REARING MANUAL FOR STORED-PRODUCT INSECTS

USED BY USDA STORED-PRODUCT INSECTS RESEARCH AND DEVELOPMENT LABORATORY, SAVANNAH, GA

Revised May 1969

PREFACE

Over 30 species of insects are reared for experimental work at the USDA Stored-Product Insects Research and Development Laboratory, Savannah, Georgia. Although most of the insects are used on this station, requests are frequently received from other research agencies and individuals for cultures of these insects. Many of the requests are also for instructions for rearing the insects in the laboratory. For the benefit of those who want to rear their own insects, the attached manual was compiled to describe the basic steps used in this laboratory for rearing the different species.

Since this manual is intended for use only as a guide for rearing, detailed information on the biology of the insects is omitted. Recognition of the various life stages and knowledge of the biology of the insects should be, therefore, the responsibilities of individuals trained in entomology.

While preparing this manual we recognized that present methods and techniques are constantly being improved and modified. Although drastic changes are not anticipated in many of these methods, revisions of these practices will be made periodically.

Alice Miller, Research Technician
Renie Philips, Research Technician
L. D. Cline, Research Entomologist
Stored-Product Insects Research and
Development Laboratory
Savannah, Georgia
May 20, 1969

TABLE OF CONTENTS

GENERAL REARING PRACTICES

Cultures are kept as standardized as possible on a year-round basis.

MEDIA

All media fed to insects should be free from pathogens and contaminants. Media ingredients that are infested when they are received should be stored at freezing temperatures for at least 48 hr. to kill insects and mites that are present. Ingredients that are not infested may be kept uninfested by refrigerating at 5°C.

All species are fed their respective media continuously.

CONTAINERS

All cultures are reared in quart jars or wide-mouth gallon jars that are capped with lids in which No. 1 filter paper discs are substituted for the metal part that normally covers the mouth of the jars. This provides adequate ventilation for the cultures. All beetles (Coleoptera) are reared in quart jars except stock cultures of Anthrenus flavipes, which are reared in gallon jars. Most moths (Lepidoptera) are reared in gallon jars. Tineola bisselliella and Sitotroga cerealella, however, are reared in quart jars.

The amount of medium used depends on the species being reared, but generally quart jars are half full and gallon jars are nearly one-fifth full of medium.

Containers should be arranged on shelves so that no jars are touching to reduce transfer between cultures of mites and insect escapees. If mites and escapees are very abundant, it is advisable to coat tops of shelves with mineral oil or petroleum jelly. Clean and recoat shelves when a layer of dust and trapped insects accumulates.

REARING ROOMS

All cultures are maintained at a constant temperature and relative humidity of 27 ± 1°C. and 60 ± 5%, respectively. All cultures are exposed to alternating 12-hr. light periods and 12-hr. dark periods except T. bisselliella, which thrives better in continuous dark.

Shelves constructed of wire are best for allowing adequate illumination and air circulation. In many rearing rooms the air will tend to stratify; thus, it may be advisable to check temperature and relative humidity at various sites in the rearing room to be certain specified conditions are being met. Illumination on the darkest shelf should not be less than 30 to 40 lux.

INSECTS

When setting up new cultures, insects should be chosen from cultures that are as close to the required age as possible. (Make every effort to use insects that are free of debris and to insure that insects used are only the desired species). Cleaning laboratory apparatus soon after working with each species will help to reduce mixed cultures and to minimize the spread of pathogens.

Cultures should be set up according to a strict schedule (i.e., daily, weekly, or biweekly) to provide an abundant number of insects at all times. Only one generation should be permitted to develop in each culture and if these are not used for research or regenerating the species, they should be destroyed.

