Smaller islands host shorter food chains

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Figure legend: The diversity of herbivore species (here: moths and butterflies) generally decreases with decreasing island size. From the smallest islands, the topmost links in the food chain (i.e. the predators feeding on the herbivores) may simply fall off. The picture shows a tenth of the herbivores encountered by the scientists. Credit: Pekka Malinen

That smaller islands will typically sustain fewer species than large ones is a widespread pattern in nature. Now a team of researchers shows that

smaller area will mean not only fewer species, but also shorter food chains. This implies that plant and animal communities on small islands may work differently from those on large ones.

Top predators the first to go

Working across a set of 20 islands off the Finnish coast, a group of Finnish scientists found that a disproportionate number of small islands were lacking the highest levels of the food chain. The results are freshly online in the journal *Ecography*.

"Ecologists have known for decades that less area means fewer species", explains Tomas Roslin, who spearheaded the current analyses. "What we show is that the decrease in species richness with decreasing area gets steeper when you climb up the food chain. That means that when you move towards smaller island size, you run out of top predators before you run out of intermediate predators, and that you lose the last plant-eaters before you lose the last plant."

The study comes with broad implications for a world shattered by human activities. "While we worked on a set of real islands, you can probably think of habitat fragments as 'islands' in a broader sense", says Tomas. "What our results then mean is that if we keep splitting natural habitats into smaller and smaller pieces, we may not only lose a lot of species from the resultant fragments, but also change the structure and functioning of local food webs."

Knowing your species the key to insights

To explore the effects of island size, the research team focused on islands spanning a hundred-fold range in area. On each of these islands, the team took samples of local food chains consisting of four levels:

plants, predators feeding on the herbivores, and top predators feeding on the predators themselves.

Among predators, the researchers targeted a specific group, i.e. parasitic wasps. "To test ideas about food chain length, you really cannot deal with raw counts of species – instead, you need to know which species form actual feeding chains" says Gergely Várkonyi, an international expert on wasps involved in the project.

"Among the wasps encountered on these islands, we were able to pick out the species truly dependent on the lepidopteran herbivores. As we see it, knowing not just what the species are but what they do in their lives is the key to sensible ecology", emphasizes Gergely.

Hundreds of species examined

"What is unique about our study is that we were able to look at patterns at the level of large species pools across the islands", explains Marko Nieminen, who spent three long summers boating around the islands, sampling insects by light and bait traps.

"Where other people have looked at effects of island size on restricted numbers of species or restricted levels in food chains, we did the full thing across four levels", he specifies. "Overall, we dealt with 200 species of plants, 415 species of lepidopteran herbivores, 42 species of parasitic wasps attacking herbivores and 7 species of wasps attacking parasitic wasps."

Deliberately keeping things simple

"In choosing the islands, we deliberately went for a simple system" says Marko. "Our islands were essentially smallish pieces of rocks with some

forest and heathland on them. Historically, they all rose from the sea just some millennia ago, after being submerged and scraped clean of life by the last ice age. This similarity in structure and history allowed us to look at effects of island size, without having to worry about other differences among islands."

Maintaining interactions may be trickier than maintaining species

All three authors worry about the message laid plain by the study: "What this really suggests is that to save ecological interactions, we may need to conserve much larger areas than for just maintaining e.g. plant diversity. If we keep splitting habitats into ever-smaller pieces, then we will be losing upper links from food chains, and important control functions along with them."

More information: Roslin, T., Várkonyi, G., Koponen, M., Vikberg, V., & Nieminen, M. 2013. Species–area relationships across four trophic levels – decreasing island size truncates food chains. *Ecography* DOI: 10.1111/j.1600-0587.2013.00218.x

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