

Identification

British land flatworms

Hugh D Jones

Land flatworms may be small and slimy, but they can be quite spectacular. Relatively little is known of their biology. Even basic information, such as what they feed on, is lacking for some of them. Most people in the British Isles had never heard of land flatworms, sometimes called terrestrial planarians, until an alien species, the New Zealand Flatworm *Arthurdendyus triangulatus*, hit the headlines a few years ago. It made the news because it had become common in Northern Ireland and parts of Scotland and because it eats earthworms which are considered to be beneficial creatures. However, no fewer than 14 species of land flatworms have been found in the British Isles – so far! Only three or four species are probably native, the rest having been introduced from various parts of the world, largely as a result of international horticultural trade. Some survive in this country only in hothouses. The British Isles, with a damp and mild climate, are especially suited to these animals, and it is quite likely that more species will be found and will become well established.

What are land flatworms?

Land flatworms belong to a group, the Platyhelminthes, which also includes aquatic free-living species and two parasitic groups, the flukes and tapeworms. Land flatworms are generally smooth

Rhynchodemus sylvaticus. The narrow, pointed, raised end is the head. The two eyes are just visible as black dots on each side on the head. Hugh Jones

and slimy. Smaller ones are frequently mistaken for small slugs, but slugs have four head tentacles and a textured mantle. The body may be nearly circular in cross-section (most of the smaller species) or flattened and ribbon-like (most of the larger species). The body narrows towards the head end, which is blunt in some and tapers to a fine point in others (in one case, the head is expanded laterally). The head end is generally lifted off the ground, apparently searching from side to side, as the animal crawls. When crawling, flatworms are 2-4 times longer than when resting. Movement is a smooth gliding, powered by microscopic cilia on the underside, or by muscular contractions passing along the whole body (not dissimilar to an earthworm). They leave a thin mucus trail, similar to that of slugs. Eyes may be visible, under magnification, as tiny black spots, but they are often obscured by body pigmentation. All the native British species have a single pair of small or large eyes near the front (family Rhynchodemidae). Most of the introduced species have many eyes down both sides, right to the posterior end (family Geoplanidae), but one introduced species has many eyes and the head is expanded into a half-moon shape (family Bipaliidae).

When I found my first land planarian (in my garden), I had no idea what it was other than a worm of some sort. It was yellow, about 3cm long

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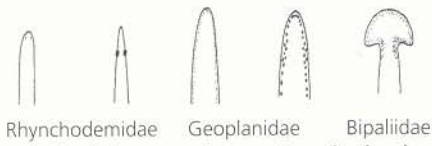


Figure 1 Head shape and eye pattern in the three families of terrestrial planarians.



Close-up of the head end of a species of *Australopacifica*, showing the multiple eyes (small black dots). Hugh Jones

and 1mm wide, and had a patch of blackish pigment at the front end. Under a stereo microscope two small black dots were clearly visible at the front – the eyes. It was completely smooth and I could see no body openings whatsoever. One expects to see a mouth or something at or near the front end of most animals. However, the mouth (more correctly, the pharyngeal aperture) of land flatworms is halfway to two-thirds of the way along the underside, and when closed is a tiny, almost invisible slit. When the animal is feeding, a muscular pharynx protrudes through this opening.

Charles Darwin was one of the first to study these animals, and he was wrong in one important

respect. In the *Voyage of the Beagle*, he states that land flatworms (he used the name *Planaria*) ‘were found, even in the drier parts of the forest, beneath logs of rotten wood, on which I believe they feed.’ Later he writes, ‘Some specimens which I obtained at Van Diemen’s Land (Tasmania), I kept alive for nearly two months, feeding them on rotten wood.’ In fact, all land flatworms are predators or scavengers, feeding on a variety of soil creatures such as earthworms, slugs, snails, insects and woodlice.