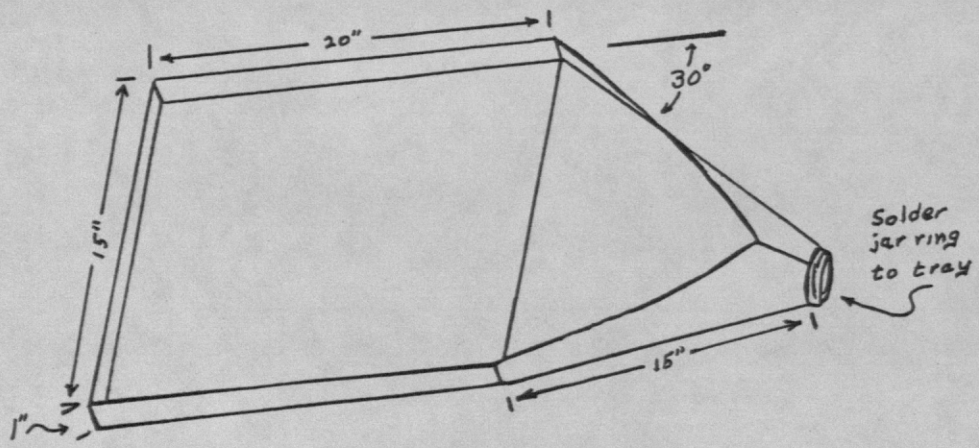
SOME EQUIPMENT USED IN REARING INSECTS

SIEVES

U.S. Standard sieves (8-in. diameter and 2-in. deep) are used. A good series to have is Nos. 10, 14, 16, 20, 30, and 40.

COLLECTING TRAYS

Custom-designed trays (see sketch) are useful for sifting onto and collecting material to be placed back in containers, as a surface to allow adults to crawl away from debris, etc.

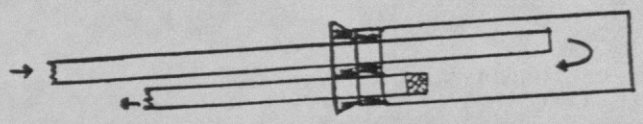


VOLUMETRIC SCOOPS

Scoops are easily made by cutting a 2-cc. plastic graduated vial (Fisher catalog #2-544-10) at the level desired and attaching a short handle. Convenient sizes are 0.5, 1.0, 1.5, and 2.0 cc.

ASPIRATOR

There are many kinds of aspirators and a simple example is shown in the sketch.



AUTOCLAVE

Any laboratory autoclave is suitable. If an autoclave is not available, a pressure cooker can be used satisfactorily.

BLENDER

If large quantities of medium are to be prepared, it may be desirable to purchase an industrial food blender to expedite the work.

Alphitobius diaperinus (Panzer) - Lesser Mealworm
(Coleoptera: Tenebrionidae)

I. MEDIUM

	Parts by vol.
White flour	10
White cornmeal	10
Yeast (brewer's or torula)	1.5
Irish potato (small slice)	

A. Blend cornmeal and flour together and autoclave mixture at 120° C. for 20 min. at 15 lb. pressure. Cool to temperature that will permit hand mixing.

B. Add yeast and mix thoroughly; be sure to break the clumps formed as a result of autoclaving.

C. Medium may be made in advance and stored until needed. Allow medium to cool to room temperature before refrigerating at 5° C.

D. Each culture will require 1 pt. or about 260 g. of medium.

II. REARING PROCEDURE

A. Place medium (1 pt. or 260 g.) in each of an appropriate number of quart jars and place a small slide of potato on the surface of medium in each jar.

B. Remove adults from several maturing cultures with a U.S. Standard No. 16 or 20 sieve and consolidate them to minimize inbreeding.

C. Place 20 to 25 adults into each jar and place jar in the rearing room. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. Adults need not be removed since they will usually die before their progeny mature.

E. Add extra slides of potato weekly or as the old slices dry up.

F. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

G. Sometimes mite infestations may be eliminated by sifting insects through coarse cornmeal several times.

III. REARING CONDITIONS

At 27 ± 1° C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 6 wk.

Anthrenus flavipes LeConte - Furniture Carpet Beetle
(Coleoptera: Dermestidae)

I. MEDIUM

Woolen fabric - Moth test cloth 1/
Yeast (brewer's or torula)

A. Wash wool in lukewarm water with mild soap, rinse thoroughly, dry, and store in tightly closed container in refrigerator.

B. Each culture will require about 500 sq. cm. of wool.

II. REARING PROCEDURE

A. Egg production

1. Put four 5-cm. square patches of wool sprinkled generously with yeast into each pint jar.

2. Remove adults of various ages from several stock cultures (II C) and consolidate them to minimize inbreeding.

3. Place 200 adults into each jar. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for culture.

4. Remove patches at weekly intervals and replace with clean ones.

5. Examine adults when changing patches and replace dead ones with live adults from stock cultures.

B. Larval rearing

1. Place four patches from II A on a 10-cm. by 40-cm. woolen patch sprinkled generously with yeast. Form large patch into a roll but avoid damaging eggs on small patches.

