Field Studies Council:
Soil Biodiversity Course

April 2017

Introduction to Collembola

Peter Shaw

University of Roehampton
London

Introduction

- Aim of the day: To introduce the main groups of UK Collembola and to give you experience of working through the FSC key to these animals, plus give you a chance to collect a few specimens!

Traditionally we assemble a complete Collembolan species list for the weekend, with specimens stored. So be sure to keep specimens safe until I can tell you whether it’s one for the collection.

Collembola (springtails)
Taxonomic position

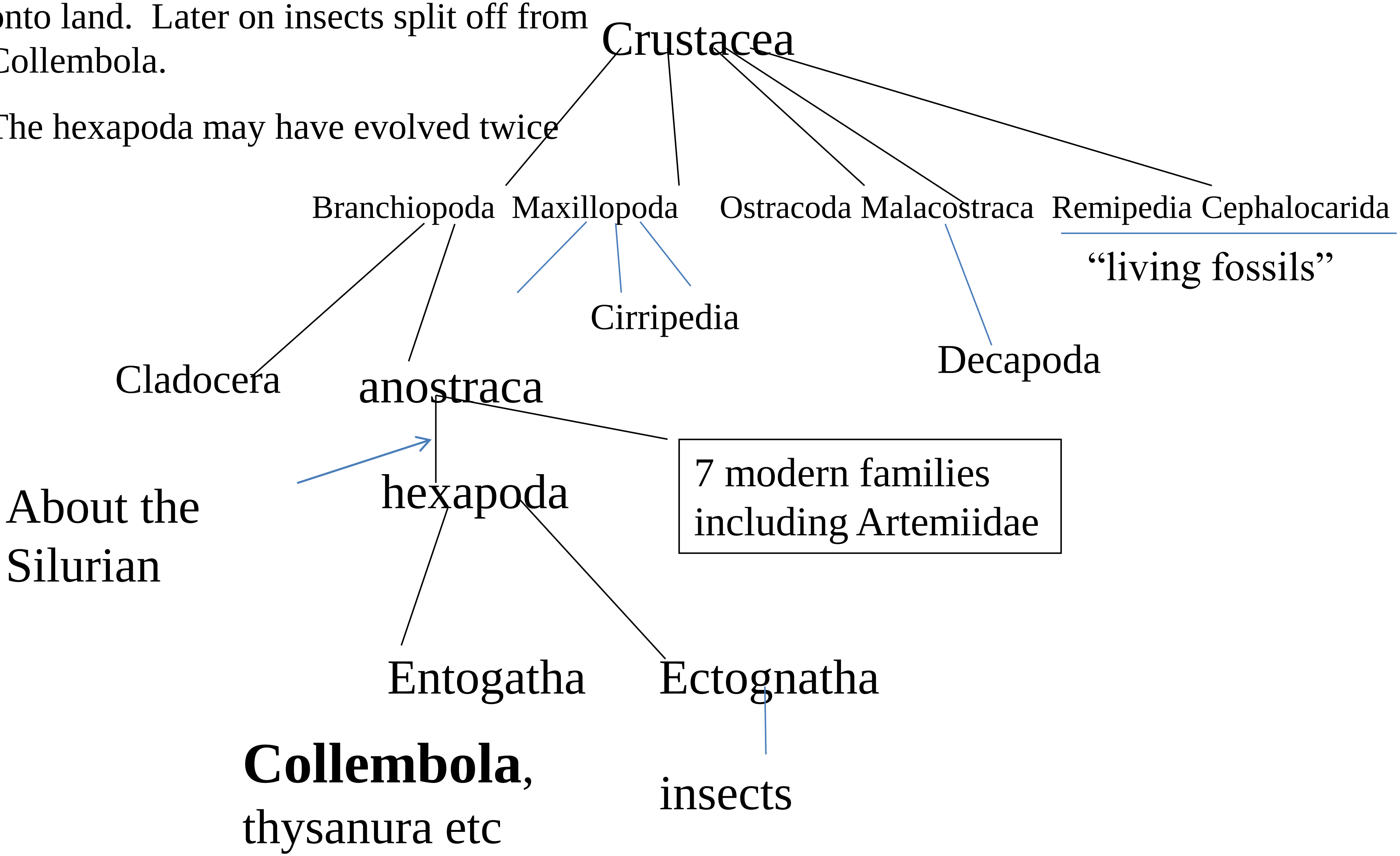
All the zoology texts call these animals apterygota – wingless insects. Hardly odd – they have 6 legs and run around on land, but lack wings.

Recent DNA work has altered this; Collembola are probably closer to crustacea. (When Peter Lawrence suggested this in 1996 the paper came with an editorial effectively questioning his sanity!)

pancrustacea by clades

What this figures shows is that an anostracan shrimp-like ancestor evolved 6 legs and came onto land. Later on insects split off from Collembola.

The hexapoda may have evolved twice



Collembola – crustaceans??

On the face of it, they're not. Only 6 legs (on the thorax only), and just 2 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 encasing gills.

The antennae are single, but there are 2 more cephalic sensory organ, the Post Antennal organs PAO, which looks like the remains of the antennule.

It is possible that the last common ancestor of springtails and true insecta had >6 legs, as do most crustacea.

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

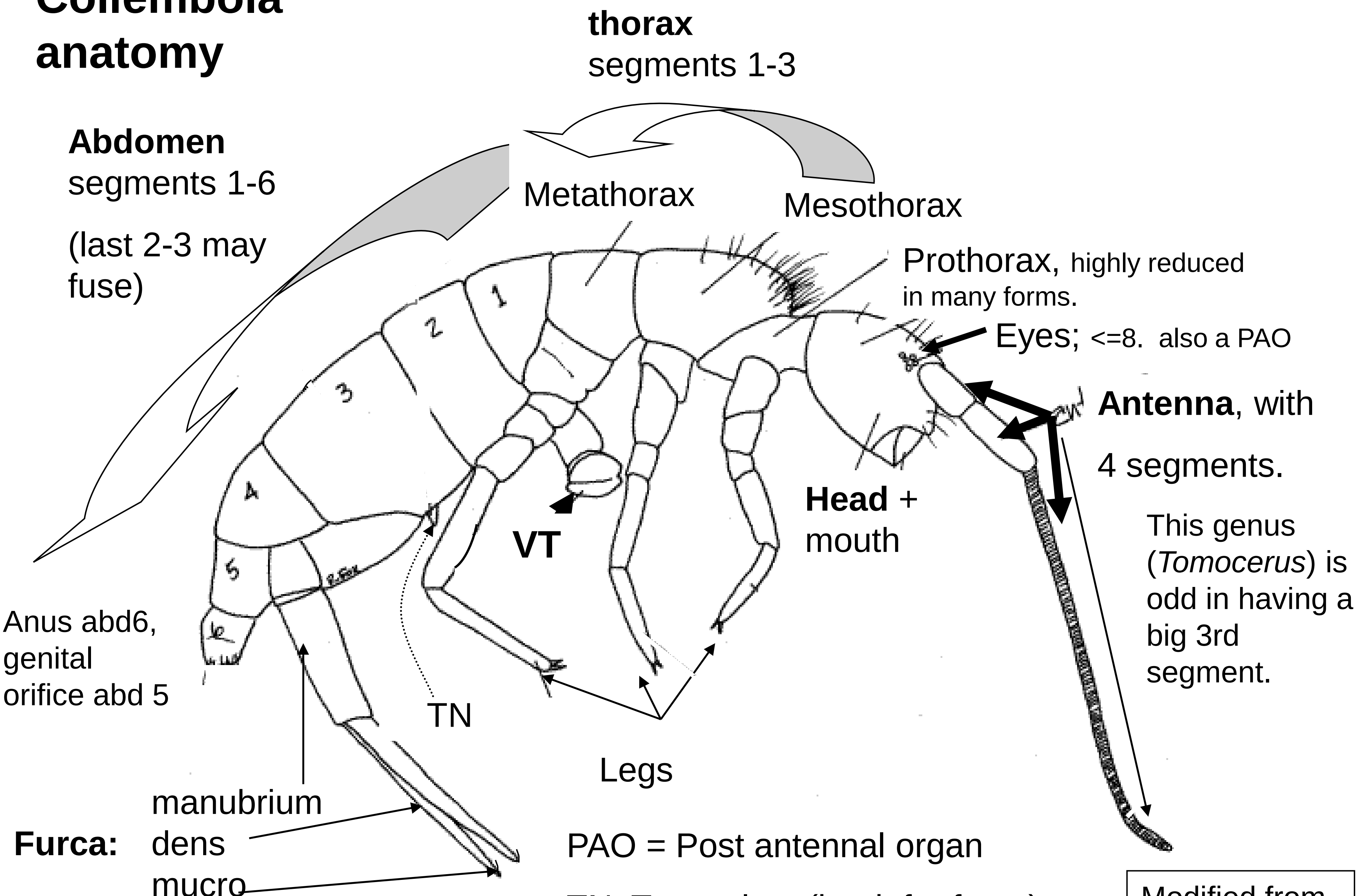
Collembola (springtails)

