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REPORT OF DIAGNOSES OF DISEASED INSECTS 1951-1961

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During the eleven-year period from January 1, 1951, through December 31, 1961, our diagnostic laboratory received a total of 1,257 accessions of diseased insects. (This is in addition to 575 accessions received prior to this time and already reported in a previous publication.) The diagnoses reported in the present paper are essentially brief statements as to the source of the diseased insect and the identity of the etiology involved. In order to provide a more detailed diagnosis, a new approach to diagnosis has been initiated which involves the use of more precise procedures, the use of more detailed forms for recording the results of the various examinations and tests, and a more efficient method of collating the data obtained. Accordingly, the report of past diagnostic findings is preceded by a section explaining the new methods of recording diagnostic data and of keeping diagnostic records.

The pathogens found in the submitted insects, and other invertebrates, are tabulated according to the type of pathogen concerned and according to the order and family of insect host. From the 1,257 accessions received during the period concerned, the microbial pathogens isolated, including repeats, totaled 148 viruses (97 nuclear polyhedrosis viruses, 46 granulosis viruses, 5 noninclusion viruses), 145 bacteria, 408 fungi, 112 protozoa (82 Microsporidia, 30 other types), and 34 nematodes. Entomophagous arthropods were found in 14 accessions. In 338 accessions no microbial pathogens were involved; in many of these cases noninfectious diseases were involved. New records of pathogens, insect hosts, and distribution are noted in the text.

All electron-microscope preparations shown in this paper were shadowed with palladium. All photographs were made in the course of routine diagnostic examination. No attempt was made to obtain electron micrographs of the quality desirable for morphological studies, for example. Most of the photographs were made in our laboratory by Ruth Leutenegger, Joyce P. Anderson, and Susan T. Marcus.

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REPORT OF DIAGNOSES OF DISEASED INSECTS 1951–1961¹

EDWARD A. STEINHAUS² and GORDON A. MARSH³

ALTHOUGH OUR LABORATORY has been receiving specimens of diseased insects and other invertebrates for diagnosis since 1944, we have published only one previous comprehensive report of diagnostic findings (Steinhaus, 1951). The latter report covered the period from August 1, 1944, through December 31, 1950, during which there were 575 accessions. The present report covers the eleven-year period from January 1, 1951, through December 31, 1961. A total of 1,257 accessions has been received from outside our department during this period, making a grand total of 1,832 accessions received since we began keeping such records. (The number of insect specimens in each accession varied from one to several hundred.)

The present report consists of a section explaining our methods of recording diagnostic data and keeping diagnostic records; a major section describing the diagnostic findings on the 1,257 accessions received, arranged according to host; a summary of these findings (Table 1, pp. 472–477); an index to host insects; and an index to microorganisms and other microbiota.

The diagnostic results reported have been accumulated during a period in which there has been considerable evolution in the methodology involved in making a diagnosis and in recording diagnostic data. Elsewhere (Steinhaus, 1963) an orientation to the principles involved in diagnostic work is presented, as well as an explanation of the terminology involved, and a detailed delineation of the steps in diagnosis—how to collect the facts necessary for diagnosis, and how to analyze the facts collected. We have also published (Steinhaus, 1955) a leaflet outlining the methods of submitting specimens for diagnosis. Heretofore, however, we have not explained our methods of keeping diagnostic records, and of reporting diagnoses. In order to supply this information we are presenting, in the following pages, a brief summary of the methods we employ as well as examples of some of the forms used in recording and keeping our diagnostic data.

Diagnosing insect diseases is similar in principle to diagnosing the diseases

¹ Contribution from the Department of Insect Pathology, College of Agriculture, University of California, Berkeley 4, California. Based partially on an investigation supported by a U. S. Public Health Service research grant, Grant No. 3211, from the National Institute of Allergy and Infectious Diseases, Public Health Service. Submitted for publication January 22, 1962.

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of other animals, but differs considerably in detail, methods, and practice. It is a science as well as an art. It demands the latest in techniques and systematized knowledge as well as experience and critical judgment. The near future will undoubtedly see electronic computers and other data-processing systems used as aids in the formulation of diagnoses. Even without these electronic aids, however, the diagnosis of insect diseases need not be the hit-or-miss proposition it so often is; much can be done to systematize and to give precision to diagnostic procedures.

Ideally, a diagnostic laboratory should have some kind of diagnostic index which systematically catalogues all information in the literature pertaining to etiology, symptomatology, pathogenesis, gross pathology, histopathology, physiopathology, and methodology as they relate to diagnosis. The index should list, and tie into the literature, every type and variety of symptom, sign, and pathology known to occur in insects. The diagnostician, in the course of examining submitted specimens or in the process of rendering a diagnosis, may, with the aid of such an index, at once determine whether a symptom, sign, or pathology with which he is concerned has been previously recorded and how much is known about it. The index may be constructed similarly to a card index in a library, or according to an electromechanical or an electronic data-processing system.

THE KEEPING OF DIAGNOSTIC RECORDS

It would be presumptuous for any diagnostician to assume that there is only one correct method of keeping diagnostic records, or that his method is the "best" method. (It is also presumptuous to assume that one person, or even a few individuals, can identify all the pathogens and diagnose all the diseases found in insects—but, as does a general practitioner of medicine, one can determine at least the general type of disease involved, and then consult a specialist to make the specific determination.) As with research notes, those pertaining to diagnoses will of necessity reflect the individuality and the personal inclinations of the person recording them. Accordingly, it is not our intention here to dictate *the* method of keeping diagnostic records, but rather, to suggest some of the requirements involved in such operations. In any case, this truth is evident: regardless of the manner of keeping diagnostic records, such records must be kept. As Beecher (1953) has commented:

Lacking as we do perfect memories, the fruits of the great sources of knowledge, recording (the notebook and pencil) takes rank as a principal aid to the advance of learning. . . . Unfortunately, clinical impression represents to the man of short memory the last two or three cases he has seen. To the man of longer memory, bias can still distort fact.

Accession Procedure. Immediately upon its receipt at the diagnostic laboratory, each lot of diseased or dead insects is assigned an accession number. This number identifies the material throughout all of its subsequent handling. If more than one species of diseased insect is received in the same shipment, each species is assigned a separate accession number. The sender is notified of this number when receipt of the material is acknowledged, and

it is cited when the diagnosis report is sent to him. In any additional correspondence relating to the specimens submitted, the accession number should be referred to by both the sender and the diagnostician.

Each accession, with its assigned number, is recorded in succession in a bound accession book. In making the entry in the accession book, we have found it convenient to record the following (using a hypothetical example):

Accession number	Date of receipt	Date of submitter's letter	Insect name	Diagnostician
1062	9-6-61	9-4-61	<i>Musca domestica</i> Linnaeus	JQD

After the entry is made in the accession book, a printed postal card is filled out acknowledging receipt of the specimens, and mailed to the submitter. The following is an example of what may be stated on the card:

The material you sent us for examination and diagnosis has just been received, and has been assigned Accession No. It will be appreciated if you will refer to this number in any future correspondence concerning the specimens submitted. We are proceeding with a pathological and microbiological examination of the material and will notify you promptly as soon as the results are obtained. In order to arrive at a satisfactory diagnosis it is frequently necessary to run time-consuming tests. Such tests may be required for the material you have submitted. In any case, you will receive a complete and prompt report when the tests are finished.

Although specimens of diseased insects are frequently brought in directly to the diagnostic laboratory by the individual desiring the diagnosis, most accessions are received by mail. When they are brought in by a person (the collector, an intermediary, or courier) an effort is made to obtain from him as much of the history of the disease as is possible. If it does not accompany the material received by mail, the same information is sought from the submitter. In addition to general aspects of the history, the general ecology and epizootiology, and the name and address of the person to whom the diagnostic report is to be made, the following information should be obtained:

1. Common *and* scientific name (including author) of the insect
2. Collector's accession or identification number, if any
3. Name and address of collector or submitter
4. Date and locality of collection
5. Name of host plant or animal, or nature of environment
6. Extent of the disease outbreak, and the conditions under which it occurred
7. Density of insect population (whether insect was present in low, moderate, or high numbers)
8. Abnormal behavior and appearance of the affected insects
9. Insecticide treatment, if any, or the possibility of exposure to insecticide treatment

All of this information,⁴ together with other aspects of the history of the disease, is recorded on a History Card.

Accession and History Card. The Accession and History Card may be a card or sheet of paper of any convenient size and character that will enable the diagnostician to make a permanent record of all pertinent information about the history of the disease. In our own laboratory, we have found it convenient to use an $8\frac{1}{2} \times 11$ -inch card upon which, as a guide, are printed the appropriate designations and blanks to be filled in with the available information. The form printed on the front of the card is designed to record the history of the disease, while that on the reverse side of the card is designed to record the diagnosis. Figure 2 represents an example of the form used to record the history. It may, of course, be altered to accommodate the needs or desires of the diagnostician. On the reverse side of this card the diagnosis is recorded (fig. 3). If necessary, the information may be condensed so that all of its essential elements are recorded on an appropriately printed 5×8 -inch card (fig. 1). The small 5×8 -inch card was used in recording most of the diagnoses reported in the present paper, but the larger card is now used and is recommended.

The Accession and History Card (and its reverse side, the Diagnosis Card) when properly filled in, constitutes the permanent record of the completed diagnosis. For this reason it is essential that the card be filled in as legibly and as completely as possible. During the period in which the diseased insects are being examined, and the diagnosis is being made, the card is held in a working file or holder. After the diagnosis has been completed, the card is filed permanently, according to number.

