Does early growth play a role in the sex determination of European sea bass *Dicentrarchus labrax* ?

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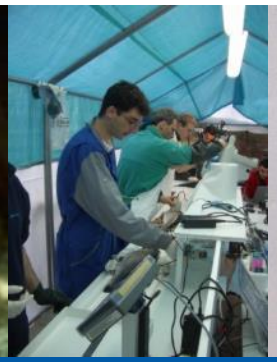


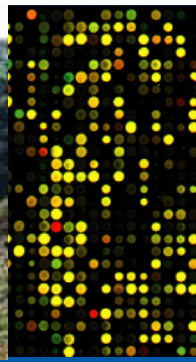

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International Symposium on Genetics in Aquaculture XII
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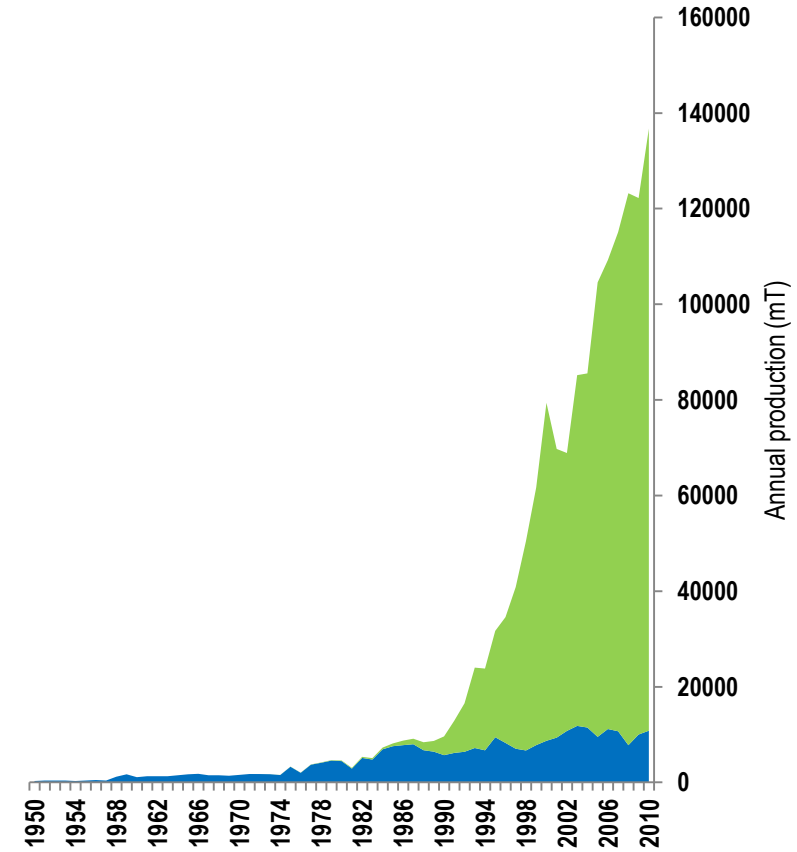
The sea bass: an important aquaculture species with unusual (polygenic) sex determination



- 75-95% males in farmed populations
- Females 20-30% heavier ➔preferred
- Warm early rearing environment ➔ males
- No protocol ensuring 50% females or more
- Polygenic sex determination postulated
  Vandeputte et al. 2007, Genetics 176: 1049-1057

➔ How to use it to manipulate sex-ratio ?

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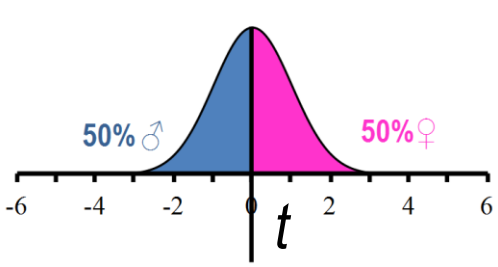
The polygenic threshold model for sex

