New evidence on the endocrine disrupting properties of chlorpyrifos

OBSERVATOIRE OCÉANOLOGIQUE de Banyuls/Mer 1882 Vincent Laudet, BIOM Observatoire Océanologique de Banyuls-sur-Mer Vincent.Laudet@obs-banyuls.fr Metamorphosis is a spectacular and exquisitely coordinated post embryonic process controled by thyroid hormones

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Biological questions - 1

Are the various manifestations of metamorphosis in Vertebrates controled by thyroid hormones?

Coral reef fishes propose many variations in life history strategies (life cycle) that can be studied in an ecological context



Biological questions - 2

How environmental pollutants alter metamorphosis/larval recruitment in coral reef fish ?





Classical life cycle of a coral reef fish

(Convict surgeonfish Acanthurus triostegus)



Profound morphological changes...

JO - Reef crest



J5 – Resteries in lagoon





... particularly in the digestive tract



0.5 mm



200µm



Holzer, Besson et al., eLife, 2017

TH signalling decreases after colonization

Gene expression



T4



- whole T4 and T3 levels decrease
- TRs and target gene expressions decrease



How to interfere with the system?





Antagonist treatment and environmental changes affect intestine lengthening



Holzer, Besson et al., eLife, 2017

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THs control the ecological transformation





Algal turf grazing ability (number of bites)

Increased by T3

Reduced by NH3 and transfer to external slope

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Holzer, Besson et al., eLife, 2017

THs control the ecological transformation



Predation experiment Survival increased by T3 Reduced by NH3 and transfer to external slope



"Hunger game" experiment

J5





THs control the development of sensory organs



THs control the visual response of the larvae





Defect in visual recognition of predators induced by blocking TH signal or altering environment

Correlated with delays in retina maturation visualized by histology



Bipolar cells (bpc)

Photoreceptor nuclei (prn)

Photocone external segments (pes)



Metamorphosis occurs during larval TH and TR levels are consistent with a TH controlled metamorphosis at reef colonization **Reef colonization = TH-dependant TH signalling** metamorphosis lagoon ocean





Coral reefs are fantastic places **BUT**....

Incredible diversity

25% of the biodiversity while only 0.02% of the surface of the ocean. Many life history strategies Unique synchronisation of larval life

Threatened:

20% already destroyed25% in great immediate threat25% will be threatened by 2050.

Global warming, acidification, pollution, overfishing, tourism hurricane intensification, Diseases,

Is *Acanthurus* metamorphosis sensitive to endocrine disruption ?







Chlorpyrifos:

Organophosphate pesticide used to kill insects and worms. Affects the cholinesterase system of targeted pests Increasingly restricted in several

countries because of potential adverse effect on fetal and neonatal brain development.

Known to decrease TH levels in mouse and rat.

Widely used in Polynesia and found in micromolar doses in some coral reef fish (*Acanthurus*).







Chlorpyrifos treatment decrease TH levels in *Acanthurus* captured at reef crest





Chlorpyrifos treatment impair *Acanthurus* metamorphosis



Intestine length



Chlorpyrifos treatment impair sensory organs development



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Chlorpyrifos treatment impair sensory organs development



Chlorpyrifos treatment affect larval "quality" in a TH-dependent manner

Predation experiment with a snaper (*Lutjanus fulvus*)



Affecting *Acanthurus* grazing activity may have a strong ecological impact





White stripes develop during clownfish

metamorphosic Amphiprion ocellaris



Chlorpyrifos also disrupt the metamorphosis of another species The clownfish (*Amphiprion ocellaris*)



DMSO

10µg/l

20µg/l

30µg/l

Chlorpyrifos also decrease TH levels during metamorphosis in clownfish (*Amphiprion ocellaris*)



TH rescue the white stripe phenotype induced by chlorpyrifos



CPF + T3/IOP 10-7 – Day 8

The pelagic larvae is transformed into a reef associated juvenile and TH coordinates this complex morphological, physiological, behavioral and ecological transformation

TH therefore ultimately control the "quality" (e.g. herbivory or escape to predation) of the juvenile newly settled in the reef

Pollutants such as chlorpyrifos disrupt this process and therefore affect larval "quality"

The effect of chlorpyrifos is rescued by the injection of thyroid hormones, suggesting that its effect is caused by the decrease of TH levels

The same effect is seen in the clownfish, Amphiprion ocellaris





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Thank you for your attention