Physical Examination Card. The record of findings made during the physical examination of diseased insects may be kept on ordinary blank sheets of paper, and later filed along with the history and other records pertaining to the accession. We have found it useful, however, to record the results of the physical examination on one side of an $8\frac{1}{2} \times 11$ -inch card, and those of the laboratory examination on the other. The physical examination side (fig. 4) provides blanks for recording the abnormal movements and behavior, the general premortem and postmortem appearance, general condition and odor, and the signs and symptoms observed in the diseased insects both macroscopically and with the aid of a stereoscopic dissecting microscope. The signs and symptoms are recorded according to the anatomical systems and tissues of the insect. Each system is numbered; the symptoms pertaining to each system are correlated with it by means of this number. The examiner is expected to record his observations in his own words, using succinct and precise terminology.

Laboratory Examination Scan Card. As just indicated, on the reverse side of the Physical Examination Card is printed what we have called a "Scan Card" pertaining to the laboratory examination (fig. 5). Before a

⁴ In the case of our own laboratory, since 1955, we have found it helpful to send those who request it, or those who are likely to submit specimens, a specially prepared leaflet (Steinhaus, 1955) which gives instructions for packing, shipping, and submitting specimens, lists the type of information that should accompany the specimens, provides a statement of the quarantine regulations possibly involved, and indicates the nature of the report that is returned to the submitter. A similar publication (Aoki, Aizawa, and Koyama, 1960) has recently been made available in Japan by the Committee for the Study of Perennial Crops.

detailed laboratory examination of the diseased insect can be carried out, it is necessary to "scan" the situation to determine the exact laboratory studies required. Thus the Laboratory Examination Scan Card provides space to record the microscopic findings in each anatomical system, organ, or tissue that appears involved. If there is evidence that a microbial pathogen is present, a check mark is placed before those categories requiring further examination in order to identify the pathogen. Similar notations are made if the disease is one that results from noninfectious causes. The data gathered during this further examination are placed on a Special Data Sheet especially designed for each category. Thus the category may be, among others, Viruses, Bacteria, Fungi, Protozoa, Nematodes, or Insect Parasites; or it may pertain to the type of additional study required, such as Hematology, Histopathology, Biochemistry, Chemical Injuries, or Nutritional Disturbance.

Because microorganisms may be found that are not associated with the disease, or that may play a secondary role in it, space is provided on the scan card to recount the general microbiological picture. For example, commensal bacteria, mutualistic protozoa, and other types of extracellular and intracellular symbiotes may be observed and be of sufficient ancillary interest to warrant being recorded.

A statement should also be made on the scan card to indicate the methodology used to initiate the laboratory examination. Included here should be the method of external sterilization, the disinfectant and period of time, the type of preparation, stains, and other procedures used.

Special Data Sheets. Obviously no ordinary single form or card can be devised to cover all the types of laboratory studies one might find necessary to follow. We have found a minimum of nineteen categories of pathogens or types of laboratory procedures that require special consideration. These are:

Viruses	Nongenetic teratologies
Rickettsiae	Nutritional disturbances
Bacteria	Genetic anomalies
Yeasts	Mechanical injuries
Fungi	Physical injuries
Protozoa	Chemical injuries
Nematodes	Hematology
Insect parasites	Serology
Neoplasms	Histopathology
Deranged metabolism	Biochemistry

For each of these categories a Special Data Sheet may be devised. Examples of seven of those used in our own diagnostic work are presented (figs. 6 to 13). For some of the categories, for example, the Bacteria, it is convenient to provide blanks for most of the items of data to be recorded. For others, for example, Fungi and Nematodes, it may be more convenient simply to provide large blank areas where the examiner can record in his own words and in his own way the data pertaining to certain of the principal features. In general, the details of the forms are self-explanatory.

It is important to emphasize that all of the forms presented here must be used in concert. That is, they are designed to be used together, not individu-

ally, in making a diagnosis because to some extent the information on one form will complement that on another. For example, information concerning the insect involved—its stage, instar, and sex—is recorded on the Accession Card, and is not repeated on subsequent sheets. Together, the completed forms constitute the diagnostic record. Other workers might prefer a different arrangement and different balance of spacing and entries, but these forms have gone through a number of changes and alterations, and have evolved out of our particular experience. This is one of the reasons that some of the larger spaces are not broken down with detailed entries. The space may be used as the diagnostician wishes with respect to the broad heading which identifies it. Variations of these forms have been used in our laboratory since 1945; the latest modifications were made in 1960. Undoubtedly other modifications and evolutionary improvements in these forms, and in our method and style of keeping diagnostic records will be made.

THE REPORTING OF THE DIAGNOSIS

Generally speaking, just as a piece of scientific research is not completed, in the classical sense, until the results are properly published or made available to other scientists, so is a diagnosis not completed until it has been properly reported to the submitter or others concerned. Ordinarily, this is not an involved or difficult duty, but experience has shown that it must be performed with care, and in accordance with certain principles. These principles may be succinctly stated under the headings: form of report, promptness, supplemental information, advice or recommendations, rights to data, and follow-up.

Form of Report. In reporting a diagnosis to the collector, submitter, or other person concerned, either of two general methods may prove satisfactory. A standardized form may be filled in with the essential information, or the report may be written as a letter. In practice we have found the latter procedure to be the most satisfactory because not only can the report be couched in phraseology commensurate with the training, background, and understanding of the recipient, but additional background information can easily be appended to the factual data of the report. Moreover, requests for additional material or information can easily be included, as can recommendations that might pertain to controlling or promoting the disease in the insects concerned.

In the letter report, ideally the submitter should be told the exact nature of the disease found in the insect. If it is an infectious disease, the full scientific name of the microbial pathogen should be given. Sometimes it has not been necessary or possible to identify the pathogen as to species; sometimes the submitter desires to know only the general type of pathogen involved, that is, whether the cause of the disease is viral, bacterial, fungal, or protozoan; and sometimes the disease or the diagnosis is not important enough to warrant a prolonged and difficult identification of the pathogen. Such diagnoses may be reported simply as "a disease caused by a granulosis virus," "an Entomophthorales infection," or "an infection by an unidentified Micro-

sporidia." In any case, the reason for such abbreviated diagnoses should always be made clear to the correspondent.

From what we have just said, the reader should not conclude that such abbreviated diagnoses are desirable. Indeed, it is to be hoped that they remain few in number. Quite the contrary should be the goal: every diagnosis and every diagnostic report should be as complete and thorough as possible. The report should contain careful and exact terminology (e.g., "nuclear polyhedrosis" rather than "wilt disease," "polyhedral disease," or "virus disease"). Scientific names should be complete, including the full generic name and the author of the species name. The report should include the name of the insect as well as that of the pathogen; that is, one should not say, "We found the insects you sent us the other day to be infected with . . .," but rather, "We found the larvae of *Musca domestica* Linnaeus which you sent us under the date of January 10 [i.e., the date of the cover letter] to be infected with . . ." The report would, of course, refer to the accession number by which the particular lot of specimens has been identified throughout the diagnostic procedure.

The letter form of the report also permits the diagnostician to explain any difficulties involved in completing a diagnosis. As might be expected, the best of diagnosticians occasionally is unable to make a diagnosis. This fact should be reported and explained forthrightly. Sometimes negative findings can be as meaningful and valuable as positive findings. For example, to be assured that insects are not dying of a microbial disease can be significant to someone studying the role of insecticides in the control of an insect pest.

It is essential that the diagnostician make clear that his report relates to and concerns *only the specimens examined*. In other words, he should avoid saying that the insects in the field or in the submitter's laboratory (or whatever the source) have such and such disease. The diagnostician can speak only with respect to the diseased insects he has examined and studied; he should leave it to the person on the scene to correlate the diagnosis with the phenomena observed at the point where the insects were collected. Many things can happen between the time the insects are collected and the time they are examined in the diagnostic laboratory: new and secondary infections may set in and obliterate the primary pathogen, the specimens submitted may not represent a fair sample of the diseased population, or two pathogens may actually be at work in the population but their relative incidence may be altered after the sample has been taken or during shipment.

Promptness. Although some diagnoses involve extensive examinations and tests, and hence may require up to several weeks to be completed, nevertheless, the submitter should be extended the courtesy of receiving the diagnostic report promptly as soon as it has been completed. If no diagnosis can be made, or if only a preliminary or a tentative diagnosis is made, the report should be made accordingly and promptly. A prompt diagnostic report can be of as much value to the diagnostician as to the submitter. If the latter receives the report soon after submitting the specimens, he may be able to make further, more penetrating, observations of the disease in nature. If the diagnosis is tentative, the collector may be able to provide additional, more

appropriate specimens. Moreover, the prompt handling of diagnostic reports helps to establish a mutually beneficial rapport between the diagnostician and the collector or submitter.

Supplemental Information. After reporting the nature of the disease and describing its etiology, it is frequently wise for the diagnostician to provide his correspondent with pertinent background or supplemental information relating to the disease or abnormality concerned. This is especially desirable if the person to whom the report is going has little experience with or knowledge of insect diseases. A brief description of the disease as it is known from previous studies may be presented, the geographical and host range may be given, and pertinent references may be cited. Frequently, the submitter has asked specific questions which the pathologist may answer in light of the diagnosis.

Advice and Recommendations. After the insect pathologist has fulfilled his role as a diagnostician, he is frequently expected to furnish advice and recommendations pertaining to problems represented by the diseased insects. Perhaps the afflicted arthropods originated in an insectary; the insectary operator might have asked the pathologist (usually at the time the insects were submitted) what steps could be taken to suppress or eradicate the disease. Or, perhaps a grower, farm advisor, or entomologist collected the diseased insects in a field crop threatened by the pest; he may have asked the pathologist if the disease is one that has potentialities as a microbial control agent. In such instances the advice and recommendations requested of the pathologist are expected along with the report of the diagnosis. Using a letter to make the report permits a special discussion of the problem.

