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Processing Mites (Oribatids) and Springtails (Collembola)

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Table of Contents

Summary

This document outlines the training, procedures, and resource materials used to process and identify mites and springtails for the ABMI. During Spring Data Collection Protocols, ABMI laboratory technicians extract soil arthropods from the organic soil samples that were collected from the field. Mites and springtails are then separated from the extracted arthropods and sorted into morphospecies groups. By removing the debris from the samples and sorting the specimens into groups, less work is required by experts. Sorted mite and springtail samples are then sent to taxonomic experts to be identified to the lowest taxonomic level possible.

Data Management

Transferring Data from the Sample Tracking Log to the Sorting Database

All organic soil samples received by the Sample Processing Centre (RAM) are tracked using the Sample Tracking Log (Appendix 1). As soil samples are processed, organic soil sample information that was recorded in the Sample Tracking Log is transferred to the Oribatid and Collembola Sorting Database (Appendix 2).

Data Entry During Sorting

Lab technicians are responsible for entering information into the Soil Arthropod Sorting Data Sheet (Appendix 3) while sorting specimens. This information is transferred to the Oribatid and Collembola Sorting Database (Appendix 2) as time allows. While transferring the data, if more that one morphospecies is identified in a sample, the lab technician inserts new rows below the original row and fills in the required information for each morphospecies present.

Checking and Storing Data During Sorting

Soil Arthropod Sorting Data Sheets are checked for accuracy at the completion of each site during the sorting process as part of quality control. Sorting sheets are transferred to the ABMI lab coordinator once the information has been transferred to the sorting database. The lab coordinator checks the database to ensure that all information is recorded accurately and that all data fields are filled in. Near the conclusion of the field season, the lab coordinator checks to ensure that sorting information for all ABMI sites is present. Sorting sheets are filled in a secure location. The Oribatid and Collembola Sorting Databases are stored on a secure computer with a back-up stored in a different building.

Data Entry During Advanced Identification

The ABMI lab coordinator sends an electronic copy of the Oribatid or Collembola Sorting Database to the taxonomic expert. The taxonomic expert fills in the required information (gray columns) as specimens are identified. The total number of specimens identified for each sorted morphospecies is entered in the Advanced ID Count column. If more that one species is identified for a sorted group, the expert inserts a new row below the original row and records the total number of specimens identified as that species in the Advanced ID Count column.

Transferring Data from the Taxonomic Expert to the ABMI Information Centre

Once the advanced ID has been completed, the expert returns the completed electronic copy of the Sorting Database to the lab coordinator. A hard copy is also printed and sent to the lab coordinator along with the identified samples. The lab coordinator checks the database for omissions or errors, stores it on a secure computer with a back-up stored in a different location, sends a copy of the database to the ABMI Information Centre, and records the data transfer in the Sample Tracking Log.

Specimen Management

To ensure that samples are not lost, all specimens received by the Sample Processing Centre (RAM) are tracked using the Sample Tracking Log (Appendix 1). All subsequent transfers of specimens, samples and data are recorded in the log.

Specimen Transfer from the Field to the Sample Processing Centre

- Every three days, sample bags containing organic soil samples are packaged into coolers by field crews, the sample information recorded onto a Sample Shipping Checklist (Appendix 4), and the coolers shipped via courier to the Sample Processing Centre (see Terrestrial Field Protocols for more information).
- Samples are logged-in when they arrive at the Sample Processing Centre. Each shipment is assigned a lot number, and the contents of each lot are tracked by that number.
- The Sample Tracking Log includes information about the date the lot arrived, the location where the samples are stored, the ABMI sites where the samples were collected, the number of samples of each type in the lot, and a detailed listing of the information about each sample.
- The ABMI lab coordinator ensures that all organic soil sample bags from each ABMI site are present, organized and recorded in the sample tracking log.

Specimen Transfer from the Sample Processing Centre to the Taxonomic Expert

- Boxes containing mite and springtail samples are shipped to the taxonomic expert for advanced identification to the lowest taxonomic level possible.
- Samples vials are packed within an inner carton, absorbent material, plastic liner, foam packing and an external cardboard box. Boxes are labelled and shipped by courier in accordance with current TDG regulations.
- The ABMI lab coordinator records the new location and the date of transfer in the sample tracking log.

Specimen Transfer from the Taxonomic Expert to the Sample Processing Centre

- All specimens and materials received from the Sample Processing Centre are returned after species have been identified.
- Samples are packed and shipped in the same manner as listed above.
- The ABMI lab coordinator checks to ensure that all samples have been returned and are properly labelled. Samples are organized and boxed for storage at the Sample Processing Centre.
- The ABMI lab coordinator records the new location and the date of transfer in the sample tracking log.

Long-term Specimen Curation at the RAM

- All specimens and residual materials collected by the ABMI are gifted to, and where appropriate curated by, RAM.
- RAM retains all ABMI materials for 2 years. This includes specimens sorted to genus/species, specimens sorted to broad taxonomic groups, and residual material including non-sorted specimens and debris.
- After 2 years, reference specimens from each genus/species (or taxonomic group if the specimens were not identified to genus/species) and training specimens are retained by the RAM for use by the ABMI. All other ABMI specimens can be loaned, traded, distributed, or disposed as the RAM sees fit.
- A policy describing the procedure RAM will use to loan and gift ABMI specimens is under development.

Sample Processing

This protocol is designed to extract arthropods from the organic soil samples, and determine the presence and abundance for these species.

Laboratory Equipment:

ABMI Laboratory Protocols
Berlese funnels w/ 20 watt light bulbs (4 per site) held in moveable extraction racks
Lab computer or laptop
Absolute ethanol
Cheesecloth
15-40x Microscope with cold (fiber-optic) light source
300 and 50 µm Sieves
Shallow plastic pan in which to rinse sieves
4 chamber glass petri dishes
Multi-well culture plates
Pasteur Pipettes
Fine-tipped probes and forceps
20 ml storage vials and caps with cone-shaped seal
2.0 ml Travel vials with rubber o-ring seal
Travel vial racks
Short-barrel funnel
Specimen cups with lids

Supervision and Quality Control

- Laboratory Staff will be trained in soil arthropod sorting and identification by a qualified sorting supervisor.
- Qualified sorting supervisors require one of the following:
    1. That they are the ABMI taxonomic expert on mites or springtails, or
    2. That they meet the following criteria:
        - Greater than two months experience in the identification and sorting of soil arthropods
        - Two or more days of training in soil arthropod identification and sorting under the supervision of the identified expert acarologist/entomologist, and
        - Successful completion of an exam (demonstrating >95 % proficiency) consisting of identification and sorting of springtails and mites of Alberta.

Specimen Extraction

- A large room is required with enough 20 Amp electrical circuits to each run 54 Berlese funnels (each funnel has a 20 watt light bulb). Light bulbs are run in series with the use of power bars and an extension cord. The setup consists of movable shelving units, each holding 54 funnels and run with three transformers (see Figure 1). Funnels are numbered sequentially.
- Assemble and check the equipment is working before the arrival of samples.
- The ABMI lab coordinator ensures that samples from all quadrants at each ABMI site are present as the samples are logged in (note that missing samples and sites where no organic soil was collected are also listed on the Sample Tracking Log). The log is backed up on the network every night.
- To ensure consistency for all samples, the samples are transferred into the Berlese funnel extractors within 6 days after being collected..
- Laboratory technicians will place a piece of moistened cheese cloth on a clean laboratory table or rack, remove the organic soil sample from its bag and place the soil sample on the cheesecloth.
- The cheesecloth/soil sample is then placed gently onto the wire mesh of the Berlese funnel prior to inserting the sample cup to minimize the amount of fine particulate matter and dry debris that passes through into the specimen cup.
- The laboratory table/rack should be wiped clean with a damp cloth before repeating the procedure to insure

that there is no cross contamination.

- Two labels are required: (1) One inserted into the specimen cup that includes the RAM Lot #number ABMI site and sub-site number, collector's initials, date of collection, funnel number, extraction start date, and the designations "Organic Soil" and "7 Day Extraction". (2) A second identical label is placed on the soil sample in the funnel. Labels are printed using the template provided on standard white paper using a laser printer.
- Laboratory technicians will add 50 ml of absolute ethanol to the specimen cup and then gently screw it into the lid attached to the stem of the funnel.
- Place the original labeled soil sample bag below the funnel.
- The date the sample is placed in the Berlese funnel is recorded in the Sample Tracking Log.
- Laboratory technicians will turn on the light bulb and run the apparatus for 7 days. They will check the extractors twice each day (first thing every morning and last thing every evening) during the process to ensure that ethanol levels are sufficient and the funnels continue to function properly (i.e., power has not failed, light bulbs burned out, etc.). Add more ethanol if levels are low. Ethanol in the specimen cups must not be permitted to dry up completely.
- It is important not to bump or otherwise disturb the extractors during the extraction process to minimize the amount of fine debris falling into the specimen cups (i.e., the dirtier the sample the more effort required to sort the specimens).
- On the 7th day, turn off the light bulbs, remove the specimen cups and discard the sample material and cheese cloth into the garbage. If the sample is not processed immediately, seal the specimen cups and store until further processing.
- Record the date the sample was removed from the Berlese funnel in the Sample Tracking Log.
- Collect the empty soil sample bags from below the funnels and store for future reference.
- Take down and clean the funnels under running water to eliminate any chance of carry-over of specimens to the next sample. Reassemble the extraction rack and prepare it for the next set of samples.
- Specimens will be processed within 60 days (2 months) of collection.

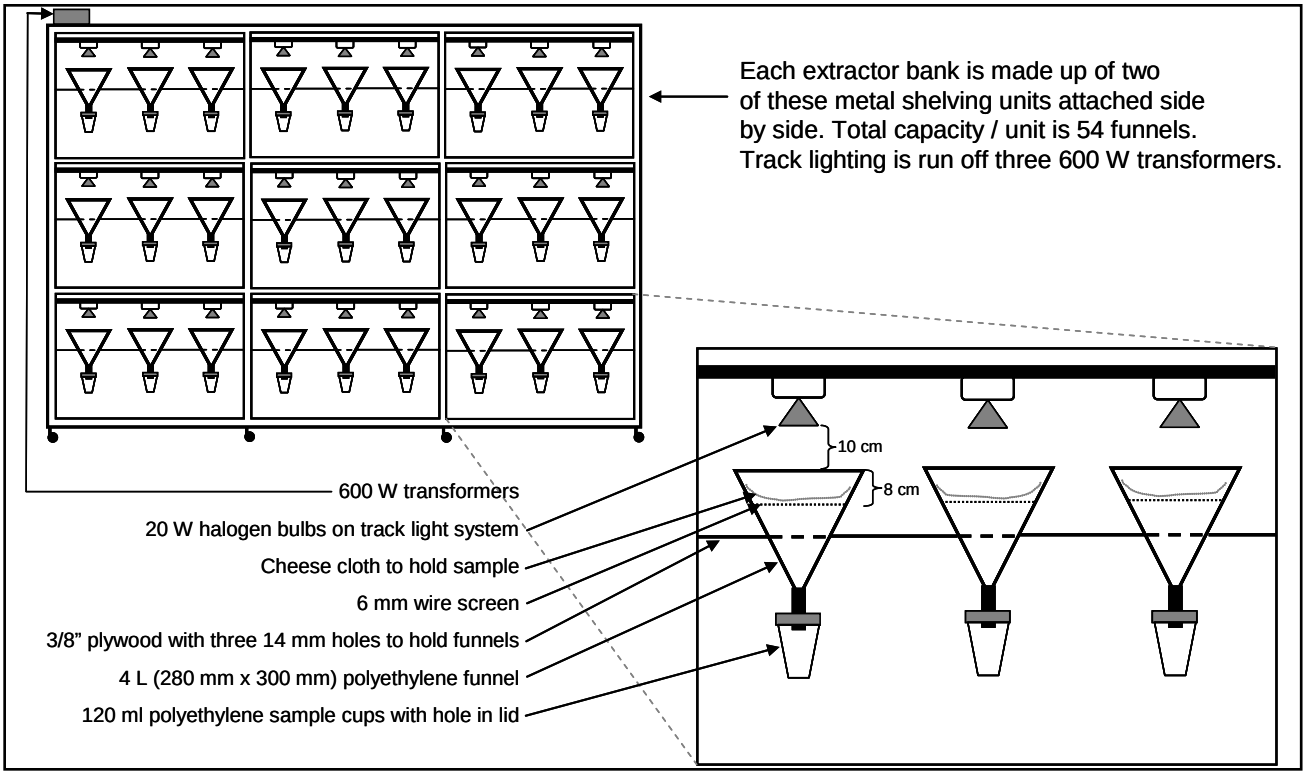

Figure 1: Diagram of organic soil extractor units

Sorting to Morphospecies Groups

- The ABMI lab coordinator will ensure that all samples from each site are present.
- Using the Laboratory Protocol Training Sections (see below) and reference collections, lab staff learn how to handle, sort, and identify the target taxa (defined as adult oribatid mites [Acari: Oribatida] and springtails [Arthropoda: Collembola] ≥300 µm in length) morphospecies as defined by the taxonomic expert.
- Each staff member will be able to process, on average, one site per day by the 2nd week of sorting.
- Staff will sort through the springtails and mites for a single sub-site at a time.
- In a container large enough to hold the sieves and collect the wash-through, pour the contents of the specimen cup through a stacked 300 and 50 µm sieve array. Rinse specimen cup and label with ethanol to ensure all extracted sample material is collected. Ensure that sand, organic material, and soil animals less than 300 µm in length have been washed through the sieve. This will make your sorting duties easier.
- Using the squirt bottle, rinse specimens trapped by the 300 µm sieve to the rim of the sieve and then rinse/back rinse them into a container.
- Specimens trapped by the 300 µm sieve will be transferred into a Petri dish. The sieve is rinsed at the sink (remembering to backwash as the last step) and then briefly checked under the microscope following transfer to ensure no organisms remain trapped in the sieve.
- Organisms trapped by the 50 µm sieve will be transferred to a 20 ml storage vial along with the a label that includes the RAM lot number, ABMI site and sub-site number, date of collection, collector's initials, funnel number, extraction start date , and the designations "Organic Soil" and "Sieved Sample (50µm to 300µm)". Labels are printed using the template provided on standard white paper using a laser printer. These samples are stored at the Royal Alberta Museum (see Specimen Management above).
- The waste ethanol and any organisms that go through the 50 µm sieve will be discarded. Waste ethanol is disposed of by running it down the drain with large amounts of water.
- Using a 15-40x microscope with a cold (fiber-optic) light source, staff will sort through the contents of the petri dish separating springtails and adult oribatid mites from the debris.
- Once all of the springtails and adult oribatid mites have been removed, transfer the debris from the Petri dish to a 20 ml storage vial along with a label that includes the RAM lot number, ABMI site and sub-site number, date of collection, collector's initials, funnel number, extraction start date , and the designations "Organic Soil" and "Residue (50µm to 300µm)". Labels are printed using the template provided on standard white paper using a laser printer.
- When sorting mites and springtails in the Petri dish, use dissecting needles and fine forceps, to move the springtails and adult oribatid mites into groups that are morphologically similar, and then count the number in each group. Springtails are sorted by family and description (see Appendix 6). Adult oribatid mites 300µm in length and larger (when in doubt, use the ocular grid in the steromicroscope to measure length) are sorted to the finest taxonomical level possible (see Appendix 7). Return any non-target arthropods to the Residual vial.
- Staff will record the number of individuals of each morphospecies onto Soil Arthropod Sorting Data Sheets (Appendix 3). These datasheets will be entered into the applicable sorting database on the computer. The original hand written copies are then given to the ABMI lab coordinator and stored in a secure location
- Use a pasture pipette to remove each individual morphospecies of springtails and oribatid mites and place them into separate travel vials containing absolute ethanol. (If specimens are too large for the pipette, then carefully grasp a leg with fine forceps to effect the transfer, but DO NOT crush specimens with forceps). Remove any debris that has been carried over. When you are finished the transfer, each vial should contain only a single morphospecies in clean ethanol.
- Oribatid mites and springtails can be sorted into well plates or small dishes before transfer to travel vials if this helps with the sorting process.
- Check each well and/or travel vial to ensure that specimens are not "lost" during the transfer and that each well or vial contains only one morphospecies.
- Only one ABMI sub-site should be processed at a time to prevent contamination or mix up of data. Once one sub-site (quadrant) has been completed, the next sample from that ABMI site will be processed.
- Insert into each travel vial a label that includes the RAM lot number, ABMI site and sub-site number, date of collection, collector's initials, date sorted, sorter's initials, morphospecies ID, total specimens in the vial, sample ID number, and the designation "Collembola" or "Oribatid". Labels are printed using the template provided on standard white paper using a laser printer. A copy of the label is also taped to the outside of the

vial. Each vial cap should be numbered on the top with a stick on label so that it is easily visible when looking through the rack. In each vial rack the slots are labeled from one to eighty.

- Unique sample ID numbers are created using a combination of the vial rack label and the location of the sample vial in the rack (e.g. C-RHI-01-01 would be the first vial in the first rack of Collembola sorted by RHI).
- Collembola and Oribatid specimens are kept in separate travel vial racks. Label the travel vial racks with "C" for collembolans or "M" for mites – sorter's initials – rack number (e.g. M-DEW-8 would be the eighth rack of mites sorted by DEW). When a vial rack is full, tape a label on the side that indicates the date, and ABMI sites present. Note when a sample is continued into the next rack (e.g. M-DEW-8 Oribatid Mites ABMI.2009 Sites: 344 (1-28), 758 (29-60), 1402 (61-65), 1109 (66-80 continued in M-DEW-9). The racks are numbered sequentially for each sorter.
- To aid expert identification, lab staff will briefly describe new/unknown morphospecies identified on description datasheets and ensure all other staff are standardized with the new/known descriptions.
- The ABMI lab coordinator will send the vial racks with the sorted morphospecies to experts for advanced identification, via courier service (see Sample Management above).

Timeline for Laboratory Training, Sorting and Identification

Overview

The laboratory component to ABMI field work is designing for maximum efficiency. Laboratory staff will be hired for springtail and mite processing. After becoming familiar wit the sorting process, one person should be able to process 5 ABMI sites per week (i.e., average 1 site/day). A great deal of focus is required by staff for them to process and sort all the year's field collections within the time required. If the following steps are followed however, staff should be able to attain the goals.

Week 1: Training

Day 1: Goals and Expectations

- ABMI lab staff will understand the general biology of springtails (*Collembola*).
- Staff will know the parts (characteristics) and terminology for springtail morphospecies.
- Staff will learn how to strain, sort/separate, and siphon specimens from collections.

Training Schedule

Introduction to Springtails (Collembola)

1. Read Appendix 5: Sorting Techniques
2. Read Appendix 6: Introduction to Sorting Springtails (*Collembola*)
3. The taxonomic expert or sorting supervisor will give an introductory lecture on soil microarthropods and explain the relevance of springtails and oribatid mites to ABMI goals.
4. Look at Reference collection.

Sorting Springtail Collections

1. Weather permitting, each trainee will collect two litter-humus (organic) samples for practice extraction and set them up in funnels according to the ABMI protocols.
2. Sort through "unknown" springtail practice specimens provided by the sorting supervisor.
3. Have your work checked by the sorting supervisor.

