Supplementary Information for "How ants move: individual and collective scaling properties"

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Autocorrelation

While the zeroth-order model is totally blind to the speeds autocorrelation, our first-order model ignores higher level correlations. To quantify correlations in time, we study here the autocorrelation of speed for ants in an observation

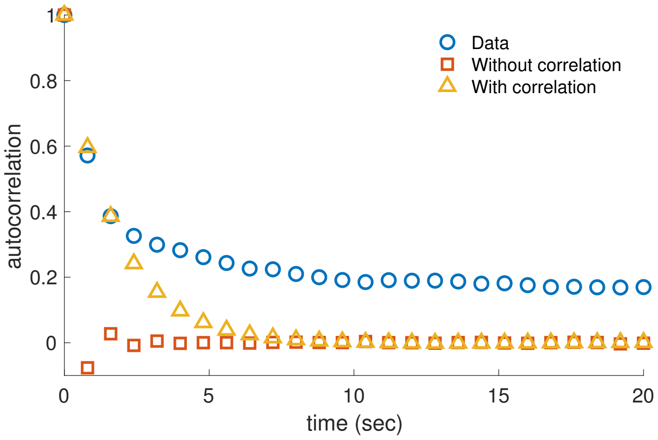

FIG. S1: The autocorrelation as function of time difference in the signal, for the data (blue circles), the zeroth-order model (red squares), and the first-order model (yellow triangles). The first-order model correctly approximates the auto-correlation up to ≈ 2 time steps (1.6 seconds). As expected, the zeroth-order model yields a flat autocorrelation of ≈ 0.

Uncorrelated null model

Shuffling the speeds without considering the correlations shown in Fig. 3A produces trajectories deviating from the empirical distribution and scaling laws observed.

