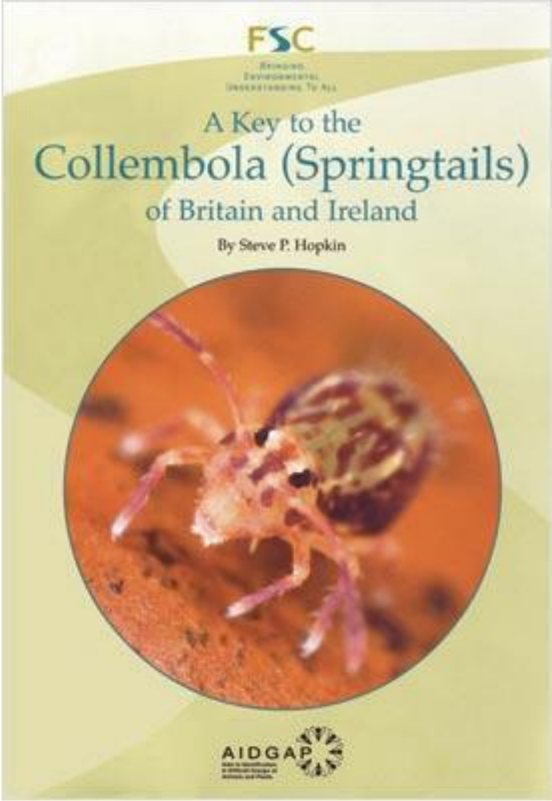
Introduction to Steve Hopkin's FSC / AIDGAP key to the Collembola

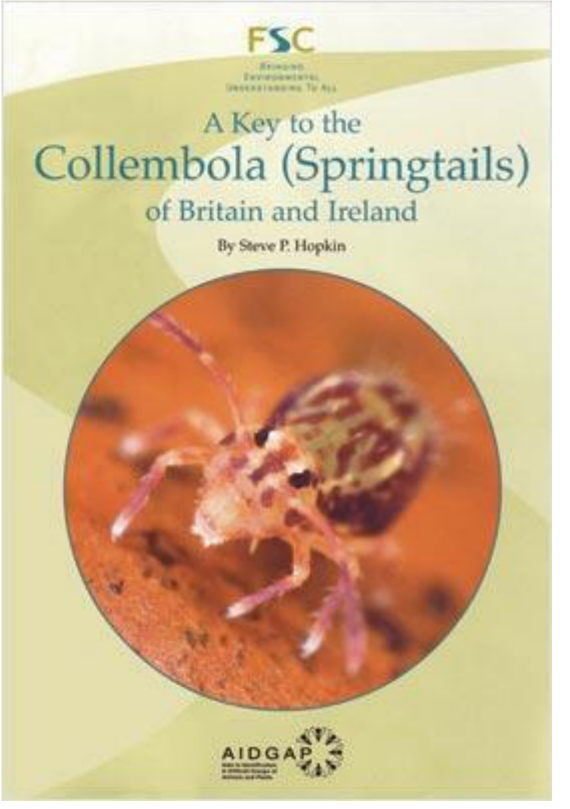


Peter Shaw

University of Roehampton

University of Roehampton London

The main key we will use:



Developed by Steve Hopkin, somewhat despairing at the problems of identifying these common animals from old keys aimed at other countries. His aim was to key out commoner species selectively, and always have simple clear dichotomous questions. (Not always simple to see the answer, but that's another story).

Taxonomic purists have been somewhat sniffy about the book’s “popularist” approach, in particular cases where different members of the same genus key out down different paths based on colour patterns.   It’s perfectly valid to ask if a UK Lepidocyrtus is creamy white or whether it is dark / patterned, and in this case they will follow different paths. Purists prefer to get the genus first, then have a separate subkey to each genus.

This approach does run into the sands badly when a new species/ genus appears – as they are doing! But for all common / often met species it works well, as well as most of the others in my experience.

Other resources

Frans Janssen's web page www.collembola.org

UK list + images + links to other sites
http://ws1.roehampton.ac.uk/collembola/taxonomy/index.html
(google roehampton collembola + follow "Taxonomy" link

Excellent keys to Nordic Collembola, almost all species covered being found in UK too, by Arne Fjellberg as hardback books.

Major key steps

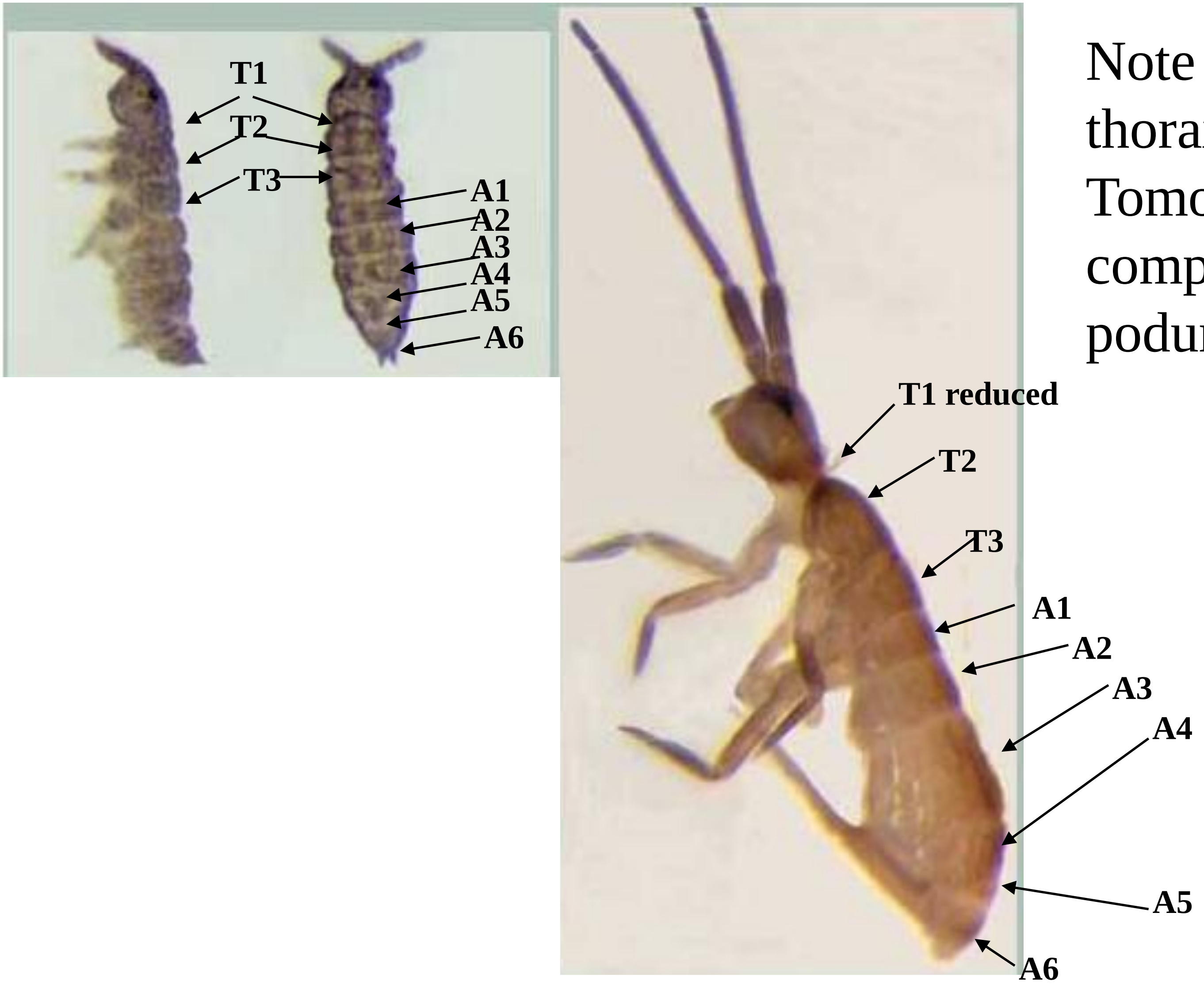
Some key questions need no explanation – “colourless or has clear pattern” etc, but often there are specific things to consider. I’ll pick up the main ones that you will keep on re-meeting.

