Journal of Animal Ecology 2000, **69**, 1–15

Predators, parasitoids and pathogens: species richness, trophic generality and body sizes in a natural food web

J. MEMMOTT*, N.D. MARTINEZ† & J.E. COHEN‡

*Leverhulme Unit, NERC Centre for Population Biology and International Institute of Biological Control, Imperial College, Silwood Park, Ascot, SL5 7PY, UK; †Romberg Tiburon Center, Department of Biology, San Francisco State University, POB 855, Tiburon, California 94920, USA; ‡Rockefeller and Columbia University, 1230 York Avenue, New York, NY 10021, USA

Summary

1. A food web is presented which describes trophic interactions among the herbivores, parasitoids, predators and pathogens associated with broom, *Cytisus scoparius* (L.) Link. The data come from published work on the community at a single site. The web comprises a total of 154 taxa: one plant, 19 herbivores, 66 parasitoids, 60 predators, five omnivores and three pathogens. There are 370 trophic links between these taxa in the web. The taxa form 82 functionally distinct groups, called trophic species.

2. Predators consumed significantly more species than did parasitoids: a median of two prey species per species of predator (range = 1–9), compared to a median of one host species per species of parasitoid (range = 1–4). Significant differences in the number of species consumed were also found among the five predator groups: birds (median = 4), spiders (median = 5), Coleoptera (median = 1), Diptera (median = 2) and Hemiptera (median = 7).

3. Vulnerability, measured by numbers of consumer species, was significantly affected by the herbivores' feeding styles: externally feeding herbivores were most vulnerable and the concealed herbivores were least vulnerable. Miners were vulnerable to the most parasitoid species and externally feeding herbivores were the most vulnerable to predators.

4. Resource species had a median vulnerability of 13 consumer species, a figure far higher than that in most published food webs. No significant relationship was found between species' vulnerability to predators and vulnerability to parasitoids. However, there was a strong negative relationship between the percentage mortality due to predation and percentage mortality due to parasitism.

5. The broom food web contains nine orders of insects, a figure higher than previously recorded. The web also contains vertebrates, arachnids, bacteria and fungi. Most of the interactions between the orders were weak. Connectance was calculated for the complete web, the parasitoid sub-web and the predator sub-web. The connectance of the predator sub-web, a value of 0·0364, was more than an order of magnitude larger than the connectance of the entire web (0·0156) or the parasitoid sub-web (0·018).

6. The body lengths of 52 species in the food web were estimated from field guides or museum specimens. Larger predators consumed smaller prey in 93% of predator–prey interactions. Smaller parasitoids consumed larger hosts in 79% of parasitoid–host interactions. Parasitoids were significantly smaller than predators.

7. The 52 species were arranged in order of increasing body length along the columns and down the rows of a food web matrix. The predator sub-web was predominantly upper triangular with 8% of non-zero elements falling below the leading diagonal. The parasitoid sub-web was predominantly lower triangular with 21%

Correspondence: J. Memmott, School of Biological Sciences, Woodland Road, Bristol, BS8 1UG, UK. Fax: 01344 873173. E-mail: Jane.Memmott@bris.ac.uk