Quality Control

- If returning staff members (2^{nd} or 3^{rd} year technician) are confident in their morphospecies identification and sorting after reviewing the material, they can start to sort springtails from an ABMI site on Day 2.
- New lab staff must complete the full training schedule before they start sorting ABMI samples.
- A qualified sorting supervisor will verify all morphospecies identifications during training to ensure specimens are sorted with ≥95% accuracy.
- Depending on how quickly new lab staff learn the morphospecies, they may be required to spend extra time training and/or acquire assistance from the sorting supervisor before sorting ABMI sites.

Day 2: Goals and Expectations

- ABMI lab staff will know the general biology of *Oribatid* mites.
- Staff will know the parts (characteristics) and terminology for mite morphospecies.

Training Schedule

Introduction to Oribatid Mites

1. Read Appendix 7: Introduction to Sorting Oribatid Mites
2. Look at Reference collection.

Sorting Mite Collections

1. Sort through "unknown" mite practice specimens provided by the sorting supervisor.
2. Have your work checked by the sorting supervisor.

Quality Control

- If returning staff members (2nd or 3rd year technician) are confident in their morphospecies identification and sorting after reviewing the material, they can start to sort oribatid mites from an ABMI site on Day 2.
- New lab staff must complete the full training schedule before they start sorting ABMI samples.
- For staff that are training, a qualified sorting supervisor will verify all morphospecies identifications during training to ensure specimens are sorted with ≥95% accuracy.
- Depending on how quickly new lab staff learn the morphospecies, they may be required to spend extra time training and/or acquire assistance from the sorting supervisor before sorting ABMI sites.
- For staff that have begun to sort ABMI sites, a qualified sorting supervisor will verify all morphospecies identifications for the first 2 ABMI sites to ensure specimens are sorted with ≥95% accuracy.

Days 3-5: Goals and Expectations

- By the end of the week, staff will be expected to show an understanding of the ABMI protocols and to demonstrate proficiency in sorting oribatid mites and springtails to morphospecies.

Training Schedule

1. Lab staff will sort practice samples into morphospecies and then ask the lab supervisor to check their identifications.
2. Each trainee should develop their personal identification tools, e.g. a notebook with sketches and characters for each of the morhospecies they have learned.
3. If ABMI samples arrive for extraction, trainees will log and set up these samples for extraction under the supervision of the sorting supervisor.
4. On Day 4, staff trainees will begin comparing their morphospecies to the references collections and attempt to determine the identity of the organisms they have sorted.

Quality Control

- For staff that are training, a qualified sorting supervisor will verify all morphospecies identifications during training to ensure specimens are sorted with ≥95% accuracy.
- For staff that have begun to sort specimens at ABMI sites, a qualified sorting supervisor will verify all morphospecies identifications of all staff for the first 2 ABMI sites and all practice material to ensure specimens are sorted with ≥95% accuracy.
- On the last day of Week 1, the sorting supervisor will question each staff trainee about protocols to insure that they understand what to do and why they are doing it. Then the supervisor will provide test mixtures of microarthropods for the trainees to sort and give each trainee an evaluation of their performance.

Week 2: Training

Note: Returning lab staff can proceed to Subsequent Weeks: Sorting to Morphospecies Groups

Days 1: Goals and Expectations

- Lab staff trainees will be able to process their practice samples with minimal assistance.

Schedule

Sorting Practice Springtail and Mite Collections

1. Staff trainees will process, and sort the samples they collected in Week 1.

Quality Control

- The sorting supervisor will insure that the trainees are following extraction protocols and verify all morphospecies identifications of trainees to ensure that ≥95% specimens are sorted to correct morphospecies.

Days 2-5: Goals and Expectations

- Staff will begin sorting ABMI samples as they become available.
- By the end of the week, ABMI staff will be able to sort one site (4 quadrant samples) per day.

Schedule

Sorting ABMI Springtail and Mite Collections

1. Begin sorting ABMI site collections

Quality Control

- The sorting supervisor will insure that the trainees are following extraction protocols and verify all morphospecies identifications to ensure that ≥95% specimens are sorted to correct morphospecies.
- What re-training process will be followed if sorting does not achieve 95% accuracy?

Subsequent Weeks: Sorting to Morphospecies Groups

Goals and Expectations

- Based on the training and instructional guidelines learned from previous weeks, ABMI lab staff should be sorting ABMI sites at an average rate of one site/day.

Quality Control

- A qualified sorting supervisor will verify 25% of all morphospecies identifications of every lab staff for 2 randomly selected ABMI sites (for every 5 sites sorted) during the second week to ensure that ≥95% of specimens are sorted to correct morphospecies.
- In subsequent weeks, 25% of all morphospecies identifications of every lab staff for 1 randomly selected ABMI site (for every 5 sites sorted) will occur to ensure that ≥95% of specimens are sorted to correct morphospecies.

Advanced Identification of Specimens

- The ABMI lab coordinator will send all sorted samples, via registered mail or courier service to an appropriate expert in springtail/mite taxonomy for identification to the lowest taxonomic level possible.
- The ABMI lab coordinator will also send an electronic copy of the Oribatid or Collembola Sorting Database into which the taxonomic expert will enter all identifications.

Selecting the Expert

- The ABMI will select experts who are known specialists in springtail/mite taxonomy. To ensure the highest of standards, and to maintain ABMI's level of credibility, the ABMI will only select experts who can meet at least one of the following criteria:
  1. Expert is endorsed by the Royal Alberta Museum, or an associated museum (i.e., Canadian Museum of Nature, etc.), as capable of expert identification of springtails or mites with >95% accuracy.
  2. Expert is endorsed by 2 members of the scientific community, recognized in the field of entomology, as capable of expert identification of springtails or mites with >95% accuracy.

3. Expert completes an ABMI certification exam consisting of 200 known springtail or mite specimens from >50 species, and from at least 10 broadly separated areas throughout Alberta. The expert must identify the specimens with an accuracy of ≥95% (i.e., maximum 10 wrong) to pass the exam.

Identifying the Mite and Springtail Specimens

- The ABMI defines target taxa as adult oribatid mites [Acari: Oribatida] and springtails [Arthropoda: Collembola] ≥300 µm in length.
- All target taxa are to be identified to the lowest taxonomic level possible. Species names must be determined based on the Species References/Authorities listed below. Alternatively, each identification should be supported by a Species Reference/Authority provided by the expert and entered into the database.
- RAM maintains the taxonomic keys, and if there is discrepancy between keys determines their order of precedence.
- If additional reference literature is needed to determine the species name, the expert will note this additional literature in the database.
- Species must be identified with ≥95% accuracy.
- Whenever possible, specimens are to be identified to species. There are however, a few exceptions:
    - Juveniles – Do not attempt to identify
    - Larval mites (3 pairs of legs) – Do not attempt to identify
- Incomplete identifications:
    1. When a specimen is recognizable as a distinct species but cannot be assigned to a named species either because it is undescribed or because identification is currently problematic (e.g. poor original description, no recent revisions, unavailability of types, etc.), the identification is listed in the format:
        - *Genus* sp. + alpha-numeric identifier + initials of identifier. For example:
          Pilogalumna sp. 1 DEW = species 1 of *Pilogalumna* as identified by David Evans Walter
          Hydrozetes sp. E RAN = species E of *Hydrozetes* as determined by Roy A. Norton
          Gymnodamaeidae sp. 3 DEW = known family, genus unsure or new, sp. 3 of DEW
    2. If the specimen cannot be identified to the species-level because it is damaged or for any other reason, the identification is listed as "sp." alone at the lowest level of identification. For example: *Genus* sp. = undetermined species of *Genus*
- If necessary, the expert will clear and mount an example of each morphospecies onto a microscope slide.
- Identified specimens that remain in the original vial retain their original label, sample ID number and position in the original rack. These specimens are labeled by writing or printing the species ID, total specimens remaining in the vial, identification date, and expert's initials on a separate slip of paper, and inserting the slip into the vial. Labels can be printed using the template provided on standard white paper using a laser printer.
- All specimens isolated from the original vial must be labeled with a new label that includes the RAM lot number, ABMI site and sub-site number, date of collection, collector's initials, species ID, total specimens in the vial or slide, expert's initial, date identified, new sample ID number (see below), and the designation "Collembola" or "Oribatid". Labels can be printed using the template provided on standard white paper using a laser printer. A copy of the new label is also taped to the outside of the vial.
- New slides and vials are organized in alpha-numerical order in new racks or slide boxes and assigned new sample ID numbers using a combination of the original sample ID number, followed by "V" for vials or "S" for slides, and sequential letters for each isolated specimen (e.g. the second specimen isolated from the original vial labeled C-RHI-01-01 onto a slide would be labeled C-RHI-01-01Sb).
- The expert will enter all required information into the Oribatid and Collembola Sorting Database (Appendix 2).
- The expert will ship the specimens back to the Sample Processing Centre, via the method above, and e-mail a digital copy of the Oribatid and Collembola Sorting Database to the ABMI lab coordinator.
- The ABMI lab coordinator will ensure the species' 7-letter codes are added to the electronic database.

Verification Process

- In order to insure that the ABMI expert's identifications are congruent with other specialists in the field, these identifications will undergo a verification process to determine what specimens are subject to differences of interpretation, nomenclatorial variation, or unintended errors of identification. This process may involve a

second expert's identification of previously identified material or the use of a different means to estimate the precision of the first expert's identifications (e.g. DNA analysis).

- For each expert identifying ABMI springtails or mites, 10% of the identified specimens (up to a maximum of 200) will be randomly selected for verification. Note that at least one randomly selected specimen from each species (or higher taxonomic group if the specimens are not identified to species) will be included.
- The ABMI lab coordinator re-labels each specimen with a reference number and sends the specimens to a second expert that meets the above credibility criteria.
- The second expert will identify the specimens and record the species name beside the matching reference number on a provided data sheet.
- The second expert than ships the specimens back to the ABMI, and emails the data sheet to the ABMI lab coordinator.
- The ABMI lab coordinator compares the data between the two experts.
- Discrepancies are reviewed by both experts (plus additional experts if necessary) to determine which differences are based on different interpretations and which involve misidentifications. Any differences in interpretation (e.g. generic limits, generic placement, species limits) will be resolved in the first specialist's favour, but the different interpretations will be noted in the ABMI spreadsheet and information made available to the public. If a discrepancy can not be resolved, the specimen in question will be recorded in the database at the lowest taxonomic level that is agreed upon by the two experts.
- If, after all interpretational differences have been resolved, there is ≥5% misidentifications on the part of the initial taxonomic expert, then the genera/species with ≥5% difference are highlighted. All individuals the initial expert identified from the highlighted species are re-identified to confirm their identity.

Specimen Storage

- All specimens (vials and slides) are stored for 2 years.
- After 2 years, all specimens are given to the Royal Alberta Museum.
- The ABMI will retain vouchers, and enough reference specimens of each species plus additional specimens for training purposes.

Species References/Authorities

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Appendix 1: Sample Tracking Log

Note: This is a portion of the complete Sample Tracking Log that shows only the columns relevant to the receiving and processing of organic soil samples.

RAM ACCESSION INFO						ABMI SAMPLE COLLECTION INFO					ORGANIC SOIL			
Data Series Count	Project	Year	Group	RAM Lot #	Date Received	Sample Type	Site #	Sub-site	Collector	Date Collected	Extractor Number	Extractor Start Date	Extractor End Date	Sample Removed from Extractor
1														
2														
3														
4														
5														
6														
7														
8														
9														

SAMPLE DISPOSITION									
Data Transferred to Database	Samples Sent for Sorting	Samples Returned from Sorting	Samples Sent for Advanced ID or Processing	Samples Returned from Advanced ID or Processing	Database Sent to Information Centre	Current Sample Disposition	Current Residual Disposition	Samples Transferred to RAM's TMS	Comments

Appendix 2: Oribatid and Collembola Sorting Database

ORIBATID/COLLEMBOLA SORTING														
RAM Lot No.	ABMI Site Number	Sub-site / Plot	Collected By	Field Collection Date	Sorted By	Date Sorted	Coarse Sorting Morphotype	Coarse Sorting Count	Voucher Location	Residual Location	Original Vial Location	Sample Disposition	Field Crew Comments	Lab Comments

ADVANCED IDENTIFICATION																
Total Still in Original Vial	New Vial Location	Total in New Vial	Slide Location	Total # / Slide	ID By	ID Date	Family	Genus	Species	Species Author	ABMI Species Code	Advanced ID Count	Reference Used	Advanced ID Comments	Verified By	Verification Date

Appendix 3: Soil Arthropod Sorting Data Sheet

Soil Arthropod Sorting Data Sheet

Rack
Date:
Tech:

Oribatid / Collembola
(circle one)

Vial	Morphotaxon	#	Site	Sub	Vial	Morphotaxon	#	Site	Sub
1					41				
2					42				
3					43				
4					44				
5					45				
6					46				
7					47				
8					48				
9					49				
10					50				
11					51				
12					52				
13					53				
14					54				
15					55				
16					56				
17					57				
18					58				
19					59				
20					60				
21					61				
22					62				
23					63				
24					64				
25					65				
26					66				
27					67				
28					68				
29					69				
30					70				
31					71				
32					72				
33					73				
34					74				
35					75				
36					76				
37					77				
38					78				
39					79				
40					80				

Appendix 4: Sample Shipping Checklist

Sample Shipping Checklist
Terrestrial Protocol - Spring

Crew ID: _______________ **Site Block #:** __________ **Sites Completed in Block:**____**of**____

Shipping Date: __________ **Shipping Method:** ____________ **Waybill #:** __________________________

Type and Total # of Containers:____

Complete one sheet for each site block in the shipment. Complete one section for each site completed in the block.
You must fill in all fields in each completed section - Record "VNA" for any fields that do not apply.
If shipping by Bus or Courier, save a copy of your waybill for future reference. If dropping off at RAM – enter the date samples are dropped off as the shipping date, enter "Delivered" as the shipping method, and enter the initials of the person dropping it off as the waybill #.

Site # ___________ **Field Collection Date** ___________ **Prairie Protocol**[1] (circle) Y N **Field Crew Initials** ____________

Moss[2]**:** Collected by: __________ **Lichen**[2]**:** Collected by: __________ **Soil Cores**[3]**:** Collected by: ___________

	NE	NW	SE	SW		NE	NW	SE	SW		NE	NW	SE	SW
Log/stump					Log/stump					LFH				
Tree/other					Tree/other					Mineral				
Wetland					Wetland									
Upland					Upland									

Comments: ____

Site # ___________ **Field Collection Date** ___________ **Prairie Protocol**[1] (circle) Y N **Field Crew Initials** ____________

Moss[2]**:** Collected by: __________ **Lichen**[2]**:** Collected by: __________ **Soil Cores**[3]**:** Collected by: ___________

	NE	NW	SE	SW		NE	NW	SE	SW		NE	NW	SE	SW
Log/stump					Log/stump					LFH				
Tree/other					Tree/other					Mineral				
Wetland					Wetland									
Upland					Upland									

Comments: ____

Site # ___________ **Field Collection Date** ___________ **Prairie Protocol**[1] (circle) Y N **Field Crew Initials** ____________

Moss[2]**:** Collected by: __________ **Lichen**[2]**:** Collected by: __________ **Soil Cores**[3]**:** Collected by: ___________

	NE	NW	SE	SW		NE	NW	SE	SW		NE	NW	SE	SW
Log/stump					Log/stump					LFH				
Tree/other					Tree/other					Mineral				
Wetland					Wetland									
Upland					Upland									

Comments: ____

Site # ___________ **Field Collection Date** ___________ **Prairie Protocol**[1] (circle) Y N **Field Crew Initials** ____________

Moss[2]**:** Collected by: __________ **Lichen**[2]**:** Collected by: __________ **Soil Cores**[3]**:** Collected by: ___________

	NE	NW	SE	SW		NE	NW	SE	SW		NE	NW	SE	SW
Log/stump					Log/stump					LFH				
Tree/other					Tree/other					Mineral				
Wetland					Wetland									
Upland					Upland									

Comments: ____

1 – Circle "Yes" if the site is sampled using prairie protocols – if not, circle "No" and enter "VNA for Moss and Lichen.
2 – For each quadrant, record "C" if a sample was collected, "None" if no specimens were found, or "VNA" if the stratum was not present.
3 – For each quadrant, record "C" if a soil sample was collected. Indicate "None" if not collected (include comments indicating why the sample was not collected).

Page 1 of 2

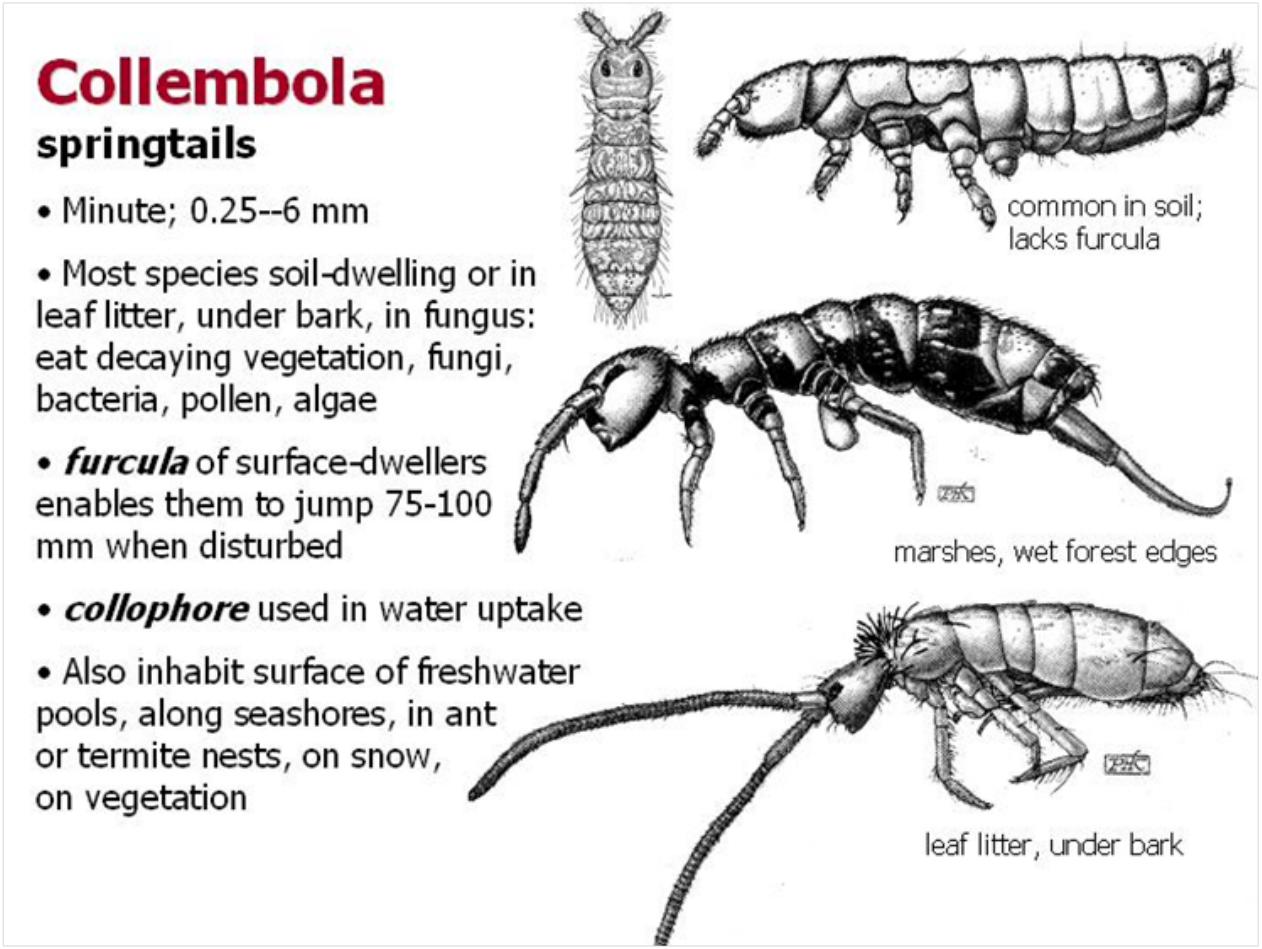
Appendix 5: Sorting Techniques

- When pouring samples through the sieves, make sure to wet down the mesh before pouring specimens through to help debris pass though the mesh.
- Make sure to rinse the 300 µm mesh thoroughly with ethanol to make sure smaller mites pass through.
- Make sure to rinse the specimen cup and original label to remove mites that might be stuck to it.
- Use the 4 chambered petri dish to help keep samples in a smaller area. This helps in the sorting process.
- When sorting, first pipette oribatid mites and springtails into separate, smaller petri dishes. This allows you to sort through only springtails and mites without other things getting in the way.
- Sort springtails and mites into separate piles, each pile being one morphospecies. It helps to keep all the arthropods together at first to make it easier to compare if any two specimens are of the same morphospecies.
- Once the morphospecies have been separated into piles, count them and transfer them to the travel vials. The piles can be transferred to well plates first if this aids the sorting process. Do not mix morphospecies groups in the vials.
- Once the mites or springtails have been placed in the travel vials, look through the petri dish and/or well plate to make sure the transfer was successful, and confirm the number of individual in each vial. Take the time to remove any debris and any arthropods that were missed.