In some, the pharynx is cylindrical and seems to penetrate the prey when feeding. In others, the pharynx is folded when retracted and when feeding is wrapped around the prey. In both, powerful digestive enzymes are secreted and the resulting ‘soup’ is sucked into the gut, where further digestion takes place. Inside the body, the pharynx opens into a gut with an anterior branch and two posterior branches (triclad), each of these three having numerous short side branches. The anterior one reaches almost to the anterior end, and the two posterior ones almost to the rear end. This is necessary because flatworms have no circulatory system and food must be distributed to the extremities of the body. There is no other opening to or from the gut.

All land flatworms are hermaphrodite, with a variously complex copulatory apparatus towards the rear of the body which operates through a single opening, the gonopore, on the underside behind the mouth. There is a single pair of ovaries, usually near the head, and a pair of oviducts runs almost to the rear end, where the two join and open to the atrium inside the gonopore. There are many pairs of testes.

Sperm are carried in a pair of ducts back to the penis, which, during mating, is protruded through the gonopore. It is believed that reciprocal mating takes place, each one of a mating pair fertilising the other.

Fertilised eggs are laid in the soil in shiny oval egg capsules. These are initially red or brown and erupt through the back of the animal, but within hours turn black. Those of small species are only 1-2mm long and may resemble some plant seeds, but those of larger species may be 5mm long and look rather like

The New Zealand Flatworm *Arthurdendyus triangulatus*. A typically coiled resting specimen. The coil is about 2cm in diameter. Hugh Jones



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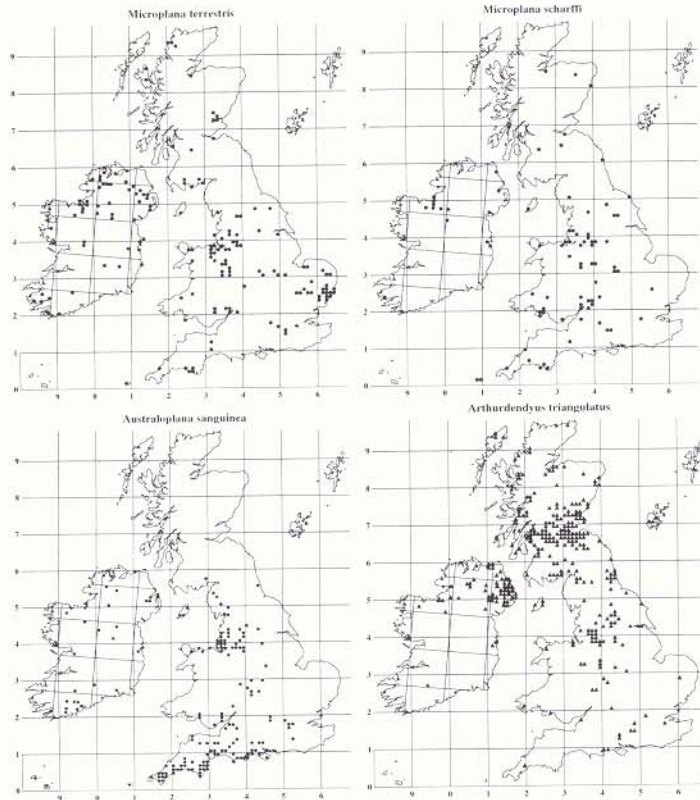
blackcurrants. After some weeks, 5-10 juveniles hatch from each capsule. Darwin did not observe sexual reproduction but he did note that, if a land flatworm was cut in half, 'in the course of a fortnight, both had the shape of perfect animals'. This regenerative property is well known in flatworms generally, and some land flatworms use fission and regeneration as a means of reproduction. They split in half, or a small posterior portion detaches, and each portion grows into an entire worm.

