ECOLOGY LETTERS

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LETTER

Resurrecting complexity: the interplay of plasticity and rapid evolution in the multiple trait response to strong changes in predation pressure in the water flea *Daphnia magna*

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Abstract

A resurrection ecology reconstruction of 14 morphological, life history and behavioural traits revealed that a natural *Daphnia magna* population rapidly tracked changes in fish predation by integrating phenotypic plasticity and widespread evolutionary changes both in mean trait values and in trait plasticity. Increased fish predation mainly generated rapid adaptive evolution of plasticity (especially in the presence of maladaptive ancestral plasticity) resulting in an important change in the magnitude and direction of the multivariate reaction norm. Subsequent relaxation of the fish predation pressure resulted in reversed phenotypic plasticity and mainly caused evolution of the trait means towards the ancestral pre-fish means. Relaxation from fish predation did, however, not result in a complete reversal to the ancestral fishless multivariate phenotype. Our study emphasises that the study population rapidly tracked environmental changes through a mosaic of plasticity, evolution of trait means and evolution of plasticity to generate integrated phenotypic changes in multiple traits.

Keywords

Ancestral reaction norms, contribution of ecology and evolutionary change, evolution of plasticity, maladaptive plasticity, multivariate reaction norms, partitioning plastic and evolutionary trait changes, phenotypic trajectory analysis, rapid evolution, relaxed selection, resurrection ecology.

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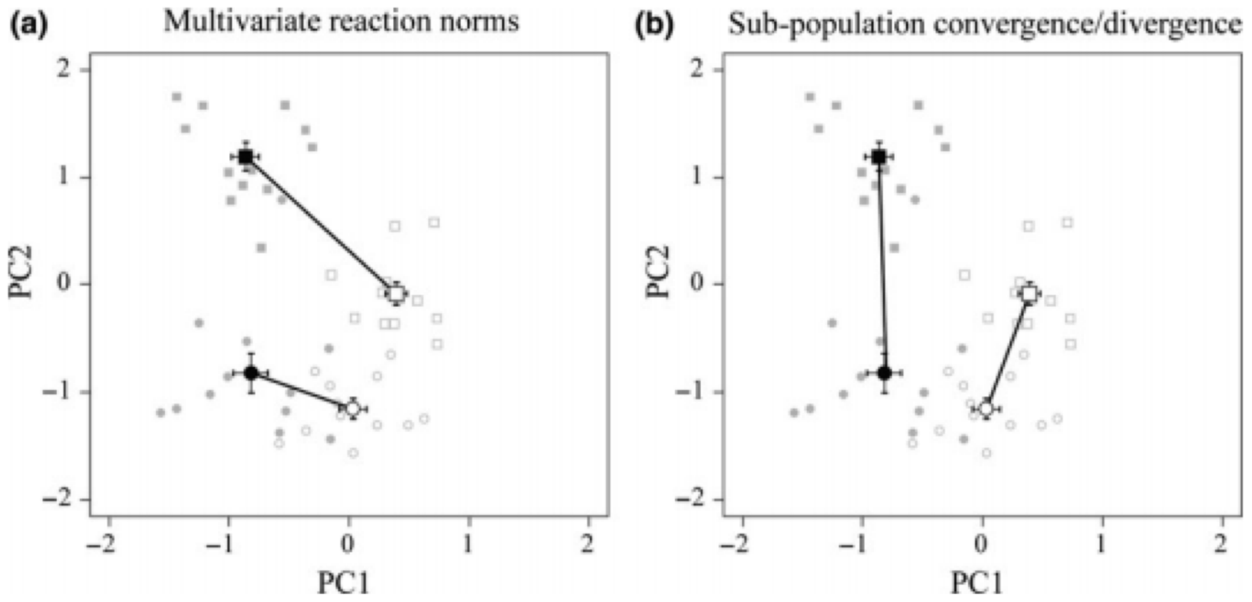