2. Place one roll into each of an appropriate number of quart jars and cap with filter paper lids.

1/ Test Fabrics, Inc., New York, N.Y.

C. Stock cultures

1. Start new cultures at monthly intervals by consolidating contents from several maturing cultures from II B into a wide-mouth gallon jar.

2. Add small strips of wool sprinkled with yeast at weekly intervals or as needed.

3. Lids are made by cutting an 8-cm. hole in the metal cap and lining with No. 1 filter paper discs (12.5-cm. diameter) to provide adequate ventilation.

4. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

III. REARING CONDITIONS

At 27 ± 1° C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 3 to 4 mo.

Attagenus megatoma (Fabricius) - Black Carpet Beetle
(Coleoptera: Dermestidae)

I. MEDIUM

	Parts by vol.
Purina Laboratory Chow(R) meal (standard)	20
Yeast (brewer's or torula)	1.5

A. Remove and discard coarse particles by screening laboratory chow with a U.S. Standard No. 20 sieve, then autoclave medium at 120° C. for 20 min. at 15 lb. pressure. Cool to temperature that will permit hand mixing.

B. Add yeast and mix thoroughly; be sure to break the clumps formed as a result of autoclaving.

C. Medium may be made in advance and stored until needed. Allow medium to cool to room temperature before refrigerating at 5° C.

D. Each culture will require 1 pt. or about 250 g. of medium.

II. REARING PROCEDURE

A. Place medium (1 pt. or 250 g.) in each of an appropriate number of quart jars.

B. Remove young adults from several cultures which are 9- to 12-mo. old with a U.S. Standard No. 16 sieve. Consolidate them to minimize inbreeding. Separate adults from debris by allowing them to crawl away from it.

C. Place 50 to 75 adults into each jar. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. Adults need not be removed since they will die before their progeny mature.

E. Remove larvae from old medium and place on new medium at intervals of 3, 6, and 9 mo. Larvae can be separated from medium with a No. 16 or 18 sieve.

F. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

G. Sometimes mite infestations may be eliminated by sifting insects through coarse laboratory chow several times.

III. REARING CONDITIONS

At 27 - 1°C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 8 to 12 mo. Each jar should yield about 1,000 to 2,000 adults.

Callosobruchus maculatus (Fabricius) - Cowpea Weevil
(Coleoptera: Bruchidae)

I. MEDIUM

Black-eyed peas (dried)

A. Refrigerate peas (5° C.) until needed to prevent infestation with insects, mites, etc.

B. Each culture will require 1 pt. or about 325 g. of medium.

II. REARING PROCEDURE

A. Place peas (1 pt. or 325 g.) in each of an appropriate number of quart jars.

B. Select adults from several maturing cultures and consolidate them to minimize inbreeding. Remove adults by aspirating them as they climb the sides of the jars.

C. Place 50 adults into each jar. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. Adults need not removed since they will usually die before their progeny mature.

E. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

III. REARING CONDITIONS

At 27 $\pm$ 1° C., 60 $\pm$ 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 4 wk.

Cryptolestes pusillus (Schönherr) - Flat Grain Beetle
(Coleoptera: Cucujidae)

I. MEDIUM

	Parts by vol.
Soft red winter wheat (cracked kernels)	14
Rolled oats, Quaker(R) old fashioned	14
Yeast (brewer's or torula)	1.5

A. Use only wheat that is free of toxic residues and store in freezer for at least 48 hr. to kill insects and mites that might be present.

B. Allow wheat to reach room temperature before using as medium.

C. Moisture content of wheat should be adjusted to about 12% before using.

D. Grind all ingredients together until they will pass through a U. S. Standard No. 8 sieve. (A model 4-E Quaker City mill is used at the Savannah laboratory).

E. Each culture will require 1 pt. or about 240 g. of medium.

II. REARING PROCEDURE

A. Place medium (1 pt. or 240 g.) in each of an appropriate number of quart jars.

B. Select adults that are 2- to 3-wk. old or adults from cultures 5- to 7-wk. old. Remove adults from several cultures by sifting them through a U. S. Standard No. 20 sieve and catching them on a No. 40 sieve. Separate adults from debris by letting them crawl away from it. Consolidate adults to minimize inbreeding.