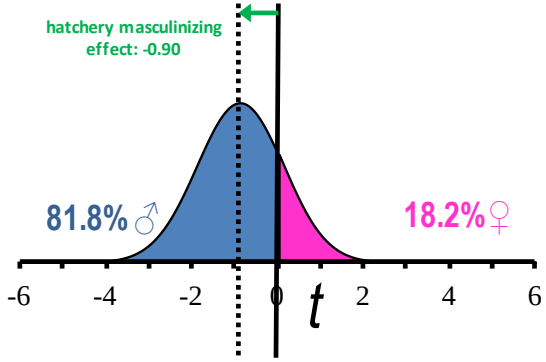
adapted from Bulmer and Bull, 1982

An underlying sex tendency *t*= G+E; if *t*>0: female, else male



In nature

Vandeputte et al. 2012,
Aquatic Living Resources 25: 77-81



In hatchery

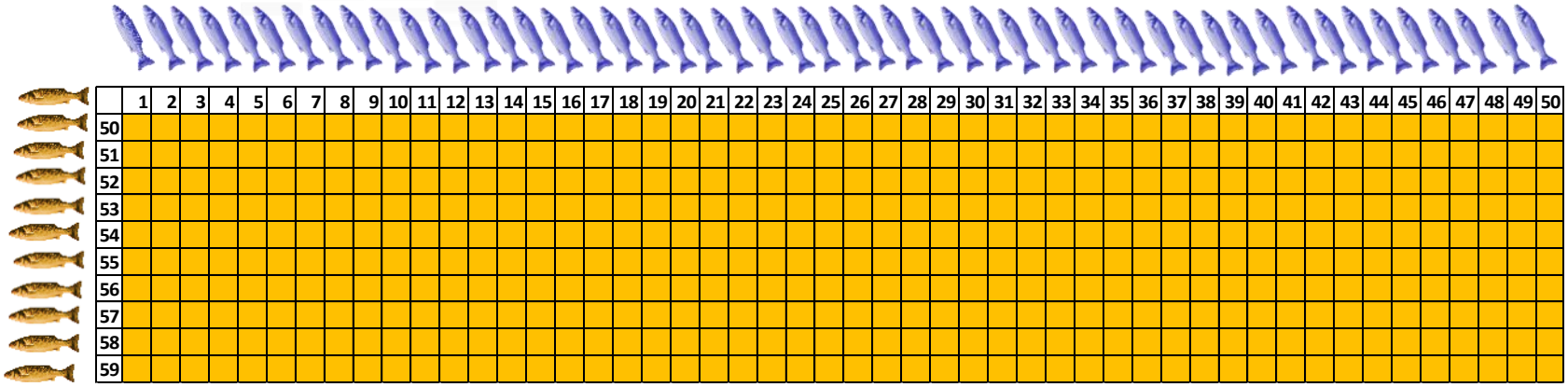
Vandeputte et al. 2007
Genetics 176: 1049-1057

t can be equally displaced by genetics and environment

t is genetically correlated with BW at 1 yr (r_A=+0.50)

Is there variation in genetic correlations of *t* and growth?

Experimental design



- 50 sires x 10 dams full factorial (G1 dom. WMED)
- All grouped in 1 batch
- 1938 tagged at 95 dph (0.57g) with nanotags

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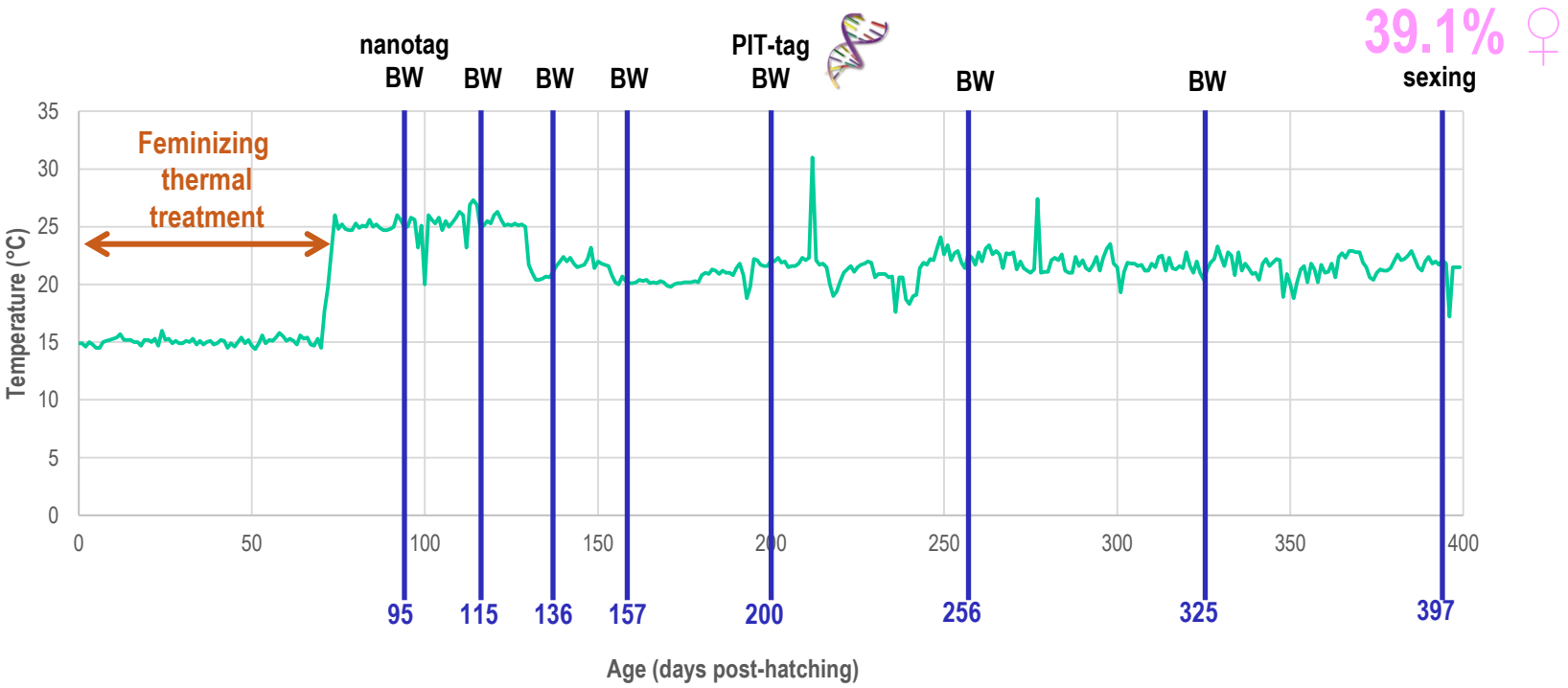
Individual micro-tagging

