# Micro-Analytical Biology Workbook for Food Sanitation Control Analysts (VOLUME II)

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## Sections in This Document

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## 1. Introduction

Entomologists are often required to teach regulatory entomology and biology principles to individuals who have little or no background in insect taxonomy or related biological sciences. This workbook is an attempt to present a uniform concept of conducting training in this area and is to be used as a manual to teach food analysts how to identify insect and rodent contaminants of food products.

The instructor should select the insects, mammalian hairs and excreta pellets to be studied, in accordance with the time allocated for the training course, and the kinds of insect and other animal contamination usually encountered in routine analysis. The selection of appropriate material to study is also important because there is too much material in this workbook to study in the time suggested by the author. Instructions for dissecting the genitalia of adult beetles and moths are included, even though there is little reference material available. Reference materials are presently available for identification of species of *Oryzaephilus*, food infesting moths, and a few others. Identification of the genitalia will become more important in the future as additional research is done, and the resulting reference material becomes available.

This workbook is divided into two volumes. Volume I provides the fundamentals of entomology and instructions for the study of beetle adults and larvae. Volume II contains instructions for the study of the remaining insects, animal hairs, and animal excreta. Each volume is color-coded for convenience and structured to satisfy the demands of classroom type study. All green sheets are illustrations of insects, insect fragments, or mites. The student is required to complete the worksheet by referring to the proper source of information or reference to appropriately name the various structures indicated. All yellow sheets contain general information and/or methodology. The pink sheets provide specific stepwise instructions for classroom exercises to be performed by each student on individual insects, animal hairs, or animal excreta. Slide mounts should be made by the student as per instructions given in the Analyst Operations Manual, Chapter 3. The required drawings indicated can be made on separate pages and incorporated into the workbook in their appropriate places. White sheets which list individual sources of reference materials should be removed when reprints of each reference are inserted into the workbook. These reference materials will be furnished by the instructor.

The author conducts a four-week course, with an examination given after each week, which is divided as follows:

First week: The selected beetle adults are dissected and studied. A four-hour examination follows which consists of 50 slides of beetle adult fragments.

Second week: The selected beetle and moth larvae are dissected and studied. A four-hour examination follows which consists of 50 slides of beetle and moth larval fragments.

Third week: The flies, cockroaches and selected miscellaneous insects are dissected and studied. An eight-hour examination follows which consists of 100 slides of insect fragments representing all the insects studied during the first three weeks.

Fourth week: Selected mammalian hairs and animal excreta pellets are studied. A four-hour examination consisting of 20 slides of hairs plus unknown excreta pellets follows.

The slides of unknown fragments and hairs are to be prepared by the instructor. During the exams, students have access to all reference materials, including their workbook and any slides which they have prepared. A minimum passing grade should be established.

The author expresses his gratitude to his wife, Doris, for her typing and her moral support. It is hoped that students studying and using this workbook in their work will find it of practical value. If so, then the long and arduous hours of preparation by the author and his typist will have been worthwhile.

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***Disclaimer: This manual was originally published in 1981 and the content is being provided "as is" for training purposes only. Entomology is an evolving field of study and our current understanding, particularly taxonomy, has changed since the publication of this manual. Users of this manual are responsible for ensuring their training program aligns with current entomological science. Minor revisions were made to address clarification and readability.***

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## 2. Moth Adults, Order Lepidoptera

1) Remove the antennae from the moth head. Make a slide of one antenna. Draw.
2) Dissect the proboscis from the moth head. Make slide. Draw.
3) Dissect the labial palps from the moth head. Make a slide of one palpi. Draw. Indicate the scale socket scars where scales have been rubbed off.

4) Remove the prothoracic, mesothoracic, and metathoracic legs from the moth. Make a slide of one intact leg. Draw.
5) Dissect the coxa, trochanter, femur, tibia, and tarsus from each of the three legs. Make a slide of each leg segment. Draw. Indicate the epiphysis on the inner aspect of the prothoracic tibia. Indicate the spurs on the mesothoracic and metathoracic tibiae. Indicate the number of segments in the tarsi.
6) Dissect cuticle from the abdomen of the moth. Make slide. Draw.
7) Make slides of scales from various places on the body and appendages of the moth. Draw.

*Ref. 14, 23.*

### 2.1. Moth Adults, Family Pyralidae

1) Remove the head from a moth. Make slide. Draw. These moths are sometimes called snout moths because the labial palps often project.
2) Remove the front and hind wings from a moth. Clear the wings if it is not possible to study the venational details. (Ref. 1)
    a. Make a slide of a front wing. Draw the wing venation. Observe the elongate or triangular shape of the wing.
    b. Make a slide of a hind wing. Draw the wing venation.

*Ref. 1, 14, 23.*

#### 2.1.1. Navel Orangeworm Adult, *Amyelois transitella* (Walker)

1) Remove the front wing from a moth. Make slide. Draw the color pattern of the wing.
2) Dissect the genitalia from a male and a female moth. Clear the genitalia in lactophenol solution (1+1). Make a slide or each. Draw. Compare with species of *Ephestia*.

*See Myelois venipars in Ref. 23.*

#### 2.1.2. Indian Meal Moth Adult, *Plodia interpunctella* (Hübner)

1) Remove the front wing from a moth. Make slide. Draw the color pattern of the wing.

2) Dissect the genitalia from a male and a female moth. Clear the genitalia in lactophenol solution (1+1). Make a slide of each. Draw. Compare with species of *Ephestia*.

*Ref. 23.*

### 2.1.3. Tobacco Moth Adult, *Ephestia elutella* (Hübner)

1) Remove the front wing from a moth. Make slide. Draw the color pattern of the wing.
2) Dissect the genitalia from a male and a female moth. Clean the genitalia in lactophenol solution (1+1). Make a slide of each. Draw. Compare with species of *Ephestia*.

*Ref. 23.*

### 2.1.4. Almond Moth Adult, *Ephestia cautella* (Walker)

1) Remove the front wing from a moth. Make slide. Draw the color pattern of the wing.
2) Dissect the genitalia from a male and a female moth. Clear the genitalia in lactophenol solution (1+1). Make a slide of each. Draw. Compare with species of *Ephestia*.

*Ref. 23.*

### 2.1.5. Mediterranean Flour Moth Adult, *Anagasta kuehniella* (Zeller)

1) Remove the front wing from a moth. Make slide. Draw the color pattern of the wing.
2) Dissect the genitalia from a male and a female moth. Clear the genitalia in lactophenol solution (1+1). Make a slide of each. Draw. Compare with species of *Ephestia*.

*See Ephestia kuehniella in Ref. 23.*

### 2.1.6. Raisin Moth Adult, *Cadra figulilella* (Gregson)

1) Remove the front wing from a moth. Make slide. Draw the color pattern of the wing.

2) Dissect the genitalia from a male and a female moth. Clear the genitalia in lactophenol solution (1+1). Make a slide of each. Draw. Compare with species of *Ephestia*.

