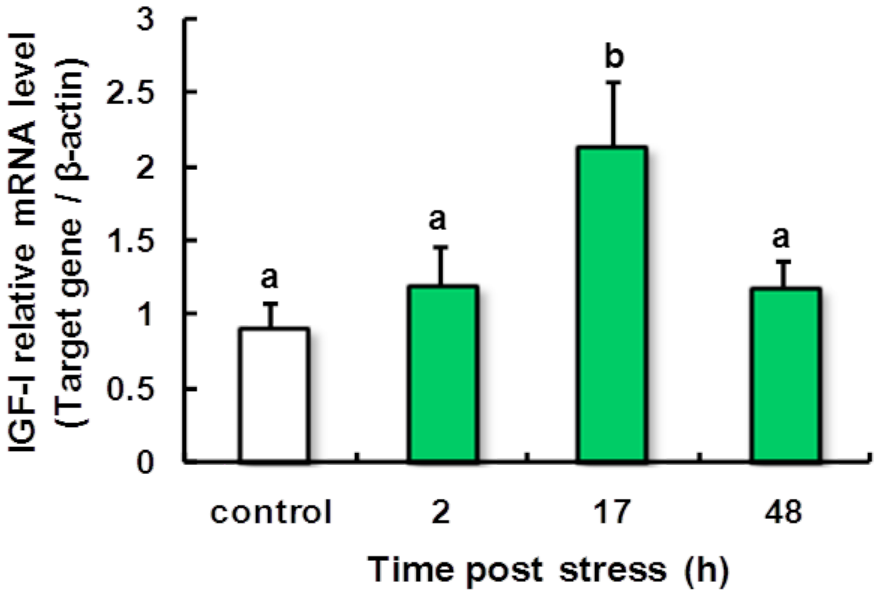


Main Points:

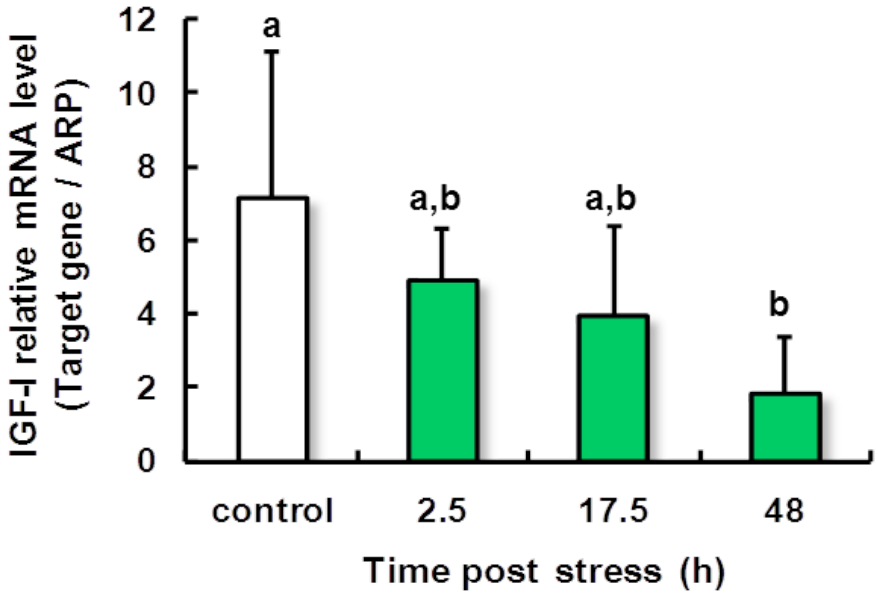
Pituitary GH mRNA expression in coho salmon increased at 2 h post stress but returned to control levels at 17 h and 48 h post stress. GH mRNA expression in rabbitfish pituitary gradually increased following heat stress treatment.