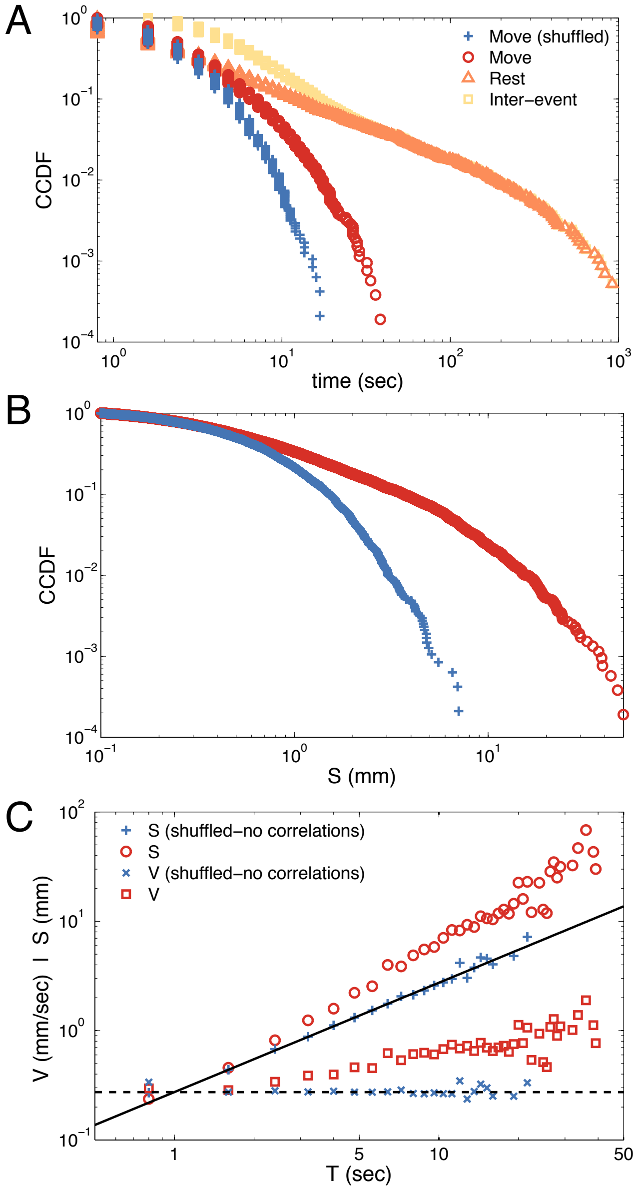

FIG. S2: (A) The complementary cumulative distribution function of the events duration T, the inter-event time and rest time, for uncorrelated shuffled trajectories and real ants. (B) The complementary cumulative distribution function of the events size S for real ants and the uncorrelated null model. (C) The scaling of the events size and speed as a function of events duration for the raw data as well as for the uncorrelated null model shows no relevant differences. Continuous and dashed lines correspond to slopes of 1 and 0 (constant) respectively. Data from colony $C^2_{35\times 28}$.

Experimental results for all colonies

Some of the experimental results of our paper are shown in the main text only for a single experimental condition. In this section we show the exact same analysis to a all colonies and sizes of the nets.

