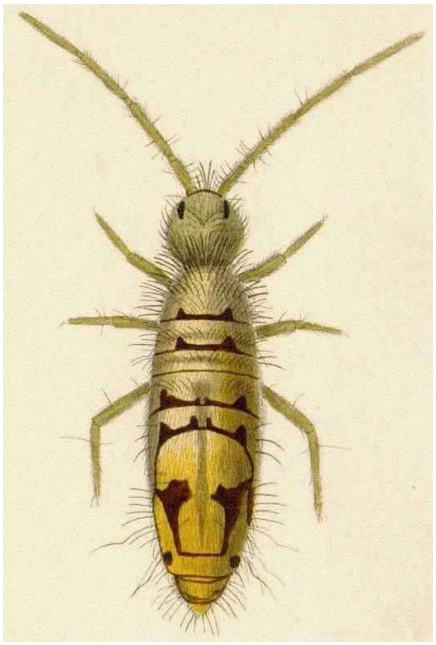
# Neglected insects in Bedfordshire: Collembola

## 15 Nov 2014



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# Springtails: aim for today

- Aim of today: to tell you about one of the commonest and most overlooked groups of animals in the UK.

..By way of a general introduction to the Collembola. Then a bit about Bedfordshire, and some research updates.

*Allacma fusca*

frontal aspect, showing the ventral tube or collophore and furca,
Hall, K. © 2005.

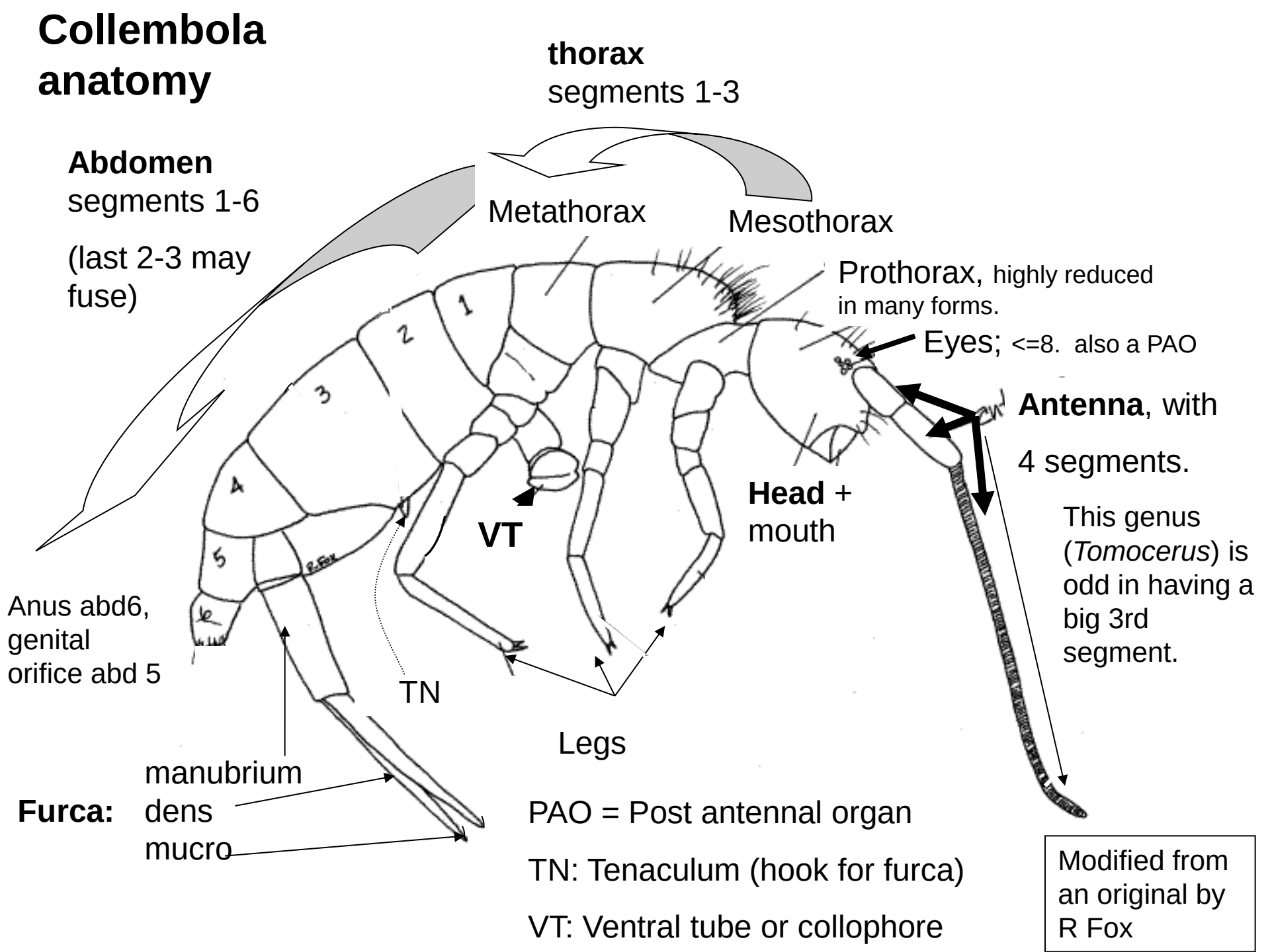
# Collembola (springtails)

These are among the oldest (evolutionarily) and least changed of all terrestrial arthropod groups.

The surface dwelling forms have an escape mechanism involving a unique jumping organ the **furca** (sometimes **furculum**), apparently fused vestigial legs that insert on abd. IV. This latches into a hook (**the tenaculum**) on abd III, stores energy and releases it to propel the animal's jump.

