which are often associated with refinery emissions. However, the survey conducted in the southern industrial corridor suggests that the refineries are unlikely to be the source. Furthermore, the two odours appear to originate from different sources.

The rotten cabbage odour occurs in Merewent under south-westerly winds and is most likely related to an upwind wastewater treatment works. The occurrence of rotten egg odours on the sea-facing slopes of the Bluff under north-easterly winds is most likely related to a source further north along the coast, similar to the long-distance paper mill odour described earlier.

Oily odour signature

The oily odour occurs only in the Merewent and Austerville areas, which are in close proximity to the oil refineries, and more particularly to their holding ponds. Wind conditions were calm to light northerly at the time that the complaints were registered and hence favour a local source.

Conclusions and recommendations

The foul air patterns described in this article are based on a limited set of complaint data. Conclusions drawn are applicable to the period analysed and may not necessarily reflect the longer term or the current pattern of complaints. Some characteristic odour signatures and patterns of distribution have been identified. Further investigation is needed to verify the probable sources in each case. It is recommended that this be done through detailed documentation of case studies of odour occurrences. Notification of an incident as it is experienced could be followed up with a detailed investigation of the characteristics of the odour, such as its duration and geographical extent. Coupled with a knowledge of meteorological factors, such as wind and stability, sources can be identified.

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South African mayflies – a renewed emphasis

Helen M. Barber-James

The importance of phylogenetic and biogeographic studies in understanding the biodiversity of mayflies was an underlying theme during the VIIth International Conference on Ephemeroptera. Systematics is a much neglected discipline in South Africa, and our ecological work suffers as a result. This is particularly so in the freshwater field.

The VIIth International Conference on Ephemeroptera, held at the University of Maine in August 1992, has put South Africa on the map of mayfly biology once more. Papers delivered at this conference dealt with every conceivable aspect of mayfly biology. Most applied studies related to water quality. A small section dealt with morphology, and the majority of the presentations covered phylogenetics, systematics or faunistics. Some papers covered life-history studies and others behaviour and ecology. Fifty-five papers were presented over three days, and delegates represented 21 countries.

The two previous occasions South Africans had any interaction with the international ephemeropterist community were in 1973, when J.D. Agnew and H.J Schoonbee attended the first Ephemeroptera conference, and in 1979, when Agnew attended the third meeting. Neither biologist has continued in this field and progress in the understanding of South African mayflies and their taxonomy has remained virtually dormant since then.

The first major step forward in South African mayfly biology was the three-month visit to this country in 1990 of the world renowned ephemeropterist, Professor W.P. McCafferty, from Purdue University, Indiana. His visit, combined with a workshop on the identification of freshwater invertebrates organized by F.C. de Moor of the Albany Museum, Grahamstown, brought freshwater biologists from around the country together to discuss mutual problems with identifications of freshwater invertebrates. McCafferty's visit highlighted how poorly our South African mayfly fauna is understood, and how little we know about the classification of our own mayflies. Impressions on the status of the South African mayfly fauna were presented in a poster presentation at the Maine Ephemeroptera conference and will be published in the conference proceedings.[1]

Freshwater biologists must have an understanding at the species level of the organisms they're dealing with. It is essential that fauna is properly identified before any worthwhile ecological work can be done. Without this the faunal biodiversity cannot be gauged, and its significance never realized. Therein lies the importance of systematics, and Europe, North America and Australia are far ahead of South Africa in this respect. Undescribed species of mayflies are still being encountered in many parts of the world, even in countries that have supported intensive research for many years. However, in such instances there are usually many more trained personnel to deal with them, and useful applied studies, for example on water quality, can be carried out with a good degree of predictive accuracy. South Africa, despite being advanced in many areas of technology, lags behind with the Third World in this respect. Conceptually, North American aquatic biologists are about 20 years ahead of us, having long since tackled these problems.[2]

Our mayfly fauna, and aquatic fauna in general, needs to be much better understood before ecological studies can give reliable answers. This would avoid money being wasted on studies that have no foundation, where far-reaching decisions are based on unsound data. Identification of specimens to generic level is not adequate for ecological surveys since there are many differences between the species within one genus. Wrong impressions can be created, for example, by extrapolating data gathered for one species and expecting others, even in the same genus, to follow suit. Resh and Unzinger[2] give a clear example of this in their discussion on the variations between the trichopteran genus *Athripsodes* in North America. Seasonal changes should also be considered as some species will be present throughout the year, whereas there will be a seasonal succession of others. The life histories of

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species need to be known, as do the habitat requirements and behavioural differences between species, and such information has not yet been documented for much of the South African fauna. This should be done before we can use a species predictively in the applied fields.