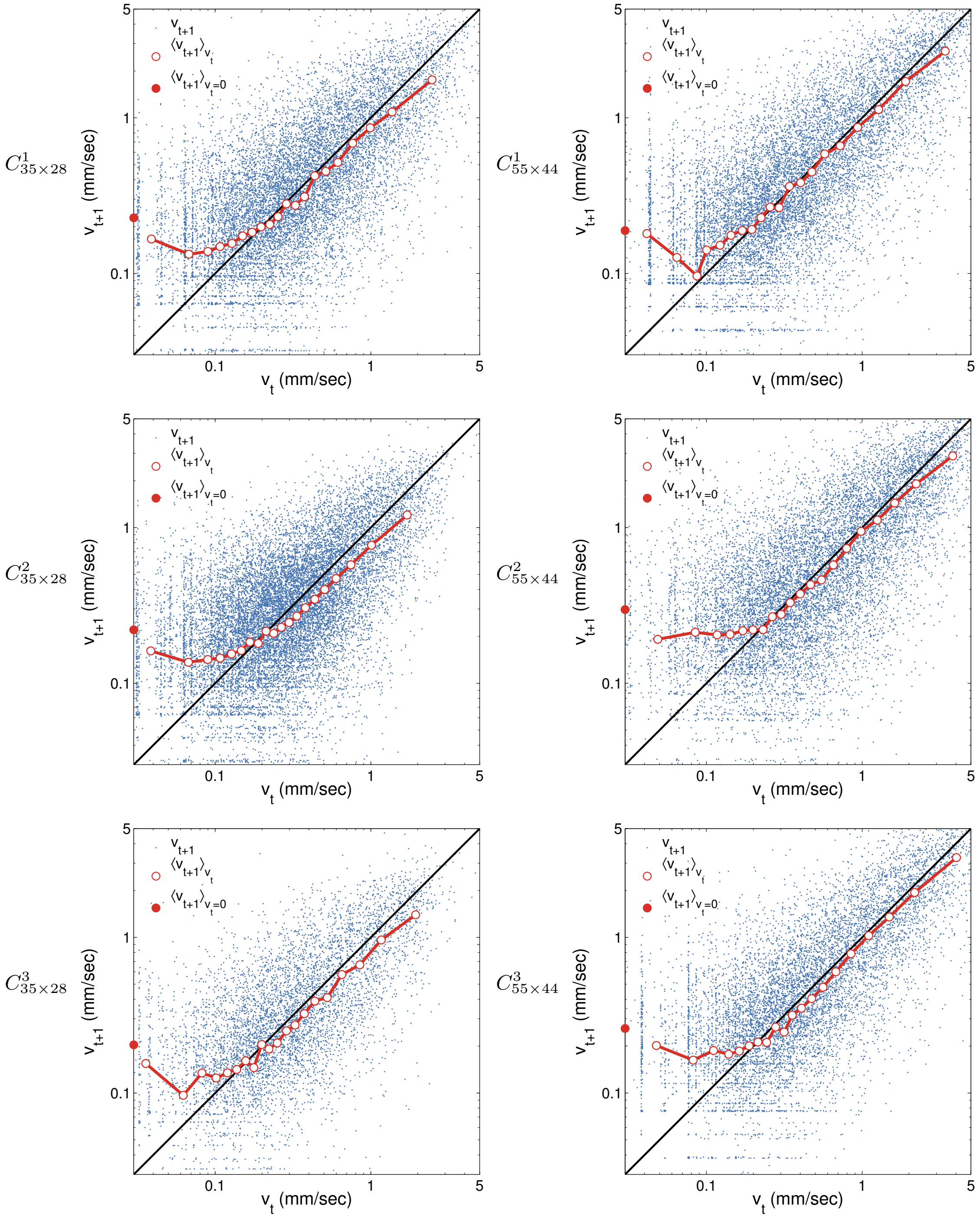

FIG. S3: **Replicas of Fig. 3A.** Return map extracted from the raw data by plotting consecutive $v(t)$ samples (dots) and its binned average $f(v_{(t)})$ (circles and continuos line) over-imposed (please note the log axis).