The diagnostic feature of the class is the ventral tube or collophore, which gave the group its name (Collembola = sticky peg).

# Collembola anatomy




PAO = Post antennal organ

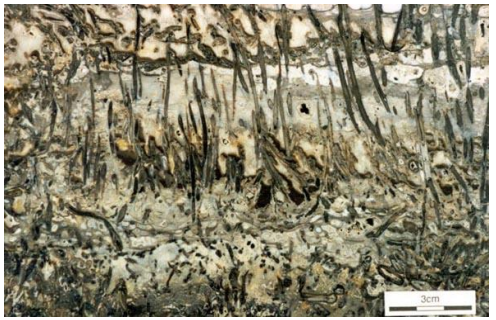
TN: Tenaculum (hook for furca)

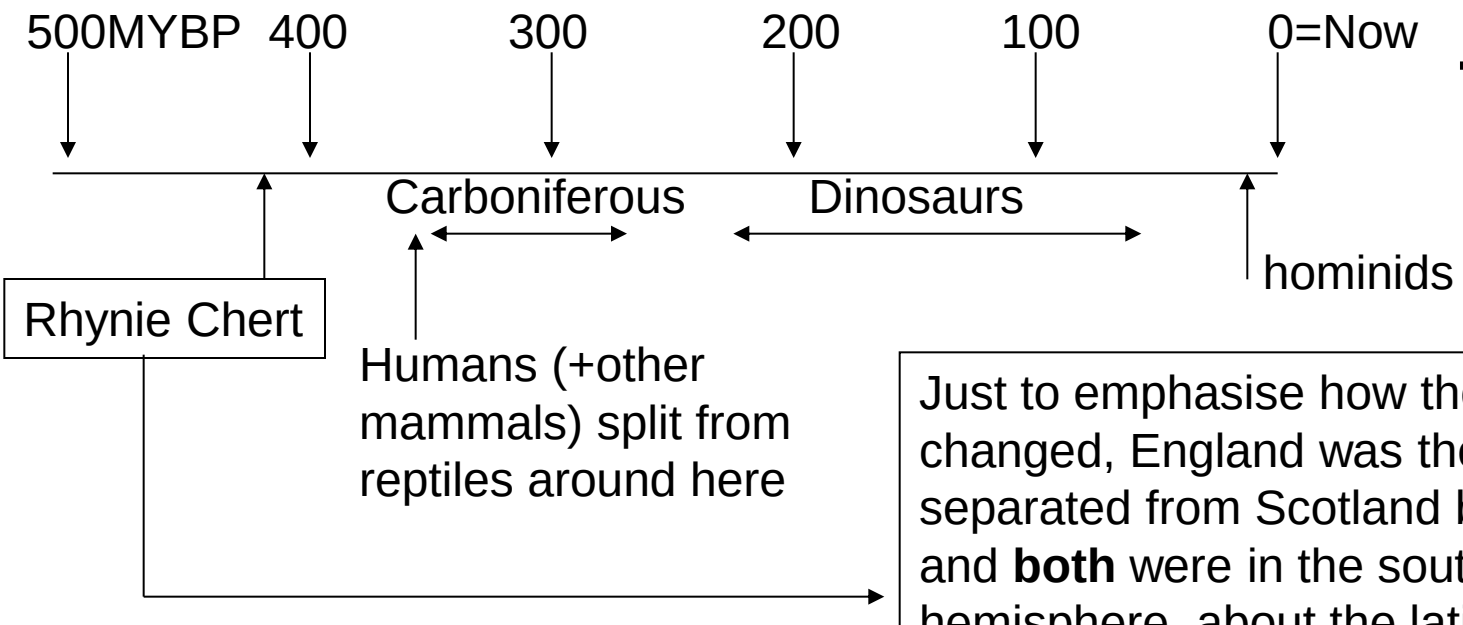
VT: Ventral tube or collophore

Modified from an original by R Fox

# The oldest hexapods in the world

Rhynie chert is one of the most famous (and inaccessible) fossil deposits in the earth's history. It was laid down in the Devonian, c. 410MYBP, at a time when the most advanced vertebrate was a fish, plants had just started to appear on land, and top predators were eurypterids. (CO2 was 10* modern levels too).





The Rhynie chert contains Springtail fossils – *Rhyniella praecursor*, plus probable remains of an opiliones (harvestman).

*Rhyniella praecursor*

Scourfield's diagram (1940)

reconstruction

# Taxonomic position

Older zoology texts call these animals apterygota – wingless insects. Hardly odd – they have 6 legs and run around on land, but lack wings.

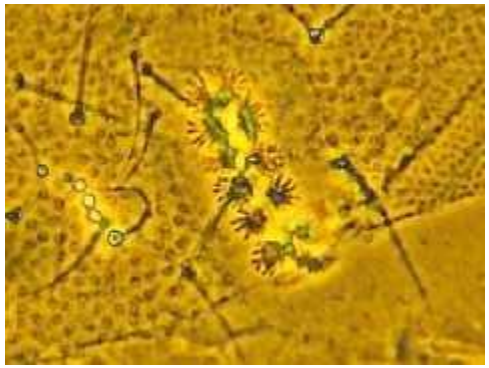
Their jaws are inside the head so they are classified alongside Protura and Diplura as “Entognatha”. Sadly this is looking unduly simple, and the alternative is that Collembola are a separate land radiation from early (anostracan?) crustaceans.