Thermal stress induced IGF-I mRNA expression in the liver

Rabbitfish



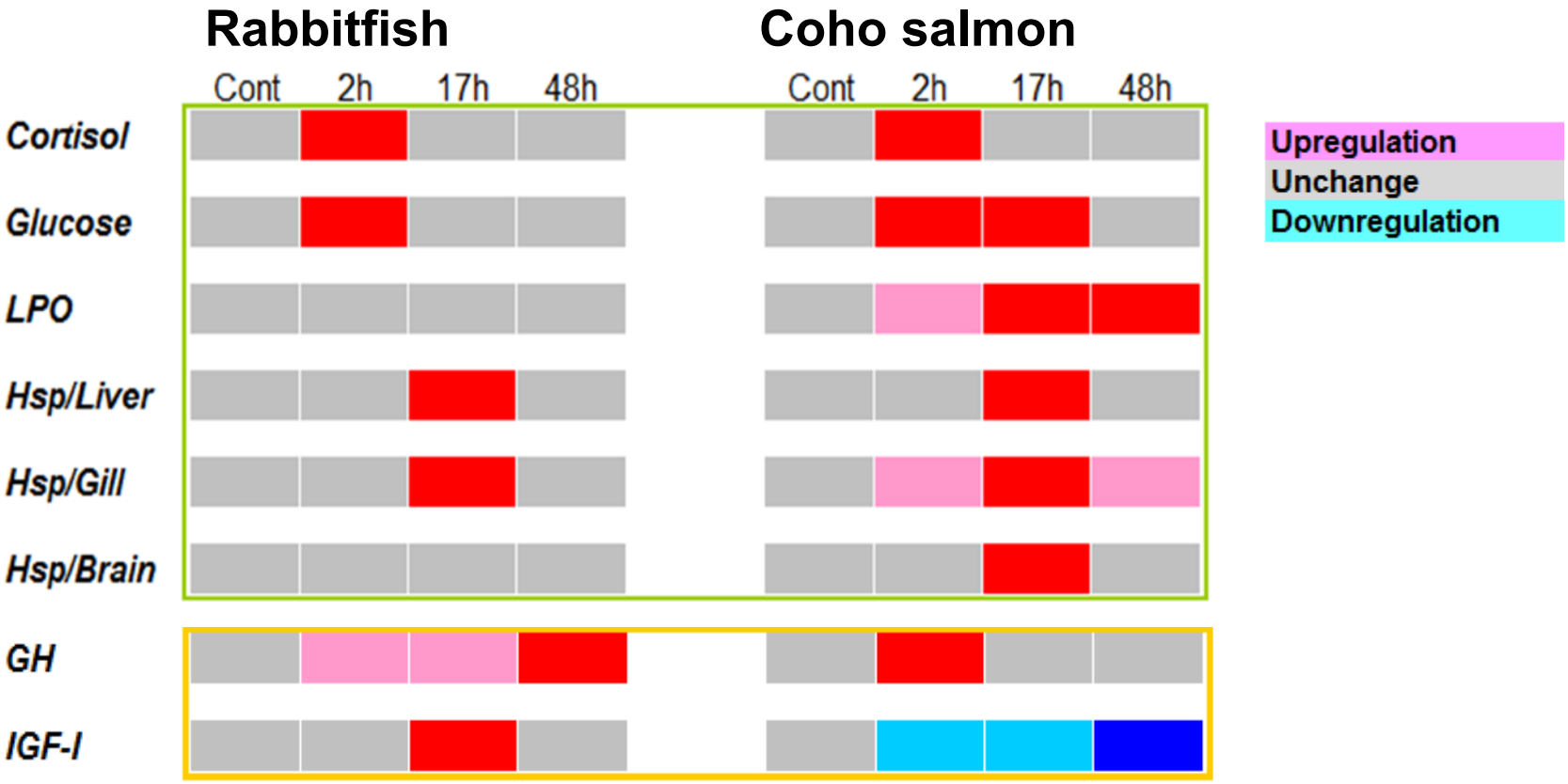
Coho salmon



Main Points:

