

SI Text

Observations of tandem running

We observed a full sequence of tandem running of termites. For observations, we used pairs of individuals that flew on the same day. We placed a female and a male on the experimental arena (*Materials and Methods*) and observed them for 60 minutes. In case that no tandem running was observed in 60 minutes, we excluded the data from the following analysis. In one replicate, as we had a trouble in the video (image got misaligned), we divided the file into two different files for analysis. Totally, we obtained the data of 28 pairs of *R. speratus* (R_A : 3 pairs, R_B : 6 pairs, R_C : 5 pairs, $R_{D,E}$: 7 pairs) and 17 pairs of *C. formosanus* (C_A : 13 pairs, C_B : 4 pairs).

In this study, we defined the tandem running using the following three different criteria: (i) we determined that termites perform tandem running when distance between centroids of a female and a male was less than 7 mm (for *R. speratus*) or 10 mm for (*C. formosanus*) for more than 3.0 seconds. As a female and a male nearly had physical contact during tandem running, these distances were adjusted to slightly exceed the body length of termites including antenna; (ii) when females did not move more than 30 mm during events of (i), we determined it cannot be tandem running. This treatment enabled image analysis to distinguish tandem running from just two individuals being close each other by chance; (iii) when an angle between moving direction of a female and a male was less than 45 degrees during two separate tandem running events, we defined this period also being in tandem running. This is because a female and a male sometimes perform tandem running without contact for a while when the moving speed of a female increased. Based on these three criteria, we measured the duration of tandem running, the distance between a female and a male during reunion search, and required time for a female and a male to encounter again. We analyzed the duration of tandem running and required time for reunion by generating KaplanMeier survival curves. Events that were disrupted because of the end of observation were right-censored.

As a result, we observed 283 events of separation in 26 of 28 pairs in *R. speratus*, while 58 events in 15 of 17 pairs in *C. formosanus*. Tandem running were maintained longer in *C. formosanus* than in *R. speratus* (log-rank test, $\chi^2=16.4$, $P<0.0001$; Fig. S1A). When a mating pair got separated, it took longer time for reunion in *C. formosanus* than in *R. speratus* (log-rank test, $\chi^2=17.4$, $P<0.0001$; Fig. S1B). During reunion search, a male and a female were separated in longer distance in *C. formosanus* than in *R. speratus*, where the mode value of the distribution of separated distance was 16.09 mm for *R. speratus* and 22.97 mm for *C. formosanus*. All reunion search were completed in 3.4 ~ 124.6 sec. in *R. speratus* ($n=282$), and in 3.4 ~ 151.8 sec. in *C. formosanus* ($n=56$) (Fig. S1C, D)

The role of pausing behavior in reunion search

In the movements of termites, one remarkable is the pausing behavior observed in females during reunion search. To investigate the advantage of pausing behavior in reunion search, we added the analysis for the encounter rates with two types of females with extreme strategies: without pausing and only pausing. The former moves with the parameter of females after separation (Table 1) but does not pause; the latter never moves. Other settings were the same as the simulation conditions in Fig. 3. We ran 1,000,000 simulations and measured the efficiency as the probability to encounter a mating partner. As a result, we found that the only pausing strategy achieved the highest encounter rates in reunion search with the conditions of both *R. speratus* and *C. formosanus*, while the only moving strategy had the lower encounter rates than the observed intermittent strategy (Fig. S6). Thus, in reunion search, the pausing behavior significantly contributed to the encounter rates.