C. Place 1,200 adults (approximately 0.5 cc.) into each jar and place jars in the rearing room. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. Although adults may still be alive when progeny mature, they are left in medium because of the difficulty in removing all of them.

E. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

III. REARING CONDITIONS

At 27 ± 1° C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 3 to 4 wk.

Dermestes maculatus De Geer - Hide Beetle
(Coleoptera: Dermestidae)

I. MEDIUM

Gainesburger(R) dog food

A. Use medium directly from package.

B. Refrigerate medium (5° C.) until needed to prevent infestation with insects, mites, etc.

C. Each culture will require 1.5 burgers.

II. REARING PROCEDURE

A. Place 1.5 burgers in each of an appropriate number of quart jars.

B. Remove adults of various ages from several maturing cultures and consolidate them to minimize inbreeding. Adults can be picked from medium or allowed to crawl away from it.

C. Place 20 to 25 adults into each jar and place jars in the rearing room. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. After 1 wk., remove adults from the medium and discard them.

E. Extra medium may be required if yield is very heavy or it may be desirable to divide a heavily populated culture into two separate cultures.

F. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

G. Sometimes mite infestation may be eliminated by sifting insects through coarse cornmeal several times.

III. REARING CONDITIONS

At 27 $\pm$ 1° C., 60 $\pm$ 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 5 to 6 wk.

Lasioderma serricorne (Fabricius) - Cigarette Beetle
(Coleoptera: Anobiidae)

I. MEDIUM

	Parts by vol.
White flour	10
White cornmeal	10
Yeast (brewer's or torula)	1.5

A. Blend cornmeal and flour together, then autoclave mixture at 120° C. for 20 min. at 15 lb. pressure. Cool to temperature that will permit hand mixing.

B. Add yeast and mix thoroughly; be sure to break the clumps formed as a result of autoclaving.

C. This medium may be made in advance and stored until needed. Allow medium to cool to room temperature before refrigerating at 5° C.

D. Each culture will require 1.5 pt. or about 390 g. of medium.

II. REARING PROCEDURE

A. Place medium (1.5 pt. or 390 g.) in each of an appropriate number of quart jars and pack firmly by tamping with a large porcelain pestle (Coors: series 522-8) or similar blunt instrument.

B. Select adults which are 1- to 2-wk. old or adults from cultures 6- to 7-wk. old. Remove adults by tapping those clinging to the lids into a clean jar. Consolidate adults from several cultures to minimize inbreeding.

C. Place 300 adults (approximately 1.0 cc.) into each jar and leave for 3 days in the rearing room. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. On the third day remove adults from medium by discarding the ones clinging to the lids and scooping the ones on top of the medium out with a teaspoon and discarding them. Return jar containing medium with eggs to the rearing room.

E. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

F. Sometimes mite infestations may be eliminated by sifting insects through coarse cornmeal several times.

III. REARING CONDITIONS

At 27 ± 1°C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 6 wk. Each jar should yield about 10,000 to 12,000 adults.

Oryzaephilus mercator (Fauvel) - Merchant Grain Beetle
Oryzaephilus surinamensis (Linnaeus) - Saw-toothed Grain Beetle
(Coleoptera: Cucujidae)

I. MEDIUM

Rolled oats, Quaker(R) old fashioned
Yeast (brewer's or torula)

A. Use oats directly from box.

B. Mix yeast and oats thoroughly.

II. REARING PROCEDURE

A. Place rolled oats (0.5 pt. or 90 g.) and yeast (1 tsp. or 5 g.) in each of an appropriate number of quart jars.

B. Select adults 1- to 3-wk. old or adults from cultures 4- to 6-wk. old. Collect adults by allowing them to crawl away from the medium and then by brushing them into a collecting tray. Consolidate adults from several cultures to minimize inbreeding.

C. O. surinamensis will require 750 adults (approximately 1.0 cc.) in each jar and O. mercator will require 850 adults (approximately 1.5 cc.). Leave jars for 3 days in the rearing room. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. On the third day remove eggs and yeast by sifting through a U. S. Standard No. 30 or 40 sieve. Place eggs and yeast in a quart jar half full of fresh rolled oats (1 pt. or 180 g.) and yeast (1 tsp. or 5 g.) and return cultures to the rearing room.

E. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

III REARING CONDITIONS

At 27 ± 1°C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 3 to 5 wk. Each jar should yield 2,000 to 5,000 adults.

Rhyzopertha dominica (Fabricius) - Lesser Grain Borer
(Coleoptera: Bostrichidae)

I. MEDIUM

Soft red winter wheat (whole kernels)
Yeast (brewer's or torula)

A. Use only wheat that is free of toxic residues and store in freezer for at least 48 hr. to kill insects and mites that might be present.

B. Allow wheat to reach room temperature before using as medium.

C. Moisture content of wheat should be adjusted to about 12% before using.

II. REARING PROCEDURE

A. Place wheat (1 pt. or 380 g.) and yeast (1 tsp. or 5 g). in each of an appropriate number of quart jars.

B. Select adults 1- to 3-wk. old or adults from cultures 7- to 9-wk. old. Remove adults from several cultures by sifting through a U. S. Standard No. 14 sieve and catching them on a No. 30 or 40 sieve. Consolidate adults to minimize inbreeding.

C. Place 600 adults (approximately 1.5 cc.) into each jar and leave for 3 days in the rearing room. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. On the third day remove adults as in II B and discard them. Return medium to jars and return jars to the rearing room.

E. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

F. Sometimes mite infestations may be eliminated by sifting insects through coarse cornmeal several times.

III. REARING CONDITIONS

At 27 $\pm$ 1°C., 60 $\pm$ 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 7 to 9 wk. Each jar should yield 1,000 to 1,500 adults.

Sitophilus granarius (Linnaeus) - Granary Weevil
Sitophilus oryzae (Linnaeus) - Rice Weevil
Sitophilus zea-mais Motschulsky

I. MEDIUM

Soft red winter wheat (whole kernels) 1/
Yeast (brewer's or torula)

A. Use only wheat that is free of toxic residues and store in freezer for at least 48 hr. to kill insects and mites that might be present.

B. Allow wheat to reach room temperature before using medium.

C. Moisture content of wheat should be adjusted to about 12% before using.

II. REARING PROCEDURE

A. Place medium (1 pt. or 380 g.) and yeast (1 tsp. or 5 g.) in each of an appropriate number of quart jars.

B. Select adults 1- to 3-wk. old or adults from cultures 5- to 7-wk. old. Remove adults from several cultures by sifting through a U. S. Standard No. 10 or 12 sieve. Separate adults from debris by letting them crawl away from it. Consolidate adults to minimize inbreeding.

C. Place 300 adults into each jar and leave for 3 days in the rearing room. Approximately 300 adults can be measured by volume. S. granarius and S. zea-mais adults will occupy about 1.5 cc. and S. oryzae will occupy about 1.0 cc. Substitute No. 1 filter paper discs (7-cm. diameter) and 40-mesh screen wire discs for the metal jar lids in the screw cap to provide adequate ventilation for cultures and to prevent escape by adults.

D. On the third day remove adults as in from medium with a No. 10 or 12 sieve. Discard adults and trash. Return medium with eggs to jars and return jars to the rearing room.

E. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

1/ Use 0.5 pt. or 190 g. wheat and 0.5 pt. or 190 g. corn for S. zea-mais.

F. Sometimes mite infestations may be eliminated by sifting insects through coarse cornmeal several times.

III. REARING CONDITIONS

At 27 ± 1°C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 4 to 5 wk.

Tenebroides mauritanicus (Linnaeus) - Cadelle
(Coleoptera: Ostomatidae)

I. MEDIUM

A. Adult Medium

Rolled oats, Quaker(R) old fashioned
Yeast (brewer's or torula)
Agar
Water

1. Mix oats (50 g.) and yeast (5 g.) thoroughly.
2. Dissolve agar (2 g.) in boiling water (15 cc.) and add to mixture.
3. Mix thoroughly by crumbling medium between the fingers until no clumps remain and medium appears dried out.
4. Each dish used for egg collection will require 3 g. of medium.

