CHEMICAL ECOLOGY, ATMOSPHERIC CHEMISTRY, AND CHEMISTRY EDUCATION

Chemicals that are found in trace quantities in the atmosphere can play significant roles in processes that directly and indirectly affect the quality of our life. Chemicals are used by plants and animals in growth, development, reproduction and defence. We are interested in understanding the sources, reactions and effects that these species have.

Understanding the way in which students learn and teachers teach will allow us to develop better teaching and learning methods.

The research programs described here are examples of what might be investigated. Other projects can be accommodated if they fall within the general theme of the group’s activities.

ATTRACTANT AND PHEROMONE COMPOUNDS OF ECONOMICALLY IMPORTANT INSECTS AND THEIR ENVIRONMENT (with Joanne Jamie, CBMS and Phil Taylor, Biology)

_Bactrocera_ fruit flies – a genus of more than 500 species – include some of the world’s most devastating insect pests of horticulture. Air-borne pheromones are used by these insects to communicate, and in synthetic form also have potential as tools for control. Attractant compounds are used to monitor and control fruit fly populations. We are also interested in how fruit flies react to odours produced by bacteria, as some bacteria are pathogens, some are symbionts, and some are key elements of nutrition. How do _Bactrocera_ fruit flies avoid harmful bacteria and locate beneficial bacteria? Natural enemies of fruit flies, such as predators and parasites, have a significant impact on the lives of fruit flies but little is known about how these flies might counter such threats. One mechanism is through detection and adaptive response to chemical cues (‘kairomones’) either emitted directly from enemies or deposited as enemies move through the environment.

Projects in these areas may focus on one or more category of compounds, and may encompass synthesis of novel and known compounds, qualitative and quantitative analysis of pheromones or odour emissions (e.g., by GC-MS), and studies of behavioural responses of _Bactrocera_ fruit flies to these compounds. Activities may include travel for the collection of emissions and assays to test for biological activity (e.g., GC-coupled electroantennogram, wind tunnel, field trials).

EMISSIONS OF ORGANIC COMPOUNDS FROM PLANTS

Vegetation emits significant quantities of Volatile Organic Compounds. These emissions may be correlated with internal chemistry of the plants, and give clues on such things as the presence of useful compounds, stage of plant development and the maturation state of fruit. The relatively new technique of Solid-Phase Microextraction (SPME) offers a route to convenient in situ sampling. SPME combines in one-step sampling and preconcentration, prior to GC or GC-MS analysis. Our research activity aims at developing methods of in situ SPME-GC analysis, and to develop a database of VOC emissions from Australian native vegetation. We are also interested in the ways that plants and animals use VOCs for signalling and deception purposes.
INDOOR AND OUTDOOR AIR QUALITY: GREENHOUSE GASES, VOLATILE ORGANIC COMPOUNDS AND SECONDARY ORGANIC AEROSOLS (with CSIRO Energy Technology, North Ryde)

Identifying and quantifying the sources of volatile organic compounds (VOCs) is important as these compounds are involved in complex chemical and physical transformations that result in effects such as smog and aerosol formation, and changes in the oxidative capacity of the atmosphere. Large volumes of VOCs are emitted from plants (biogenic VOCs) and from human activities (anthropogenic VOCs). We have a range of projects concerned with identifying and quantifying VOCs and their sources and looking at the chemical composition of aerosols formed from these compounds. Of interest at the moment is the fate of carbon sequestering amines fugitively emitted to the atmosphere.

MATHS ANXIETY IN CHEMISTRY STUDENTS, CHEMICAL MISCONCEPTIONS AND CONSTRUCTIVISM

Maths anxiety is the situation where, to greater or lesser extent, panic, helplessness, paralysis, and mental disorganization. This may mean that the student stops him- or herself from starting on a task, even if capable of doing it. Students may be caught in a cycle of maths avoidance when, in the past, the student has suffered a bad experience relating to maths. It is of interest to measure the extent of maths anxiety amongst the student cohort, and to develop mechanisms for identifying these people early in their studies, so that appropriate support for them can be provided. "Constructivism" refers to the theory that the process of learning is not one of simple acceptance and remembrance of facts, but one where the learner must incorporate them into an already constructed world-view. It is necessary for teachers to understand the ways in which students incorporate knowledge into these existing knowledge frameworks, which may include preconceptions and/or misconceptions. Misconceptions in chemistry are extremely persistent and are likely to still be present in tertiary level students, right through to those studying for their Ph.D.’s. It is important that teachers are aware of the range of preconceptions and misconceptions that students bring with them, and put in place appropriate teaching methods that adequately address these issues.

Selected publications

4. S.J. White, I.M. Jamie and D.E. Angove, "Chemical characterisation of semi-volatile and aerosol compounds from the photooxidation of toluene and NOx", Atmospheric Environment, 83 (2014) 237-244

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