*See Ephestia figulilella in Ref. 23.*

### 2.1.7. Murky Meal Moth Adult, *Aglossa caprealis* Hübner

1) Remove the front wing from a moth. Make slide. Draw the color pattern of the wing.
2) Dissect the genitalia from a male and a female moth. Clear the genitalia in lactophenol solution (1+1). Make a slide of each. Draw. Compare with species of *Ephestia*.

*Common name is Murky meal caterpillar in Ref. 23.*

### 2.1.8. Meal Moth Adult, *Pyralis farinalis* Linnaeus

1) Remove the front wing from a moth. Make slide. Draw the color pattern of the wing.
2) Dissect the genitalia from a male and a female moth. Clear the genitalia in lactophenol solution (1+1). Make a slide of each. Draw. Compare with species of *Ephestia*.

*Ref. 23.*

### 2.1.9. Rice Moth Adult, *Corcyra cephalonica* (Stainton)

1) Remove the front wing from a moth. Make slide. Draw the color pattern of the wing.
2) Dissect the genitalia from a male and a female moth. Clear the genitalia in lactophenol solution (1+1). Make a slide of each. Draw. Compare with species of *Ephestia*.

*Ref. 23.*

## 2.2. Moth Adults, Family Gelechiidae

1) Remove the head from a moth. Make slide. Draw. The labial palps are long and upcurved. The terminal segment is long and pointed.

2) Remove the front and hind wings from a moth. Clear the wings if it is not possible to study the venational details. (Ref. 1)
    a. Make a slide of a front wing. Draw the wing venation. Observe the shape of the wing.
    b. Make a slide of a hind wing. Draw the wing venation. Observe the shape of the wing.

*Ref. 1, 14, 23.*

#### 2.2.1. Angoumois Grain Moth Adult, *Sitotroga cerealella* (Olivier)

1) Remove the front wing from a moth. Make slide. Draw the color pattern of the wing.
2) Dissect the genitalia from a male and a female moth. Clear the genitalia in lactophenol solution (1+1). Make a slide of each. Draw. Compare with species of *Ephestia*.

*Ref. 23.*

## 3. Moth Larvae

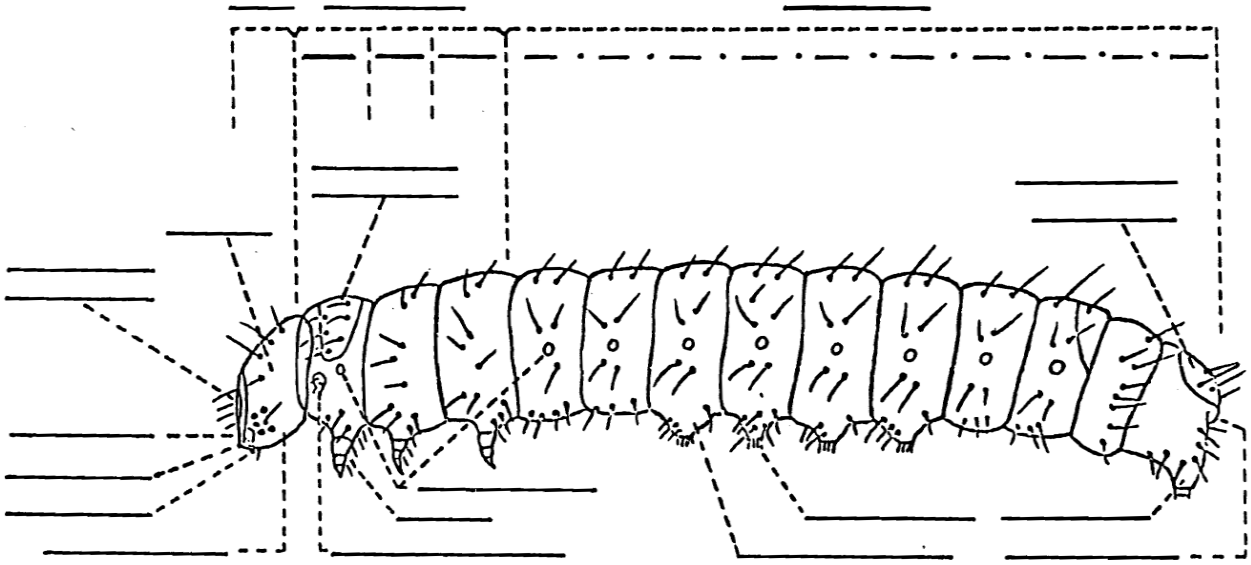
### 3.1. Lepidoptera and Coleoptera larvae Differences

List and illustrate by drawings the differences between Lepidoptera and Coleoptera larvae.

*Ref. 13, page 905.*

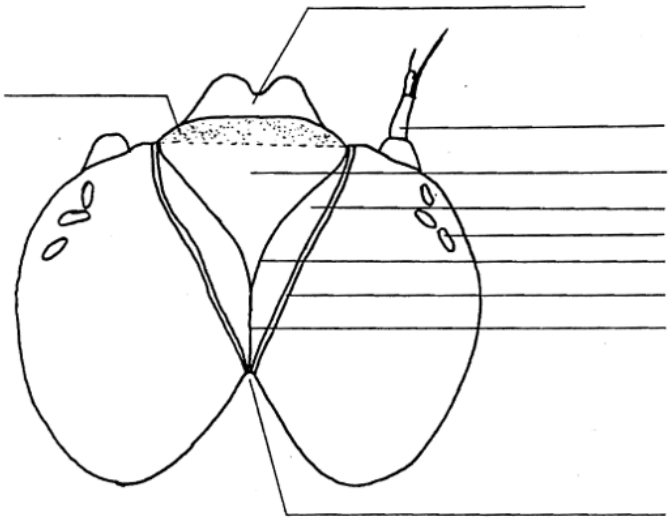
### 3.2. Moth Larva Morphology

*Fig. 50. General morphology of a moth larva*.



*From and used with the permission of Journal of the Association of Official Agricultural Chemists. Ref. 9.*

*Fig. 51. Dorsal view of Lepidoptera larval head.*



*From Micro-Analytical Entomology for Food Sanitation Control, by O.L. Kurtz and K.L. Harris, Association of Official Agricultural Chemists, Washington, D.C. Used with the permission of the publisher.*

### 3.3. Moth Larvae, Order Lepidoptera

1) Remove the head from a larva. Dissect the mandibles from the head. Make a slide of the resulting head capsule. Draw. Observe the frons, with adfrontals and ocelli.
2) Dissect the labrum from a moth larval head. Make slide. Draw. Observe the hook-like articulations at each end of the proximal margin. Observe the labral notch, which is the median indention on the distal margin.
3) Dissect the labium from a larval head. Make slide. Draw. Observe the spinneret and the labial palps.
4) Dissect the antennae from a larval head. Make slide. Draw.
5) Dissect a post gena from a larval head. Make slide. Draw.
6) Dissect an abdominal proleg from a larva. Make slide. Draw. Observe the crochets on the proleg.
7) Dissect a thoracic leg from a larva. Make slide. Draw.
8) Dissect the ninth and tenth abdominal segments from a larva. Make slide. Draw. Observe the suranal plate on the dorsal surface of the tenth segment.

