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► To cite this version:

Marc Vandeputte, Mathilde Dupont-Nivet, Pierrick Haffray, H. H. Chavanne, A. A. Vergnet, et al.. Can we obtain monosex sea bass populations through selective breeding?. 62. Annual Meeting of the European Association for Animal Production (EAAP), Aug 2011, Stavanger, Norway. pp.328. hal-01001399

HAL Id: hal-01001399

<https://hal.science/hal-01001399v1>

Submitted on 3 Jun 2020

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Can we obtain monosex sea bass populations through selective breeding ?

Vandeputte, M.^{1,2}, Dupont-Nivet, M.¹, Haffray, P.³, Chavanne, H.⁴, Vergnet, A.², Quillet, E.¹ and Chatain, B.²

¹INRA, UMR1313 GABI, Domaine de Vilvert, 78350 Jouy en Josas, France, ²Ifremer UMR110 INTREPID, Chemin de Maguelone, 34250 Palavas les Flots, France, ³Sysaaf, Campus de Beaulieu, 35000 Rennes, France, ⁴ISILS, Localita la Quercia, 26027 Rivolta d'Adda, Italy

Context

In the European sea bass, the sex-ratio of farmed populations is usually highly male-biased (> 75%), while wild populations seem to conform to a 50/50 sex ratio. Females are preferred by farmers due to better growth and later puberty. The situation in farmed populations is known to be linked to larval and post-larval rearing temperature, but also to genetic factors which are presumably polygenic, and linked with growth rate. We tested the impact of domestication and phenotypic selection for growth on population sex-ratio, in a quantitative genetics framework where phenotypic sex is modeled as a threshold trait with an underlying liability called "sex tendency", which is influenced both by genetic and environmental effects.

