Evaluation of endocrine disruption in sea bass (Dicentrarchus labrax): Effects of persistent organic pollutants on their thyroid function

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Many aspects of thyroid endocrinology are very well conserved across vertebrate taxa.

These aspects include thyroid hormone chemistry, synthesis, transport, regulation.

Same proteins involved in these processes
- **Special functional anatomy:** Thyroid epithelial cells are arranged in spheres called **thyroid follicles**. Follicles are filled with **colloid**, a proteinaceous depot of thyroid hormone precursor.
Secrete a prohormone: which has to be metabolized by specific enzymes deiodinases.
Thyroid hormones play a crucial role in:

- Metabolism
- Growth
- Protein synthesis
- Cardiovascular effects
- Development

Thyroxine (T4) and Triiodothyronine (T3)
Regulation

T4 → Centrally controlled hypothalamus-pituitary-thyroid axis

TH conjugation

T3 → Peripheral control in extra-thyroidal tissues
Endocrine disruptors:
- synthetic chemicals
- mimic or block hormones
- disrupt hormone function

Sea as “final sink” for pollution contains high concentrations of endocrine disruption chemicals
Organochlorinated pollutants

- Polychlorobiphenyls (PCBs)
- similar structures as thyroid hormones
- may generate an endocrine disruption
Sea bass (*Dicentrarchus labrax*)

- easily accessible, large distribution and relatively abundant
- optimal size
- long lived animals at the top of the food web
- sedentary habits

Perfect for sentinel species
Aims of this study

- Evaluate the potential effect of environmental pollutants on the thyroid function using simultaneously different thyroid parameters
- Study the underlying mechanisms and effects of such an endocrine disruption
5 tanks containing each 15 sea bass

Experimental part

Day 0: 15g et 11cm
Day 120: 30g et 15cm

Contamination levels of [7 ICES PCBs] in preys of D. labrax

In order to examine all facets of fish thyroid function, we propose to study simultaneously different endpoints.
Thyroid Histology

- Follicles dispersed on connective tissue near the pharyngeal region located next to the ventral aorta.
- Irregular or oval follicular lumen
- Surrounded by flattened, cuboidal epithelial cells
- Measure follicle size, cell heights, roundness, form factor and aspect ratio.
Histomorphometry

- No clear relationship to pollutant levels
Thyroid Histology

- Heterogeneity of follicle size

![Control vs 1 ppm](image.png)
Metabolic activity

- 115% increase in mean deiodinase activity
- 50% decrease in mean sulfation activity

Towards more conversion of T4 to T3 and less elimination of thyroid hormones
Thyroid status

- Thyroid hormone levels preserved in environmental relevant exposure
- Important depression @ 10 ppm!
Environmental relevant concentrations

T4 → Centrally controlled brain-pituitary-thyroid axis

T4 + T3

TH conjugation

T3 → Peripheral control in extra-thyroidal tissues

Organs/tissue
In sea bass exposed to environmental relevant concentrations of PCBs, we observe:

- Preserved thyroid hormone status
- Changes in activity of metabolic pathways
- Changes in synthesis/secretion activity

→ Compensation by extensive autoregulatory feedback

We see at higher contamination levels:

- Depression of thyroid hormone status
- lower number of follicles and disorganized tissue
- lymphoid cell infiltration, enlargement of interstitial tissue, degenerated colloid
- might have caused hypothyroidism in 10ppm fish!!!
@ 10 ppm

T4 → Centrally controled brain-pituitary-thyroid axis

T3 → Peripheral control in extra-thyroidal tissues
Conclusions

- In sea bass exposed to environmental relevant concentrations of PCBs, we observe:
  - Preserved thyroid hormone status
  - Changes in activity of metabolic pathways
  - Trend of a raise of synthesis/secretion activity

  → Compensation by extensive autoregulatory feedback

- We see at higher contamination levels:
  - Depression of thyroid hormone status

  → Altered thyroid hormone synthesis!
Thank you for your attention!!!

- Please come and have a look on my poster:

  WE373

- A field study on sea bass in European coastal waters