*Ref. 13, 23.*

#### 3.3.1. Moth Larvae, Family Pyralidae

1) Dissect the prothorax from a larva. Make slide. Draw a setal map of the prothorax.

   Note: The prespiracular wart has 2 setae.

2) Remove the abdomen from a larva. Make slide. Observe the abdomen at 10X to 30X and illustrate the following:

   a. The abdomen may be of a more or less uniform color, or it may be spotted due to conspicuous pigmented pinacula at the base of the primary setae.

   b. The setae on the abdomen are primary setae with few or no secondary setae.

   c. Prolegs are present on abdominal segments 3 through 6 and 10.

   d. The prolegs usually bear uniserial biordinal crochets.

*Ref. 23.*

#### 3.3.1.1. Navel Orangeworm Larva, *Amyelois transitella* (Walker)

1) Dissect the right and left mandibles. Make a slide of each. Draw. Indicate any differences between the mandibles.

   Note: All sketches in Ref. 9 are of right mandibles.

2) Dissect the eighth abdominal segment. Make slide. Draw the setal map. Compare with other species of Pyralidae.

*See Myelois venipars in Ref. 9, 23.*

#### 3.3.1.2. Indian Meal Moth Larva, *Plodia interpunctella* (Hübner)

1) Dissect the right and left mandibles. Make a slide of each. Draw. Indicate any differences between the mandibles.

   Note: All sketches in Ref. 9 are of right mandibles.

2) Dissect the eighth abdominal segment. Make slide. Draw the setal map. Compare with other species of Pyralidae.

*Ref. 9, 23.*

#### 3.3.1.3. Tobacco Moth Larva, *Ephestia elutella* (Hübner)

1) Dissect the right and left mandibles. Make a slide of each. Draw. Indicate any differences between the mandibles.

   Note: All sketches in Ref. 9 are of right mandibles.

2) Dissect the eighth abdominal segment. Make slide. Draw the setal map. Compare with other species of Pyralidae.

*Ref. 9, 23.*

#### 3.3.1.4. Almond Moth Larva, *Ephestia cautella* (Walker)

1) Dissect the right and left mandibles. Make a slide of each. Draw. Indicate any differences between the mandibles.

   Note: All sketches in Ref. 9 are of right mandibles.

2) Dissect the eighth abdominal segment. Make slide. Draw the setal map. Compare with other species of Pyralidae.

*Ref. 9,23.*

#### 3.3.1.5. Mediterranean Flour Moth Larva, *Anagasta kuehniella* (Zeller)

1) Dissect the right and left mandibles. Make a slide of each. Draw. Indicate any differences between the mandibles.

   Note: All sketches in Ref. 9 are of right mandibles.

2) Dissect the eighth abdominal segment. Make slide. Draw the setal map. Compare with other species of Pyralidae.

*See Ephestia kuhniella in Ref. 9, 23.*

#### 3.3.1.6. Raisin Moth Larva, *Cadra figulilella* (Gregson)

1) Dissect the right and left mandibles. Make a slide of each. Draw. Indicate any differences between the mandibles.

   Note: All sketches in Ref. 9 are of right mandibles.

2) Dissect the eighth abdominal segment. Make slide. Draw the setal map. Compare with other species of Pyralidae.

*See Ephestia figulilella in Ref. 9, 23.*

#### 3.3.1.7. Murky Meal Moth Larva, *Aglossa caprealis* Hübner

1) Dissect the right and left mandibles. Make a slide of each. Draw. Indicate any differences between the mandibles.

   Note: All sketches in Ref. 9 are of right mandibles.

2) Dissect the eighth abdominal segment. Make slide. Draw the setal map. Compare with other species of Pyralidae.

Common name is Murky meal caterpillar *in Ref. 9, 23.*

#### 3.3.1.8. Meal Moth Larva, *Pyralis farinalis* Linnaeus

1) Dissect the right and left mandibles. Make a slide of each. Draw. Indicate any differences between the mandibles.

   Note: All sketches in Ref. 9 are of right mandibles.

2) Dissect the eighth abdominal segment. Make slide. Draw the setal map. Compare with other species of Pyralidae.

*Ref. 9, 23.*

#### 3.3.1.9. Rice Moth Larva, *Corcyra cephalonica* (Stainton)

1) Dissect the right and left mandibles. Make a slide of each. Draw. Indicate any differences between the mandibles.

   Note: All sketches in Ref. 9 are of right mandibles.

2) Dissect the first abdominal segment. Make slide. Draw the setal map.

3) Dissect the eighth abdominal segment. Make slide. Draw the setal map. Compare with other species of Pyralidae.

*Ref. 9, 23.*

### 3.3.2. Moth Larvae, Family Gelechiidae

1) Dissect the prothorax from a larva. Make slide. Draw a setal map of the prothorax.

   Note: The prespiracular wart has three setae.

2) Remove the abdomen from a larva. Make slide. Observe the abdomen at 10X to 30X and illustrate the following:

   a. abdomen is gradually narrowed behind.
   b. The prolegs are rudimentary.
   c. The prolegs have only 2 or 3 indistinct crochets.

*Ref. 23.*

#### 3.3.2.1. Angoumois Grain Moth Larva, *Sitotroga cerealella* (Olivier)

1) Dissect the right and left mandibles. Make a slide of each. Draw. Indicate any differences between the mandibles.

   Note: All sketches in Ref. 9 are of right mandibles.

2) Dissect the eighth abdominal segment. Make slide. Draw the setal map. Compare with species of Pyralidae.

*Ref. 9,23.*

## 4. Flies

### 4.1. Housefly Adult, *Musca domestica* Linnaeus

1) Remove the head from a fly. Dissect the proboscis from the head. Make slide. Draw. Observe the rostrum, labellum, and the maxillary palps.
2) Dissect the labellum from a proboscis. Make slide. Draw.
3) Dissect the maxillary palps from a proboscis. Make slide. Draw.
4) Dissect the antenna from the head. Make slide. Draw.
5) Dissect the arista from an antenna. Make slide. Draw.
6) Remove the prothoracic, mesothoracic, and metathoracic legs from the fly. Make a slide of each. Draw.
7) Dissect the terminal tarsal segment from one leg. Make slide. Draw.
8) Remove a wing from the fly. Make slide. Draw the wing venation. Include the microspines and heavy spines in the drawing.
9) Dissect a halter from the metathorax. Make slide. Draw.
10) Dissect fragments of the thorax and the dorsal surface of the abdomen. Make a slide of each. Draw.
11) Dissect the ovipositor from a female fly. Make slide. Draw.
12) Make slides of large and small setae from the body and legs of a fly. Make slides of each. Draw. Indicate the characteristics which identify these as housefly-type setae.