Rights to Diagnosis Data. Since most laboratories that offer to make diagnoses do so as a service, it is to be expected that the submitter has the right to do whatever he wishes with the diagnostic report. He may use it in his publications or in his station reports. Should he desire to quote directly and verbatim from the report, he should give the diagnostician the opportunity to check the quotation prior to its publication.

On the other hand, conducting a diagnostic service is not all a matter of altruism. To be sure, the great majority of specimens received have diseases that the pathologist has seen many times before. But, from the standpoint of the diagnostician, the routine diagnosis of these specimens is well worth the effort when one considers that it provides a means of screening numerous afflicted insects for new and interesting diseases, that it augments the knowledge and experience of the pathologist even with respect to well-known diseases, and that it provides the pathologist with fresh material for study, collections, and, in educational institutions, for teaching purposes.

Most diagnostic laboratories reserve the right to include the results of the diagnostic examination in any of their own publications. Full acknowledgment should, of course, be made to the submitter or collector for providing the diseased insects concerned. Furthermore, after providing the submitter with a report, the diagnostic laboratory should be free to make whatever use of the diseased insects or isolated pathogens it may desire. Occasionally, the person submitting the diseased specimen will request its return after the diagnosis has been completed. This can be done only rarely, however, such

as when an entomogenous fungus on the exterior of an insect is clearly identifiable. Usually, a complete diagnostic examination requires dissection or mutilation of the specimen.

The Follow-up. One of the interesting aspects of diagnostic work is what may be called "the follow-up." After a diagnosis has been made and reported, a number of sequels are possible. First, there are the sequelae of the disease itself as manifested in the insect. These may take the form of injuries lasting for the life of the insect, postmortem changes, abnormalities transferred or transmitted to the next generation, and the like. These changes or manifestations are not likely to change the diagnosis one has made, but a study of them does help to "round out" one's knowledge of the condition being observed.

Secondly, it is of value to integrate the diagnosis into the disease situation at its source. Knowing the nature or cause of the disease, the epizootiologist can study the disease in nature in a much more intelligent and revealing fashion. Sometimes the diagnostician receives the specimens during an early phase of the epizootic, together with epizootiological information available up to that time. In many such instances it is of value to obtain a follow-up report on the disease, to add this report to the history part of the diagnostic records, and to compare it with the follow-up histories obtained in the case of other similar epizootics.

Thirdly, conducting a diagnostic service gives one an opportunity to obtain all manner of data and information relative to statistical aspects of disease among insects, to compile morbidity and mortality statistics, to accumulate information relative to the host and geographical range of insect diseases, and to contact and study areas of enzootic disease.

Lastly, one of the important follow-up activities to a diagnosis may be the isolation of a pathogen that may eventually be considered for use in the control of insect pests. This has happened a number of times in our own experience, beginning with the use of a nuclear polyhedrosis virus in the control of the alfalfa caterpillar, *Colias eurytheme* Boisduval, in California. Study of the virus began after receipt of specimens for diagnosis in 1945 (see Steinhaus, 1948, 1950, 1951). It is unfortunate that the lack of adequate time, facilities, and personnel throughout insect pathology does not allow for more screening and testing of microbial pathogens found in the course of diagnostic work.

SIDE 1.

ACCESSION CARD AND RECORD OF DIAGNOSIS

Date received..... Collector's Number..... Accession Number.....

Name of insect.....

Common nameScientific nameFamily

Condition of material..... Form and method of shipment.....

No. of specimens: Dead..... Ailing..... Normal..... Stage.....

(egg, larva, pupa, adult)

Males..... Females..... Host plant or animal.....

Name of collector..... Address of collector.....

Cover letter dated..... Date collected..... Locality.....

Other collection data:

(See reverse side for diagnostic report)

SIDE 2.

DIAGNOSIS

Date examination begun..... Date completed.....

Date receipt card sent..... Date collector or cor-
respondent notified..... How?..... By.....

Preliminary diagnosis:

By:

FINAL DIAGNOSIS:

By:

Additional specimens needed?.....

Disposition of material.....

Slides or photographs.....

University of California
Insect Pathology.

Fig. 1. The two sides of a 5 × 8-inch accession and record card. This card was used in recording most of the diagnoses reported in the present paper. However, the larger card described in the text and shown in figure 2 is now in use in our laboratory and is recommended in preference to the small card shown here.

SIDE 1.

ACCESSION AND HISTORY CARD

Date received..... Collector's Number..... Accession No.....

Scientific name of insect.....

Common name of insect.....

Condition of specimens.....

Method of submittal or shipment.....

No. of specimens: Dead..... Ailing..... Healthy..... Stage..... Instar.....

Males..... Females..... Time held prior to submittal..... Temp.....

Abundance or prevalence of insect.....

Host plant or animal.....

Extent of disease outbreak.....

.....

Environmental conditions (including temperature and humidity).....

.....

.....

Possibility of insecticide treatment.....

Name of collector..... Address of collector.....

.....

Name of submitter..... Address of submitter.....

.....

Cover letter dated..... Date collected..... Locality.....

.....

Additional description or history provided by collector or submitter:

.....

.....

Additional history provided by diagnostician:

.....

Recorder.....

(See reverse side for diagnostic report.)

Fig. 2. The 8½ × 11-inch accession card used to record the history of the diseased insects received for diagnoses.

SIDE 2.

DIAGNOSIS

Date diagnostic examination begun..... Date completed.....

Date receipt card sent..... Signed by..... How sent.....

Preliminary diagnosis:

By:.....

Tentative diagnosis:

By:.....

FINAL DIAGNOSIS

REASONS:

By:..... Confirmed by:.....

Material referred to..... Date.....

Date report sent to collector or submitter..... How?..... By.....

Additional specimens needed?..... Kind needed?

Disposition of material.....

Microscope slides or photographs.....

New record?..... New pathogen?..... New host?..... New area?.....

Previous record or reference (if not common).....

Published?..... Reference.....

Department of Insect Pathology
University of California, Berkeley

(History on reverse side)

Fig. 3. Card on which the diagnosis is recorded. It is the reverse side of the accession and history card (fig. 2).

SIDE 1.

PHYSICAL EXAMINATION

(Observations made macroscopically or with dissecting microscope)

Date..... Insect..... Accession No.....

A. Abnormal movements and behavior:

B. General external appearance; general condition and odor (relate to healthy specimen)

Premortem:

Postmortem:

C. Signs and symptoms: (Record according to anatomical system or tissue, correlating description with appropriate number.)

1. Integument	4. Excretory system	7. Respiratory system	10. Fat body (adipose tissue)
2. Circulatory system	5. Glands	8. Nervous system and sensory organs	
3. Alimentary system	6. Muscular system	9. Reproductive system	

Photographs.....

Examiner.....

(OVER)

Fig. 4. Form used to record observations made during the course of the physical examination of the diseased insect.

SIDE 2.

LABORATORY EXAMINATION SCAN SHEET

Date..... Insect..... Accession No.....

Microscopic findings: (Record according to anatomical system or tissue, correlating description with appropriate number.)

1. Integument	4. Excretory system	7. Respiratory system	10. Fat body (adipose tissue)
2. Circulatory system	5. Glands	8. Nervous system and sensory organs	
3. Alimentary system	6. Muscular system	9. Reproductive system	

Sketch:

Photographs.....

Examined further for:(Check square ☒ if Special Sheet is used.)

☐ Viruses	☐ Protozoa	☐ Nutritional disturbances	☐ Chemical injuries
☐ Rickettsiae	☐ Nematodes	☐ Genetic anomalies	☐ Hematology
☐ Bacteria	☐ Insect parasites	☐ Nongenetic teratologies	☐ Serology
☐ Yeasts	☐ Neoplasms	☐ Mechanical injuries	☐ Histopathology
☐ Fungi	☐ Deranged metabolism	☐ Physical injuries	☐ Biochemistry
☐ Other anomalies, disturbances, or pathological conditions			

General microbiology and miscellaneous:**Method of examination:** (Method of external sterilization, types of preparations, stains used, etc.)

Examiner.....

(OVER)

Fig. 5. Form used to record preliminary microscopic findings, and to indicate the type of additional examinations that might be required as the result of scanning the different anatomical systems involved (reverse side of fig. 4).

SIDE 1.

Special Data Sheet

VIRUSES
(and Rickettsiae)

Date..... Strain No..... Accession No.....

Insect..... Stage or instar.....

Appearance of insect (if different than at time of physical examination).....

Type of virus infection.....

Rickettsial infection?..... Inclusion bodies present?.....

In which tissues?.....

Location in cells..... Cytological changes.....

Description of Inclusions:

Wet mount..... Section.....

Type of inclusion.....

Size microns

Shape.....

Relative number.....

Staining reactions.....

Sketch of inclusions or infected cells:

Soluble in.....

Insoluble in.....

Appearance in: Bright field.....

Dark field.....

Phase contrast.....

Polarized light.....

Electron microscope.....

..... Plate No..... Mag.....x

(Continued over)

Fig. 6A. Special data sheet used to record data pertaining to viruses and rickettsiae associated with a diseased insect.

SIDE 1.