If there is a good ecological reason to skip a step, that’s fine! The definitive case is the Mesentoma/Entomobrya split, which is either a very hard-to-see spine at the base of the mucro, or asking whether it came from the seaside!

Segmentation patterns

Despite morphological stability, there are segmentation anomalies that you need to look out for.

The most important is the reduction of thorax 1, which is diagnostic of the Entomobryidae and Isotomidae. This pops up at couplet 2 (after the separation into symphylopleona vs arthropleona).



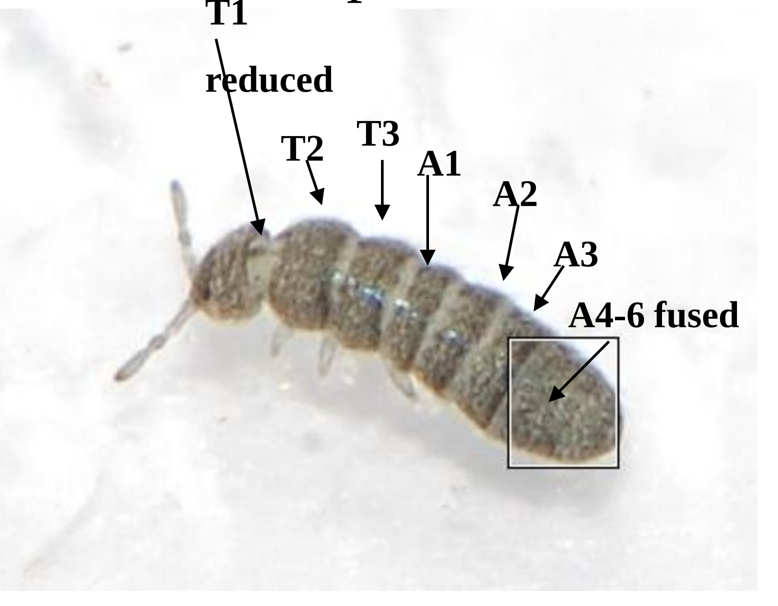
Note reduction of thorax 1 in the Tomocerus compared to the podurid.

Segmental fusion: fusion of 4-6

This is mainly the indicator of one genus of Isotomids; Folsomia. These are small white/grey (<1.5mm), and abd 4-6 are always perfectly fused.

Folsomia candida

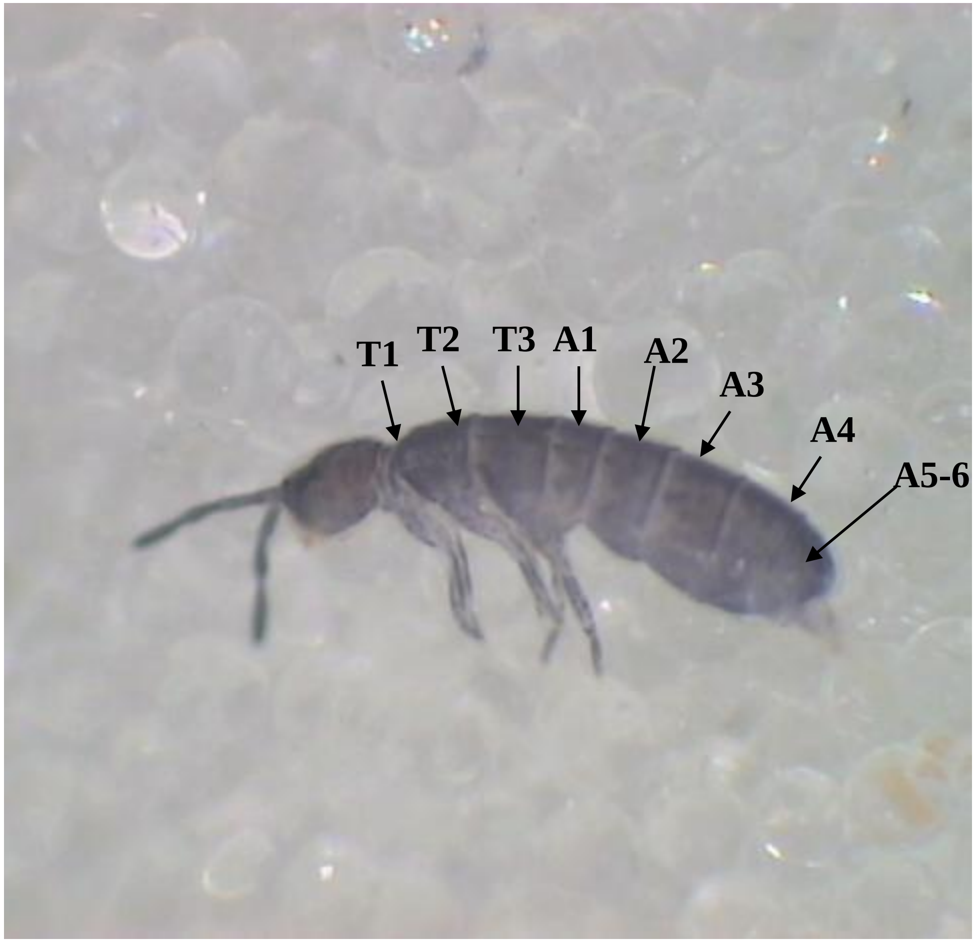
Folsomia sp



Fusion of Abd 5-6

Pseudisotoma sensibilis, 1mm.