B. Larval Medium

	Parts by vol.
Whole wheat flour	20
Yeast (brewer's or torula)	1.5

1. Autoclave whole wheat flour at 120°C. for 30 min. at 15 lb. of pressure. Allow flour to cool to temperature that will permit hand mixing.
2. Add yeast and mix thoroughly.
3. Medium can be made in advance and stored until needed. Allow medium to reach room temperature before refrigerating at 5°C.
4. Each culture will require 1 pt. or 230 g. of medium.

II. REARING PROCEDURE

A. Egg Production

1. Place 3 g of medium for I A and one oviposition block in each of an appropriate number of petri dishes. An oviposition block is made by inserting a small piece of paper that is approximately the thickness of a file card (0.25 to 0.30 mm.) between two small squares (2-to 3-cm. square) of rigid plastic or glass and holding them together with an elastic band.

2. Select adults from several maturing cultures (II C) and consolidate them to minimize inbreeding

3. Place three males and three females into each petri dish. Change adult medium twice a week to provide a continuous supply of high moisture content diet.

4. Remove the oviposition block with eggs every 3 days and replace with a clean one. Replace dead adults with live ones.

5. Set up new dishes of adults at monthly intervals or when egg production declines.

B. Larval Rearing

1. Place 1 pt. or 230 g. of medium from I B in each of an appropriate number of quart jars.

2. Place approximately 100 eggs (usually 3 or 4 oviposition blocks) into each jar and leave for 10 wk. in the rearing room. Separate the two halves of the oviposition block and add either the block with eggs attached or add just eggs by removing them with a sharp blade. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

C. Pupal Rearing

1. Place 1 pt. or 230 g. or medium from I B and two pupation chambers in each of an appropriate number of quart jars. A pupation chamber is made by cutting a 3-cm. by 700-cm. strip of corrugated paper 1/ and forming it into a roll. Small blocks of builder's cork are also suitable as pupation chambers.

2. Remove larvae from 10-wk.-old cultures by sifting cultures with a U. S. Standard No. 16 sieve.

3. Place 50 larvae into each jar and place jar in the rearing room for 7 wk.

1/ Corobuff(R), Bemiss Jason Corp., Long Island, N. Y.

4. Adults can be obtained after 7 wk. by braking open the pupation chamber.

D. Examine all stages regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

III. REARING CONDITIONS

At 27 ± 1°C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 4 to 5 mo.

Tribolium castaneum (Herbst) - Red Flour Beetle
Tribolium confusum Jacquelin duVal - Confused Flour Beetle
(Coleoptera: Tenebrionidae)

I. MEDIUM

	Parts by vol.
White flour	10
White cornmeal	10
Yeast (brewer's or torula)	1.5

A. Blend cornmeal and flour together and autoclave mixture at 120°C. for 20 min. at 15 lb. of pressure. Cool to temperature that will permit hand mixing.

B. Add yeast and mix thoroughly; be sure to break the clumps formed as a result of autoclaving.

C. This medium may be made in advance and stored until needed. Allow medium to cool to room temperature before refrigerating at 5°C.

D. Each culture will require 1 pt. or about 260 g. of medium.

II. REARING PROCEDURE

A. Place medium (1 pt. or 260 g.) in each of an appropriate number of quart jars.

B. Select adults 1- to 3-wk. old or adults from cultures 7- to 9-wk. old. Remove adults from several cultures by sifting through a U. S. Standard No. 20 sieve and consolidate them to minimize inbreeding.

C. Place 300 adults (approximately 2.0 cc.) into each jar. Leave T. castaneum 2 days in the rearing room. Leave T. confusum 3 days in the rearing room. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. On the second or third day, depending on the species being reared, remove adults from medium with a No. 20 sieve. Discard adults. Return medium with eggs to jars and return jars to the rearing room.

E. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

F. Sometimes mite infestations may be eliminated by sifting insects through coarse cornmeal several times.

III. REARING CONDITIONS

At 27 ± 1°C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation of *T. confusum* is about 6 to 7 wk. and 5 to 6 wk. for *T. castaneum*. Each jar of *T. confusum* should yield about 1,000 to 1,5000 adults. Each jar of *T. castaneum* should yield about 2,000 to 3,000 adults.