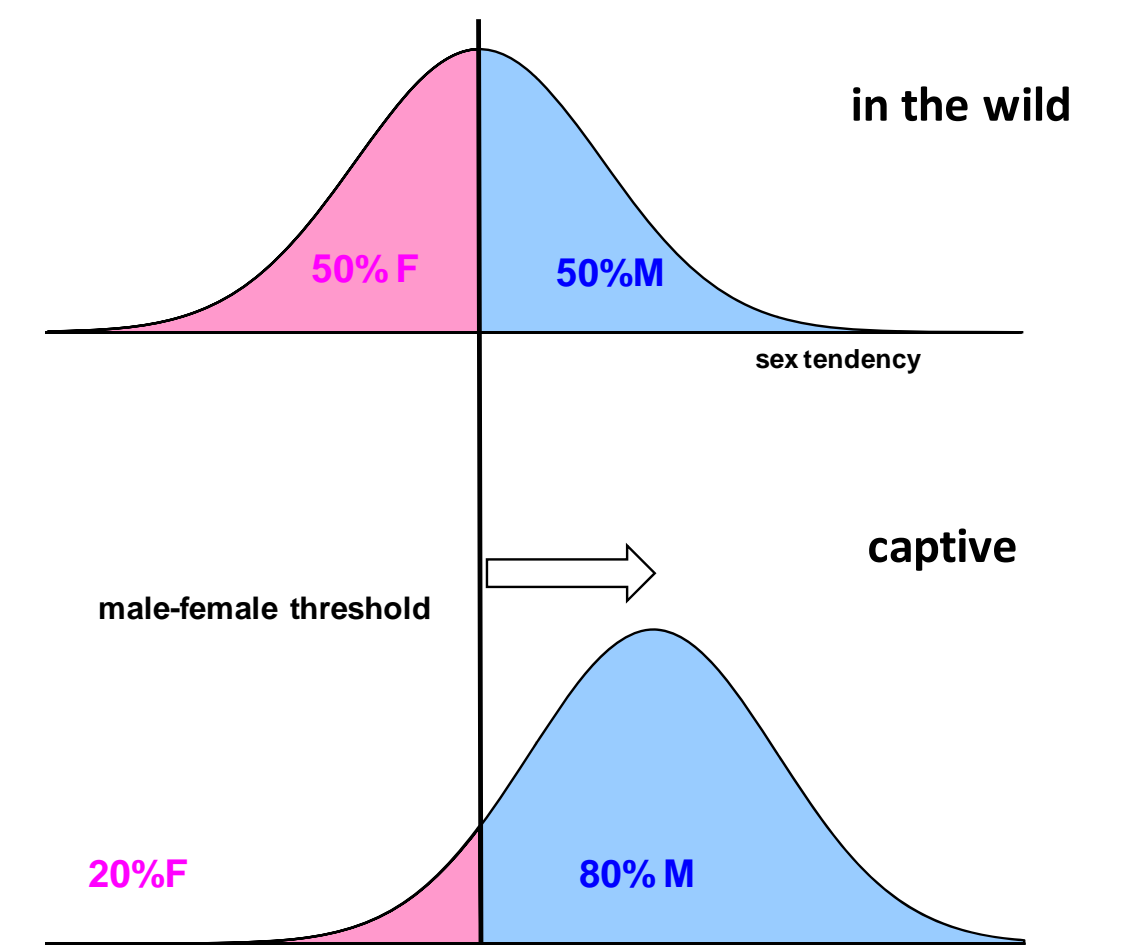
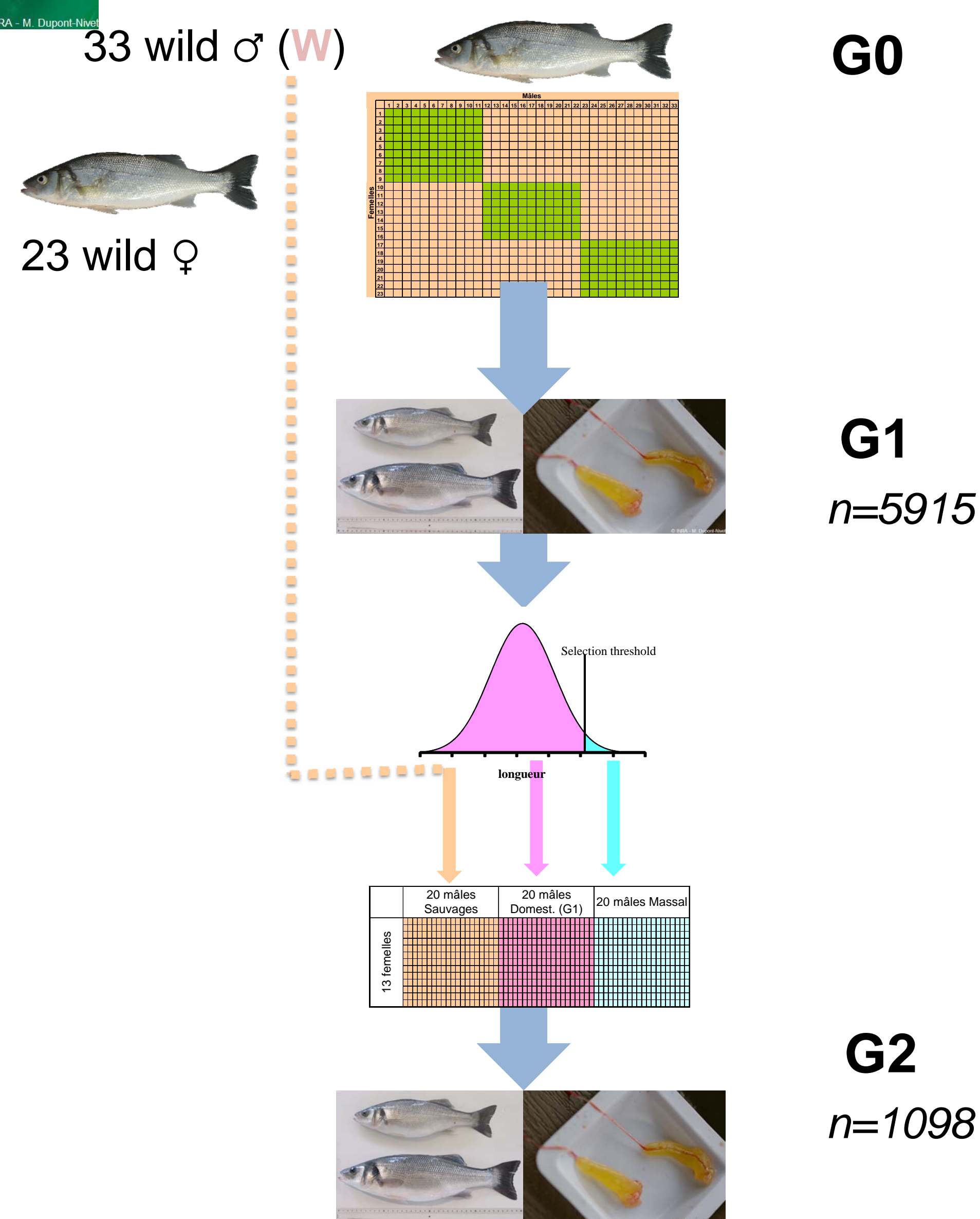


Figure 1: The threshold model for sex-ratio in sea bass, with the phenotypic effect of early rearing environment in farms.

Material and methods



1. Factorial mating design with 33 wild G0♂ (W), 23 W♀ 7000 offspring individually tagged at 35 g (1 year), parentage assignment by genotyping of microsatellites (>98%), phenotyping of G1 at 400g (2 yrs) for sex & growth
2. Estimation of genetic parameters of growth & sex (h^2 , r_A) in G1 fish by covariance between relatives (REML)
3. experimental selection for growth on G1 fish, P=5% on body length (BL) → 20 S males, + 20 males with average body length (D = domesticated)
4. Evaluation of response to selection and domestication on body weight and sex-ratio (20 W, D and S males mated to 13 standard wild females)
5. Stochastic simulation study of selection on body length (quantitative genetics framework, $h^2=0.41$ for body length, 0.62 for sex tendency, genetic correlation = 0.48) & estimation of the correlated response on sex-ratio.