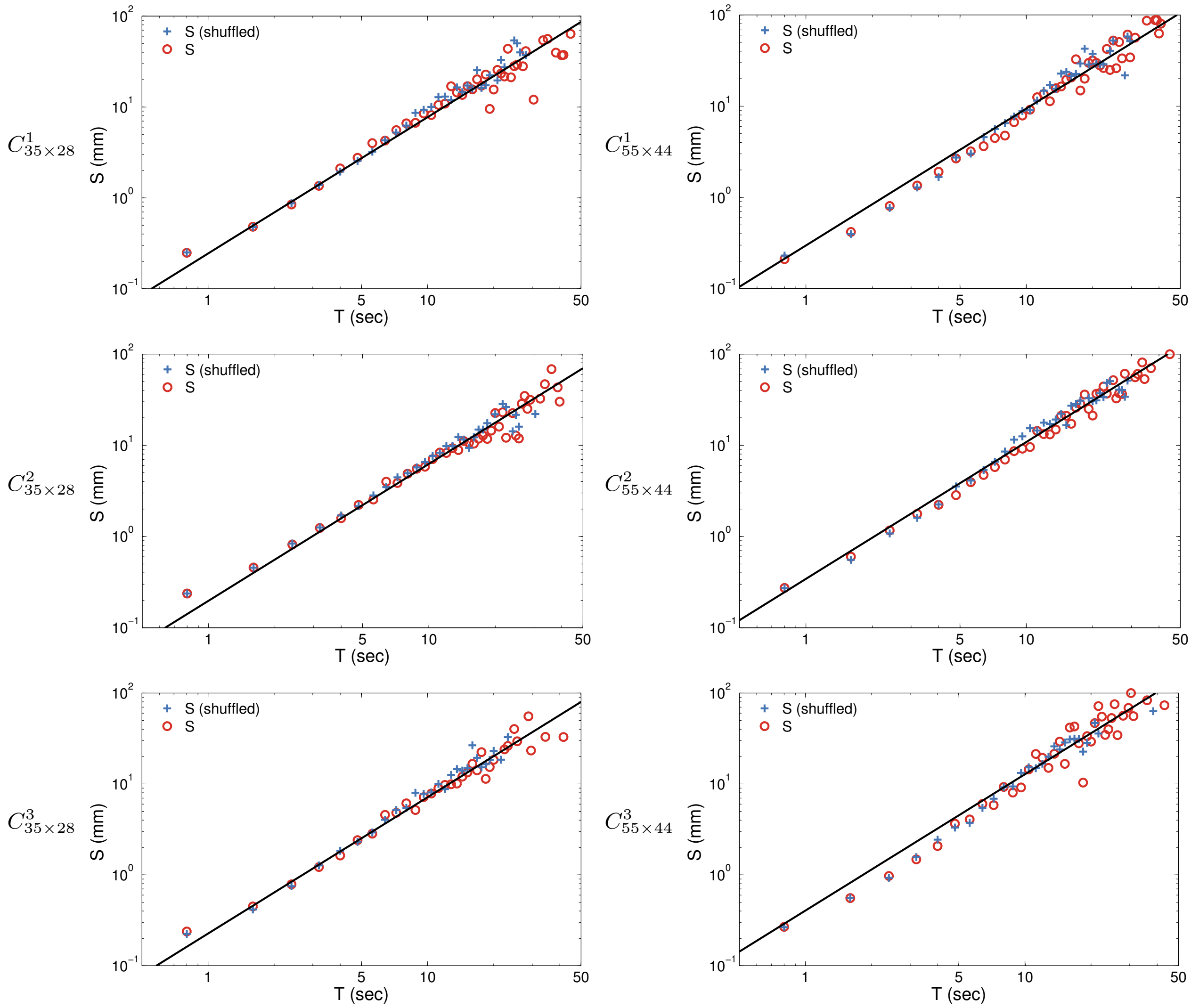

FIG. S4: **Replicas of Fig. 4C.** Real and null model trajectories exhibit very similar scaling statistics. The scaling of the events size and speed as a function of events duration for the raw data as well as for the null model shows no relevant differences. The solid line correspond to a slope of 1/2.

