Genetic parameters for the operculum and jaws deformities in larvae of gilthead seabream (*Sparus aurata*, L. 1758)

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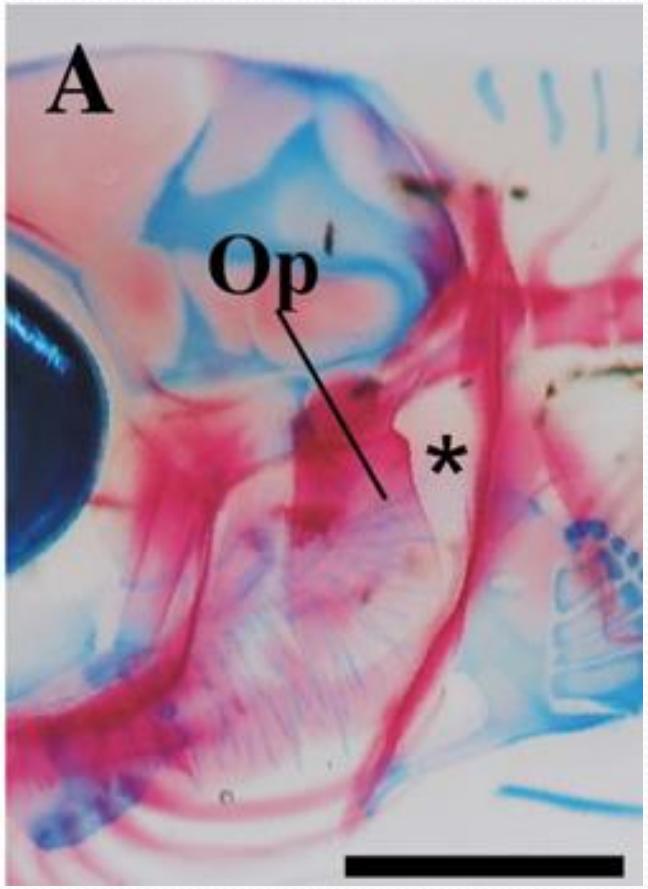
Deformities

- Skeletal deformities are a major problem of product quality in finfish aquaculture downgrading the product value

Operculum deformities

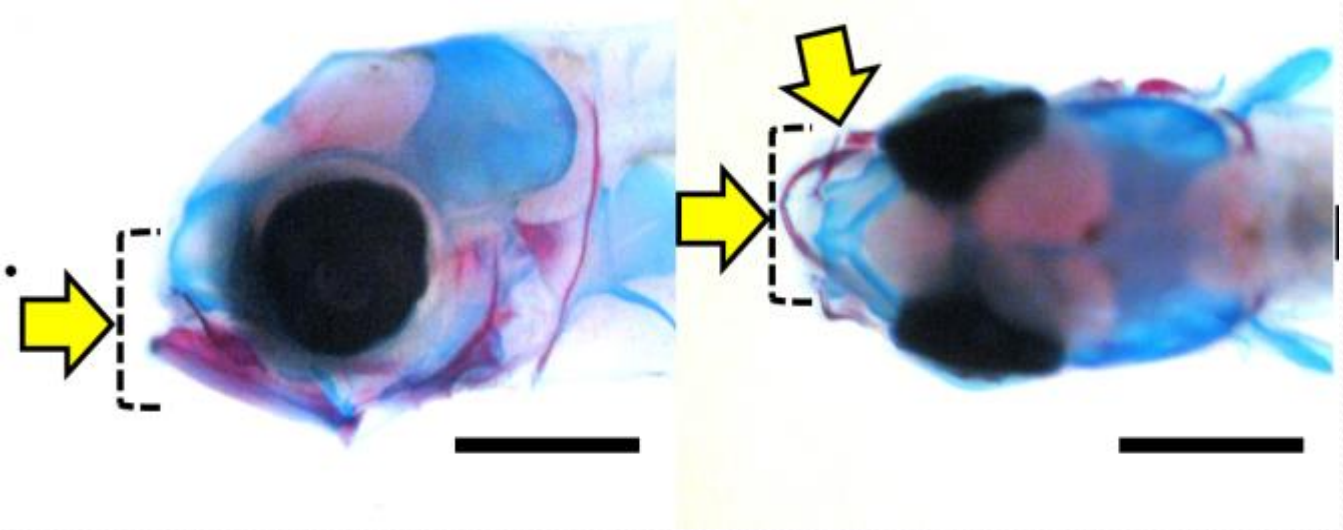
- The most common deformity is inside folding, atrophy or/and over-ossification