Where to look and what to look for

Look for land flatworms under objects (logs, planks, paving stones, plastic sacks, grow-bags, chipboard sheets) lying on soil, particularly in damp, shaded areas. (Always seek permission of the landowner, and always replace any objects turned over.) Small patches of slime or narrow slime trails may indicate their presence, but of course slugs leave similar trails. Look closely at any small, slug-like organism. If it has tentacles on its head and a textured skin, it is a slug. If it has no tentacles and a smooth skin, then maybe it is a land flatworm. Since some of them are scavengers, one way of finding them is to squash a slug, woodlouse or earthworm under a stone and look a day or two later.

What to do

Collect any suspected specimens into a small airtight container (e.g. specimen tube, aspirin pot, margarine tub), together with a little damp soil, moss or other vegetation. **Keep them cool – in the fridge.** Have a good look at them with a hand lens or stereo microscope if you have one. If you have access to macro-photography (still or video – most camcorders are superb at macro), take close-up pictures on a natural background (damp wood is good, or a large leaf), with a scale object (coin or ruler). Digital photos can then be e-mailed.



Distribution maps (10km squares) of the four most widespread species of land flatworms. These are from my own records, contributed to by many people. Maps prepared using DMAP (Dr Alan Morton, Blackthorn Cottage, Chawridge Lane, Winkfield, Windsor SL4 4QR)

If necessary, specimens can be preserved in 70% alcohol (methylated spirit will do), but worms may contract strongly. They can be killed in hand-hot water, which minimises contraction, and then put in alcohol. Place a label, written in pencil, **INSIDE** the specimen tube, giving date, location, etc.

A specimen of *Bipalium kewense* about 20cm long descending from a leaf. After the tail has left contact, they can continue to descend on a string of their own mucus. Hugh Jones



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The following have been recorded from the British Isles.

Species with two eyes, family Rhynchodemidae (all except the first are probably native species)

Dolichoplana striata Moseley, 1877

5-10cm long (exceptionally to 20cm), less than 1mm wide. Six dark lines on a pale brown background. Eyes on the side of the head. This markedly long and thin species has been found only in hothouses at Kew and in heated vivaria at Jersey Zoo (also several places worldwide). An introduced species; origin Sri Lanka or south-east Asia. Rarely mature, apparently reproduces by fission. Food unknown, but maybe earthworms.

Microplana humicola Vejdovsky, 1890

0.5cm long, white with greenish anterior. Probably native, but its tiny size means that it is markedly under-recorded, with only three UK records (Devon, Norfolk, Northumberland), but it could occur almost anywhere. Also recorded from mainland Europe. Feeding unknown.

Microplana scharffi (von Graff, 1896)

2-5cm long, 1-2mm wide. Round in cross-section and smooth when extended, but slightly flattened and creased when contracted. The eyes are tiny black dots at anterior end, which is whitish and translucent. Unfed specimens are bright yellow, with a small blackish patch just behind the head; after feeding on earthworms they may be quite pink or, after feeding on slugs, yellow-grey. A native species, very widespread in the UK (see map). Also found in the rest of Europe and has been introduced to USA. Apparently a scavenger, feeding on dead slugs and earthworms.

Microplana terrestris (Müller, 1774)

1-2cm long, 1-2mm wide. Plump and round in section when extended, anterior end blunt. Black, dark grey or brown (I suspect that the brown ones are in fact another species). This is a native flatworm and is the most common and widespread UK species, being found almost anywhere in the UK (see map). Also occurs in the rest of Europe. Scavenger, feeding on dead slugs and earthworms.

Rhynchodemus sylvaticus (Leidy, 1851)

1-3cm long, 1-2mm wide. Round in section. Black or dark grey, with two black dorsal lines and a central dark patch. Tapers to the markedly slender head with two large eyes on the side, and slight neck. Head and neck may have circular corrugations (looking almost segmented). Head is held above the ground and waved from side to side when crawling (the 'snake-headed flatworm'). Probably native. Several widely scattered UK records. Also Europe, USA and Bermuda. I have observed it feeding on woodlice.