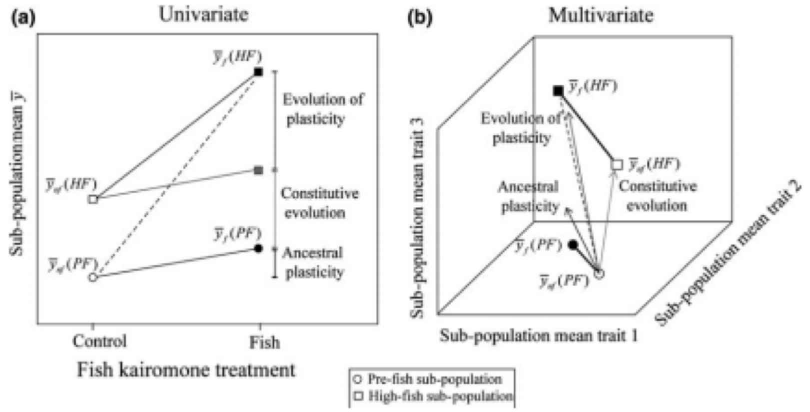

Abstract

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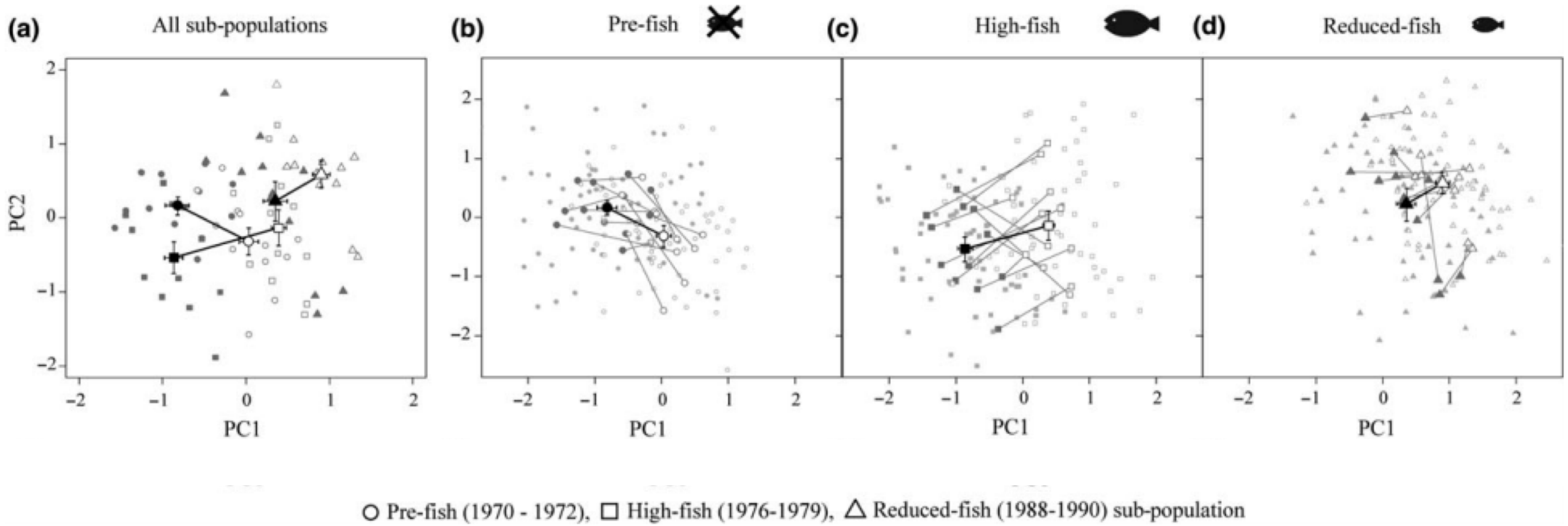

Figure 4 Principal components analysis plots showing as solid lines the phenotypic trajectories (multivariate response to fish kairomones for 14 morphological, life history and behavioural traits) in response to fish kairomones (open symbol: absence, filled symbol: presence) of (a, e) three different sub-populations of *Daphnia magna* representing periods with different levels of fish predation pressure in a natural pond (Oud-Heverlee Zuid), (b, f) the pre-fish *Daphnia* clones, (c, g) the high-fish *Daphnia* clones and (d, h) the reduced-fish *Daphnia* clones. Shown are patterns for PC1 and PC2 (a-d) and PC1 and PC3 (e–f). Both in the absence and in the presence of fish kairomones all sub-populations were differentiated from each other in phenotypic space (for all pair-wise differences between centroids $P = 0.001$).