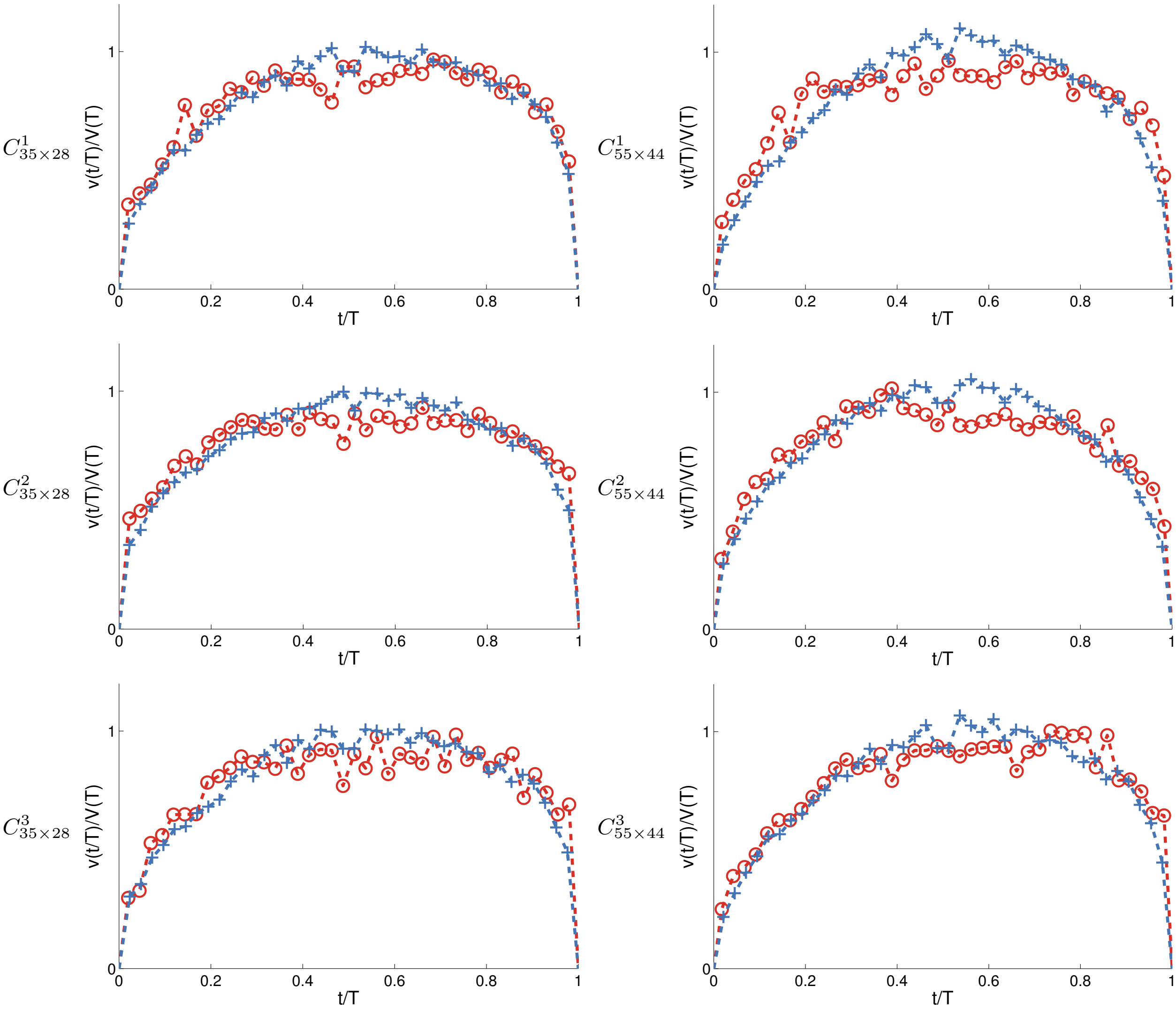

FIG. S5: **Replicas of Fig. 5.** The normalized average speed profile for shuffled trajectories (blue plus signs) and real ants (red circles). After rescaling, all the events profiles collapse to an universal function that presents a plateau close to the average speed for intermediate time. The same collapse can be observed in the synthetic trajectories, however the shape of the curve is less flat. We notice that the shuffled trajectories also reproduce the skew of the curve.