Special Data Sheet	
BACTERIA	
Date of isolation.....	Strain No..... Accession No.....
Insect.....	
Triturated?..... If dissected, list anatomic parts in which found.....	
Medium from which isolated.....	
Temp. at which isolated.....	Incubation period.....
Number of colonies.....	Predominant colony?.....
(abundant, moderate, few)	
Cellular morphology.....	Sketch:
Size..... microns.	
Gram reaction.....	
Special staining:.....	
.....	
Spores (size)..... microns.	Position.....
Colony morphology on.....	medium:.....
Nutrient agar slant.....	
.....	
..... agar slant.....	
Potato slant.....	
Blood agar (hemolysis).....	
Nutrient broth.....	
.....	
Temperature relations: Optimum.....	Range.....
Relation to free oxygen.....	
Litmus or purple milk.....	
Gelatin liquefaction.....	
(Continued over)	

Fig. 7A. Special data sheet used to record data pertaining to bacteria associated with a diseased insect.

SIDE 2.

Strain No.....

Hydrogen sulfide (Medium:.....)

Motility..... Glucose..... Lactose..... Inositol.....

Capsule..... Galactose..... Cellobiose..... Sorbitol.....

NO₃ to NO₂..... Mannose..... Trehalose..... Dulcitol.....

Indole..... Arabinose..... Melibiose..... Glycerol.....

M. R..... Xylose..... Dextrin..... Adonitol.....

V. P..... Fructose..... Inulin..... Erythritol.....

Citrate..... Rhamnose..... Raffinose..... Arabitol.....

Ammonia..... Levulose..... Melezitose..... Salicin.....

Starch hyd..... Sucrose..... Mannitol..... Aesculin.....

Uric acid..... Maltose.....

Infectivity test.....

Identification and classification:

Based on the taxonomic data in Bergey's Manual of Determinative Bacteriology, or

....., this organism

Is identical with.....

Is close enough to be.....

May be.....

Note differences:

Is probably a species belonging to.....

Is apparently a new species..... Why?.....

Reference.....

Examiner.....

Fig. 7B. Reverse side of fig. 7A.

SIDE 1.

Special Data Sheet

FUNGI

Date of isolation..... Strain No..... Accession No.....

Insect.....

Fungus evident externally?..... Only internally?..... Abundance.....

Description of fungus as associated with insect:

Macroscopic:

Microscopic:

Description of fungus on artificial media:

Media used..... Sporulation time.....

Method of inoculation..... Incubation temp.....

Imperfect Stage

Macroscopic:

Microscopic:

Perfect Stage

Macroscopic:

Microscopic:

(Continued over)

Fig. 8A. Special data sheet used to record data pertaining to fungi associated with a diseased insect.

SIDE 2.

Cultural and physiological tests

(List each of differential media used and results in each.)

Infectivity test:

Identification and classification:
Authority.....

Is identical with.....

Is close enough to be.....

May be.....

Note differences:
If the above is the perfect form, the name of the imperfect stage is.....

If the above is the imperfect form, the name of the perfect stage is.....

Is probably a species belonging to.....

Is apparently a new species..... **Why?**.....

References:.....

Photographs:

Examiner.....

Fig. 8B, Reverse side of fig. 8A.

Special Data Sheet PROTOZOA		
Date.....	Accession No.....	
Insect.....		
Morphological description of protozoan, as seen with:		
Wet mount; bright field	Wet mount; dark field	Wet mount; phase contrast
Stained with.....:		Electron microscope:
		Infectivity test:
Composite and generalized description of protozoan, and sketch:		
Identification and classification:		
Is identical with..... May be.....		
Probably species belonging to..... New species?.....		
Why?.....		
Authority and reference.....		
Examiner.....		

Fig. 9. Special data sheet used to record data pertaining to protozoa associated with a diseased insect.

Special Data Sheet

NEMATODES

Date.....

Accession No.....

Insect.....

Morphological description of nematode, as seen with:

Bright-field microscope	Dark-field microscope	Phase-contrast microscope

Other techniques used:

Composite and generalized description of nematode, and sketch:

Photographs.....

Identification and classification:

Is identical with..... May be.....

Probably species belonging to..... New species?.....

Why?.....

Authority and reference.....

Examiner.....

Fig. 10. Special data sheet used to record data pertaining to nematodes associated with insects.

Special Data Sheet

HEMATOLOGY

Date.....

Accession No.....

Insect.....

Stage, instar, sex, and condition.....

Differential Count

BLOOD-CELL GROUPS	HEALTHY SPECIMENS				DISEASED SPECIMENS			
	Smear A No. & %	Smear B No. & %	Smear C No. & %	Mean %	Smear A No. & %	Smear B No. & %	Smear C No. & %	Mean %
I. Prohemocytes, including transitional cells (chromophils).....								
II. Oenocytoids.....								
III. Plasmatocytes, including podocytes, vermiform cells, and cystocytes ¹								
IV. Granulocytic series (Spherule cells, adipohemocytes, granular hemocytes and cystocytes ²),.....								
V. Unclassified cells.....								
VI. Degenerating cells.....								
Total cells counted.....								
Mitotic figures (%).....								
Cells showing phagocytosis (%).....								

¹ Unstained preparations.

² Stained preparations.

Total cell count (hemocytes/mm³).....

Microorganisms present in plasma or involved in phagocytosis.....

How blood collected.....

Larva heat fixed?.....

Fixative and stain used on smears.....

Condition of blood (or plasma) (volume, color, pH, coagulation, etc.).....

Giant cell formation?.....

Abundance?.....

Sketch and describe any of above, as well as cells showing pathological changes, on reverse side of sheet.

Notes:

Examiner:.....

Fig. 11. Special data sheet used to record data pertaining to the hematology of diseased and healthy insects. The "Blood-Cell Groups" represent a tentative, convenient grouping (for diagnostic purposes) of hemocytes, the classification of which will undoubtedly continue to be modified as more knowledge of insect blood cells is attained.

Date of fixation..... Stage, instar, sex.....

[illegible]

Preparator..... [Over]

Fig. 12A. Special data sheet used to record data pertaining to histopathology of a diseased insect.

SIDE 2.

Block No.																
Stain	H*	M*			H	M			H	M			H	M		
Slide No.	1 11	1 11	1 11	1 11	1 11	1 11	1 11	1 11	1 11	1 11	1 11	1 11	1 11	1 11	1 11	1 11
	2 12	2 12	2 12	2 12	2 12	2 12	2 12	2 12	2 12	2 12	2 12	2 12	2 12	2 12	2 12	2 12
	3 13	3 13	3 13	3 13	3 13	3 13	3 13	3 13	3 13	3 13	3 13	3 13	3 13	3 13	3 13	3 13
	4 14	4 14	4 14	4 14	4 14	4 14	4 14	4 14	4 14	4 14	4 14	4 14	4 14	4 14	4 14	4 14
	5 15	5 15	5 15	5 15	5 15	5 15	5 15	5 15	5 15	5 15	5 15	5 15	5 15	5 15	5 15	5 15
	6 16	6 16	6 16	6 16	6 16	6 16	6 16	6 16	6 16	6 16	6 16	6 16	6 16	6 16	6 16	6 16
	7 17	7 17	7 17	7 17	7 17	7 17	7 17	7 17	7 17	7 17	7 17	7 17	7 17	7 17	7 17	7 17
	8 18	8 18	8 18	8 18	8 18	8 18	8 18	8 18	8 18	8 18	8 18	8 18	8 18	8 18	8 18	8 18
	9 19	9 19	9 19	9 19	9 19	9 19	9 19	9 19	9 19	9 19	9 19	9 19	9 19	9 19	9 19	9 19
	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20	10 20

Examination of Slides

Slide No.	Stain	Description	Sketch	Photographs

* H = Heidenhain's Fe hematoxylin; M = Mallory's triple connective.

Examiner..... [Reverse]

Fig. 12B. Reverse side of fig. 12A.

Tissue Block Work Card

Block No. _____ Acc. or Expt. No. _____ Date _____

Tissue _____

Insect and Stage _____

Condition of Specimens _____

Killing and Fixation: _____

Clearing: _____

Infiltration: _____

Washing: _____

Storage: _____

Oven Temp: _____

Embedding: _____

Dehydration: _____

Alcohols				

Other treatment and/or comments: _____

References: _____

Filing: _____

Other: _____

Preparator _____ (Over)

Fig. 13A. Tissue block work card used to record data and aid in the processing of a diseased insect being sectioned for histopathological examination.

Staining Work Card

Slide No.	Stain	Date	Variations

Comments:

Filing:

Preparator _____

Fig. 13B. Reverse side of fig. 13A. Staining work card used in histopathological examination.

ABBREVIATED REPORTS OF DIAGNOSES OF DISEASED INSECTS

The abbreviated diagnostic reports which follow represent only the basic information pertaining to each accession, and a designation of the etiology when this has been determinable. Since, as indicated in the preceding section, it is our belief that the diagnosis of an insect disease involves much more than identifying the pathogen or other etiologic agent, it is our hope that in future reports we shall be able to include more data pertaining not only to the etiology and history of the disease but also to the symptomatology, gross pathology, histopathology, physiopathology, and epizootiology. For certain basic information (as indicated in the previous section) we are dependent upon the submitter to provide full particulars; steps have been taken to ensure better communication with the submitter in this regard.

The abbreviated diagnostic reports are arranged according to the insect host. The families are arranged alphabetically within the orders, the genera alphabetically within the family, and the species alphabetically within the genus. Each diagnosis is preceded by the Accession Number. These numbers range from 576 to 1832.⁵ Also included is the name of the person who submitted the diseased insects, and the date on which they were received at our laboratory. A host index arranged according to genus and species, and an index to pathogens will be found at the end of this paper. The authors of the names of the host species are given in the text, but in order to conserve space the authors of the names of the pathogens are given only in the index.

