

Freshwater Biodiversity

Eumadicole midges – film stars of the freshwater world

Ian Boothroyd takes us on a tour of the stars' homes.

New Zealand has become famous for its film productions, and has produced its own fair share of celluloid heroes. Less well known are the film stars that inhabit some of the more unusual and secretive places of New Zealand. In this case the film is not the celluloid variety, but thin films of water that occur as seepages, cascades, waterfalls, and splash zones throughout New Zealand's diverse landscape.

Filmy habitats

In biological terminology, the madicolous – or hygropetric – habitat consists of a thin film of water flowing over a substrate, and generally includes splash zones. Hygropetric habitats are diverse, ranging from small waterfalls, margins of larger waterfalls, cliff faces, large boulders in streams, stream banks, spring and coastal seepages, and lakeside habitats. Animals living in these environments are called eumadicoles; some are restricted to this type of habitat only (obligatory eumadicoles) and others are opportunists in a variety of habitats (facultative eumadicoles).

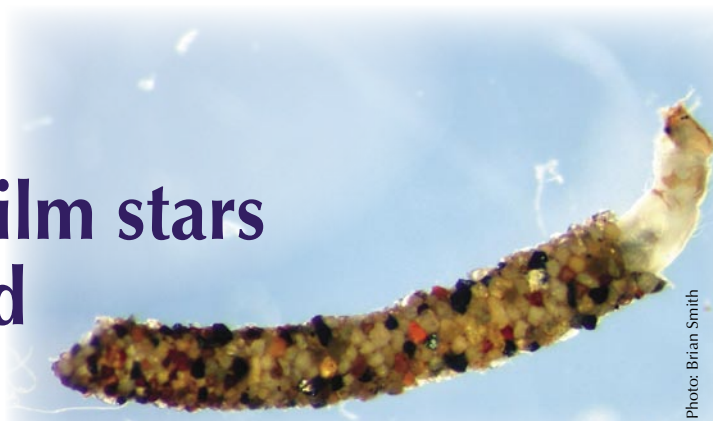
Eumadicole midges

Various freshwater organisms inhabit madicolous environments: snails, worms, caddisflies, and dipteran flies, including the chironomids or non-biting midges (Chironomidae). Most of the major groups of the Chironomidae are represented among the 47 madicolous midge species reported worldwide. Only five species appear to have a strictly madicolous habitat and one New Zealand species belongs to this exclusive group of chironomids.

Non-biting midges

Non-biting midges are two-winged flies (Diptera) and form the Family Chironomidae. The mosquito-like flies are common inhabitants of almost all freshwater environments throughout the world. Although the adult flies (which form large swarms) can reach nuisance proportions in some circumstances, these midges form an important component of the biodiversity and ecological processes of aquatic ecosystems.

The life cycle is comprised of an egg, larva, pupa, and adult. The adults rarely live for more than a day and do not feed, relying instead on the energy resources accumulated during the growth and feeding stages of the larva. Chironomid larvae are maggot-like and different species have adapted to a great variety of habitats, including the madicolous zone.



Stempellina larva in its case of sand grains.

Photo: Brian Smith

Blast from the past

The madicolous midges include some of the earliest chironomids, some of which are related to Gondwanan cousins in Australia and South America. *Maoridiamesa stouti* occurs only within the splash zone of large boulders in streams, within the wetted area exposed to the air, in the splash zone along the margins of waterfalls, and in seepages. With the exception of the adult, the entire life cycle, from egg to emerging pupa, is spent within this zone. Larvae occur close to the stream surface and migrate vertically with changes in stream water level, while pupae are cocooned within a silken case. The larva remains tethered to the substrate by a strong silk thread and can return to its original station if dislodged by flowing water.

Some like it hot

Eumadicole midges can also be found in the more extreme habitats of warm geothermal fields. A *Polypedilum* species inhabits the waters cascading over the sinter terraces (hard silica deposits) of geothermal fields of the Central Volcanic Plateau. This species lives in waters of up to 40°C, creating tubes on the surface of soft sediments in the small shallow gullies formed in the sinter.

Another inhabitant of the sinter beds is the ubiquitous *Paratrichocladius pluriserialis*. The larvae can be found beneath flakes of sinter where thin films of water and algae accumulate, warmed by the steaming ground and the species even pupates in this location. *P. pluriserialis* is a good example of a facultative eumadicole and is also common in the Waikato, Hawke's Bay, and Auckland. This species lives in a great variety of habitats including streams, cold springs, lakes, and wetlands, and is often found living attached to submerged plants and hard substrates.