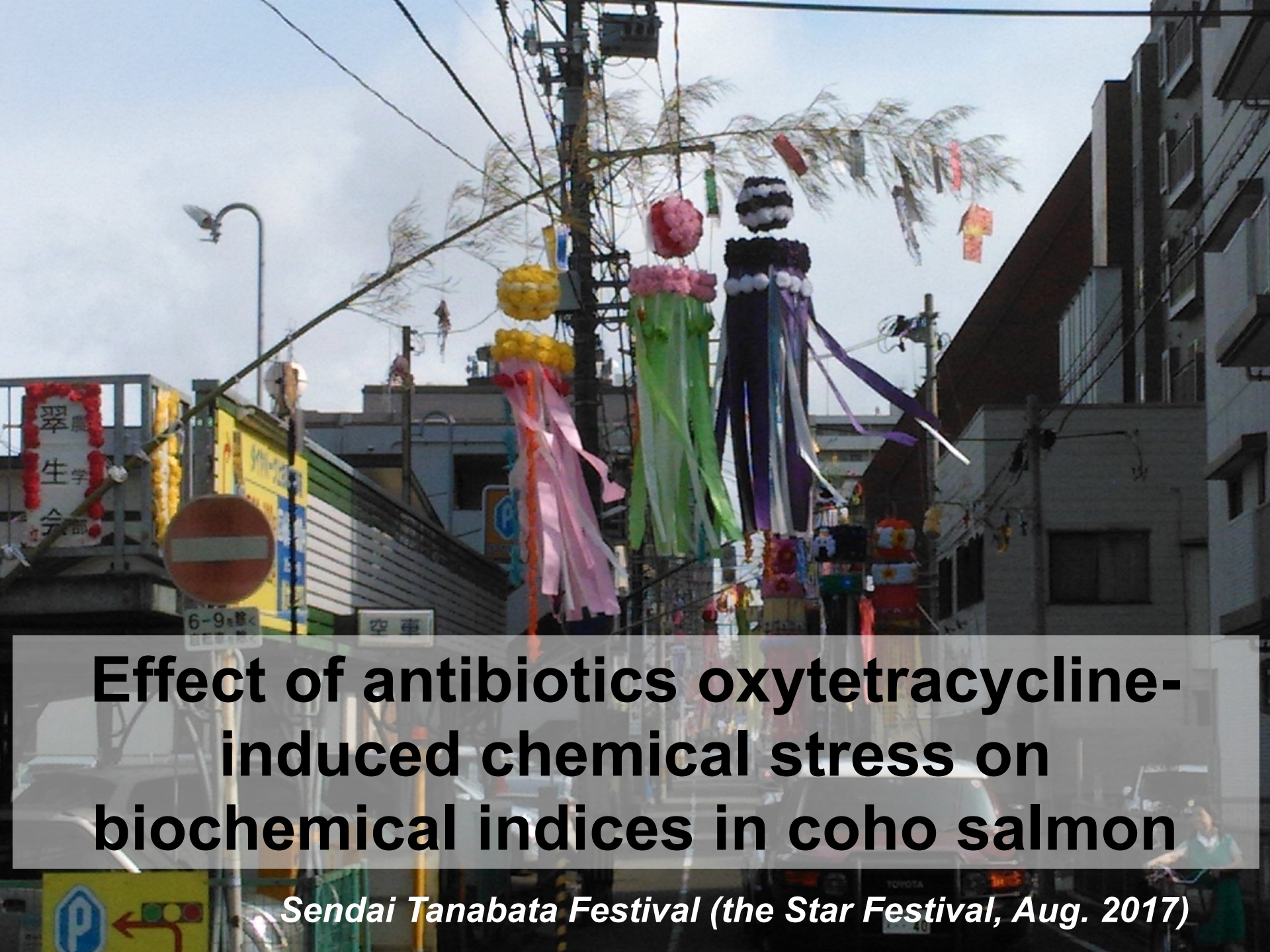
Hepatic IGF-I mRNA in coho salmon gradually decreased following heat stress treatment; while in rabbitfish liver it increased, reaching its highest value at 17 h post stress before decreasing.

Summary



The level of stress-related markers in coho salmon have been changed by stress at initial stage, compared with rabbitfish.