# Collembola – crustaceans??

On the face of it, they're not. Only 6 legs (on the thorax only), and just 2 antennae? Crustacea have legs on the abdomen and 2 pairs of antennae.

But their jumping organ (furcula) is fused abdominal legs, and latches onto the tenaculum which looks like it could be homologous with fused legs. The ventral tube looks like it derived from legs – one gene knockout returns it to legs.

The antennae are single, but there is a cephalic sensory organ, the Post Antennal organs PAO, which looks like the remains of the antennule.



*Deutaphorura inermis* PAO

*Orchesella cincta* with 8 legs, after 1 HOX gene is disabled.

Reproduction: Males deposit a spermatophore, and females take it into their genital aperture. Clearly this gives the female considerable leeway in her choice!

It may also explain the complex mating dances that have evolved in a few species, such as *Deuterosminthurus*. Sminthurides males have specially modified antennae to hold the female during mating.

*Deuterosminthurus* mating danc

Some tropical neanurids are very colourful

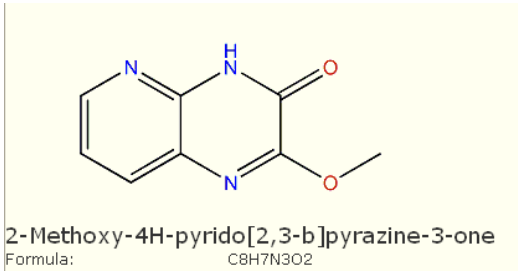
Paralobella orousseti
After Deharveng, L., 2002 ©

*Neanura takoensis* from China
after www.yellowman.cn., 2007 ©

*Orchesella flavescens* –
prettiest UK species?

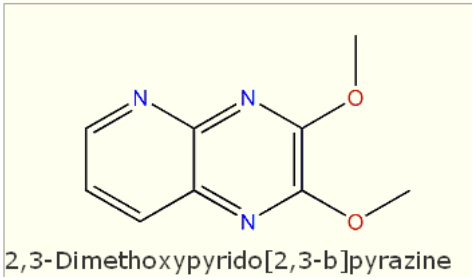
The biggest Collembola known is *Tetrodontophora bielanensis*, from the Urals, peaking at 9mm long.

*Tetrodontophora bielanensis*




2-Methoxy-4H-pyrido[2,3-b]pyrazine-3-one

Formula: C8H7N3O2




2,3-Dimethoxypyrido[2,3-b]pyrazine

# How many species?

Globally? No idea! Actually 6500 has been mentioned, but let's aim lower.

How many in the UK? As recorder, my list has 392 species (ignoring synonyms).

Going down this list and removing fictional, dubious and otherwise shaky records: 315 species.

Do I believe this? No! New spp are arriving, old ones being split. In the Onychiurids we REALLY don't know about spp richness at all; the field was plagued with false splits, but may hide molecular species.

| | |
|---|---|
| Brachystomella parvula (001 BRpar) | Xenylla corticalis (043 XLcor) |
| Ceratophysella armata (002 CEarm) | Xenylla grisea (044 XLgri) |
| Ceratophysella bengtssoni (003 CEben) | Xenylla humicola (045 XLhum) |
| Ceratophysella denticulata (004 CEden) | Xenylla longispina |
| Ceratophysella engadinensis (005 CEeng) | Xenylla maritima (047 XLmar) |
| Ceratophysella gibbosa (006 CEgib) | Xenylla mucronata |
| Ceratophysella granulata (007 CEgra) | Xenylla tullbergi (049 XLtul) |
| Ceratophysella longispina | Xenylla welchi (050 XLwel) |
| Ceratophysella rufescens | Xenylla xavieri (051 XLxav) |
| Ceratophysella scotica (010 CEsco) | Friesea acuminata (052 FRacu) |
| Ceratophysella sigillata | Friesea afurcata |
| Ceratophysella succinea | Friesea claviseta (054 FRcla) |
| Choreutinula inermis | Friesea emucronata |
| Hypogastrura assimilis (013 HYass) | Friesea mirabilis (056 FRmir) |
| Hypogastrura browni (013.5 HYbro) | Friesea truncata (057 FRtru) |
| Hypogastrura burkilli (014 HYbur) | Lathriopyga longiseta (058 LAlon) |
| Hypogastrura distincta (014.5 HYdis) | Monobella grassei (059 MOgra) |
| Hypogastrura elegans | Neanura muscorum (060 NNmus) |
| Hypogastrura lapponica | Paranura sexpunctata (061 PUsex) |
| Hypogastrura litoralis (017 HYlit) | Yuukianura aphoruroides (062 YUaph) |
| Hypogastrura manubrialis (018 HYman) | VACANT |
| Hypogastrura neglecta (018.5 HYneg) | Anurida denisi (064 ANden) |
| Hypogastrura packardi | Anurida ellipsoides (065 ANell) |
| Hypogastrura purpurescens (020 HYpur) | Anurida granaria (066 ANgra) |
| VACANT | VACANT |
| Hypogastrura sahlbergi (022 HYsah) | Anurida maritima (068 ANmar) |
| Hypogastrura serrata | VACANT |
| Hypogastrura socialis (024 HYsoc) | Anurida thalassophila (070 ANtha) |
| Hypogastrura tullbergi (025 HYtul) | Anurida tullbergi (071 ANtul) |
| Hypogastrura vernalis (026 HYver) | Anuridella calcarata (072 ADcal) |
| Hypogastrura viatica (027 HYvia) | Anuridella immsiana (073 ADimm) |
| Mesogastrura libyca (028 MElib) | Anuridella marina (074 ADmar) |
| Schaefferia cavernicola | Anuridella submarina (075 ADsub) |
| Schaefferia emucronata 'group' (030 SCen | Micranurida forsslundi (076 MIfor) |
| Schaefferia lindbergi | Micranurida granulata (077 MIgra) |
| Schaefferia longispina | Micranurida pygmaea (078 MIpyg) |
| Schaefferia pouadensis | Micranurida sensillata (079 MIsen) |
| Schoettella ununguiculata (033 SHunu) | Pseudachorutella asigillata (080 PLasi) |
| Willemia anophthalma (034 WLano) | Pseudachorutella clavata |
| VACANT | Pseudachorutes boerneri (082 PCboe) |
| Willemia buddenbrocki (036 WLbud) | Pseudachorutes corticicolus (083 PCcor |

