Unravelling the chemistry of our native plants

Nigel Perry[1] and John van Klink

Today, plant-derived natural products form the basis of many pharmaceutical and agrochemical agents. Other natural substances from plants have useful and important applications in today's flavour and fragrance, and dye and pigment industries. New Zealand has unique qualities as a group of islands that have been separated from any major continent for several million years, resulting in a country of unusual flora and fauna, with many species found nowhere else on earth. For this reason alone the native flora and fauna are pretty special. Now, the chemical make-up of our native species is also proving to be special.

Scientists at Crop & Food Research in Dunedin have been collecting plants, fungi and other organisms from around New Zealand and testing them to find biologically active natural products. Extracts from the collections are first tested against a wide range of human and farm pests and diseases to see if they have sufficient levels of activity to warrant further investigation. Separations (typically using chromatography) are aimed at the discovery of new substances with potential as pharmaceuticals in fighting various human health problems, or as active agents against agriculturally-related diseases. We determine the structures of such biologically-active natural products by using a variety of scientific instruments. Once the natural product's structure is determined, the relationship between biological activity and structure can be studied by synthetic chemistry, and by comparison with similar compounds (if any are known). This work has been successful on both commercial and science fronts. While extracts with commercial potential are subject to commercial sensitivity and are developed with New Zealand funding, "pure" science research can be pursued with international support.

In addition to screening native plants for potential pharmaceuticals and agrochemicals, we are also involved in a programme to evaluate plants as harvestable and sustainable new crops. This includes both native and introduced plants that produce volatile essential oils or other useful extracts. Manuka (*Leptospermum scoparium*, family Myrtaceae), valued for its antibacterial properties, is probably the most well known of the essential oil-bearing natives that we have studied. In addition, work undertaken by the Crop & Food Research in Palmerston North has involved developing varieties of *Leptospermum* for use as ornamentals. The essential oils research programme has also examined variation of the volatile oils of various northern hemisphere herbs, including coriander, lavender, thyme and sage. Many of these plants that produce volatile oils show quite large variability in the composition of the oils. This can be due to either genetic differences (including different chemical types that are often used in "chemotaxonomy" to define species boundaries) or to natural variation in response to season or local environment.

During a screening of some of the members of New Zealand's unique subantarctic flora, we were able to investigate the chemistry of the essential oils of the genus *Anisotome* (family Apiaceae or Umbelliferae). This research started with the analysis of essential oils from the subantarctic mega-herbs *A. antipoda* and *A. latifolia*. The composition of these oils included monoterpenes, sesquiterpenes and phenylpropanoids. These classes of compound are also found in many of the introduced essential oil-bearing plants, like the mints, oregano and eucalypts, which are valued for their antimicrobial and/or flavour and fragrance constituents.

Investigation of the mainland species of *Anistome* found that they also contained volatile oils, though these were more gum- or resin-like. An "alpine carrot", *A. flexuosa*, collected from the Mt Earnslaw area in Central Otago contained high levels of a gummy diterpene acid. While this

[1]Crop & Food Research, University of Otago, P.O. Box 56, Dunedin, Tel: 03 479 8354, Fax: 03 479 8543
Email: perryn@crop.cri.nz www.crop.cri.nz/plantex

***Figure 1. The coastal South Island and Stewart island species,* Anisotome lyalli.**

was not unusual (pine trees also have 20-carbon compounds in their resins), the structure of the *Anisotome* carbon skeleton has not been seen before. Nothing like it has been reported from anywhere else in the world, so we have named the skeleton anisotomane after this New Zealand genus.

This unique carbon skeleton must arise from an unprecedented biosynthetic route and this has provided a new area of exploration in science. Examining how plants use the basic building blocks from photosynthesis to produce complex secondary metabolites is an area that has only recently been applied to New Zealand plant natural products. Improvements in the sensitivity of scientific equipment, the use of *in vitro* (sterile) culture and isotope labelling experiments have enabled insights into, and often elucidation of, complex biosynthetic pathways. This approach was recently used to confirm the highly unusual coupling of the chemical compounds from which the irregular anistomane skeleton is formed in *Anisotome lyallii*, one of the coastal species. This research was supported from a German scholarship in collaboration with Professor Hans Becker at the University of Saarbruecken in Germany.

The new class of diterpene compounds from *Anisotome* has not yet shown any useful biological activity in medicinal and agrochemical assays, but it could have ecological importance to the plants. Interestingly, various weevils and moths are specialist feeders on alpine carrots. Research undertaken in collaboration with Dr Christian Zidorn of Innsbruck University (Austria) has shown that the new compound, and related compounds, are present only in the genus *Anisotome*, but not all *Anisotome* species. Since the New Zealand Apiaceae differ from most other members of the family in their tendency to hybridise, it would be interesting to study hybrids between anisotomane-containing and anisotomane-free taxa. During this work another member of the family Apiaceae was also studied, the New Zealand giant spear grass, *Aciphylla scott-thompsonii*. It also contains a compound with an unusual carbon skeleton, that of a long-chain polyacetylene, unlike anything found elsewhere. To what degree *Aciphylla* (spear grass) is related to *Anisotome* (alpine carrot) is not clear, since the chemical taxonomy is not well defined.

We are continuing to collaborate with other scientists in this field, and given the distinctive nature of New Zealand's flora, it is likely to yield further strange and unique compounds to excite the curiosity of the international science world. For more information, please contact Nigel Perry using the information shown above.

Acknowledgements

We thank the Department of Conservation for permission to collect plant samples. Funding from Deutsche Forschungsgemeinschaft (DFG) to Christian Zidorn is gratefully acknowledged, as is support from the New Zealand Foundation for Research, Science and Technology (Contract C02X0002) to Nigel Perry, and an Alexander von Humboldt Fellowship to John van Klink.

Nigel Perry became interested in natural products during his university studies in England, but decided there was more scope for discovery in New Zealand. He climbed rimu trees to get samples during his PhD research at the University of Otago. After that, he went on SCUBA diving trips all around the country, and under the Antarctic ice while working on marine animals, especially sponges, at the University of Canterbury. In his current job, running the Plant Extracts Research Unit in Dunedin for Crop & Food Research, Nigel has collected samples from the West Coast rainforests to the sub-alpine herb fields.

John van Klink was born and raised in Christchurch. He was employed by Crop & Food Research in Dunedin, primarily to analyse the composition of essential oils and medicinal herbs. This interest led to PhD work on the antibacterial components of manuka. John also currently works for Crop & Food Research at the Plant Extracts Research Unit.

Figure 2. One of the subantartic mega-herbs,* Anisotome latifolia*, which grows in relatively inaccessible places on Auckland and Campbell Islands.