- There is a significant temperature effect on the development of the deformities (Georgakopoulou *et al.* 2010)



(Georgakopoulou *et al.* 2010)

Jaw deformities



- ✓ Significant alteration of the external morphology
- ✓ The most common deformity is the reduction of the jaw length and the lateral displacement of the jaws

Causes of Deformities

- Their development is often attributed to the environmental conditions:
  - Light
  - Temperature
  - Salinity
  - Hydrodynamic variables
  - Nutrition

Is there any genetic basis of Deformities?

	Lordosis	Vertebral fusion	Jaw deformities	Lack of Operculum
Castro *et al.* 2008	0.021±0.019			0.032±0.023
Bardon *et al.* 2009	0.33±0.06 (*D. labrax*)			
Lee-Montero *et al.* 2014	0.16–0.41		0.00–0.05	0.06–0.11
García-Celdrán *et al.* 2014	0.58±0.18			0.19±0.13
Negrín-Báez *et al.* 2015	0.34±0.03	0.40±0.07		0.46±0.11
Negrín-Báez *et al.* 2015 (QTL)	1 (1)	1 (2)	1 (1)	

Aim of the present study

- Existing studies usually record these traits at advanced developmental stages, ignoring the fact that the majority of the skeletal deformities originate during the first ontogenetic period

➢ In the present study, we focused on the early ontogenetic period (larvae) and recorded deformities of the operculum and the jaws.

?

i. **Anatomic characterization of the deformities**
ii. **Estimation of the genetic parameters**

The design

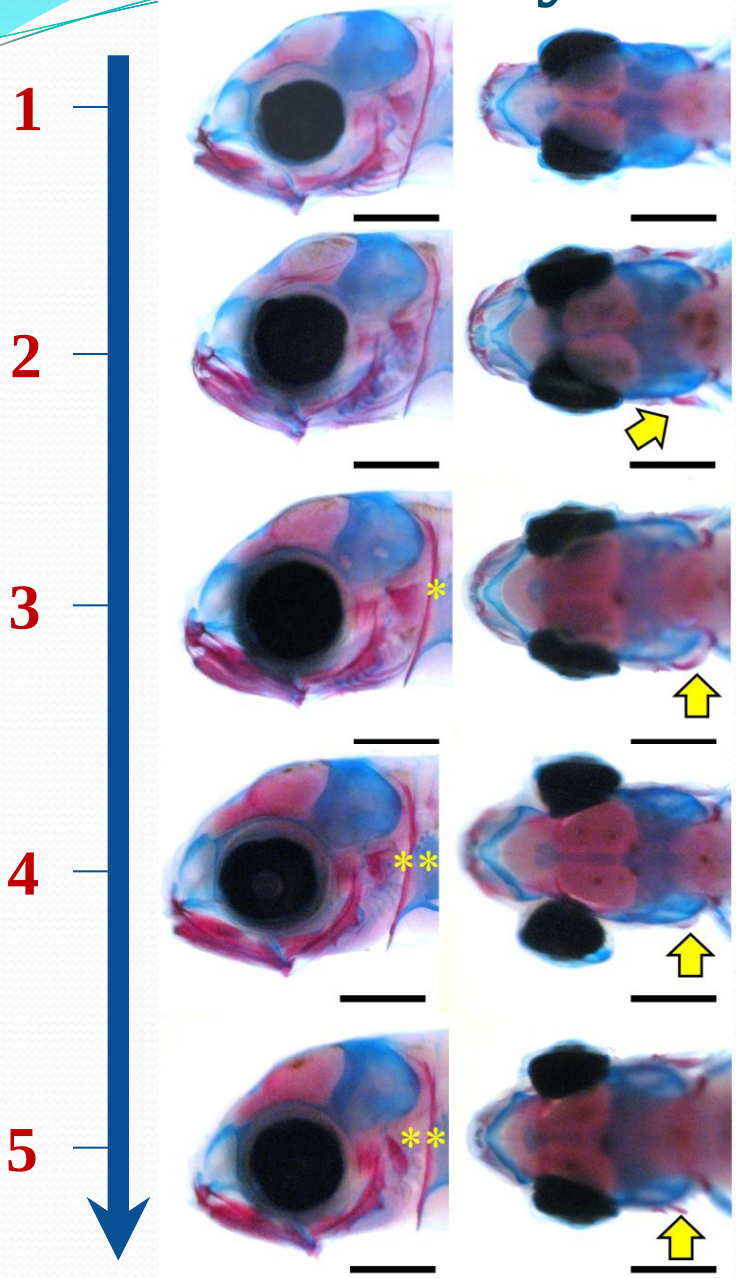
Broodstock (64♂ x 63♀)