Species with multiple eyes, family Geoplanidae (all introduced)

Arthurdendyus albidus Jones & Gerard, 1999

8-12cm long, 3-5mm wide. Uniform creamy white. Innumerable minute eyes. Found in two gardens in Scotland (but now seems to be extinct in both). Origin probably New Zealand, but has yet to be found there. Eats earthworms and reproduces sexually.



Microplana scharffi. About 3cm long. The narrow end is the head. Hugh Jones



Microplana terrestris. About 2cm long. The narrower end is the head. Hugh Jones



Rhynchodemus sylvaticus. About 1.5cm long. Hugh Jones



Arthurdendyus albidus. On graph paper, thus about 13cm long. The black swelling near the posterior end is an egg capsule about to be laid. It erupts through the dorsal surface, which then heals. Hugh Jones

Arthurdendyus triangulatus (Dendy, 1895) The 'New Zealand Flatworm'

5-20cm long, 5-10mm wide, flattened. Dark brown with pale, spotted margin and underside. Innumerable minute eyes. Typically found resting in a flat coil. Many UK records, mostly from Northern Ireland, Scotland and northern England (see map). Origin South Island, New Zealand. Reproduces mostly sexually; the shiny black egg capsules are about the size of a large blackcurrant. Capsules can be found throughout the year, but are laid mainly in the spring. Five to eight pale juveniles, 6-8mm long, hatch after 2-3 months. Its name was changed in 1999 from *Artioposthia triangulata*. The reason is that

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both this and the previous species have complex ovaries which are adjacent to the copulatory apparatus, rather than near the anterior end as in most species.

It was first noticed in Northern Ireland and Scotland in the early 1960s, but there are unconfirmed reports from the mid-1950s in Edinburgh. One of the first reports from Northern Ireland was from a toilet bowl! In the 1980s it became abundant and widespread in Northern Ireland and central Scotland, and there are records from England and Wales.

New Zealand Flatworms feed almost exclusively on earthworms. Because of this (any reduction in earthworm populations is considered a matter of concern) and its abundance in some areas, much work has been carried out on this species and there is an extensive scientific literature. It seems that its major effect is to eliminate the large, deep-burrowing and long-lived species of earthworm, but the smaller, shallower-burrowing and rapidly reproducing species are largely unaffected. It probably arrived in the British Isles from New Zealand by way of plant pots and the horticulture trade. I have recently been contacted by someone who worked in a New Zealand plant nursery. He reports that Camellias used to be exported to the UK in non-sterile growing medium which could have been the method of transfer. Within the British Isles, it is distributed mainly by such transfer, and nurseries and garden centres take precautions to minimise the risk. It is an offence under the Wildlife and Countryside Act knowingly to distribute this species.

***Australopacifica coxii* (Fletcher & Hamilton, 1888)**
1-2cm long, 1mm wide. Cylindrical or oval. Black, with iridescent blue flecks and two narrow iridescent blue lines close to the midline. Eyes relatively large, in a single row, 30-40 each side. Five dark lines ventrally. UK records only from the Isles of Scilly and Penzance. Origin Australia. Feeding unknown.

***Australopacifica* sp.**
2.5cm long, 1-2mm wide. Clear yellow, with reddish-brown front tip which grades to grey and then faint grey mid-dorsal line. Many eyes. A single specimen was found in October 2000 in a florist's shop in Penzance, on a tree fern imported from Victoria, Australia. The flatworm was immature, so could not be identified to species (even if it had been described). It fissioned and the tail grew a new head. Unfortunately, both died and autodigested to a pulp before being preserved. I fed it on mealworms.