These are among the oldest (evolutionarily) and least changed of all terrestrial arthropod groups. Most books still call them apterygote insects, close to protura and diplura. A better model is to see the entire group 'Pancrustacea' (= hexapods plus crustacea) as a folded sheet of paper; insects up one side, crustacea up the the other, and Collembola up the middle! They moult continuously throughout life.

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

Collembola following this morphology are the superfamilies poduromorpha and entomobryomorpha.

Poduridae

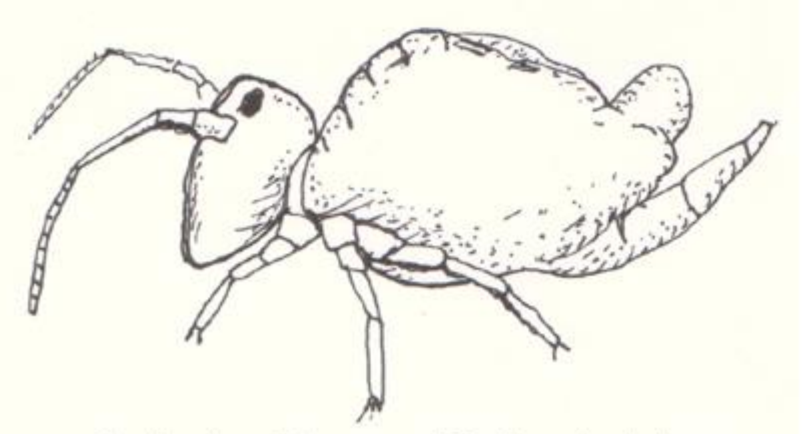
Isotomidae

Entomobryomorpha

Here *Tomocerus*

'*' shows the prothorax

The symphypleona (sminthurids) follow this basic plan but have fused body segments and look very weird. They do have the furca and ventral tube, and are usually <1mm.



Sminthuridae sp. (Collembola)

About the only Collembola pests are in this group; the lucerne flea *Sminthurus viridis*, which sometimes nibbles clover.

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

It has two “lateral vesicles” which swell out of the end and are sticky; they adhere to the substrate. By pulling the vesicles back in, they right themselves.

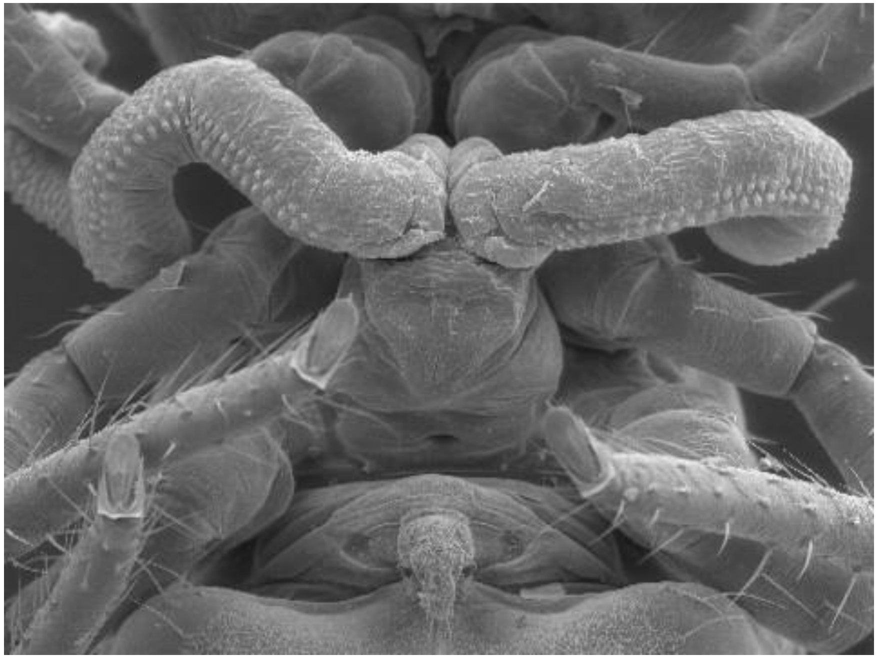
Here we see one of the 2 sacs of the ventral tube: these can be used to groom the animal, to drink up water, and to pull itself up, to anchor: think of an elephant’s trunk! The tube can be retracted quickly – a lucky photo. In alcohol these animals look disembowelled, but aren’t!

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

© Jim McClarin, USA:

Allacma purpurescens

© the bald eagle,south Dakota



Sminthuridae sp.: collophore with eversed vesicles, ventral aspect. SEM by Zeppelini, D. (2005).

Allacma fusca

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

Dicyrtomina saundersii
drinking using its collophore

Respiration – mainly cuticular, though some sminthurids have a simple tracheal system. Their thin permeable cuticle makes them creatures of damp habitats.

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 pallipes*. Sminthurides males have specially modified antennae to hold the female during mating.

Many springtails are partially or fully parthenogenetic, probably due to systemic infection with *Wolbachia*.

Taxonomic overview

Class Collembola

Class level

Arthropleona (debateably taxonomically valid)

("normal springtails")

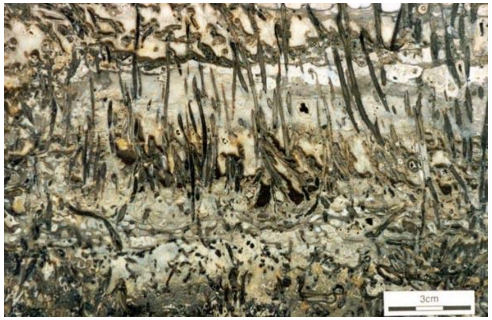
Poduromorpha | Entomobryomorpha | Symphypleona | Neelipleona

Order level

(few and tiny spp but common)

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. (CO_2 was 10* modern levels too).



