Communities as cliques

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High-diversity species assemblages are very common in nature, and yet the factors allowing for the maintenance of biodiversity remain obscure. The competitive exclusion principle and May's complexity-diversity puzzle both suggest that a community can support only a small number of species, turning the spotlight on the dynamics of local patches or islands, where stable and uninvadable (SU) subsets of species play a crucial role.

We [1,2] mapped the question of the number of different possible SUs a community can support to the geometric problem of finding maximal cliques of the corresponding graph. This enables us to solve for the number of SUs as a function of the species richness in the regional pool, N.

When the interspecific and the intraspecific competition terms have the same scale, we show that the growth of the number of SUs is subexponential in N (if the competition is symmetric) and sublinear in N (if it is asymmetric), contrary to long-standing wisdom [3]. To understand the dynamics under noise we examine the relaxation time to an SU. Symmetric systems relax rapidly, whereas in asymmetric systems the relaxation time grows much faster with N, suggesting an excitable dynamics under noise.

In the limit of weak competition and large variance [4] we use the same mapping to examine the number of SUs, which now corresponds to the number of maximum cliques in a network close to its fully connected limit. Now the number of SUs grows exponentially with the number of species, unless the network is completely asymmetric. In the asymmetric limit the number of SUs is order one. Numerical simulations suggest that these results are valid for models with continuous distribution of competition terms.

Our results in this regime agree with two recent works, by Fisher and Mehta [5] and Bunin [6], both suggest that the number of SUs grows exponentially with the number of competing species, implying that the system may undergo a glass transition at finite "temperature" (i.e., strength of stochasticity).

[l] Fried et al, Scientific reports **6**, 35648 (2016).

[2] Fried et al, arXiv1703.00940.

[3] Gilpin and Case, Nature **261**, 40 (1976).

[4] Fisher and Mehta, PNAS **111**, 13111 (2014).

[5] Bunin, arXiv1607.04734.