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COMMENT

Response: on the consequences of sexual selection for fisheries-induced evolution

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We welcome the comment by Urbach and Cotton (2008) on our exploratory analysis of the consequences of sexual selection for fisheries-induced evolution (Hutchings and Rowe 2008). Two primary conclusions emerged from our work. First, irrespective of the underlying cause, fisheries-induced evolution of traits linked to reproductive success may lead to unanticipated consequences regarding the rate and direction of genetic change. Secondly, if reproductive success increases with body size, and if the variability in body size declines with increased fishing pressure, the strength of selection for smaller body size may be comparatively rapid.

While accepting these conclusions, Urbach and Cotton (2008) proffer the legitimate argument that an increase in reproductive success with body size need not always be a consequence of sexual selection. With regard to our analysis, they suggest that (i) our example might represent natural selection rather than sexual selection and (ii) the consequences of sexual selection to fisheries-induced evolution may be more complicated than our analyses might have indicated. We agree entirely with the second point. Regarding the first point, the authors argue that increased reproductive success with increasing body size in Atlantic cod need not be a consequence of sexual selection. Rather, given the curvilinear increase, for example, in fecundity with female body size characteristic of most fishes, such a relationship may be more appropriately described as being a consequence of natural selection.

In response, we might initially caution against drawing a finer distinction between sexual and natural selection than may be warranted. Nonetheless, Urbach and Cotton (2008) draw attention to what constitutes an appropriate null model for the question at hand. Within this context, one means of addressing the issue (for females) is to compare the slope of the regression relating fecundity to female body size with that of the regression relating reproductive success to female body size. If the slopes are equal, then the argument could be made that our exploratory analysis dealt with an element of natural, rather than sexual, selection. Alternatively, if the slope of the reproductive success:body size regression exceeds that of the fecundity:body size regression (indicating that success increased at a faster rate with body size than that predicted by the rate of increase in egg number with body size), the argument could be made that our paper dealt with sexual, rather than (or, more appropriately, in conjunction with) natural selection.

Estimates of the slopes of fecundity:length regressions have been reported for Atlantic cod in the same geographical region from which our experimental cod were obtained. Fitting egg number and body length data to the same exponential function that Hutchings and Rowe

(2008) used to estimate reproductive success as a function of length, McIntyre and Hutchings (2003) reported slopes of 0.044 and 0.052 for cod inhabiting the Southern Gulf of St Lawrence and Georges Bank, respectively. These are lower than the slope of the regression between body length and offspring number for females (0.071) in the data set used by Hutchings and Rowe (2008). Based on this comparison, and based on the highly skewed relationships that have been documented between male body size and reproductive success in Atlantic cod (Rowe et al. 2008), we suggest that it may be premature to discount the possibility that sexual selection is partially responsible for the increased reproductive success concomitant with increases in body size modelled by Hutchings and Rowe (2008).

We concur with Urbach and Cotton's (2008) recommendation that the effects of sexual selection on fisheries-induced evolution warrant considerably more research than has been undertaken to date. By articulating several predictions and various points for consideration, they have contributed to the development of a theoretical framework within which one might assess the influence of sexual selection on the strength, rate and direction of evolutionary change generated by exploitation.

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