The sudden collapse of pollinator communities

— Supplementary material —

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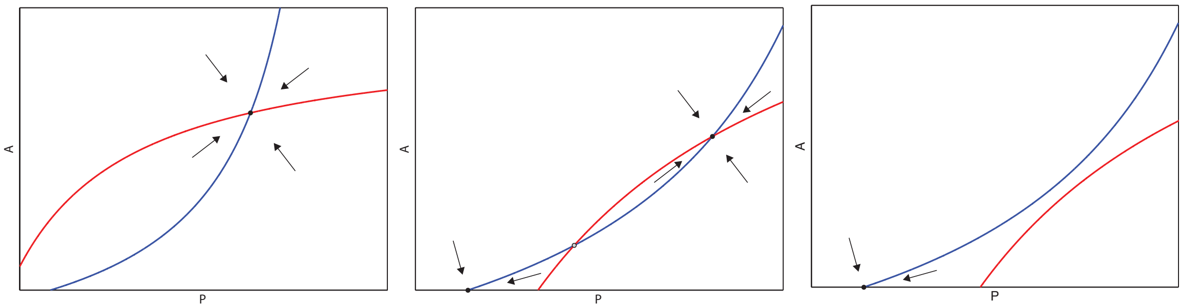

(a) $d_A < r_A$ (b) $d_A > r_A$ (c) $d_A >> r_A$

Figure S1: Nullclines of two mutualistically interacting species. Filled dots indicate stable equilibria, open dots indicate unstable equilibria. Fundamentally different configurations exist when (a) the driver of pollinator decline, d_A, is smaller than intrinsic growth rate r_A, (b) when the driver of pollinator decline, d_A, is bigger than intrinsic growth rate r_A and, (c) when the driver of pollinator decline, d_A, is substantially larger than intrinsic growth rate r_A. By increasing the driver of pollinator decline, d_A, we change from a regime with one stable state, presented in *a*, to the regime with two alternative stable states presented in *b*, until eventually a tipping point is reached where pollinators collapse to extinction. For a further analysis of models with two mutualistically interacting species see May (1978), Dean (1983), and Wright (1989).

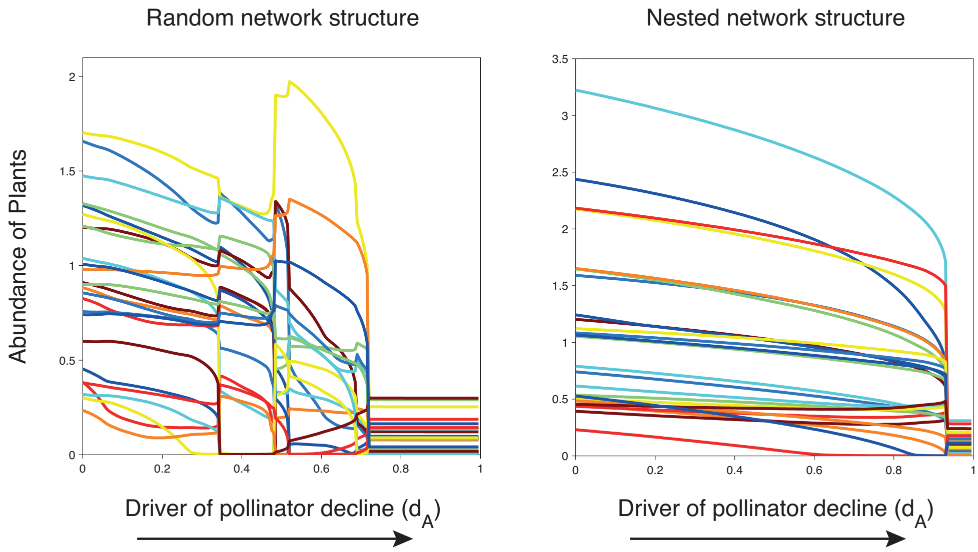

Figure S2: Collapse of plant populations when *increasing* the mortality d_A of pollinators. Results are shown for a random (left) and a nested (right, N=0.6) network. Parameter settings are the same as in figure 2.