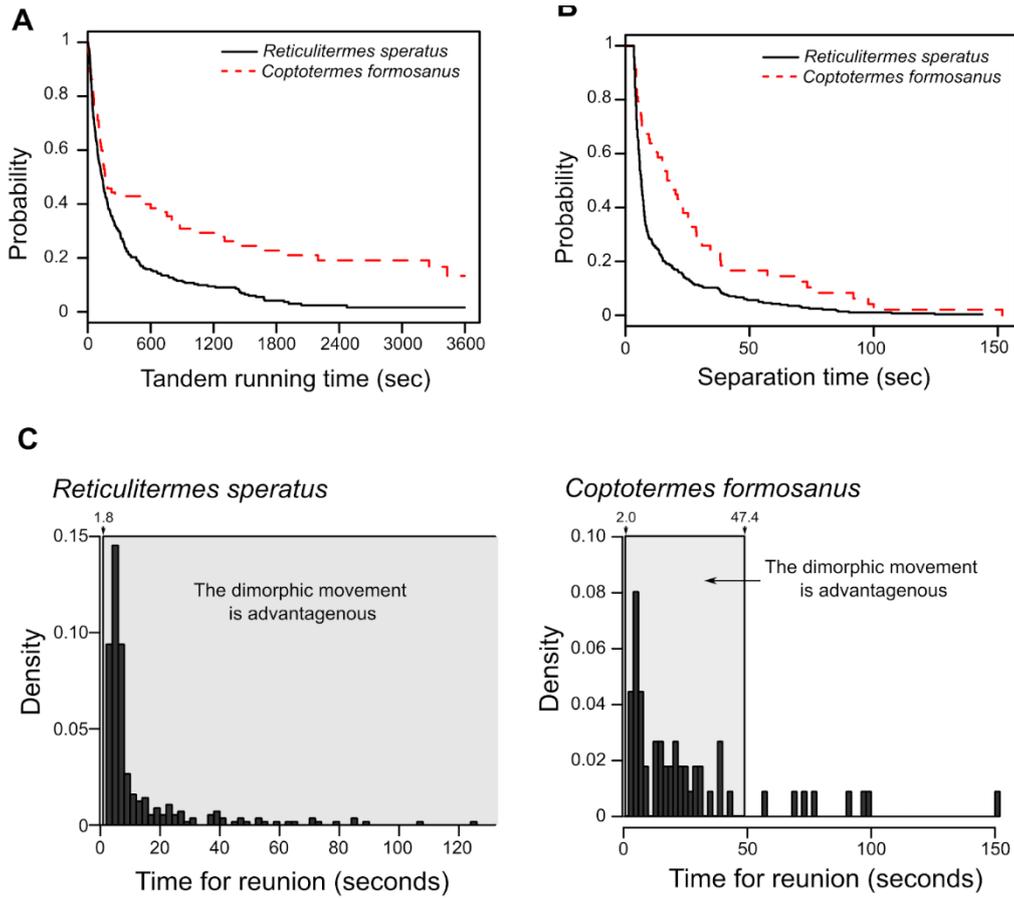


Fig. S1. Duration of two different phases observed in tandem running. *A* Continuation time of tandem running until a pair got separated and lost (sec). Tandem running of *Coptotermes formosanus* was likely to continue longer than that of *Reticulitermes speratus* (log-rank test, $\chi^2 = 16.4$, $P < 0.0001$). *B* Time required for a separated pair to reunite (sec). Pairs of *C. formosanus* required longer time to reunite than those of *R. speratus* when they were separated (log-rank test, $\chi^2 = 17.4$, $P < 0.0001$). *C* The distribution of time required to reunite. The shade areas indicate the search time in which observed sexually dimorphic movements achieved higher efficiency (Fig. 3).

