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First Results of 3 Year Monitoring of Red Wood Ants' Behavioural Changes and Their Possible Correlation with Earthquake Events

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Short-term earthquake predictions with an advance warning of several hours or days can currently not be performed reliably and remain limited to only a few minutes before the event. Abnormal animal behaviours prior to earthquakes have been reported previously but their detection creates problems in monitoring and reliability. A different situation is encountered for red wood ants (RWA; Formica rufa-group (Hymenoptera: Formicidae). They have stationary nest sites on tectonically active, gas-bearing fault systems. These faults may be potential earthquake areas and are simultaneously information channels deeply reaching into the crust.
A particular advantage of monitoring RWA is their high sensitivity to environmental changes. Besides an evolutionarily developed extremely strong temperature sensitivity of 0.25 K, they have chemoreceptors for the detection of CO_2 concentrations and a sensitivity for electromagnetic fields. Changes of the electromagnetic field are discussed or short-lived "thermal anomalies" are reported as trigger mechanisms for bioanomalies of impending earthquakes.
For 3 years, we have monitored two Red Wood Ant mounds (Formica rufa-group), located at the seismically active Neuwied Basin (Eifel, Germany), 24/7 by high-resolution cameras equipped with a colour and infrared sensor. In the Neuwied Basin, an average of about 100 earthquakes per year with magnitudes up to M 3.9 occur located on different tectonic fault regimes (strike-slip faults and/or normal or thrust faults). The RWA mounds are located on two different fault regimes approximately 30 km apart. First results show that the ants have a well-identifiable standard daily routine. Correlation with local seismic events suggests changes in the ants' behaviour hours before the earthquake event: The nocturnal rest phase and daily activity are suppressed, and standard daily routine is continued not before the next day. Additional parameters that might have an effect on the ants' daily routine (including climate data, earth tides, lunar phases and biological parameters) are recorded and correlated with the analysed daily activity. Additionally, nest air measurements (CO_2, Helium, Radon, H2S and CH4) are performed at intervals.
At present, an automated image analysis routine is being applied to the acquired more than 45,000 hours of video stream data. It is a valuable tool to objectively identify and classify the ants' activity on top of mounds and to examine possible correlations with earthquakes. Based on this automated approach, a statistical analysis of the ants' behaviour is intended.
The investigation and results presented here are a first access to a completely new research complex. The key question is whether the ants' behavioural changes and their correlation with earthquake events are statistically significant and if a detection by an automated system is possible. Long-term studies have to show whether confounding factors and climatic influences can clearly be distinguished. Although the first results suggest that it is promising to consolidate and extend the research to determine a pattern for exceptional situations, there is, however, still a long way to go for a usable automated earthquake warning system.

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