Results

1. 18.2% females in G1, $h^2=0.62$ for sex tendency, $h^2=0.41$ for body length, $r_A=0.48$
2. Body weight in G2: S > D = W, +15 to 20% for S
3. Sex-ratio in G2: S 58.4%♀, D 47.1%♀, W 41.4%♀ ($P < 0.001$)
4. Simulation: 75% females in G10 if the 5% largest fish are selected at each generation (fig2). If those G10 fish were reared in conditions mimicking the natural ones, 95% females would be expected

Conclusions

1. Selection for body length induces a correlated response on sex-ratio, with more females in growth-selected fish
2. Combining selection for growth and manipulation of environmental conditions should allow the production of quasi-monosex populations of sea bass for aquaculture.

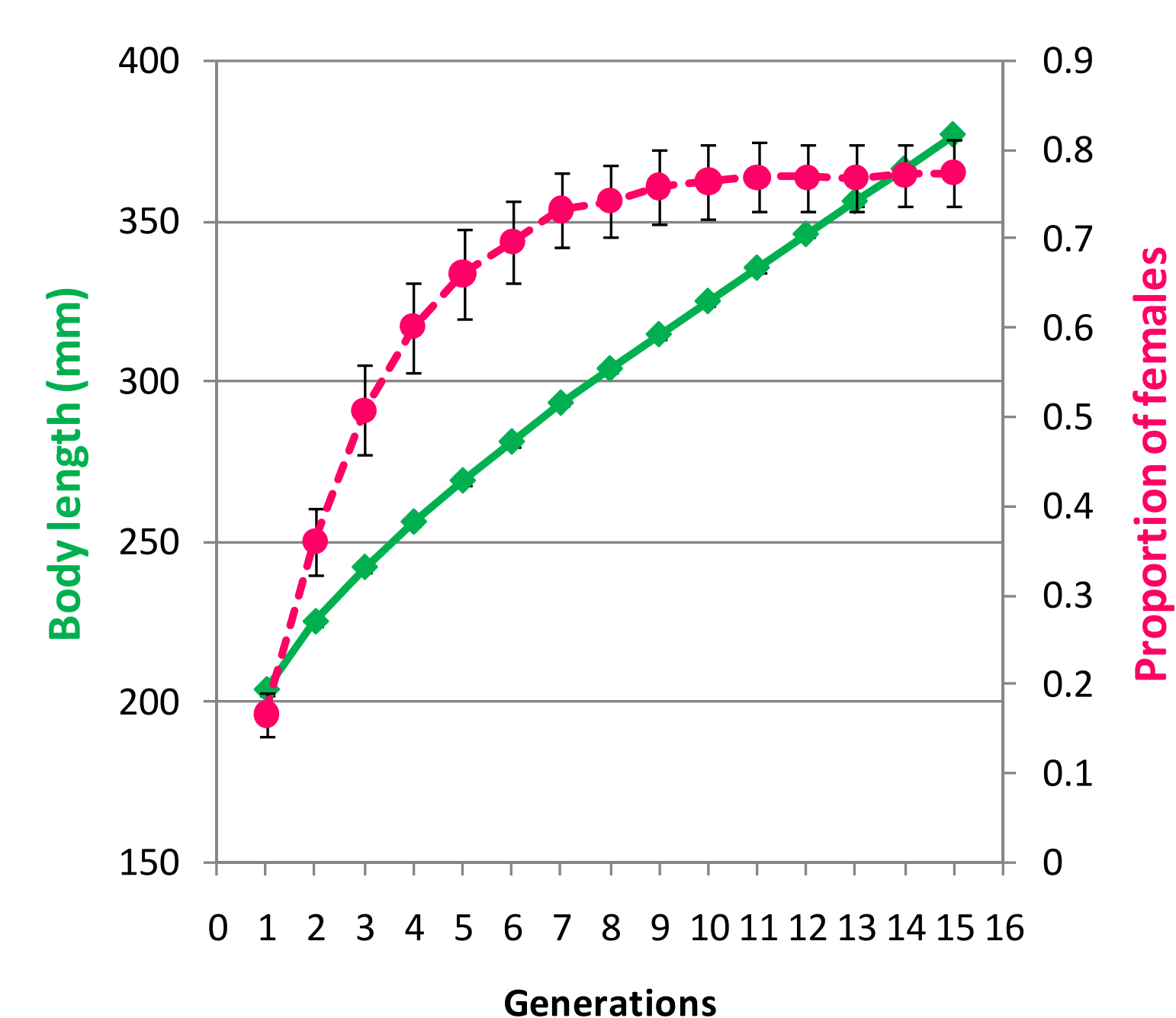


Figure 3: Simulated co-evolution of body length and sex-ratio in a population of sea bass submitted to phenotypic selection on body length with a proportion selected of 5% at each generation

Acknowledgements

This work was conducted in the frame of two European projects, Heritabolum (Q5CR-2002-71720) and Competus (COOP-CT-2005-017633). It is also part of the work programme of the INRA-Ifremer Research Group on Sustainable Fish Breeding.

62nd EAAP Annual Meeting, Stavanger, Norway - 29 August - 1 September 2011