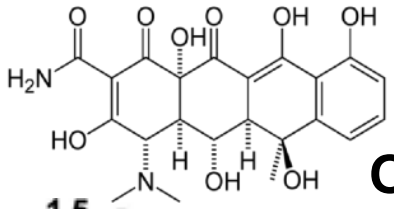
- ☑ **The susceptibility for stress might depend on fish species.**
- ☑ **Temperate fish species such as coho salmon is subject to thermal stress, compared with tropical fish.**



Effect of antibiotics oxytetracycline-induced chemical stress on biochemical indices in coho salmon

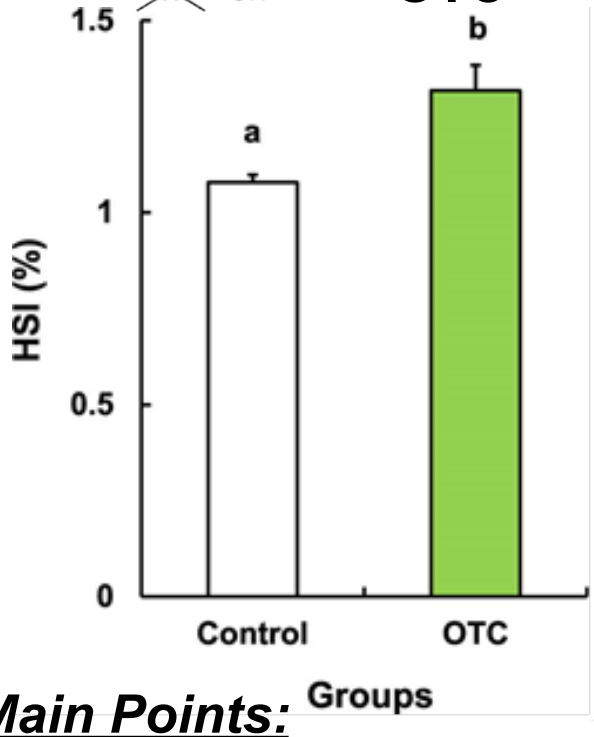
Sendai Tanabata Festival (the Star Festival, Aug. 2017)

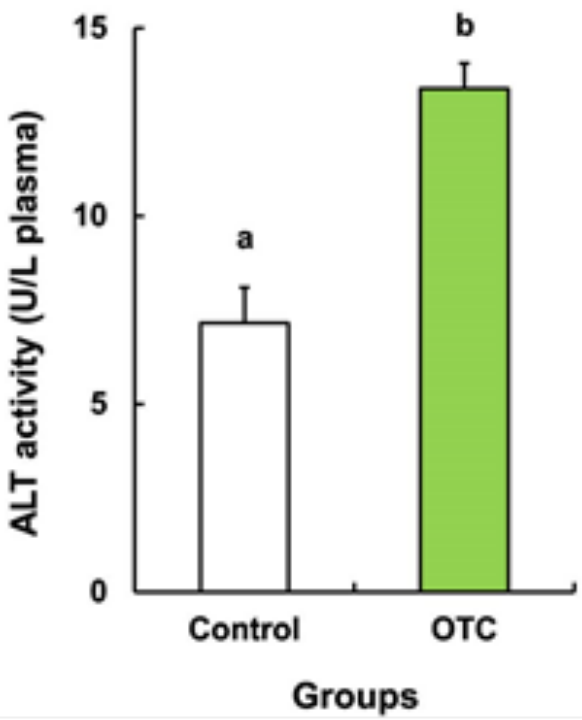
High doses of oxytetracycline induced damage in the liver of coho salmon