Trogoderma glabrum (Herbst)
Trogoderma inclusum LeConte
(Coleoptera: Dermestidae)

I. MEDIUM

	Parts by vol.
Purina Laboratory Chow(R) meal (standard)	13
Wheat germ	6
Instant nonfat dry milk	6
Meat and bone scrap (powdered)	2
Yeast (brewer's or torula)	1

A. All ingredients should be ground to pass through a U. S. Standard No. 20 sieve.

B. Medium may be made in advance and stored in two ways:

1. Thoroughly mix ingredients, place in closed container, and refrigerate at 5°C. Autoclave medium in jars and cool to room temperature before using.

2. Thoroughly mix ingredients, place medium (0.5 pt. or 150 g.) in each of an appropriate number of quart jars, cap jars with filter paper lids, autoclave medium in jars at 120°C. for 8 to 10 min. at 15 lb. of pressure, shake jars to loosen medium after removing jars from autoclave, cool to room temperature, and refrigerate at 5°C until needed. Warm jars to room temperature before using.

II. REARING PROCEDURE

A. Obtain an appropriate number of autoclaved jars with medium from 1 B.

B. Select young adults (about 1-wk. old) from several maturing cultures and consolidate them to minimize inbreeding. Remove adults by placing a small piece of crumpled paper in the jar and aspirating the adults as they climb from the medium.

C. Place 100 to 150 adults into each jar and place jars in the rearing room. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. Adults need not be removed since they will usually die before their progeny mature.

E. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

F. Sometimes mite infestations may be eliminated by sifting insects through coarse cornmeal several times.

III. REARING CONDITIONS

At 27 ± 1°C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 7 to 8 wk.

Trogoderma parabile Beal
(Coleoptera: Dermestidae)

I. MEDIUM

	Parts by vol.
Purina Laboratory chow(R) meal (standard)	20
Yeast (brewer's or torula)	1.5

A. Remove and discard coarse particles by screening laboratory chow with U. S. Standard No. 20 sieve, then autoclave medium at 120°C. for 20 min. and 15 lb. of pressure. Cool to temperature that will permit hand mixing.

B. Add yeast and mix thoroughly; be sure to break the clumps formed as a result of autoclaving.

C. Medium may be made in advance and stored until needed. Allow medium to cool to room temperature before refrigerating at 5°C.

II. REARING PROCEDURE

A. Place medium (1 pt. or 240 g.) in each of an appropriate number of quart jars.

B. Select young adults (about 1-wk. old) from several maturing cultures and consolidate them to minimize inbreeding. Remove adults by placing a small piece of crumpled paper in the jar and aspirating the adults as they climb from the medium.

C. Place 100 to 150 adults into each jar and place jars in the rearing room. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. Adults need not be removed since they will usually die before their progeny mature.

E. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

F. Sometimes mite infestations may be eliminated by sifting insects through coarse cornmeal several times.

III. REARING CONDITIONS

At 27 ± 1°C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 7 to 8 wk.

Anagasta kuehniella (Zeller) - Mediterranean Flour Moth
Cadra cautella (Walker) - Almond Moth
Cadra figulilella (Gregson) - Raisin Moth
Ephestia elutella (Hübner) - Tobacco Moth
Plodia interpunctella (Hübner) - Indianmeal Moth
(Lepidoptera: Phycitidae)

I. MEDIUM

	Parts by vol.
White cornmeal	4.0
Whole wheat flour	4.0
Gaines(R) dog food (granular or pellets)	2.0
Yeast (brewer's or torula)	1.0
Honey	1.0
Glycerine (96%, white, chemically pure)	1.0
Rolled oats, Quaker(R) old fashioned	1.0
Wheat germ	0.5

A. If units used are pints, this recipe will make enough medium for about 10 cultures.

B. Refrigerate ingredients (5° C.) until needed to prevent infestation with insects, mites, etc.

C. Grind required amounts of rolled oats and dog food together until they will pass through a U. S. Standard No. 8 sieve. (A model 4-E Quaker City mill is used at the Savannah laboratory.)

D. Mix fresh medium as needed. Place medium loosely in jars (do not pack but avoid any large air pockets) soon after formulation to avoid having to break the clumps that form when medium hardens.

II. REARING PROCEDURE

A. Place 1.5 pt. of medium in each of an appropriate number of wide-mouth gallon jars. C. figulilella requires about 40 g. of raisins sprinkled on top of the regular medium.