There are a few isotomid genera where abdomen 5-6 are fused, at least partly (in the lower portion of the joint). This is most commonly met in *Pseudisotoma*, a common grey/black isotomid that likes warm open sunny areas and has clavate hairs on each foot + fused abd 5-6. We have (maybe!) only 1 species. *P. sensibilis*, though *P. monochaeta* has been claimed, and there are several colour morphs.



Similar abdominal fusion occurs in *Archisotoma*, *Agrenia* and *Cryptopygus*.

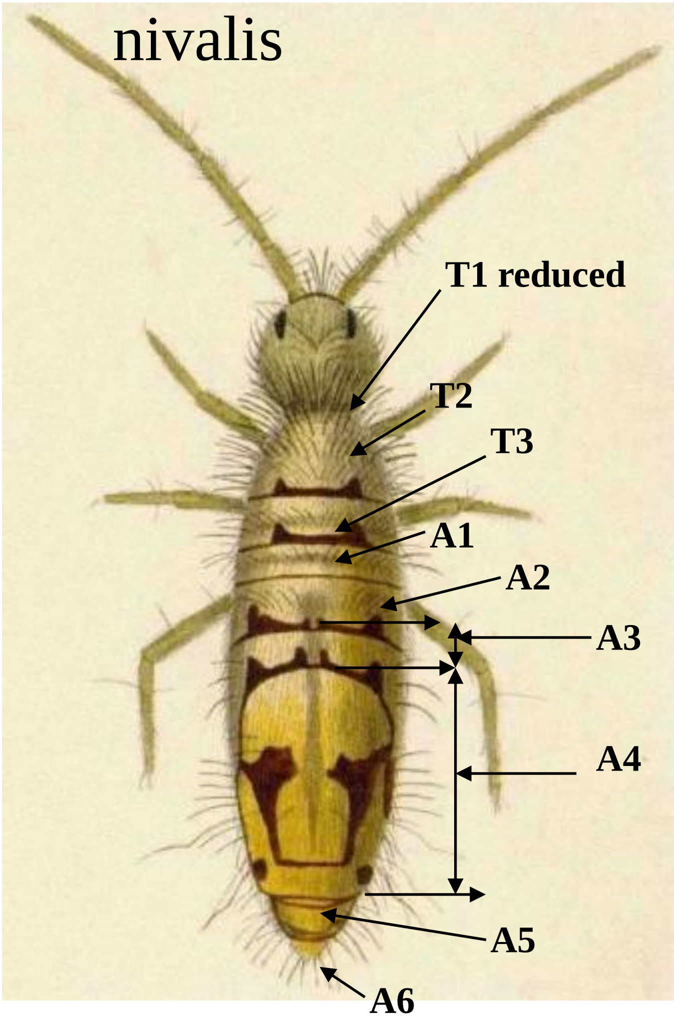
Has it a saddle? (Abd 4 / abd 3 ratio)

A profoundly important division occurs at step 124, when the key asks about the ratio of abd 3 and 4. If the ratio of abd4/abd3 <= 2, jump on to the Tomoceridae/Isotomidae.

If not, you have one of *Entomobrya* (+ closely related *Mesentoma*, *Entomobryoides*), or *Cyphoderus*, *Sinella*, *Pseudosinella*, *Seira*, *Lepidocyrtus*, *Willowsia*. These have an elongated abd 4, that Erica Mcalister likened to wearing a saddle!

These are all large active surface-dwelling spp with long jumps; the size of abd4 reflects its enhanced musculature.

Entomobrya nivalis



Arrow shows abd 4.

Heteromurus major

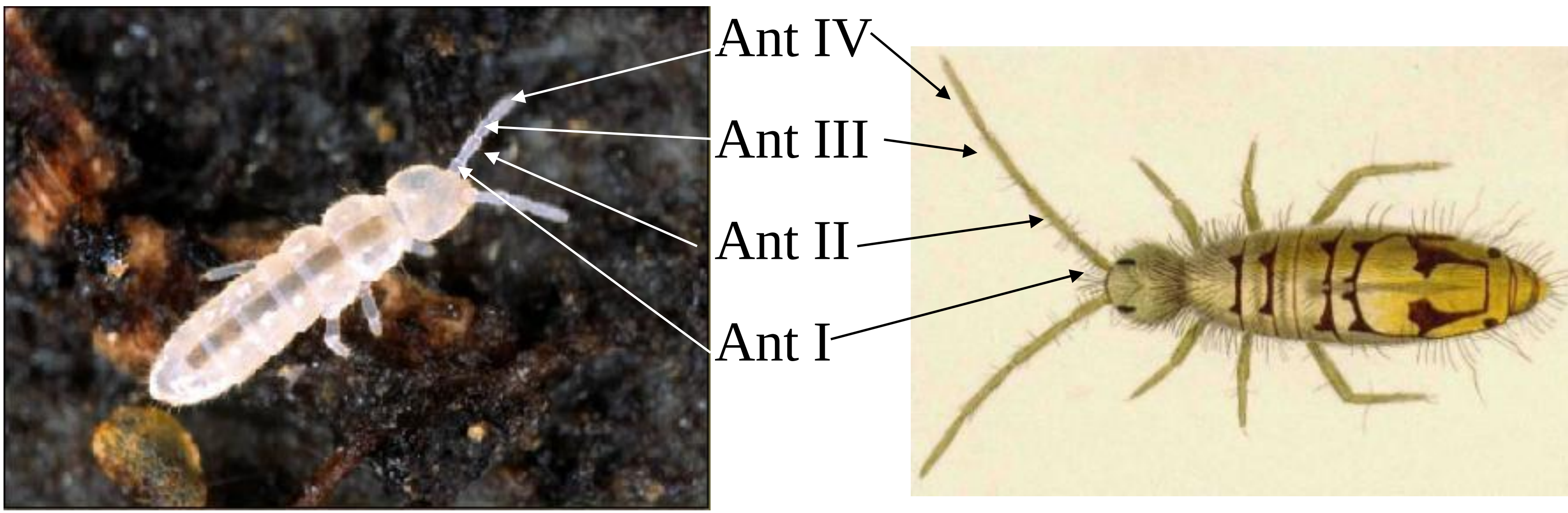
Lepidocyrtus sp

As shown, this ratio looks like a doddle. In practice it can be tricky, especially without a graticule! Even with objective measuring tools, you can easily be tricked by perspective into measuring the wrong distance.

Heteromurus major turned up quite recently in the UK – if you mis-measure abd 4 it keys down to *Lepidocyrtus*, and almost makes sense there – but compare the ‘saddle’ effect with a real *Lepidocyrtus*.