Ferrari et al., 2014. Aquaculture 426-427: 165-171


nanotag
BW
BW
BW
BW
PIT-tag
BW
BW
BW
39.1% ♀
sexing
Feminizing
thermal
treatment
Temperature (°C)
35
30
25
20
15
10
5
0
0
50
100
150
200
250
300
350
400
95
115
136
157
200
256
325
397
Age (days post-hatching)

Parentage assignment

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Total
50	9	12	1	1	1	7	4	11	5	10	4	3	6	4	3	0	7	9	10	9	12	1	2	4	3	13	4	1	7	10	10	0	5	6	4	2	2	4	4	6	7	6	2	0	13	3	2	7	8	0	264
51	2	3	3	2	2	1	1	1	4	6	1	0	0	6	9	1	0	1	1	2	3	1	0	3	12	4	3	6	6	0	0	1	3	2	5	0	2	0	3	3	6	0	3	1	5	1	0	0	2	0	121
52	1	2	8	4	3	6	8	3	6	1	1	2	3	0	6	1	5	5	1	6	4	8	7	2	7	4	4	3	13	2	2	1	0	3	14	4	6	2	2	8	3	1	4	8	6	2	0	2	1	0	195
53	0	3	4	0	2	3	1	2	2	2	1	0	2	2	4	1	2	3	1	4	4	3	2	0	2	3	3	0	6	2	1	1	1	2	1	2	1	2	1	5	4	0	0	1	2	0	1	0	1	0	90
54	0	1	0	3	2	2	7	0	2	0	2	0	4	2	3	2	0	0	1	3	3	2	1	5	0	0	0	1	4	2	2	3	5	2	4	4	2	0	1	6	2	0	3	0	3	3	2	1	0	0	95
55	4	1	4	2	9	4	1	19	1	0	2	3	16	2	4	0	10	12	8	3	11	1	3	3	1	5	27	0	4	13	14	1	1	6	1	2	2	4	12	1	7	6	2	0	7	0	9	2	5	0	255
56	0	0	0	0	1	0	7	1	1	0	1	1	1	0	1	2	1	0	1	0	1	1	0	0	0	0	0	0	2	2	1	0	1	2	0	2	1	0	0	3	0	0	0	0	2	1	2	0	0	0	39
57	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5
58	0	0	1	0	0	0	0	2	0	0	0	0	0	0	1	0	2	1	0	0	0	0	0	0	0	0	0	1	0	1	2	0	0	0	0	1	0	0	0	0	3	0	0	0	3	0	0	1	0	0	19
59	2	2	0	2	1	0	1	1	1	2	1	0	1	1	1	0	0	2	2	1	4	0	0	1	1	2	2	4	1	1	0	0	1	0	3	0	2	2	1	0	0	0	0	0	3	0	0	2	0	0	51
	18	25	21	15	21	23	30	40	22	21	13	9	34	17	32	7	27	33	25	28	42	17	15	18	26	31	43	16	44	33	32	7	17	23	32	17	18	15	24	32	32	13	14	10	44	10	16	15	17	0	1134

- Genotyped for 12 microsatellites LABOGENA
- 98.0% assignment (VITASSIGN, 2 mismatches tolerated)
- 1134 individuals with complete phenotypes and pedigree