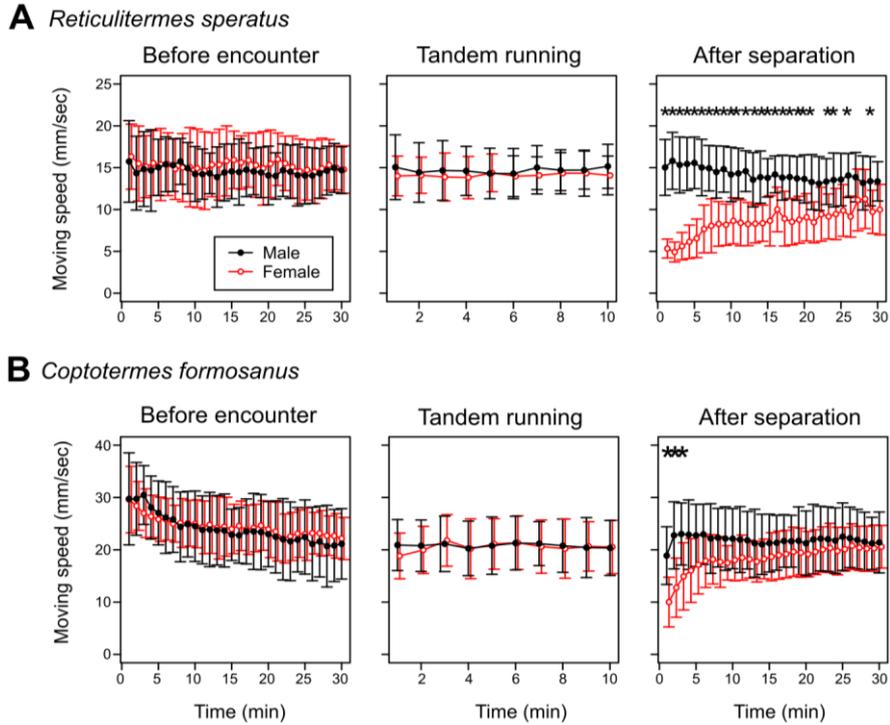


Fig. S2. Moving speeds of termite dealates across different periods in mate search. We first observed free-walking behavior of males and females before pair-formation. Then we added single mating partner of the other sex to observe their movements during tandem running. Finally we carefully removed the partner using an aspirator and again observed free-walking behaviors. (A, B) Comparison of moving speeds between sexes in (A) *R. speratus* and (B) *Coptotermes formosanus*. Females of both species specially decrease their movement speeds immediately after separation, where *R. speratus* showed distinct sexual dimorphism. Points with bars represent mean values with standard deviations. * indicates the significant difference (Wilcoxon rank-sum test with Bonferroni corrections, $P < 0.05/70$).

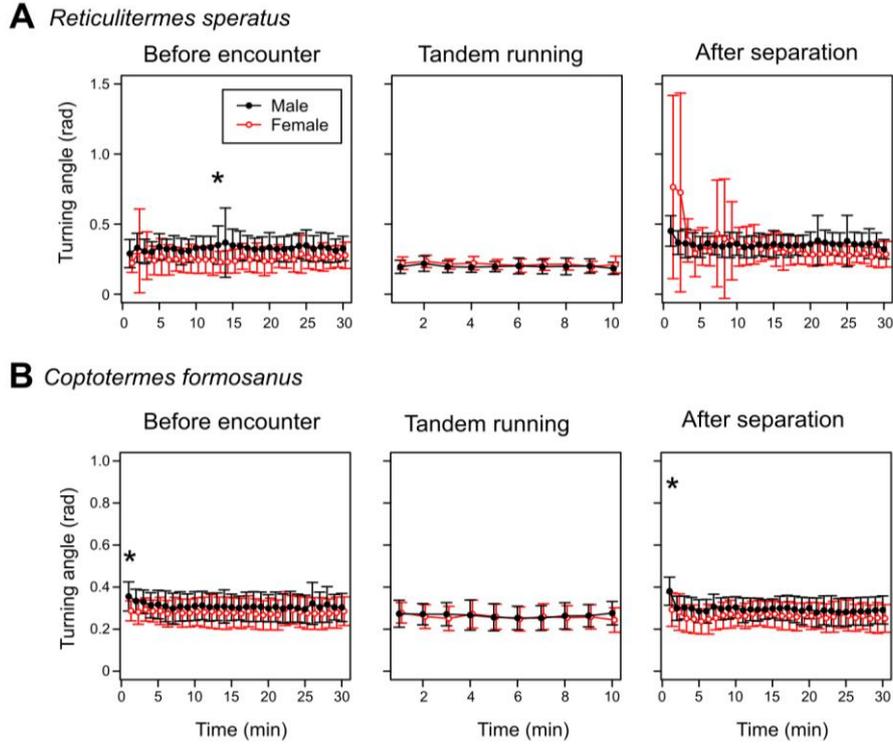


Fig. S3. Turning angles of termite dealates across different periods in mate search. We first observed free-walking behavior of males and females before pair-formation. Then we added single mating partner of the other sex to observe their movements during tandem running. Finally we carefully removed the partner using an aspirator and again observed free-walking behaviors. (A, B) Comparison of turning angles between sexes in (A) *R. speratus* and (B) *Coptotermes formosanus*. Points with bars represent mean values with standard deviations. * indicates the significant difference (Wilcoxon rank-sum test with Bonferroni corrections, $P < 0.05/70$).

