Abstract*

Ants and bits (Hymenoptera: Formicidae)

Boris RYABKO & Zhanna REZNIKOVA

Prof. Dr. Boris Ryabko (contact author), Siberian University of Telecommunication and Informatics, Kirov ul. 82, 630102, Novosibirsk, Russia. E-mail: boris@ryabko.net

Prof. Dr. Zhanna Reznikova, Institute for Animal Systematics and Ecology, Siberian Branch, Russian Academy of Sciences, Frunze ul. 11, 630091, Novosibirsk, Russia. E-mail: zhanna@reznikova.net

Myrmecol. News 10: 121

After twenty years in the shadow of the binary tree (REZNIKOVA & RYABKO 1986, 1994, 2003, RYABKO & REZNIKOVA 1996, NOVGORODOVA 2006), we can now summarize what the information theory introduced by SHANNON (1948a, b) furnishes for explorers of ants' communication. Unlike bees, whose dance language remains the most complex among the animal communication systems decoded to date, ants belong to the overwhelming majority of species with codes so far inaccessible for cracking because of many methodological barriers.

We have applied ideas and methods of information theory to study ants' communication systems. The main point of our approach is not to decipher signals, but to concentrate rather on the process of transmission of a measured amount of information (in bits) and thus to evaluate the potential power of ants' "language". The information concerns the sequence of turns towards the trough. We used the "binary tree" maze, where each "leaf" of the "tree" ends with an empty trough with the exception of one filled with syrup. In different trials, the number of forks was changed from 2 to 6. The number of bits necessary to choose the correct way is equal to the number of forks. We tested 10 laboratory colonies of *Formica polyctena* FÖRSTER, 1850, *F. pratensis* RETZIUS, 1783, *F. sanguinea* LATREILLE, 1798 and *Camponotus saxatilis* RUZSKY, 1895, with all ants individually labelled. We forced the scouting ant to enter the trough, and then, when it returned to the nest, measured the duration of its touch contacts with foragers in the nest. As soon as foragers appeared on the laboratory arena, we isolated the scout, and the foragers had to search for food without guidance. To avoid both the possible odour trail and the food odour, we replaced the maze by a new one with all troughs empty while the scout was inside the nest. When the foragers reached the goal correctly, they were rewarded with a drop of syrup.

The results obtained with this method demonstrated the high quantity of potentially transmitted messages, and the correlation between the duration of the information transmission and the information quantity. We also succeeded in revealing the ants' ability to memorize and use simple regularities in order to "compress" transmitted information: Ants spent considerably less time for the transmission of information on regular fork sequences than on random ones of the same length. Accordingly, this approach allows an evaluation of important characteristics of ants' natural communication systems, including their potential flexibility. Highly social ant species seem to possess an even more intricate "language" than honey bees.

Elaborated within the frame of a HAS-RAS Academic Exchange Project and supported by the RFBR (05-04-48104).

References

NOVGORODOVA, T.A. 2006: Experimental investigation of information transmission in *Formica pratensis* (Hymenoptera, Formicidae) using "the binary tree" maze. – Entomological Review 86: 287-293.

REZNIKOVA, ZH. & RYABKO, B. 1986: Investigations of ant language by methods of Information Theory. – Problems of Information Theory 21: 103-108.

REZNIKOVA, ZH. & RYABKO, B. 1994: Experimental study of the ants communication system with the application of the Information Theory approach. – Memorabilia Zoologica 48: 219-236.

REZNIKOVA, ZH. & RYABKO, B. 2003: In the shadow of the binary tree: Of ants and bits. In: ANDERSON, C. & BALCH, T. (Eds): Proceedings of the 2nd International Workshop of the Mathematics and Algorithms of Social Insects. – Georgian Institute of Technology, Atlanta, pp 139-145.

RYABKO B. & REZNIKOVA, ZH. 1996: Using Shannon Entropy and Kolmogorov Complexity to study the communicative system and cognitive capacities in ants. – Complexity 1: 37-42.

SHANNON, C. 1948a: A mathematical theory of communication I. – The Bell System Technics Journal 27: 379-423.

SHANNON, C. 1948b: A mathematical theory of communication II. – The Bell System Technics Journal 27: 623-656.

* Based on a presentation at the 2nd Central European Workshop of Myrmecology at Szeged, Hungary, 17 - 19 May 2007