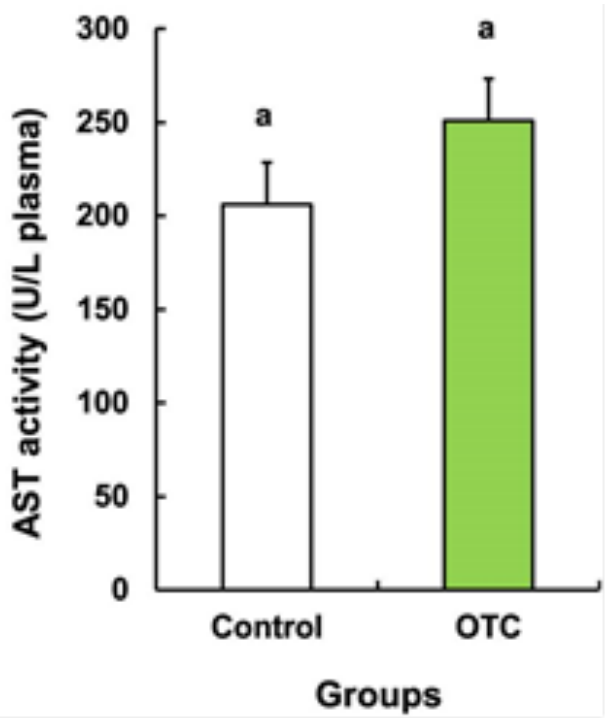


OTC

OTC: 100 mg/kg body weight/day for 2 wks



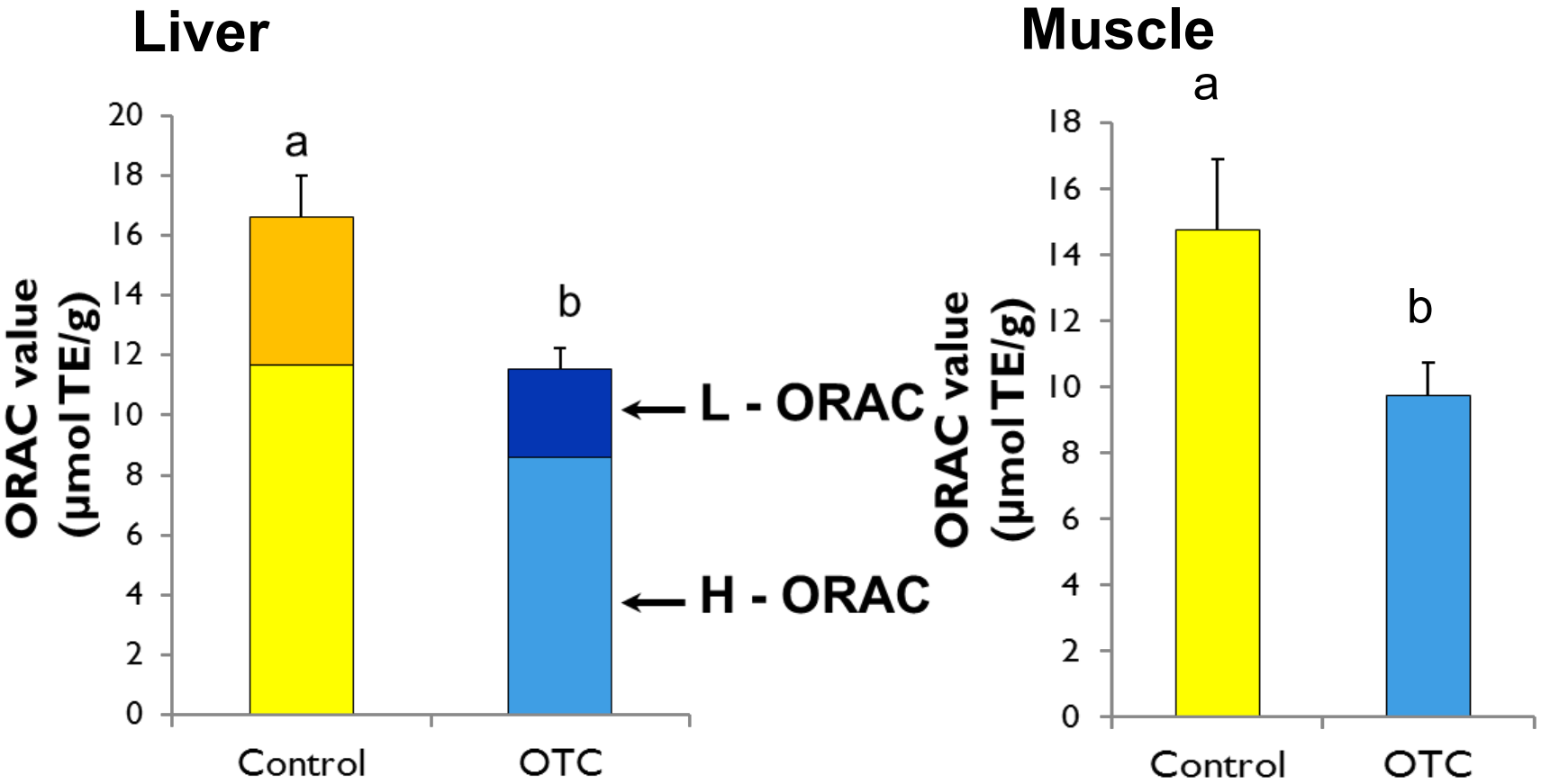




Main Points:

The both level of hepatosomatic index and plasma ALT/GPT activity in OTC-fed fish was higher than those in control fish. The liver of OTC-fed fish might be damaged by OTC.