In this report, those accessions on which we were unable to render a positive diagnosis are included. Admittedly, their negative character adds little in the way of scientific information, but they are included for the sake of completeness, and to provide a record as to their having been submitted for diagnosis. Also, in some instances there is value just in knowing that a given insect appears to have suffered from disease in a given area; the nature of the disease is sometimes determined from subsequent specimens and can be related to this previous record. These negative reports also highlight the difficult task sometimes presented the diagnostician when it is necessary to attempt a diagnosis from a single shipment of dead insects, especially when they represent an exotic species.

A considerable number of diagnoses were impossible to complete because we had no way of confirming them by means of infectivity tests. This was especially true of accessions received from outside the state of California and outside the United States. In both cases, quarantine laws and regulations prohibit or seriously restrict the entry of living insects that can be used for appropriate infectivity tests or for rearing sufficient stocks of the insect species concerned. These restrictions also preclude obtaining certain insects suitable for experimental and test purposes. Frequently, a native insect of a closely related species or genus is not available or, if it is at hand, is not susceptible to the suspected pathogen, thus thwarting meaningful infectivity

⁵ Accessions numbered from 1 through 575 have been reported previously (Steinhaus, 1951). Further study of some of the protozoa found in the accessions reported in the present paper has been made by Lipa and Steinhaus, 1962. Some of our identifications both as to species and genus are reported in the latter paper.

tests. At this point the invertebrate pathologist can envy the vertebrate pathologist—especially the practitioner of human medicine—because the latter is concerned with but one, or a few, species, and has established “guinea pigs” to use as test animals for most of the pathogens he encounters. The problem thus confronted by a diagnostic laboratory such as ours is frequently so serious that it becomes a most discouraging and frustrating factor in the diagnostic work. It is particularly frustrating in reporting diagnostic results since if appropriate infectivity tests could be run the results would not so frequently have to be reported as “probable,” “possible,” “questionable,” or “negative.”

It should also be explained that for some of the diagnoses reported here, the pathogen involved has been identified only as to the major group to which it belongs. In other words, in the past, it was frequently enough (for the purposes of the submitter) to know that the disease was, for example, a bacterial disease, a protozoan disease, or a virus disease; that the disease was bacterial, caused by a member of the coliform group, or protozoan, caused by a species of *Nosema*. Sometimes the taxonomic status of the group to which the pathogen belongs is so chaotic that more precise identification was impossible or would have been impractical or misleading.

Of the total of 1,257 accessions reported in the present paper, the microbial pathogen was identified as to species with certainty in 466 instances (that is, 37 per cent); as to probable species in 80 instances (6.4 per cent); as to genus 170 times (14 per cent) with certainty and an additional 28 times (2 per cent) probably. It was further identified as to one of the higher taxonomic categories 64 times (5 per cent) with certainty and 69 times (5.6 per cent) with a high degree of probability. Thus, in 877 instances, or 70 per cent of the time, the pathogen could be identified as to one of the higher taxa or better. In 70 instances (5 per cent) the diagnosis could be considered no better than a wild guess, and in 310 additional instances (25 per cent) no reasonably accurate diagnosis could be made either because of completely negative findings or because susceptible insects were not available with which to run appropriate tests. The latter also accounts for the fact that the pathogen could be identified as to species with absolute certainty in only 466 (37 per cent) of the 1,257 accessions received. If susceptible host insects were available, it is likely that this figure could be doubled, and that the number of “guesses” and inconclusive and negative diagnoses could be substantially reduced. Thus is exposed one of the greatest difficulties in providing a highly successful diagnostic service for all manner of diseased insects received from all parts of the world.

In general, therefore, it should be remembered that some of the inadequacies in the reports to follow are inherent in the nature of the work and the material received, some are intentional in that with many of the earlier accessions no effort was made to go beyond a general or cursory identification of the pathogen involved, and some are caused by the unavailability, at the time, of specific healthy insects in which the pathogen could have been maintained, its life cycle determined, or its role as a true etiological agent verified.

ARTHROPODA

Insecta

BLATTARIA

BLATTIDAE

Blattella germanica (Linnaeus)

910—Many adults and nymphs from T. C. Lawrence; Berkeley, California, November 13, 1953; laboratory stock with abnormal white abdomens. Diagnosis: Abdomens filled with abnormal amounts of urate crystals. Metabolic disease.

Blatta orientalis Linnaeus

913—Antennae preserved in alcohol from A. G. Richards; St. Paul, Minnesota, November 30, 1953; laboratory cultured specimens. Diagnosis: Laboulbeniales, *Herpomyces periplanetae*. Identified by M. N. Smith and A. G. Richards.

Periplaneta americana (Linnaeus)

593—One adult from T. C. Lawrence; Berkeley, California, March 2, 1951; laboratory culture. Diagnosis: Septicemia. *Serratia marcescens* (See Steinhilber, 1959a).

1518—Several adults from H. L. Sweetman; Amherst, Massachusetts, October 2, 1959; laboratory roach cultures which began dying soon after a shipment of additional roaches was introduced from Maryland. Diagnosis: Bacterial septicemia. *Serratia marcescens*.

POLYPHAGIDAE

Polyphaga aegyptiaca (Linnaeus)

978—One microscope slide from M. M. El Moufty; Alexandria, Egypt, August 25, 1954; nematode collected from cockroach colon. Diagnosis: Nematode infection. *Leidynema appendiculatum*.

COLEOPTERA

ANOBIIDAE

Ernobius spp.

1132—One larva from H. Ruckes, Jr.; Point Lobos State Park, Monterey County, California, December 7, 1956; collected from *Pinus radiata*. Diagnosis: No pathogen related to death. Miscellaneous gram-negative rods and yeast isolated.

1147—Two larvae from H. Ruckes, Jr.; Cuyamaca State Park, San Diego County, California, April 4, 1957; collected from Jeffrey pine. Diagnosis: No evidence of microbial pathogens. Symbiotes and secondary fungus present.

CERAMBYCIDAE

Acanthocinus spectabilis (LeConte)

1100—One dead pupa from D. Burdick; eleven miles east of Mount Hamilton, California, May 8, 1956; field collected. Diagnosis: No pathology or pathogenic organisms observed.

Monochamus marmorator Kirby

1530—One larva from R. S. Soper, Jr.; Orono, Maine, November 11, 1959; specimen laboratory-reared from egg laid in August, 1958. Diagnosis: Mycosis. *Beauveria bassiana*.

1535—One larva from R. S. Soper, Jr.; Orono, Maine, January 6, 1960; field-collected and laboratory-reared from balsam fir (*Abies balsamea*). Diagnosis: Mycosis. *Beauveria bassiana*. Saprophytic *Mucor* sp. also present.

1544—One adult female from R. S. Soper, Jr.; Orono, Maine, February 15, 1960; laboratory-reared adult infected with a mycosis. Diagnosis: Mycosis. *Beauveria bassiana*.

Monochamus notatus (Drury)

1186—One adult from R. L. Hodgdon; Old Town, Maine, July 22, 1957; adult collected from *Pinus strobus*; found dead with external mycelium 6 days after introduction into breeding cage with male. Similar mycosis observed occasionally in field. Diagnosis: Mycosis. *Beauveria bassiana*.

Monochamus notatus (Drury) or *M. scutellatus* (Say)

1385—Nine larvae, pupae, and adults from R. S. Soper, Jr.; Orono, Maine, April 6, 1959; field-collected from pine (*Pinus strobus*) pulpwood pile; removed from galleries or pupal chambers. Diagnosis: Mycosis. All but two infected with *Beauveria bassiana*. One specimen harboring two different nematodes, *Diplogasteroides* sp. and *Aphelenchoides* (*Bursaphelenchus*) sp.

1387—One prepupa from R. S. Soper, Jr.; Orono, Maine, April 10, 1959; collected from 12-inch diameter *Pinus strobus* log and returned to laboratory. Appeared unusually white when collected; external growth evident in laboratory. Diagnosis: Mycosis. *Spicaria* sp. near *laxa*.

1390—Seven larvae and prepupae from R. S. Soper, Jr.; Orono, Maine, April 17, 1959; field-collected from *Pinus strobus*. Diagnosis: Three live prepupae with black cuticular lesions probably the result of mechanical injury. All pupated and subsequently emerged as normal adults. One larva was infected with *Beauveria bassiana*. Three specimens harbored small numbers of gram-negative, short, nonsporeforming rods, some yeasts, and *Bacillus cereus* var. *mycoides*.

1391—Three prepupae and pupae from R. S. Soper, Jr.; Orono, Maine, April 23, 1959; field-collected from pupal chambers in *Pinus strobus* and reared in laboratory. Larvae had abnormally white abdomens and one pupa developed a fungal growth about the mandibles. Diagnosis: Mycosis. *Beauveria bassiana* in all specimens.

1413—Three prepupae and pupae from R. S. Soper, Jr.; Orono, Maine, June 1, 1959; field-collected from *Pinus strobus* and brought into laboratory for rearing; bacterial infection suspected. Diagnosis: No specific pathogen found. All specimens heavily laden with *Aerobacter aerogenes*, which might have caused a septicemia.

1529—One larva from R. S. Soper, Jr.; Orono, Maine, November 25, 1959; larva removed from infested eastern white pine (*Pinus strobus*) log in August 1959 and reared in the laboratory. Diagnosis: Mycosis. *Beauveria bassiana*.

1536—Two larvae from R. S. Soper, Jr.; Orono, Maine, January 6, 1960; laboratory-reared on eastern white pine (*Pinus strobus*). Diagnosis: Both larvae harbored a mixed infection of *Verticillium* sp. near *V. terrestre* and a short gram-negative, lactose-negative bacterium.

1543—Four larvae from R. S. Soper, Jr.; Orono, Maine, February 15, 1960; laboratory-reared on balsam fir (*Abies balsamea*). Diagnosis: Mycosis. *Verticillium* sp., near *V. terrestre*. One specimen also harbored a saprophytic fungus (*Trichoderma* sp.).