Apart from a tentative key to the genera of South African mayfly nymphs compiled in 1990 (McCafferty, unpublished), South African freshwater biologists are basing their identifications on descriptions and keys produced in the 1930s and 40s. Although these older studies are mostly of a good standard, they are often outdated by the revisions carried out by overseas systematists on related species. Phylogenetic studies have thrown much light on the relationships between the mayflies of the world, and many taxa have been sunk and others created to produce a more natural classification. This bears direct relevance to the South African fauna. Whole genera have been sunk (for instance, African *Centroptilum* spp. have become *Afroptilum* spp.[3] because *Centroptilum* was a paraphyletic group, with true *Centroptilum* having a Holarctic distribution, although it is still possible that true Centroptilum may be represented in Africa. In addition, some members which were originally in *Centroptilum* have been placed in separate genera, such as *Acanthiops* and *Demoulinia*. Therefore, the grouping of Ephemeroptera into natural taxa is gradually progressing. The average South African freshwater biologist, having little training in systematics, has not kept up to date with the new literature, and wonders at the confusion he's faced with.

The question of which taxon a newly collected mayfly belongs to remains the key issue in practical terms. Unless aquatic biologists are able to accurately identify the specimens they encounter, the new classification becomes nothing more than an academic exercise. Taxonomic information needs to be channelled to the biologist in a user-friendly form, with many annotated illustrations and photographs to clarify areas of uncertainty. A team of mayfly biologists in Switzerland[4] have achieved just that with the Swiss mayflies – a simple but comprehensive book which introduces the morphology of both the nymphal and adult stages and goes through the general biology, including life history, behaviour, feeding, and nymphal habitats. It also looks at collecting and storage methods for mayfly material. After dealing with the phylogenetic classification, a list of Swiss species is presented, with tables summarizing various ecological facts about each species. Keys to family, genus and species for nymphs and adults follow. Whole nymphs of each species are illustrated, with magnified details of salient diagnostic features. Characteristic features of adults are also drawn. Photographs of both nymphs and adults are presented in a series of colour plates.

This is exactly what we are aiming at for the South African mayflies – something that even someone who is relatively inexperienced can use and yet be fairly certain of the resulting identification. However, our current lack of knowledge and expertise means that this is a long-term aim, and the production of such a guide will not be feasible in the foreseeable future. Many parts of South Africa have not yet been properly surveyed, and when a new area is investigated, unidentified species are collected each time. For example, in a preliminary survey of the rivers of the north-eastern Cape, Barber-James[5] found that of 41 species of mayfly collected, about 20 species were undescribed. Before much else can be done, our streams need to be surveyed and our newly found species described and related to the world fauna. This must be done with great care and by knowledgeable systematists to avoid misplacement of new taxa and further confusion in the future.

A technique widely used overseas to help clarify dubious species groups is the examination of mayfly eggs using scanning electron micropscopy. This could prove to be a useful additional tool for identification of at least some South African mayflies, though mayfly eggs do not always show species-specific or even generic-specific morphological differences. It is not known what level of specificity is inherent in South African mayfly eggs. A potentially useful feature is that the eggs are fully developed in mature nymphs and usually exhibit no external differences whether from mature nymphs, subimagos or adults. They may therefore be useful in correlating the adult and nymphal stages, an important link in completing the understanding of a particular species, and often necessary to confirm identifications. The association of the adult and nymphal stages of a species is not always easy in field collecting, and is usually achieved by rearing mature nymphs through to the adult stage in the laboratory. This is not always successful because of the nymphs' sensitivity to changing thermal conditions when removed from their stream, and the final moult from the subimago to the imago is affected by changes in humidity (most subimagos are not sexually mature and are therefore no use diagnostically). The SEM approach may well be used in South Africa to sort out problem species but could be too expensive and time consuming as a routine identification method.

In summary, the systematics of South African Ephemeroptera is generally lagging behind that of First World countries. Indeed, this is true for most groups of aquatic insects throughout Africa. Although many projects involving freshwater organisms are being carried out here, there is a void of knowledge relating to these organisms. This problem cannot be solved overnight. The long-term solution is to encourage students to study the systematics and life histories of particular groups and thus build up such expertise in our country. It is regrettable that we have to rely on foreign experts to tell us about our fauna, and in the long run, an expensive way of doing things. Without local expertise, we may well continue to work in the dark, losing many species due to habitat alteration that we have never even known existed.

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