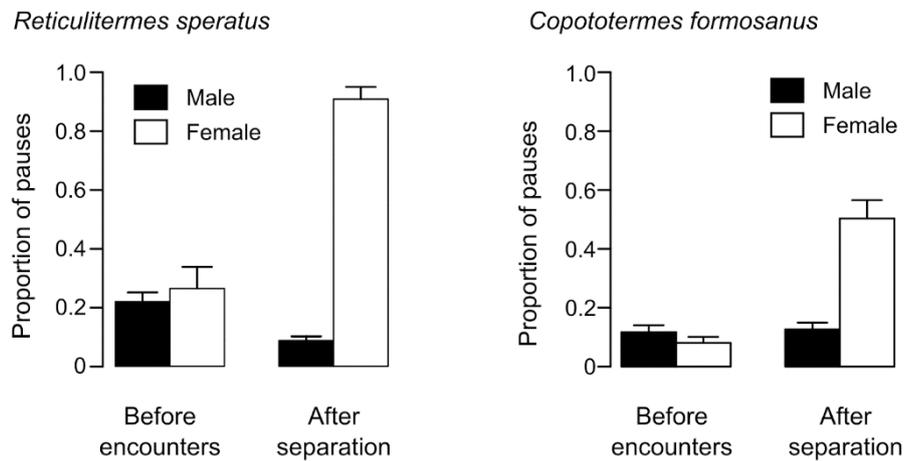


Fig. S4. Comparison of the proportion of pausing times between sexes and conditions. In both species, females paused more than half of periods in average.

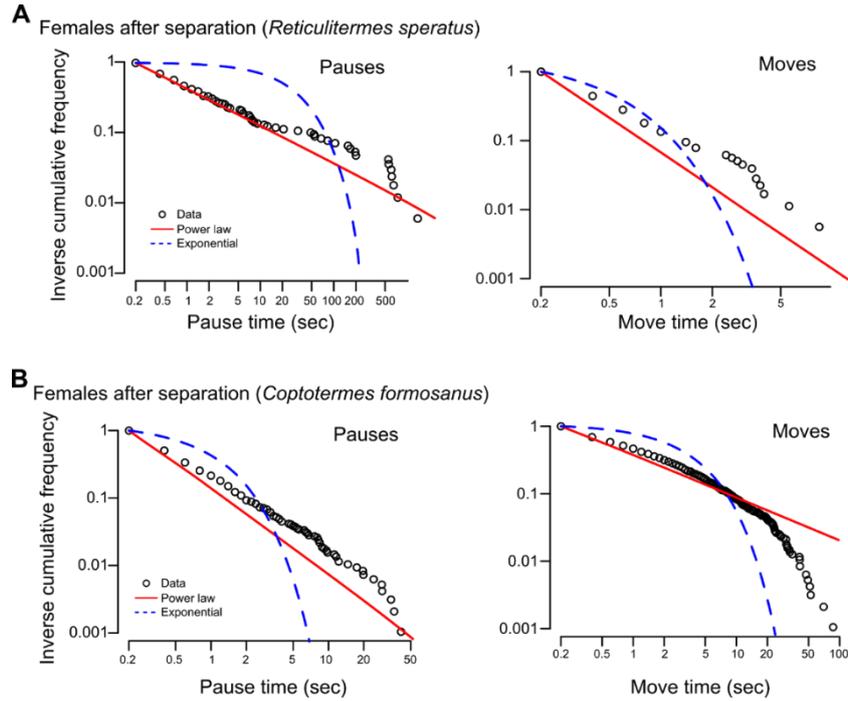


Fig. S5. Inverse cumulative frequency distribution of the duration of pauses and moves observed in females after separation in (A) *R. speratus* and in (B) *C. formosanus*, which are better described by power-law distributions than exponential distributions. Dots are observations, red and blue dashed lines are power-law and exponential distributions, respectively, fitted to the data.