*Ref. 2, 23.*

### 4.2. Housefly Pupa, *Musca domestica* Linnaeus

1) Remove the mouth hooks (hypopharyngeal sclerites) from within the puparium. Make slide. Draw.

   Note: See procedure for taxonomic study of muscoid larvae and pupae.

2) Dissect the posterior spiracles (stigmal plate) from the puparium. Make slide. Draw.

   Note: See procedure for taxonomic study of muscoid larvae and pupae.

*Ref. 23.*

### 4.3. Housefly Larva, *Musca domestica* Linnaeus

1) Remove the thorax (first three body segments), which normally includes the mouth hooks (hypopharyngeal sclerites) and the anterior spiracles, from the larva. Make slide. Draw.

   Note: See procedure for taxonomic study of muscoid larvae and pupae.

2) Dissect the posterior spiracles (stigmal plate) from the larva. Make slide. Draw.

   Note: See procedure for taxonomic study of muscoid larvae and pupae.

*Ref. 23.*

*Fig. 52. Musca domestica, mature larva, side view.*

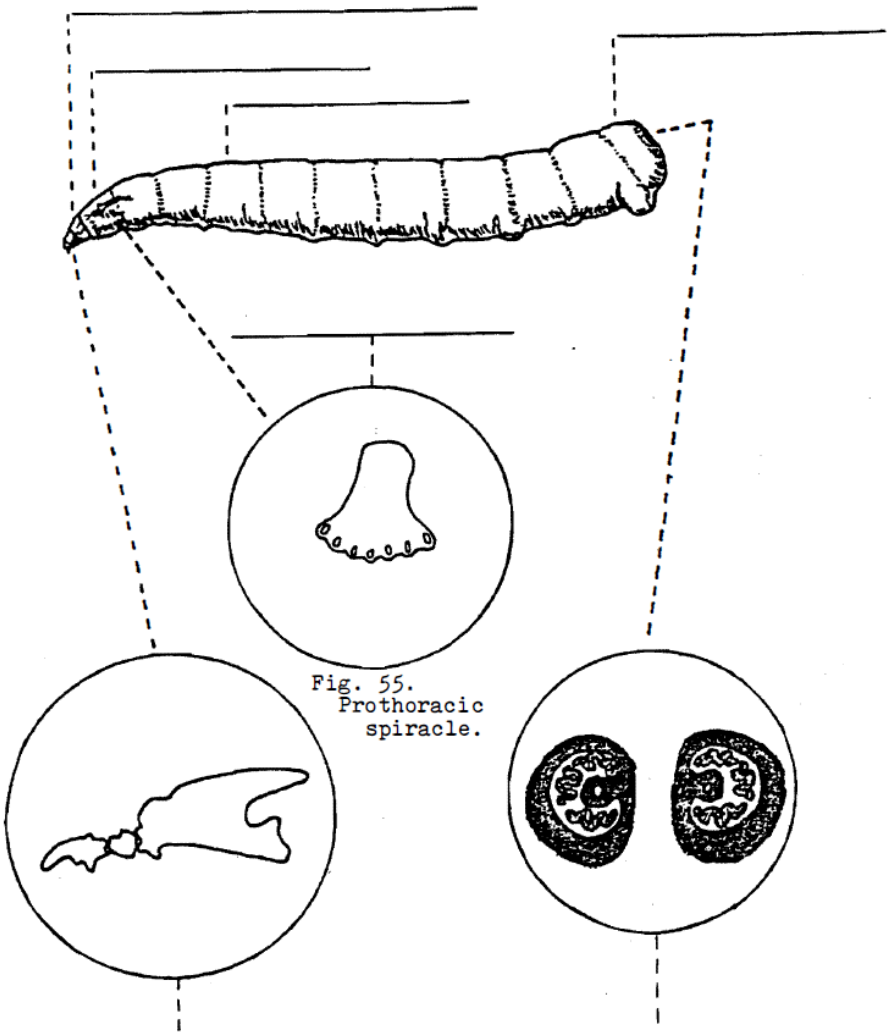



*Fig. 53. Mouth hooks.* *Fig. 54. Caudal spiracles.*

*Fig. 52 from The Flies That Cause Myiasis in Man, Ref. 19.*

*Figs. 53 and 54 from Micro-Analytical Entomology for Food Sanitation Control.*

*Used with the permission of AOAC, Ref. 23.*

*Fig. 55 from Microscopic-Analytical Methods in Food and Drug Control, Food and Drug Technical Bulletin No. 1, Ref. 11.*

### 4.3.1. Procedure for Taxonomic Study of Muscoid Larvae and Pupae

Aside from general body conformation, appendages, etc., the taxonomy of muscoid dipterous larvae is based on the morphology of the hypopharyngeal sclerites and of the stigma plates and stigmata or spiracles. The hypopharyngeal sclerites, or mouthparts, are usually withdrawn into or

concealed in the body and in some instances are not visible at all externally. The spiracles, spiracular slits, and the button are frequently so small that their morphology is not easily determined except under very high magnification. It is necessary, therefore, to make micro-slide preparations of these structures for detailed study and accurate determination.

The procedure is simple. The larvae should be killed in hot water, or KAA, or alcohol. They may be stored indefinitely in 80% ethyl alcohol.

To make a slide preparation, select the largest larva available. Place it on white filter paper in a petri dish and, while holding it firmly with a pair of forceps, remove the thorax (first three body segments) which normally includes the hypopharyngeal sclerites and the anterior spiracles. Transfer the thorax into a crucible containing the clearing agent (KOH, NaOH, or lactophenol solution 1+1).

Returning to the specimen, while holding it firmly with the forceps, carefully cut off the stigmal plate. With the plate face down (or the internal side up) on the filter paper, carefully scrape away as much of the extraneous tissue as possible using a probe. Then transfer the plate to the clearing agent. Preserve the rest of the body in alcohol for possible future reference.

The crucible containing the clearing agent and the front and rear parts of the larva may now be heated gently on a hot plate. As soon as the tissues appear to be thoroughly macerated, remove from heat, and allow to cool. Never set a hot crucible down on a bare table or on the stage of the microscope. Set it on a fiber block until cool. Then place it on a microscope and, using the micro-spatula, scrape away or tease out the macerated tissue, leaving only the cuticle containing the spiracles and wash with alcohol if cleared in a caustic solution. If cleared in L-P, there is no need to acidulate.

The specimens are now ready to be embedded, which may be done in any standard mounting medium such as Hoyer’s Solution, or PVA, or Euparal, or clarite, etc. Orient the stigmal plate with external surface uppermost and dorsal surface on the side nearest the operator (this is done because compound microscopes reverse images and the plate will then be right side up when viewed through the microscope). The hypopharyngeal sclerites should be oriented in such a manner that the anterior portion will be pointing to the left and the whole assembly is seen in lateral aspect. It is customary to have the stigmal plate uppermost and the “head" below. As soon as the cover slip is on, the slide should be labeled with a temporary label and set in an oven at 55$^{o}$C for at least 12 hours. It may then be removed, ringed, properly labeled and identified, and added to the permanent collection.