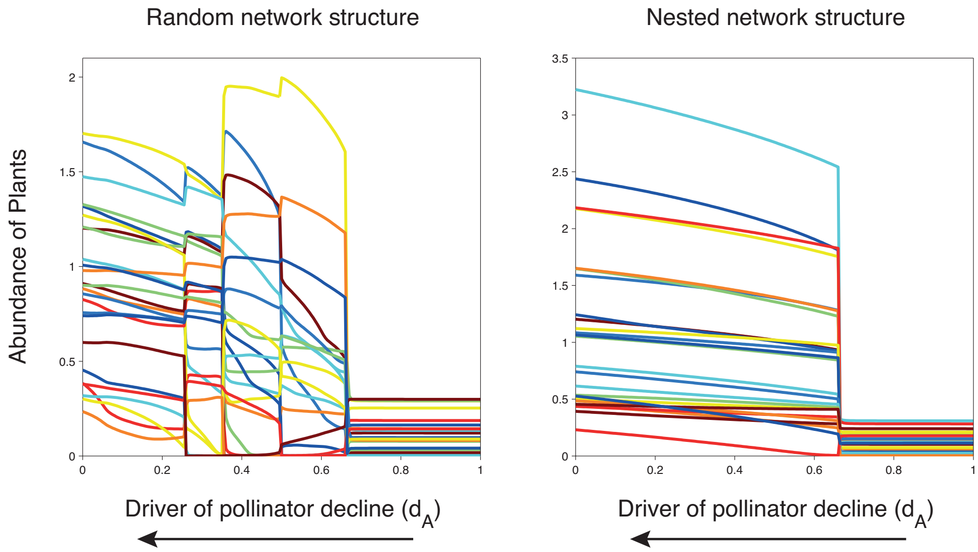

Figure S3: Re-establishment of plant populations when *decreasing* the mortality of pollinators d_A. Results are shown for a random (left) and a nested (right, N=0.6) network. Parameter settings are the same as in figure 3.

SUPPLEMENTARY MATERIAL 3

We tested the extent to which our results depend on the specific number of species, connectance or fraction of forbidden links chosen (see figure S4, S5, S6 and S7).
Furthermore, we show in figure S8 and S9 what our results look like if we do not allow any species to have less than 2 partners during any step of the algorithm we used to generate nested networks.
We only found qualitative differences in the behaviour of our model.

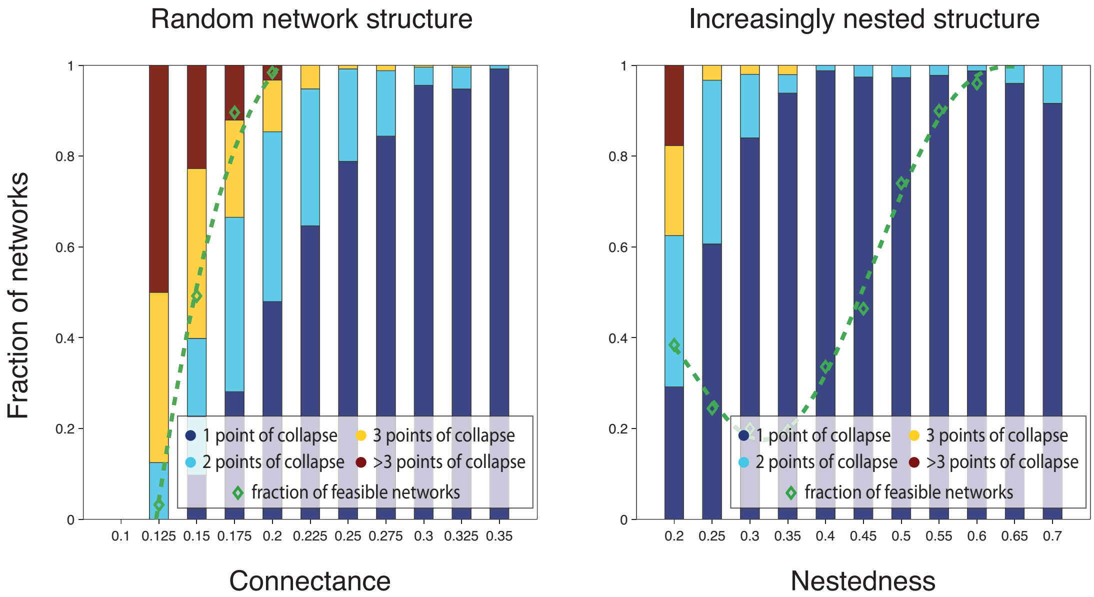

Figure S4: Results when using the same parameter settings as in figure 4, only now the community consists out of 35 plant and 35 pollinator species. As in figure 4, the coloured bars represent the fractions of feasible networks in which a certain number of collapses is found. The fraction of networks in which feasible solutions are found is indicated with the green diamonds.

