Research Update

Changing sex at the same relative body size
Allsop , D.J. and West, S.A.
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Sex change invariants

Evolutionary ecologists usually deal with variation. Systems are seldom simple and relationships between quantities of interest are often weak, even when significant. It thus comes as a surprise when an explored relationship turns out to have virtually no scatter, particularly when data derive from diverse studies spanning a range of major taxonomic groups. A recent and most striking case concerns the timing of sex change in sequentially hermaphrodite animals.

Sex change occurs in several invertebrate taxa (echinoderms, crustaceans, molluscs, polychaete worms) and in fish. Some species are male in early life and later change into females, other species exhibit female to male sex change. Sex change is thought to occur because the evolutionary fitness of individuals varies with both size and gender: when individuals are small it pays most to live as a member of one sex but, once they have attained a certain size, fitness can be maximized by switching to being the other sex. One might expect that different directions of sex change and the diversity of sequentially hermaphrodite taxa might lead to a diversity of switch points; but it turns out that sex change occurs when individuals reach 72% of their maximum body size and, to a close approximation, that's it.

Allsop and West calculated the mean relative size at sex change (i.e. average size at sex change [L50] divided by maximum size [Lmax]) using data from 77 species of echinoderms, crustaceans, molluscs and fish. The mean relative size at sex change was 0.72 (95% confidence interval, CI: 0.67-0.77), that is, sex change occurs when 72% of maximum size is attained. If the sex change switch point is invariant across species a regression of ln(L50) against ln(Lmax) should give a slope of 1.0. An independent contrasts analysis, that takes phylogenetic relationships into account, gave a slope of 0.97 ± 0.05 (95% CI) and explained 90.8% of the variance in size at sex change. An analysis using species as independent data points gave a slope of 1.05 ± 0.03 (95% CI) and explained 96.7% of the variance. Explanations of 91-97% of variance are unusual: indeed studies in ecology and evolutionary biology can generally only explain 2.5-5.4% [see Møller and Jennions (2002) Oecologia, 132].

Allsop and West's taxonomically broad study has its roots in a comparison of sex change in populations of a single shrimp species. Similarly, nearly all of the variance was explained and a simple switching rule identified. Both studies used a dimensionless variable, L50/ Lmax, which facilitates comparison by converting data on body size from an absolute to a relative scale. This dimensionless approach is clearly useful for detecting generalities in the life-history patterns of taxonomically, physically and behaviourally diverse organisms.

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