Timeline

500MYBP 400 300 200 100 0=Now

Carboniferous

Dinosaurs

hominids

Rhynie Chert

Humans (+other mammals) split from reptiles around here

Just to emphasise how the world has changed, England was then still separated from Scotland by a deep sea, and **both** were in the southern hemisphere, about the latitude of modern New Guinea.

The Rhynie chert contains Springtail fossils of *Rhyniella praecursor*, plus a possible true insect (only as it had 2 hinges in its jaw).

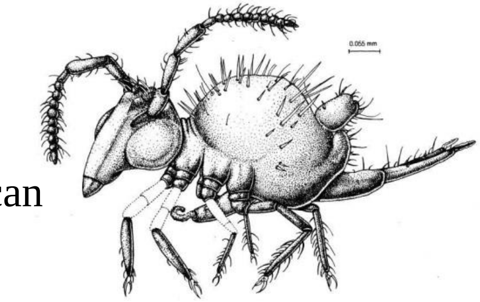
Scourfield's diagram (1940)

Rhyniella praecursor

reconstruction

Cretaceous - Miocene

Grinnellia ventis from amber from the Dominican Republic, original and reconstruction 2006
© Christiansen, K. & Nascimbene, P.



We have many specimens of ancient springtails, almost wholly due to the preservative properties of amber.

There are especially big deposits in the Dominican republic (cretaceous) and the baltic (miocene and more recent), with many species presumed to be climbing trees.

The ‘recent’ deposits have familiar genera (mainly *Lepidocyrtus* and *Seira*), while cretaceous amber has new genera in new families. Another K/T biodiversity loss?

Cretaceous Research (2002) **23**, 165–188
doi:10.1006/cres.2002.0313, available online at http://www.idealibrary.com on IDEAL®

Cretaceous Collembola (Arthropoda, Hexapoda) from the Upper Cretaceous of Canada

***K. Christiansen and †E. Pike**

**Grinnell College, Grinnell IA 50112, USA; e-mail: christak@grinnell.edu*
†972 Edgement Rd., Calgary, Alberta T3A-2J3, Canada; e-mail: tmpike@home.com

Revised manuscript accepted 31 January 2002

Previously only one specimen of springtail (Collembola) has been described worldwide from the Cretaceous. The present work reports the results of an examination of seventy-eight collembolan specimens from Canadian Upper Cretaceous amber. Sixty-three specimens have been identified at the generic level, none of which belongs to extant genera. All are placed within eight newly erected genera. Most of these specimens belong to a single new genus, *Protoisotoma*, of the family Isotomidae. Also included are members of the broadly construed families Sminthuridae, Neanuridae, and Tomoceridae. Re-examination of the type of *Protentomobrya* reaffirms its separate familial status. One additional specimen of an undescribed genus is placed in a new family. These data support a probable extinction of the Canadian arboreal Collembola fauna at the end of the Cretaceous.
© 2002 Elsevier Science Ltd. All rights reserved.

KEY WORDS: Collembola; springtail; Cretaceous; Campanian; Canada; taxonomy; amber.

How many species of Collembola?

Globally? No idea!   Actually 6500 if you believe lists

How many in the UK? As recorder, my list has 395 species (ignoring synonyms).

Going down this list and removing fictional, dubious and otherwise shaky records: 317 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.

Pronunciation

There are no agreed standards for pronunciation! I've heard an US citizen talk about Sye-loss-obby for what I call Sigh-Low-sigh-bee.

Dicyrtoma

Dye – sir – tomer?

Dick – row – tomer?

So I put out a global email asking how to say this:

Dee-zeer-to-mah

Dee – churr – tome –er

Dye – sir – tomer – a

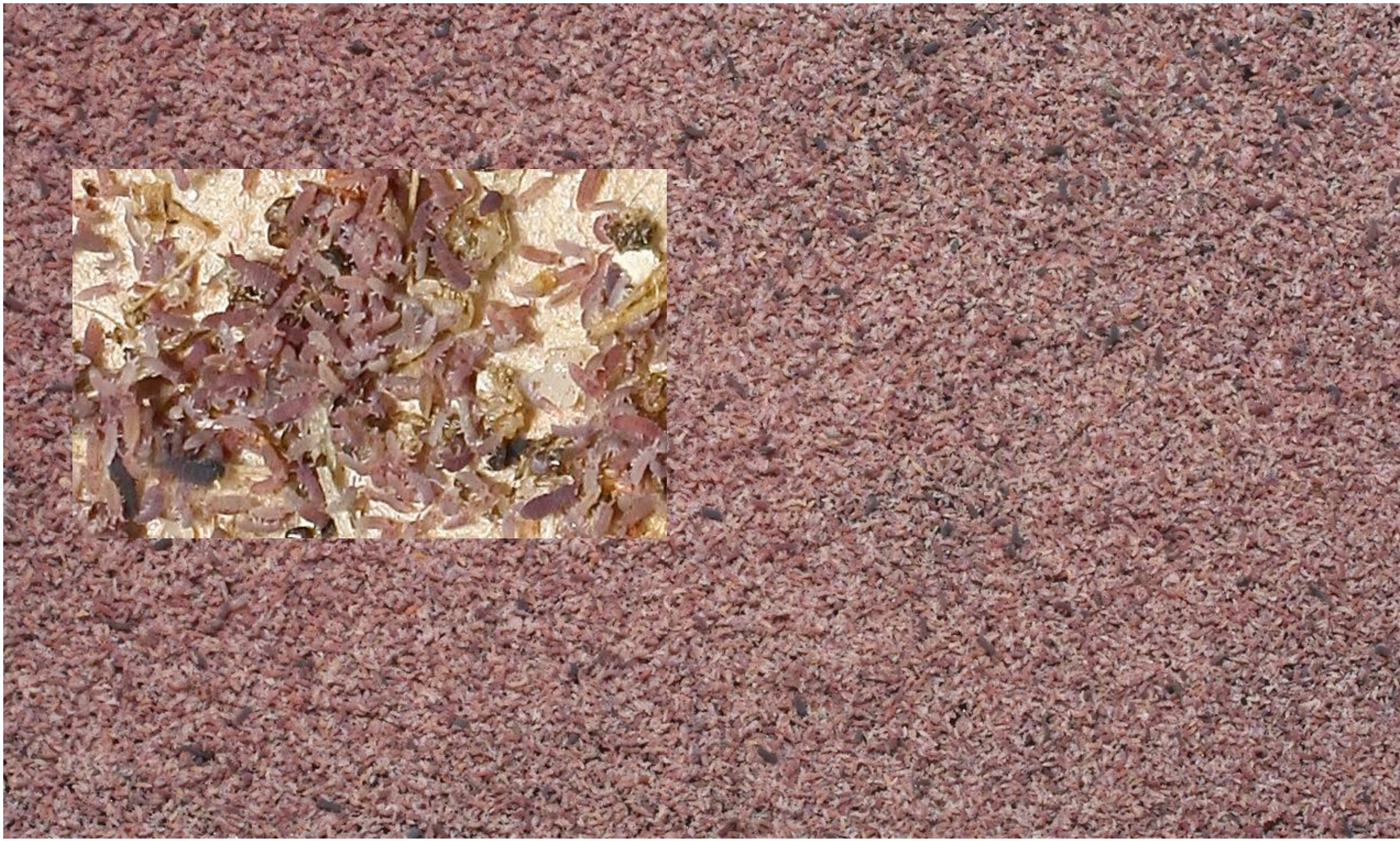
[A as in "jam"]