Hydroslides

The varied topography of New Zealand means that streams take many different shapes and forms. Streams flowing off the Stockton Plateau of the west coast of the South Island form fast, shallow cascades of water over steeply inclined bedrock, like recreational hydroslides down the steep escarpment to the sea. This habitat is home to an *Eukiefferiella* species (as yet undescribed) which has only been found in this location.

Eumadicole midge habitats include (top to bottom):
geothermal sinter terraces,
urban concrete channels,
and boulder-strewn pastoral streams.

Like others of the genus, this particular species has additional hooks on the pupal abdomen. These enable a better holdfast to keep the silken cocoon attached within small holes in the bedrock, and thus protect the pupa from being swept away.

Concrete havens

Often described as having no ecological values, the concrete channels that make up much of our urban stream networks resemble hygropterid habitats. Especially at baseflows, water flowing within these waterways spreads out to form a thin film over the flattened and smooth concrete base. Within these flowing films live several species of chironomids including *Paratrichocladius pluriserialis*, *Tanytarsus*, *Chironomus*, and *Polypedilum* species.

On the beach

The seashore is not exempt from madicolous habitats. Midges inhabit the seepages and thin films of water that drip from the cliff faces and banks of rocky shores. *Semiocladus* is a marine midge found around the Pacific rim (including Japan, Australia, Hawaii), and around the New Zealand coastline. The adults of these midges can be seen swarming in small clouds above the rocky shore, while the larvae live and pupate on the vertical cliff faces and pools on rocky platforms, feeding on algal and bacterial films.

A star is born

Research into the biodiversity of seepages and springs has recorded a new genus of Chironomidae in New Zealand. *Stempellina* larvae construct long, curved, transportable cases out of fine sand grains, similar to small cased caddis larvae (see opposite page). The larvae resemble the commonly occurring

Tanytarsus but are readily identified by a finger-like shape on the antenna. *Stempellina* has a worldwide distribution, with about 14 species, and has been recorded from moorland pools, brackish waters, and even thermal springs.


Why eumadicoles?

The evolutionary advantage of living exclusively in this madicolous habitat is unclear. Food source seems to be limited; in many cases we assume that a very fine layer of organic (bacterial/algal) material on the substrate forms the food source. Potential competition for the food is reduced but other components of the aquatic community can also take advantage of this habitat. Similarly, predation pressure from other aquatic insects will be reduced but the risk of exposure to terrestrial and airborne predators will be increased by the habitat. Many eumadicoles breathe atmospheric air and this may provide the advantage of adapting to the madicolous environment.

The madicolous habitat may derive from New Zealand's geological history. Such habitats may have formed refugia during the Pleistocene ice ages when a succession of glacial and interglacial stages, tectonic activity, and fluctuating temperatures would have resulted in the local evolution of some endemic species. Adaptations to living in these habitats, which may have been greater in extent and distribution than today, would have been an advantage to survival.

Loss of habitat

The seemingly secretive madicolous habitats are often ignored and overlooked in stream surveys. This means that their extent and significance to aquatic biodiversity and ecosystem functioning is unknown. Furthermore, while these habitats might be perceived as commonplace, they are often very patchy in distribution. For example, the hygropterid habitat of *Maoridiamesa stouti* is very fragmented, with often only a handful of boulders in a single stream catchment providing suitable habitat, and may not occur at all in neighbouring catchments. Low flows resulting from abstractions or climate change may result in these habitats drying out, and infrastructure developments often cause complete loss of the local madicolous habitat.

The extreme patchiness of these habitats means that recolonisation may be limited – once habitat is removed and lost there is little opportunity for the organisms to return. Midge dispersal is by localised larval drift and movements within the waterbody, or by adult flight; although midges are generally not strong fliers, distribution from wind may be significant. Without localised sources it is unlikely recolonisation can occur once a madicolous habitat has been destroyed or modified. 



Photos: Ian Boothroyd

Dr Ian Boothroyd, formerly of NIWA, continues to contribute to NIWA's research on the biodiversity of freshwater organisms. He now works as an environmental consultant, and is also a senior lecturer at the University of Auckland.