VARIATION IN THE STRESS RESPONSE

BETWEEN GENETICALLY DIFFERENT STRAINS

OF COMMON CARP, *CYPRINUS CARPIO* L.

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Introduction

Inter and intra-species differences in the response to stress have been well reported in the literature (Salonius & Iwama, 1991; Ruane et al., 1999). While these differences with respect to species are clear, the genetic and environmental influences causing intra-species variations in the stress response are difficult to separate. Therefore in this study isogenic carp strains with a known genetic background were used. Fish for each experiment were produced on the same day and reared under identical conditions to reduce environmental influences.

Materials and Methods

Fish

Different isogenic strains of common carp were produced by normal fertilization techniques (Komen et al., 1988) or by androgenesis (Bongers et al., 1998) in the University hatchery (De Haar Vissen, Wageningen University). Fish larvae were fed freshly hatched *Artemia* nauplii for the first 21 days and with pelleted food thereafter at a rate of 20 g/kg $^{0.8}$. This level was reduced to 10 g/kg $^{0.8}$ at 100 days post hatch (dph) and all fish were sampled at 145 dph. Fish were weighed

every two weeks and the new feeding level was calculated based on the average weight of all strains. Two experiments were carried out each investigating the response of four strains of carp to a 3-h net confinement: one strain (E4E5 x R3R8) was used in both experiments to assess the magnitude of inter-experimental variation.

Table 1. Overview of the different carp strains used in both experiments.

Exp 1. Strain	Sex	Wt. 145 dph (g)	Exp 2. Strain	Sex	Wt. (g)
E4E5 x R3R8	XY	84.7 ± 1.8	E4E5 x R3R8	XY	84.6 ± 2.0
E4	XX	80.7 ± 5.9	41DF x R3R8	XY	88.0 ± 1.8
E5	XX	96.2 ± 6.7	0DD0 x R3R8	XY	91.1 ± 2.5
R3R8	YY	75.5 ± 6.8	EB9E x R3R8	XY	85.8 ± 1.2

Parents R3R8 : homozygous male (YY), inbred strain, Polish/Hungarian origin E4 : homozygous female (XX), inbred strain, Dutch origin E5 : homozygous male sex-reversed (XX), inbred strain, Dutch origin
E4E5 : isogenic progeny of E4 x E5
41DF, 0DD0, EB9E : homozygous inbred strains selected for high, high, low cortisol response to cold shocks

Experimental Procedures and Analyses

Each carp strain was reared separately in duplicate tanks containing 20 – 30 fish each. The net confinement procedure used was described previously (Ruane et al., 1999). Plasma cortisol levels were measured by radioimmunoassay (Tanck et al., accepted) and statistically analysed using the parametric general linear model procedure (SAS Institute Inc.) with a Tukey test as post test determining differences with the control 0-h values and between the strains at each sample point.

Results and Discussion

Environmental effects

The standard strain (E4E5 x R3R8) included in both experiments as a control showed a similar growth rate (Table 1) and also had a comparable cortisol response to the confinement stressor indicating that the environmental differences between each experiment were minimal. These data support the

suggestion by Bongers et al. (1998) that genetically uniform fish perform in a predictable manner under similar environmental conditions.

Genetic effects

Net confinement induced a significant increase in plasma cortisol levels in all carp strains tested (Figs 1A & B). Significant differences were found in the cortisol response between the strains in experiment 1, but not in experiment 2.

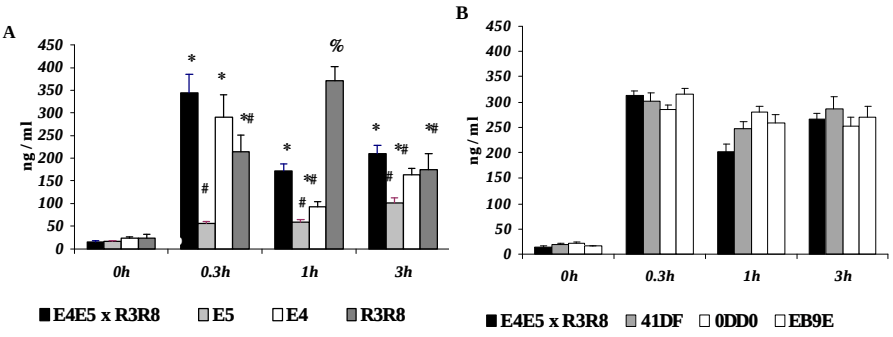

Fig 1. The effect of a 3-h net-confinement on plasma cortisol in different strains of common carp. Values are means ± SEM, n = 5-10. Different symbols indicate significant differences at that sample point. All confined cortisol levels (0.3, 1 and 3 h) are significantly higher than the respective 0 h controls.

The female fish used in experiment 2 had previously been selected based upon a high or low cortisol response to a temperature shock (Table 1, M. Tanck & J. Komen, unpubl. data). Crossing with the R3R8 male which appeared to have a higher response (Fig. 1A) eliminated this effect. However it may also be possible that selection for a response to one type of stressor (e.g. cold shocks) may not necessarily be similar for another type (e.g. net-confinement). Further work will be carried out to determine the underlying mechanisms for the different cortisol responses in experiment 1 and whether this conveys significant benefits/costs in physiological performance.

Acknowledgements

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