# Taxonomic overview

## Class Collembola

Class level

Arthropleona (debateably taxonomically valid)

("normal springtails")

("globular springtails")

Poduromorpha  Entomobryomorpha  Symphypleona  Neelipleona

Order level

(few and tiny spp but common)

Basic Collembola body forms

Surface dwelling Entomobryomorpha:

These are often large (>2mm) forms with distinct colour patterns and well developed jumping organ. Commonly encountered genera are *Entomobrya*, *Lepidocyrtus*, *Tomocerus*, *Isotoma*.

Entomobrya

*Lepidocyrtus cyaneus*

Tomocerus

# Basic Collembola body forms

Surface dwelling  poduromorpha: medium-large, coloured, generally with furcula (but often small).

Less conspicuous than jumping forms but very common and widespread – *Neanura muscorum* is ubiquitous, secretes 1,3 dimethoxybenzene, phenol and 2aminophenol!

*Neanura muscorum*

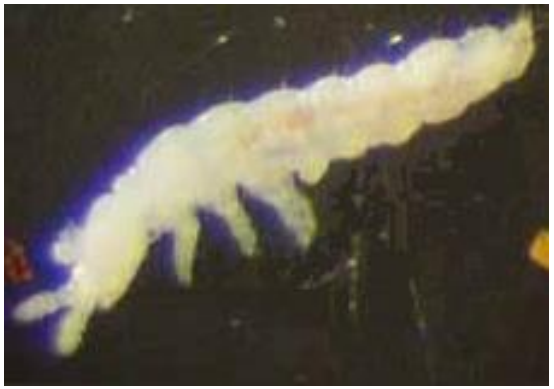
*3mm long*

# Basic Collembola body forms

Euedaphic poduromorpha: white, eyes reduced or absent, furcula tiny or (generally) absent.  The hardest group to ID!

*Protaphorura* (formerly Onychiurus) *armata*

*Mesaphorura* (formerly Tullbergia) sp



# Basic Collembola body forms

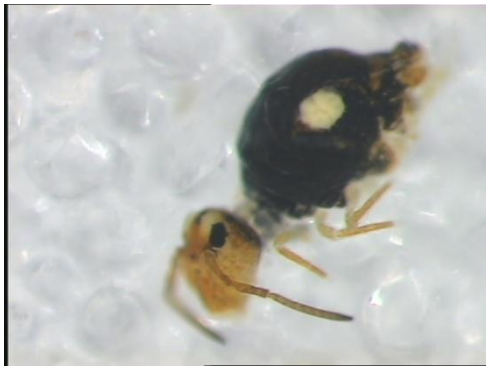
Surface dwelling symphylopleona medium-tiny, coloured, invariably with well developed furcula. “Lucerne fleas” (strictly = *Sminthurus viridis*).

*Dicyrtomina sp*

*Sminthurus viridis*

*Sminthurinus elegans*

*Sminthurinus trinotatus*



*Ptenothrix atra*

When symphypleona jump and land on their back, they protrude their ventral tube to 2* body length.

It has lateral vesicles which are sticky; they adhere to the substrate, and as they pull it in they right themselves.

Here we see one of the 2 sacs (vesicles) of the ventral tube: these can be used to groom the animal, to drink up water, and to pull itself up, to anchor: think of an elephant's trunk!  The tube can be retracted quickly – a lucky photo.  In alcohol these animals look disembowelled, but aren't!

Picture of a Dicyrtomina laying on its back using its everted sacs of the VT to pull it back on its feet



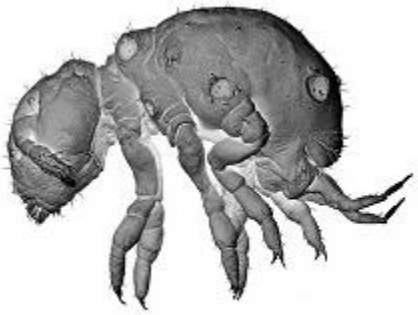
*Allacma purpurescens*

*Dicyrtomina saundersii*
drinking using its collophore

# Basic Collembola body forms

Euedaphic symphylopleona : white, small-tiny, reduced eyes, furcula present.

*Neelides murinus*



Megalothorax sp.
1999 © Walter, D.E.

*Megalothorax minimus* (next to *Pogonognathellus longicornis)*

# Lifestyles: feeding

Most Collembola are “detritivores”. This comes from finding a variety of particles + soil microbes in their guts. Most probably specialise in fungi but a few are micro-predators.

# Pests?

Most Collembola are blameless grazers on soil fungi. There are few old reports of springtails causing damage, usually attacking delicate young seedlings. At worst a nuisance.

