SUMMARY

The study examines the sensory ecology of CO_2 perception in leaf-cutting ants. It begins with the ecological role of CO_2 for leaf-cutting ants. Inside the subterranean nests of *Atta vollenweideri* large amounts of CO_2 are produced by the ants and their symbiotic fungus.

Measurements in field nest at different depths revealed that CO_2 concentrations do not exceed 2% in mature nests. These findings indicate effective ventilation even at depths of 2 m. Small colonies often face the situation of reduced ventilation when they close their nest openings as a measure against flooding. A simulation of this situation in the field as well as in the laboratory revealed increasing CO_2 concentrations causing reduced colony respiration which ultimately might limit colony success.

Wind-induced ventilation is the predominant ventilation mechanism of the nests of *Atta vollenweideri*, shown by an analysis of external wind and airflow in the channels. The mound architecture promotes nest ventilation. Outflow channels have their openings in the upper, central region and inflow channels had their openings in the lower, peripheral region of the nest mound. Air is sucked out through the central channels, followed by a delayed inflow of air through the peripheral channels. The findings support the idea that the nest ventilation mechanism used by *Atta vollenweideri* resembles the use of *Bernoulli's* principle in *Venturi Tubes* and *Viscous Entrainment*.

CO_2 is important in a second context besides microclimatic control. A laboratory experiment with *Atta sexdens* demonstrated that leaf-cutting ants are able to orientate in a CO_2 gradient. Foragers chose places with higher CO_2 concentration when returning to the nest. This effect was found in all homing foragers, but it was pronounced for workers carrying leaf fragments compared to workers without leaf fragments. The findings support the hypothesis that CO_2 gradients are used as orientation cue inside the (dark) nest to find suited fungus chambers for unloading of the leaf fragments.

After the importance of CO_2 in the natural history of the ants has thus been demonstrated, the study identifies for the first time in Hymenoptera type and location of the sensory organ for CO_2 perception. In *Atta sexdens* a single neuron associated with the sensilla ampullacea was found to respond to CO_2. Since it is the only neuron of this sensillum, the sensillum characters can be assumed to be adapted for CO_2 perception. A detailed description of the morphology and the ultrastructure allows a comparison with sensilla for CO_2 perception found in other insects and provides more information about sensillum characters and their functional relevance.

The CO_2 receptor cells respond to increased CO_2 with increased neural activity. The frequency of action potentials generated by the receptor cell shows a phasic-tonic time course during CO_2 stimulation and a reduced activity after stimulation. Phasic response accomplished with a reduced activity after stimulation results in contrast enhancement and the ability to track fast fluctuations in CO_2 concentration. The neurons have a working range of 0 to 10% CO_2 and thus are able to respond to the highest concentrations the ants might encounter in their natural environment. The most exciting finding concerning the receptor cells is that the CO_2 neurons of the leaf-cutting ants do not adapt to continuous stimulation. This enables the ants to continuously monitor the actual CO_2 concentration of their surroundings.

Thus, the sensilla ampullacea provide the ants with the information necessary to orientate in a CO_2 gradient (tracking of fluctuations) as well as with the necessary information for microclimatic control (measuring of absolute concentrations).