Notable, misc

- Some species form swarms, most commonly on snow (yes, even in UK – first recorded 1867). *Achorutes* covered a chalk wall in Mickleham with a swarm millions strong. 6 widely different spp have swarmed in the UK

Ceratophysella swarm

A swarm of *Ceratophysella bengtsonni* Bedfordshire May 2013



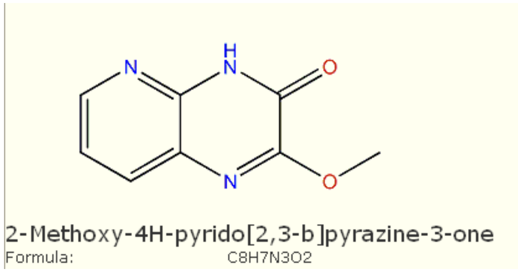
Some neanurids are very colourful

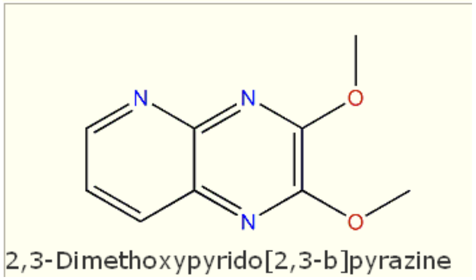
Neanura takoensis from China
after www.yellowman.cn., 2007 ©

Paralobella orousseti
After Deharveng, L., 2002 ©

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

Tetrodontophora bielanensis





Recently some unusual defensive chemicals have been identified in the giant springtail *Tetrodontophora bielanensis*, which double as alarm pheromones.

A common UK species, *Neanura muscorum*, secretes 1,3 dimethoxybenzene, phenol and 2aminophenol!

Pheromones

Much of these animals' behaviour is linked to pheromones, eg Hypogastruras have been shown to synchronise their moulting by means of a pheromone. (They also tend to be smelly in culture – some protective/pheromonal compounds?).

They have aggregation pheromones, leading to multi-species aggregations and terribly noisy ecological data! (It also attracts predatory mites).

Basic modern Collembola body forms

I'm not going to try to guess which of these is ancestral, but there are some clearly defined body forms now to be encountered:

Surface dwelling entomobryomorpha: medium-large, coloured, almost invariably with furcula (often well developed)

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

Surface dwelling symphypleona medium-tiny, coloured, invariably with well developed furcula.

Euedaphic poduromorpha: white, eyes reduced or absent, furcula tiny or (generally) absent.

Euedaphic symphypleona : white, reduced eyes, furcula present.

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, *Brachystomella* in disturbed sites, *Xenylla* up surfaces

Xenylla maritima

Brachystomella parvula

Neanura muscorum

3mm long

Lathyriopyga longiseta

Basic Collembola body forms

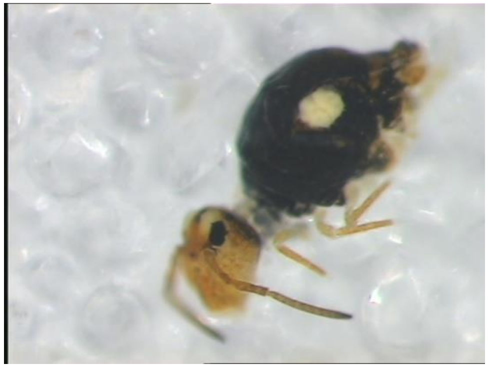
Surface dwelling symphylopleona medium-tiny, coloured, invariably with well developed furcula. "Lucerne fleas" (strictly = *Sminthurus viridis*).

Dicyrtomina sp

Sminthurus viridis

Sminthurinus elegans

Sminthurinus trinotatus



Ptenothrix atra

Basic Collembola body forms

Euedaphic poduromorpha: white, eyes reduced or absent, furcula tiny or (generally) absent. The hardest group to ID, probably not valid until molecular systematics catch up with field-based reality!

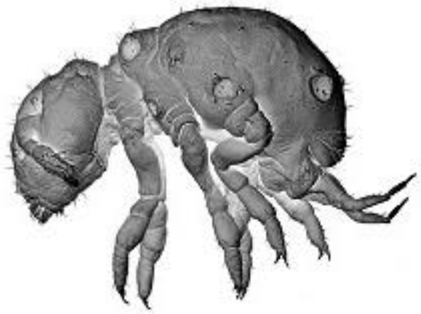
Protaphorura (formerly Onychiurus) *armata*

Mesaphorura (formerly Tullbergia) sp

Basic Collembola body forms

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

Neelides murinus



Megalothorax sp.
1999 © Walter, D.E.

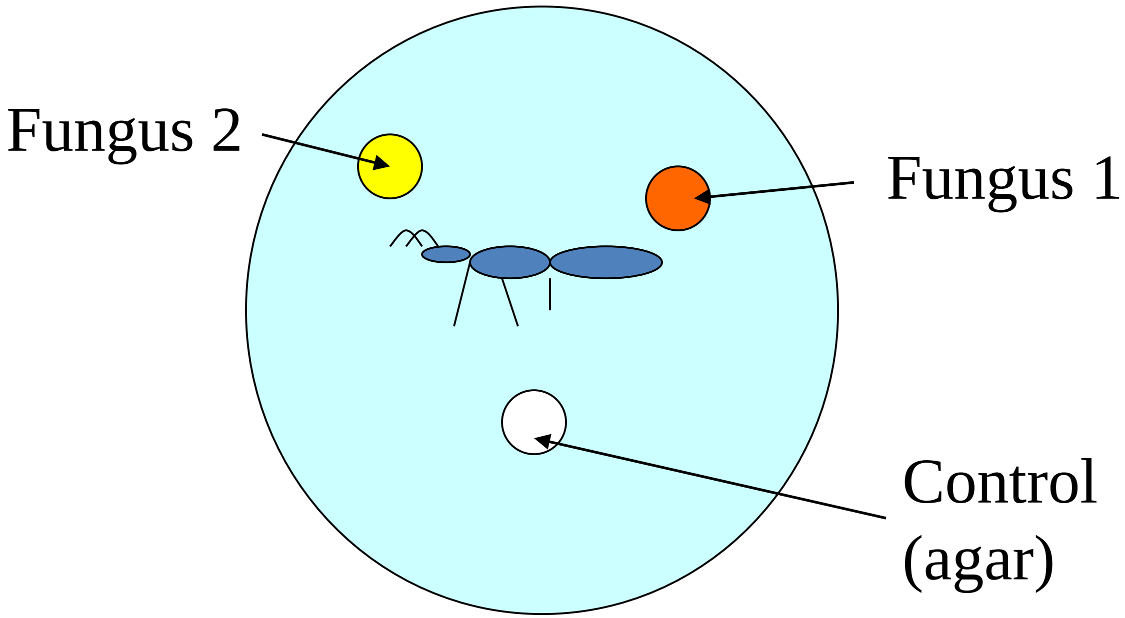
Megalothorax minimus (next to *Pogonognathellus longicornis)*

Lifestyles: feeding

Most Collembola are “detritivores”. This comes from seeing them in leaf litter feeding on indeterminate particles, and finding a variety of particles + soil microbes in their guts.

Actually, when given a choice springtails are quite discriminating about food choices, with a preference for yeasts and other non-toxic fungi. They will also culture well on the green algae from tree bark (*Pleurococcus*).