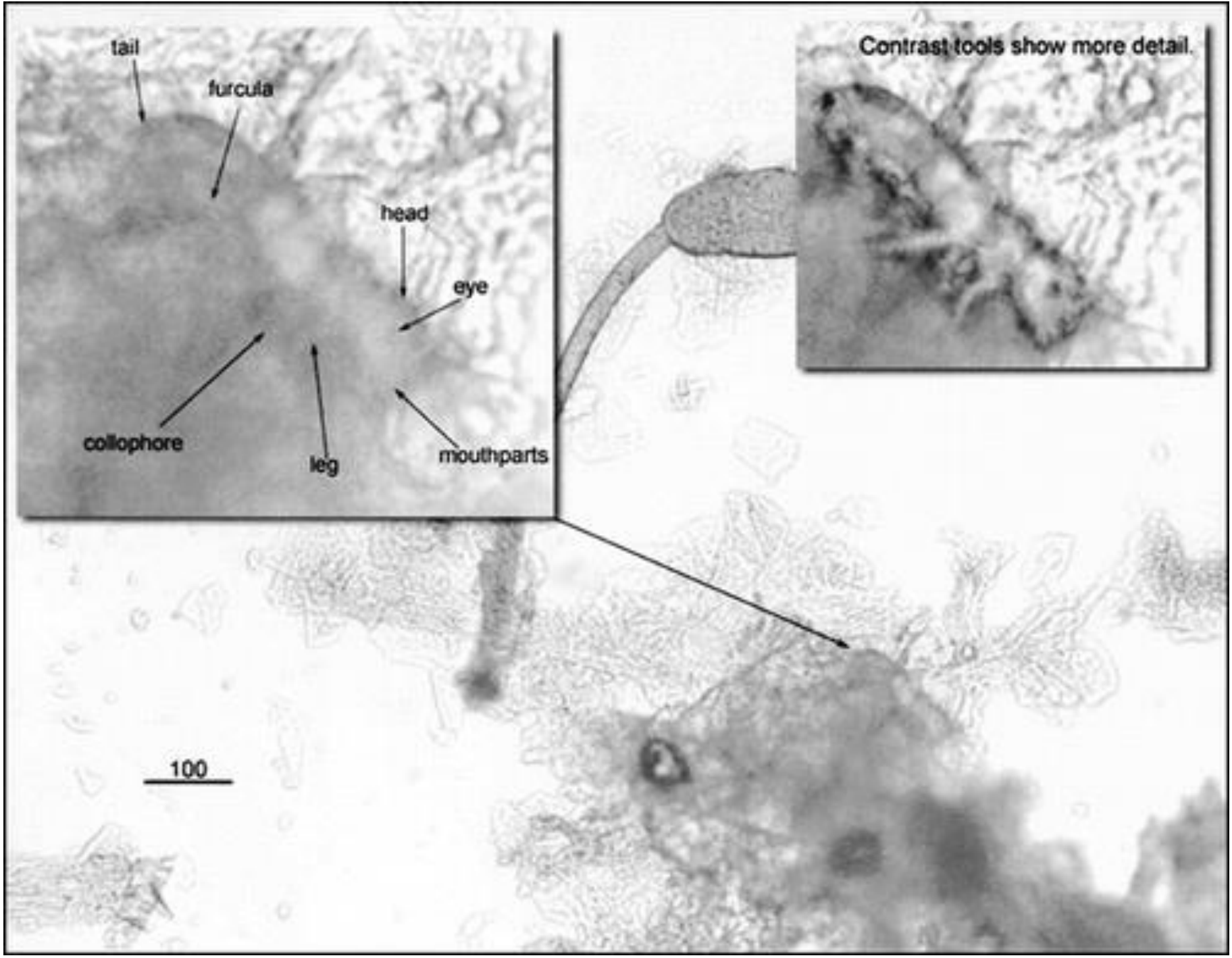
*Sminthurus viridis* does explode to pest proportions in New Zealand where it damages clover and alfalfa. Happened in Wales in 2012.

# Humans?

There is one case of an entomologist who pooted too hard and got *Isotoma olivacea* eggs in his nose – they hatched, 50 emerged, and made him quite unwell for a while.

The only credible Collembola-human zoonosis I've heard of! (One case of a woman with a scalp infestation was traced to an entomobryid-laden plant pot by the head of her bed!!)

Bizarrely there are a few cases in the wilder medical literature attributing human parasitoses to springtails. These are actually examples of delusory parasitoses – purely imagined, and the springtail-like shape in one flake of skin an artefact of preparation. I have been asked to survey a client for this once (until the university insurers heard the phrase "collect medical samples from a psychiatric patient"). Twaddle, they're imagining it. (I found one paper about skin collembola that referred to their pupae!) Search on Morgellons for a related delusional condition.


tail
furcula
head
eye
collophore
leg
mouthparts
Contrast tools show more detail.
100

http://www.usfreeads.com/538138-cls.html

There are three main types of skin parasites that often get misdiagnosed by the medical community. If you have felt like something was crawling on your skin or biting you but your doctor or dermatologist said there is nothing wrong, it may just be that they don't know how to properly look for scabies, collembola and morgellons disease.

**SYMPTOMS OF A COLLEMBOLA (SPRINGTAIL) INFESTATION**

Fatigue
Brain Fog, memory loss, difficulty thinking or concentrating
Mood Swings & Depression
Joint swelling and pain all over your body; Fibromyalgia
Visual decline
Autoimmune decreases
Hair Loss
Lesions that hurt and include inflammation
Hard Nodules under the skin
Itching, creepy crawly feeling
Organisms biting, moving & scratching under the skin
Sores that do not heal
Sleep Disorders

Gold standard unmitigated paranoia-inducing lies!!

Over abundance of lint or dust in the house; believed to be moulting by the springtail.

