

<http://www.treesforlife.org.uk/tfl.midge.html>

Highland biting midge

(*Culicoides impunctatus*)

This tiny insect is a major nuisance during summers in Scotland, but is also known as a guardian of wildness in the Highlands.

Worldwide distribution

The Highland biting midge is one of over 1,400 species of midges in the genus *Culicoides* which occur on every continent except Antarctica, and at elevations of up to 4,250 metres on Mount Everest. Apart from the polar regions, it is only in the far south of South America and in New Zealand that *Culicoides spp.* midges are absent. Midges have existed on the planet for a long time: specimens related to species alive today have been found preserved in 120 million year old amber in Lebanon.

Culicoides impunctatus has been reported as occurring in Europe from Scandinavia south to Spain and Portugal. However, because of the challenges in positively identifying this species, its actual distribution is still unclear.

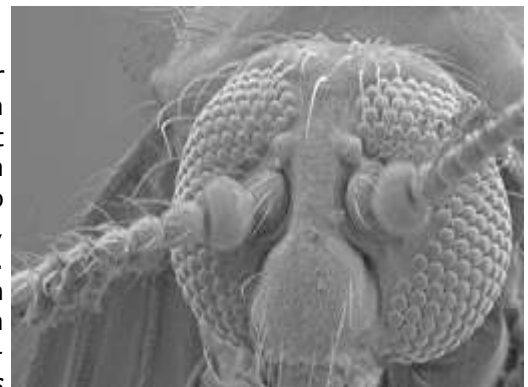
Throughout their range, midges are known by a variety of common names, including no-see-ums (in North America), knotts (Norway), biting gnats and sandflies, while in Gaelic they are called *meanbh-chuilleag*, meaning 'tiny fly'.

Distribution in Scotland

In Scotland 37 different species of *Culicoides* midges have been recorded. *Culicoides impunctatus*, which is responsible for up to 90% of the bites on humans, occurs throughout the country, although it is most abundant in the west and the north, where the boggy and acidic ground provides an optimal environment for breeding. Midges are at their most numerous at lower elevations, and are seldom encountered above about 500 metres, where the wind reduces their ability to fly.

Physical characteristics, life cycle and behaviour

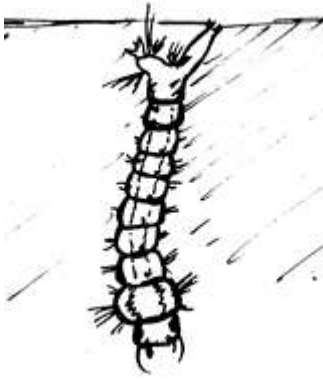
The Highland biting midge is a member of the order Diptera, which is the scientific classification for flies with two wings. It is very small in size, with a wingspan of about 1.4 mm., a body length of slightly less than that and a weight of about 0.5 microgram. The midge has two compound eyes, each with numerous facets, and its legs, antennae and parts of its body are covered in small hairs. The transparent or membranous wings contain six or seven dark blotches and these form a distinctive pattern which differentiates the Highland biting midge from closely-related species, such as the garden midge (*Culicoides obsoletus*). When it is at rest, the midge's wings are positioned over its back, with one wing on top of the other, like the blades of scissors when they are closed.



Close up of the head of a midge, showing the compound eyes, and the base of the antennae

The Highland biting midge begins life as an egg which is laid in summer on moist soil, often characterised by rushes (*Juncus articulatus* and *J. acutiflorus*). The eggs are laid in batches of 30-100, 5 days after the female is fertilised, and the larvae hatch within a day and burrow into the watery top layers of the soil. The larvae are both omnivorous and detritivores, feeding on other larvae, nematodes, protozoa and green algae, as well as dead organic material. Each larva goes through 4 stages of growth, or instars, which are separated by moults, and it passes the winter in the final instar stage, when it is about 5 mm. long. Triggered by increasing temperatures and hours of daylight, the larva enters the pupal stage for 1-2 days between mid-May and July. Inside the

pupa, metamorphosis takes place, and the midge emerges as a flying adult, with a lifespan of 20-30 days.



The larva of the Highland biting midge lives in the watery top layers of the soil

In conditions which are ideal for larval development, midge densities reach extraordinary levels, with a hectare of land estimated to contain up to 24 million larvae. In one study, 500,000 midges were collected, emerging from an area of just 2 metres by 2 metres. Midges do not generally disperse far from their breeding grounds, although they can be carried a kilometre or more in gentle breezes. At wind speeds of over 8.8 kilometres per hour (5.5 miles per hour) midges are unable to fly, and will land on ground vegetation or tree trunks.

