Figures and figure supplements

Rapid diversification associated with a macroevolutionary pulse of developmental plasticity

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Figure 1. Mouth dimorphism and novelty in Diplogastridae. (A) The diplogastrid eurystomatous (Eu) morph, as shown here for *Parapristionchus giblindavisi*, is marked by a wider mouth, larger teeth, and often greater stomatal complexity than the stenostomatous (St) morph. (B) *P. giblindavisi*, St morph. False coloring in (A and B) indicates individual cuticular compartments of the mouth, providing a basis for tracking changes in homologous structures (yellow, cheilostom; blue, gymnostom; red, stegostom except telostegostom). View in (A and B) is right lateral and at same scale. Scale bar, 10 μm. (C) Opposing teeth, shown here for *Fictor* sp. 1, are a structural novelty of Diplogastridae and used for predatory feeding. Visible serrated plates are among other feeding innovations of Diplogastridae. Dorsal is right; scale bar, 5 μm.

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Figure 2. A radiation of feeding structures in diplogastrid nematodes. (A) Phylogenetic relationships inferred for nematodes of Rhabditina, including 54 species of Diplogastridae (Figure 2—source data 1A,B) from an alignment including SSU rRNA, LSU rRNA, and 11 ribosomal protein genes (for Diplogastridae, 468 kb excluding missing data), and RNA polymerase II. History of dimorphism inferred by stochastic character mapping on the set of sampled Bayesian posterior trees (consensus tree is shown). **100% posterior probability (PP); *99% PP. (B) Morphological diversity of mouthparts in Diplogastridae (light blue and white blocks), which are strikingly complex with respect to outgroups (yellow block). The origin of plasticity coincided with a radiation of complex feeding-forms, which variously include opposing teeth, bilateral asymmetry, and additional armature and articulations. In shape, form, and complexity, the mouths of outgroups (Ri, Ce, Hb) are more similar to the St than the Eu morph of dimorphic species. For dimorphic taxa, Eu morph is shown. Two-letter designations abbreviate Linnaean binomials of depicted species.

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Figure 3. Developmental plasticity, morphological disparity, and evolutionary tempo in diplogastrid nematodes. (A) Stomatal morphology and positions of 11 two-dimensional landmarks (taxa coded in Figure 2). Below is a projection of the first two principal components of stomatal shape-space. Purple circles represent non-diplogastrid Rhabditina (Rh), green circles mark monomorphic Diplogastridae (Mn); blue and red circles connected by lines mark St and Eu morphs, respectively, of dimorphic Diplogastridae. (B) Phenotypic disparity of non-diplogastrid Rhabditina (Rh), Diplogastridae (Dip, dimorphic taxa are represented by St morph; Dip*, by both morphs), and individually of St, Eu, and monomorphic (Mn) Diplogastridae, as estimated by the sum of Figure 3. continued on next page
variances on shape- and form-space axes. Bars show mean values from 10,000 bootstrap replicates. Whiskers represent a 95% confidence interval. (C) Model-averaged relative estimates of evolutionary rates, as estimated under a Brownian motion model. Both a two-rate model (left) and a three-rate model (right) are shown (Dm, dimorphic Diplogastridae as represented by St morph). Bars are mean rates calculated across 5000 reconstructions of dimorphism history and 500 trees. Whiskers represent the standard deviation. (D) Rate estimates of stomatal form evolution in Rhabditina. In dimorphic taxa, rates are for St morph. Branch color indicates rates of evolutionary change; posterior rates are color-coded in legend.

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Figure 3—figure supplement 1. Projections of the first two principal components of Procrustes morphospace of stomatal landmarks. In phylogenetic principal components analysis (phylogenetic PCA), dimorphic species are represented by the St morph. Purple circles represent non-diplogastrid Rhabditina (Rh), green circles mark monomorphic Diplogastridae (Mn), red circles, St morph of dimorphic Diplogastridae; blue and red circles connected by lines mark St and Eu morphs of individual dimorphic species. (A) Phylogenetic PCA of form. (B) Phylogenetic PCA of shape. (C) PCA of shape.

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Figure 3—figure supplement 2. Rate estimates of stomatal shape evolution in Rhabditina. In dimorphic taxa, rates are for St morph. Branch color indicates rates of evolutionary change; posterior rates are color-coded in legend.
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Figure 3—figure supplement 3. Posterior densities of rates of stomatal form and shape evolution in Rhabditina. Bars below represent highest posterior density intervals of weighted rate estimates for the groups. Rh, nondiplogastrid Rhabditina; Dm, dimorphic Diplogastridae; Mn, monomorphic Diplogastridae. (A) Rates of change of Procrustes form. (B) Rates for Procrustes shape. Results from analyses of form show both groups of Diplogastridae to have higher rates than monomorphic outgroups, although rates were highest in secondarily monomorphic lineages. Analyses of shape also clearly show higher rates in Diplogastridae as compared with outgroups.
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Figure 4. Correlation of polyphenism and complexity of nematode mouthparts. Painted branches show congruence of simulated character histories of dimorphism (right tree; 0 = absent, 1 = present) and stomatal complexity (left tree; complexity index ranges from 0 to 9). Covariance tests (see text) show that the apparent phylogenetic correlation between dimorphism and complexity is significant.

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Figure 4—figure supplement 1. Tabulating complexity of nematode mouthparts. The complexity index (ci) was tabulated as the sum of all stomatal ‘structures’, that is, geometric deviations marked by a <135˚ vertex from the cylindrical walls of the stoma or from the arched anterior margins of the pharyngeal radii. Tabulated structures are false-colored on illustrations of four example species. Iterative structures and bilaterally symmetrical duplicates were scored as a single structure due to their co-dependence. All aspects are left and lateral unless otherwise specified. Color-coded structures are recorded in Figure 4—source data 1: red, dorsal tooth; pink, right subdorsal denticle; orange, left subventral tooth; yellow, dorsal, basal stegostomatal fold; mauve, gymnostomatal serratae (iterative); dark green, articulated apodeme (bilaterally symmetrical); light blue, radial cheilostomatal divisions (iterative); teal, subventral stegostomatal warts (iterative); purple, left subventral ridge. (A) *Mononchoides* sp. 3 (ci = 8), right lateral aspect. An additional structure (pro- and mesostegostomatal serratae) is not observable from this aspect. (B) *Paroigolaimella micrura* (ci = 3). (C) *Koerneria luziae* (ci = 4). (D) *Fuchsnera halleri* (ci = 1).

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