***Australoplana sanguinea* (Dendy, 1891)**
The 'Australian Flatworm'
2-8cm long, 2-5mm wide, flattened. Orange (or pinkish-orange after feeding) with pink front end. Innumerable minute eyes. Many UK records, mainly in the south-west and the north-west (see map). Eats earthworms. A ten-year study in a domestic garden near Southport has been carried out during which flatworms were collected from under the same paving stones and planks three times a week. A total of 5,121 Australian Flatworms was found, with peak numbers in November (average 215) and fewest in June, July and August. These numbers are correlated with rainfall and soil moisture. Over all that



***Arthurdendyus triangulatus* ('New Zealand Flatworm').** Two extended specimens, each about 10cm long. Hugh Jones



***Australopacifica coxii*.** About 2cm long. Hugh Jones



***Australopacifica* sp. from a florist's shop in Penzance.** About 2.5cm long. The brown end is the head. Hugh Jones



***Australoplana sanguinea*.** ('Australian Flatworm'). About 7cm long. Hugh Jones

time only three egg capsules were found, and it is suspected that it reproduces mainly by fission, the rear half breaking off and regenerating.

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Caenoplana coerulea. About 3cm long. The vivid blue ventral colour is visible, hence 'coerulea'. Hugh Jones



Kontikia andersoni. About 1.5cm long. Hugh Jones



Kontikia ventrolineata and *Bipalium kewense* (Bipaliidae). The former about 1.5cm long, the latter much coiled. Hugh Jones



Bipalium kewense. Close-up of the head. Head width about 6mm. Hugh Jones

Caenoplana coerulea Moseley, 1877

2-3.5cm long, 1-2mm wide. Flattened oval. Dark purplish-brown with dark cream median line, anterior pinkish, ventral intense cobalt-blue. Many eyes. The only UK record is from a hothouse in Liverpool. Origin Australia. Eats snails.

Kontikia andersoni Jones, 1981

1-2.5cm long, 1mm wide. Oval or cylindrical. Pale brown with three rows of darker brown spots, median row narrower than the lateral rows. Relatively large eyes in a single row. Records from Northern Ireland, Isle of Man, Cornwall, Isles of Scilly and Irish Republic. Origin unknown, but may be Australia or New Zealand. Feeding unknown.

Kontikia ventrolineata (Dendy, 1892)

1-2cm long, 1-2mm wide. Oval to cylindrical. Black with two narrow pale grey lines close to the midline. Four dark lines ventrally. Many eyes, but difficult to see because of the mainly black body colour. UK records from Liverpool, Cornwall and Guernsey. Also Irish Republic, USA, Hawaii, New Zealand, Australia. Origin Australia. Eats small snails and maybe slugs. Recently observed in Cornwall scavenging on a squashed hawkmoth caterpillar.

With many eyes and expanded, half-moon-shaped head, family Bipaliidae (introduced)

Bipalium kewense Moseley, 1878

5-35cm long, 3-5mm wide. Head expanded laterally (the 'moon-headed' flatworm). Buff-coloured with five dark purple stripes. Unmistakable amongst British species owing to the head shape and the large size (there are over 200 other bipaliid species from south-east Asia, India and Madagascar). Scattered UK records, mostly from hothouses. First described from Kew Gardens. Originally from south-east Asia, but now has a worldwide distribution through human agency. Eats earthworms. Reproduces in the UK by fission, the last 2-4cm detaching and growing a head.

Further reading

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- Jones, H D 1998 The African and European land planarian faunas, with an identification guide for field workers in Europe. *Pedobiologia* 42: 477-489
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- Jones, H D, & Boag, B 2001 The invasion of New Zealand flatworms. *Glasgow Naturalist* 23 (Supplement) 77-83
- Jones, H D, Santoro, G, Boag, B, & Neilson, R 2001 The diversity of earthworms in 200 Scottish fields and the possible effect of New Zealand land flatworms (*Arthurdendyus triangulatus*) on earthworm populations. *Annals of Applied Biology* 139: 75-92

Hugh Jones retired from the University of Manchester in 2003. He is a Scientific Associate of the Natural History Museum, London. He continues to research land flatworms, currently from Bermuda and southern Africa, as well as the British Isles. He can be contacted by e-mail: flatworm@btopenworld.com