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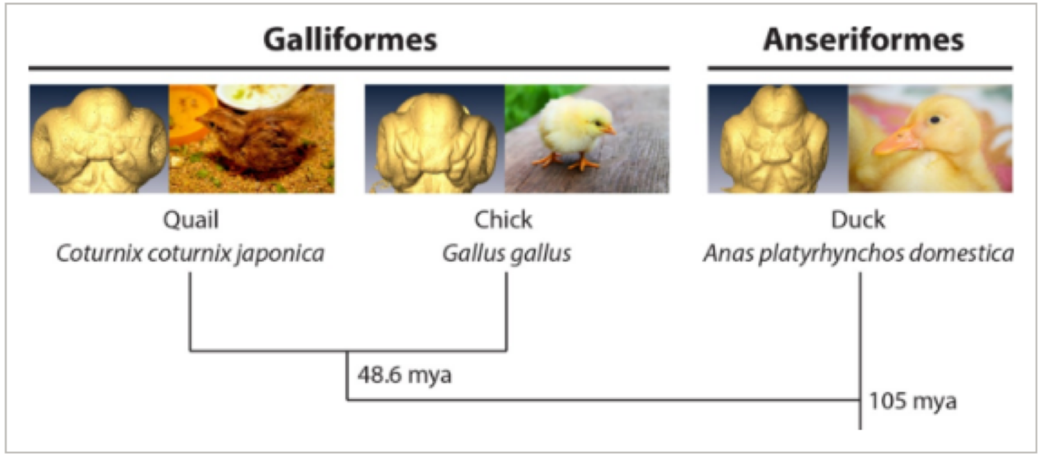

