1 Compilation of networks and metric validation

We compiled plant-herbivore networks from published sources as described in the main text. Supplemental Table 1 lists publications used in compiling these networks.

Researchers have put forward to set of “network metrics," including nestedness (Bascompte et al., 2003; Ulrich et al., 2009) and modularity (Newman & Girvan, 2004; Olesenet al., 2007), to understand the complex structure of ecological networks. Null models are used to evaluate the statistical significance of these metrics and to compare between networks of different size (Ulrich et al. 2009). We compare the results derived from two common null models: the “probabilistic null" of Bascompte et al. (2003) and the “fixed-fixed null" (Ulrich et al., 2009). The “probabilistic null" uses the relative degree distributions of plants and herbivores as weights while randomizing links, but suffers from high Type II error (Ulrich et al., 2009). The “fixed-fixed null" (Ulrich et al., 2009) maintains the exact number of links assigned to each species while randomizing which interactors fill the requisite set of links, but suffers from high Type I error (Ulrich et al., 2009). We find that using these different null models does not change any trends in our network statistics across the Hawaiian chronosequence but different null models do influence the sign and significance of the network metrics (Fig. 1). We therefore do not interpret the sign or significance of the metrics but only their relative trends across site age.

Because these networks are based on opportunistic data associated with species descriptions and not based on standardized ecological surveys, we cannot interpret patterns in network metrics without evaluating possible sampling biases (Nielsen & Bascompte, 2007; Gibson et al., 2011; Rivera-Hutinel et al., 2012). To do so we rarify networks by the number of Hemiptera species included and, for each subsampled network, re-calculate nestedness and modularity z-scores. This rarefaction procedure shows that nestedness is very sensitive to network size (Fig. 3), a known property of nestedness (Nielsen & Bascompte, 2007; Gibson et al., 2011; Rivera-Hutinel et al., 2012). However the relative nestedness z-scores across networks remain qualitatively similar to those observed for the complete networks (Fig. 3). Modularity depends on network size in a more variable way (Fig. 3). Modularity is expected to decrease with network size (Rivera-Hutinel et al., 2012) and so the marked increase in modularity with network size on Haleakala is unexpected. However in light of the large number of highly specialized taxa this pattern is more reasonable if most species only have within module links then removing these species through subsampling will only reduce overall modularity. Thus this pattern speaks to the high level of specialization on Haleakala, and to a lesser extent at Kokee, which also shows a slight increase in modularity with network size (Fig. 3).

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