ETHANOL and WATER do not mix! Use ethanol for rinsing and for filling up the petri dish while sorting. Mixing the two together causes the solution to swirl about and is very frustrating.

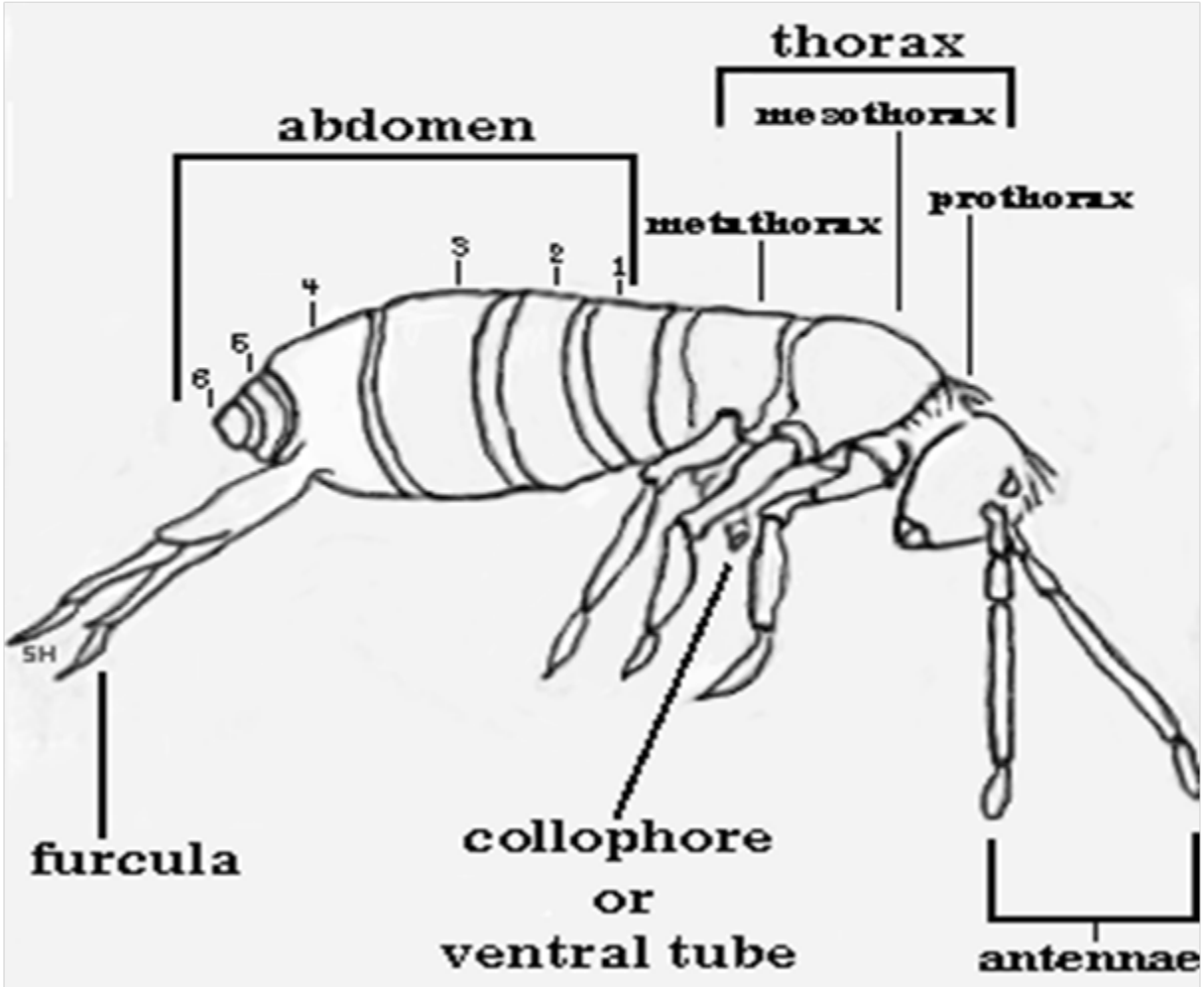
Appendix 6: Introduction to Sorting Springtails *(Collembola)*

What is a Springtail?



http://ltreadwell.ifas.ufl.edu/insects/05simple.htm

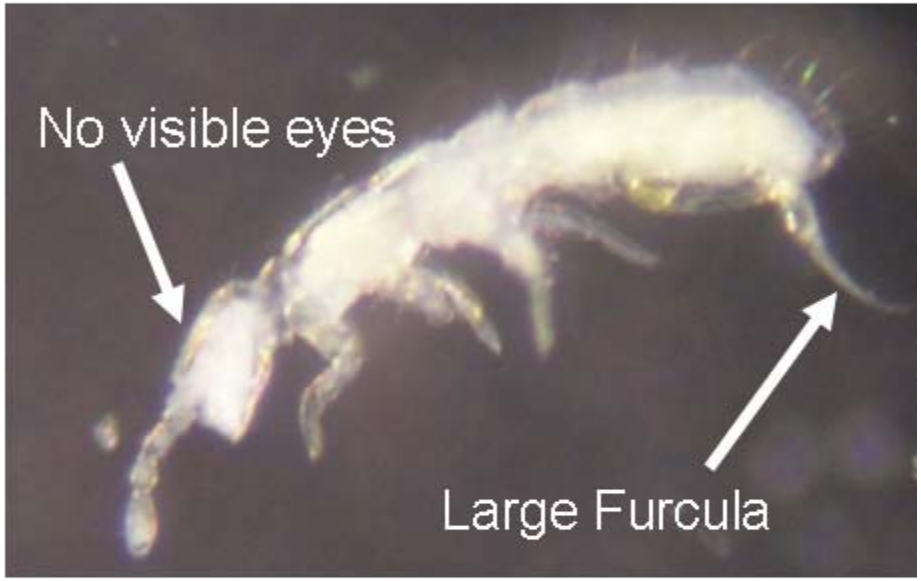
Collembola anatomy



Folsomia morphospecies

Identifying characteristics

- No visible eyes
- Distinct furcula
- Whitish to clearish in color
- Fairly common
- Can vary in size

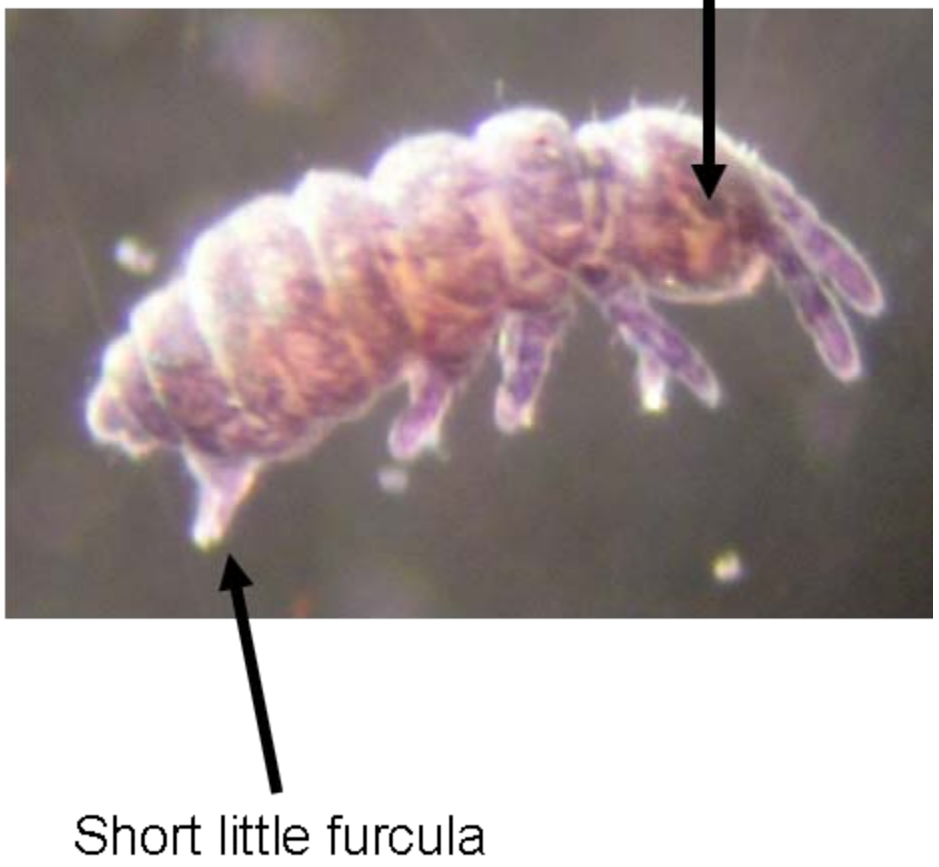


Notes

Hypogastura morphospecies

Identifying characteristics

- Short squat body
- Generally purple in color
- Distinct eyes
- Stubby antennae
- Short little furcula

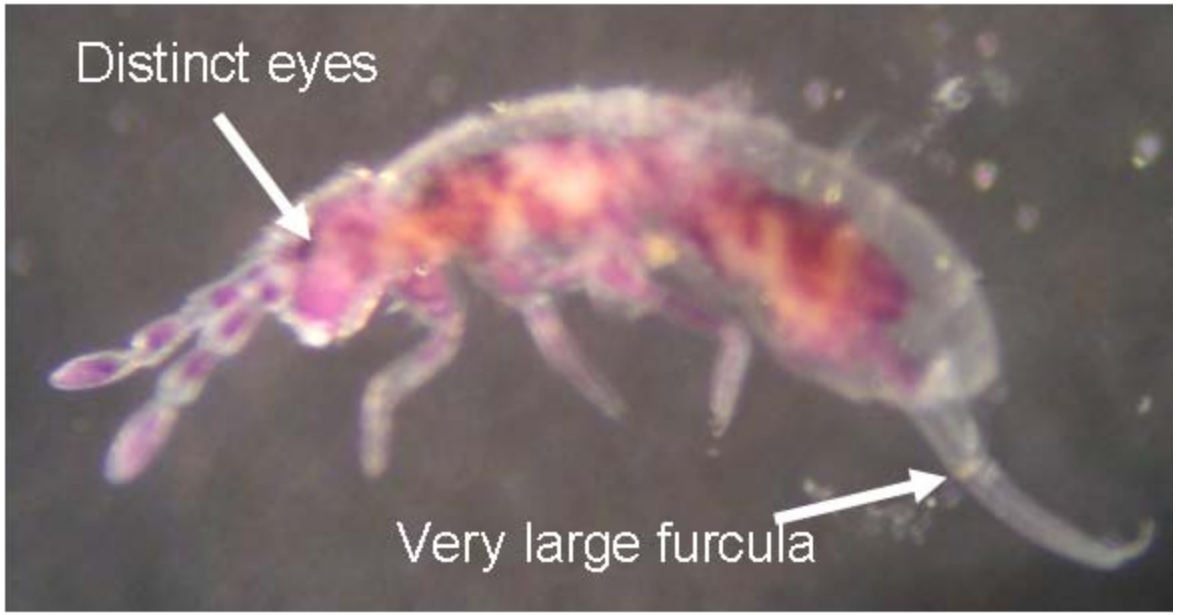


Notes

Isotoma nigrifrons morphospecies

Identifying characteristics

- Very distinct
- Purplish color
- Very large body size
- Reasonably common
- Distinct eyes

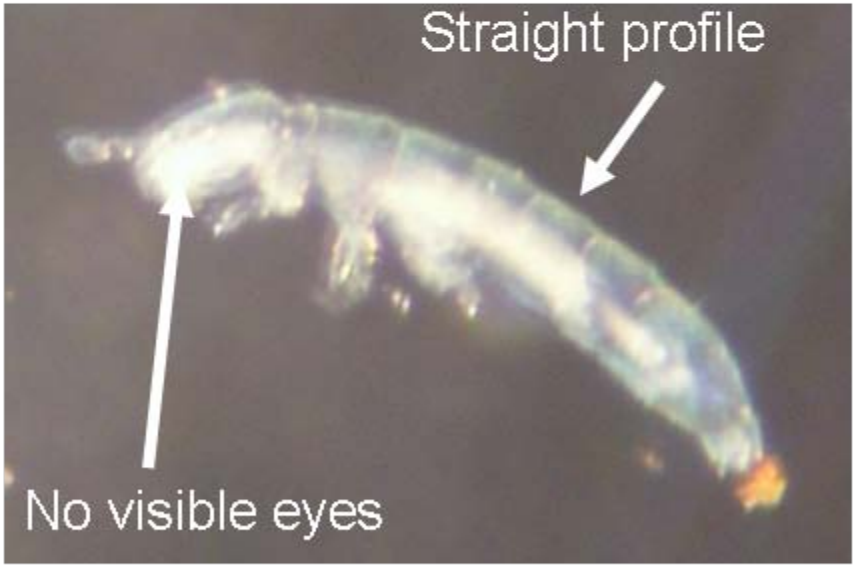


Notes

Onychirus morphospecies

Identifying characteristics

- Lacks eyes and furcula
- White or clear in color
- Long body and tend to have a straight profile
- Quite common



Notes

Sminthurides morphospecies

Identifying characteristics

- Big fat head
- Has distinct eyes
- Usually purple or white in color
- Globular body type

Picture required of white and purple version

Notes

Neelidae morphospecies

Identifying characteristics

- Bright red in color
- Not very common
- Stubby body shape
- Very distinct
- Covered in hairs
- Short furcula present


Very distinct body shape and color

Notes

Appendix 7: Introduction to Sorting Mites *(Oribatids)*

Appendix 2: ABMI Oribatid Morphotaxon Identification

by Dave Walter & Darcie Thauvette

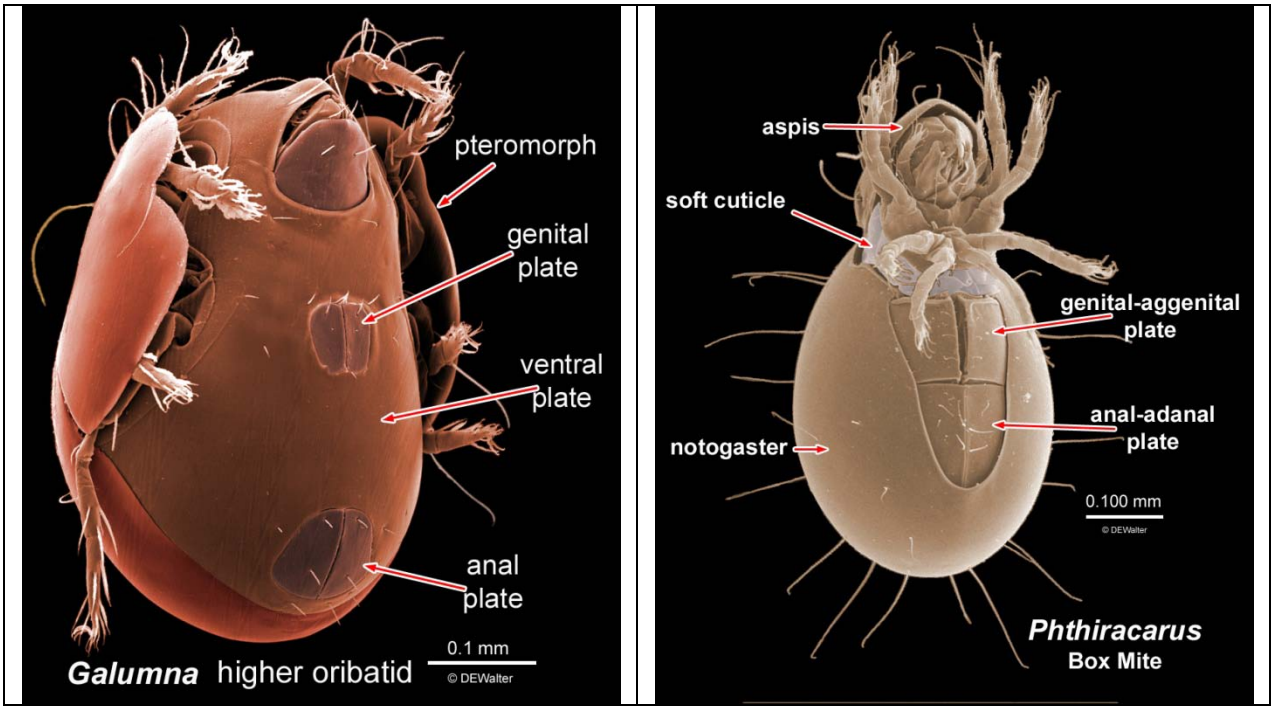
Please send any corrections or suggestions to dew@ualberta.ca

(Light microscope photos by DT unless otherwise noted; SEMS, line drawings by DEW)
NB – This a work in progress: characters apply to known Albertan species, not all taxa are illustrated. Trainees should learn **bolded** characters and taxa (present in 2007 samples.)