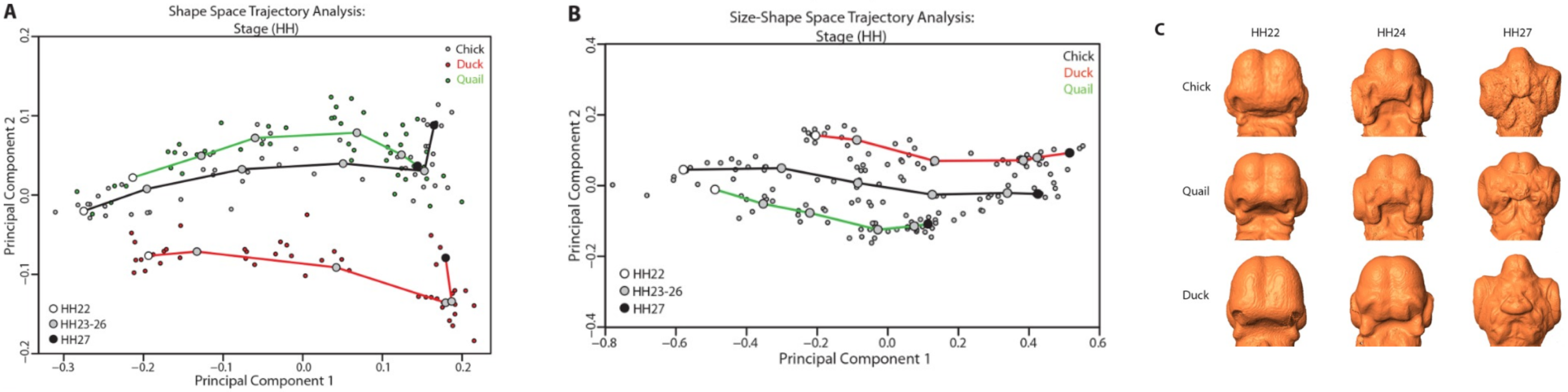

Developmental Dynamics

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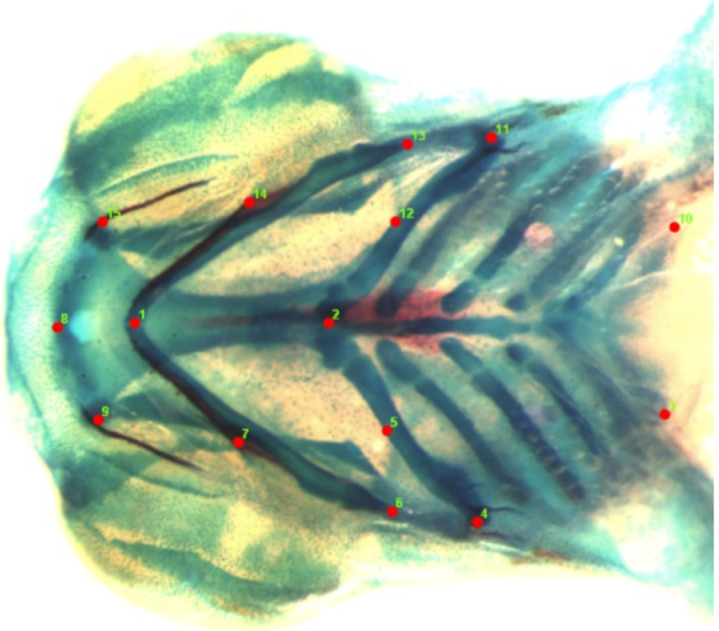