1579—Three larvae and prepupae from R. S. Soper, Jr.; Old Town, Maine, May 31, 1960; specimens originally removed from

Pinus strobus and laboratory-reared. Two specimens disintegrated. The third was artificially exposed to a specimen infected with *Isaria farinosa* as identified by E. B. Mains. Diagnosis: Bacteremia and mycosis. Numerous gram-negative small rods and *Bacillus cereus* isolated from first two specimens. Third infected with *Isaria farinosa*. Larva had fungus spores smeared between 4th and 5th abdominal segments on March 21. External mycelium visible on March 29; synnemata began to develop April 4 and had fully developed by April 11.

1608—Three larvae from R. S. Soper, Jr.; Old Town, Maine, July 16, 1960; specimens collected in log butts of *Pinus strobus* and returned to the laboratory for rearing. Larvae were successfully maintained for about one month when reddish spots first began to appear on the cuticle. The spots enlarged and coalesced into large dorsal and ventral patches on the thorax. Mycelium appeared shortly and the bodies became completely mummified within a few days. Diagnosis: Mycosis. *Beauveria bassiana*. Both *Penicillium* sp. and *Aspergillus* sp. were also present as saprophytes and accounted in part for the dense mycelial mat covering the larvae.

1624—Eight larvae from R. S. Soper, Jr.; University Forest, Old Town, Maine, August 11, 1960; two larvae were collected May 3, 1960, from *Pinus strobus* and laboratory-reared under conditions of very high humidity. Sixty-seven larvae obtained from two trees succumbed to a fungus infection which initially showed reddish-black spots (later spreading) on the thorax and a white mycelium issuing from the cuticle at these foci of infection. The remaining larvae were collected July 7, 1960, from *Pinus strobus* and reared in a similar fashion. However, the body tissues became translucent prior to the emergence of flocculent white mycelium. Twenty-five per cent of the larvae from one tree were infected. Diagnosis: Mycosis. *Beauveria bassiana* isolated from two larvae; *Fusarium* sp. from five other larvae. Both cases appeared to be frank infections.

Monochamus scutellatus (Say)

1133—Several larval lots from T. P. Fickus; Orono, Maine, December 26, 1956; collected from pine. Diagnosis: Larvae collected from under loose bark infected with *Beauveria tenella*. Two blackened larvae preserved in alcohol indicated probable bac-

terial infection. One larva from prepupal chamber had long white wormlike anal protrusion, which proved to be the evaginated larval intestine.

1209—One adult from R. L. Hodgdon; Orono, Maine, September 30, 1957; larvae removed from pupal chamber in *Pinus strobus*, refrigerated for 11 months, and reared at 23.9° C and 86 per cent R.H. Fungal growth appeared two days after death. Diagnosis: Mycosis. Sterile mycelium. Unable to culture for identification.

1275—Two prepupae from R. L. Hodgdon; Bucksport, Maine, June 16, 1958; both specimens removed from pupal chambers, one as a slimy mass, the other normal but developing a mycelial growth after being in the laboratory for 11 days. Diagnosis: Mycosis and bacteriosis. *Beauveria bassiana* in one, *Pseudomonas* sp. in the other.

1531—Three larvae from R. S. Soper, Jr.; Orono, Maine, November 25, 1959; laboratory-reared specimens originally field-collected from balsam fir (*Abies balsamea*) and white spruce (*Picea glauca*). Diagnosis: Two specimens infected with a *Spicaria* sp. and harboring secondary saprophytic bacteria. One specimen harboring large numbers of small gram-negative rods (*Aerobacter* sp.).

1537—Two larvae from R. S. Soper, Jr.; Orono, Maine, January 6, 1960; laboratory-reared on white spruce (*Picea glauca*). Diagnosis: Bacteremia. Enterobacteriaceae.

1542—Two larvae from R. S. Soper, Jr.; Orono, Maine, February 15, 1960; laboratory-reared on balsam fir (*Abies balsamea*). Diagnosis: Mycosis. *Verticillium* sp., near *V. terrestre*. The second larva contained large numbers of a small gram-negative, lactose-negative bacterium, as well as a light infection with *Verticillium*.

1583—One pupa from R. S. Soper, Jr.; University Forest, Old Town, Maine, June 6, 1960; removed from pupal chamber in *Pinus strobus*. Some external mites and numerous nematodes, some of which were issuing from the leg joints. Diagnosis: Nematodes are *Diplogaster* sp., presumably commensal or saprophytic. Mites found attached to wing axilla and pads. Others were found within, and completely occluding, the meso- and metathoracic spiracular atria. Identified as *Lasioscius* (sensu Evans, 1958) by Evert E. Lindquist. Other species of this genus have been found in the spiracular antra of millipedes.

Monochamus sp. [probably *notatus* (Drury)]

1240—One larva from R. L. Hodgdon; Orono, Maine, March 31, 1958; Diagnosis: No pathogen found.

Monochamus spp.

1402—Five prepupae and pupae from R. S. Soper, Jr.; Orono, Maine, May 11, 1959; specimens field-collected from *Pinus strobus* logs and reared in laboratory where they succumbed to fungus infections. Diagnosis: Mycosis. All infected with *Beauveria bassiana* except one, which harbored an external saprophytic growth of *Trichoderma* sp., near *koningii*.

1411—One larva from J. A. Chemsak; 4.5 miles northeast of Santa Margarita, San Luis Obispo County, California, May 26, 1959; collected from *Pinus sabiniana* and brought into laboratory for rearing. Specimen had consistency of a kneaded rubber eraser with pale subcuticular pink cast when submitted. Diagnosis: Mycosis. *Beauveria bassiana*.

1429—Five larvae from R. S. Soper, Jr.; Orono, Maine, June 23, 1959; field-collected from *Pinus strobus* and reared in laboratory. Diagnosis: One specimen harbored large numbers of nematodes (*Diplogaster* sp.). A second specimen, also harboring nematodes on the cuticle, was contaminated with a fungus (*Trichoderma* sp.) which was also actively growing along the walls of the gallery in the wood. The remaining specimens were found to contain large numbers of a small, rod-shaped, nonlactose-fermenting bacterium.

1430—Eight prepupae from R. S. Soper, Jr.; Orono, Maine, June 23, 1959; laboratory-reared from field material taken from *Pinus strobus*. Diagnosis: Mycosis. *Beauveria bassiana* infected seven specimens. One specimen contained a gram-negative, small, rod-shaped bacterium which did not ferment lactose.

1452—Diluted body fluids from larva from R. S. Soper, Jr.; Orono, Maine, July 13, 1959; material taken from liquefied larva removed from *Pinus strobus* burrow. Diagnosis: No pathogen found. Organisms isolated from diluted body fluids and submitted for diagnosis were holotrichous ciliates belonging to the genus *Colpoda*.

1540—Larvae from R. S. Soper, Jr.; University Forest, Old Town, Maine, January 18, 1960; field-collected from eastern white pine (*Pinus strobus*) and brought into the

laboratory for rearing. Diagnosis: No pathogen isolated. Miscellaneous saprophytic bacteria present.

Necydalis cavipennis LeConte

1160—One larva from J. A. Chemsak; Berkeley, California, May 14, 1957; collected alive from dead oak log; held in laboratory 10 days. Specimen became pink and abnormally firm. Diagnosis: Mycosis. *Beauveria bassiana*.

Prionus sp.

1549—One larva from H. O. Lund; Griffin, Seminole County, Georgia, February 26, 1960; larvae taken from soil where they had been doing considerable damage to Bahia pasture grass roots. The submitted specimen was covered with a green mold. Diagnosis: Mycosis. *Metarrhizium anisopliae*.

Saperda horni Joutel

1142—One moribund larva from J. A. Chemsak; near Pittsburg, Contra Costa County, California, February 15, 1957; removed from larval gallery inside dead willow tree. Diagnosis: Mycosis. *Cephalosporium* sp.

Teiaopes sublaevis Casey

1375—One prepupa from E. G. Linsley; Hopkins Well, Riverside County, California, February 10, 1959; specimen became ill after being held in laboratory 22 days for rearing purposes. Diagnosis: Bacterial septicemia. *Serratia marcescens*.

Tragosoma nigripennis (Bates)

1231—One adult in alcohol from P. D. Hurd, Jr.; 11,300 feet, El Nevada de Toluca, Mexico, February 11, 1958; field-collected. Diagnosis: Mycosis. *Beauveria bassiana*.

CHRYSOMELIDAE

Acalymma trivittata (Mannerheim)

893—Five larvae from E. R. Oatman; Berkeley, California, September 16, 1953; laboratory-reared. Diagnosis: *Gregarina* sp., near *diabrotica*; secondary coliform bacteria abundant, probable contributing factor to terminal death.

1703—Five larvae from C. Gonzales; Berkeley, California, February 16, 1961; laboratory-reared in temperature-humidity cabinets at about 100 per cent R. H. and from 23° to 34° C. Submitted larvae repre-

sented the first three instars were fed bean sprouts. Larvae ceased to feed and turned black. Diagnosis: No pathogen found. Three colonial types of bacteria isolated; all small gram-negative rods, both lactose-negative and lactose-positive species.

1714—Six larvae from C. Gonzales; Berkeley, California, February 24, 1961; laboratory-reared under conditions described for Accession No. 1703 above. Larvae died, became flaccid, and darkened. Diagnosis: No pathogen found. Secondary bacteremia.

1728—One pupa from C. Gonzales; Berkeley, California, April 7, 1961; external surface of pupa infested with large numbers of nematodes. A moderate number of nemas were also present in the sand in which the beetle had pupated in the insectary. Diagnosis: No pathogen found. Dissection of the pupa verified the assumption that the nematodes (*Rhabditis* sp.) occurred only on the surface and were not actually parasitizing the beetle.

