Separate and combined treatment effects of simulated reproductive migration and hormonal stimulation on sexual maturation in European eels

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Background

In nature, European eels (*Anguilla anguilla*) sexually mature during and/or after their ~6,000 km reproductive migration. Experimentally, maturation can be induced by weekly injections with pituitary extract (PE; hypophysation) over a long period of 12-24 weeks. However, this long trajectory treatment compromises egg quality.

In our studies, broodstock is conditioned from the early juvenile glass eel stage onwards by feminisation and simulated migration to advance maturation and reduce the hypophysation period. Here we present the results of the separate and combined treatment effects of simulated migration and hormonal stimulation on sexual maturation in eels of different backgrounds.

Methods

Experiment 1: groups of farmed, feminized and wild silver eels were subjected to **simulated migration** to investigate the effects on sexual maturation. A fourth group of wild silver eels was not subjected to simulated migration but received a **17-methyltestosterone (17MT) implant** to compare treatment effects.

Experiment 2: groups of farmed, feminized and wild silver eels were each split and did or did not receive a **single PE injection** after which they were all subjected to **simulated migration** to investigate whether more advanced maturation could be induced by the combined treatment.

Simulated migration (2 months swimming covering ~3,000 km under mimicked photothermal conditions; Fig. 1) was executed in a 3,600 L swim gutter. Before and after, eels were measured to determine changes in the eye index (EI); sampled for blood to measure plasma 17β-estradiol (E2) and 11-ketotestosterone (11-KT) levels, and gonadosomatic index (GSI) was non-invasively determined by applying ultrasound.

Results

Both experiments showed that simulated migration enhanced early maturation (higher EI and GSI). The 17MT implants had similar but stronger effects and increased GSI up to values of 4, known for eels that started vitellogenesis (Table 1). Eels that received a PE injection showed more advanced maturation after simulated migration (higher GSI) than non-injected eels but still below GSI values indicating yolk deposition (Table 2). Feminised eels were more sensitive to treatment (higher GSI, plasma E2) than farmed eels.

Figure 1. From left to right: Simulated migration of eels in the swim gutter; Measuring eye diameters and pectoral fin lengths; Applying ultrasound to determine the GSI non-invasively; blood sampling for measuring E2 and 11-KT; Injecting PE (hypophysation); larvae from wild and feminised eels.

Table 1. Experiment 1 results.

Parameters	START	END
Farmed		
EI	8.81 ± 0.26	**9.67 ± 0.35**
GSI	1.02 ± 0.04	**1.20 ± 0.06**
11-KT (pg/mL)	13.64 ± 1.46	19.30 ± 4.25
E2 (pg/mL)	10.45 ± 1.44	9.98 ± 2.21
Feminized		
EI	8.18 ± 0.28	**8.93 ± 0.27**
GSI	1.10 ± 0.05	**1.29 ± 0.06**
11-KT (pg/mL)	14.31 ± 2.04	18.51 ± 3.08
E2 (pg/mL)	11.40 ± 1.38	11.39 ± 1.37
Wild Freshwater		
EI	10.33 ± 0.36	10.34 ± 0.30
GSI	1.30 ± 0.06	**1.48 ± 0.08**
11-KT (pg/mL)	29.06 ± 5.01	25.69 ± 3.04
E2 (pg/mL)	23.07 ± 8.60	26.89 ± 10.12
Wild Freshwater 17MT		
EI	9.94 ± 0.47	**13.13 ± 0.54**
GSI	1.26 ± 0.06	**2.50 ± 0.20**
11-KT (pg/mL)	23.65 ± 2.22	**9.83 ± 0.95**
E2 (pg/mL)	24.93 ± 5.27	23.02 ± 4.72

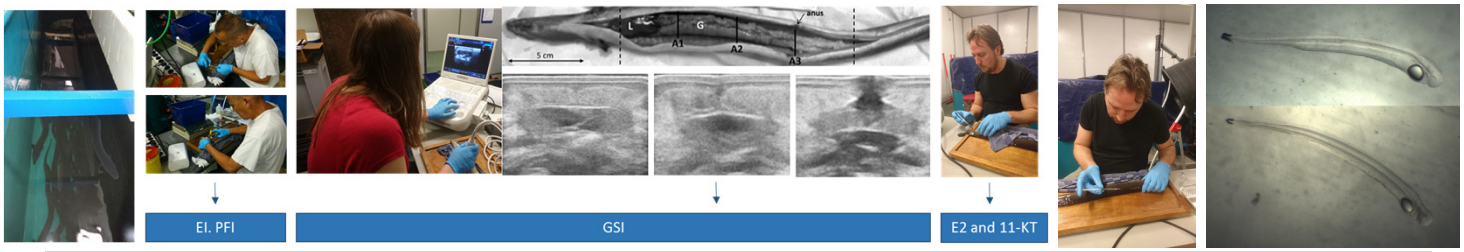
Table 2. Experiment 2 results.

	Without CPE injection		With CPE injection	
Parameters	**START**	**END**	**START**	**END**
Farmed				
EI	7.95 ± 0.34	**8.99 ± 0.44**	9.21 ± 0.45	9.05 ± 0.41
GSI	1.05 ± 0.06	1.25 ± 0.10	1.17 ± 0.07	**1.45 ± 0.11**
11-KT (pg/mL)	9.93 ± 2.88	10.78 ± 1.73	9.53 ± 1.95	11.73 ± 1.64
E2 (pg/mL)	30.50 ± 5.40	**11.86 ± 1.85**	28.91 ± 4.67	**15.91 ± 3.05**
Feminized				
EI	7.84 ± 0.24	8.21 ± 0.30	7.75 ± 0.37	**8.76 ± 0.32**
GSI	1.15 ± 0.09	**1.44 ± 0.08**	1.15 ± 0.09	**1.58 ± 0.09**
11-KT (pg/mL)	8.32 ± 1.81	12.69 ± 2.13	10.12 ± 2.73	32.30 ± 11.88
E2 (pg/mL)	31.80 ± 11.00	**20.67 ± 4.97**	35.58 ± 4.72	**27.87 ± 5.77**
Wild Freshwater				
EI	10.28 ± 0.66	10.50 ± 0.58	9.27 ± 0.58	10.03 ± 0.84
GSI	1.33 ± 0.06	**1.53 ± 0.05**	1.24 ± 0.08	**1.53 ± 0.09**
11-KT (pg/mL)	6.20 ± 1.16	**18.15 ± 2.95**	7.00 ± 2.02	**18.95 ± 3.95**
E2 (pg/mL)	29.38 ± 8.28	**14.99 ± 2.80**	21.70 ± 7.57	**14.70 ± 5.10**
Wild Seawater				
EI	8.93 ± 0.41	9.23 ± 0.50	9.63 ± 0.55	**10.86 ± 0.62**
GSI	1.32 ± 0.09	**1.53 ± 0.07**	1.30 ± 0.11	**1.81 ± 0.16**
11-KT (pg/mL)	10.2 ± 2.25	20.03 ± 4.62	6.30 ± 1.93	**20.31 ± 4.78**
E2 (pg/mL)	27.20 ± 6.40	22.16 ± 15.97	39.09 ± 6.68	**11.40 ± 3.15**

The hypophysation period was shortened after treatments. N=77 females fully matured, N=39 egg batches were fertilized, N=6 batches gave embryos and in N=3 cases larvae were obtained that survived up to 8 days.

Conclusions

Simulated migration and 17MT implants provide useful tools to enhance early maturation in eels and to reduce the hypophysation period which supposedly increases egg quality and reproductive success.



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