If only puparia are available, the same procedure should be followed except that great care must be used to locate the mouthparts within the puparium.

They will be found free, jammed into the anterior end of the puparium. Generally, no clearing of these mouthparts is necessary but the stigmal plate should be boiled in the clearing agent to soften it and allow it to lie flat under the cover slip.

*This previously unpublished procedure was furnished by, and is printed with the permission of, Wilbur R. Enns, Department of Entomology, College of Agriculture, University of Missouri, Columbia, Missouri 65211.*

### 4.4. Fly Eggs, Housefly type

1) Make a slide of a fly egg. Draw.
2) Clear fly eggs in lactophenol solution (1+1). Make slide. Observe the network of cells, of the outer membrane, at high magnification. Draw. Describe the shape of the cells.

*Ref. 23.*

### 4.5. Drosophila Adults, *Drosophila* spp.

1) Remove the head from a fly. Dissect the proboscis from the head. Make slide. Draw. Observe the rostrum, labellum, and the maxillary palps.
2) Dissect the labellum from a proboscis. Make slide. Draw.
3) Dissect the maxillary palps from a proboscis. Make slide. Draw.
4) Dissect the antenna from the head. Make slide. Draw.
5) Dissect the arista from an antenna. Make slide. Draw.
6) Remove the prothoracic, mesothoracic, and metathoracic legs from the fly. Make a slide of each. Draw.
7) Dissect the terminal tarsal segment from one leg. Make slide. Draw.
8) Remove a wing from the fly. Make slide. Draw the wing venation. Include the microspines and heavy spines in the drawing.
9) Dissect a haltere from the metathorax. Make slide. Draw.
10) Dissect fragments of the thorax and the dorsal surface of the abdomen. Make a slide of each. Draw.
11) Dissect the ovipositor from a female fly. Make slide. Draw.
12) Make slides of large and small setae from the body and legs of a fly. Make slides of each. Draw. Illustrate the difference between these setae and housefly-type setae.

*Ref. 23.*

### 4.6. Drosophila Pupae, *Drosophila* spp.

1) Dissect the head cap from a pupa. Make slide. Draw. Indicate the stalked anterior spiracles.
2) Dissect the anterior-ventral end from a pupa. This portion bears the larval mouth hooks. Make slide. Draw.
3) Dissect the posterior end of a pupa. This portion bears the stalked posterior spiracles. Make slide. Draw.

*Ref. 23.*

### 4.7. Drosophila Larvae, *Drosophila* spp

1) Remove the thorax (first three body segments), which normally includes the mouth hooks (hypopharyngeal sclerites) and the anterior spiracles, from the larva. Make slide. Draw.

   Note: See procedure for taxonomic study of muscoid larvae and pupae.
2) Dissect the posterior stalked spiracles from the larva. Make slide. Draw.

   Note: Clear the spiracles in lactophenol solution (1+1) if they are to be observed at high magnification.

*Ref. 23.*

### 4.8. Fly Eggs, Drosophila type

1) Make a slide of a Drosophila egg. Observe the filaments which arise from one end of the egg. Draw. Indicate the number of filaments present.
2) Clear fly eggs in lactophenol solution (1+1). Make slide. Observe the network of cells, of the outer membrane, at high magnification. Draw. Describe the shape of the cells.

*Ref. 23.*

## 5. Cockroaches

### 5.1. American Cockroach Adult, *Periplaneta americana* (Linnaeus)

1) Remove the antennae from the head. Make slide. Draw.

2) Dissect the right and left mandibles from the head. Make a slide of each. Draw each. Indicate any differences between the mandibles.
3) Dissect the labrum from the head. Make slide. Draw.
4) Dissect a maxilla from the head. Make slide. Draw. Indicate the lacinia, galea and the maxillary palpus.
5) Dissect the labium from the head. Make slide. Draw. Indicate the labial palps.
6) Remove the prothoracic, mesothoracic and metathoracic legs from the thorax. Make a slide of one leg. Draw.
7) Dissect the coxa, femur, tibia, and tarsus from each of the three legs. Make a slide of each leg segment. Draw. Indicate any differences between the prothoracic, mesothoracic and metathoracic leg segments.
8) Dissect a large seta from a tibia showing a distinct step and serrations along one side. Make slide. Draw.
9) Dissect the cerci from the abdomen. Make slide. Draw.
10) Remove the front and hind wings from the thorax. Make a slide of each.

Draw the wing venation of each.

*Ref. 8,23.*

### 5.2. American Cockroach Nymph, *Periplaneta americana* (Linnaeus)

1) Remove the antennae from the head. Make slide. Draw.
2) Dissect the right and left mandibles from the head. Make a slide of each. Draw each. Indicate any differences between the mandibles.
3) Dissect the labrum from the head. Make slide. Draw.
4) Dissect a maxilla from the head. Make slide. Draw. Indicate the lacinia, galea, and the maxillary palpus.
5) Dissect the labium from the head. Make slide. Draw. Indicate the labial palps.
6) Remove the prothoracic, mesothoracic, and metathoracic legs from the thorax. Make a slide of one leg. Draw.
7) Dissect the coxa, femur, tibia, and tarsus from each of the three legs. Make a slide of each leg segment. Draw. Indicate any differences between the prothoracic, mesothoracic, and metathoracic leg segments.

8) Dissect a large seta from a tibia showing a distinct step and serrations along one side. Make slide. Draw.
9) Dissect the cerci from the abdomen. Make slide. Draw.

*Ref. 8, 23.*

### 5.3. American Cockroach Egg Case (ootheca), *Periplaneta americana* (Linnaeus)

1) Draw the side view of an egg case. Indicate the crimped edge.
2) Draw the end view of an egg case.
3) Break an egg case open and observe the individual egg chambers. Draw.
4) Break a piece of the crimped seam off the egg case. Make slide. Draw.

### 5.4. German Cockroach Adult, *Blattella germanica* Linnaeus

1) Remove the antennae from the head. Make slide. Draw.
2) Dissect the right and left mandibles from the head. Make a slide of each. Draw each. Indicate any differences between the mandibles.
3) Dissect the labrum from the head. Make slide. Draw.
4) Dissect a maxilla from the head. Make slide. Draw. Indicate the lacinia, galea, and the maxillary palpus.
5) Dissect the labium from the head. Make slide. Draw. Indicate the labial palps.
6) Remove the prothoracic, mesothoracic, and metathoracic legs from the thorax. Make a slide of one leg. Draw.
7) Dissect the coxa, femur, tibia, and tarsus from each of the three legs. Make a slide of each leg segment. Draw. Indicate any differences between the prothoracic. mesothoracic and metathoracic leg segments.
8) Dissect a large seta from a tibia showing a distinct step and serrations along one side. Make slide. Draw.
9) Dissect the cerci from the abdomen. Make slide. Draw.
10) Remove the front and hind wings from the thorax. Make a slide of each. Draw the wing venation of each.