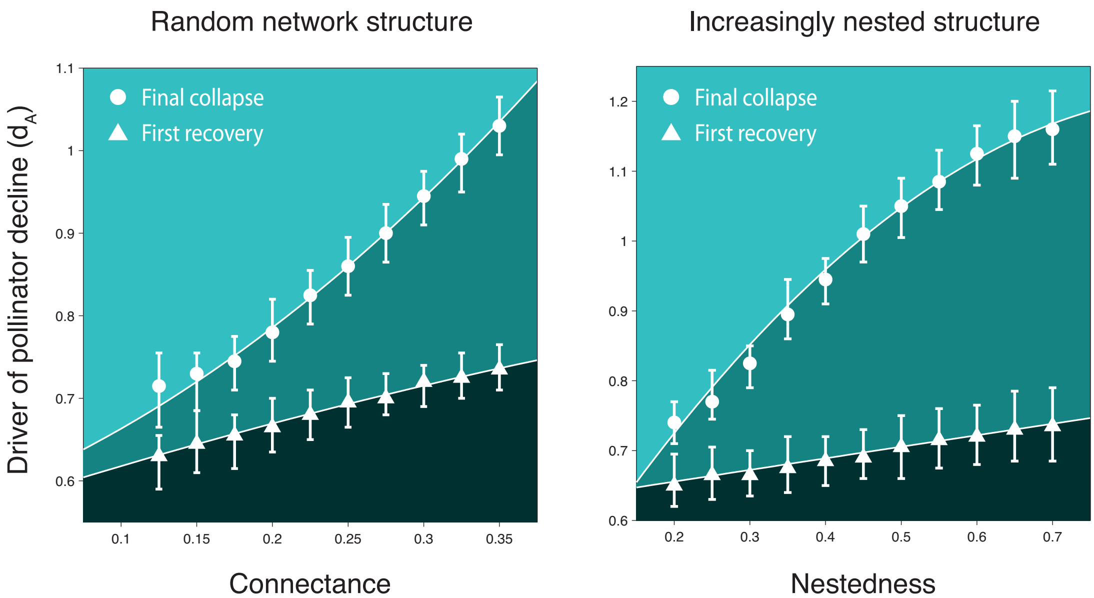

Figure S5: Points of collapse (circles) when the driver of pollinator decline, d_A, is increased, and points of recovery (triangles) when the driver of pollinator decline, d_A, is decreased. In case of multiple collapses and/or recoveries, the final point of collapse and the first point of recovery was plotted. Parameter settings are as in figure S4.