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Models used

- **Multivariate sire models in VCE 6.0**

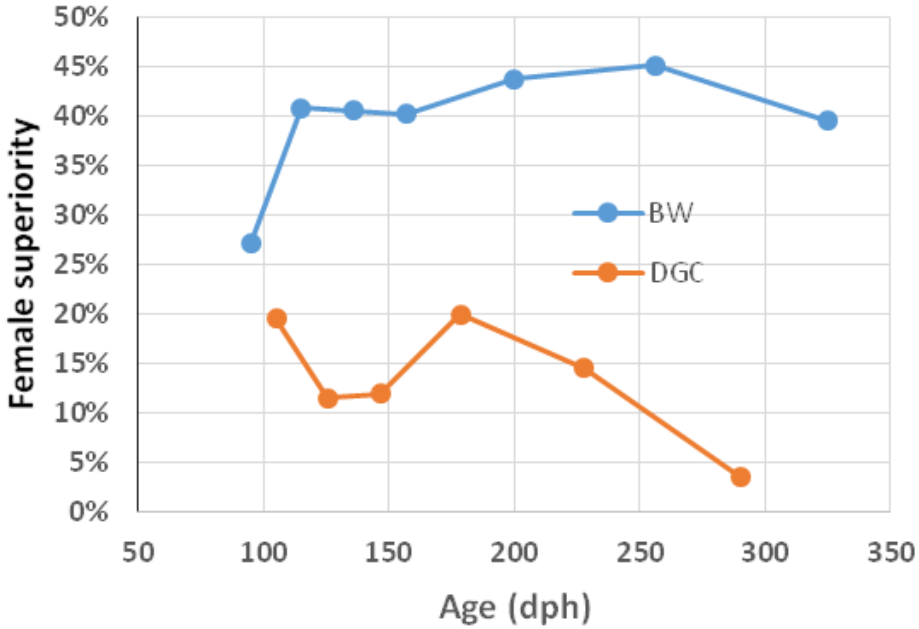
$Sex\ (0,1) = Sire + \varepsilon$

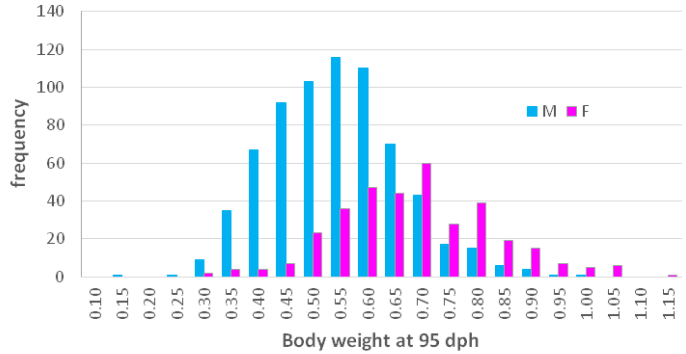
BW_x *or* $DGC_{x-y} = sex + Sire + \varepsilon$ (if growth= consequence of sex)

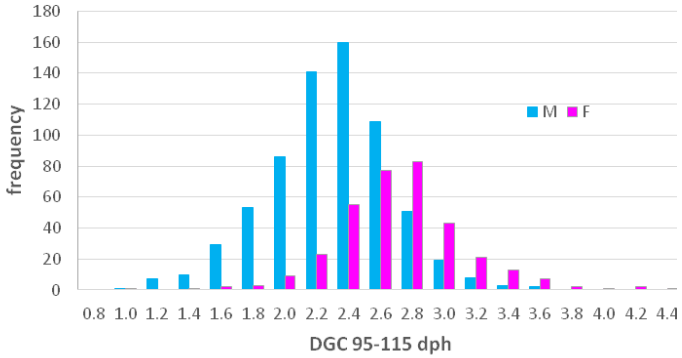
BW_x *or* $DGC_{x-y} = Sire + \varepsilon$ (if growth= cause of sex)

Dempster & Lerner (1950) correction for h^2_U

Sex dimorphism for BW & DGC







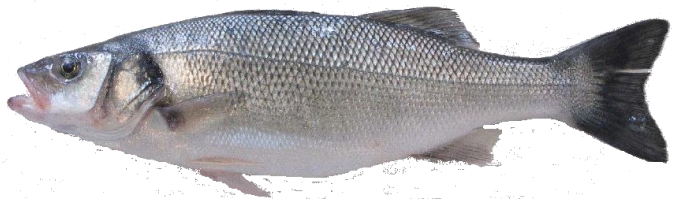
Heritability of sex tendency

$h^2_u = 0.39 \pm 0.12$

WEM

Lower than previous estimate :