**Are scabies and springtails the same?** No, they are different parasites altogether. There is a big difference on how the scabies mite and the springtails move around. Springtails have more of a jumping action; where the scabies can only move approximately 2.5 cm per minute. It is not uncommon for people to see a springtail, if the light is just right, to jump from an arm to a leg.

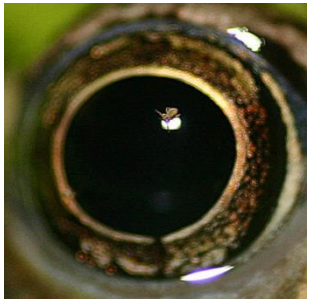
Additionally, we believe the skin crawling sensation may be due to the multiple flagella on the organism and the fibers are produced by the organism itself. One researcher claims that the organism is found widespread in bottled spring water from France. One study revealed that 1/3 of bottled waters are contaminated with this organism.

# Where to find springtails?

Most Collembola live in the soil, in or below the litter layer, declining rapidly as one enters the mineral soil.

*Orchesella cincta*

ON freshwater, the Neustonic community.



*Sminthurides aquaticus*

# Leaf surfaces and tree bark

Katiannidae sp nov

Richmond park,
April 2009

*Deuterosminthurus pallipes*
mating dance

*Entomobrya albocincta* –
rarely found
in the soil.

You will almost always find *Cyphoderus albinus* in any ants nest.

*Cyphoderus albinus*

You will find Collembola in the inter-tidal zone and deep in caves (but not in Bedfordshire).

*Schaefferia lindbergi* plus juvenile *Oligaphorura schoetti* top right © P Chapman
(in Ogof Ffynnon Ddu )

*Anurida maritima*

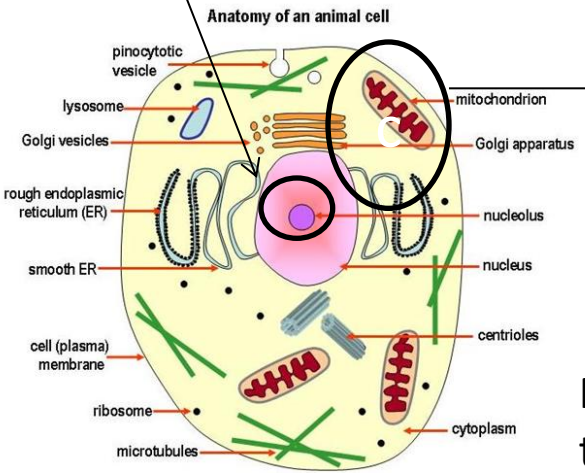
**A little research, showing how DNA can advance species boundaries.**

There is a standard DNA sequence that all animals must have, that bypasses sexual recombination, and that happens to evolve at a good rate for separating species: this is the molecular barcode sequence mtCOI, the mitochondrial oxidase I sequence, 658 BP that are being used to re- assemble  the tree of life.

Standard COI barcoding – the 658 bps of mt Cytochrome oxidase 1

In theory mt genes should amplify better than nuclear as there are 20-50* more copies. (Actually sometime COI is tricky to amplify)

Nuclear DNA

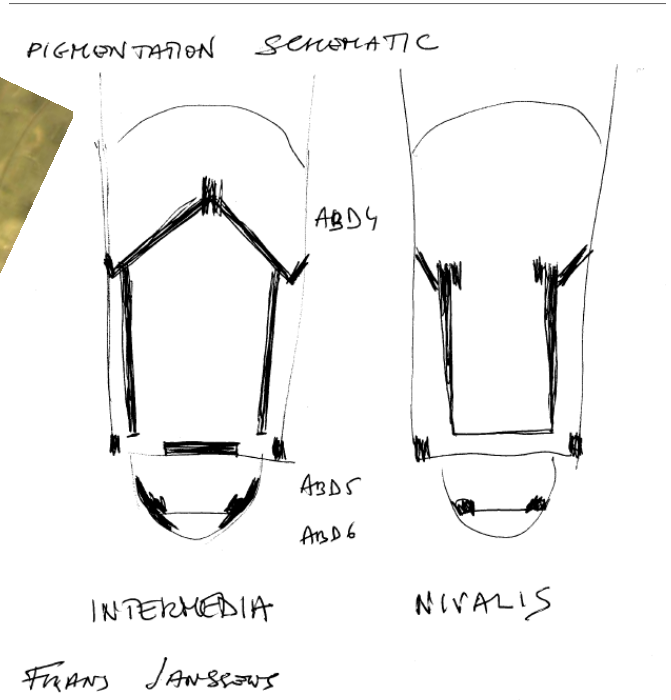



mitochondrial DNA

PCR up Cytochrome oxidase 1; get base pairs for the sequence flanked by COI- primers

Comparison with and entry to BOLD database, AMOVA and permutation-based tests to validate morphospecies boundaries

The FSC key omits the one of commonest springtails in the UK!! Not because Steve Hopkin didn't know its name, but at the time there was an older name for a very similar species: *Entomobrya nivalis* L. There is another name, *Entomobrya intermedia*, with a subtly different abd4 pattern.




To cut a long story short, I got funding to collect Entomobryas (+more) around the UK to see how well barcodes corresponded to morphospecies.

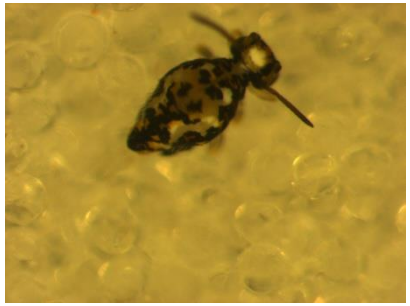
For the Entomobryas the answer is “pretty well!”. In particular the barcodes for *Entomobrya intermedia* and *E. nivalis* were clearly separated, parting about 2 million years ago.