4 consecutive spawning days

Eggs hatched and reared up to 39 dph

1400 larvae → stained for bone and cartilage and phenotyped & genotyped

Deformity intensity of the operculum



Normal

Light alteration
Dislocation

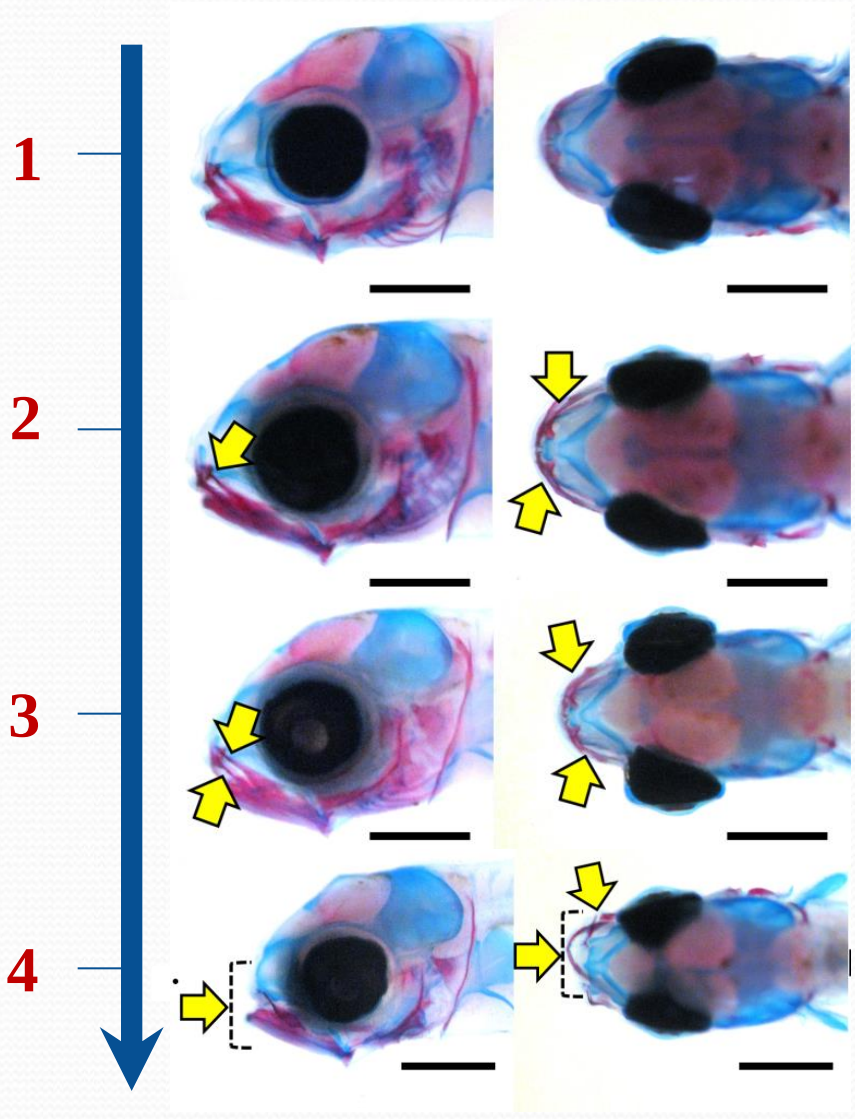
Main alteration
Inside folding / reduction of the operculum