$h^2_u = 0.62 \pm 0.12$



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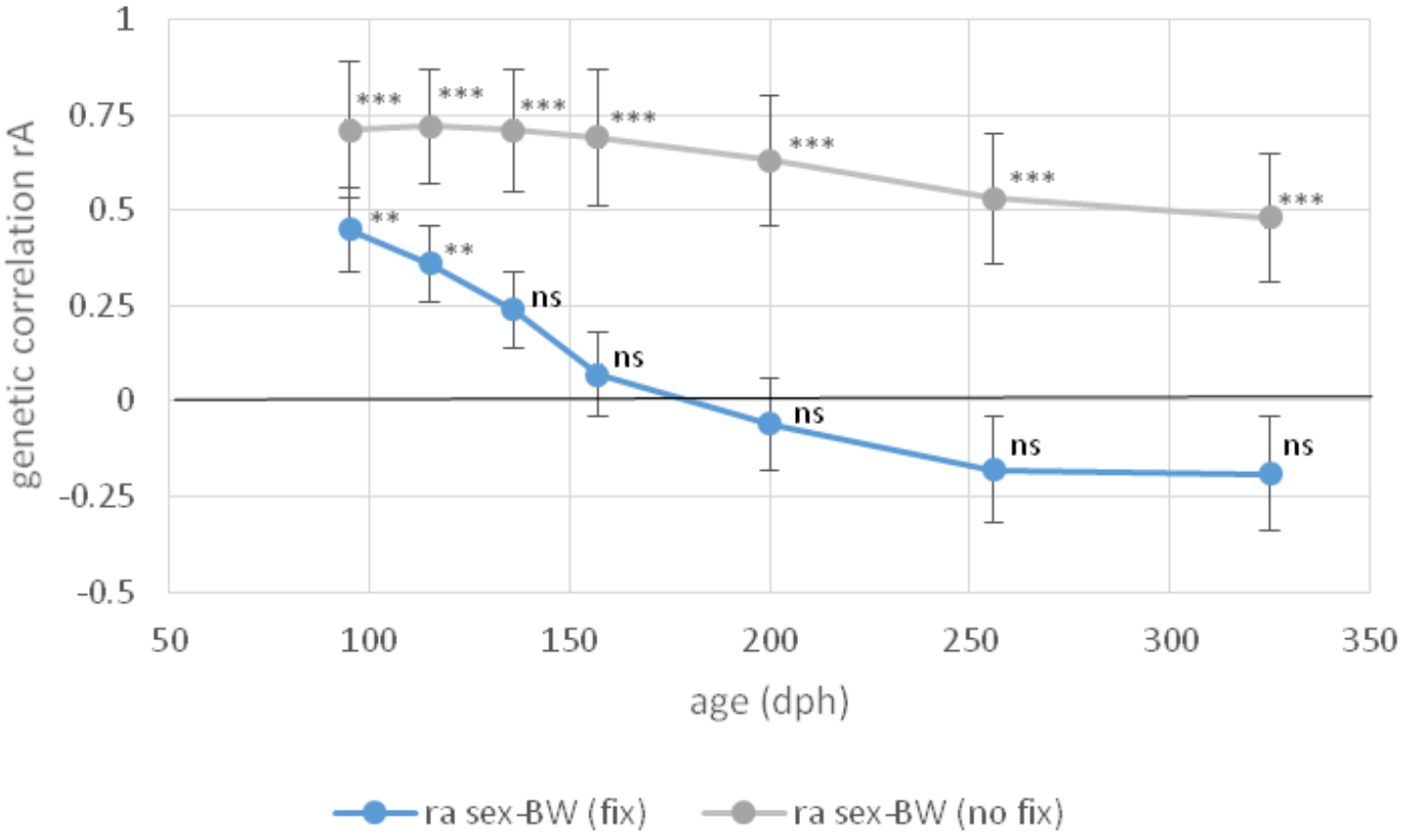
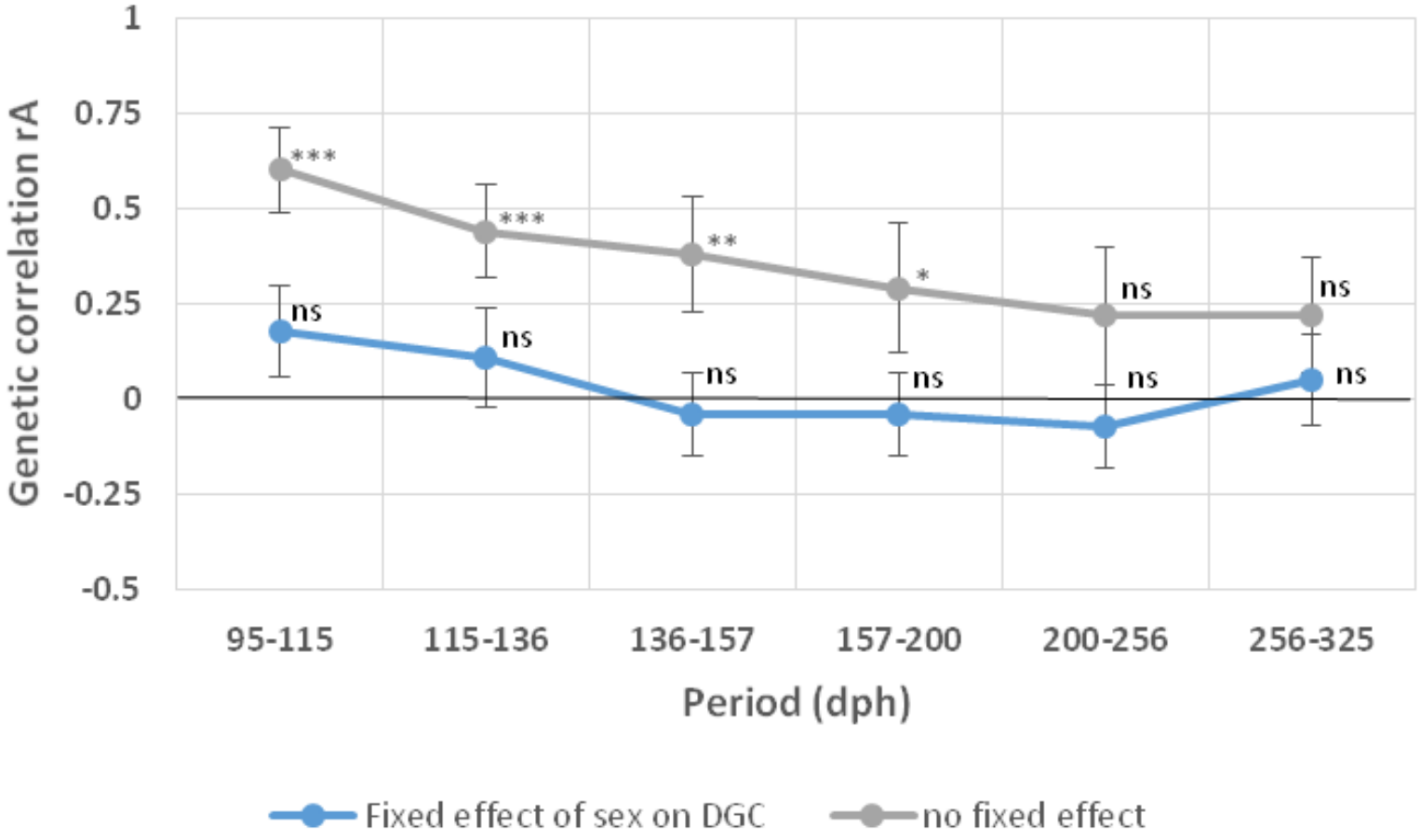
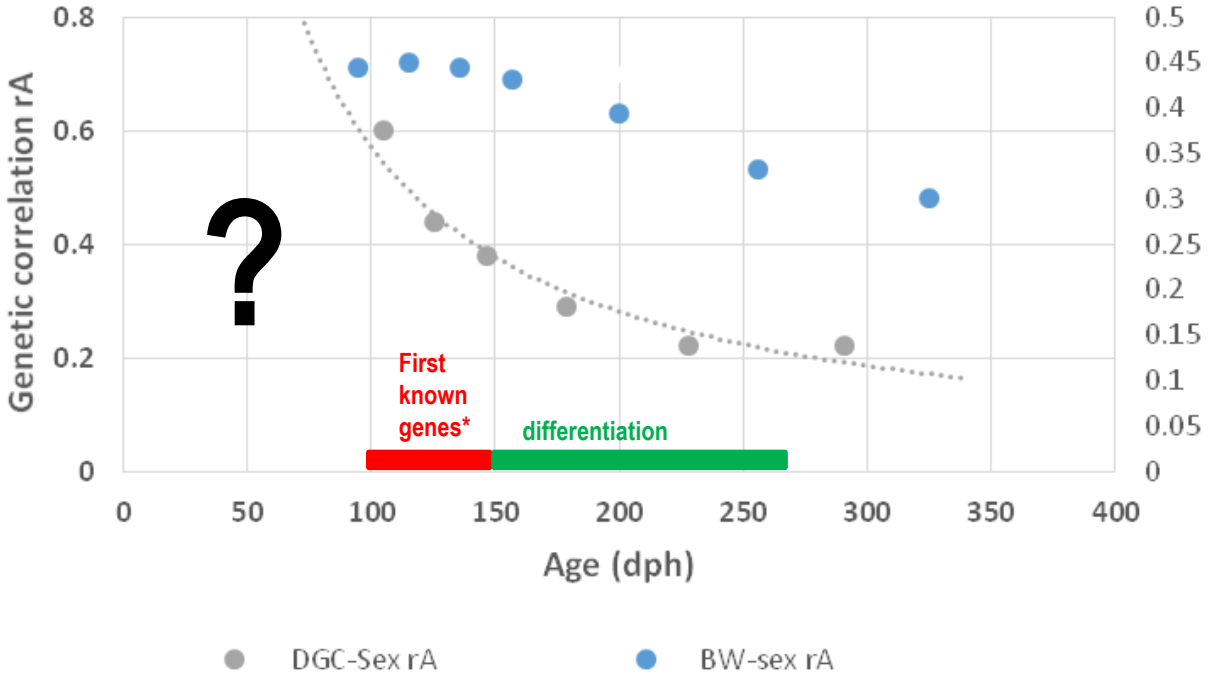
Sex tendency – BW genetic correlations