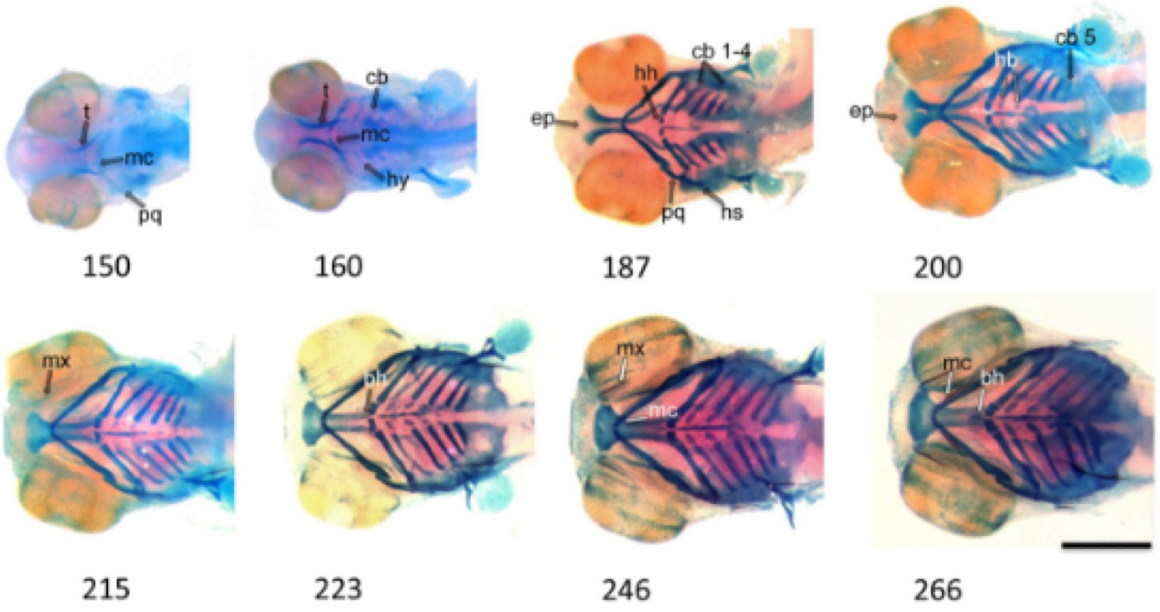
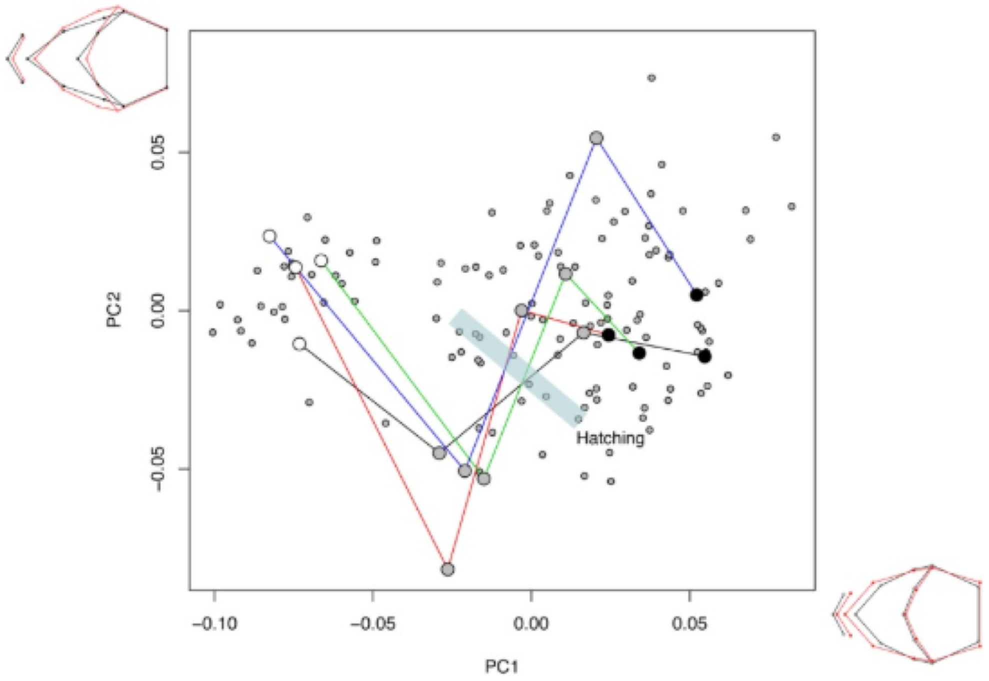
Bones in motion: Ontogeny of craniofacial development in sympatric arctic charr morphs

