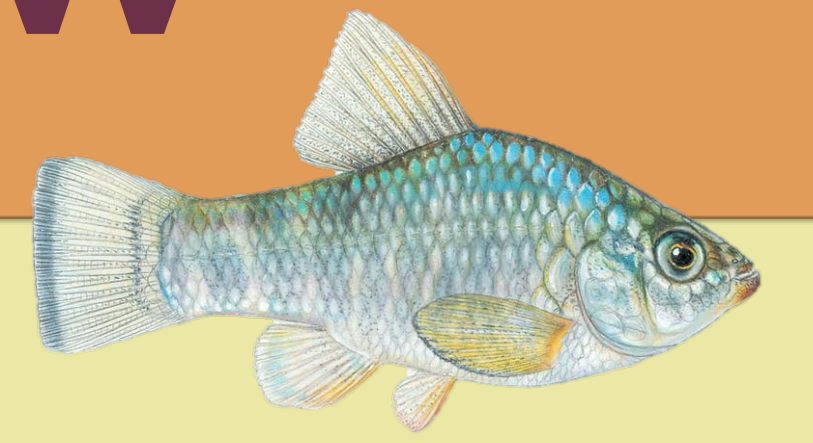# EXPERIMENTAL VENUE AFFECTS GROWTH RATE AND BODY SHAPE IN THE SHEEPSHEAD MINNOW

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Abstract

When designing experiments, the choice of venue or housing is typically not given much thought (at least in ichthyological research). Anecdotal accounts, however, suggest the choice of aquarium or container size could influence the phenotype of the studied individuals. To empirically assess whether this is something to be concerned about, we tested how cage size influenced growth and body shape of the sheepshead minnow, *Cyprinodon variegatus*, a common east coast estuarine fish. We grew individuals over the course of 8 weeks in 3 cylindrical chamber sizes (diameter small=50 mm, medium=85 mm, large=135 mm; n=15 per treatment). We photographed and digitally measured fish weekly for length estimation and at the end of the experiment for geometric morphometrics analysis. Chamber size influenced both growth rate and body shape. Individuals grown in the medium and large containers had similar growth rates, while those in the small chambers had significantly slower growth rates and consequently achieved a smaller final size (~10% smaller). Fish shape differed across all treatments, as individuals grown in large containers featured more prominent humps than the others, fish grown in medium containers were deeper bodied, and small-chamber-grown fish had a narrow body and subdued hump. These results confirmed the importance of rearing venue to life history and morphological traits. We must therefore take proper precautions when undertaking meta-analyses and carefully design hatcheries to avoid undesired phenotypes.

Introduction

Anecdotal evidence from aquarists suggest that fish grow differently depending on aquarium size. This could have important implications for ichthyologists and hatchery/aquaculture managers.

Here, we test whether growth chamber size, independent of other important factors like density, influence growth rate and body shape in a well-studied fish. Sheepshead minnows, *Cyprinodon variegatus*, are common estuarine fish of the US east coast. They are widely used as an ecotoxicology model system, and results from these studies (from various laboratories) are sometimes integrated into meta-analyses.

Methods

15 7-day-old larvae (from laboratory-reared parents) were randomly selected and placed into containers of 3 different diameter sizes (small=50 mm, medium=85 mm, large=135 mm)

3 sea tables were used to house 15 chambers (5 of each size randomly placed throughout)

Fish rearing followed standard protocols (temperature=29 ±1°C, salinity=20.5 ±1 psu, 14:10 L:D cycle, 3x *ad libitum* daily feedings, regular water quality testing, 10% daily water changes)