Oribatida (=Oribatei, Cryptostigmata; beetle, moss or armored mites)

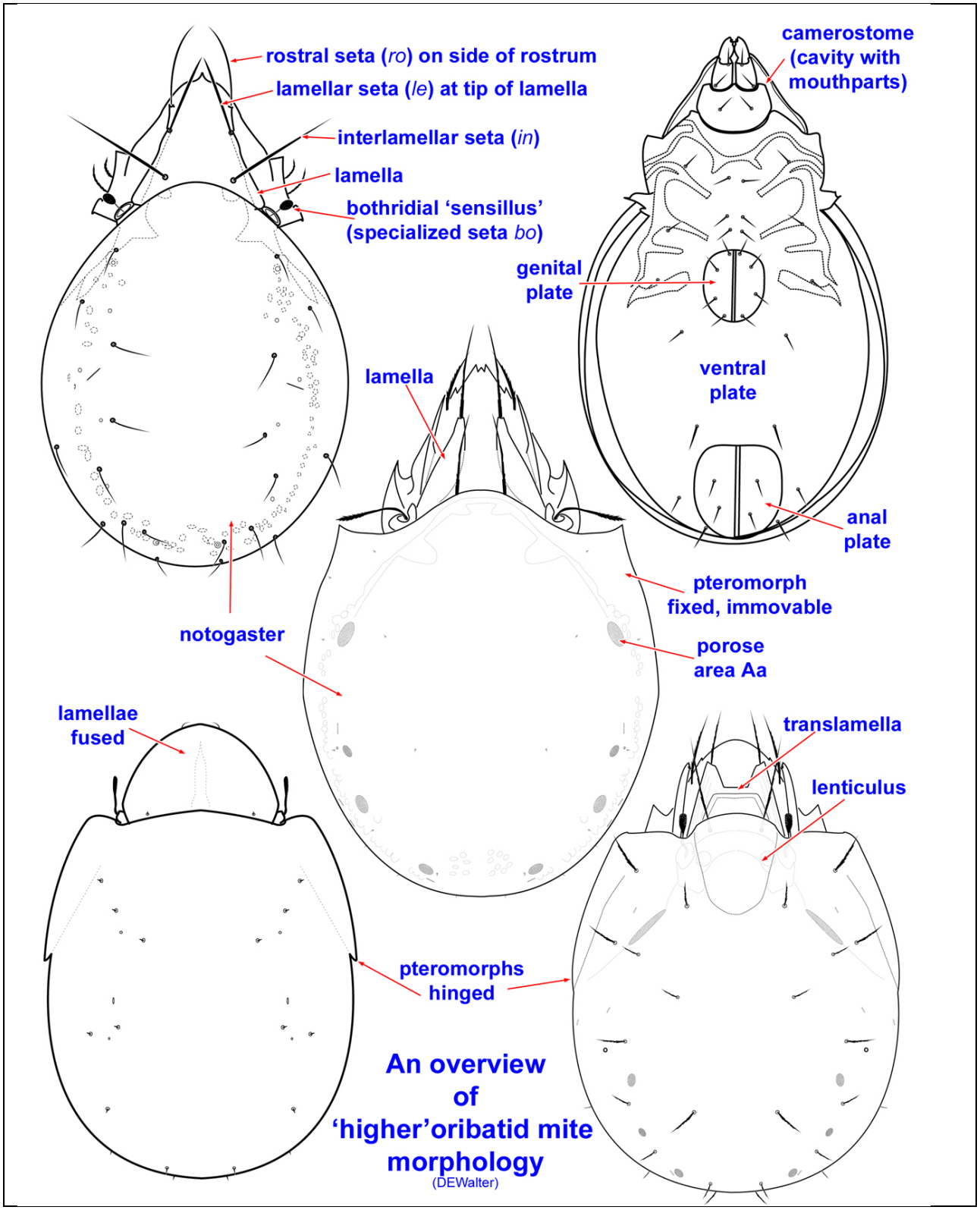
Oribatid mites are a major component of the fauna of terrestrial soil-litter systems, where densities often exceed 100,000 per square metre; many also are found in freshwater and arboreal habitats. Approximately 10,000 species have been described in about 175 families.

The typical adult oribatid mite is completely encased in armor and may resemble a small beetle or a seed. They may be smooth and shiny, sculptured or foveolate, leathery, covered in thick waxy excretions (**cerotegument**), or with adherent debris. Immature stages (egg-prelarva, larva, and three nymphal stages) bear little or no resemblance to the adults and most are difficult or impossible to associate with adults using morphology alone. In length, adult oribatid mites range from about 0.15-3.0 mm: ABMI protocols target species with adult body lengths >0.300 mm. Most oribatid mites have two cup-like bothridia on the prodorsum, each holding a specialized seta, the **bothridial seta**. Three basic body types of oribatid mites can be recognized: higher oribatids (beetle mites), box mites, and lower oribatids:

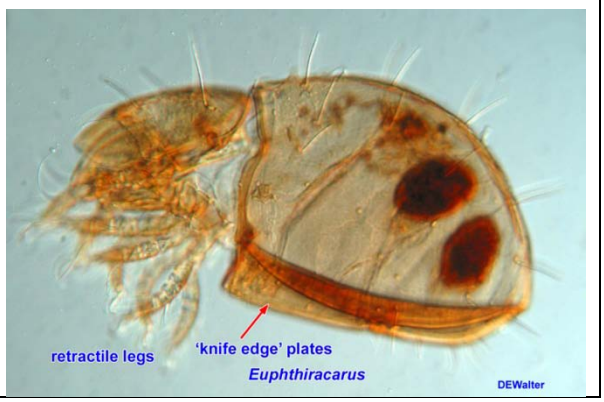


A. 'Higher oribatids' beetle-like mites with a rigid ventral plate with relatively small genital and

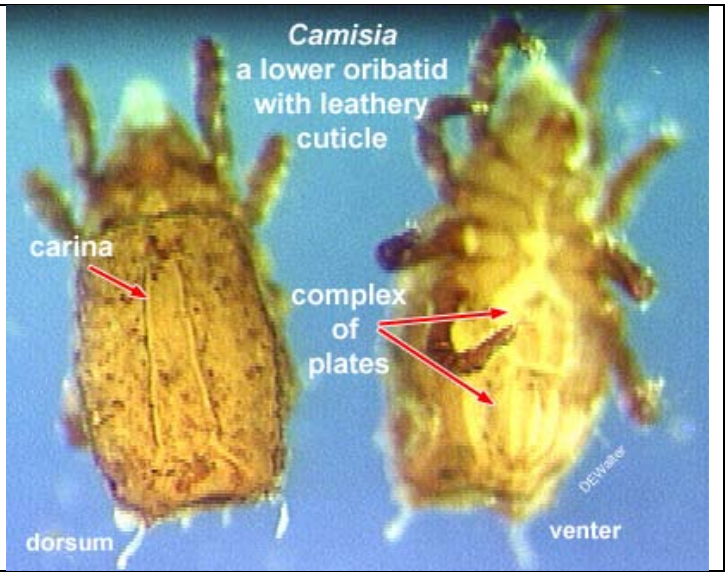
anal plates and a cap-like notogastral shield. Most also have various shelves (**tecta**, **lamellae**) and flaps (**pteromorphs**) that serve to protect their legs and many have notogastral **porose areas** or **saccules**. All of these structures are useful in identification.

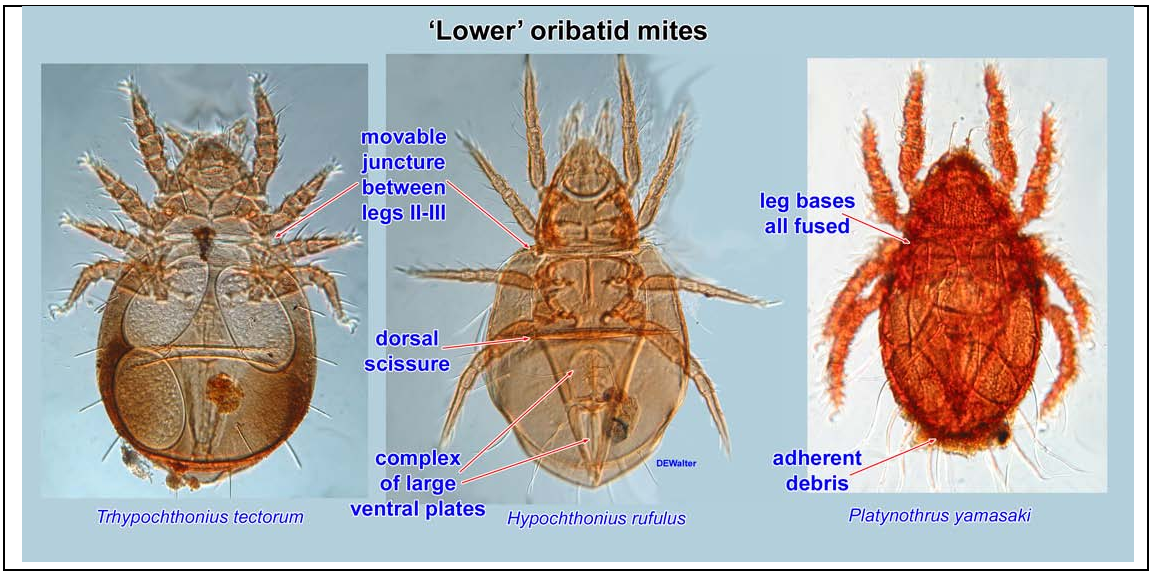


B. 'Box mites' – mites with genital and anal openings covered by large plates and an area of soft cuticle that allows the legs to be retracted and their front end (aspis) to close over the legs (i.e. ptychoidy). Two superfamilies are know from Alberta: **Phthiracaroidea** (ventral plates very broad) and **Euphthiracaroidea** (ventral plates meet in knife-like edge).



C. 'Lower oribatids' – a hodge-podge that includes leathery, more or less rectangular mites (often with dorsal ridges [**carinae**] and adherent debris) and variously armored mites with a variety of articulations (dorsal and ventral). Both types have a complex of large plates in the ano-genital region. In some lower oribatids, juveniles are similar to adults and may be difficult to distinguish.





A. Higher Oribatid Mites

1. Elephant-ear mites - Superfamily Galumnoidea, Family **Galumnidae** (including ***Galumna***, ***Pergalumna***, *Pilogalumna*, ***Acrogalumna***);

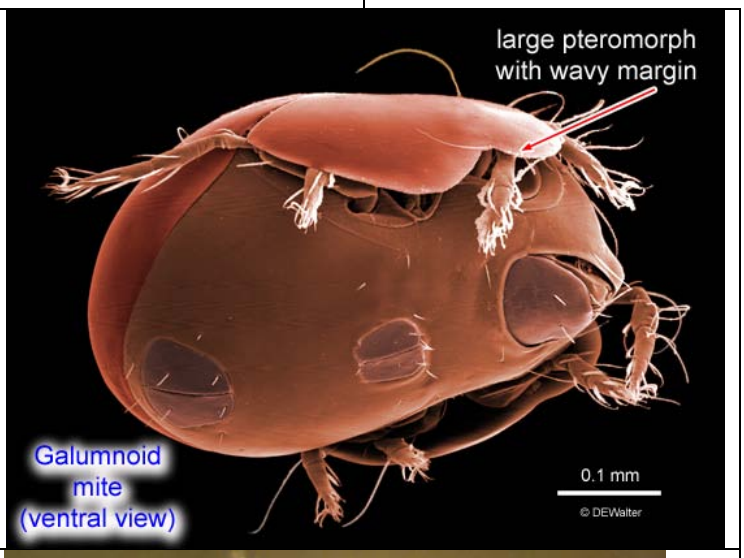
also Superfamily Oripodoidea, Family Parakalummidae (***Neoribates*****)**

Diagnostic characters:

- large, +/- spherical (***Neoribates*** are oval), beetle-like mites with "elephant ear": **pteromorphs**; hinged, moveable, with wavy margin; reddish to yellowish brown in colour
- shelf-like **lamellae** usually absent (present in ***Neoribates***); **lenticulus** usually absent; **porose areas** present; **tutorium** absent

Similar morphotaxa:

see Ceratozetoidea

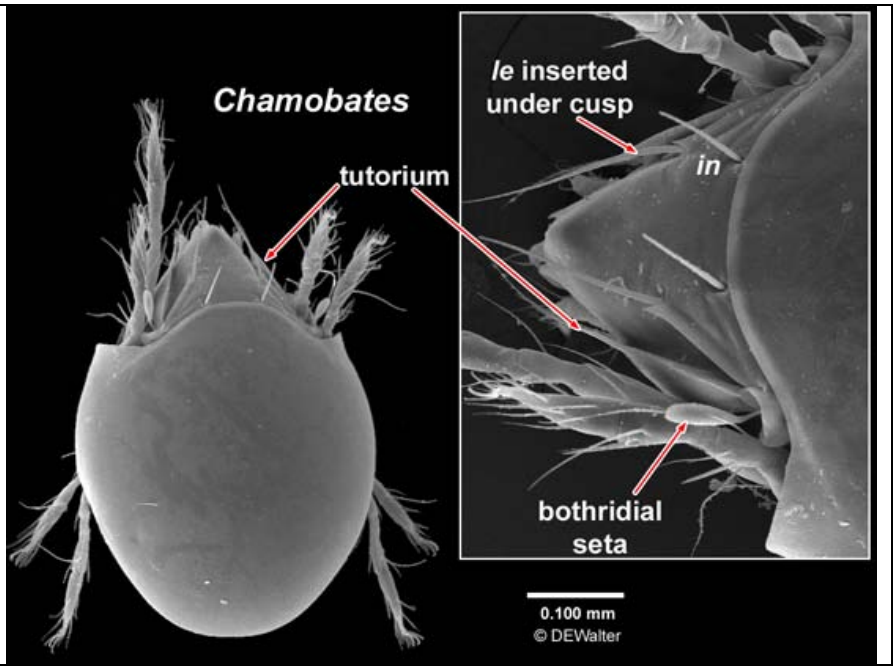


2. Chamobatid mites - Superfamily Ceratozetoidea, Family Chamobatidae (***Chamobates***)

Diagnostic characters:

- small, **spherical** higher oribatids reddish brown in colour; **tutorium** present
- **pteromorphs** fixed, tightly curling around legs; sensillum short, elongate club
- **lamellae** marginal, with pointed cusp; **lamellar setae (*le*) inserted under cusp**; **translamella absent**; interlamellar setae (*in*) reaching about half length of prodorsum
- **lenticulus** present, diffuse; **porose areas** present
- cuticle usually shiny in reflected light

Similar morphotaxa: see other Ceratozetoid mites

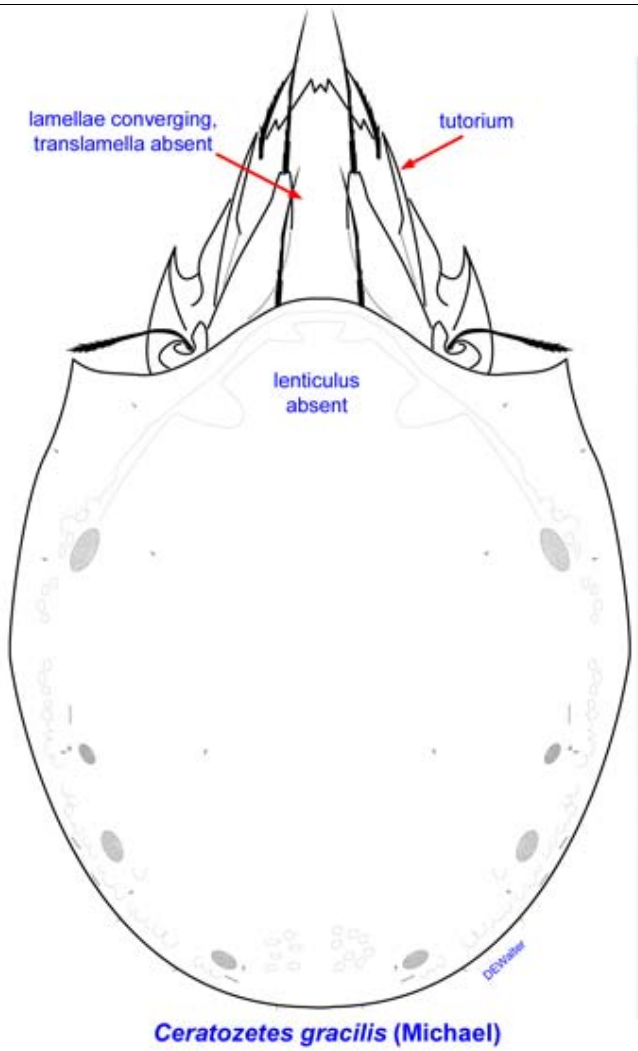


3. *Ceratozetes*-like mites with converging lamellae and without a translamella or lenticulus - Superfamily Ceratozetoidea, Family Ceratozetidae (including ***Ceratozetes***), Mycobatidae (*Cyrtozetes*); also Limnozetidae, ***Limnozetes*** (Hydrozetoidea)

Diagnostic characters:

- small to large **oval** ceratozetoids usually reddish brown (or yellowish if small) in colour; **tutorium** present
- **pteromorphs** fixed, tightly curling around legs; sensillum various
- **lamellae** shelf-like, with pointed cusp; lamellar setae (*le*) inserted on cusp; interlamellar setae (*in*) various
- **lenticulus** usually absent or diffuse; **porose areas** usually present, but may be absent
- cuticle shiny in ***Ceratozetes***; dull, pebbly in ***Limnozetes***

Similar morphotaxa: see other Ceratozetoid mites, Chamobatid mites



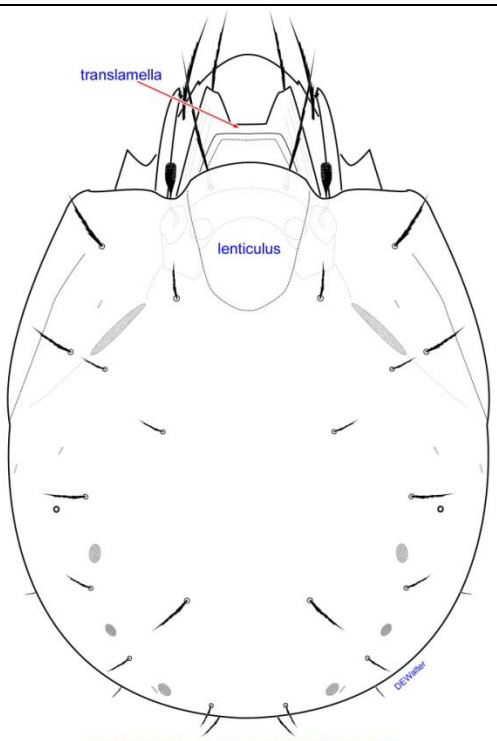
***Ceratozetes gracilis* (Michael)**

4. Ceratozetoid mites with a translamella and a lenticulus - Superfamily Ceratozetoidea, Family Ceratozetidae (including ***Diapterobates, Fuscozetes, Trichoribates***)

Diagnostic characters:

- medium to large **oval** ceratozetoids reddish brown to almost black in colour; **tutorium** present
- **pteromorphs** fixed or hinged posteriorly (*Diapterobates*); sensillum various
- **lamellae with translamella**; lamellar setae (*le*) inserted on cusp; interlamellar setae (*in*) various
- **lenticulus** distinct; **porose areas** usually present (saccules in *Trichoribates polaris*), Aa elongate in ***Diapterobates***
- cuticle dull to shiny, sometimes with reticulate or punctate pattern; brown with dark spots around bases of setae or porose areas in ***Fuscozetes***

Similar morphotaxa: see other Ceratozetoid mites, Pelops mites



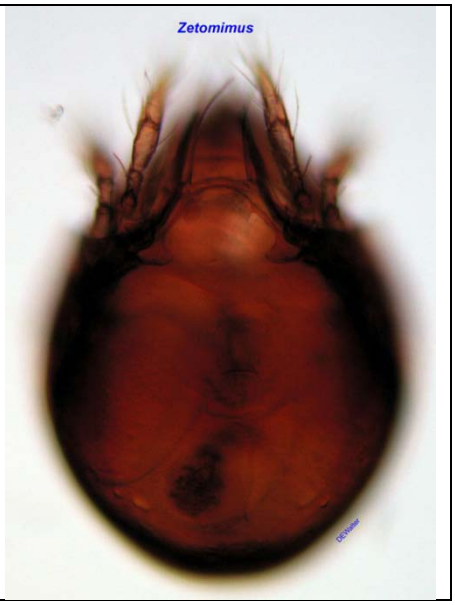
***Diapterobates humeralis* (Hermann)**

5. Ceratozetoid mites without a translamella, but with a lenticulus - Superfamily Ceratozetoidea, Family Ceratozetidae (including *Diapterobates variabilis*, *Melanozetes*, *Iugoribates*, *Svalbardia*), Zetomimidae (***Zetomimus***, ***Heterozetes***)

Diagnostic characters:

- medium to large, grey-brown to almost black, **oval** ceratozetoids; **tutorium** present
- **pteromorphs** fixed, tightly curling around legs; sensillum various
- **lamellae without translamella**; lamellar setae (*le*) inserted on short to long cusps; interlamellar setae (*in*) various
- **lenticulus** present; **porose areas** usually present
- cuticle shiny or thicker, dull

Similar morphotaxa: see other Ceratozetoid mites, Pelops mites

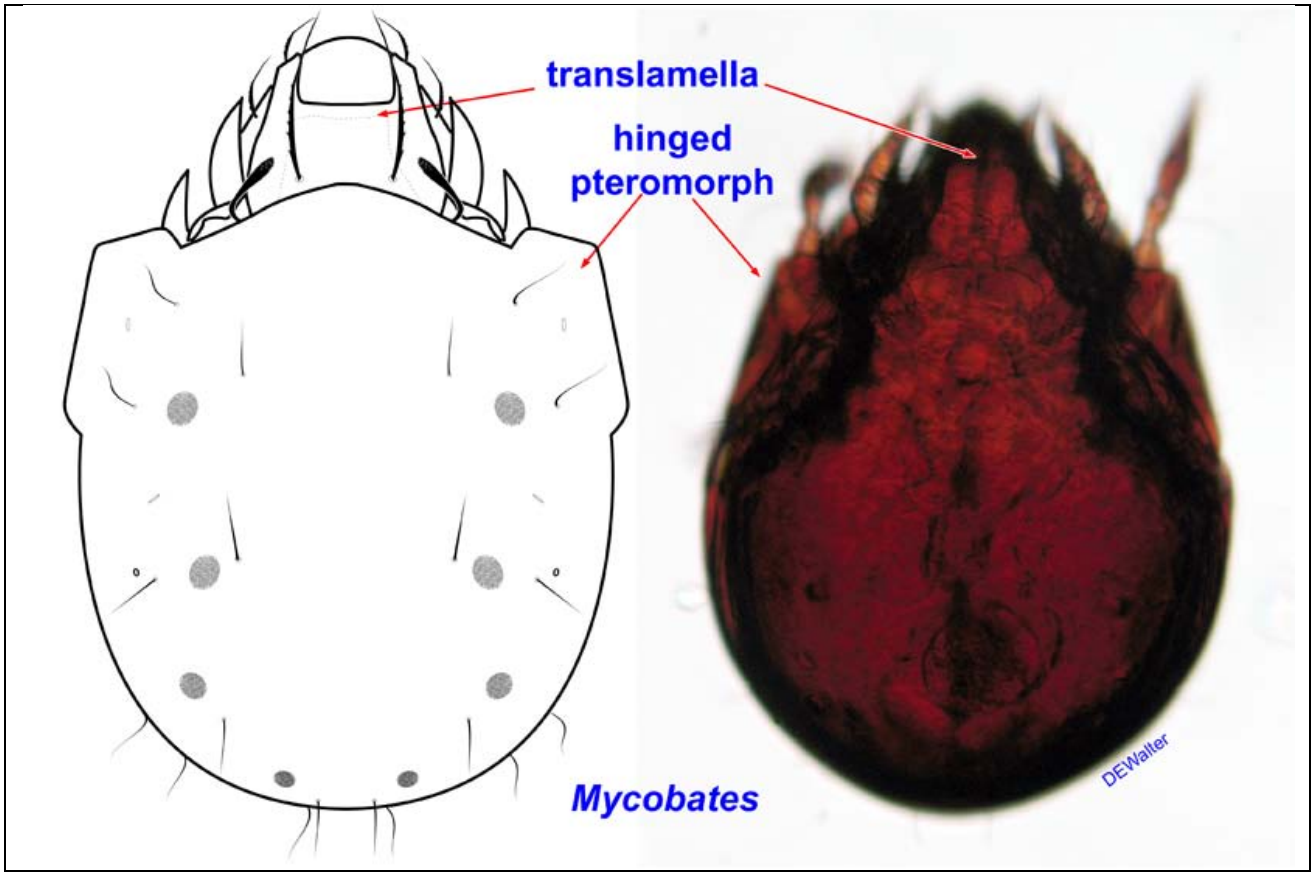


6. Ceratozetoid mites with a translamella but without a lenticulus - Superfamily Ceratozetoidea, Family Ceratozetidae (including *Latimellobates*, ***Neogymnobates***), Mycobatidae (including ***Mycobates***, *Zachvatkinibates*, *Ceresella*)

Diagnostic characters:

- small to large, dull brown to black, **oval** ceratozetoids **tutorium** present
- **pteromorphs** fixed or movable; sensillum an elongate club
- **lamellae with translamella**; lamellar setae (*le*) inserted on short to long cusps; interlamellar setae (*in*) various
- **lenticulus** absent; **porose areas** present
- cuticle shiny (***Mycobates***) or thicker, dull (***Neogymnobates***)

Similar morphotaxa: see other Ceratozetoid mites, Pelops mites

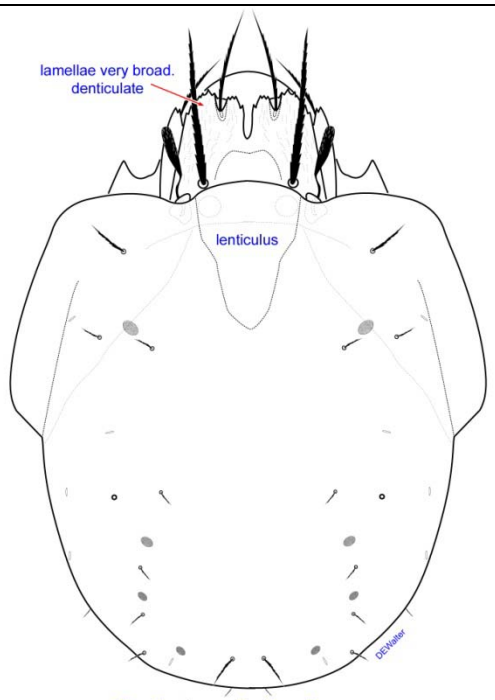


7. Ceratozetoid mites with lamellae closely adjacent, usually very broad, translamella very short or absent - Superfamily Ceratozetoidea, Family Ceratozetidae (***Dentizetes***), Mycobatidae (*Guatemalozetes*)

Diagnostic characters:

- small to large ceratozetoids brown to almost black in colour; **tutorium** present
- **pteromorphs** fixed; sensillum elongate club
- **lamellae closely adjacent anteriorly**; **short, narrow in *D. ledensis*, broad, denticulate in *D. rudentiger*;** very broad and converging in *Guatemalozetes*
- **lenticulus** distinct (***Dentizetes***) or absent (*Guatemalozetes*); **porose areas** present
- cuticle dull to shiny; *Guatemalozetes* has punctations

Similar morphotaxa: see other Ceratozetoid mites, Pelops mites



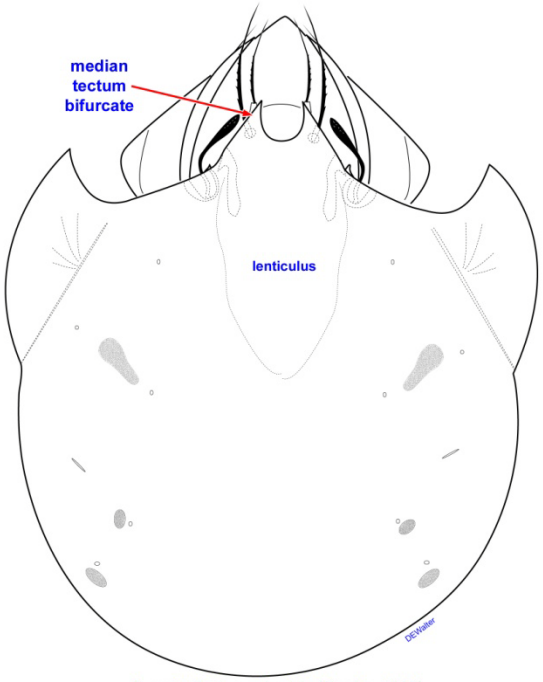
***Dentizetes rudentiger* Hammer**

8. *Punctoribates* - Superfamily Ceratozetoidea, Family Mycobatidae (***Punctoribates***)

Diagnostic characters:

- medium **subcircular** ceratozetoids; **tutorium** present
- **pteromorphs** hinged; sensillum an elongate club
- **Prodorsum covered by notogastral tectum that comes to 2 points (bifurcate)**
- **lenticulus** present; **porose areas** present
- cuticle shiny

Similar morphotaxa: see other Ceratozetoid mites; Pelops mites, *Gustavia*



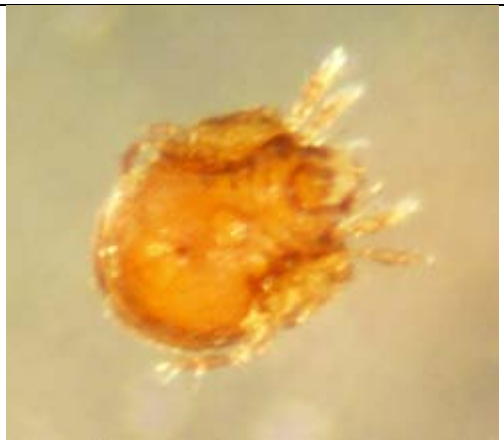
***Punctoribates palustris* (Banks, 1895)**

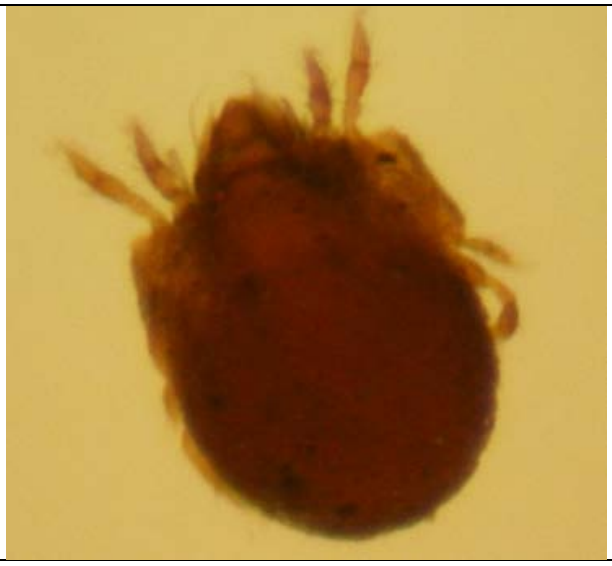
9. Pelops mites - Superfamily Phenopelopoidea, Family Phenopelopidae (including ***Eupelops, Peloptulus, Propelops***)

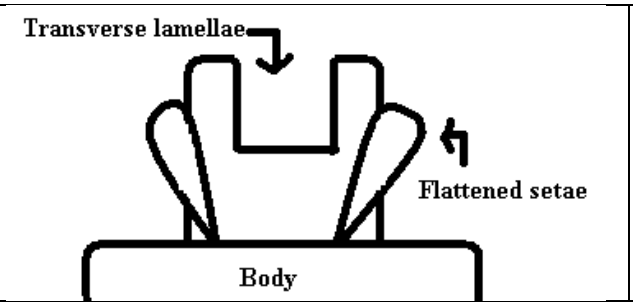
Diagnostic characters:

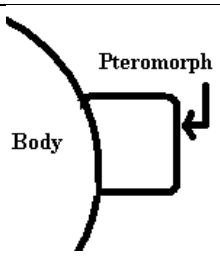
- small to large higher oribatids reddish brown to black in colour; **tutorium** present
- **chelicerae pelopsiform** (***Eupelops***, ***Peloptulus***) or normal (***Propelops***)
- **pteromorphs** hinged and usually movable, rectangular and often jutting from body; sensillum various
- **lamellae** with translamella and cusps, reduced and obscured in ***Eupelops***; lamellar setae (*le*) inserted on cusp; interlamellar setae (*in*) short or long, expanded and resembling sensilla in ***Eupelops***
- **lenticulus** present, distinct; **porose areas** present but minute
- cerotegument thick, blocky, often with adherent soil

Similar morphotaxa: see *Punctoribates*, Ceratozetoid mites







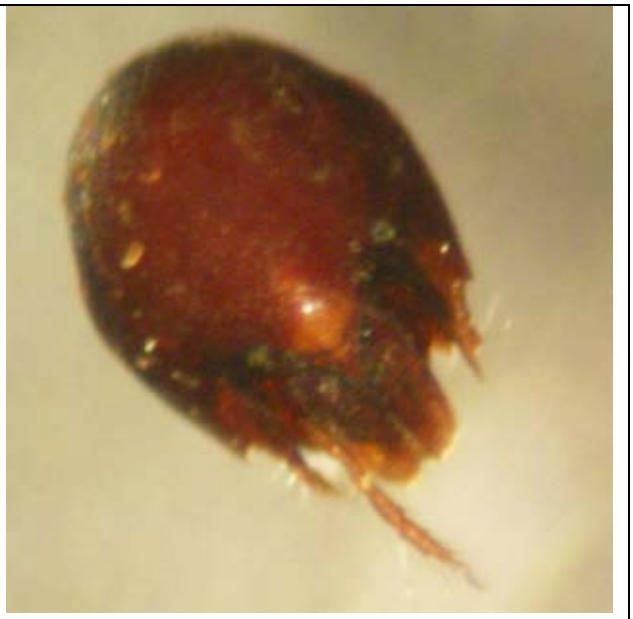


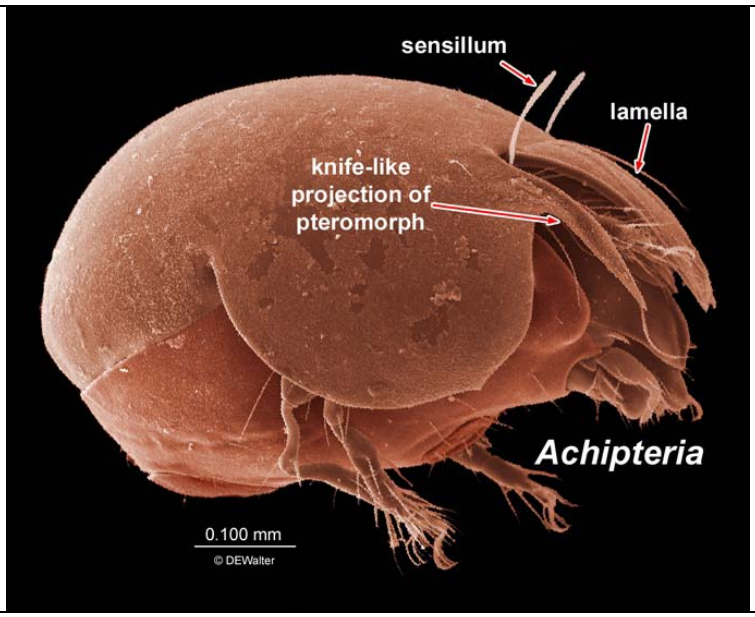
10. Achipterid mites - Superfamily Achipteroidea, Family Achipteridae (including ***Achipteria, Parachipteria, Anachipteria***)

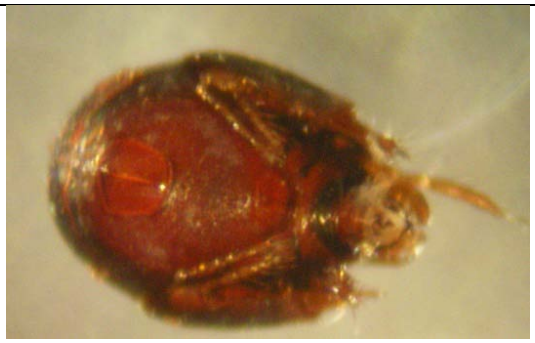
Diagnostic characters:

- medium to large higher oribatids reddish brown to black in colour
- **pteromorphs** fixed, tightly curling around leg; **with knife-like pointed projection** (most) or without (***Anachipteria***)
- **lamellae large and closely adjacent medially**; sensillum various
- **lenticulus** present, diffuse; **porose areas** present or absent (saccules present)
- cerotegument thick and dull (most ***Achipteria***) or thin, shiny in reflected light

Similar morphotaxa: see Ceratozetoid mites, Pelops mites, Oribatelloid mites, Tegoribatid mites