High doses of oxytetracycline decreased total antioxidative activity in coho salmon

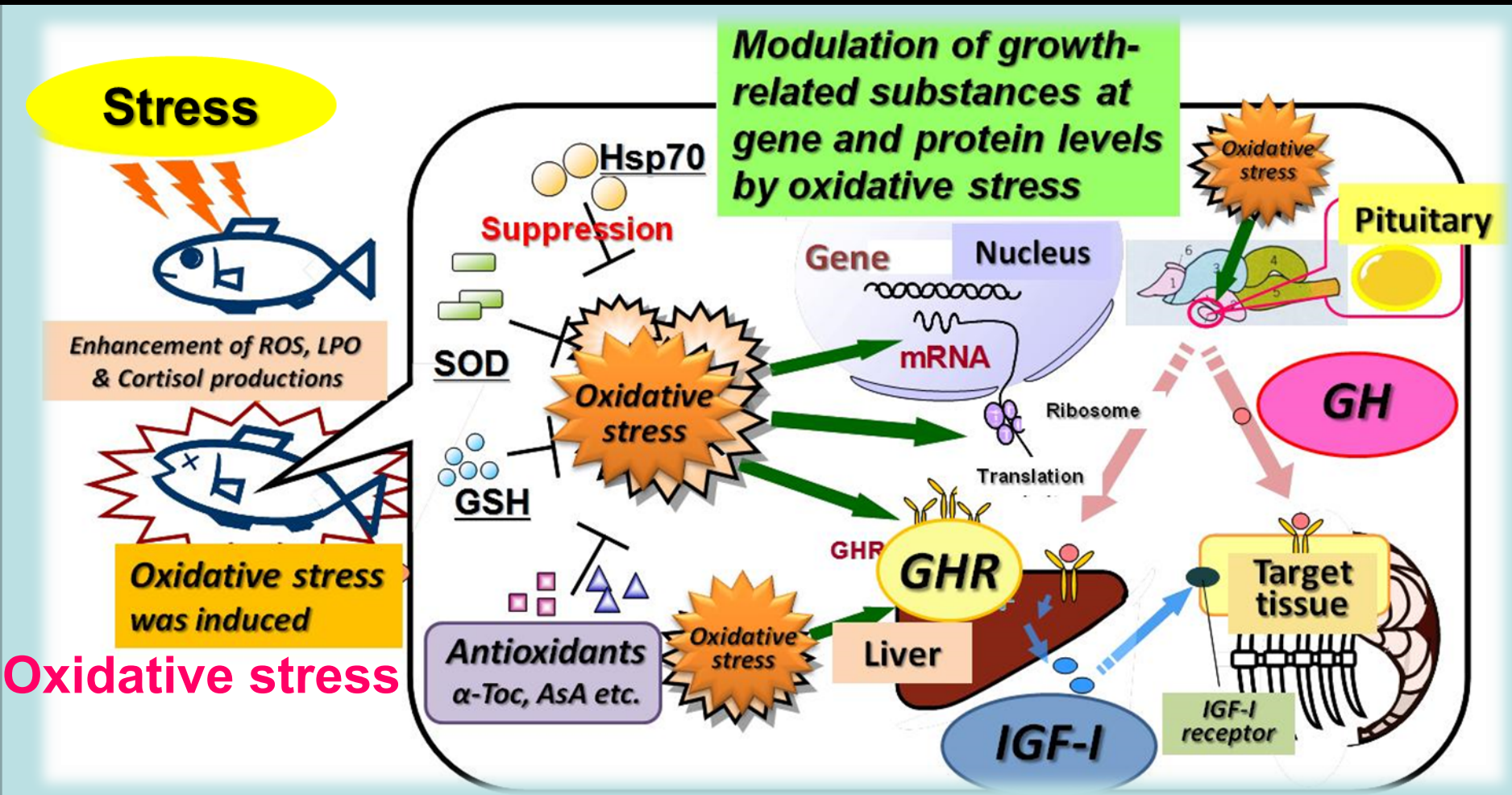


Main Points:

The total antioxidative activities indicated as an oxygen radical absorbing capacity (ORAC) value of both liver and muscle in OTC-fed fish were lower than those in control fish.