We photographed the fish weekly and used ImageJ to measure their lengths. After 8 weeks, we euthanized the fish and photographed them laterally for geometric morphometric analysis. 12 landmarks were identified and analyzed.
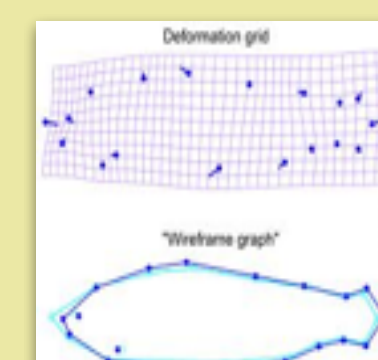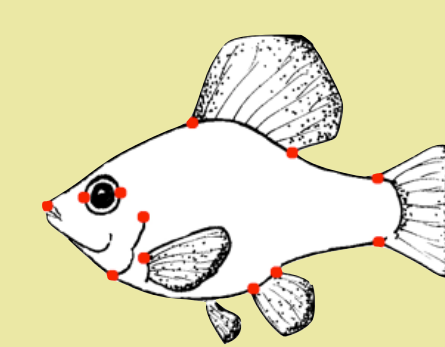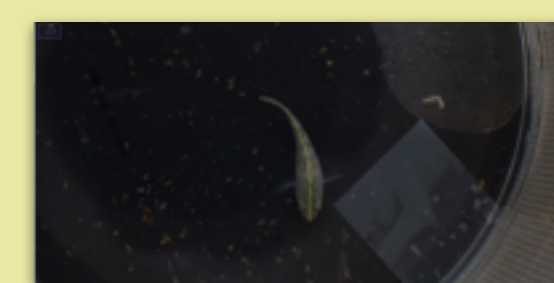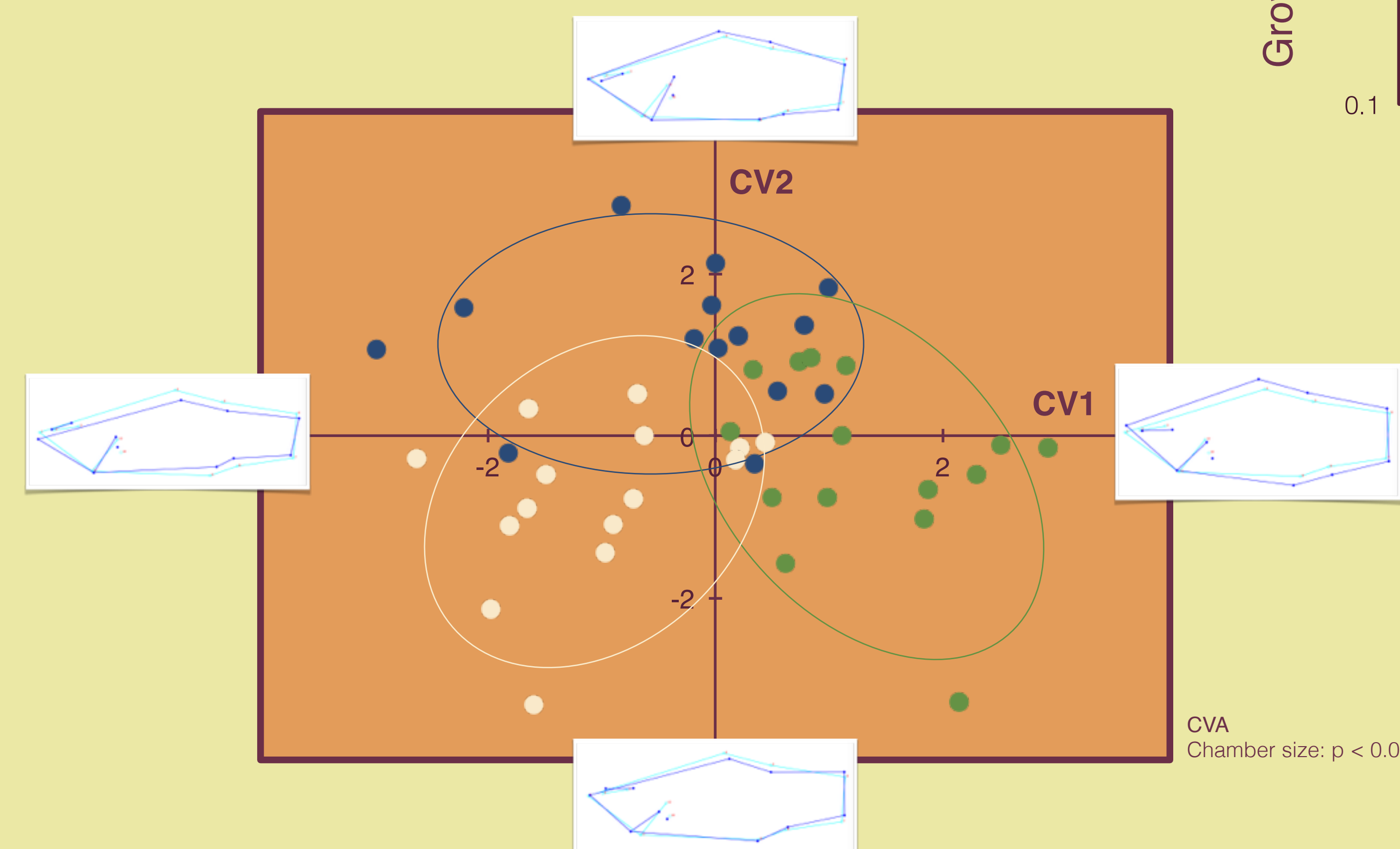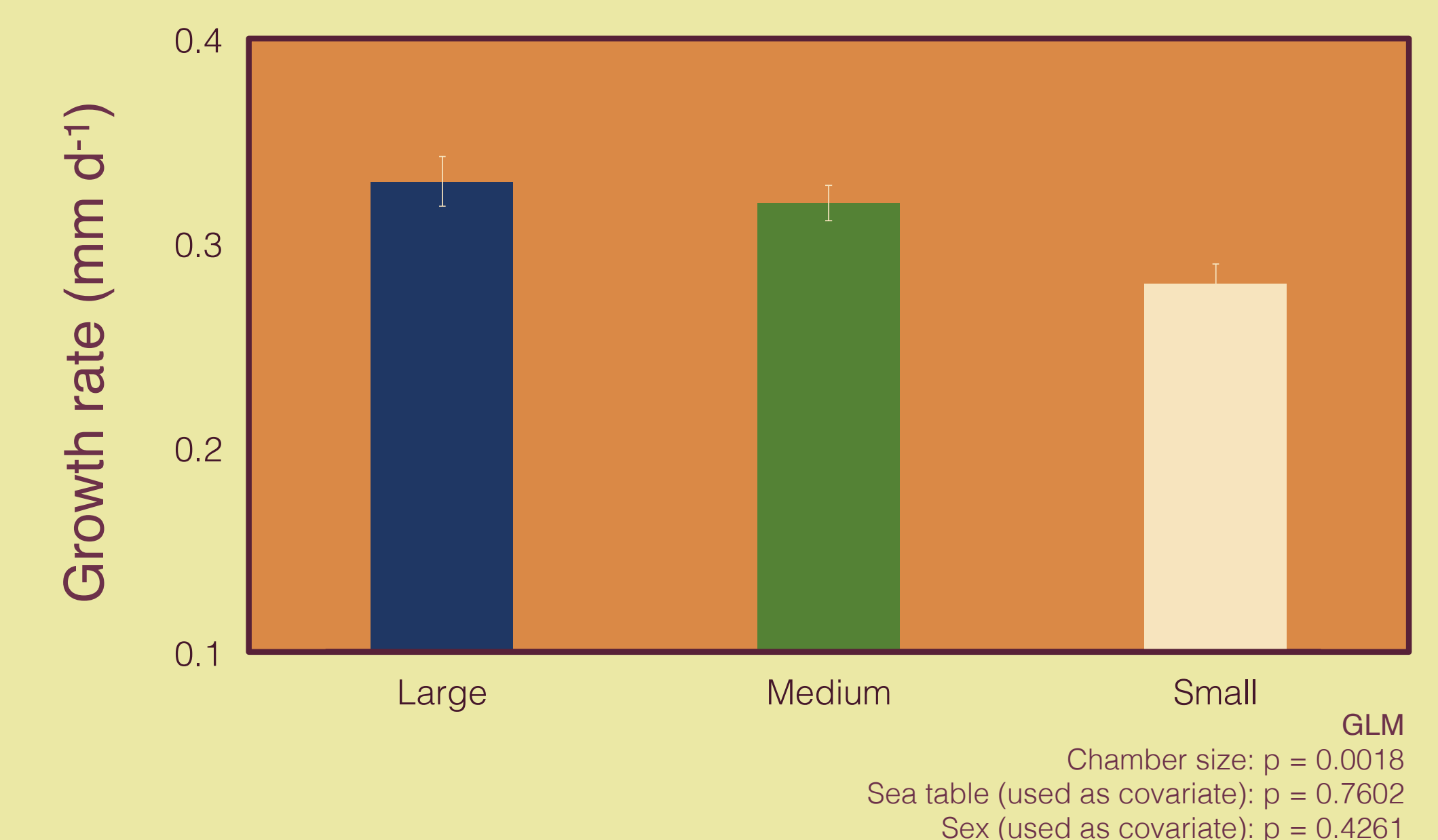
Results
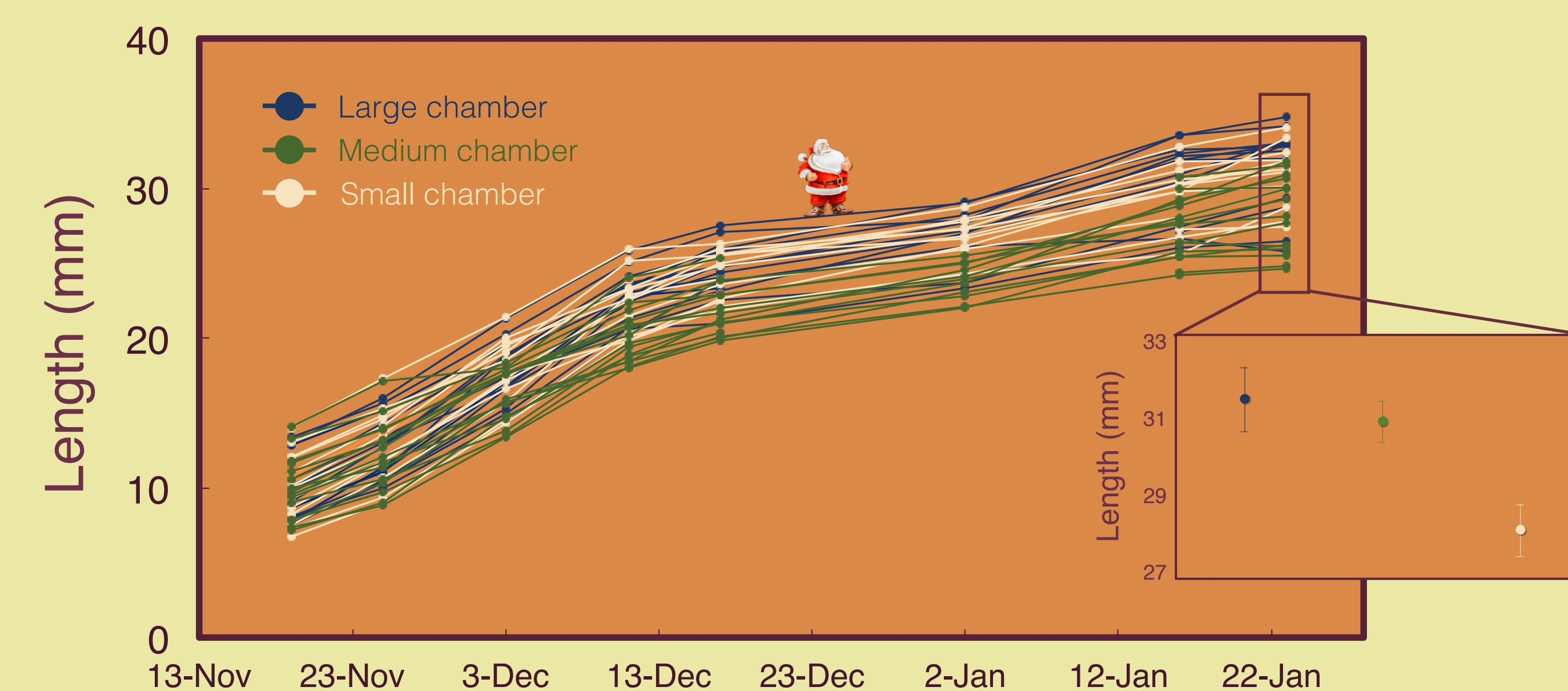
Individual growth trajectories throughout the experiment. Inset shows differences in final size among treatments ±SE (L=31.4 mm, M=30.9 mm, S=28.2 mm)

GLM
Chamber size: p = 0.0034
Sea table (used as covariate): p = 0.3802
Sex (used as covariate): p = 0.9027

Fish grown in large and medium containers showed the fastest growth rates (L=0.33 mm d^{-1}, M=0.32 mm d^{-1}). Growth rate of fish from small chambers was 15% lower (S=0.28 mm d^{-1}).

GLM
Chamber size: p = 0.0018
Sea table (used as covariate): p = 0.7602
Sex (used as covariate): p = 0.4261

Fish in the large and medium chambers were thicker along the body while fish in the small ones were more streamlined and had a narrower body.

CVA
Chamber size: p < 0.0001

Discussion

Size of experimental chamber affects growth rate and body shape in larval sheepshead minnows

Care must be taken when aggregating empirical data from various sources (in, e.g., meta-analyses)

As others have remarked (e.g., Winkler and Van Buskirk. 2012. *Funct Ecol* 26:513-521) it is important to consider constraints and research questions when designing experiments