Antennae

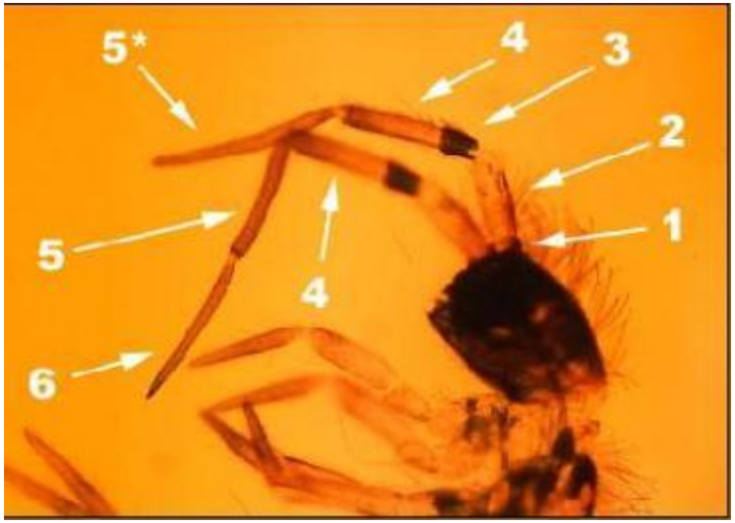
These are always 4 segmented, but often don't look it!   The default position is set by Isotomids, or here an Entomobrya: 4 segments, the basal one rather squat, the rest about equal in length.



Orchesella

All Orchesella have ant. I and ant. II subdivided into 2 sections, so they seem to have 6 segments.

I once got thrown badly by the first couple of instars of *Orchesella cincta*, which have simple antennae and a simple colour pattern. Often in adults, one side is short.   If ID really matters, you should have multiple specimens where possible!



Many podurids, have tiny squat antennae, like stacks of 4 progressively smaller tyres.

Lathyriopyga longiseta (poduridae)

Adhesive vesicles!

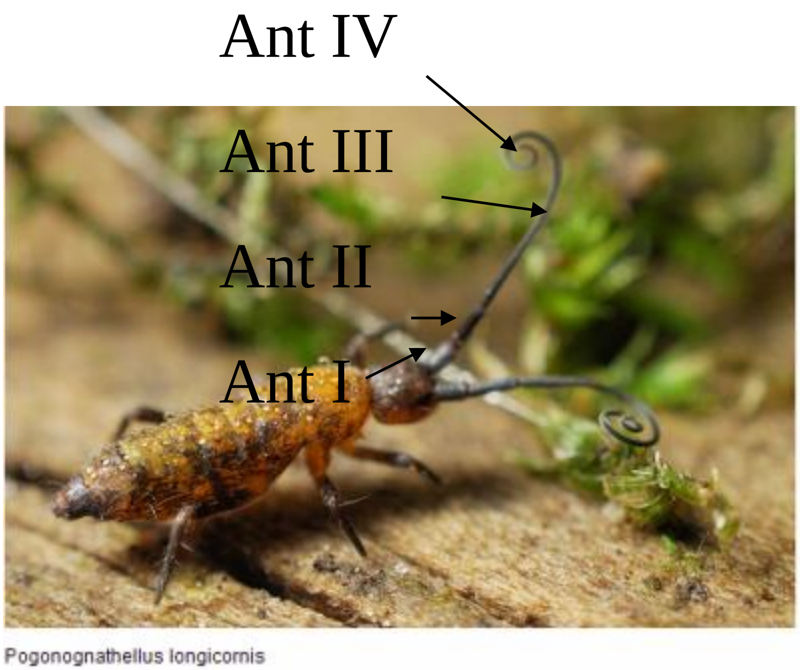
One may sometimes see a small balloon-like swelling on an antennal tip (actually between ant III and ant. IV). These are adhesive vesicles, as shown here by *Ceratophysella*, who have landed on them.

Ceratophysella bengtssoni from the UK
2004 © Hopkin, S.P.

Tomocerus / Pogonognathellus

These large common and distinctive springtails have Ant3 greatly enlarged, and annulated. This alone is diagnostic of the group. These do tend to snap off in alcohol though.

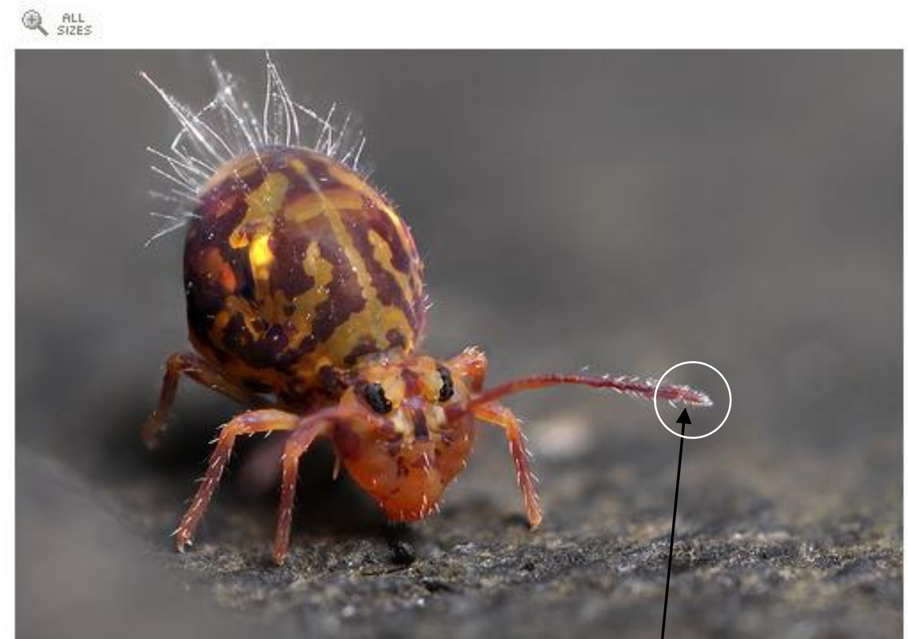
Pogonognathellus longicornis



From Costa Rica, don't have a name but look at ant 1+2! The next 2 segments are longer than the body, but fall off in handling. (It is probably close to *Salina*, which is amazonian and has antennae 3* body length)

Dicyrtoma / Dicyrtomina

Another easy give-away is seeing a sminthurid with ant4 stunted, reduced. This makes it a dicyrtomid; in the UK we have Dicyrtoma, Dicyrtomina and one (rare) Ptenothrix.



Dicyrtomina saundersii, showing waxy filaments that dissolve in IMS.