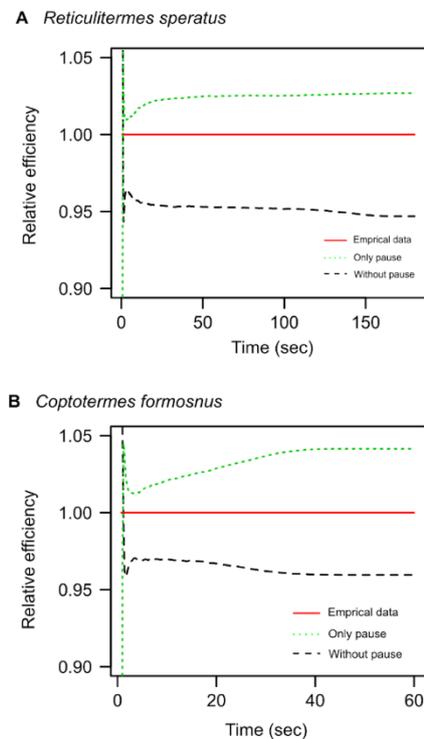


Fig. S6. The encounter rates of the females with observed strategy, only pausing strategy and without pausing strategy in reunion search. The efficiency is computed as the encounter rates in 1,000,000 trials, where relative efficiencies to the observed strategy were described. (A) The results with the condition of *Reticulitermes speratus*, and (B) *Coptotermes formosanus*.

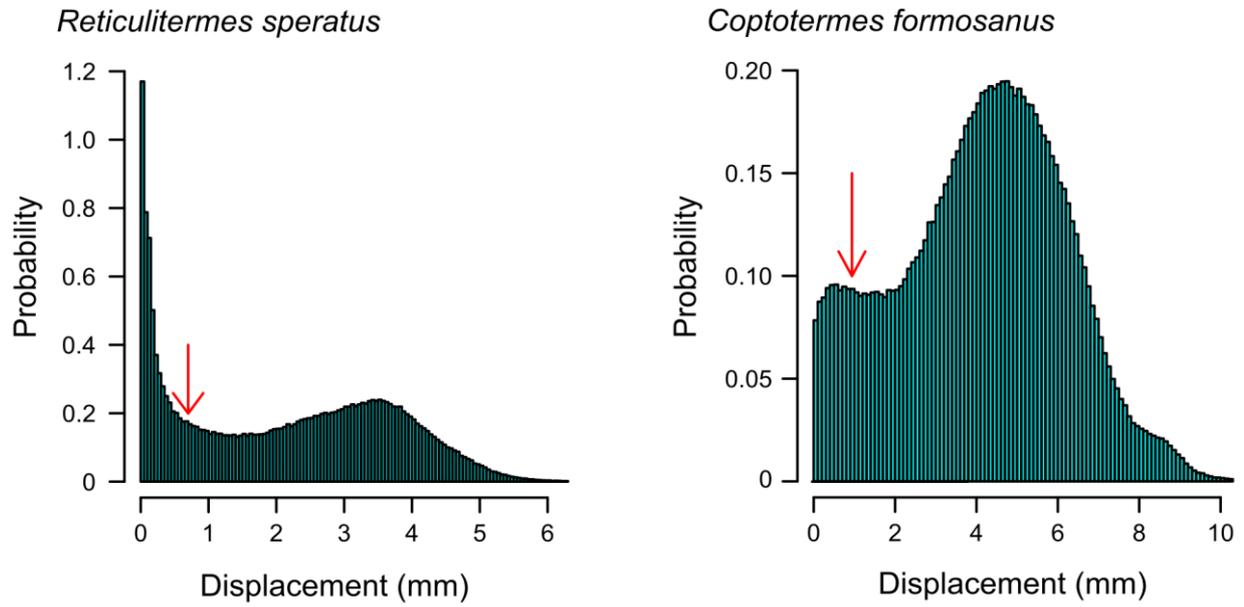


Fig. S7. Histogram of the length of displacements between successive frames (0.2 s). Each histogram was produced by pooling the data of all individuals. Red arrows indicate the threshold values for move/pause (≈ 0.70 mm for *R. speratus*; 0.94 mm for *C. formosanus*).