Kalina H. Kapralova, Zophonías O. Jónsson, Arnar Palsson, Sigrídur Rut Franzdóttir, Soizic le Deuff, Bjarni Kristófer Kristjánsson, Sigurður S. Snorrason







Sympatric ecological divergence associated with a color polymorphism

Henrik Kusche, Kathryn R. Elmer and Axel Meyer

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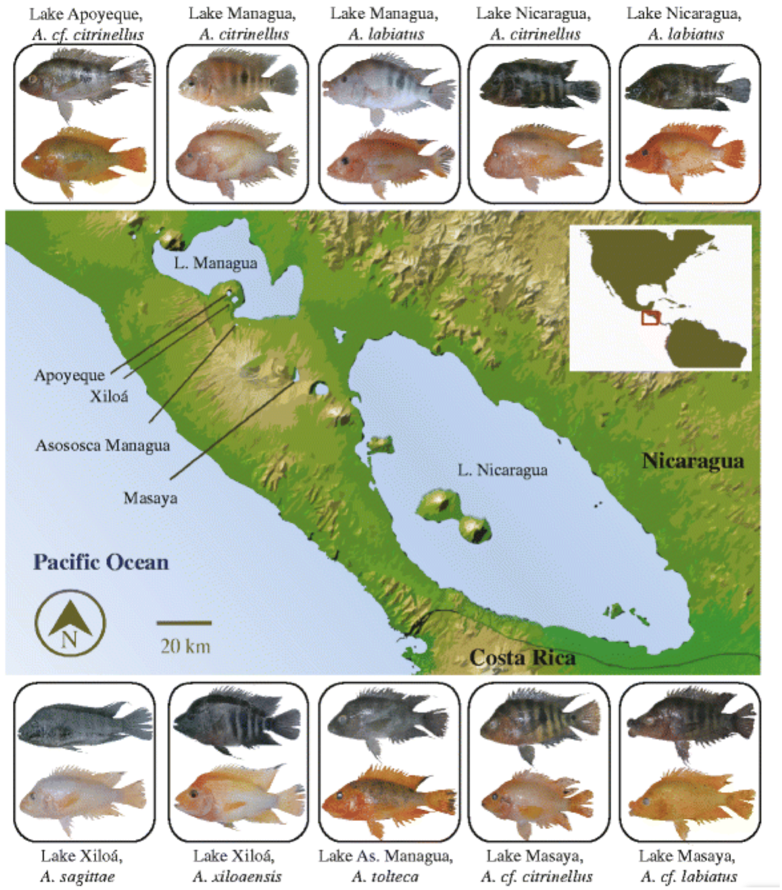