Ant IV

(reduced)

Sminthurid ant IV segmentations

Many of our smallest collembola are sminthurids with multiple divisions within ant IV. Counting them is often vital. Seeing boundaries is tricky, and simply deciding if the divisions are real or just faint annulations is sometimes surprisingly hard. Patience is a virtue, while the alternative is exploring both sides of the key to see what turns up!

Sminthurides pseudassimilis, not UK

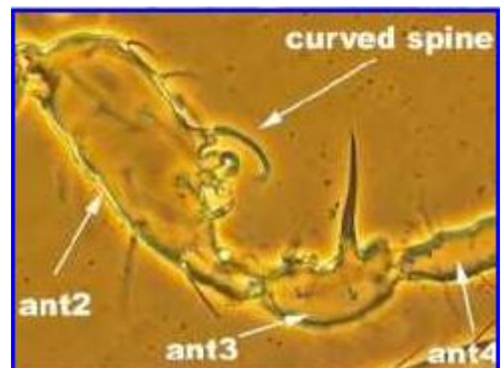
Sminthurus viridis has 18 segments in ant IV

Sminthurus hispanicus, Ibiza

Male *Sminthurides*

These alone have the wierdest antennae of any collembola – like mini-antlers, for mating. They develop a hook-like projection on ant 2, used to hold onto female in mating.

Sminthurides aquaticus from the UK
2009.06.17 © Robertson, A.
Male advancing larger female

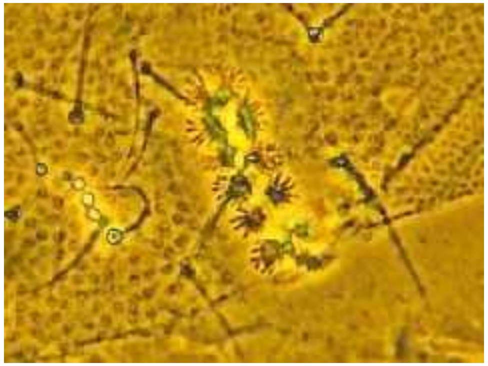


Stenacidia violacea from the UK
Male antenna
2004 © Hopkin, S.P.

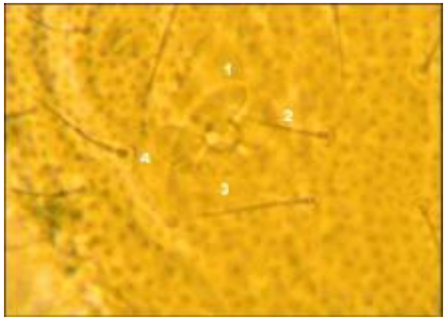
PAO – Post Antennal organ

Many, though not all, Collembola have a second sensory organ near the antennal base, called the post-antennal organ. Possibly/probably homologous with the crustacean antennule?

Where present, is taxonomically very useful.

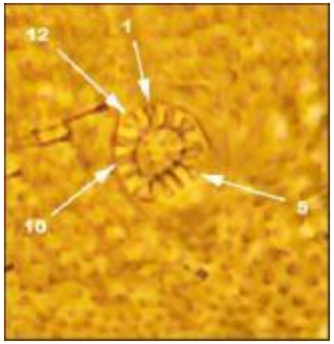


Deutaphorura inermis PAO



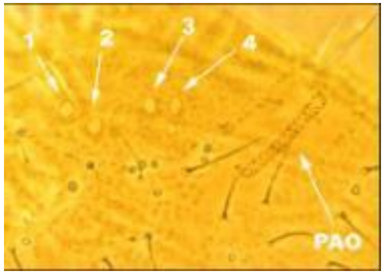
PAO: *Willemia denisi*

4 lobes



PAO: *Anuridella immsiana*

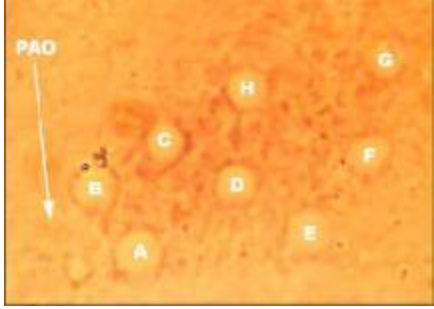
12 lobes



Protaphorura armata

Numbers are pseudocelli

Ocelli - eyes



Eight ocelli (A-H) and post antennal organ (PAO) on the head of *Brachystomella parvula*

Most Collembola have eyes, never >8. Most have either 0 or 8, but all intermediates occur (7 only as a ‘sport’). The genus Folsomia is classified partly on eye #, with 0, 1, 2 and 3 eyed species all occurring. *Parisotoma notabilis* is very common and has 4 in a square eye patch. Xenyllas often have 5 eyes, Tomocerus 6.

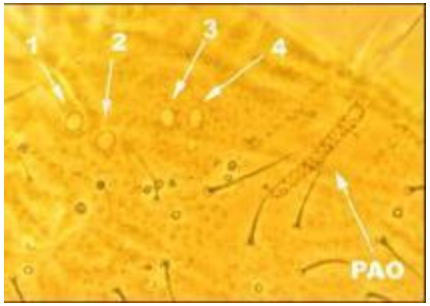
Most symphylopleona have 8 eyes, excepting only the blind neelides and the euedaphic genus Arrhopalites (1+1)

Eyes can be terribly hard to see, especially in highly cleared specimens. I find that cold light illumination on *100 stage is often best. In a few species (eg *Lathyriopygia longiseta*) the eyes are so hidden under warty excrescences as to be almost invisible.

Pseudocelli

Many of the blind white springtails in the family Onychiuridae protect themselves from attack by secreting noxious chemicals. The orifices from which they ooze are called pseudocelli, and have been used as the basis for much taxonomic splitting.

Sadly, this is deluded – it is frequent to find animals with assymetrical pseudocelli. At least half the names in the Onychiurids list are probably invalidated by this.



Protaphorura armata

Numbers are pseudocelli

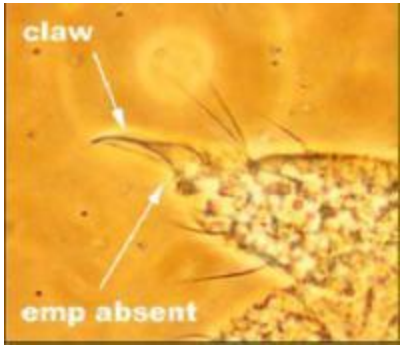
Protaphorura armata with PS2 missing from TH2.

Feet and associated structures

The typical springtail foot has two terminal sclerites, the CLAW (the larger part of the foot), opposed by the EMPODIUM (empodial development, etc..)

The claw is always present, the empodium is sometime absent. (Care! Easily overlooked when small).

Hypogastrura assimilis from the UK
Footcomplex with empodium
and one clavate tenant seta
2002 © Hopkin. S.P.



