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Emergence of colony-specific architectures in termite shelter-tube construction

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Social insects build sophisticated and complex architectures such as huge nests and underground galleries based on self-organizing rules. The structures of these architectures vary widely in size and shape within a species. Some studies have revealed that the current difference of environmental and/or social conditions can cause differences in the architectures that emerge from collective building. However, little is known about the colony variation of the structure under the same condition. Here, we show that termite colonies build colony-specific architecture using shelter-tube construction as a model system. When we divided a colony into multiple groups of individuals, groups drawn from the same colony performed similar patterns of construction, whereas groups from different colonies exhibited different patterns. Some groups laid many shelter tubes from the nest, while others constructed fewer but longer shelter tubes. We also found groups that formed no shelter tubes but simply covered the bottom of the container with mats. Our two-dimensional lattice model demonstrated that these colony variations in shelter-tube patterns can be attributed to the following two factors: 1) the sensitivity of workers to the cement pheromone which is involved in indirect local communication among workers; 2) the number of workers that engaged in shelter-tube construction. These results indicate that dramatic variations of architectures emerge from the difference of the workers' property among colonies even under the identical condition. The colony variations of architectures can be interpreted as the result of the adjustment of each colony to the original situation in the field. We will discuss the fitness consequence of the different structural patterns of constructions.