Sex tendency – DGC genetic correlations

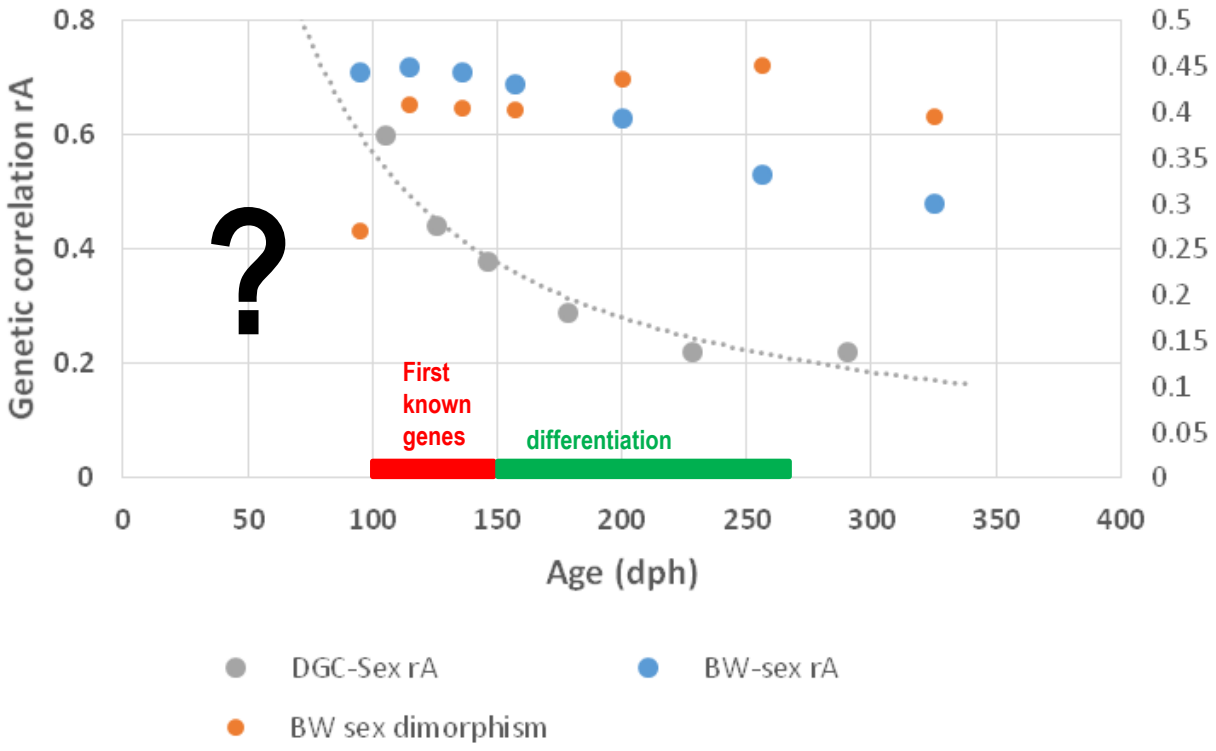


So what happens ?