*Ref. 8, 23.*

### 5.5. German Cockroach Nymph, *Blattella germanica* Linnaeus

1) Remove the antennae from the head. Make slide. Draw.
2) Dissect the right and left mandibles from the head. Make a slide of each. Draw each. Indicate any differences between the mandibles.
3) Dissect the labrum from the head. Make slide. Draw.
4) Dissect a maxilla from the head. Make slide. Draw Indicate the lacinia. galea and the maxillary palpus.
5) Dissect the labium from the head. Make slide. Draw. Indicate the labial palps.
6) Remove the prothoracic, mesothoracic and metathoracic legs from the thorax. Make a slide of one leg. Draw.
7) Dissect the coxa, femur, tibia, and tarsus from each of the three legs. Make a slide of each leg segment. Draw. Indicate any differences between the prothoracic, mesothoracic, and metathoracic leg segments.
8) Dissect a large seta from a tibia showing a distinct step and serrations along one side. Make slide. Draw.
9) Dissect the cerci from the abdomen. Make slide. Draw.

*Ref.8, 23.*

### 5.6. German Cockroach Egg Case (ootheca), *Blattella germanica* Linnaeus

1) Draw the side view of an egg case. Indicate the crimped edge.
2) Draw the end view of an egg case.
3) Break an egg case open and observe the individual egg chambers. Draw.
4) Break a piece of the crimped seam off the egg case. Make slide. Draw.

*Ref.8, 23.*

## 6. Miscellaneous Insects

### 6.1. Ants, Order Hymenoptera, Family Formicidae

1) Remove the head from an ant. Remove the antennae from the head and dissect the right and left mandibles. Make a slide of the resulting head capsule with the dorsal surface up. Draw. Indicate the compound eyes and the ocelli.

2) Make a slide of an antenna. Draw. Describe the shape.
3) Make a slide of the right and left mandibles. Draw. Describe the shape.
4) Dissect the prothoracic, mesothoracic and metathoracic legs from the ant. Make a slide of each intact leg. Draw each. Indicate the antenna cleaner on the prothoracic leg.
5) Dissect the pedicel. Make slide. Draw.
6) Remove the front and hind wing from a winged ant. Make a slide of each. Draw. Indicate the row of tiny hooks on the anterior margin of the hind wings (hamuli).

*Ref. 23.*

### 6.2. Aphids, Order Homoptera, Family Aphididae

1) Remove the head from an aphid. Remove the antennae from the head. Make a slide of the head. Draw. Describe the mouth parts.
2) Make a slide of an antenna. Draw. Indicate the circular sensory structures.
3) Make a slide of the apical segment of an antenna. Draw. Indicate the step-like indention, if present.
4) Dissect the beak from a head. Make slide. Draw.
5) Remove the prothoracic, mesothoracic, and metathoracic legs from the aphid. Make a slide of each intact leg. Draw.
6) Dissect the coxa, trochanter, femur, tibia, and tarsus from one leg. Make a slide of each leg segment. Draw each. Indicate the identifying characteristics of the femur, tibia, and tarsus.
7) Dissect the cornicles from the abdomen. Make slide. Draw. Indicate the reticulation on the cornicle.
8) Remove a front wing and a hind wing from a winged aphid. Make a slide of each. Draw the wing venation of each.

*Ref. 23.*

### 6.3. Thrips, Order Thysanoptera

1) Remove the head from a thrips. Remove the antennae from the head. Make a slide of the head. Draw. Indicate the mouth. cone and the ocelli.
2) Make a slide of an antenna. Draw. Describe the shape of the segments.

3) Remove the prothoracic, mesothoracic, and metathoracic legs from the thrips. Make a slide of each intact leg. Draw each. Observe the last segment of the tarsus which terminates in a hoof-like or bladder-like protrusion.
4) Remove a front wing and a hind wing from a thrips. Make a slide of each. Draw.
5) Make a slide of a thrips abdomen. Draw.

Note: Thrips is both singular and plural.

*Ref. 23.*

### 6.4. Psocids, Order Psocoptera

This order includes the common wingless cereal psocid, *Liposcelis divinatorius* (Muller).

1) Remove the head from a psocid. Remove the antennae and dissect the mandibles from the head. Make a slide of the resulting head capsule. Draw.

   Note: The compound eyes are prominent in the winged forms and 3 ocelli are present. The wingless species do not have ocelli.
2) Make a slide of an antenna. Draw.
3) Make a slide of the right and left mandibles. Draw. Indicate any differences between the mandibles.
4) Dissect the sclerite of the esophagus from the head. Make slide. Draw.
5) Remove the prothoracic, mesothoracic, and metathoracic legs from the psocid. Make a slide of each intact leg. Draw.

   Note: Observe especially the broad femur of the metathoracic leg.
6) Remove a front wing and a hind wing from a winged psocid. Make a slide of each. Draw the wing venation of each.
7) Make a slide of an abdomen. Draw.

*Ref. 23.*

### 6.5. Mites, Class Arachnida, Order Acari

This order includes the spider mites and harvest mites.

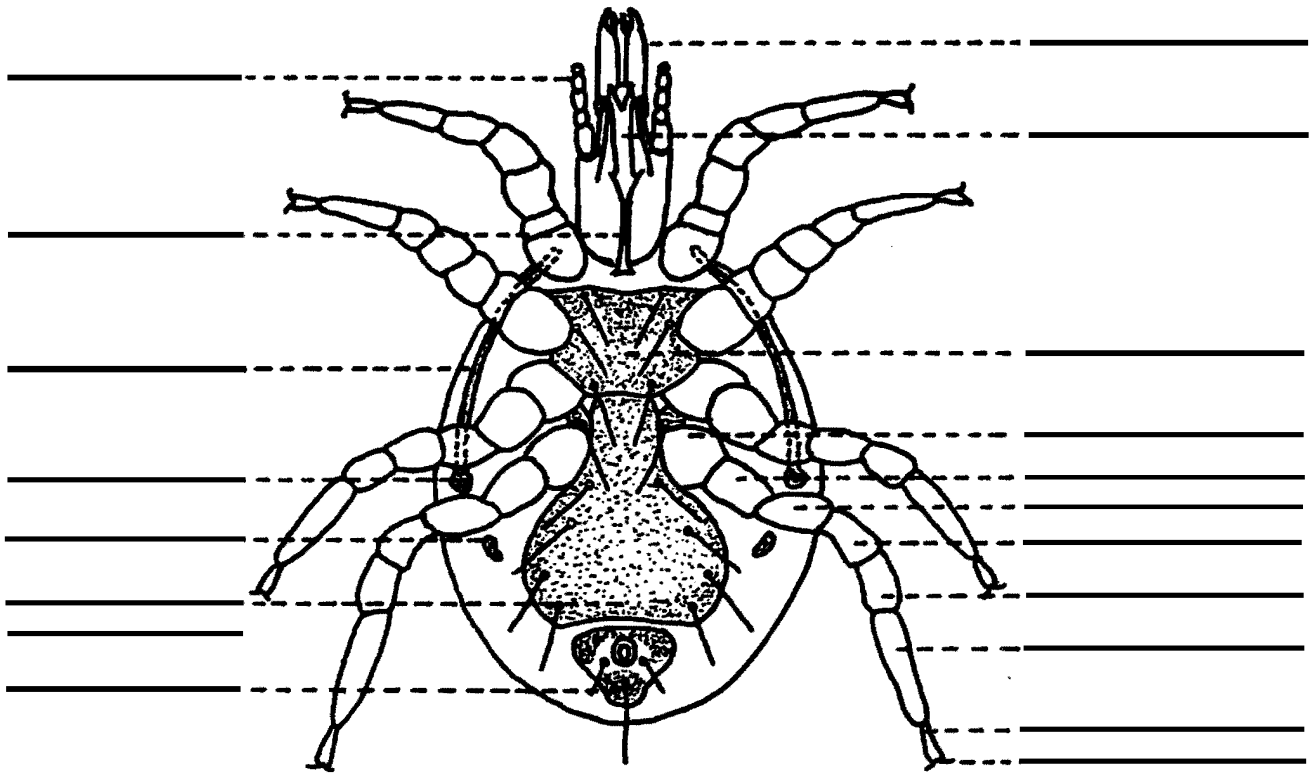
1) Clear mites in lactophenol solution (1+1).

