

What Does the Pattern of Territories of Animal Tell Us?

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1. Introduction

When the spring season approaches, people wait it eagerly after the cold winter in every year. At the same time, all living creature starts to prepare for the new season. During this time, birds start to sing cheerfully in forests and woods and fishes start to move actively in brooks. Many kinds of animals start their breeding activities, at this time, namely, making their nests, laying eggs and rearing their childs. For the purpose of breeding, they need to have a certain area of place. This is the “territory” of animal.

2. The Law of Territory

How are the territories of animal made, and what is their “form” and what is their meaning? By observing the actual territories of animal, they look apparently as if their structure is made at random. However, in reality, there exists a kind of law in the structure.

Let us suppose that a mass of territorial animal settles in a certain area called “habitat”. Individuals of the animal keep each territory through a “territorial behaviour”, namely, the behaviour which defend the occupied area and display against other individuals of the same species. Such behaviours result in the pattern of territories with spacing-out property. In this situation, the group of animal in the habitat as a whole can maintain the breeding activity steadily, by avoiding with each other fatal struggles.

As an example, let us see a population of fish kept in a large outdoor pool. Figure 1 shows a schematic diagram of the pattern of territories formed by males of mouthbreeder fish, *Tilapia mossambica*, a kind of fish which brings up childs by keeping eggs or fry within the mouth for the purpose of protection against predator. At the bottom of this pool, uniform shallow sand is spread initially. In the breeding season, territorial male fish simultaneously starts to excavate breeding pits. Each fish spit sand away from the pit center toward his neighbours. When the density of fish is high, the reciprocal spitting results in sand parapets which form a polygonal territory as shown in Fig.1.

Hereupon, the following question arises. Does the pattern of territories of any other animal show a similar nature as in Fig. 1? It is not true in fact (Tanemura and Hasegawa, 1980).

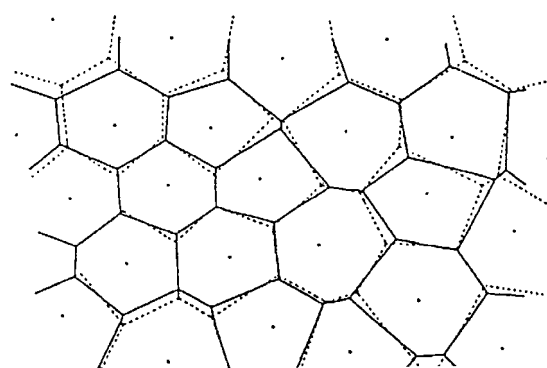


Fig. 1. Territorial pattern of the mouthbreeder fish, *Tilapia mossambica*.

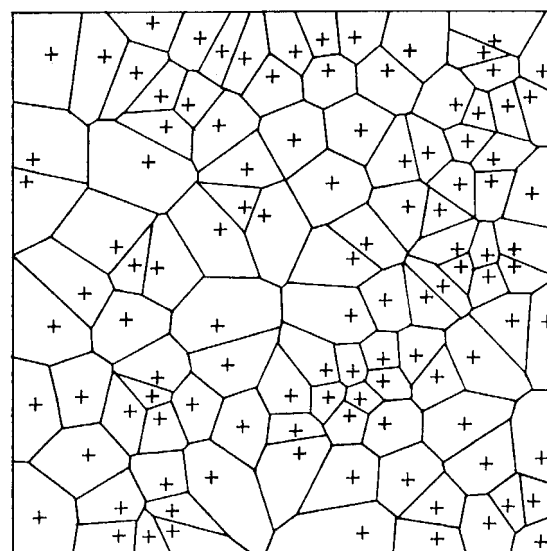


Fig. 2. Nesting pattern in a colony of gray gull, *Larus modestus* and its Voronoi tessellation.

3. The Shape of Territory

The strength of territorial behaviour depends on the species of animal and it is also dependent on the difference between individuals even among the same species. Because of this, the shape of territory, namely, the pattern of territories is extremely various. Moreover, the pattern of ter-

ritories shows a diversity due to other factors, such as the environmental condition of habitat and so on.

In Fig. 2, the nesting pattern in the nest building area, called "colony", of gray gull, *Larus modestus*, and the pattern of territories which was made by the Voronoi tessellation are shown. The data was observed at the colony of seashore near the south of Chile. It will be clear that the pattern in Fig. 2 is different from the pattern in Fig. 1 which is the territorial pattern for the mass of male fish artificially bred in the outdoor pool.

Then, conversely, is it possible to infer about the factors of territory formation, such as the strength of territorial behaviour, from the observed shape of territories or from the observed pattern of territories? We believe it is true (e.g., Hasegawa and Tanemura, 1986).

Within the observed pattern of territories, it can be thought that the information about the pattern formation should be contained. It will exactly be a theme of statistics in the science on form to extract such an information from the seemingly complex and diverse pattern of territories (e.g., Tanemura, 1983).

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