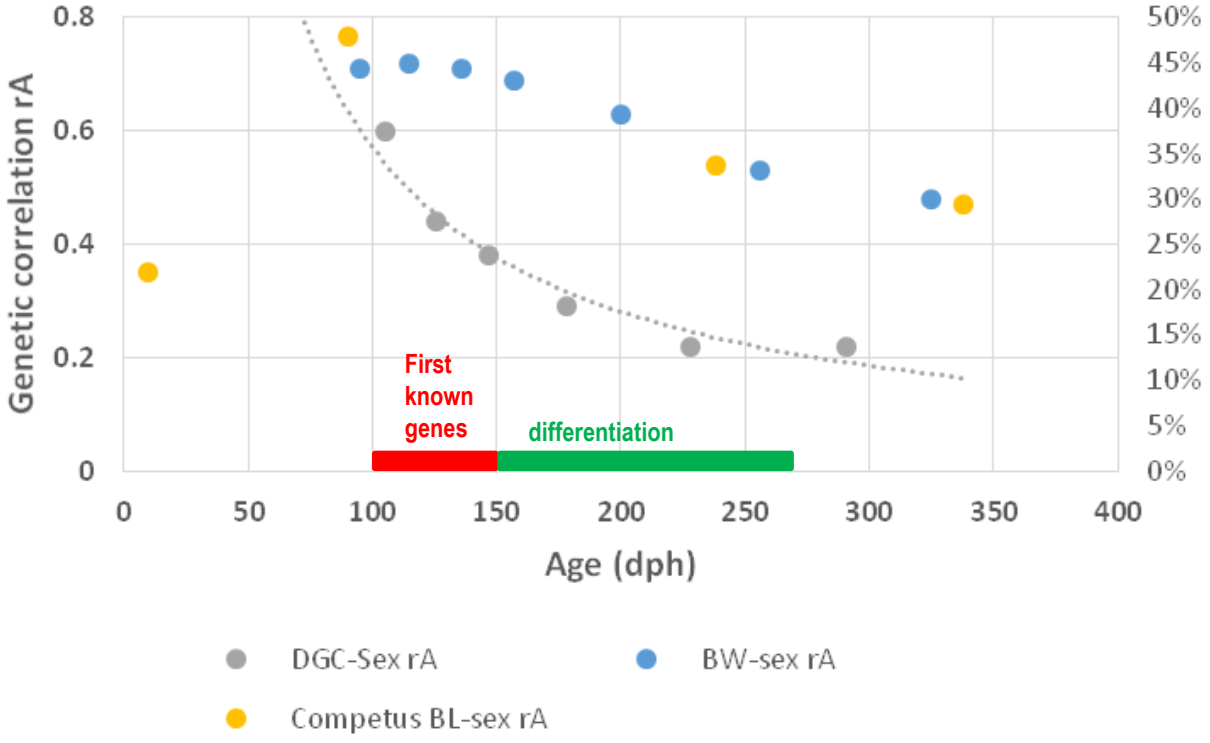


*cyp19a, Blazquez et al, 2009

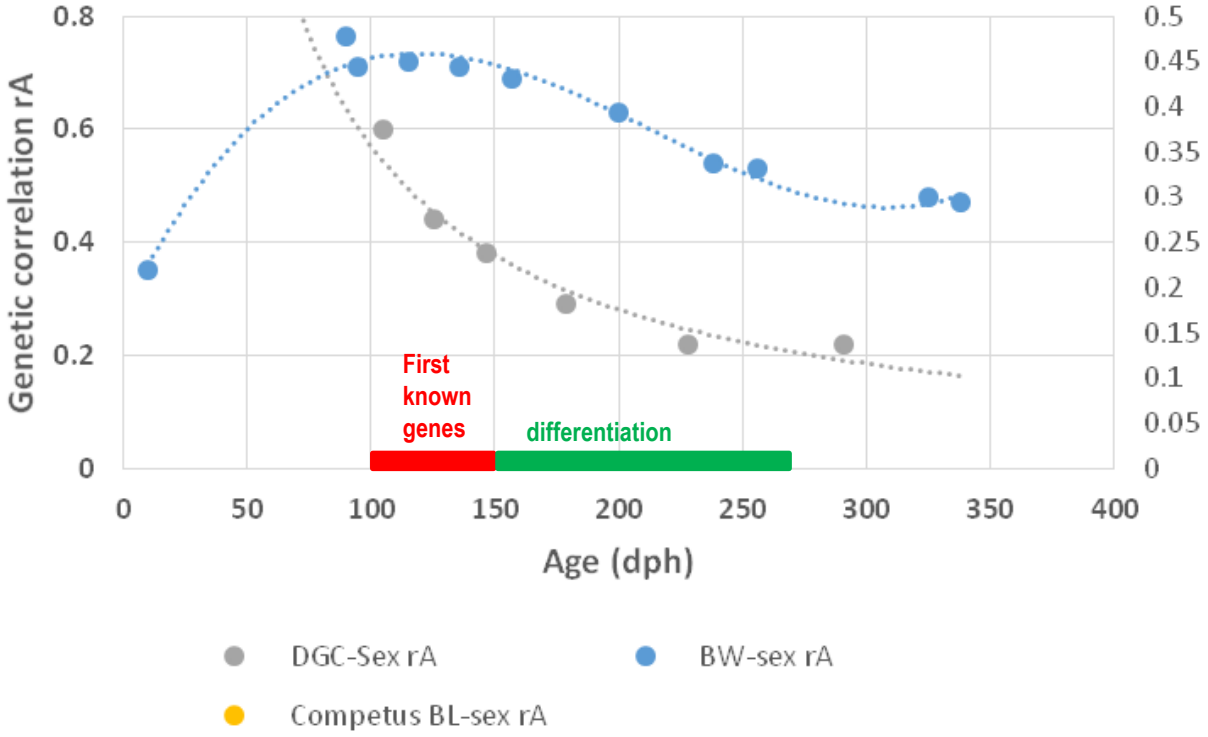
So what happens ?