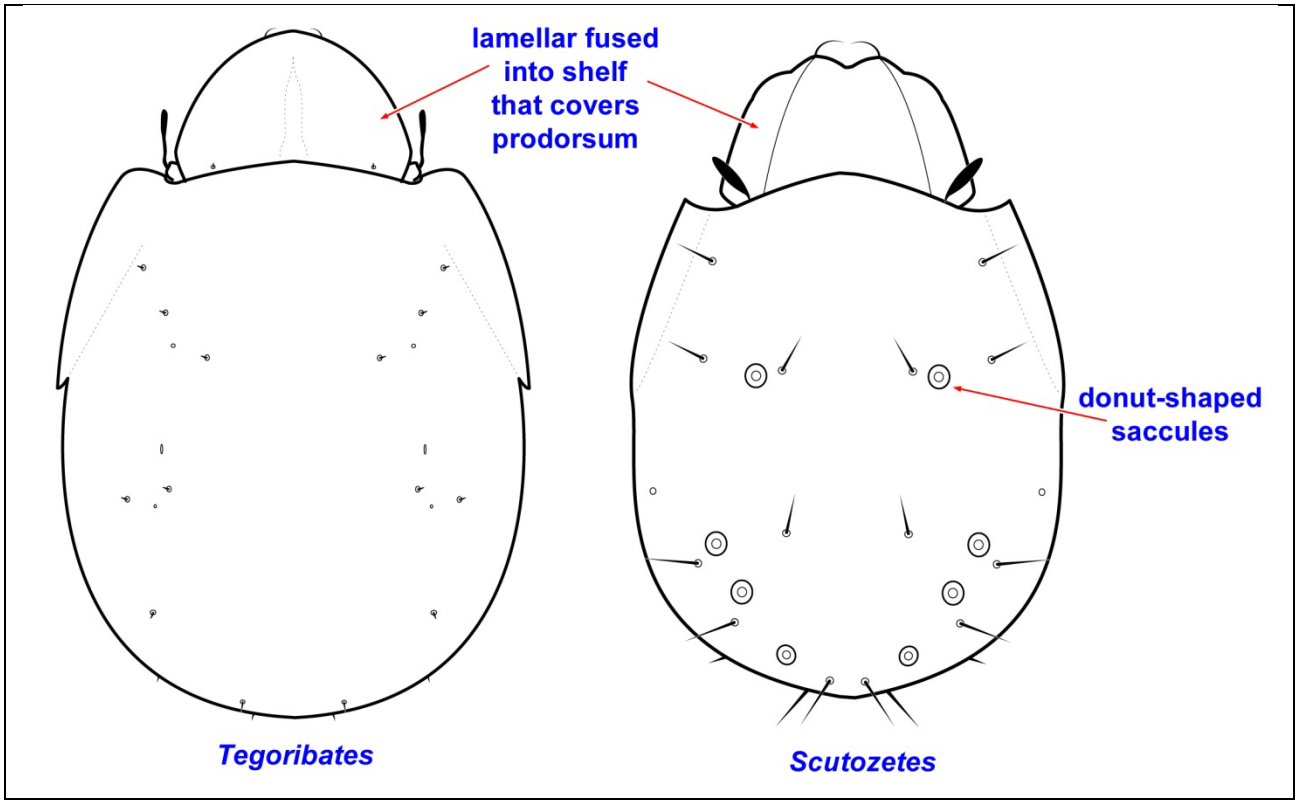


11. Tegoribatid mites - Superfamily Achipteroidea, Family Tegoribatidae (including ***Tegoribates, Lepidozetes, Scutozetes***)

Diagnostic characters:

- small, oval higher oribatids usually dark red-brown to black in colour
- **pteromorphs** tightly curling around legs
- **lamellae fused into shelf that covers prodorsum**
- **lenticulus** present, indistinct, or absent; **porose areas** present (***Lepidozetes***) or absent; ***Scutozetes*** has very large, donut-like saccules
- cuticle cuticle shiny in reflected light

Similar morphotaxa: *Dentizetes rudentiger* (Ceratozetoidea), Oribatelloid mites, and Achipterid mites have very broad lamellae but they are separate medially

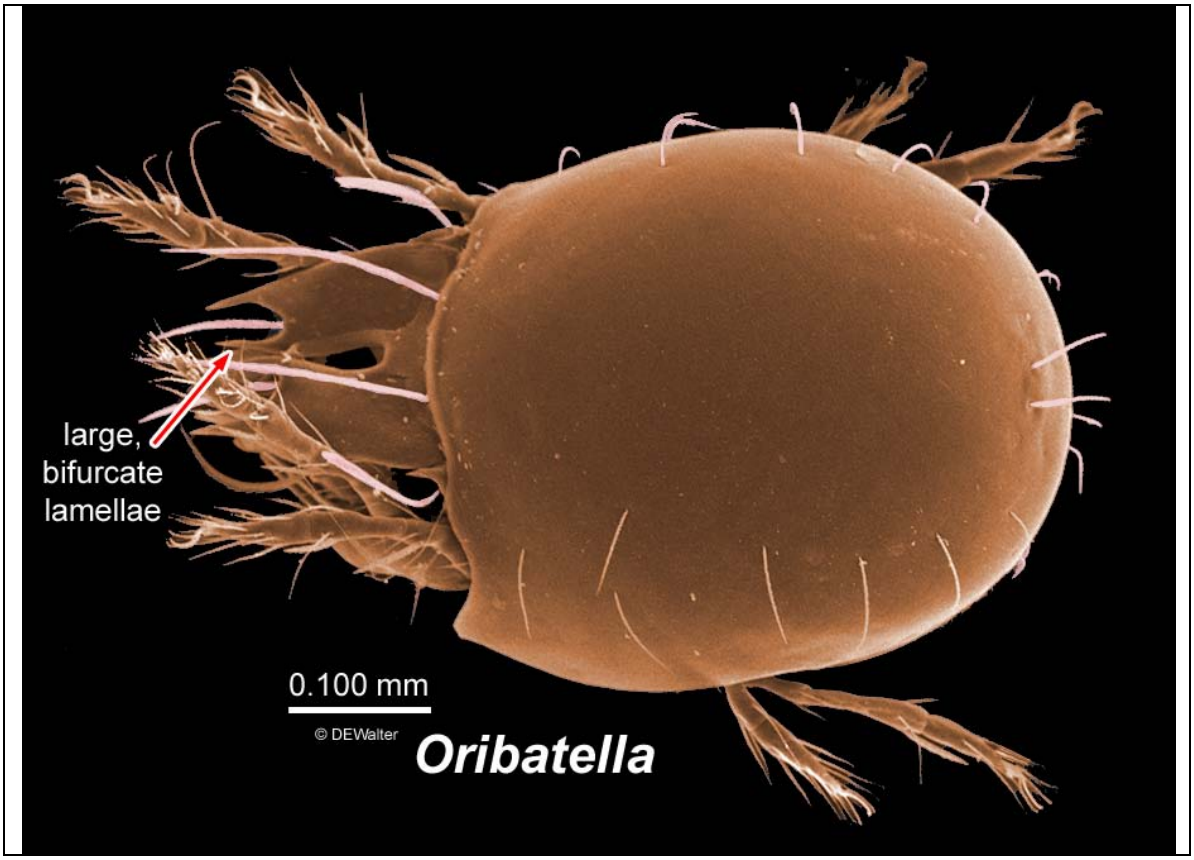


12. Oribatellid mites - Superfamily Oribatelloidea, Family Oribatellidae (including ***Oribatella***)

Diagnostic characters:

- small to medium higher oribatids red-brown to black in colour
- **pteromorphs** fixed, tightly curling around legs
- **lamellae very broad, bifurcate distally**
- **lenticulus** present, indistinct, or absent; **porose areas** usually present
- cuticle cuticle shiny in reflected light

Similar morphotaxa: *Dentizetes rudentiger* (Ceratozetoidea) and Achipterid mites have very broad lamellae but they are not bifurcate distally; Tegoribatid mites have the lamellae fused into a shelf



13. Oripodoid mites without pteromorphs – Superfamily Oripodoidea: Scheloribatidae (***Dometorina***), Oribatulidae (***Oribatula***, ***Epioribatula***, ***Paraleius***, ***Zygoribatula***)

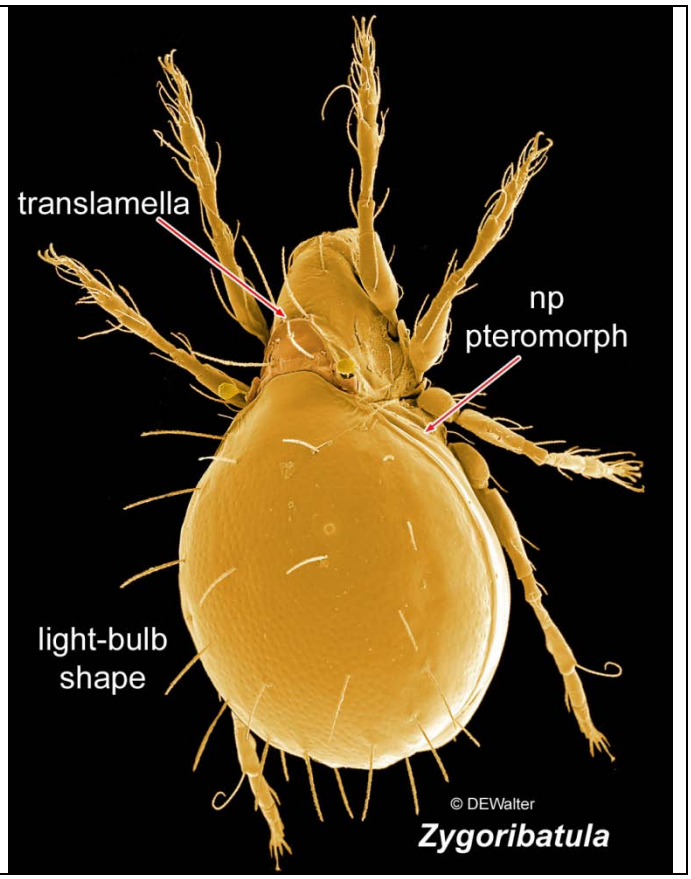
Diagnostic characters:

- small to medium beetle-like mites light brown to yellowish in colour; tutorium absent
- **pteromorphs** absent or reduced to short ledge
- **lenticulus** absent; **porose areas** absent or present
- **lamellae** present but usually narrow**;** translamella present (***Zygoribatula***) or absent

Similar morphotaxa:

- see Ceratoppian mites, Oripodoid mites with pteromorphs

Oribatula

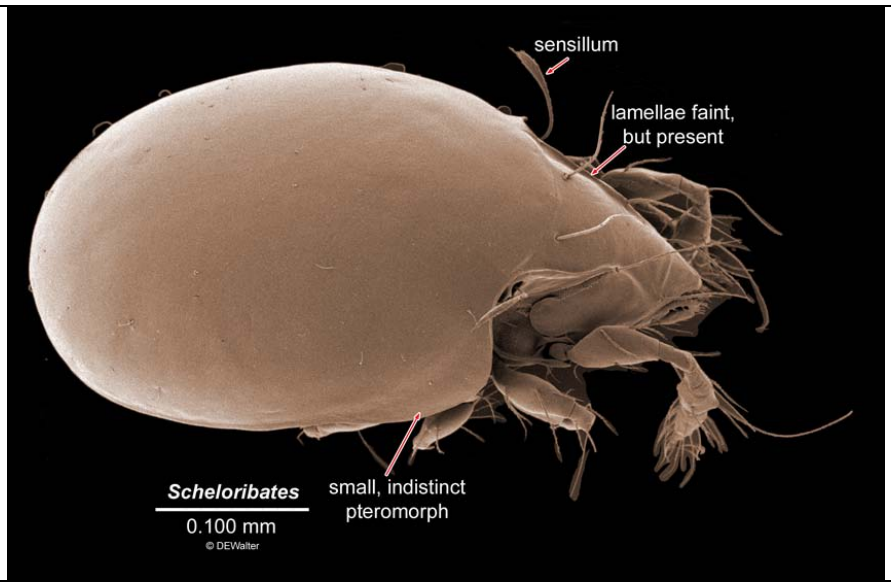


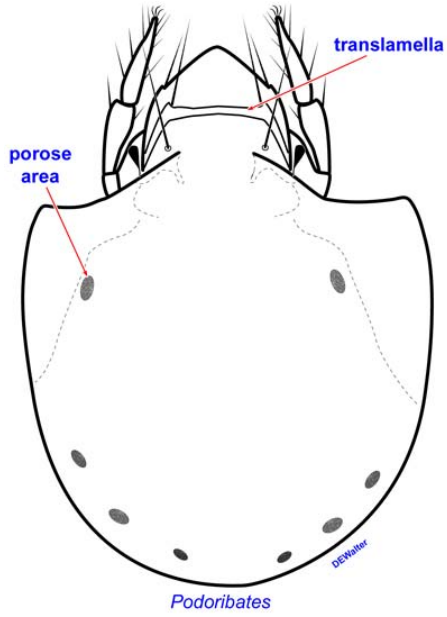
14. Oripodoid mites with pteromorphs– Superfamily Oripodoidea: Scheloribatidae (*Scheloribates*), Haplozetidae (*Peloribates*, *Xylobates*, *Protoribates*), Mochlozetidae (*Podoribates*)

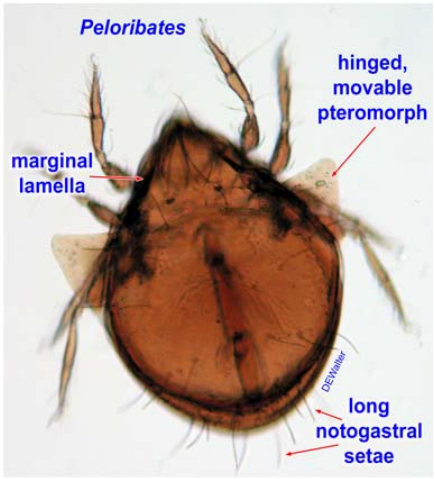
Diagnostic characters:

- small to medium beetle-like mites **light brown to yellowish in colour**, rarely reddish brown; tutorium absent
- **pteromorphs**: (a) immovable, well developed (***Podoribates***); (b) immovable, indistinct (***Scheloribates***): or (c) well developed, hinged (***Peloribates***, ***Xylobates***)
- **lenticulus** absent; +/- **porose areas**
- **notogastral setae** fine, indistinct or **long (*Peloribates*)**
- **lamellae** present**;** translamella present (***Podoribates***) or absent

Similar morphotaxa: see Ceratozetoid mites, Oripodoid mites without pteromorphs





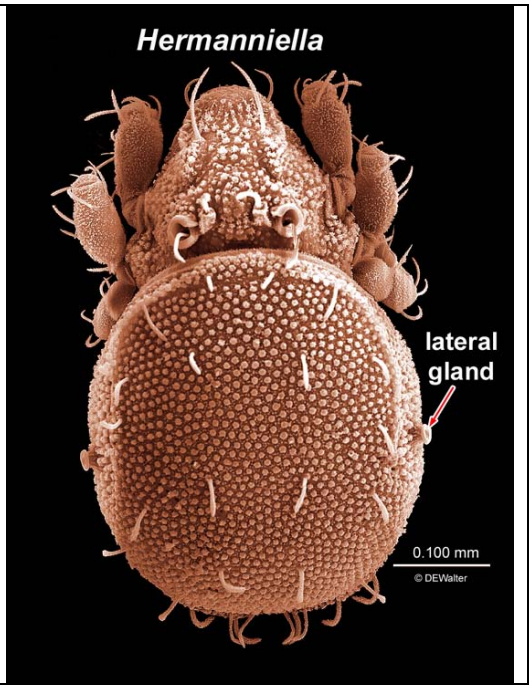


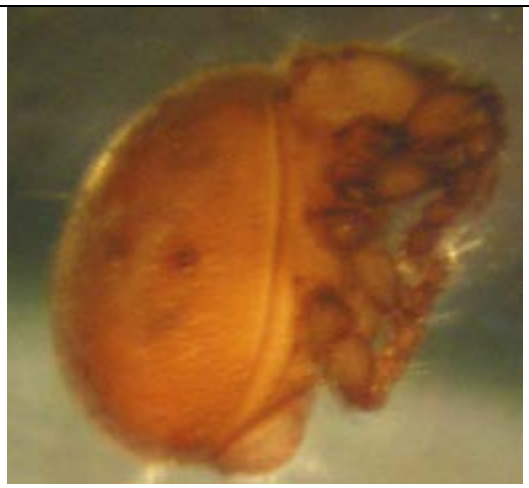
15. Cannon-gland mites - Superfamily Hermannielloidea, Family Hermanniellidae (including ***Hermanniella***)

Diagnostic characters:

- large, oval, yellowish to reddish brown mites with a dome-like notogastral shield with a **prominent lateral gland spout** on either side looking somewhat like a cannon protruding from a ship's gun port
- notogaster sculptured (retained tritonymphal exuviae)
- **genital and anal plates large and closely adjacent**
- **lamellae**, **pteromorphs**, **lenticulus, porose areas** absent

Similar morphotaxa: Damaeoid mites have longer legs and lack the gland; also see *Nanhermannia*



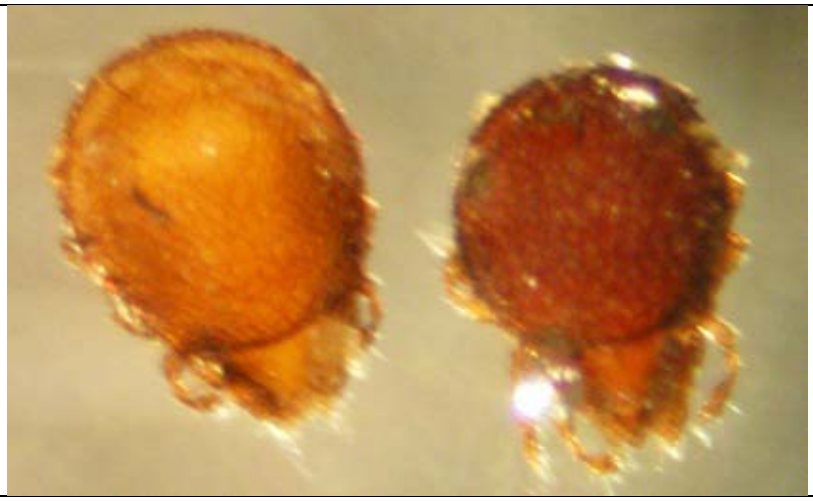


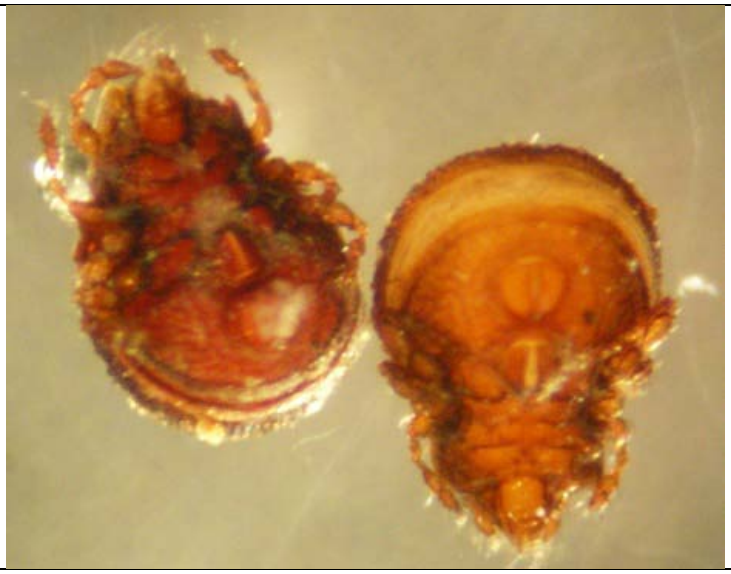
16. Cepheid mites - Superfamily Cepheoidea, Family Cepheidae (including ***Cepheus, Oribatodes***)

Diagnostic characters:

- medium to large mites dull reddish to dark brown in colour
- **notogaster subcircular in outline**, +/- dorso-ventrally flattened
- **cerotegument thick, foveate**, often with adherent soil
- notogastral setae short (***Cepheus***) or extending beyond margin of body (***Oribatodes***)
- **lamellae** marginal, well-developed shelves
- **pteromorphs**, **lenticulus, porose areas** absent