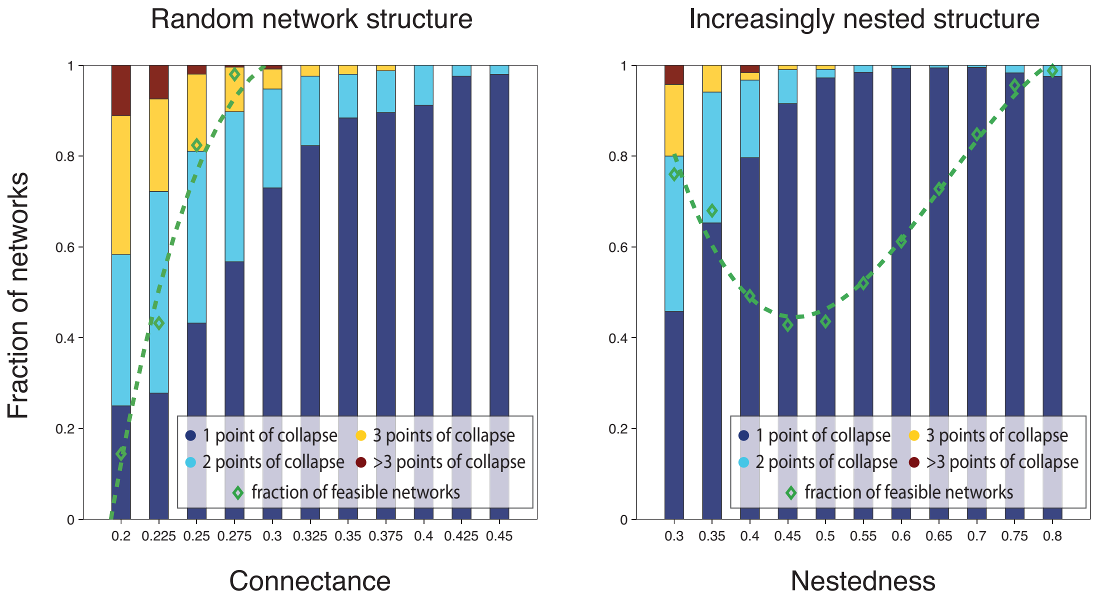

Figure S6: Results when using the same parameter settings as in figure 4, only now competition between species is a bit stronger, $C_{ij} \sim U(0.025, 0.075)$, and in communities with increasingly nested network topologies (right panel), the connectance is fixed to 0.25, and the fraction of forbidden links is fixed to 0.25. As in figure 4, the coloured bars represent the fractions of feasible networks in which a certain number of collapses is found. The fraction of networks in which feasible solutions are found is indicated with the green diamonds.

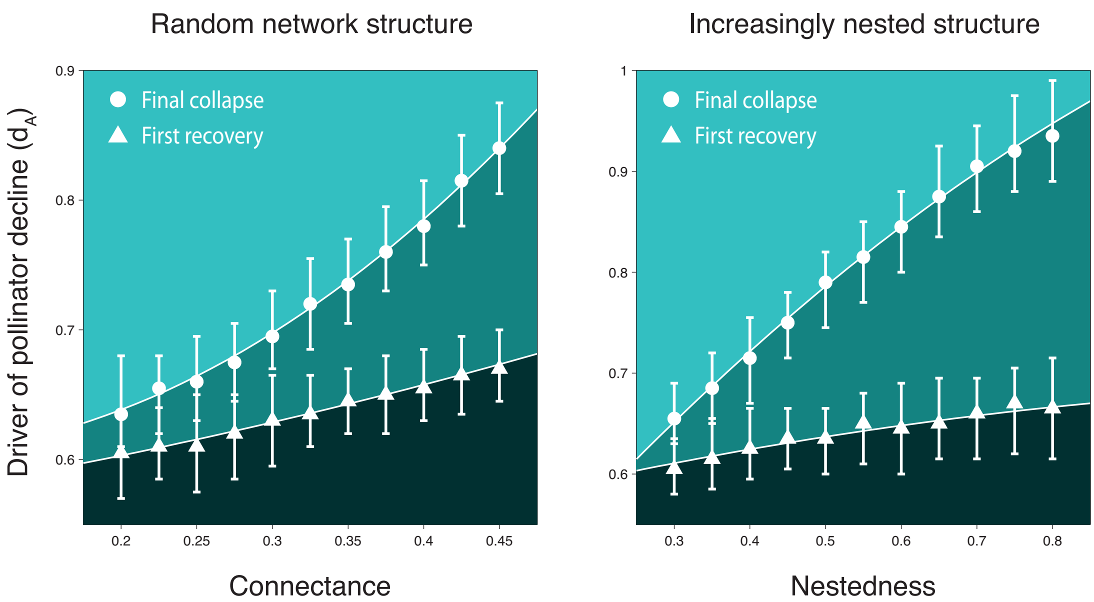

Figure S7: Points of collapse (circles) when the driver of pollinator decline, d_A, is increased, and points of recovery (triangles) when the driver of pollinator decline, d_A, is decreased. In case of multiple collapses and/or recoveries, the final point of collapse and the first point of recovery was plotted. Parameter settings are as in figure S6.