Schoetella ununguiculata
UK

Tenant hairs

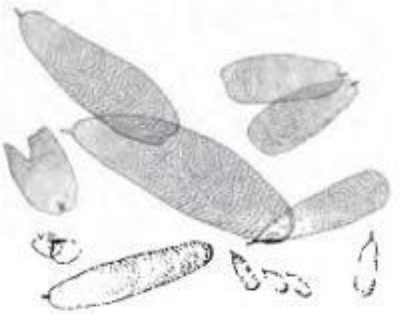
Some species have ‘tenant’ (=knobbed) hairs around/by their feet. These seem to have an adhesive function, and are found in surface-active forms. They are also taxonomically very useful. They also snap off in handling and need high power / phase contrast to see!

Hypogastrura distincta from Sweden

If you see these on an isotomid it’s almost certainly purple, lives up trees, and is either *Pseudisotoma* (abd5-6 fused) or *Vertagopus* (abd 5-6 separate).

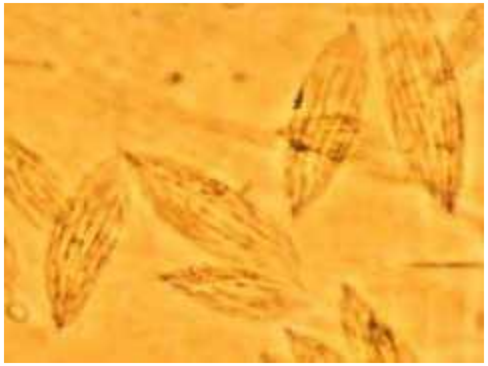
Scales

Some surface-dwelling spp have scales, most easily visible on the 'back of the neck' (Th2). In Victorian times these were prized as microscopic objects, and are indeed genuinely good for checking the optical setup on a microscope.



Lepidocyrtus scales

Willowsia scales



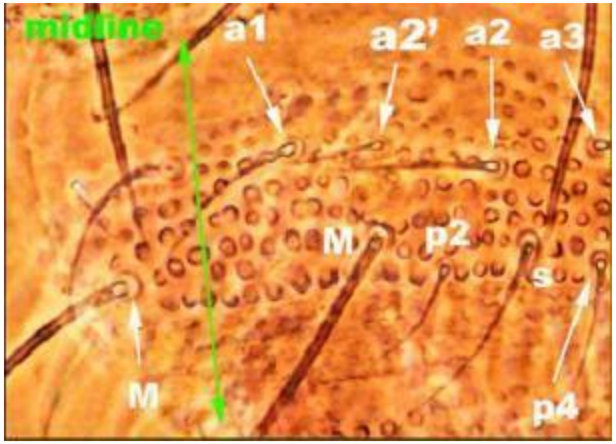
The genus *Lepidocyrtus* is made shiny silver by their thick coat of scales (Lepido = scaly).   Sadly, the species are mainly separated by presence/absence of scales on legs and antennae, which are terribly hard to be sure about!

Lepidocyrtus cyaneus

Setae and chaetotaxy

Virtually all Collembola have some ‘hairs’ on their body. Clearly these are cuticular outgrowths, in no way homologous to mammalian hairs.

A ‘normal’ seta (pl. setae) is pointed, smooth sided, not longer than a body segment. Sometimes the exact layout of these on body segments is checked – refer to the diagrams that go with the key step! Note that bigger ones are macrosetae. Small delicate ones are ‘sensillae’.



Dorsal chaetotaxy of fifth abdominal segment of *Ceratophysella denticulata*. Note the presence of seta a2' (absent in *Ceratophysella engadinensis*) (M (macroseta) = p1; s (sensilla) = p3).

Ciliated macrosetae

On some Collembola, some of the longest setae are not simple but have side-branchlets, like a very skinny feather. These are ‘ciliated macrochaetae’, and often help to narrow down a species ID.

Especially common in entomobryids, I was caught out early in my PhD by big Isotomas also having ciliated macrochaetae. A few smaller ones too eg *Isotomiella minor*.

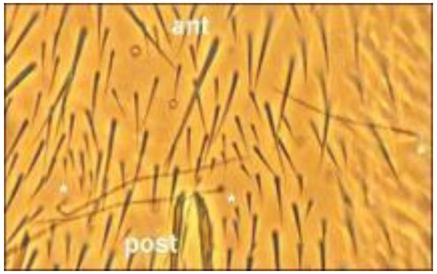
Trichobothria (or bothriotricha!!)

Distinctive ciliated sensory hairs that stick stiffly out from the body. (The same name is applied to a similar organ on scorpions, but it's not clear whether they are truly homologous).

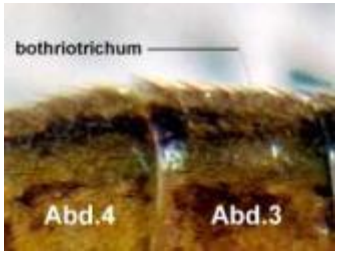
The most important time to watch out for these is when you find an isotomid, especially from a wet area and especially with a stripe along its dorsal midline. Isostomids with abdominal trichobothria are *Isotomurus*, common and widespread everywhere wet.

Isotomurus palustris

2.5mm



trichobothria



Isotomurus palustris

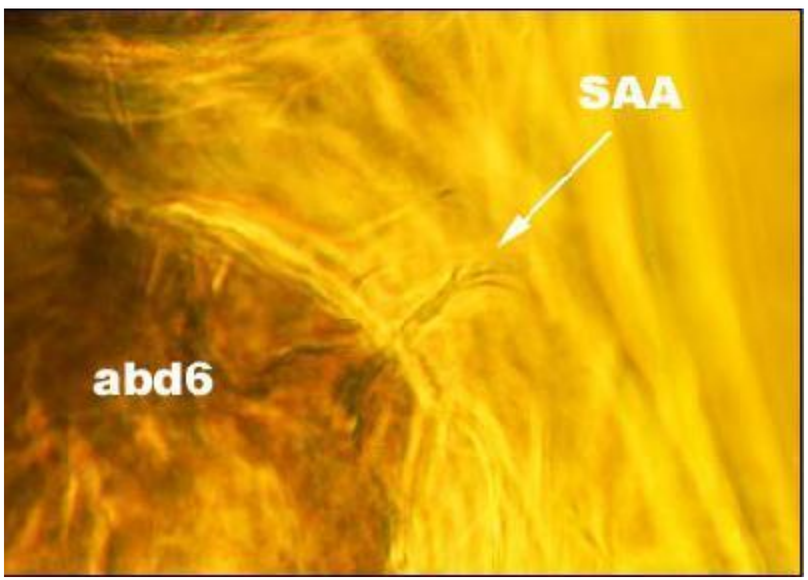
© Baas, A.H.