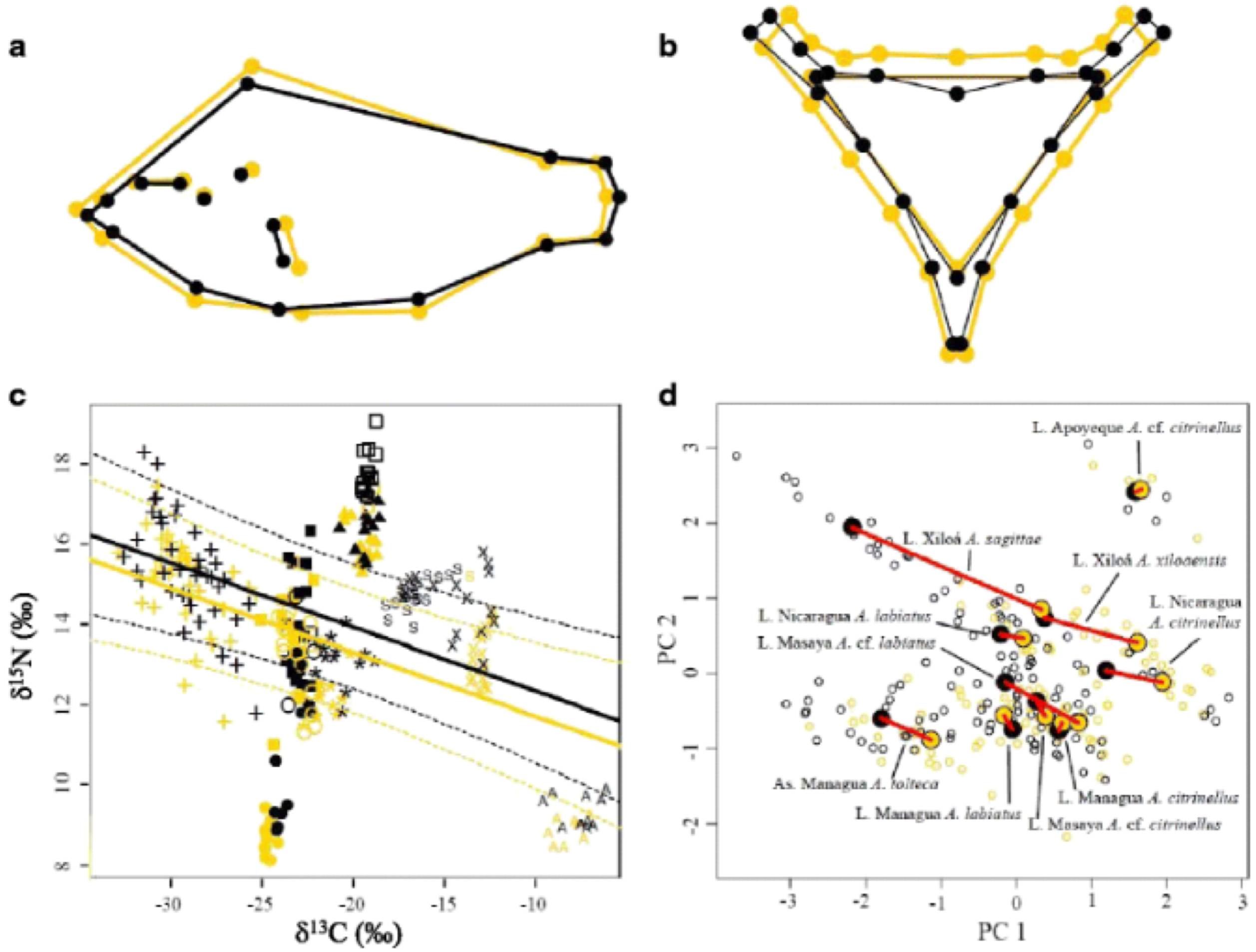

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Article

Retrospective stable isotope analysis reveals ecosystem responses to river regulation over the last century

Thomas F. Turner, Trevor J. Krabbenhoft, Michael L. Collyer, Corey A. Krabbenhoft, Melanie S. Edwards, Zachary D. Sharp