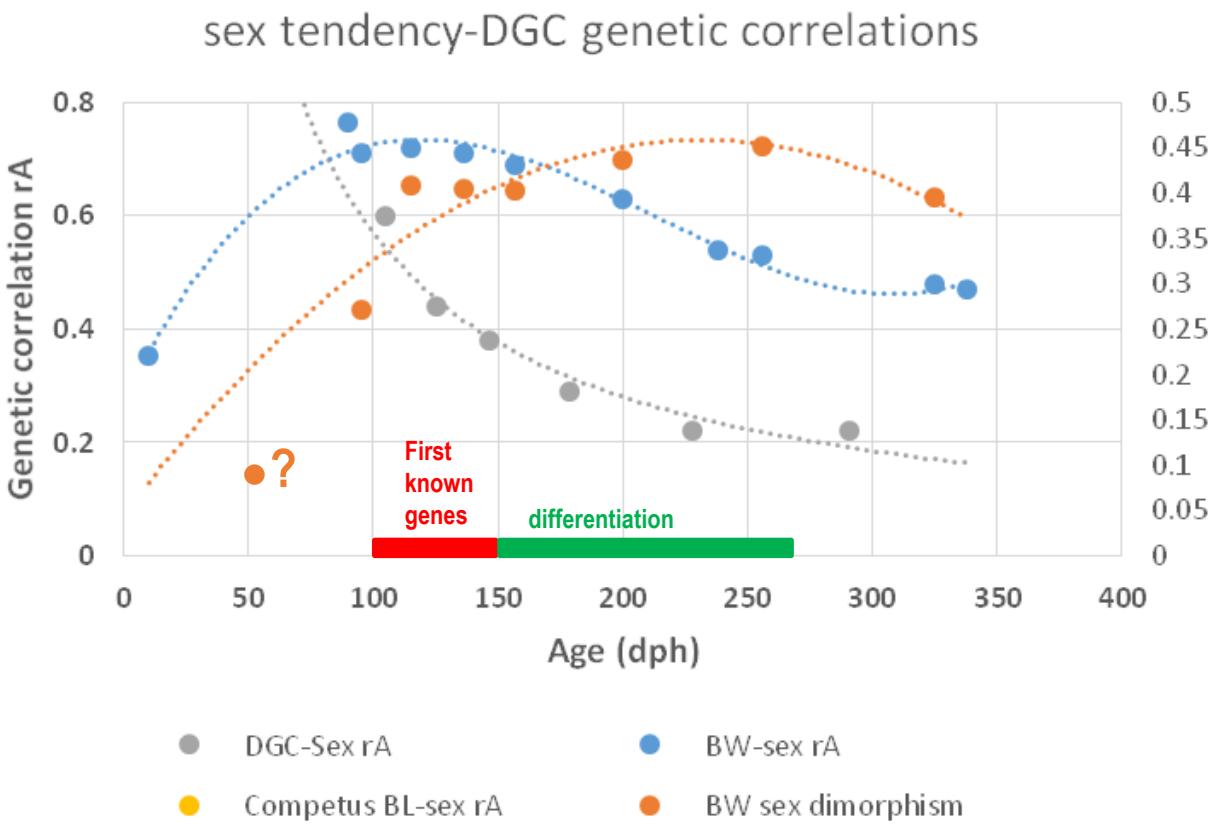
So what happens ?



So what happens ?



So what happens ?



In summary

- With micro-tagging and genotyping, we could obtain genetic parameters of sex and growth in sea bass starting at 570 mg (95 dph)
- Sex-ratio is heritable in WMED sea bass (h^2u=0.39)
- Genetic correlation of growth with sex tendency is highest at 95 dph
- Future females are already 27% heavier than males at 95 dph
- This is before the first published signs of differential gene expression

- We hypothesize that differential growth around 70-120 dph can be a cause rather than a consequence of female differentiation

➔ Possible new approaches to manipulate sea bass sex-ratios ?

Questions ?

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SEVENTH FRAMEWORK PROGRAMME

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