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FRACTALITY OF THE EXPLORATORY BEHAVIOR IN COCKROACHES (*Periplaneta Fuliginosa* and *Periplaneta Americana*)

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1. INTRODUCTION

Fractal phenomena have been studied by many researchers from the end of 1970 [1], and many papers with respect to fractal analysis for diffusion-limited-aggregation [2], viscous fingering [3], ink imbibition experiment [4, 5] *et al.* have been offered. Fractal has become one of the important studies in various fields at present. There are, however, few papers which investigated the fractal properties of animal behaviors [6], because of animal behaviors are considered to be one of the random and complex phenomena.

2. EXPERIMENT

In order to investigate fractal properties of animal behaviors, we have performed an experiment using a cockroach. The species of cockroaches are *Periplaneta Fuliginosa* and *Periplaneta Americana.*

We have observed the exploratory behavior of subjects which move in the plastic cylindrical open enclosure with the diameter of 600mm and the height of 110mm. We have measured the time for which cockroach stays on each food box and the locomotion time of a subject between two food boxes. Food boxes with the diameter of 30mm and the depth of 8mm are arranged in the open enclosure (Fig. 1). Figure 1 shows the arrangement of food boxes in the case that the distance between two food boxes is 100mm.

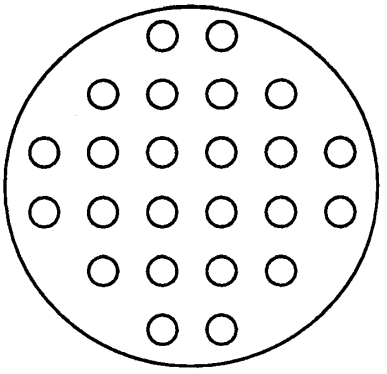

Fig. 1
The mark ○ indicates foodbox.

3. RESULT AND DISCUSSION

In order to research the fractal properties of cockroach behaviors, we study the fractal dimension D of the distribution of the staying and locomotion time as follows.

$$P(\geqq t) \sim t^{-D},$$

where t is a staying or locomotion time and $P(\geqq t)$ is the probability that the staying or locomotion time is larger than or equal to t. Table 1 shows the results for *Periplaneta Fuliginosa.*

Table 1 Fractal Dimension of Exploratory Behavior of *Periplaneta Fuliginosa*

Distance between Two Food Boxes	Number of Food Boxes	Staying Time		Locomotion Time	
		Adult	Child	Adult	Child
100 (mm)	24	1.1	1.8	1.5	1.0

In Table 1, the fractal dimension of staying time distribution of adult cockroach (1.1) is smaller than the fractal dimension of staying time distribution of child cockroach (1.8) and the fractal dimension of locomotion time distribution of adult cockroach (1.5) is larger than the fractal dimension of locomotion time distribution of child cockroach (1.0). From these results, we guess that the behavior of adult cockroach is slower than the behavior of child cockroach in the period of exploration.

We have performed an experiment for *Periplaneta Americana,* too. The results are shown in Table 2. Only adult cockroach is used in the case of *Periplaneta Americana.*

Table 2 Fractal Dimension of Exploratory Behavior of *Periplaneta Americana*

Distance between Two Food Boxes	Number of Food Boxes	Staying Time	Locomotion Time
100 (mm)	24	0.87	0.88

The differences of fractal properties between species of cockroaches have been found by comparing with Table 1 and Table 2. As a result, we have guessed that *Periplaneta Americana* is tranquiller than *Periplaneta Fuliginosa.*

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