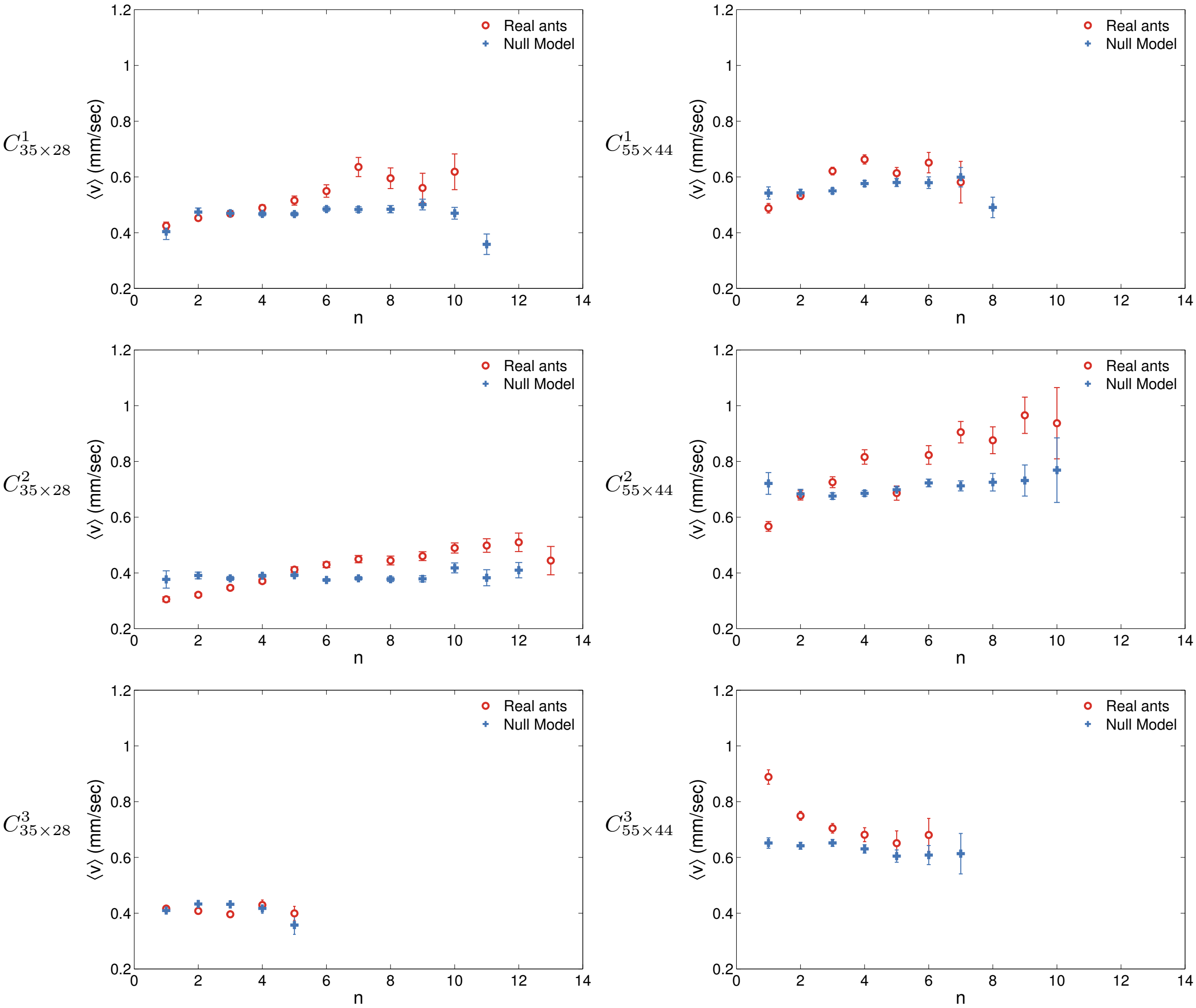

FIG. S6: **Replicas of Fig. 6B.** The null model shows that growth of speed with N, observed for colonies C^1 and C^2, is not due to the statistics of single ants' behavior.

Dependence of individual and collective scaling on the colony and nest sizes.

Our work used the data of three ant colonies with activities recorded in artificial nests of different sizes. The three colonies C^1, C^2, and C^3 were formed by 121, 92, 67 ants respectively at the time of the experiment. The experiment was run in nests of either 35×28mm or 55×44mm. Here we provide information on how the number of ants in each colony and the size affects the scaling effects observed.

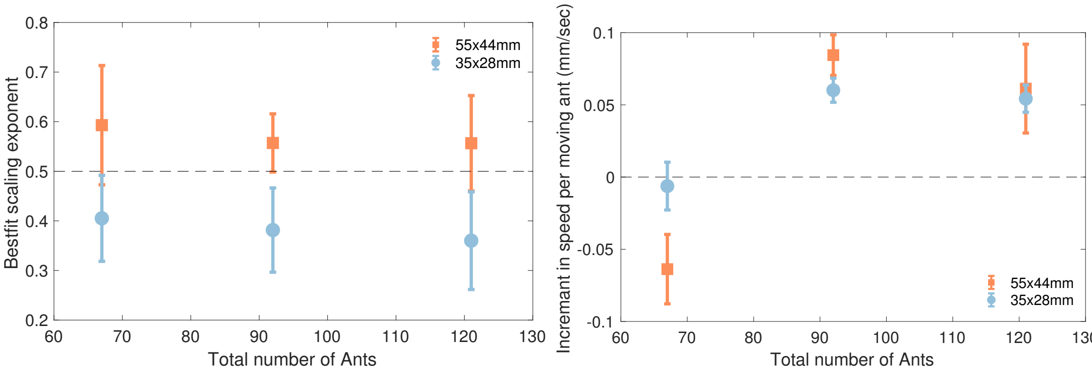

FIG. S7: **(Left)** The values of the slopes associated experimental best-fits of the curves proposed in Fig. S4 for the different experimental setups does not depend on the number of ants, but varies with the nest dimensions (the larger the nest, the larger the scaling exponent). **(Right)** The growing trend in the experimental data of Fig. 6A is not observed for the colony with the smallest number of ants C^3, while is significantly positive for the two largest colonies C^1 and C^2 independently on fthe nest size.