Both species are widespread and common (*E. nivalis* tends to be more northerly, but they co-occur in most sites, at least in southern England).
Embarrassingly, the FSC key denies that *Entomobrya intermedia* exists, while its photograph of “*Entomobrya nivalis*” is in fact clearly an *E. intermedia.*

"The UK is undergoing invasions by waves of alien immigrants"

Not Nigel Farrage, but a widespread entomological observation.

Katiannidae
New to science
Heligan gardens 2009



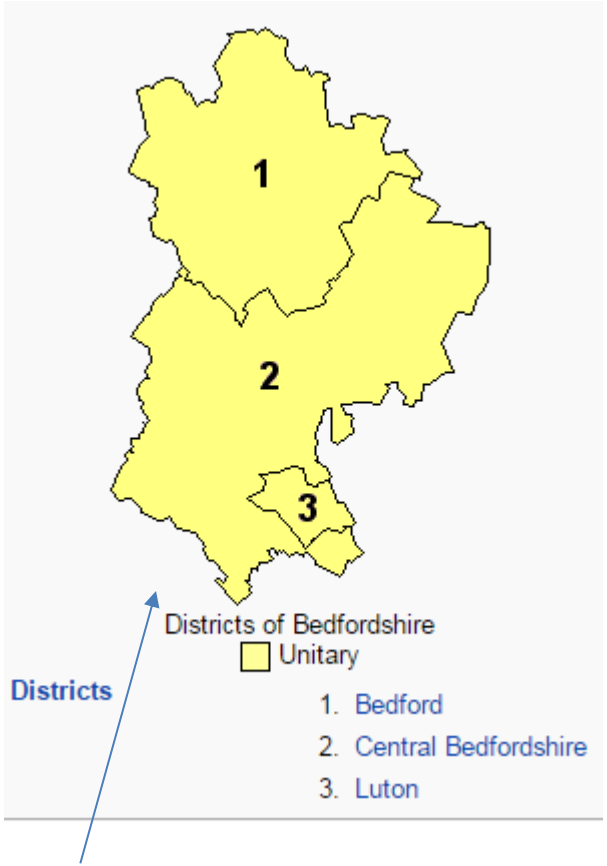
Katiannidae
New to science
Bodmin 2012

*Sminthurides bifidus* (?)
New to UK
Somerset 2012

So one thing to get is barcodes of these oddities. We've got a few, but haven't yet had many international hits.

*Calvatomina "superba"* (not same pattern as this species so probably *sp nov*) New to UK
Sheffield 2009,

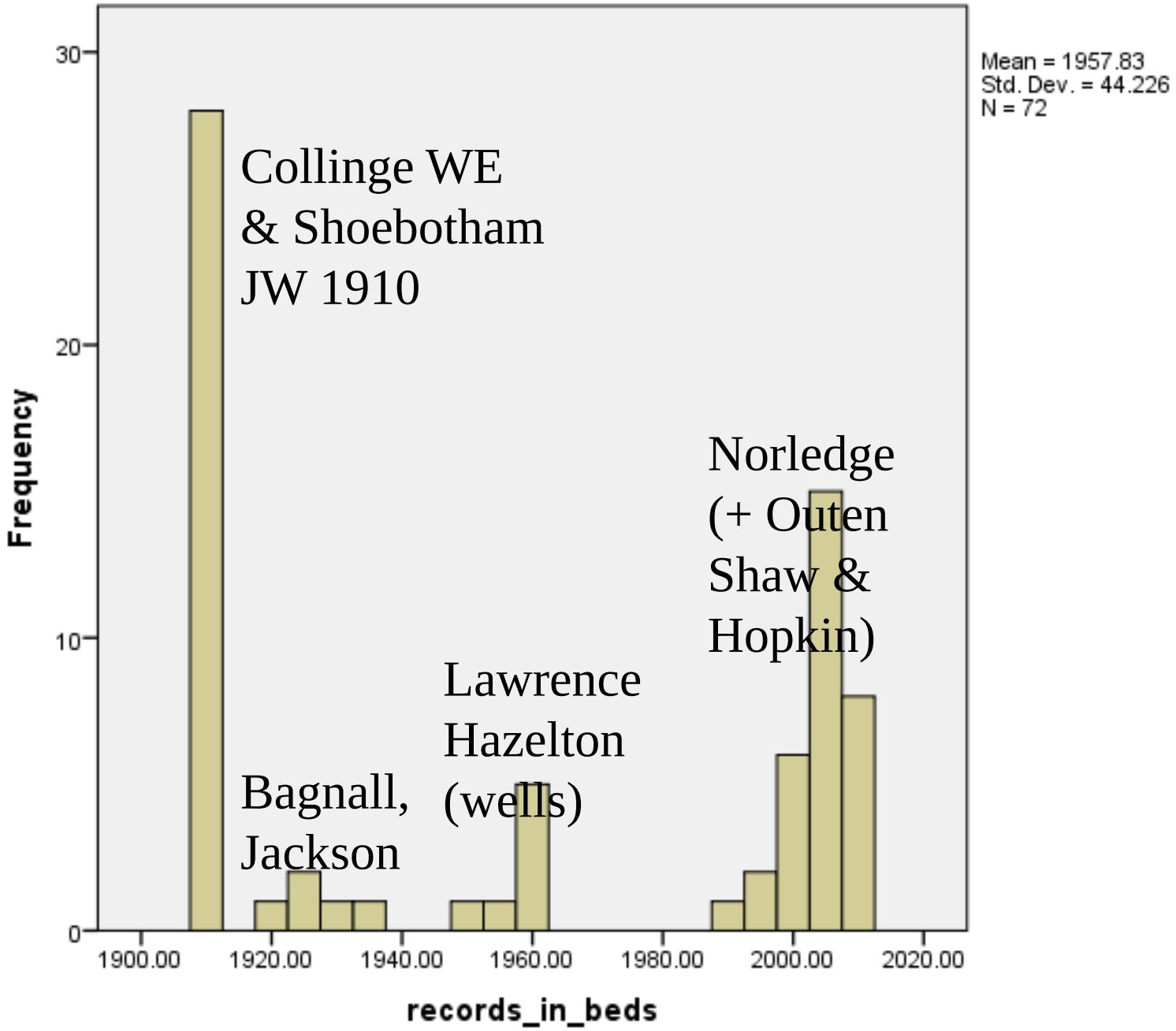
Bedfordshire records.