2) Make slides of individual mites. Draw. Indicate the two body regions and the number of legs present.

3) List below the characteristics which differentiate mites from insects.

*Ref. 4.*

*Fig. 56. Morphology of a mite (ventral view).*



From Pictorial Keys to Arthropods, Reptiles, Birds and Mammals of Public Health Significance, U.S. Department of Health, Education and Welfare, Public Health Service, Center for Disease Control.

## 7. Mammalian Hairs

### 7.1. Rat or Mouse Hairs

1) Clear fur and guard hairs as directed in Ref. 29, or as directed by instructor. Make slides of each. Draw.

2) Identify and label the following structures of the hairs:

cuticle

scales

cortex

medulla

air spaces

pegs

internodes

3) Describe the shape of the medulla and of the air spaces.
4) Name other animal hairs which have internodes.

Identities of all hairs should be made at 400X to 400X.

*Ref. 11, 29, 31.*

### 7.2. Rabbit Hairs

1) Clear fur and guard hairs as directed in Ref. 29, or as directed by instructor. Make slides of each. Draw.
2) Identify and label the following structures of the hairs if they are present:

cuticle

scales

cortex

medulla

air spaces

pegs

internodes

3) Describe the differences between the structures of these hairs and those of rats or mice.

Identities of all hairs should be made at 400X to 430X.

*Ref. 11, 29, 31.*

### 7.3. Squirrel Hairs

1) Clear fur and guard hairs as directed in Ref. 29 or as directed by instructor. Make slides of each. Draw.

2) Identify and label the following structures of the hairs. if they are present:

   cuticle

   scales

   cortex

   medulla

   air spaces

   pegs

   internodes

3) Describe the differences between the structures of these hairs and those of rats or mice.

   Identities of all hairs should be made at 400X to 430X

   *Ref.11, 29, 31.*

### 7.4. Cat Hairs

1) Clear fur and guard hairs as directed in Ref. 29 or as directed by instructor. Make slides of each. Draw.
2) Identify and label the following structures of the hairs, if they are present:

   cuticle

   scales

   cortex

   medulla

   air spaces

   pegs

   internodes

3) Describe the differences between the structures of these hairs and those of rats or mice.

   Identities of all hairs should be made at 400X to 430X.

   *Ref. 11, 29, 31.*

### 7.5. Dog Hairs

1) Clear fur and guard hairs as directed in Ref. 29 or as directed by instructor. Make slides of each. Draw.
2) Identify and label the following structures of the hairs if they are present:

   cuticle

   scales

   cortex

   medulla

   air spaces

   pegs

   internodes
3) Describe the differences between the structures of these hairs and those of rats or mice.

   Identities of all hairs should be made at 400X to 430X.

   *Ref. 11, 29, 31.*

### 7.6. Shrew Hairs

1) Clear fur and guard hairs as directed in Ref. 29 or as directed by instructor. Make slides of each. Draw.
2) Identify and label the following structures of the hairs if they are present:

   cuticle

   scales

   cortex

   medulla

   air spaces

   pegs

   internodes
3) Describe the differences between the structures of these hairs and those of rats or mice.

   Identities of all hairs should be made at 400X to 430X.

*Ref. 11, 29, 31.*

### 7.7. Bat Hairs

1) Clear the hairs as directed in Ref. 29 or as directed by instructor. Make slides. Draw.
2) Identify and label the following structures of the hairs if they are present:

   cuticle

   scales

   cortex

   medulla

   air spaces

   pegs

   internodes
3) Describe the differences between the structures of these hairs and those of rats or mice.

4) Identities of all hairs should be made at 400X to 430X.

   *Ref. 11, 29, 31.*

### 7.8. Human Hairs

1) Clear hairs taken from different areas of the body as directed in Ref. 29 or as directed by instructor. Make a slide of each type of hair. Draw each.
2) Identify and label the following structures of each hair:

   cuticle

   scales

   cortex

   medulla
3) Make slides of human hairs of different races and compare these with the hairs which were examined in #1 above. Draw and label the structures of all types of hairs.

   Identities of all hairs should be made at 400X to 430X.

   *Ref. 11, 19, 31.*

### 7.9. Cow Hairs

1) Clear fur and guard hairs as directed in Ref. 29 or as directed by instructor. Make a slide of each. Draw.
2) Identify and label the following structures of the hairs:

   cuticle

   scales

   cortex

   medulla
3) Compare these hairs with those of the human, horse, goat, and hog.

   Identities of all hairs should be made at 400X to 430X.

   *Ref. 11, 29, 31.*

### 7.10. Goat Hairs

1) Clear fur and guard hairs as directed in Ref. 29 or as directed by instructor. Make a slide of each. Draw.
2) Identify and label the following structures of the hairs:

   cuticle

   scales

   cortex

   medulla
3) Compare these hairs with those of the human, cow, horse, and hog.

4) Identities of all hairs should be made at 400X to 430X.

   *Ref. 11, 29, 31.*

### 7.11. Horse Hairs

1) Clear hairs taken from the mane, tail, and body as directed in Ref. 29 or as directed by instructor. Make a slide of each type of hair. Draw each.
2) Identify and label the following structures of the hairs if they are present:

   cuticle

   scales

   cortex

medulla

3) Compare these hairs with those of the human, cow, and hog.