Similar morphotaxa: see Carabodid mites





17. Carabodid mites - Superfamily Carabodoidea, Family Carbodidae (including ***Carabodes***)

Diagnostic characters:

- small to medium sized mites **very dark brown to black in colour** (unless recently moulted)
- cuticle covered in tubercles, foveae, or pustules
- **lamellae** marginal shelves, not especially distinct
- **notogastral setae short, often erect, projecting**
- **pteromorphs**, **lenticulus, porose areas** absent

Similar morphotaxa: see Cepheoid mites, *Tectocepheus*

18. *Tectocepheus* - Superfamily Tectocepheoidea, Family Tectocepheidae (including ***Tectocepheus***)

Diagnostic characters:

- **small grey-brown mites with dull, granular cerotegument**
- notogaster may have two rows of three circular depressions or be smooth
- **lamellae** difficult to see, but with long cusps and translamella
- **pteromorphs**, **lenticulus, porose areas** absent

Similar morphotaxa: see Carabodid mites

19. Water mites - Superfamily Hydrozetoidea **(**including ***Hydrozetes, Limnozetes*****)**

Diagnostic characters:

- medium sized aquatic mites with short, clubbed sensilla
- **pteromorphs** absent (***Hydrozetes***) or present (***Limnozetes***)
- **lenticulus** present with a clear lens **(*Hydrozetes*)** or absent **(*Limnozetes*)**
- **lamellae** with (***Limnozetes***) or without (***Hydrozetes***) a translamella, **porose areas** absent

Similar morphotaxa: see Damaeoid mites, Ceratozetoid mites

20. Eremaeid mites - Superfamily Eremaeoidea, Family Eremaeidae (including ***Eremaeus***, ***Eueremaeus***), Family Megeremaeidae (*Megeremaeus*)

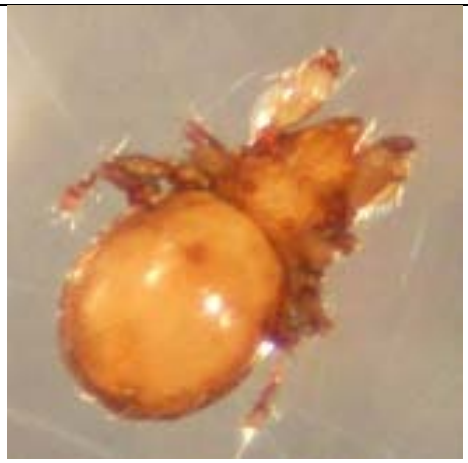
Diagnostic characters:

- medium to large (*Megeremaeus*) dull brown mites with a somewhat teddy-bear like

outline

- **lamellae**, **pteromorphs**, **lenticulus, porose areas** absent
- prodorsum often with distinct costulae that may converge

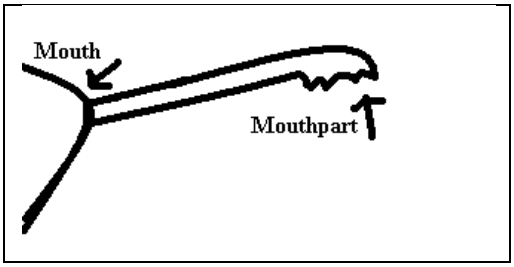
Similar morphotaxa: ***Hydrozetes***



21. BB mites - Superfamily Gustavioidea, Family Gustaviidae (including ***Gustavia***)

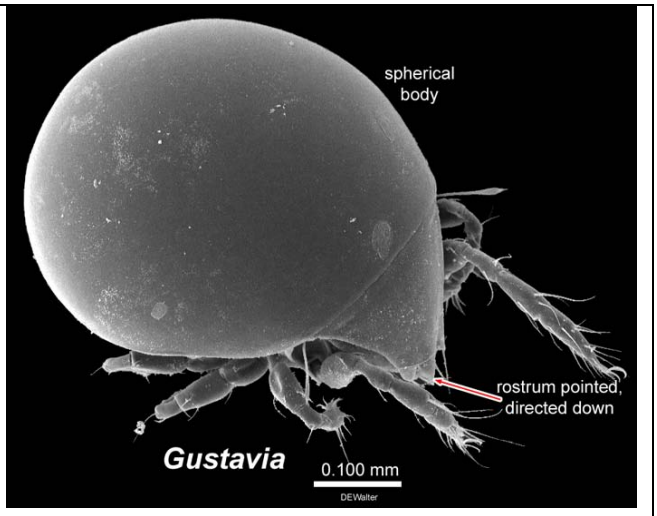
Diagnostic characters:

- medium to large **spherical** mites with rostrum directed ventrally



- **chelicerae long, thin, rake-like**
- **lamellae** marginal shelves
- **rostrum comes to point, directed down**
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see other Liacarid mites, *Punctoribates*

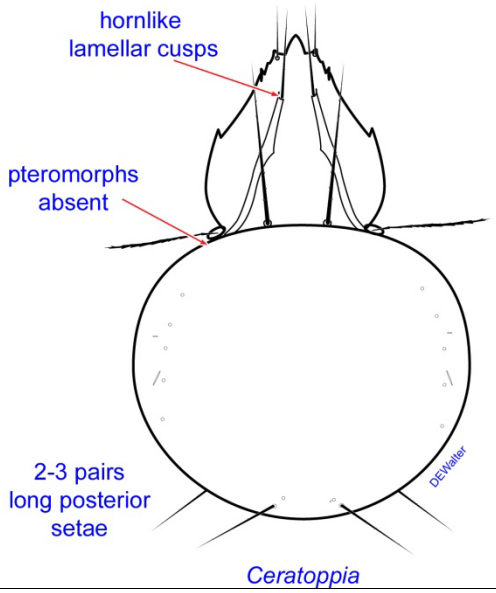


22. Ceratoppian mites - Superfamily Gustavioidea, Family Peloppiidae (including ***Ceratoppia, Parapyroppia***, ***Pyroppia***)

Diagnostic characters:

- medium to large mites with a **spherical notogaster with only 2-3 pairs of long posterior setae** and **prodorsal horns**
- **lamellae** cylindrical and project well forward; lamellar setae on long cusps
- bothridial seta usually setiform, long
- pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see other *Gustavia*, Damaeoid mites



23. Liacarid mites - Superfamily Gustavioidea, Family Liacaridae (including ***Dorycranosus,*** *Liacarus*)

Diagnostic characters:

- large oval, shiny red-brown to dark brown mite
- **lamellae converging shelves with median pointed process**
- lamellae, pteromorphs, lenticulus, porose areas absent

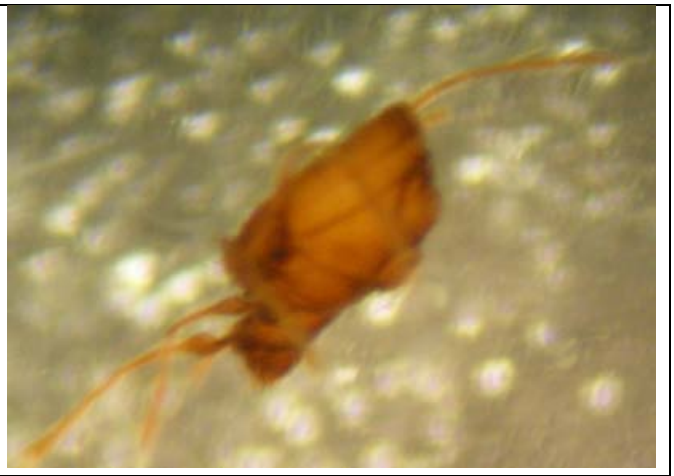
Similar morphotaxa: see Gustavia mites, Ceratozetoidea (***Fuscozetes***)

24. Flat-backed mites - Superfamily Plateremaeoidea , Family **Gymnodamaeidae (*Gymnodamaeus*)**

Diagnostic characters:

- medium to large reddish-brown mites with **flattened notogaster** and **very long, thin legs**
- **notogaster** usually with waxy pattern
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Damaeoid mites, Small flat-backed mites

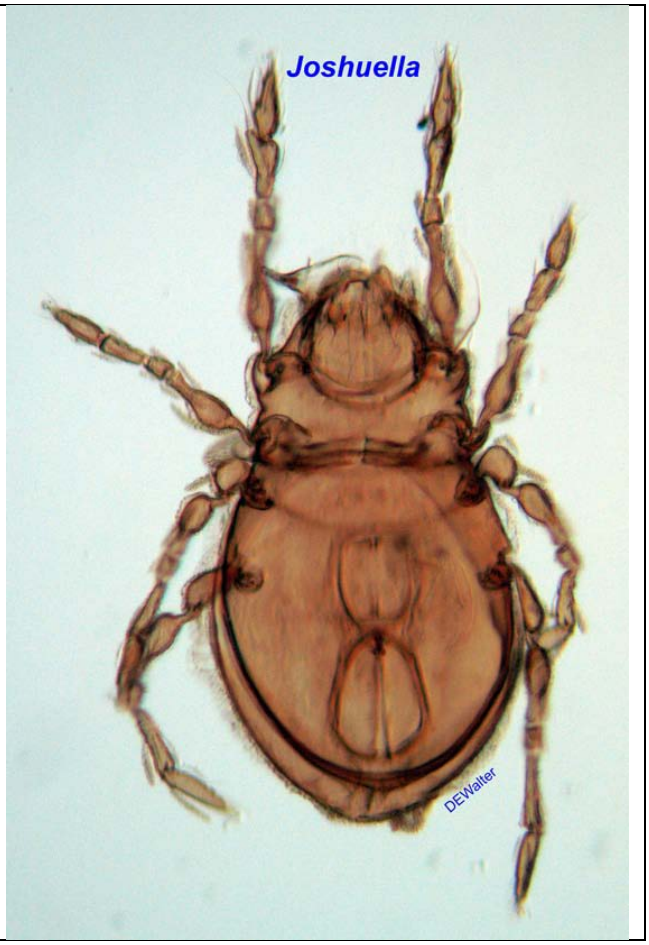


25. Small flat-backed mites - Superfamily Plateremaeoidea , Family **Gymnodamaeidae (**including ***Gymnodamaeus*? sp. s, *Nortonella*, *Joshuella*, *Jacotella*, *Pleodamaeus*)**

Diagnostic characters:

- small mites (body <0.5 mm) with **flattened notogaster** and **long legs**
- **notogaster** usually with waxy pattern
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Damaeoid mites, Flat-backed mites

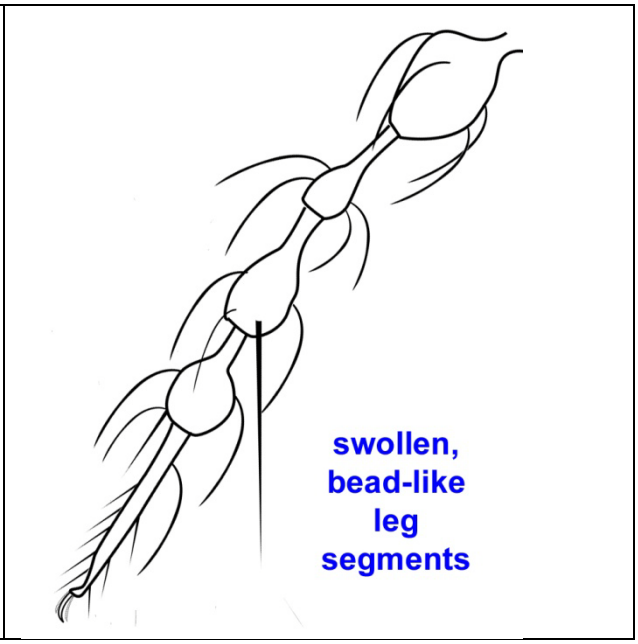


26. Damaeoid mites - Superfamily Damaeoidea (including ***Epidamaeus, Lanibelba, Dyobelba,*** *Belba*, ***Quatrobelba,*** *Caenobelba*)

Diagnostic characters:

- large red-brown mites carrying scalps, debris or eggs or small to medium mites light brown in colour
- with **long legs with swollen, bead-like segments**
- **dome-shaped notogaster with well developed setae**
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Incidental oppioid mites, Flat-backed mites, *Veloppia*

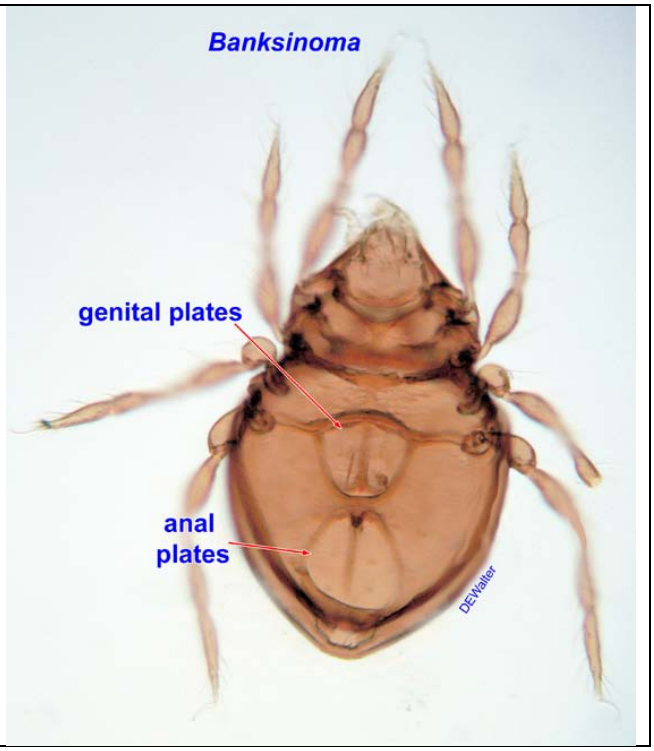


27. Thyrisomid mites – Superfamily **Oppioidea,** Family **Thyrisomidae** (***Banksinoma***, ***Gemmazetes***)

Diagnostic characters:

- small, oval, **yellow-brown** mites
- **costulae** very short, with clusters of denticles (***Banksinoma***) or longer, without denticles (***Gemmazetes***)
- legs +/- bead-like
- **genital and anal plates large**, closely inserted
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Incidental oppioid mites, Suctobelbid mites, Autognetid mites, *Veloppia*

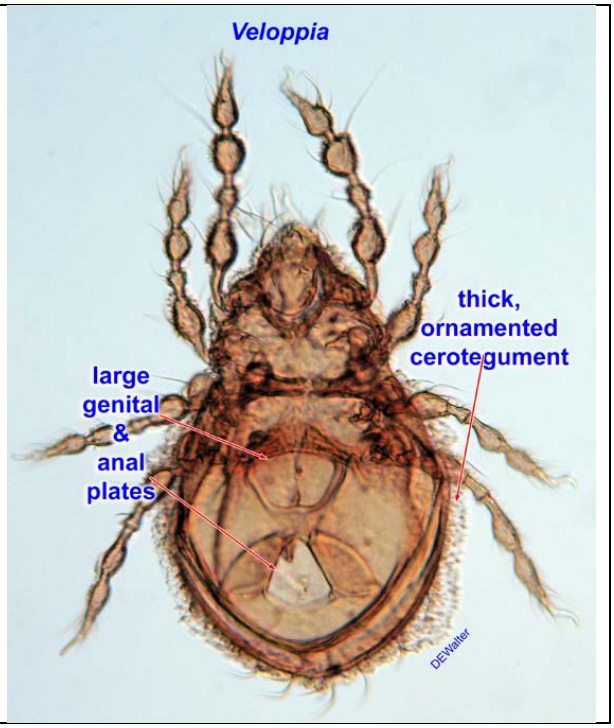


28.Veloppia mites – Superfamily Ameroidea**,** Family Caleremaeidae (incidental species of *Veloppia* <0.300 mm long)

Diagnostic characters:

- small mites with thick, strongly ornamented cerotegument
- **genital and anal plates large**, closely inserted
- legs bead-like
- long notogastral setae
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Incidental oppioid mites, Suctobelbid mites, Thyrisomid mites, Autognetid mites

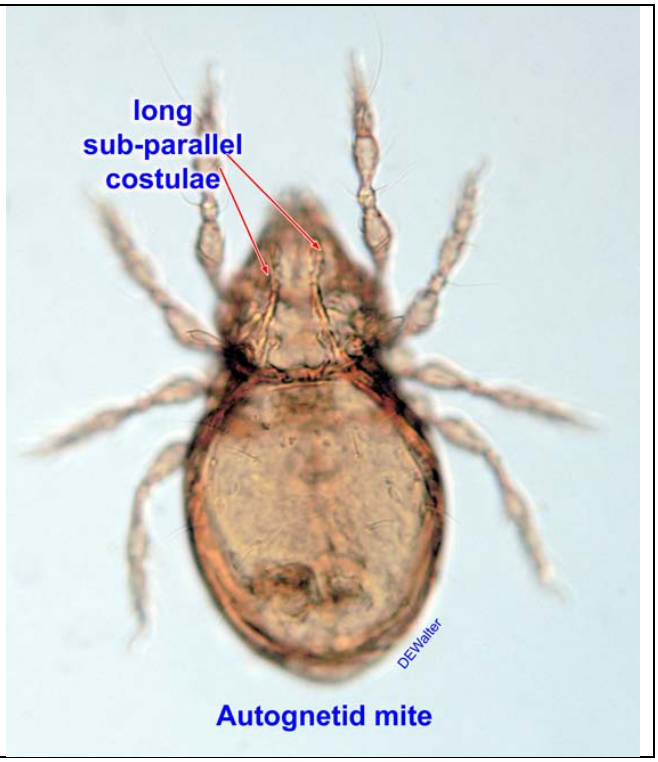


29. Autognetid mites – Superfamily **Oppioidea,** Family **Autognetidae** (***Autogneta,*** *Conchogneta*)

Diagnostic characters:

- small mites, mostly just over 0.300 mm long
- with long, +/- parallel **costulae**
- legs +/- bead-like
- genital and anal plates relatively small, distant
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Incidental oppioid mites, Suctobelbid mites, Thyrisomid mites, *Veloppia*



30. Incidental oppioid mites – Superfamily **Oppioidea,** Family Oppiidae (mostly incidental species <0.300 mm long including *Oppiella*, *Moritzoppia*, *Microppia*), Quadroppiidae (*Quadroppia*); ***Multioppia*** sp. and some ***Oppiella*** are >0.300 mm long

Diagnostic characters:

- small mites, mostly <0.300 mm
- often with short **costulae** and **cristae** (anterior notogastral carinae)
- legs +/- bead-like
- genital and anal plates relatively small, distant
- lamellae, pteromorphs, lenticulus, porose areas absent