Rothamsted

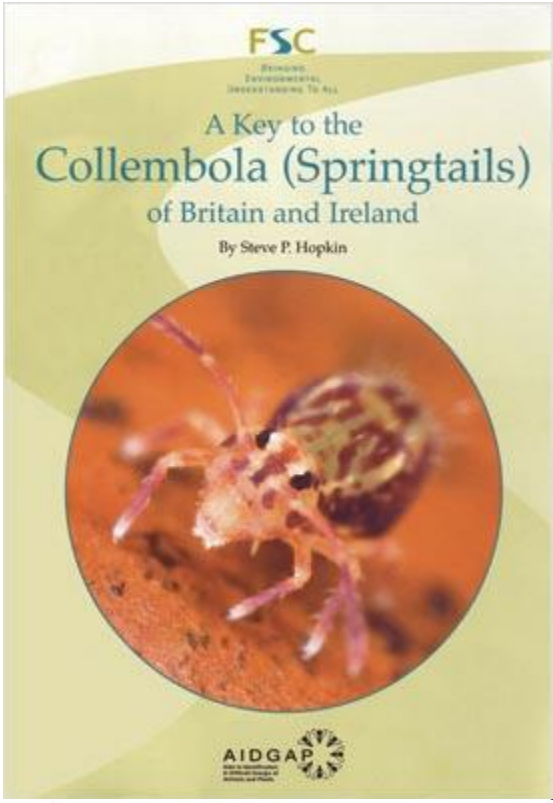
Beds is not a particularly big county. When I searched the UK database I used a rectangular fit, and picked up lots of records from Rothamsted, just outside your boundary.

Having deleted them, I have 113 records of 64 species of Collembola in Bedfordshire. Nothing very noteworthy I'm afraid. The only UK claim of *Pachytoma ultonica* is a 1931 collection from near Luton, but this is probably a short-lived immigrant 'tramp' species.


Mean = 1957.83
Std. Dev. = 44.226
N = 72
Collinge WE & Shoebotham JW 1910
Norledge (+ Outen Shaw & Hopkin)
Lawrence Hazelton (wells)
Bagnall, Jackson
Frequency
records_in_beds
0
10
20
30
1900.00
1920.00
1940.00
1960.00
1980.00
2000.00
2020.00

What I'd like from the entomologists of Bedfordshire:

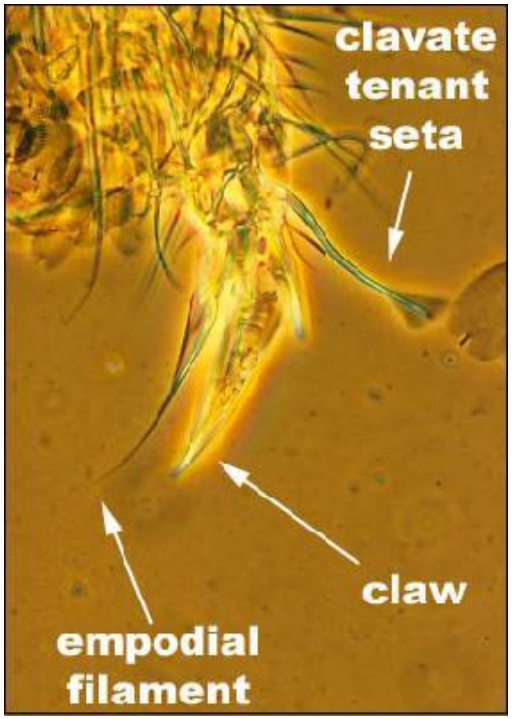
1: Get the FSC AIDGAP guide to Collembola (by Steve Hopkin RIP)




2: Put some leaf litter samples into a Tullgren apparatus and at least ID a few of the bigger easier springtails. (.. Then tell me!)

**One I'm sure you can get:**

*Pogonognathellus longicornis* is already the commonest Collembolan in Bedfordshire. If the antennae curl fully back, that's definitive. Ideally one should check the empodium of the foot, which uniquely has a long thin filament. Steve Hopkin's key calls it *Tomocerus longicornis.*



One I'd love you to find: Check the surface of old ponds, fens etc for *Podura aquatica*. Put dredged-out pondweed into a collector. Supposed to be common but I have only collected it once, and we have no Bedfordshire records.

*Podura aquatica*

Acknowledgements: funding from University of Roehampton, Linnean soc, Guild of St Ursula, UEA + Plymouth university

Thanks for listening and happy hunting!