Identities of all hairs should be made at 400X to 430X.

*Ref. 11, 29, 31.*

### 7.12. Hog Hairs

1) Clear hairs from the body as directed in Ref. 29 or as directed by instructor. Make a slide. Draw.
2) Identify and label the structures of the hair.
3) Compare these hairs with those of the human, cow, and horse.

Identities of all hairs should be made at 400X to 430X.

*Ref. 11, page 203.*

## 8. Animal Excreta

### 8.1. Rat or Mouse Excreta Pellets

1. Rat or mouse excreta pellets are irregularly cylindrical in cross section and are usually rounded on one end and tapered to a point on the other end.
2. These pellets have a mucous coating which turns to a slimy covering when the pellet is wet with water.
3. Rats and mice groom themselves with their mouths; consequently, they swallow their own hair. These hairs go through the digestive tract and appear in the feces as identifiable rat or mouse hairs.
4. An embedded hair may be identified as a rat or mouse hair at low power (30X) if an internode is present.
5. If hairs with internodes cannot be found in the pellet, then hairs should be cleared, mounted on slides and identified as rat or mouse hairs at 400X to 430X.
6. An excreta pellet must have the right size and shape, a mucous coating and an embedded rat or mouse hair to be called a rat or mouse excreta pellet.

7. If no hairs are found in an excreta pellet, that excreta pellet must be recorded as an unidentified animal excreta pellet, regardless of size, shape, and/or mucous coating.
8. It is generally recognized that rat or mouse excreta pellets 10 mm long or more are probably rat excreta pellets and those under 10 mm in length are probably mouse excreta pellets. However, this does not mean an analyst should identify these pellets by their length. All these excreta pellets should be identified "rat or mouse" excreta pellets, with their length recorded. Analysts should state facts only.

1) Describe the general shape of these excreta pellets. Draw. Record the length in mm.
2) Add a few drops of water to the excreta pellet and observe the mucous coating which forms.
3) Tear the excreta pellet apart. Describe the composition of the excreta pellet. Locate embedded hairs and identify them.

*Ref. 11.*

### 8.2. Rabbit Excreta Pellets

1) Describe the general shape of these excreta pellets. Draw. Record the length in mm.
2) Add a few drops of water to the excreta pellet. Does a mucous coating form?
3) Tear the excreta pellet apart. Describe the composition of the pellet. Locate embedded hairs and identify them. Compare embedded hairs with authentic rabbit hairs. Embedded hairs must be identified at 400X to 430X. Select guard hairs, if possible, as they are much easier to identify than fur hairs.

*Ref. 11.*

### 8.3. Squirrel Excreta Pellets

1) Describe the general shape of these excreta pellets. Draw. Record the length in mm. Compare these excreta pellets with those of rat or mouse.

2) Add a few drops of water to the excreta pellet. Does a mucous coating form?

3) Tear the excreta pellet apart. Describe the composition of the pellet. Locate embedded hairs and identify them. Compare embedded hairs with authentic squirrel hairs. Embedded hairs must be identified at 400X to 430X. Select guard hairs, if possible, as they are much easier to identify than fur hairs.

### 8.4. Bat Excreta Pellets

1) Describe the general shape of these excreta pellets. Draw. Record the length in mm. Compare these excreta pellets with those of rat or mouse.

2) Add a few drops of water to the excreta pellet. Does a mucous coating form?

3) Tear the excreta pellet apart. Describe the composition of the pellet. Note that most bats feed on nocturnal insects. Locate embedded hairs and identify them. Compare embedded hairs with authentic bat hairs. Embedded hairs must be identified at 400X to 430X.

*Ref. 11.*

### 8.5. Frog or Toad Excreta Pellets

1) Describe the general shape of these excreta pellets. Draw. Record the length in mm. Compare these excreta pellets with those of rat or mouse.

2) Add a few drops of water to the excreta pellet. Does a mucous coating form? Describe what does happen.

3) Tear the excreta pellet apart. Describe the composition of the excreta pellet. Upon what do frogs and toads feed?

### 8.6. American Cockroach Adult Excreta Pellets

1) Describe the general shape of these excreta pellets. Draw the excreta pellet. Also draw this excreta pellet in cross section. Record the length in mm.

2) Add a few drops of water to the excreta pellet. Does a mucous coating form? Describe what does happen.

3) Tear the excreta pellet apart. Describe the composition of the excreta pellet. Locate any embedded hairs and identify them.

Note that rat or mouse hairs are sometimes found in cockroach excreta. Cockroaches are omnivorous, even feeding on such things as rat or mouse excreta pellets or dried carcasses of rodents, thus ingesting these hairs.

### 8.7. American Cockroach Nymph Excreta Pellets

1) Describe the general shape of these excreta pellets. Draw the excreta pellet. Also draw this excreta pellet in cross section. Record the length in mm.
2) Add a few drops of water to the excreta pellet. Does a mucous coating form? Describe what does happen.
3) Tear the excreta pellet apart. Describe the composition of the excreta pellet. Locate any embedded hairs and identify them.

Note that rat or mouse hairs are sometimes found in cockroach excreta. Cockroaches are omnivorous, even feeding on such things as rat or mouse excreta pellets or dried carcasses of rodents, thus ingesting these hairs.

### 8.8. German Cockroach Adult Excreta Pellets

1) Describe the general shape of these excreta pellets. Draw the excreta pellet. Also draw this excreta pellet in cross section. Record the length in mm.
2) Add a few drops of water to the excreta pellet. Does a mucous coating form? Describe what does happen.
3) Tear the excreta pellet apart. Describe the composition of the excreta pellet. Locate any embedded hairs and identify them.

Note that rat or mouse hairs are sometimes found in cockroach excreta. Cockroaches are omnivorous, even feeding on such things as rat or mouse excreta pellets or dried carcasses of rodents, thus ingesting these hairs.

### 8.9. German Cockroach Nymph Excreta Pellets

1) Describe the general shape of these excreta pellets. Draw the excreta pellet. Also draw this excreta pellet in cross section. Record the length in mm.
2) Add a few drops of water to the excreta pellet. Does a mucous coating form? Describe what does happen.
3) Tear the excreta pellet apart. Describe the composition of the excreta pellet. Locate any embedded hairs and identify them.

Note that rat or mouse hairs are sometimes found in cockroach excreta. Cockroaches are omnivorous, even feeding on such things as rat or mouse excreta pellets or dried carcasses of rodents, thus ingesting these hairs.

### 8.10. Moth Larvae Excreta Pellets

1) Describe the general shape of these excreta pellets. Draw.
2) Add a drop of water to several of these excreta pellets. Does a mucous coating form?

*Ref. 11.*

### 8.11. Beetle Adult and Larval Excreta Pellets

1) Describe the general shape of the excreta pellets from beetle adults and larvae which infest food products. Illustrate with drawings.
2) Add a drop of water to several of these excreta pellets. Does a mucous coating form?

*Ref. 11.*

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