Shape, fit of reproductive organs evolve quickly and in concert, leaving size behind

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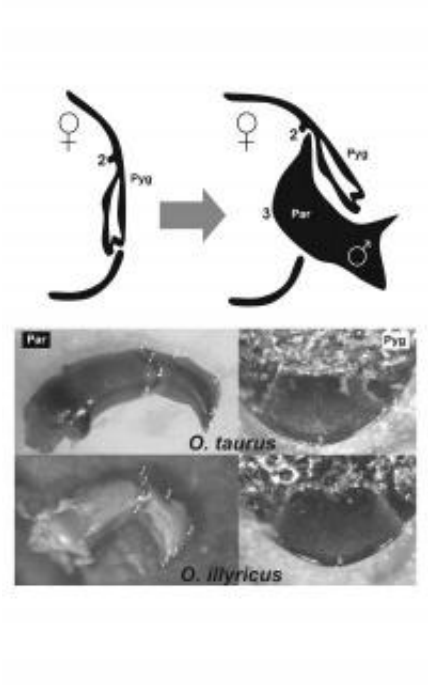

Drawing, top left, shows side view of abdomen of female without a male copulatory organ inserted, and at right, with inserted organ. Structure labeled Par is the male paramere; Pyg is the female pygidium. Bottom photos, left, show copulatory organ of male Onthophagus taurus and O. illyricus and, right, underside of female pygidium of each species. Credit: Indiana University Department of Biology

Believed critical for determining which individuals can -- or cannot -- successfully reproduce with each other, genitalia not only figure

prominently in the origin of new species, but are also typically the first type of trait to change as new species form.

Today, new international research led by Indiana University shows that as populations and species diversify, the exact shape and fit of genitalia steals the show over size.

In data gathered from populations isolated for less than 50 years, to species separated for millions of years, researchers studying scarab beetles have shown that both male and female genitalia have evolved extremely rapidly and have done so along parallel timetables. But most surprisingly, this codivergence occurred much faster in, or was even restricted to, genital shape rather than size.

"Parallel evolutionary divergence in male and female genitalia was something scientists long suspected or assumed, but we've had little or no data to support this assumption," said lead author Armin Moczek, an associate professor in the IU Bloomington College of Arts and Sciences' Department of Biology. "But to see that this parallel divergence is so much faster for genital shape than size is a big surprise."

Too much focus in past research on sizes, rather than shapes of genitalia -- which is much harder to measure in arthropods -- may have misled past research in judging how genitalic evolution may enable diverging populations to evolve into separate species unable to hybridize.

Just as interesting is the remarkably short time frame -- as short as populations being separated by 50 years -- that would support the notion that it may be surprisingly easy for the genitalia of males and females to evolve concomitantly, and for males and females of different populations to diverge from each other to a degree approximating what is normally seen only between species separated for more than 10,000 years.

"If it is correct that such divergences aid in establishing reproductive isolation -- something we did not test, but which is widely assumed -- then by extension this finding suggests that evolving new species, or at least getting populations started in the process, may be much easier and faster than we generally assume," Moczek said.

In this research, the team examined the female genital tract and the male copulatory organs of eight populations of five different species of Onthophagus beetles, including three populations in the Eastern U.S., Western Australia and Eastern Australia which were established from an ancestral Mediterranean population in the 1970s as part of a biocontrol program.

The researchers focused on male and female genitalic parts that interact physically during copulation -- the female pygidium, a moveable plate that provides grooves and pits that serve as anchor points for the correct positioning of male genitalia, and the male parameres, part of the male copulatory organ, which includes projections that fit into said grooves and pits of the female pygidium.

The research team then examined how shapes and sizes of these interacting female and male copulatory structures had diverged across populations and species using landmark-based geometric morphometric tools, a key methodology that enabled the team to examine differences in shape irrespective of differences in size.

"Once we compared the patterns of divergence across sexes we found that the relative sizes of male and female copulatory organs do evolve, but do so independent of each other. But for genital shape, we found a striking signature of parallel divergence, suggesting that male and female copulatory structures that are linked mechanically during copulation may diverge in concert with respect to their shapes," Moczek said. "Our results also suggest that genital divergence in general, and co-divergence

of male and female genital shape in particular, can evolve over an extraordinarily short time frame."

Provided by Indiana University