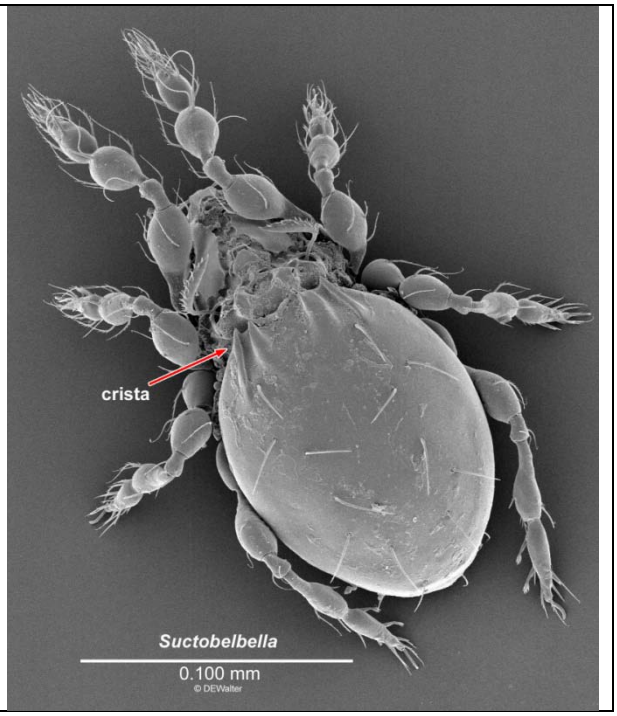
Similar morphotaxa: see Suctobelbid mites, Thyrisomid mites, Autognetid mites, *Veloppia*

31. Incidental suctobelbid mites – Superfamily **Oppioidea,** Family **Suctobelbidae** (mostly incidental species < 0.300 mm long including *Suctobelba, Suctobelbella*)

Diagnostic characters:

- small mites with suctobelbid mouthparts (elongate, +/1 needle-like with pointed rostrum & whisker-like rostral setae)
- prodorsum strongly ornamented with ridges and tubercles
- often with **costulae** and **cristae**
- legs bead-like
- genital and anal plates relatively small, distant
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Incidental oppioid mites, Thyrisomid mites, Autognetid mites, *Veloppia*

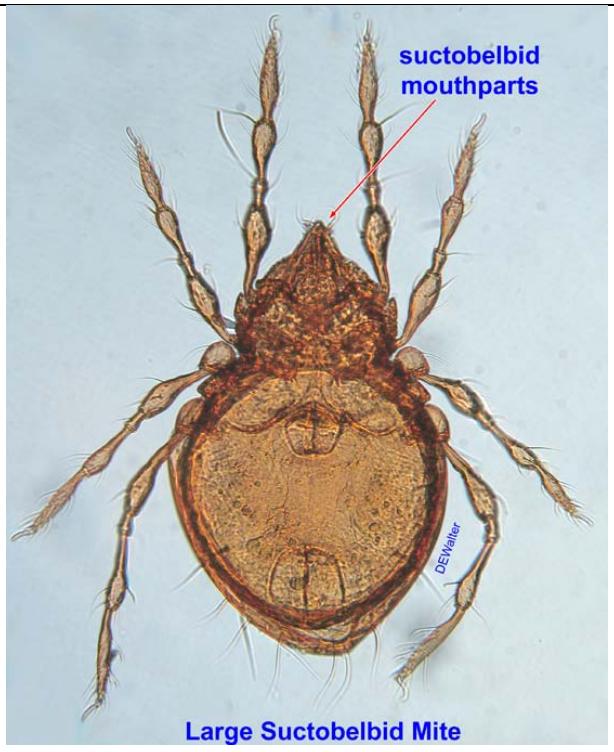


32. Large suctobelbid mites – Superfamily **Oppioidea,** Family **Suctobelbidae** (species over 0.300 mm long including ***Allosuctobelba***, ***Suctobelbella***)

Diagnostic characters:

- medium-sized mites with suctobelbid mouthparts (elongate, +/1 needle-like with pointed rostrum & whisker-like rostral setae)
- prodorsum strongly ornamented with ridges and tubercles
- with or without **cristae**
- legs bead-like
- genital and anal plates relatively small, distant
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Incidental suctobelbid mites, *Veloppia*



33. *Passalozetes*– Superfamily Licneremaeoidea**,** Family Passalozetidae (***Passalozetes*** – small mites characteristic of dry soils)

Diagnostic characters:

- small mites (most <0.300 mm) with **flattened notogaster** and **strongly ornamented cerotegument**
- **lenticulus** usually present and distinct
- **genital and anal plates are large**, closely inserted
- lamellae, pteromorphs, porose areas absent

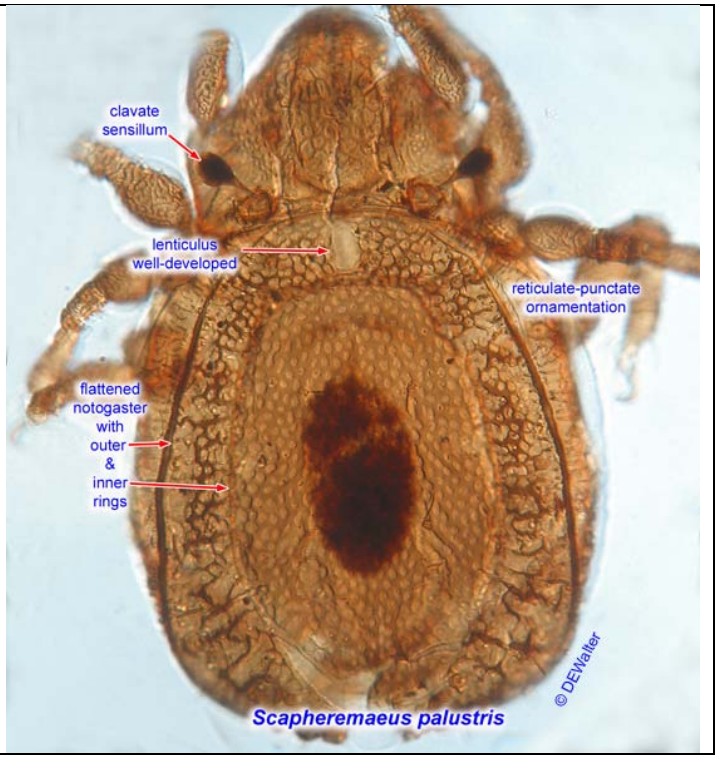
Similar morphotaxa: see Small flat-backed mites, Thyrisomid mites, *Scapheremaeus*

34. *Scapheremaeus* – Superfamily Cymbaeremaeoidea**,** Family Cymbaeremaeidae (***Scapheremaeus*** – arboreal species that occasionally show up in soil samples)

Diagnostic characters:

- small mites with **flattened notogaster**, strongly ornamented cuticle, and often 1-2 rings
- sensillum clavate
- **lenticulus** present
- **genital and anal plates are large**, closely inserted
- lamellae, pteromorphs, porose areas absent

Similar morphotaxa: see Small flat-backed mites, Thyrisomid mites, *Passalozetes*



B. Box Mites – Phthiracaroidea, Euphthiracaroidea

1. Phthiracarid box mites - Superfamily Phthiracaroidea**,** Family **Phthiracaridae (**including ***Phthiracarus, Atropacarus, Hoplophthiracarus*****)**

Diagnostic characters:

- **box mites with very broad plates in the genital and anal region**s
- usually yellowish, gray-brown to beige (***Phthiracarus, Hoplophthiracarus***) or pinkish (***Atropacarus***) in colour
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Euphthiracaroid box mites

2. Euphthiracaroid box mites - Superfamily **Euphthiracaroidea:** Family Euphthiracaridae **(**including ***Euphthiracarus, Rhysotritia, Microtritia*****);** Family Oribotritiidae **(*****Protoribotritia***, *Maerkelotritia*)

Diagnostic characters:

- **box mites with narrow plates in the genital and anal region**s **that join along a knife-like median edge**
- usually largish box mites yellow with reddish brown regions (***Euphthiracarus***) or dark brown (***Rhysotritia***); ***Protoribotritia*** is small and a light yellow in colour
- **interlocking triangle** present in Euphthiracaridae
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Phthiracarid box mites

C. Lower oribatids – Hypochthonioidea, Crotonioidea

1. *Hypochthonius*- Superfamily Hypochthonioidea**,** Family **Hypochthoniidae (*Hypochthonius*)**

Diagnostic characters:

- **dorsally flattened mites with a single division across the notogaster and joint between legs II-III**
- usually yellowish brown to pink in colour
- **complex of large plates in genital and anal region**
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see *Eniochthonius*

2. *Eniochthonius* - Superfamily Hypochthonioidea**,** Family **Eniochthoniidae (*Eniochthonius* – 3 species in Alberta)**

Diagnostic characters:

- **small, laterally compressed with 2 apparent divisions across the notogaster and joint between legs II-III**
- usually light yellow in colour
- **complex of large plates in genital and anal region**
- lamellae, pteromorphs, lenticulus, porose areas absent

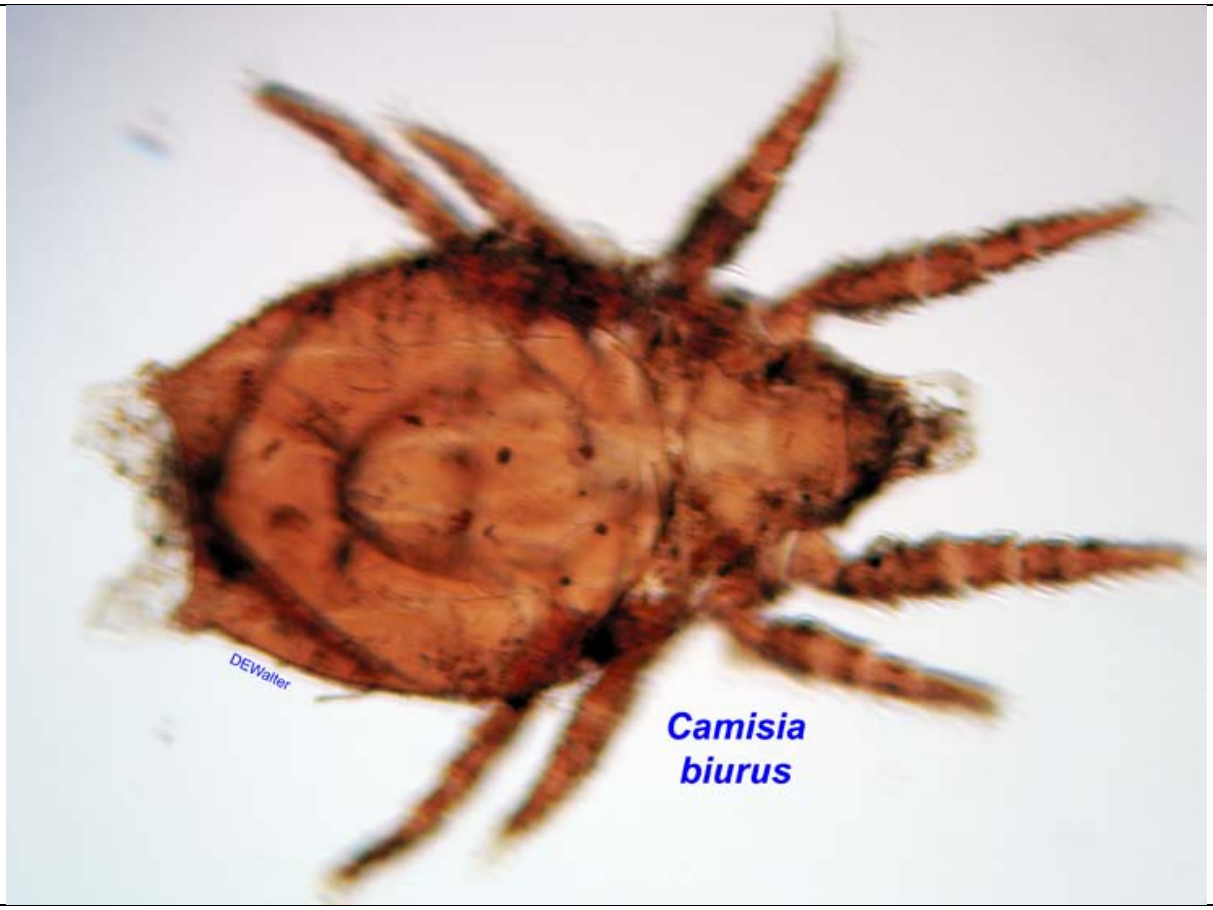
Similar morphotaxa: see *Hypochthonius*

3. *Camisia* - Superfamily Crotonioidea**,** Family **Camisiidae (*Camisia*)**

Diagnostic characters:

- **dorsally flattened, leathery mites usually with adherent soil**
- usually grayish to brown in colour
- **complex of large plates in genital and anal region**
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see *Platynothrus*, *Heminothrus*, *Neonothrus*



4. *Platynothrus* - Superfamily Crotonioidea**,** Family **Camisiidae (*Platynothrus*)**

Diagnostic characters:

- **dorsally flattened, leathery mites** usually brown to black in colour
- **notogaster with carinae**
- **often with adherent soil on the posterior**
- **complex of large plates in genital and anal region**
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see *Nothrus*, *Heminothrus*, *Neonothrus*

5. *Heminothrus* - Superfamily Crotonioidea**,** Family **Camisiidae (*Heminothrus*)**

Diagnostic characters:

- **dorsally flattened, leathery mites with thick coating of adherent soil**
- body grey-brown, but soil often very dark brown or black
- **complex of large plates in genital and anal region**
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see *Camisia*, *Platynothrus*, *Neonothrus*

6. *Neonothrus* - Superfamily Crotonioidea**,** Family **Camisiidae (*Neonothrus*)**

Diagnostic characters:

- **small, dorsally flattened, leathery mites** grey to brown in colour
- often with irregular adherent soil
- **body +/- rectangular in outline**
- **complex of large plates in genital and anal region**
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see *Camisia*, *Platynothrus*, *Heminothrus*, *Nothrus*

7. *Nothrus* - Superfamily Crotonioidea, Family **Nothridae (*Nothrus*)**

Diagnostic characters:

- **large, dorsally flattened, leathery mites**
- usually reddish to dark brown in colour
- **cuticle usually free of adherent debris and with distinct foveolate pattern**
- **complex of large plates in genital and anal region**
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see *Platynothrus*, *Neonothrus*

8. Trhypochthoniid mites - Superfamily Crotonioidea**,** Family Trhypochthoniidae **(*Trhypochthonius, Mainothrus badius, Mucronothrus nasalis*)**

Diagnostic characters:

- medium in size, beige to brown, in colour; usually darker around gland opening
- **+/-flattened, leathery mites**
- **complex of large plates in genital and anal region**
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Malaconothrid mites

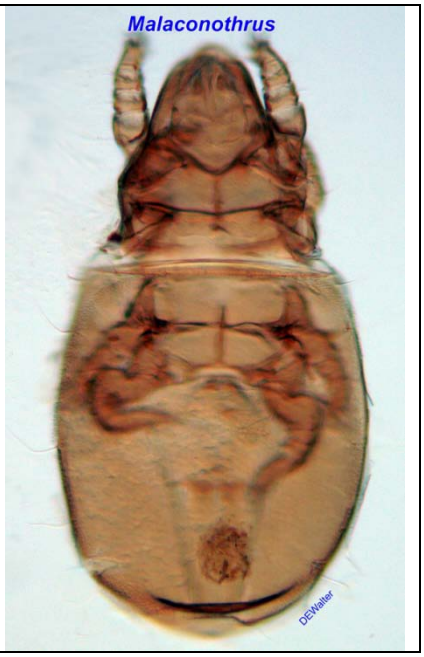
Mainothrus badius

9. Malaconothrid mites - Superfamily Crotonioidea**,** Family Malaconothridae **(*Malaconothrus, Trimalaconothrus*)**

Diagnostic characters:

- small to medium sized, **dorsally flattened, leathery mites**
- **leathery mites with flattened, subrectangular notogaster**
- **complex of large plates in genital and anal region**
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Trhypochthoniid mites

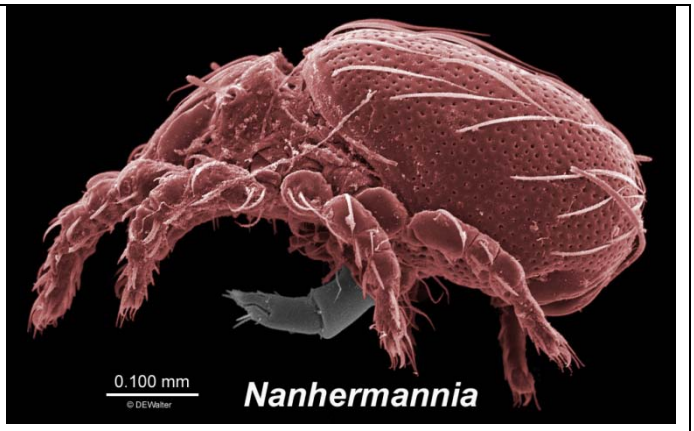


10. *Nanhermannia* - Superfamily Crotonioidea**,** Family **Nanhermanniidae (*Nanhermannia*)**

Diagnostic characters:

- **medium, cylindrical, heavily sclerotized, with punctate ornamentation**
- red-brown in colour
- **resemble higher oribatids**
- lamellae, pteromorphs, lenticulus, porose areas absent

Similar morphotaxa: see Cannon-gland mites



Glossary

area porosae - usually round to oval aggregations of pores (porose areas), designated Aa, A1, A2, A3 etc.

bifurcate – split into two at the tip or a structure with two distal processes

bothridial sensillus (sic) (= trichobothrium, bothridial sensillum) - an often elaborately modified seta set in a cup-like base (the bothridium) on the prodorsum

camerostome - a recess under the rostral tectum that allows retraction of the chelicerae and palps of oribatid mites and that is sealed by the subcapitulum when retracted

carina (pl. carinae) – longitudinal ridges in the cuticle

cerotegument - the layer of wax and cement that protects the cuticle; often thin and inconspicuous, but sometimes very thick, ornamented, and obscuring the underlying cuticle; thick ceroteguments often can be peeled off to expose a very different-looking mite

costula (pl. costulae) – linear ridges on the prodorsum that may resemble lamellae

lamella (pl. lamellae) – a longitudinal projection on the prodorsum of many oribatid mites that protects legs I when they are retracted; lamellae usually arise near the base of the bothridia and terminate with a projecting lamellar seta (often on a free cusp). Lamellae may be connected by a translamella.

lenticulus – an unpaired light sensitive organ that occurs on the anterior midline of the notogaster; it may be oval and lens-like or a more diffuse area of light-coloured cuticle

notogaster – the cap-like shield covering the posterior body region in oribatid mites

pedotectum (pl. pedotecta) - a scale-like tectum arising around the insertion of legs I or II that covers the insertion of the leg and sometimes forms a protected space into which the legs can be withdrawn

prodorsum – the anterior top part of a mite that bears the lamellae, bothridial sensillum, tutorium, etc.

pteromorph – a wing-like to shelf-like tectum that juts from the anterior-lateral margin of the notogastral shield and protects the legs; pteromorphs may have muscles and hinges that allows them to be moved (tightly pulled against legs or jutting well out from the body in dead mites) or be fixed and immovable.

ptychoidy - the ability of some oribatid mites to withdraw the legs between two body regions like a penknife being closed or a box being closed (hence box mites), and resulting in a seed-like appearance

tectum (pl. tecta) - any shelf-like projection of the cuticle

tutorium - a ridge on the lateral prodorsum, ventral and more or less parallel to the lamella and protecting legs I when retracted