3-5 levels based on the intensity of the deformity➔ <30%, 30-50%, >50%

Scale of 5 levels

Deformity intensity of the jaws

Macro-scale



Normal

Scale of 4 levels

Light alteration

Main deformation

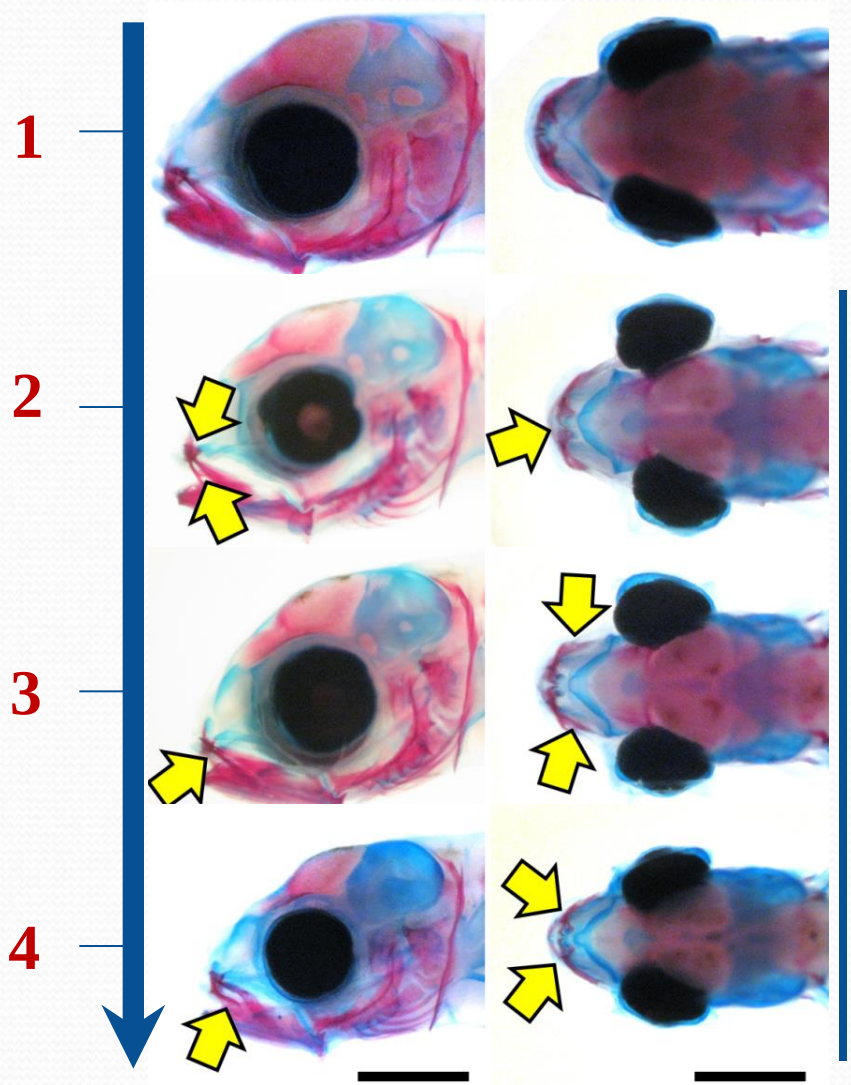
Alteration of the external morphology

Reduction of the upper jaw

Lateral displacement of the lower jaw

Scale of deformity intensity of the jaws

Micro-scale



Normal

Scale of 4 levels

Main deformation

Anatomic alteration of the mandibular and premandibular bones

11 distinct deformities (of 7 individual elements)

Levels: 4

Parentage

- Set of nine microsatellites (multiplexed)
- Parentage allocation with exclusion method

Family characteristics of the pedigree structure obtained

	Full-sibs	**Maternal Half-sibs**	**Paternal Half-sibs**
N of families	282	58	51
Mean family size	4.9	24.1	27.5
Min	1	2	1
Max	39	114	124

Data analysis

- Univariate animal model
  - Y = Xb + Za + e ➔ (on the observed scale)