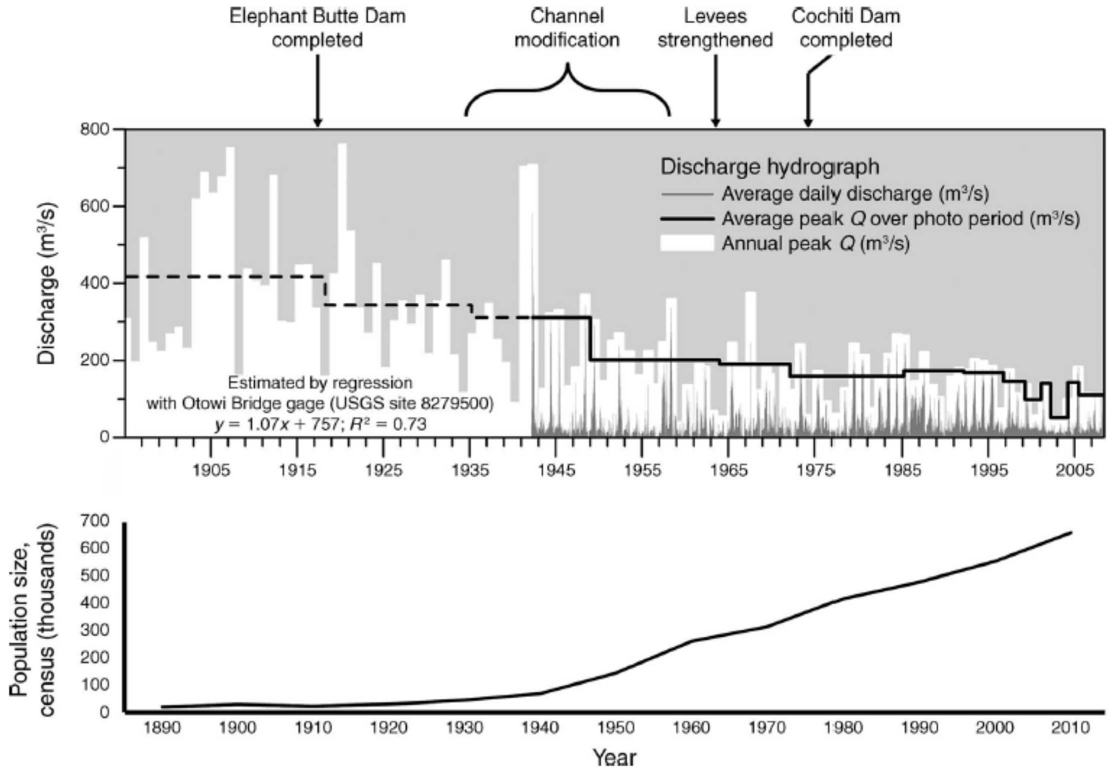

FIG. 1. Changes in river flow regime (discharge; upper panel) and human population size (census number; lower panel) in the Rio Grande Valley since 1890. Discharge values were taken from the Ottowi, New Mexico gage, and summary statistics were compiled in Swanson et al. (2011). Approximate times that regulatory structures were completed or river flow regulation actions were taken are indicated on the time line. Census values were obtained from http://www.census.gov/prod/www/decennial.html

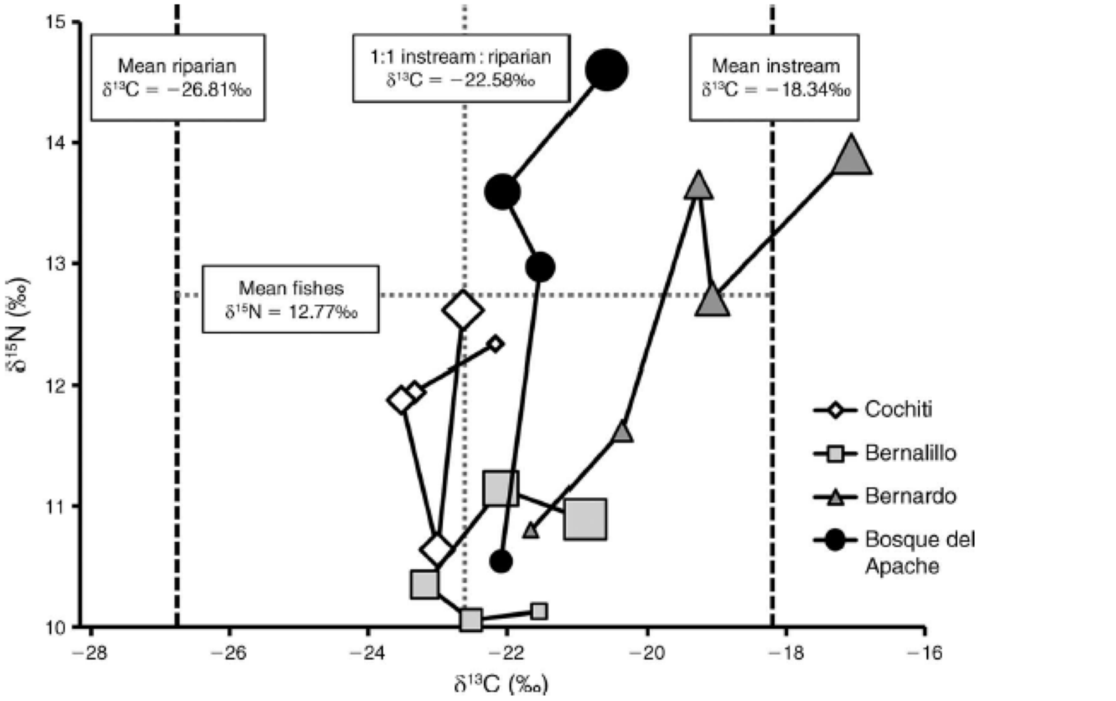

FIG. 6. Trajectories of change in centroid position over time, by locality. This analysis is focused on identifying directional shifts in centroid position in bivariate isotopic space that are predicted when nitrogen is added to the system. Larger centroid symbols are more recent in time. Five time periods are shown for Cochiti, Bernalillo, and Bernardo (from 1939 to 2002). Four time periods are shown for Bosque del Apache (from 1977 to 2002). For reference, vertical dashed lines indicate mean $\delta^{13}C$ values of riparian primary producers, instream primary producers, and the midpoint between these two end points (from Turner and Edwards 2012). The horizontal dashed line indicates mean $\delta^{15}N$ across all fishes in the 2002 sample.

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Quantifying biomechanical motion using Procrustes motion analysis

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