- Old soil biology texts claimed soil animals to be very non-fussy, on the basis of the wide variety of material found in their guts. This involves a rather crude operation known as ‘gut-squashing’.
- In fact if you offer most springtails a choice of foods, they routinely turn out to be highly selective:



From some expts I ran in my PhD

Fungi avoided included ‘poison pie’ and fly agaric. Coincidence?

One Collembolan, a small slow moving dumpy little things called *Friesea mirabilis*, is apparently an active predator of soil nematodes (I have no idea how).

Friesea mirabilis

Recent stable isotope work has shown the common “teddy-bear” springtail *Neanura muscorum* is a relatively high-level carnivore.

Neanura muscorum, image by Peter Boardman

Pests?

There are few, but persistent, reports of springtails causing agricultural damage. These are invariably a combination of high numbers and animals attacking delicate young seedlings or leaves. There have been a few cases of stems being girdled, but reduced leaf area is commonest. At worst a nuisance.

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

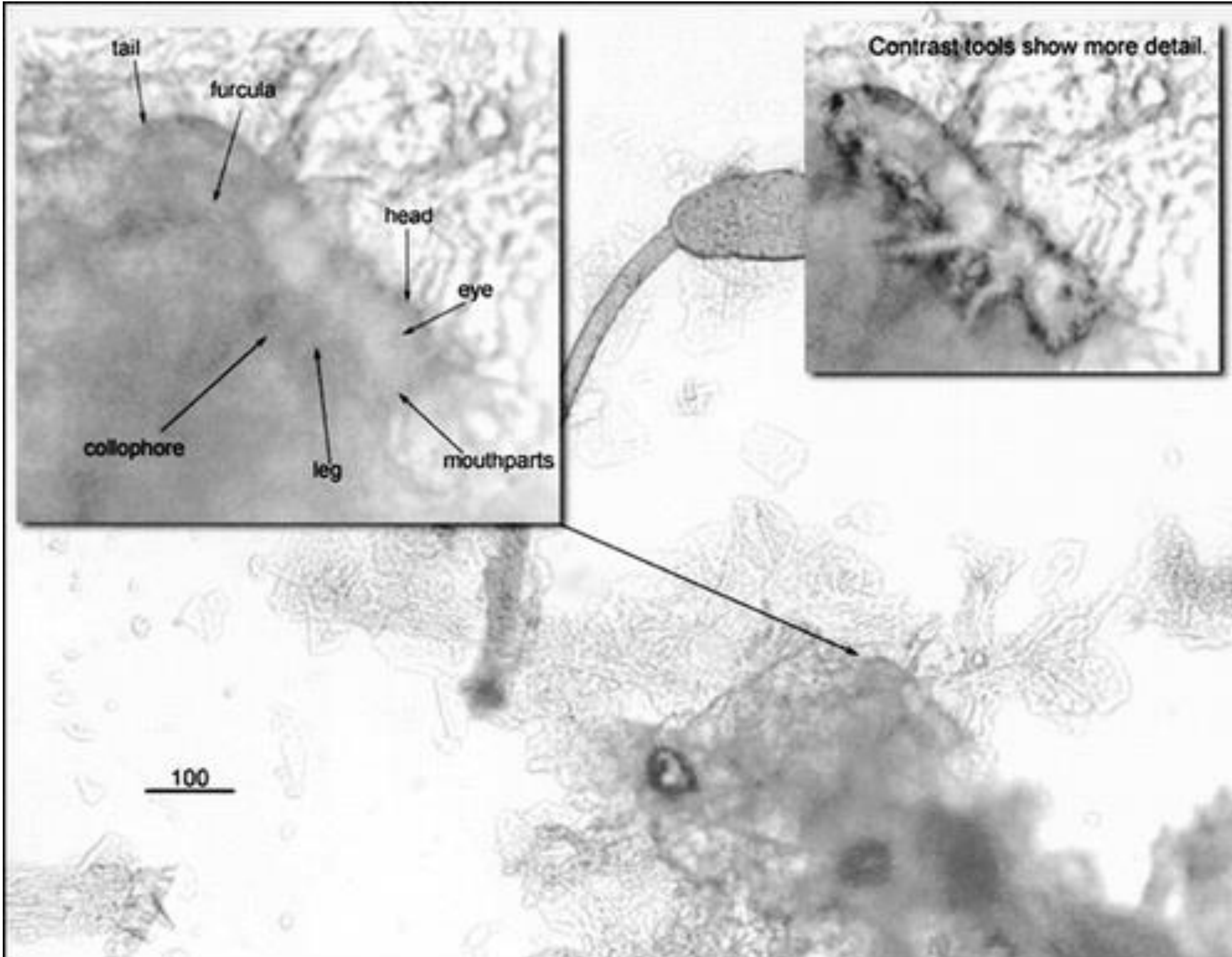
1st UK Collembola damage for decades! Clover nibbled by *Smithurus viridis* Bodnant Aug 2014

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

Gold standard unmitigated paranoia-inducing lies!!

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.

A lifetime ambition: Barcoding UK Collembola

Dr Peter Shaw describes the background to, and early stages of a long-term project to answer an apparently simple question: “What species of Collembola occur in Britain?” by using molecular barcodes.

Posted: Monday, 24 February 2014

Collembola - Parasitosis

In his latest blog blog post, it is not so much of a write-up of work done so much as it is a wish list of work to do!

Dr Shaw explains:

At the moment, we have three separate programmes collecting these springtail barcodes. One focuses specifically on just two genera (Entomobrya and Lepidocyrtus) overseen by Brent Emerson of UEA + la Laguna Tenerife. A second forms part of PhD work by Stephanie Bird – co-funded by the Royal Horticultural Society. The third programme is more ad-hoc, overseen by Carly Benefer (Plymouth) and it is this third programme that forms the basis of this blog. We should also add mention of some work by Jonathan Ellis of Manchester Metropolitan University, who (with MSc students) has been barcoding inter-tidal Anuridas.

Read the full blog here

Habitats: soils

In terms of species richness, the majority of Collembola live in the soil in or below the litter layer, declining rapidly as one enters the mineral soil.

You would expect that (like plants and many invertebrates) contrasting soil/litter types would have contrasting Collembola communities. To an extent this is true, and forms the basis of many small projects. Where the contrasts are sharp (eg lagoon -> ash dump -> woodland) one can easily show community development.

In fact this effect is rather weak, with only a minority of species showing clear habitat associations. There are soome, eg *Tetracanthella wahlgreni* is a glacial relic confined to high cold sites, while *Folsomides* turn up in quarries that bake dry.

I also recall in York under Mike Usher, I was studying acid wet pine woodland in the borders and Richard next to me looked at a dry calcareous chalk quarry near York. We had several species of Collembola in common! One (*Isotoma viridis*) is now a group of 3 species, but the point about low specificity stands.

The lines are 1mm marks on a ruler

Tetracanthella wahlgreni
BenMacdui 2011, c. 1200m

By the sea

Unsurprisingly for a near-crustacean radiation, some Collembola are marine. None swim, and only a few are evolved to survive tidal immersion.

The best known of these is *Anurida maritima* (once *Lipura maritima*), which is probably ubiquitous on our rocky shores.

Anurida maritima

These grey/black animals emerge at low tide to graze (about 1 hour after the rocks start to dry, in my experience); at high tide they retreat to a cavity where their water-repellent hairs act to trap air.