Chalepus signaticollis Baly

839—Two adults from G. M. Boush; Chapingo, Mexico, September 4, 1952; collected on soybeans, held in laboratory. Diagnosis: Mycosis. *Beauveria bassiana*.

Diabrotica longicornis (Say)

692—One adult from K. D. Arbuthnot; Ankeny, Iowa, September 17, 1951; field-collected. Diagnosis: Mycosis. *Beauveria bassiana*.

1584—Two adults from J. A. Chemsak; Berkeley, California, June 9, 1960; specimens originally collected in 1953 by J. H. Lilly for systematic purposes. During museum curation, it was noted that two specimens had what appeared to be a growth of some kind, in one case extending from the neck, in the other issuing from the abdominal pleura. Diagnosis: Cervical and abdominal hernia. Entire mid-gut extruded from intersegmental membranous area. (See fig. 14, p. 382.)

Diabrotica undecimpunctata undecimpunctata Mannerheim

1730—Egg masses from C. Gonzales; Berkeley, California, April 10, 1961; nematodes crawling all over egg masses deposited by insectary-held females in sand containers. Diagnosis: No pathogen found. Nematodes (*Rhabditis* sp.) not parasitic.

Fig. 14. Museum specimen of the northern corn rootworm, *Diabrotica longicornis* (Say), with the entire mid-gut extruded through the ruptured intersegmental membrane of the neck. (Acc. No. 1584, p. 381.)

Galerucella xanthomelaena (Schränk)

712—Several adults from R. G. Rosenstiel; Corvallis, Oregon, October 18, 1951. Diagnosis: Mycosis. *Beauveria bassiana*.

1461—Many larvae and pupae from D. E. Howell; Stillwater, Oklahoma, July 27, 1959; field-collected with observed mortality of about 20 per cent. Abnormal rainfall, five times that of normal, occurred during the epizootic. Diagnosis: Bacterial septicemia. *Serratia marcescens* consistently isolated from specimens. Secondary saprophytic *Mucor* sp. present.

Leptinotarsa decemlineata (Say)

1056—Fifteen adults from R. W. Portman; Moscow, Idaho, August 15, 1955; collected on ground between rows of severely defoliated potato plants. Diagnosis: Bacteriosis. Gram-negative, lactose-negative small rod.

1151—Fourteen larvae fixed in alcohol from E. Horber and A. Hanggi; Zurich, Switzerland, October, 1956; larvae showed symptoms of "Schwarzfleckenkrankheit" (black spot disease) of E. Thiem. Diagnosis: No pathogenic microorganisms found.

Pagria vignaphila Bryant

1620—Many adult beetles from J. J. H. Szent-Ivany; Oriomo Agricultural Experiment Station, 30 miles west of Daru, Western District, Papua, August 5, 1960; field population collected from *Pueraria phaseoloides* where an estimated 99.5 per cent of the total population had succumbed to a fungus infection. Some shot-hole damage and etching was apparent on the leaves, but most of the population was killed by disease. Diagnosis: Mycosis. *Beauveria tenella*.

1678—Many adults from J. J. H. Szent-Ivany; Oriomo Agricultural Station, Western District, Papua, October 26, 1960; large numbers of fungus-infected beetles found adhering to leaves of *Pueraria phaseoloides*. Dense populations of a galerucid occurred in the same area but were not infected. Diagnosis: Mycosis. *Beauveria tenella*.

Unidentified sp.

1679—Two adults from J. J. H. Szent-Ivany; Oriomo Agricultural Station, Western District, Papua, October 26, 1960; collected from sweet-potato field about 100 yards from area where Accession 1678 above was taken. Diagnosis: Mycosis. *Beauveria bassiana*.

COCCINELLIDAE*Anatis rathvoni* LeConte

1424—Two adults from C. Gonzales; Linden, California, June 17, 1959; collected with *Hippodamia* and *Olla*. Diagnosis: No pathogen found.

Chilocorus cacti Linnaeus

1382—Six adults from H. A. Thomas; Weslaco, Texas, March 17, 1959; adults with small, dark-brown spots on dorsal or lateral abdominal segments, occasional specimens with same lesions on elytra. Diagnosis: No microorganisms associated with the lesions. Possible mechanical injury.

Chilocorus stigma (Say)

1016—Six larvae from J. Drea; Albany, California, February 24, 1955; heavy mortality in laboratory colonies. Diagnosis: Bacterial septicemia. Mixture of gram-negative short rods and micrococci.

1077—Twenty live adults from J. Drea; Palermo, California, December 8, 1955; field-collected. Diagnosis: Unidentified nematode infection.

Hippodamia convergens Guérin-Ménéville

1043—Ten adults from N. A. Walker; Yosemite National Park, California, June 3, 1955; field-collected. Diagnosis: Mycosis. *Beauveria bassiana*.

1422—Numerous larvae, pupae and adults from C. Gonzales; Linden, California, June 17, 1959; all stages appeared to be diseased but the pupating larvae succumbed more readily than the other stages. Diagnosis: Microsporidiosis. *Nosema hippodamiae*. (See Lipa and Steinhaus, 1959.)

1607—One adult from C. Gonzales; Linden, California, July 13, 1960; brought in from the same area as the previous year (see Accession No. 1422 above), where microsporidiosis (*Nosema hippodamiae*) was first discovered, to determine if the organism was still present in the field. Diagnosis: No pathogen found. Microsporidia negative.

Hippodamia sp.

1153—One larva from K. Hagen; Albany, California, May 3, 1957; laboratory-reared. Diagnosis: No evidence of pathogens.

Olla abdominalis (Say)

1423—Six larvae and one adult from C. Gonzales; Linden, California, June 17,

1959; collected in conjunction with Accession No. 1422 above. Diagnosis: No pathogen found.

CURCULIONIDAE*Anthonomus grandis* Boheman

1533—Many adults from W. H. Whitcomb; Fayetteville, Arkansas, December 12, 1959; heavy mortality in overwintering adults being held at 10° C in the laboratory. Fungus present in most specimens. Diagnosis: No pathogen found. Mycosis a secondary invader by a species of *Fusarium*.

Brachyrhinus cribricollis (Gyllenhal)

1025—Nine larvae and adults from G. Schaefer; Berkeley, California, April 12, 1955; laboratory culture. Diagnosis: Mycosis. *Beauveria bassiana*.

1632—Eight adults from W. H. Lange; Castroville, Monterey County, California, August 26, 1960; fungus reduced population in artichoke field during a 1-week period and appeared to give effective control. Diagnosis: Mycosis. *Beauveria bassiana*. (See fig. 15, p. 384.)

Cylas formicarius elegantulus (Summers)

615—Eight adults from M. Sherman; Honolulu, Hawaii, May 2, 1951; laboratory stock. Diagnosis: Mycosis. *Beauveria bassiana*. The bacterium *Serratia marcescens* also present. (See Steinhaus, 1959a.)

739—Several specimens from P. Weber; Louisiana, December 26, 1951. Diagnosis: Double infection, septicemia and mycosis. *Serratia marcescens* and *Beauveria bassiana*.

1123—Several adults from P. Surany; Banghor, Ceylon, October 22, 1956; field-collected. Diagnosis: Mycosis. *Beauveria bassiana*.

Cylas sp.

1669—Two fungus slants isolated from adults and submitted by Sothorn Prasertphon; Choburi Province, Thailand, October 12, 1960; isolated from field-collected larvae. Diagnosis: Mycosis. *Beauveria bassiana*.

Hypera brunneipennis (Boheman)

869—Several larvae from E. J. Dietrick; El Centro, California, March 16, 1953; collected on alfalfa. Diagnosis: No pathogen found.

Fig. 15. Adults of *Brachyrhinus cribricollis* (Gyllenhal) killed by an infection with *Beauveria bassiana* (Balsamo) Vuillemin. (Acc. No. 1632, p. 383.) (Photo courtesy W. H. Lange.)

Hypera postica (Gyllenhal)

938—One live larva from R. F. Smith; Tracy, California, March 29, 1954; collected on alfalfa. Diagnosis: Bacteriosis. *Pseudomonas* sp. and coliform bacterium.

944—One adult from R. F. Smith; Tracy, California, April 27, 1954; field-collected. Diagnosis: Mycosis. *Beauveria bassiana*.

945—Fourteen dead and ailing larvae from L. Ruud; Berkeley, California, April 28, 1954; laboratory-reared. Diagnosis: Gram-negative small rod, isolated and fed to healthy larvae; infectivity was negative; probably nonmicrobial death with secondary bacteriosis.

1466—Three nematodes taken from body

cavity of fourth-instar larva from G. O. Poinar, Jr.; Fishkill, New York, July 31, 1959; diseased larvae were more wrinkled and larger than normal larvae. Diagnosis: Nematode infection. Mermithidae. (See Poinar and Gryscio, 1960, 1962.)

1690—Over thirty adults from A. A. Guerra; Blacksburg, Virginia, December 1, 1960; numbers of adults found moribund in the field. Hyphae emerged shortly after they were brought into the laboratory. Diagnosis: Mycosis. *Beauveria bassiana*.

Hypera punctata (Fabricius)

596—Ten larvae from E. Clark; Berkeley, California, March 12, 1951; collected

on clover. Diagnosis: Cause of death undetermined; nonmicrobial.

691—Several larvae from F. F. Dicke; Knoxville, Maryland, September 17, 1951; suspected infection with *Entomophthora sphaerosperma*. Diagnosis: Mycosis. Entomophthorales; material not viable for further identification.