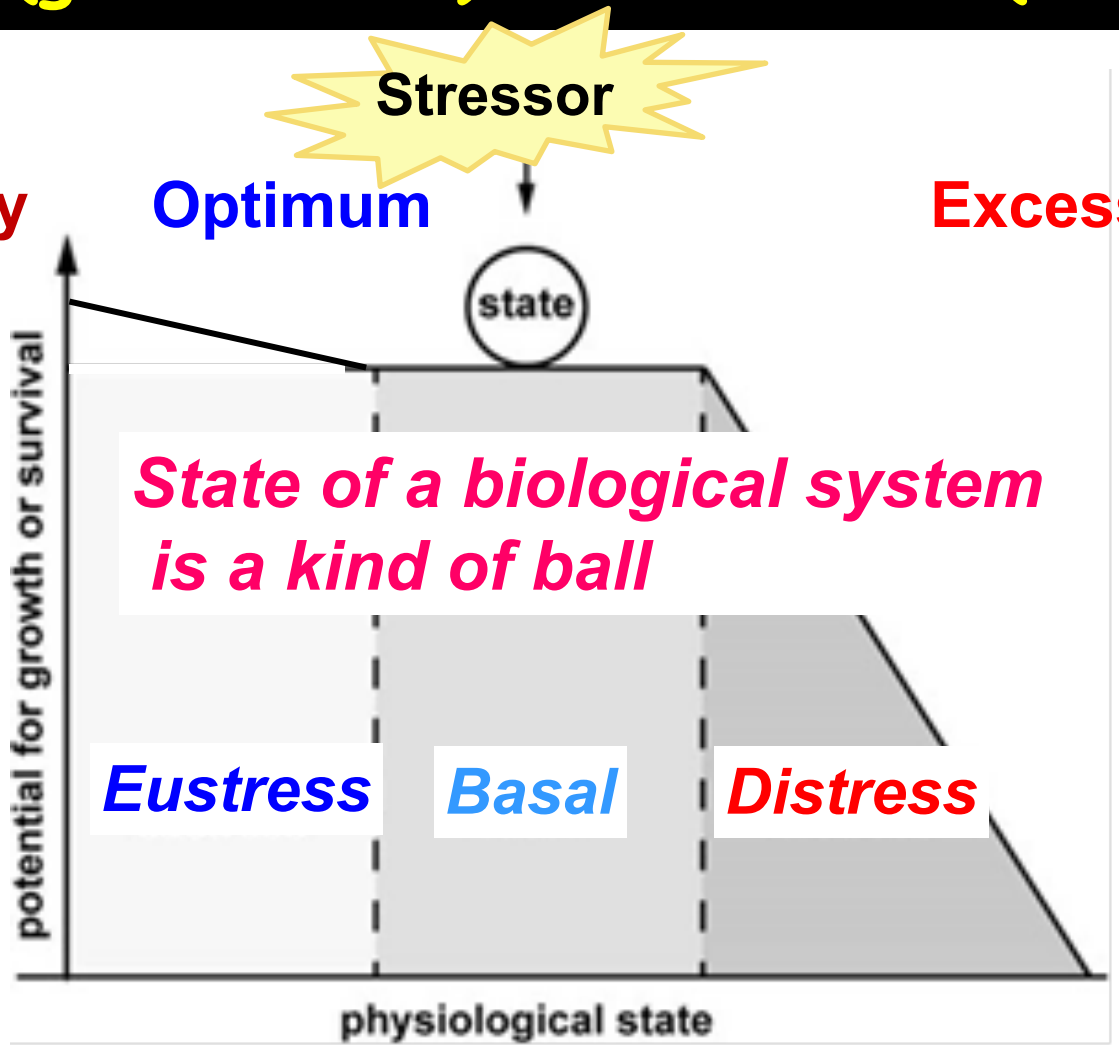
Proposed internal phenomena in stressed fish

Oxidative stress might be often induced.

