Explicit cost of grouping

The model described so far includes a cost of vigilance (insofar as prey cannot forage at the same time that they are vigilant), but there is no explicit cost to choosing to group aside from the possibility of aiding a competing individual. In a final treatment, we implement such a grouping penalty in order to model the realistic constraints of limited resources and the resulting scramble competition for food [30, 36, 40, 49]. This grouping penalty is only assessed on prey who choose to forage in the group, and decreases the amount of food they receive in that simulation time step proportional to the number of prey in the group. The group foraging penalty is imposed according to the equation:

$$\text{Food} = \frac{1.0}{M * G} \tag{1}$$

where G is the number of prey in the group and M is the penalty multiplier that allows us to experimentally control the severity of the penalty. Given this penalty, prey foraging in larger groups receive less food every time they forage, but potentially enjoy the benefits of group vigilance.

3 Results

We evolve the vigilance behavior of prey by subjecting them to predation under a variety of treatments that vary reproductive strategy and group composition. Vigilance is measured as the percent chance that a prey will be vigilant at a given moment in time, averaged across all of the prey in the population. These treatments are repeated across a wide range of group sizes, allowing us to study not only whether the selection for vigilance can be generalized to groups of varying sizes, but also whether we can observe the inverse relationship between group size and vigilance predicted by the many eyes hypothesis.

In our first experiment, all prey in the simulation are forced to forage in the same group,