Isotomurus maculatus

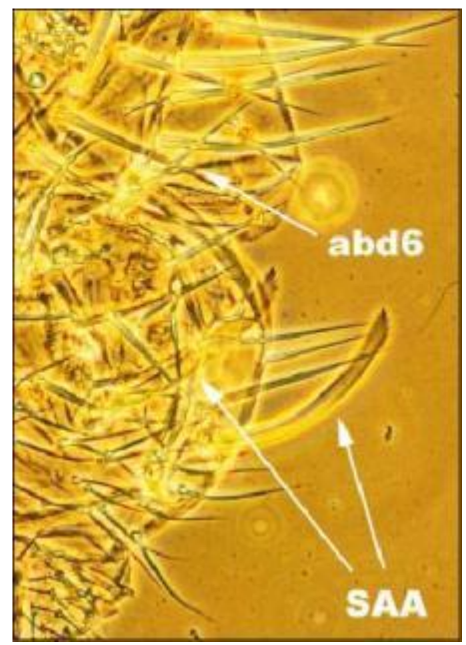
2.5mm

Appendices anales (Sub-anal appendages = SAA)

Perhaps sadly, for many sminthurids, ID requires the oddly shaped hairs around the ano/genital region of females. (Yes, that means that quite a few individuals cannot be keyed out if immature or male). These are the sub-anal appendages or *appendices anales*. Variants include being club-shaped, curled over and being feathered.



appendices anales, female *Sminthurinus aureusc*



appendices anales, female *Allacma fusca*

Furca

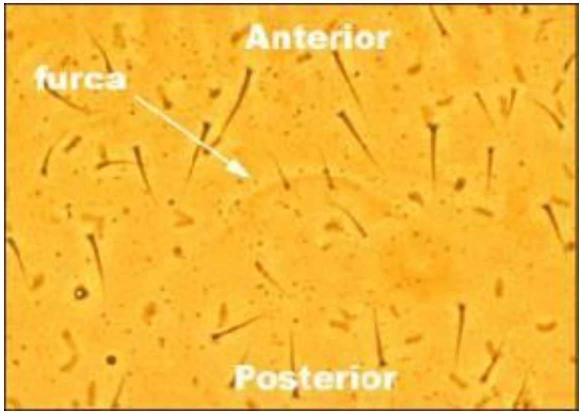
(The name furca means a pitchfork)

3 parts – manubrium, dens, mucro. Usually either present or absent, though there are a few awkward intermediate cases.

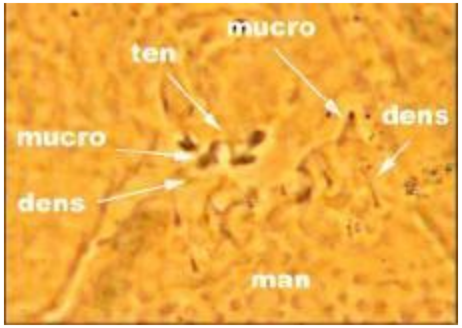
Protaphorura (aka *Onychiurus*) *armatus* group have a hard-to-see very vestigial fold on abd 4, thought to be remains of furca.

My pet dislike – the hard-to-see furca of *Friesea mirabilis*

Vestigial furca of *Protaphorura armata*



Furca of *Friesea mirabilis*
man, manubrium; ten, tenaculum.



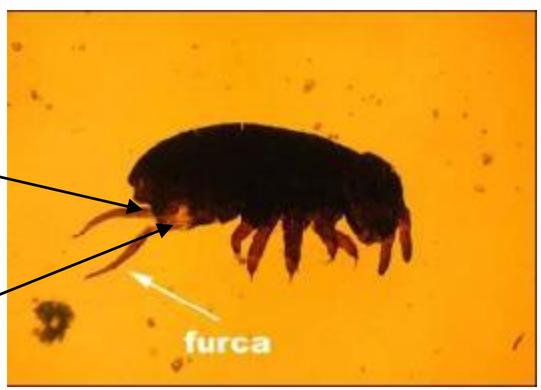
Manubrium

The main key qs here concern the number and location of hairs on the manubrium. Be careful of which side is dorsal – imagine the animal having jumped, furca pointing backwards, then ask which side is dorsal and which ventral.

Dorsal

Ventral

(anterior)