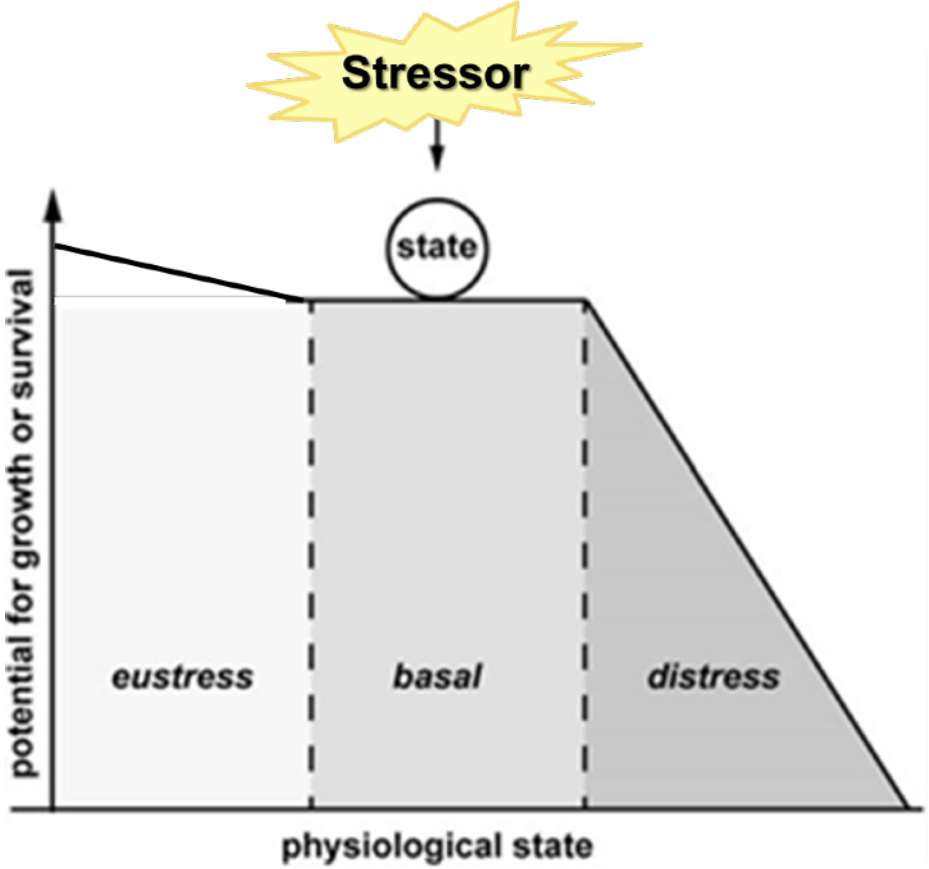


Influence of stressors on physiology

Eustress (good stress) and Distress (bad stress)



Okegbe et al. (2012)



The normal functional state of a biological system could be likened to a ball on a plateau.

Stressors can push the ball to the edge of the precipice, but biological systems activity maintain the functional state.

This sometimes requires the organism to transition to a new, qualitatively different functional state, as can occur when the stressor is a source of eustress.

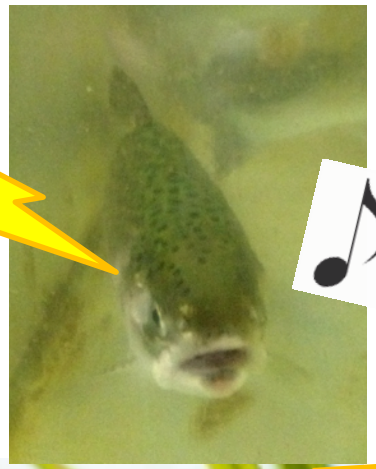
Conclusion

Oxidative stress is often induced in tissues of fish. So antioxidative dietary supplements could suppress oxidative stress and improve redox state and growth in cultured fish.

Manipulation of eustress (good, positive, moderate stimuli, such as mild physiological or thermal treatment, osmotic stress, and light condition) might be useful to control fish fitness in terms of health, growth, immune system, etc.

Importance of eustress study in agriculture (aquaculture as well)

Stress



Unfortunately, very few analysis of stress attend to the concept of eustress.

Eustress

Thank you for your attention

THE END