

Ecosystem Function and...

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Ecosystem Function and...

CONSUMER DIVERSITY

We know diversity is essential to a functioning ecosystem, particularly in changing environments, but what isn't known is how many (or which) species an ecosystem can lose before it is altered irrevocably. Is the need for diversity due to the need for recruitment of a few key species, or the need for an assortment of species to perform complementary functions, or some combination of the two? Ecologists have devoted considerable attention to these questions in recent years, and a new study on community structure in coral reefs adds another important piece to the puzzle.

In two yearlong experiments, Georgia Institute of Technology biologists Deron Burkepile and Mark Hay followed the impact of herbivorous fish diversity on macroalgal and coral reef communities (21 October, *Proceedings of the National Academy of Sciences* or *PNAS*). Enclosures containing equal densities of single or mixed herbivore species, and controls with no herbivores, were set up in replicate on a reef in the Florida Keys. The biologists studied redband parrotfish and ocean surgeonfish (year 1) and redband parrotfish and princess parrotfish (year 2), and measured macroalgal abundance and coral growth.

In enclosures with mixed herbivore species, upright macroalgae were reduced dramatically in both cover and biomass compared with single-species treatments and controls. Corals in the mixed-species treatments survived and grew in direct correlation to the extent to which macroalgal cover was reduced, whereas in single-species treatments and controls, coral mortality increased and coral area declined.

Burkepile and Hay have shown that herbivore consumer diversity affects reef community structure through complementary resource use, allowing corals to thrive by reducing macroalgal cover, biomass, and diversity. Managing marine ecosystems to restore diverse and ecologically critical fish populations, say the authors, may preserve coral reefs from further decline and hasten their recovery.

REMOVING A CONSUMER

Catastrophic amphibian declines are another example of the impact of lost diversity on ecosystem structure and function. What happens to primary producers in streams, for example, when an entire group of consumers—amphibian tadpoles—is removed? A group of scientists from five US universities was in the process of answering that question when the frog-inhabited stream they were studying suffered a 90% die-off of amphibians. University of Georgia graduate student Scott Connelly is first author of the study, which appears in the 23 September online edition of *Ecosystems*.

The original experiment was designed to compare algal communities growing on the submerged surfaces of two upland Panamanian streams, one stream with its frog populations intact and one that had already experienced a catastrophic loss of amphibians from a fungal pathogen. Electric enclosures and non-electrified controls were placed in both streams to assess algal growth in the absence and presence of tadpoles. Before the experiment was interrupted by another fungal outbreak, the results demonstrated that grazing tadpoles significantly alter algal composition and increase net primary production (on a per-biomass basis) of streams. The explanation for this is that tadpoles stir up and perhaps ingest sediment that otherwise accumulates on algal communities; the differences between treatments placed in pools as compared with riffles supported this explanation. The enclosures did not differ from tadpole-accessible controls in the frogless stream, where there were no tadpoles.

After the fungal outbreak and decline of frogs in the stream with frog populations, the scientists continued to follow changes in the algal community composition. The community of small adnate (closely attached) diatom taxa was replaced by a community with a higher percentage of large upright taxa. Net primary production (on a per-unit-area basis) in the formerly frog-filled stream went up more than scientists expected,

judging from the small-scale enclosure treatments. The frogless stream, which has had years to adjust to life without tadpoles, showed levels of algal community structure and function intermediate to that of the pre- and postdecline frog stream, indicating that other consumers had not wholly replaced tadpoles in function.

IDENTIFYING A CULPRIT

How the pathogen responsible for many of the massive amphibian declines in recent decades, the chytrid fungus *Batrachochytrium dendrobatidis*, attacks its host is not well understood. To get a handle on the mysterious killer, molecular biologists led by Erica Bree Rosenblum, of the University of Idaho, have now sequenced and begun functionally analyzing its genome (13 October online edition of *PNAS*).

The life cycle of *B. dendrobatidis* comprises two main life stages: the swimming, free-living, unattached zoospore stage, and the substrate-dependent, skin-eating, zoospore-producing sporangia stage that lives on amphibian hosts. The scientists created probes for 8255 of *B. dendrobatidis*'s 9000 genes; more than half of the genes studied (55%) showed differential expression between free-living (16%) and substrate-dependent (39%) stages. A number of invariant genes, which are equally expressed in both stages, were also identified (18%).

The scientists also characterized the expression of identifiable gene families, most notably those with a possible role in pathogenicity. Two peptidases, fungalsin metallopeptidase and serine-type peptidase, are possible candidates showing differential expression; both have been associated with pathogenicity in other fungi and have undergone large expansions in the genome of *B. dendrobatidis*. The next step is to look at how these genes behave in the presence of host tissue.

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