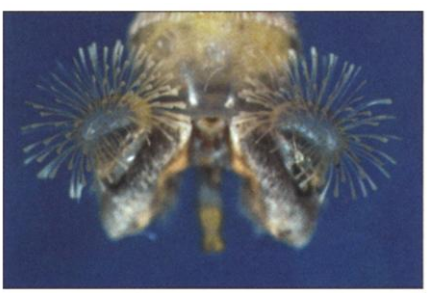
Chemical Ecology: Missed Opportunities?

Chemical ecology, a discipline emergent during the past half century, is now an established reality. It is a discipline driven by the recognition that organisms of the most diverse kinds, ranging from microbes to mammals, make use of chemicals to find mates, recruit symbionts, deter enemies, and fend off pathogens. Chemical ecologists endeavor to decipher both the chemical structure and the information content of the mediating molecules. The field is continuing to foster exciting exploration at the interface of natural products chemistry and biology and has come to affect profoundly our view of the living world. Our own reliance on visual and acoustic signals notwithstanding, it is by way of molecules that most organisms communicate; the vocabulary of living things is overwhelmingly chemical in nature.

The field of chemical ecology is now undergoing a major directional change. A new dimension has been added to its objectives, in direct consequence of its expansion into the contemporary domain of molecular biology. Much is expected of this novel branch of chemical ecology, variously designated as molecular ecology or chemical biology. The signal molecules that convey information from one organism to another are biosynthesized under genetic control; deciphered at specific receptor sites; transduced into neuronal, neuroendocrine, or phytoendocrine signals; and eventually, after triggering intermediate cascading effects, translated into behavioral, physiological, or morphogenetic responses. Each step can be dissected at the molecular level; by clarifying the underlying molecular mechanisms, the "new" chemical ecology is destined to make its mark. Breakthroughs, both in the elucidation of gene function and in the understanding of ligand and enzyme structure, are already in the making; and applied benefits in such diverse fields as pest management, medicine, and ecosystem health management are foreseeable. Partnerships between genome biologists and chemical ecologists will likely be extremely synergistic.



Scent brush of a male moth, *Utetheisa ornatrix*

There is, however, a downside to these developments. The danger is that the fundamental ecological branch of chemical ecology, the branch one might call revelatory, is being deemphasized. Revelatory chemical ecology is, very largely, the exploratory branch of the discipline. Its practitioners are latter-day naturalists dedicated to characterizing biodiversity and discovering new chemical interactions, and natural products chemists intent on identifying the mediating signals. Working together and driven by common interest, these scientists have provided a first sketch of the immensely complex communicative landscape that forms the backdrop of life. But the sketch so far is only the ghost of an image. Most organisms have themselves yet to be discovered, let alone the intricacies of their chemical interactions.

The potential for revelation in this unknown domain is at an all-time high because of the increased sophistication and sensitivity of the analytical instruments now available. Nanogram samples of messenger molecules may suffice nowadays for analysis, and vastly improved techniques are available for isolating components from mixtures. The ability to characterize unknown natural products has increased astronomically.

Unfortunately, now that the proper analytical tools are available and affordable, some universities and funding agencies are backing away from support of chemical ecology and natural products chemistry. Institutions in which the field of chemical ecology has flourished for years have allowed their traditional strengths in the area to wither, and natural products research is being phased out or downsized at major pharmaceutical companies. This retreat is especially ironic in that it is occurring just when other nations are increasing their investment. Indeed, U.S. institutions might do well to follow the example of Germany, where a new Max Planck Institute has been founded in chemical ecology. The yield from this discipline is especially important given our increasing concern for environmental quality: Chemical ecology can contribute much to our understanding of the workings and health of the biotic world.

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