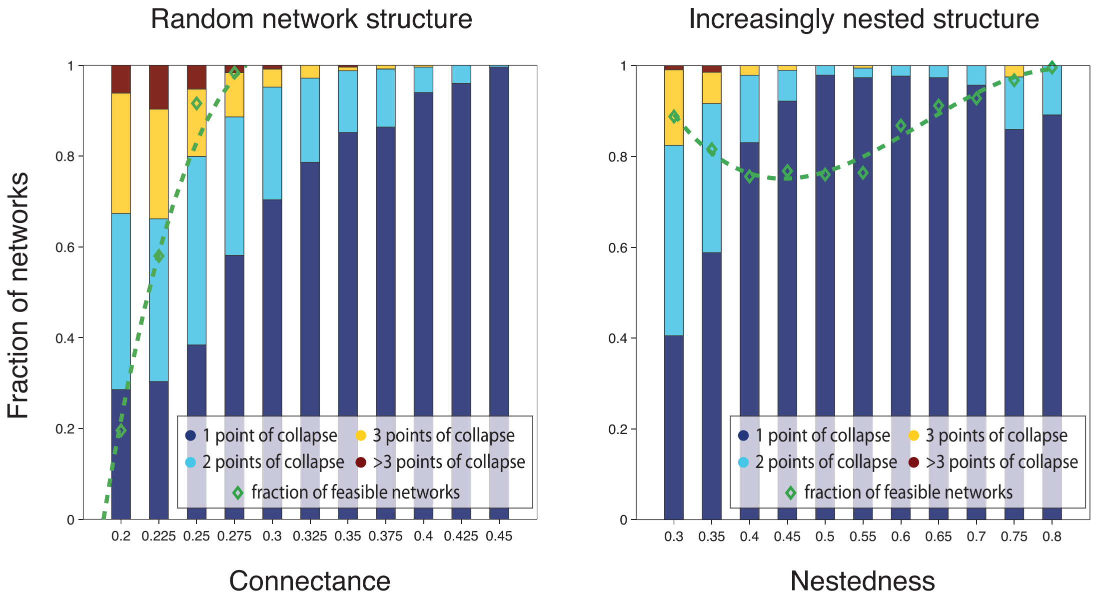

Figure S8: Results when using the same parameter settings as in figure S6, only now each species has at least two interactions. As in figure S6, the coloured bars represent the fractions of feasible networks in which a certain number of collapses is found. The fraction of networks in which feasible solutions are found is indicated with the green diamonds.

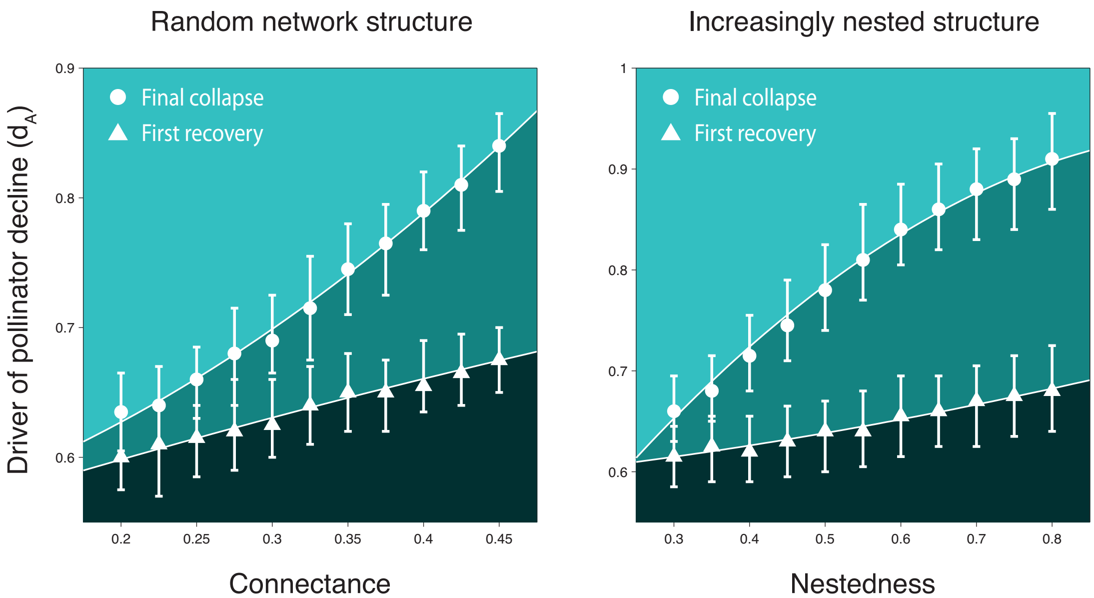

Figure S9: Points of collapse (circles) when the driver of pollinator decline, d_A, is increased, and points of recovery (triangles) when the driver of pollinator decline, d_A, is decreased. In case of multiple collapses and/or recoveries, the final point of collapse and the first point of recovery was plotted. Parameter settings are as in figure S8.

REFERENCES SUPPLEMENTARY MATERIAL

Dean, A. M. (1983). A simple model of mutualism. Am. Nat., 121, 3, pp. 409−417.

May, R. (1978). Studies in Mathematical Ecology. II Populations and Communities, chapter Mathematical aspects of the dynamics of animal populations., pp. 317−366. Washington, DC: Mathematical Association of America.

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