Hypogastrura viatica swarm on seaweed, Orkney
Jan 2016, Photo by Lee Johnson.

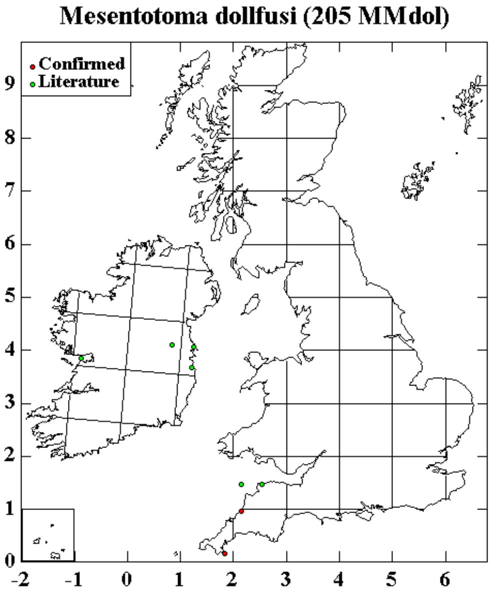
There are another 5 similar things below the tideline (2 *Anurida* and 3 *Anuridella*) so it's worth grabbing a few on sight to check ID.

You could easily add dots to the UK map!

Anurida granaria Kew bridge, inter-tidal zone 16xi2012

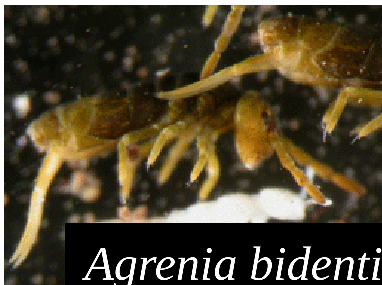
One springtail lives under sea water for long periods – months, maybe life? *Cryptopygus clavatus* (formerly *Proisotoma buddenbrocki*) lives under stones in rock pools and can be kept submerged all winter happily grazing the biofilm.

Seaweed can turn up other Collembola in other families, eg the coastal ‘counterpart’ to *Entomobrya nivalis* is *Mesentoma dollfusi*, which seems scarce but may be present on every beach in the south of England!



Mesentoma dollfusi

In fresh water!



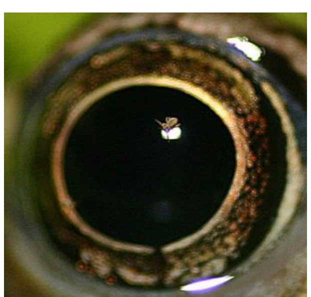
Agrenia bidenticulata

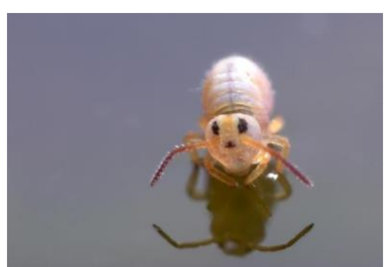
(*Folsomia* sp behind)

- Actually very few live IN freshwater, but *Agrenia bidenticulata* is fairly common and confined to stones in acid upland streams.

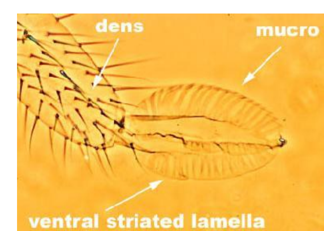
Rather more spp live ON freshwater, famously *Podura aquatica* but also the tiny Sminthurides (with a gutter shaped mucro to catch the water film). This is the Neustonic community. (The Neuston is the community of animals associated with the surface film of water).

Podura aquatica





Sminthurides aquaticus



Up trees!

Rather bizarrely, springtails are incorrigible tree climbers! Not all species, but canopy communities can have the odd soil species.

The commonest tree climbers are large scaly species in the genera *Tomocerus* s.lat., *Lepidocyrtus* and *Orchesella*, plus *Entomobrya* (large and hairy though not scaly) and *Vertagopus* (waxy).

Entomobrya albocincta – rarely found in the soil.

Up plants

Leaf surfaces are the preferred habitat of some sminthurids, notably *Sminthurus viridis*, also *Deuterosminthurus* and *Bourletiella* species. These are often missed by soil core collection and are tiny to see, but vacuum up well!

Steve Hopkin mentions that while writing his book on Collembola, there was a gentle stream of *Deuterosminthurus pallipes* falling out of the bushes onto his laptop – notable also for their complex mating dances.

Katiannidae sp nov

Richmond park, April 2009

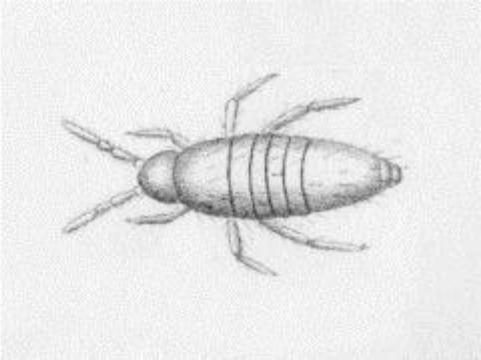
Bourletiella arvalis

Deuterosminthurus pallipes mating dance

In ant nests

Cyphoderus albinus

Bizarrely there are a few Collembola that associate with ants. The commonest UK myrmecophile is *Cyphoderus albinus*, a large blind white animal fairly close to Entomobrya. We also have a rare myrmecophilous Entomobryid (*Entomobryoides myrmecophilus*).



When I checked a load of ants nest springtails what turned up with *C. albinus* was *Lepidocyrtus cyaneus* (not supposed to!)

In Caves

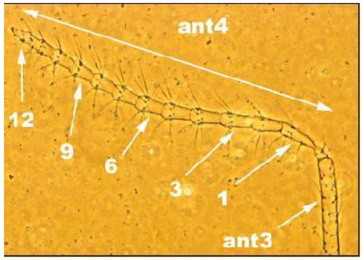
Troglobites – species only found in caves
Oligaphorura schoetti; Folsomia agrelli,

Maybe *Disarrhopalites patrizi* (I couldn't find it..)

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

Disparrhopalites patrizi

Oligaphorura schoetti on raft of exuviae



Troglophiles – also have viable populations above ground, eg *Heteromurus nitidus, Folsomia candida*

Folsomia candida

Heteromurus nitidus

(Image: Rafael Jordana and Enrique Baquero

The deepest-dwelling land animal is a springtail *Plutomurus ortobalaganensis*, 1980m deep in the world's deepest cave Krubera-Voronja, near the Black Sea in Abkhazia (Georgia.) along with three new species of Collembola: *Anurida stereoodorata*, *Deuteraphorura kruberaensis* and *Schaefferia profundissima*.

Snow fleas

A few species have anti-freeze compounds that allow them to survive well below freezing; snow fleas (*Hypogastrura harvei* and *nivicola*) actively graze snow algae on the surface of snow in mountains and the arctic in winter! *Hypogastrura cocklei* is the golden snow flea.

[Do not confuse these "snow fleas" with the winter-active mecopteran with the same name]

Just in 2008 the amino acid used as an antifreeze was synthesised and found to have no sequence similarity to any known protein. (This amino acid is being used to inform edible antifreezes to put into ice cream).