B. Cultures are frequently started by either of two methods. All species can be set up by the first method since very little parent material is needed. The second method is used at the Savannah Laboratory only for species that are reared in large numbers (i.e., P. interpunctella and C. cautella). The second method yields much more uniform cultures.

1. First Method: Select adults 1 to 3 days old. Adults will emerge from cultures 3- to 4-wk. old. Consolidate adults from several cultures to minimize inbreeding. Collect adults by gently aspirating them to prevent injury. Place 20 to 25 randomly selected adults (a 1:1 male:female ratio is desirable) in each jar and place them in the rearing room. Adults die in about a week so it is not necessary to remove them from the cultures.

2. Second Method: Remove all adults from four or five 3- to 4-wk.-old cultures and consolidate into a 1-gal. jar fitted with a pleated piece of chip board or construction paper to provide more resting surfaces for the adults. Invert the jar over a 40-mesh screen and collect the eggs which are laid. Place 25 mg. of eggs (approximately 1,000 eggs) in each of the new cultures. It is desirable to design a volumetric egg scoop that will deliver the required amount of eggs.

C. Lids are made by cutting an 8-cm. hole in the metal cap and lining with No. 1 filter paper discs (12-5-cm diameter) to provide adequate ventilation.

D. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

III. REARING CONDITIONS

At 27 ± 1°C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation of C. cautella or P. interpunctella is about 3 to 4 wk.; for C. figulilella or E. elutella about 5 to 6 wk. and A. kuehniella about 6 to 7 wk.

Yield from each jar and from various species will differ, but it is reasonable to expect between 70 and 100% adult progeny from a given number of eggs.

Sitotroga cerealella (Olivier) - Angoumois Grain Moth
(Lepidoptera: Gelechiidae)

I. MEDIUM

Soft red winter wheat (whole kernels)
Corn (whole kernels)

A. Use only grain that is free of toxic residues and store in freezer for at least 48 hr. to kill insects and mites that might be present.

B. Allow grain to reach room temperature before using as a medium.

C. Mix corn and wheat thoroughly.

II. REARING PROCEDURE

A. Place medium (0.5 pt. or 190 g. wheat and 0.5 pt. or 190 g. corn) in each of an appropriate number of quart jars.

B. Select adults 1 to 4 days old. Remove adults from cultures 5- to 7-wk. old by gently aspirating them to prevent injury. Consolidate adults to minimize inbreeding.

C. Place 20 to 25 adults in each new culture. A 1:1 male:female ratio is desirable. Place cultures in the rearing room. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

D. Adults die in about a week so it is not necessary to remove them from cultures.

E. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

III. REARING CONDITIONS

At 27 $\pm$ 1°C., 60 $\pm$ 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 5 to 7 wk. Each jar should yield about 300 to 600 adults.

Tineola bisselliella (Hummel) - Webbing Clothes Moth
(Lepidoptera: Tineidae)

I. MEDIUM

Woolen fabric - Moth test cloth 1/
Yeast (brewer's or torula)

A. Wash wool in lukewarm water with mild soap, rinse thoroughly, dry, and store in tightly closed container in refrigerator.

B. Each culture will require about 500 sq. cm. of wool.

II. REARING PROCEDURE

A. Egg production

1. Put four 5-cm. square patches of wool sprinkled generously with yeast into each pint jar.

2. Remove adults of various ages from several maturing cultures in II B by gently aspirating moths to prevent injury. Consolidate adults to minimize inbreeding.

3. Place 120 to 130 adults into each jar with patches and leave 3 days in the rearing room. Substitute No. 1 filter paper discs (7-cm. diameter) for the metal jar lids in the screw cap to provide adequate ventilation for cultures.

B. Larval rearing

1. Place four patches from II A on a 10-cm. by 40-cm. woolen patch sprinkled generously with yeast. Form large patch into a roll but avoid damaging eggs on small patches.

2. Place one roll into each of an appropriate number of quart jars and cap with filter paper lids.

3. Examine cultures regularly. Cultures that contain pathogens or contaminants such as mites, fungi, or other insect species should be destroyed and containers should be cleaned thoroughly.

1/ Test Fabrics, Inc., New York, N. Y.

III. REARING CONDITIONS

At 27 ± 1°C., 60 ± 5% R.H., and 12-hr. light-dark cycles, the normal time for a generation is about 5 to 6 wk.