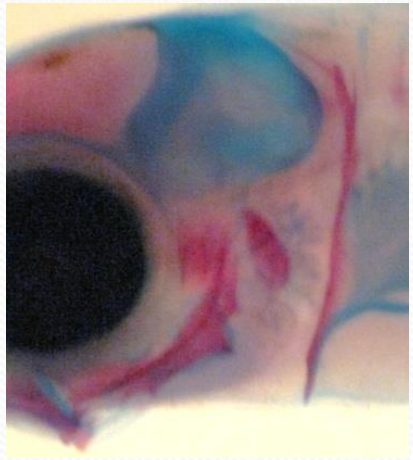
- Genetic correlations were estimated with multivariate animal model

- Heritability estimates were transformed to the underlying liability scale

➢ Low heritability estimates for the operculum deformities

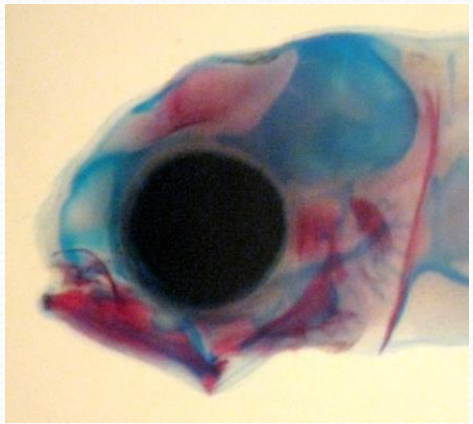
Trait	$h^2 \pm SE$
TL (mm)	0.259 ± 0.060
Def. Degree LEFT	0.013 ± 0.019
Def. Degree RIGHT	0.039 ± 0.025
Sum ALL	0.020 ± 0.021

TL: Total length
Def. Degree LEFT/ RIGHT: The scale of intensity
Sum ALL: the sum of both sides



➢ High heritability estimates for the jaw deformities “d6-d7”

	Trait	$h^2 \pm SE$
Micro-scale	d1+d6+d7	0.049 ± 0.032
	d6+d7	0.219 ± 0.059
	Sum ALL	0.027 ± 0.026
	Macro-scale	0.115 ± 0.041



➢ Some deformity scores on micro-scale create noise

➢ It is important to study the correct deformity as a trait to improve

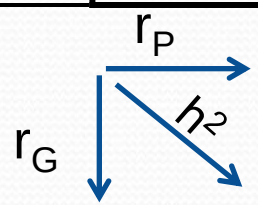
Sum ALL: the sum of scores on Micro-scale

Heritability estimates for the jaw deformities (observed & liability scale)

Trait	h2 (observed scale)	h2 (underline liability scale)
d1	**0.050**	0.102
d2	**0.047**	0.486
d3	**0.077**	0.157
d4	**0.054**	0.319
d5	**0.058**	0.372
d6	**0.166**	0.533
d7	**0.162**	0.331
d8	**0.042**	0.106
d1+6+7	**0.049**	0.415
d6+7	**0.203**	0.32
d2+3+4+5+8+9	**0.094**	0.157
d1+2+3+4+5+8+9	**0.050**	0.39
d1+2+3+4+5+6+7+8+9+11	**0.056**	0.85
d1+2+3+4+5+6+7+8+9+10+11	**0.055**	0.785

Negative correlations between size and jaw deformities

ALL	TL	SUMall	Score5	Score1	Score2	Score3	Score4	Macro-scale
TL	**0.21**	-0.39	-0.39	-0.22	-0.01	-0.36	-0.40	-0.33
SUMall	-0.32	**0.04**	1.00	0.67	0.22	0.82	0.94	0.57
Score5	-0.29	1.00	**0.04**	0.67	0.22	0.82	0.94	0.57
Score1	-0.80	0.33	0.32	**0.05**	0.42	0.14	0.55	0.33
Score2	-0.24	0.33	0.36	0.50	**0.20**	-0.03	-0.11	0.32
Score3	0.29	0.76	0.78	-0.33	0.06	**0.05**	0.85	0.48
Score4	-0.10	0.71	0.70	-0.01	-0.40	0.69	**0.03**	0.45
Macro-scale	-0.40	0.94	0.93	0.41	0.28	0.65	0.71	**0.10**



Thank you for your attention

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