Hypogastrura spp or 'snow fleas' swarming on snow

In Europe the ‘snow flea’ has been said to be “*Isotoma nivalis*”, though this species appears to be fictional! *Desoria saltans* is a valid name for a winter-active isotomid, and Frans Jansenns has seen a snow swarm of *Isotoma viridis*. I have seen a report that in 1927 Ernst Handschin found people trying to extract food oil from snow-surface swarms of *Hypogastrura longispina* in the alps (better than starving, probably, just!)

Probably quite a few species will swarm on snow given correct conditions.

A swarm of *Ceratophysella sigillata* in late winter. (Part of an annual cycle with changes in morphology called epitoky)

Biophysical Journal Volume 92 March 2007 1717–1723

Structural Modeling of Snow Flea Antifreeze Protein

Feng-Hsu Lin,* Laurie A. Graham,* Robert L. Campbell,* and Peter L. Davies†
*Department of Biochemistry and the †Protein Function Discovery Group, Queen's University, Kingston, Ontario K7L 3N6, Can

ABSTRACT The glycine-rich antifreeze protein recently discovered in snow fleas exhibits strong freezing point d activity without significantly changing the melting point of its solution (thermal hysteresis). BLAST searches did not c protein with significant similarity in current databases. Based on its circular dichroism spectrum, discontinuities in its repeat pattern, and intramolecular disulfide bonding, a detailed theoretical model is proposed for the 6.5-kDa isofo model, the 81-residue protein is organized into a bundle of six short polyproline type II helices connected (with one e by proline-containing turns. This structure forms two sheets of three parallel helices, oriented antiparallel to each c central helices are particularly rich in glycines that facilitate backbone carbonyl-amide hydrogen bonding to four ne helices. The modeled structure has similarities to polyglycine II proposed by Crick and Rich in 1955 and is a close ma polyproline type II antiparallel sheet structure determined by Traub in 1969 for $(\text{Pro-Gly-Gly})_n$. Whereas the latter two are formed by intermolecular interactions, the snow flea antifreeze is stabilized by intramolecular interactions bet helices facilitated by the regularly spaced turns and disulfide bonds. Like several other antifreeze proteins, this model is amphipathic with a putative hydrophobic ice-binding face.

INTRODUCTION

A newly discovered antifreeze protein (AFP) from the snow flea, *Hypogastrura harveyi* Folsom, is thought to help these primitive arthropods to survive freezing temperatures by inhibiting the growth of ice (1). At subzero temperatures, uncontrolled ice growth can lead to the dehydration or rupture of cells, loss of tissue functions, and, ultimately, the organism's death. AFPs, also known as thermal hysteresis proteins (2), bind to a growing ice crystal surface (3) by an adsorption-inhibition mechanism (4) creating microcurvature of the ice front that makes it less favorable for water molecules to add to the crystal due to the Kelvin effect (5). In this way, AFP increases the energy requirement for ice growth and the resulting inhibition of growth prevents freezing damage. Although surface adsorption of AFPs to ice is generally accepted, the details of the antifreeze mechanism are uncertain. See the recent review by Prabhu and Sharp (6) for a discussion of some of the outstanding issues.

cysteines, which were found to form two disulfi based on the mass difference after reduction and a although the bonding pattern is not known. Interest larger isoform has only two cysteines, and these disulfide bonded.

The amount of sfAFP that can be readily puri natural sources is insufficient for conventional determination. It has proven difficult to collect e amounts of this organism (5–10,000 individual which microgram quantities of AFP can be Moreover, it is not easy to produce the AFP as a w recombinant protein because of its unusual prop thermal instability (data not shown). In the interi out to model the protein structure ab initio.

METHODS

NewScientist Tech

Home News In-Depth Articles Blog Opinion Video Galleries Topic G

SPACE TECH ENVIRONMENT HEALTH LIFE PHYSICS&M

Home | Tech | Physics & Math | News

Edible antifreeze promises perfect ice cream

18:33 11 January 2008 by Tom Simonite

Edible antifreeze developed by a US researcher could keep ice cream tasty and smooth, and prevent other frozen foods from being ruined. The antifreeze contains proteins similar to those that help "snow flea" insects survive winter without freezing solid.

The taste of good ice cream depends on a blend of flavour, temperature, and texture - what food scientists call "mouth feel".

The formation of tiny ice crystals, each around 15 to 20 microns wide, is crucial to making smooth ice cream. But if ice cream is subjected to sudden temperature fluctuation - when transported home from the store, for example - these crystals can grow to 40 microns or larger, as water melts and refreezes.

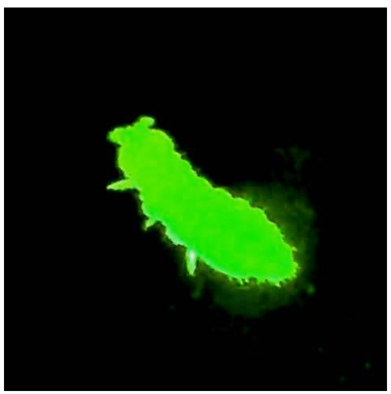
This can ruin the texture of good ice cream, making it gritty to eat. It can also damage frozen soft fruits.

Gum-like carbohydrates are used by manufacturers to restrict the movement of water molecules and prevent big ice crystals from forming in ice cream. However, as anyone who has tasted crunchy ice cream will know, these carbohydrates do not work perfectly.

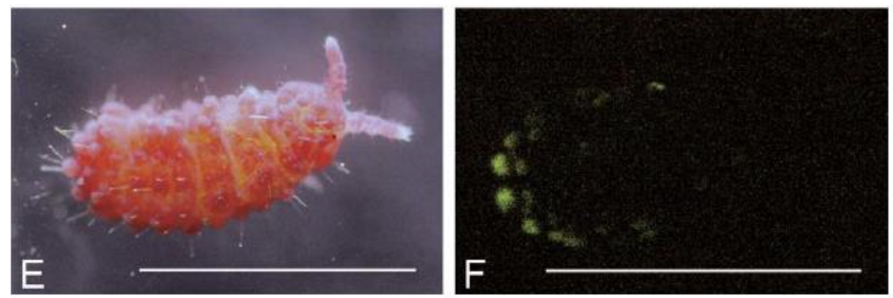
Crystal prevention

Luminous Collembola

It is little known but a few Collembola are among the truly luminous life forms. This is best known for *Anurida granaria*: Arne Fjellberg found one glowing in a riverbank in Iceland. In New Zealand they may be collected and cultured. They glow when the tube is tapped – dunno why!



http://www.byteland.org/bioluminus/methodology.html



Lobella sp, Japan

http://xa.yimg.com/kq/groups/3650837/564405651/name/2011_The%20Terrestrial%20Bioluminescent%20Animals%20of%20Japan.pdf

How to collect?

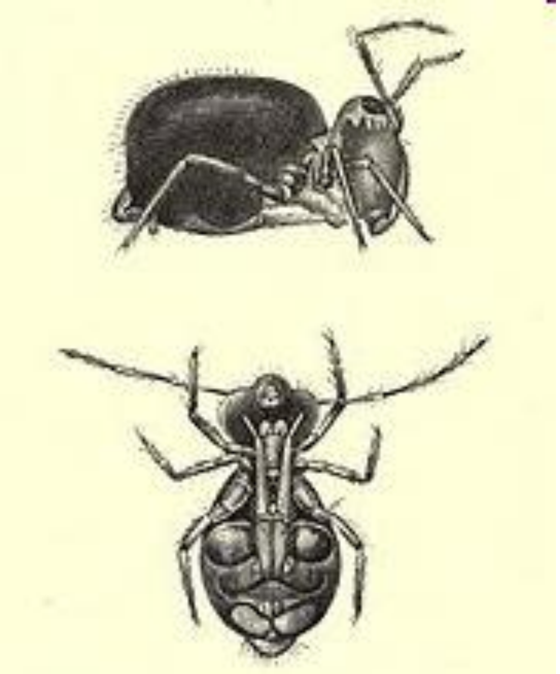
The standard, default is to put remove soil (/litter/etc) from the field and place into a Tullgren funnel

Vacuum collection from exposed surfaces (esp. tree bark)

New idea – leave plastic scouring pads in place for a few weeks then collect back in; they attract Collembola well (so far up trees and down caves).