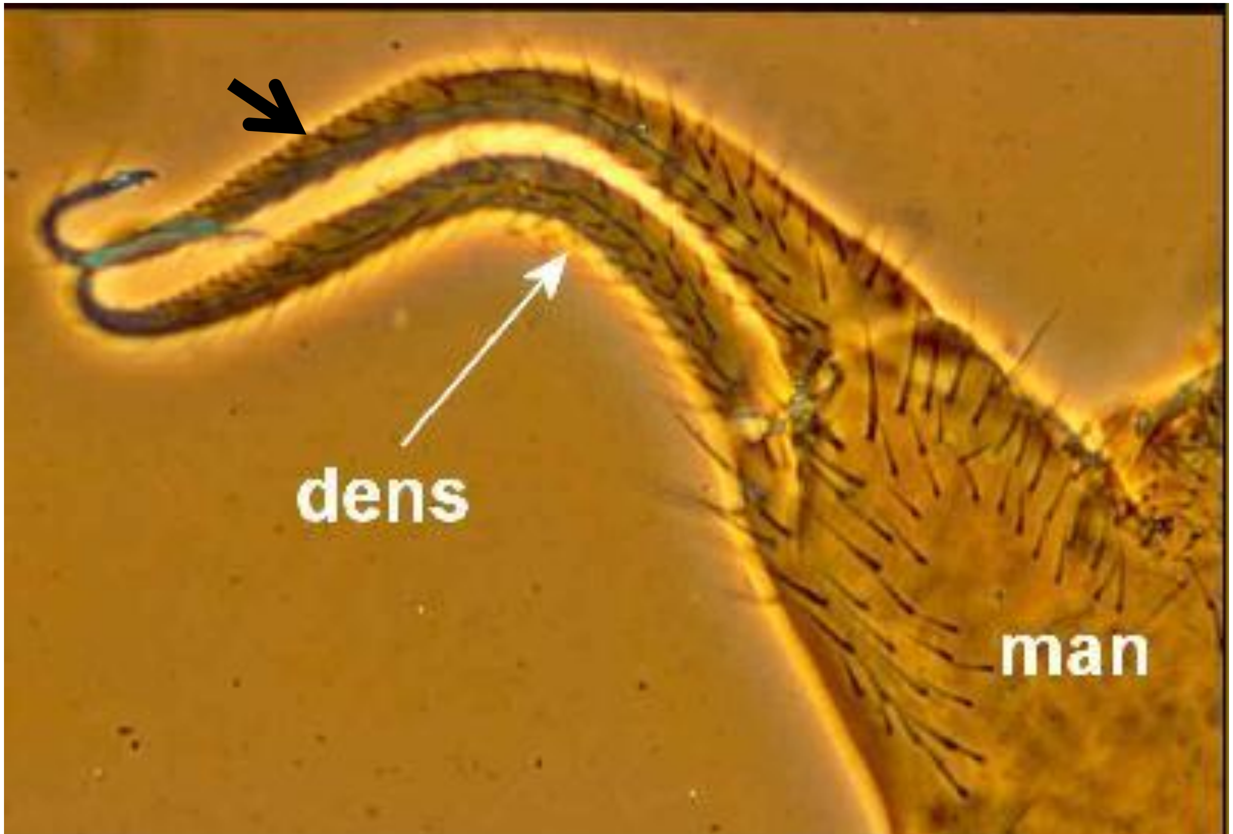


Short stout manubrium of Ballistura

Dens

Thin or stout, smooth or crenulated

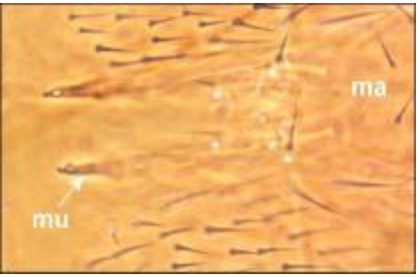
Crenulated dorsal side of furca, here a Bagnall collection of *Parisotoma notabilis*



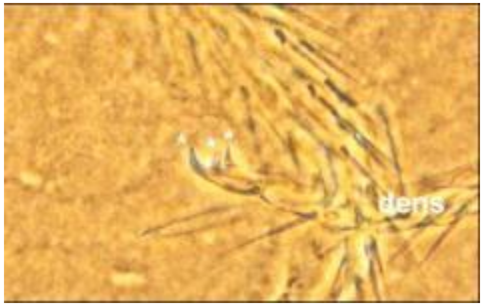
Mucro

Check carefully for number of teeth, any basal spines or hairs

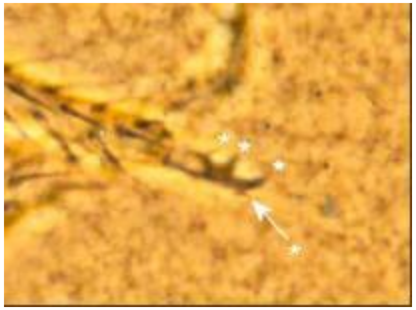
Folsomia quadrioculata – 2 mucronal teeth



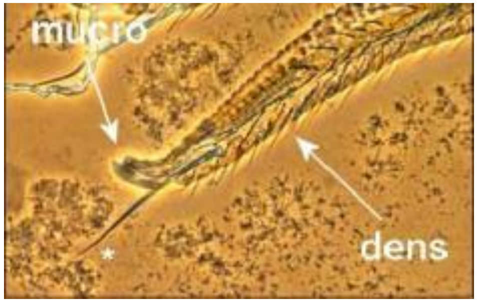
Isotoma anglicana – 3 mucronal teeth



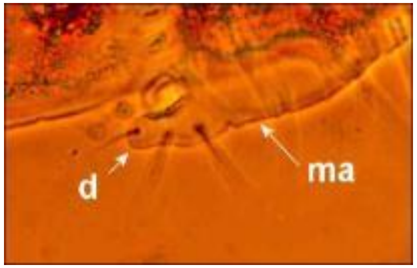
Isotoma antennalis – 4 mucronal teeth



Agrenia bidenticulata – hair passes tip of mucro



Sometimes absent!



Tetracanthella wahlgreni, manubrium and dens but no mucro

Anal spines

A surprising thing is that many Collembola have small sharp spines on abd. 6. These are presumably defensive, maybe to help wedge themselves into crevices? The commonest pattern is 2, *Friesea* spp have 3, *Tetracanthella* spp. have 4, *Proctostephanus* (?extinct in UK) had a ring.

Protaphorura armata

2 spines

Friesea mirabilis

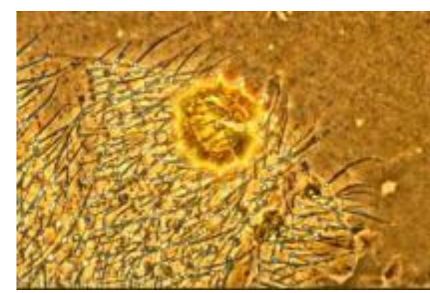
3 spines

Tetracanthella wahlgreni

4 spines

Proctostephanus

Ring of spines



Ecomorphosis

Just to be confusing, spine-less species sometimes grow spines under ecological stress or at certain stages in their life cycle. The genus "Spinisotoma" was created for some Isotoma that did this.

Epitoky

Epitoky is regular morphological changes in the breeding cycle. Only few known examples, *Ceratophysella bengtsonni* reduces motor activity and motility while increasing sexual and sense organs during the reproductive period, then return to normal at next moult.

Collembola sample handling

This is not simple, and my early years were not a shining example (blame the supervisor!). Bird-watchers are rarely asked to supply proof that they saw a blue tit, but Collembologists often change or split (or fuse) names, so unless you preserve the specimens a future researcher will just say "wrong ID, I don't believe you".

Best – at least 70% IMS (95% better), in a tube with labels giving collection details plus ID, inside an outer jar of IMS. I have brought some along. These should outlast human bodies, though it is important to change the outer IMS every now and then.

I tend to work with cavity slides and IMS – spills vanish!!

In principle the best thing to do with Collembola specimens is to keep them in 100% IMS, in small glass tubes inside glass jars of IMS. As long as topped up this should last forever – though IMS can dilute itself by evaporation, so specimens decay despite being in IMS. (BTDT!)

Steve Hopkin’s advice was to keep them loose in IMS, as this way you can usually jiggle a specimen to see dorsal or ventral or whatever. We will handle specimens in IMS 70% on cavity slides.

Then you find a key step about the molar plate, or details of chaetotaxy, and you need to see through the body.

The easiest solution is to mount in a clearant medium; PVA or Hoyers. Almost magical in their clarity and dissolving power!

You can also clear in KOH, or lactic acid. Arne Fjellberg has a recipe based on chromic acid! These are all tricky, and need the chemical removing with DW, then dehydrated before mounting.

But..

- My PhD samples and early heathland work simply dissolved into invisibility amidst a maze of crystals. Even if properly sealed with nail varnish, BMNH will not accept slides using Hoyers etc – only Euparal or Canada balsam.

So

- This means that to see and individual AND preserve it for ever one clears it first – lactic acid or KOH – then neutralises it, then dehydrates it, then mounts it. (And cross fingers).

- For the BMNH also supply date of collection, collector and location / grid ref.