Adult midges rely mainly on the nectar of flowers for their energy source, but may also feed on the sap wounds of trees and rotting vegetation. The main imperative of adult midges is to reproduce, and the males sometimes form swarms, in which they may be stimulated by the sound of the females' beating wings. Copulation lasts for 2-3 minutes, and after fertilisation the females require a meal of blood for the eggs to develop fully. This bloodsucking, or haematophagous, behaviour involves feeding on mammals, typically **red deer** (*Cervus elaphus*) or cattle, and, to a lesser extent, sheep. Other mammals, including humans, are fed upon when the opportunity arises.

Research has shown that, in her quest for blood, the female midge is attracted to dark-coloured moving objects, particularly where they are associated with carbon dioxide, which is given out in the breath of mammals. In addition, the midge has a well-developed olfactory sense, which it uses to detect the presence of several chemicals in the body odour of humans and other mammals, such as acetone and lactic acid.

Once prey has been located, the midge cuts through a soft area of skin with specialised mandibles and mouthparts. The mouthparts are then rolled into a tube and inserted into the wound, to suck up the blood. If the midge is undisturbed it will drink for up to 4 minutes, by which time the abdomen is distended and swollen. When she has found a blood meal, the female midge releases a chemical called a pheromone, which acts as an attractant to other females. This leads to mass attacks, involving hundreds or even thousands of individuals, at the height of the midge season in July and August.



A female midge with an engorged abdomen, filled with blood

Midges are crepuscular in their behaviour, meaning that they are most active around dawn and dusk, when light levels are reduced. Light is the most significant environmental factor for their biting activity - on a bright sunny day, few midges may be encountered, but on a dull, overcast day, substantial numbers may bite, even in the middle of the day.

Two other aspects of the midge's life cycle contribute to its proliferation in the Highlands. The first is that the midge can lay its first brood of eggs without requiring a blood meal, thereby enabling the female to reproduce quickly after hatching. In addition, research has shown that although the full cycle from egg to mature adult normally takes 10 months or so, eggs laid by females early in the season pass through the larval stages quickly and emerge as adults in late summer. In September, midge numbers decline, and the first frosts of autumn kill off those which still survive, thereby leaving the Highlands free of their most notorious inhabitant until the following May.

Ecological relationships of the Highland biting midge

Although it is so numerous, the Highland biting midge is not a major food source for any insectivorous animals or birds. Pipistrelle bats (*Pipistrellus pipistrellus*) do eat insects in the midge family, but these only form a small part of their diet. Similarly, birds such as warblers (*Phylloscopus spp.*) and swifts (*Apus apus*) will feed on midges, but this is rare due to their small size and crepuscular habits. Midges are a food source for insectivorous plants such as sundews (*Drosera spp.*), of which there are 3 species in Scotland, and butterworts (*Pinguicula vulgaris*). These plants flourish in the wet, acid soils where midges live, but the numbers of midges caught by them are a minuscule fraction of the annual population. Midge larvae are fed upon by the larvae of other Dipteran flies and by the larvae of Coleoptera (beetles), but again the numbers eaten are insignificant.



It has been suggested that in the past, when Scotland was mostly forested, midge numbers were lower than today, and that, following the loss of the trees, the increased water content in the soils provided the opportunity for the midges to proliferate. If this theory is correct, it could explain why there are no species which take advantage of the huge numbers of midges - there may not have been enough time for the process of evolution to produce a midge-eating specialist.



A recent discovery in Skye and Argyll is that the larvae of two species of red mites (*Parafeiderium stuarti* and *Centrotrombidium blackwellae*) are parasites on adult midges, and this has led to speculation that they could be utilised to provide a biological control for the midge hordes.

As a **haematophagous parasite**, the midge has a significant effect on the animals it preys upon, and in the summer, for example, red deer are forced to move up to high ground to avoid being bitten. However, it is on humans that the midge has its greatest effect, and one which is seemingly out of all proportion to its tiny size.

Scanning electron micrographs of a Highland biting midge

It has been estimated that up to 20% of the summer working days in outdoor jobs such as forestry are lost due to midge attacks. Even a simple task such as tying bootlaces becomes impossible when midges are at their worst. For the summer months of the midge season, this minuscule insect, by dint of its biting habit and sheer numbers, is a dominant factor in life out of doors in the Highlands, causing significant changes to human behaviour. There is a positive side to this though, as the midges have undoubtedly contributed to keeping the north and west of Scotland sparsely populated, and therefore as wild as they still are today.

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