People behind this course

(generally far behind…)

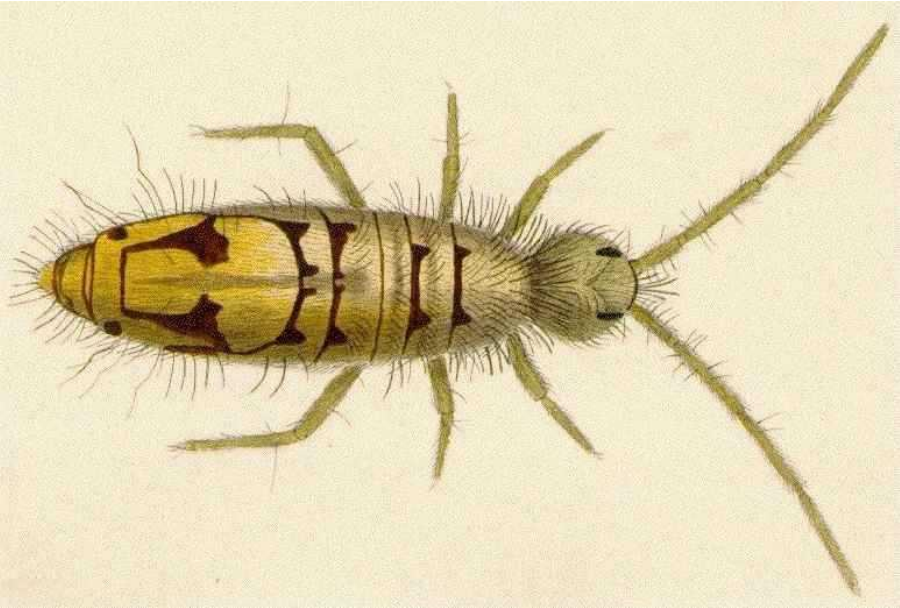


Springtail (Papirius), greatly enlarged (after Lubbock).

Sir John Lubbock MP, naturalist
30/4/1834 – 28/5/1913

(later Baron Avebury)

As an MP he introduced many banking reforms including the introduction of bank holidays.



As a naturalist he produced a magnificent work on UK Collembola, with engravings specially commissioned from a deaf & dumb man called Mr Hollick

PUNCH'S FANCY PORTRAITS.—No. 97.

SIR JOHN LUBBOCK, M.P., F.R.S.

How doth the Banking Busy Bee
Improve his shining Hours
By studying on Bank Holidays
Strange Insects and Wild Flowers!

How doth the Banking Busy Bee
Improve his shining Hours?
By studying on Bank Holidays
Strange insects and Wild Flowers!

Richard Siddoway Bagnall

(14 July 1889, Winlaton near Whickham -19 January 1962)

Was a hotel inspector by trade, odd but meant he travelled around the UK, collecting insects (especially apterygota) as he did. He also described new species, and probably got many of them right (but his descriptions were rather vague, leaving a question mark over many species that look to be UK endemics.)

I have seen him called a dipterist, and also a specialist in the thysanoptera. (One of his species has turned up as a pest in Brazil recently).

Other names that pop up extensively in 20th Century UK Collembola records/literature:

H. Gisin – Switzerland; a unified European key, still cited.

HE Goto

Peter Miles

HJ Gough

Peter Lawrence, NHM

Mike Usher, York

Steve Hopkin
1956 -19/5/2006

It should have been Steve giving this course; Steve was a lecturer at Reading university with a wide interest in invertebrates. He was killed in a car crash in 2006 in Cornwall, where he was about to retire. When I took over his files about Collembola distribution (which remain definitive, though aging slowly) I was approached by cornish spider experts and the UK millipede group, both of whom had found his work invaluable, which ecotoxicology journals gave him an obituary all about his work on pesticides and heavy metals.

Arne Fjellberg

Very much alive and kicking, Arne produced a series of keys to Collembola in his native Norway, with an interest in arctic and high-altitude species.

Arne has published many detailed taxonomic papers describing and re-describing new and poorly-defined species of Collembola, and gave Steve Hopkin much valuable information, especially when unravelling some of Bagnall's descriptions and relating the UK fauna to the wider european fauna.

Frans Janssens

Frans is based in Antwerp, Belgium, and has become involved in photo-ID of Collembola on the Flickr photo-sharing website.

He runs the immensely useful webpage

www.Collembola.org

Featuring photos and online keys. He has also added species to the UK list by online macro-photography groups.

See also http://www.janvanduinen.nl/collembolaengels.html
For amazing photos

Matty Berg – Vrije University, Amsterdam

Matty's research has a focus on the explanation of soil fauna community composition over time and across space. He studies the importance of species traits (incl. variability and plasticity) for species interactions. This involves, among other experiments, adding various Collembola species by pooter to microcosms, to explore their effects on community composition and key ecological processes. He has build a large trait databases for Collembola that helps him to understand community changes.

He has also published a series of papers on unusual springtails in the Netherlands, where he monitors and maps the biogeography of Collembola and other soil invertebrates (Isopods, Diplopoda, Chilopoda). He is currently the coordinator of the Collembola survey group in the Netherlands.

Myself

With a degree in zoology I undertook a PhD on Collembola of lodgepole pine plantations with Mike Usher of York university. The aim was to see whether they grazed the hyphae of ectomycorhizal fungi, thereby damaging the trees. (Work based in Spadeadam forest, borders). That turned out to be fearsomely tricky to answer and even now the answer is along the lines of "probably, but not much".

After submitting my PhD I started work with the CEGB on acid rain. Sadly I never got the time or funding to link springtails and acid rain – blame NERC for not funding it !!

Latterly I did acquire an interest in the biodiversity of ex-industrial sites (PFA), and have found nice successional changes in Collembola corresponding to soil development.

Roehampton University London

Roehampton!

In 1991 Thatcher privatised us, and in 1992 I started at Roehampton. The acid rain work needed a team of technicians that had just blown apart, so I returned to Collembola (inter alia). I collaborated somewhat with Steve Hopkin, realised what a huge amount he'd done and how not to trust my IDs without double checking!

If we have a living link it's my ex-PhD student Erica McAlister, now NHM – we took some of her specimens to Steve to check ID.

Then he died unexpectedly in 2006 after writing the FSc Collembola key but before it was published. I was able to proof check and correct the manuscript (virtually no typos or silly mis-numberings; quite remarkably well put together). We rescued enough files to put Steve's card index onto the NBN gateway, and I am UK recorder for Collembola. Each paper has had to be retyped into a database to cross link records to sources!

What we're going to do:

You have some Tullgren extracts, and later we will see what comes out.

Next –some D-Vac / beating arboreal collection, then intro to the key and to some common species.

After lunch – further specimens, not all so easy. I want to assemble a collection of Idd species, for future reference + courses here.