

Pigmentation and/or immunity?

Trade-offs between pigmentation and immunity in *Betta Splendens*

Carotenoid pigments are responsible for many examples of sexual attractive red, orange and yellow coloration in animals and play an important role in antioxidant and immune defences. In this study an experimental approach has been used to test the carotenoid trade-off hypothesis between maintaining coloration and health.

Methodology

Experimental approach on *Betta splendens*;

Female - for male color:

A dichotomus mate choice test was conducted in the laboratory

Carotenoid supplementation

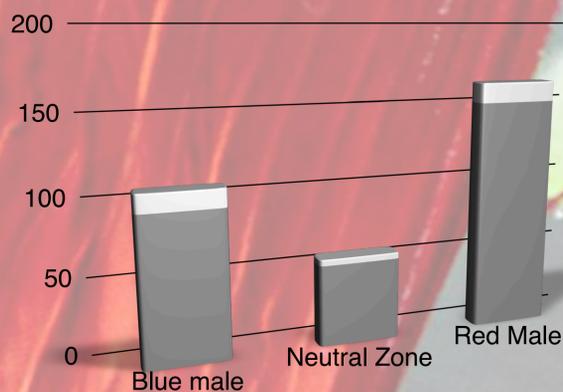
A Carotenoid diet was given number of *Betta splendens* in each color (red/blue). The reflectation was measured using a Ocean

Optics USN2000 spectrometer connected to a PX-2 pulsed xenon light.

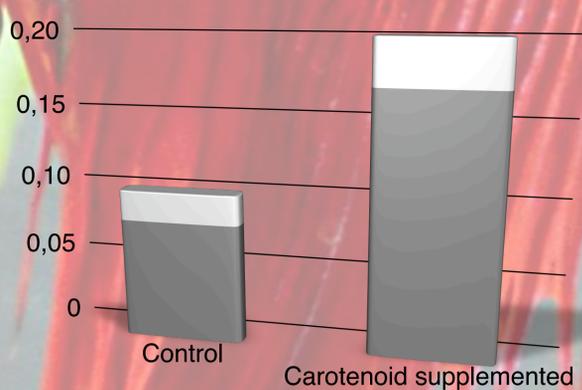
Immune response
Tested by using PHA.

Pigmentation analysis
Analysis of dermis and epidermis with spectrophotometer.

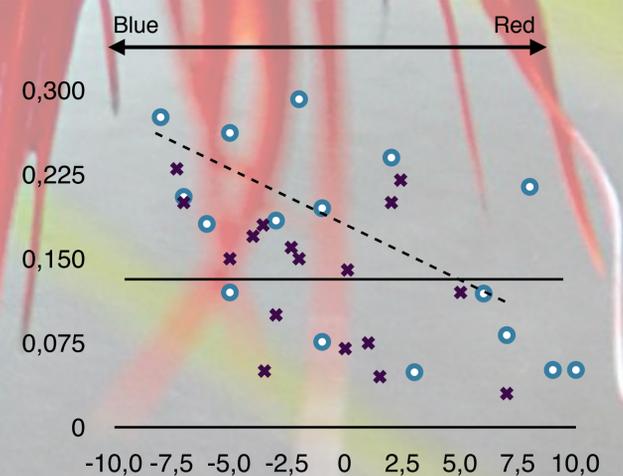
Statistic analysis
To conduct statistical analyses SAS 9.1.3, ANOVA and t-test was used.



Female *Betta splendens* spent more time (Mixed model ANOVA: $F_{1,44} = 9.36$, $P = 0.004$) associated with red males (149.0912.12 s) than with blue males, (96.4812.21 s).



Fish feed with dietary carotenoids ($N=33$) did have a significantly greater immune respons to the PHA injection than the controls ($N=28$). (Mean postinjection swelling in mm SE: control = 0.087 0.01 mm, $N = 28$; supplemented = 0.17 0.02 mm, $N = 33$; carotenoid supplemented group: $F_{1,58} = 12.68$, $P = 0.001$)



Fishes with low PC2 values (more blue) showed a larger increase in immune activity than redder fish supplemented with carotenoids. (Overall model: $F_{4,56} = 7.83$ $P < 0.0001$; initial redness: $F_{1,56} = 7.59$, $P < 0.01$; supplementation: $F_{1,56} = 15.5$ $P = 0.0002$).

Conclusion

The carotenoid trade-off hypothesis is supported in *Betta splendens*. The carotenoid pigments are both used for coloration, preferred by females in sexual selection and boost both immunity and coloration when abundance. Female *Betta splendens* preferred to associate with red males over blue males, which suggest a sexual selection to being red. Carotenoid-supplemented fish became redder and a natural redder fish had higher carotenoid concentration in their skin. In contrast, blue males of *Betta splendens* did not change in coloration but instead benefited immunological more than both redder males and controls. This gives an understanding of carotenoid mobilization and utilization pathways in animals.