1026—Two larvae from T. C. Lawrence; Berkeley, California, April 12, 1955; field-collected. Diagnosis: Nonmicrobial death.

Hypera saulcyi Capiomont

1680—Flask with triturated larvae suspended in distilled water from I. Harpaz; Rehovot, Israel, October 28, 1960; laboratory culture which exhibited a high mortality. Diagnosis: No specific pathogen noted or isolated. Saprophytic bacteria present, but negative for other major groups of entomogenous organisms.

Listrodercs costirostris obliquus (Klug)

1349—Ten larvae from F. Wilson; Canberra, Australia, October 27, 1958; laboratory-reared. Diagnosis: No pathogen found. Bacteria present but varied in kind from larva to larva. Two small gram-positive rods isolated which could have been secondary cause of death.

Pantorhytes proximus Faust

1330—Nine adults from J. J. H. Szent-Ivany; Buba (Markham Valley), Territory of Papua and New Guinea, September 3, 1958; adults field-collected from cocoa trees and held in laboratory. Diagnosis: Mycosis. *Beauveria bassiana*.

Pissodes fasciatus LeConte

1453—Two larvae from P. W. Orr; Central Point, Oregon, July 13, 1959; larvae collected from root collar of young Douglas fir. Woodlot was treated with malathion, but larvae appear to have died from some microbial pathogen. Diagnosis: Mycosis. *Beauveria bassiana*.

Raymondionymus (Schizomicrus) caecus (Casey)

902—One adult from E. E. Gilbert; Marin County, California, October 14, 1953; field-collected. Diagnosis: No pathogen found.

Rhabdoscelus obscurus (Boisduval)

826—One larva from D. D. Questel; Belle

Glade, Florida, July 8, 1952; field collection. Diagnosis: Mycosis. *Beauveria bassiana*.

Sitona hispidula (Fabricius)

721—Three adults from L. White; Modoc County, California, near Tule Lake, November 1, 1951; field collection on clover. Diagnosis: Mycosis. *Beauveria bassiana*.

928—Six adults from E. C. Turner; Blacksburg, Virginia, February 15, 1954; field-collected and artificially infected with presumed saprophytic fungus found on some dead specimens. Diagnosis: Mycosis. Probably *Beauveria bassiana*. Fungus not viable for culture.

1244—One larva from R. J. Lavigne; Amherst, Massachusetts, April 10, 1958; collected overwintering in soil. Diagnosis: Mycosis. *Beauveria bassiana*.

1268—Two adults from R. J. Lavigne; Amherst, Massachusetts, May 26, 1958; each specimen obviously attacked by a different fungus. Diagnosis: Mycosis. One specimen infected with *Beauveria bassiana*; the other had an external growth which proved to be a saprophytic *Penicillium* sp.

1292—Three larvae and pupae from R. J. Lavigne; Amherst, Massachusetts, July 7, 1958; laboratory-reared specimens. Diagnosis: Mycosis. *Beauveria bassiana*.

1301—Nematodes from dead larvae and pupae from R. J. Lavigne; Amherst, Massachusetts, July 23, 1958; nematodes found in dead and dying specimens which, when placed in formaldehyde-treated soil, would issue from the oral region of larvae, pupae, and newly emerged adults in large numbers. Some living larvae have been observed with nematodes just beneath the cuticle. Diagnosis: Nematosis. *Diplogaster* sp.

1331—One adult from R. J. Lavigne; Amherst, Massachusetts, September 15, 1958; field-collected from alfalfa soil sample. Diagnosis: Mycosis. *Hirsutella* sp.

1333—Four adults from R. J. Lavigne; Amherst, Massachusetts, September 15, 1958; collected from soil in alfalfa plot. Diagnosis: Mycosis. *Hirsutella entomophila*. (See fig. 16A, B, C, p. 386.)

DERMESTIDAE

Trogoderma glabrum (Herbst)

1571—Twenty-four larvae from B. H. Kantack; Lincoln, Nebraska, May 10, 1960; laboratory colony reared on whole-wheat-

Fig. 16. The entomogenous fungus *Hirsutella entomophila* Patouillard isolated from the clover root curculio, *Sitona hispidula* (Fabricius). A. Adult weevils with multiple synnemata. B. Photomicrograph of synnema apex with hairlike phialides and terminal conidia. C. Enlargement of phialides with inflated bases and detached spores. (Acc. No. 1333, p. 385.)

flour medium; mortality heavy in some cultures, light in others. No possibility of exposure to insecticides. Diagnosis: Protozoan infection. *Mattesia* sp.

Trogoderma inclusum LeConte and *T. simplex* Jayne

1214—Many larvae from G. H. Spitler; Mesa, Arizona, October 22, 1957; pathogen accidentally transmitted to *Trogoderma parabile* and *T. granarium*; the latter culture exhibited 50 per cent infection. Terminal four or five segments shrank, head capsule sank into first thoracic segment, and finally insect was unable to walk. Diagnosis: Schizogregarine infection. *Ophryocystis* sp., perhaps *O. mesnili*.

ELATERIDAE

Conoderus vespertinus (Fabricius)

1289—Nine larvae from R. L. Rabb; Clayton, North Carolina, July 2, 1958; field-collected and held in laboratory for rearing in small metal box. Diagnosis: Mycosis. *Metarrhizium anisopliae*.

1388—Three larvae from R. L. Rabb; Clayton, North Carolina, April 15, 1959; field-collected from soil samples. Dark thoracic area spreading slightly. Diagnosis: No specific pathogen found. Nematodes (*Diplogaster* sp.) directly associated with darkened thoracic areas. Yeasts, apparently saprophytic, were the dominant organism cultured.

1403—Eight larvae from R. L. Rabb; Raleigh, North Carolina, May 13, 1959; field-collected and reared in laboratory. Diagnosis: Two specimens which were rubbed with the carcass of a fungus-infected carabid adult were infected with *Metarrhizium anisopliae*. Other specimens harbored numerous nematodes (*Diplogaster* sp.), as well as miscellaneous gram-negative saprophytic bacteria. One pink, distended, and somewhat brittle specimen was filled with spores similar to *Sorospora* but culture was unsuccessful.

1441—Four larvae from R. L. Rabb; Clayton, North Carolina, July 9, 1959; after larvae became pink, slightly distended, and then brittle. Diagnosis: Mycosis. Unidentified. Spores somewhat resembled that of *Sorospora*, but could not be cultured.

Conoderus sp.

1410—One larva from R. L. Rabb; Clayton, North Carolina, May 25, 1959; found

in field while soil samples were being sifted; rigid and covered with white mycelium when collected. Diagnosis: Mycosis. *Metarrhizium anisopliae*.

Unidentified sp.

943—Seventeen larvae from C. E. Woodworth; Walla Walla, Washington, April 26, 1954; laboratory-reared. Diagnosis: Saprophytic *Mucor* sp., larvae killed with endrin prior to fungus infestation.

HYDROPHILIDAE

Tropisternus sp.

1643—Several adults and fragments from H. H. Keifer; Durham, California, September 9, 1960; collected by M. Poyner in a rice field. External fungus evident. Diagnosis: Mycosis. *Beauveria bassiana*.

LUCANIDAE

Sinodendron sp.

867—One larva from W. Hazeltine; Oakland Hills, California, January 20, 1953; field-collected. Diagnosis: No pathogen found.

NITIDULIDAE

Glischrochilus quadrasignatus (Say)

656—One adult from K. D. Arbuthnot; Ankeny Field Station, Des Moines, Iowa, August 2, 1951; field collection. Diagnosis: Saprophytic fungus, *Aspergillus* sp.

687—Two specimens from K. D. Arbuthnot; Ankeny, Iowa, September 12, 1951; field collection. Diagnosis: Mycosis. *Beauveria bassiana*.

693—Eighteen adults from K. D. Arbuthnot; Ankeny, Iowa, September 17, 1951; laboratory-reared. Diagnosis: Mycosis. *Beauveria bassiana*.

SCARABAEIDAE

Amphimallon majalis (Razoumowsky)

995—Seven larvae from H. L. Parker; Rueil-Malmaison, France, November 30, 1954; field-collected. Diagnosis: Nematode infection. Nematodes unidentified. Other specimens with bacteremia caused by *Bacillus cereus* var. *mycoides*.

1562—Ten larvae from H. Tashiro; Geneva, New York, April 20, 1960; field-

collected and held in soil in storage trays at 1.67 to 4.44°C for about 6 months prior to experimentation. Mortality greater than predicted. Diagnosis: No definite pathogen found. Rickettsia negative. Small gram-positive streptococcus isolated as well as *Bacillus cereus* var. *mycoides*.

Anomala sp.

744—Several larvae from W. Büttiker; Salisbury, Southern Rhodesia, Africa, January 17, 1952; field collection. Diagnosis: No pathogen found.

Aphodius sp.

1130—Several larvae from R. W. Lauderdale; Elko County, Nevada, November 21, 1956; larvae with darkened area from center to tip of abdomen; presumably damaging pasture grasses. Diagnosis: Bacteriosis. Coliforms abundant.

Geotrupes mutator Marsh

730—Fat body in paraffin block from J. Théodoridès; Moulis, Ariège, France, November 29, 1951; brown corpuscles in tissue. Diagnosis: Physiological abnormality, amicrobial.

Heteronychus sanctaehelenae Blanchard

1008—One slide (histological cross section) from R. L. Beard; Canberra, Australia, January 7, 1955; field-collected. Diagnosis: Coccidiosis. Appears to be a new species.

Hoplia oregona LeConte

953—Four larvae from L. G. Smith; Hollister, California, June 1, 1954; field-collected on strawberries. Diagnosis: Nematoda, immature stages only, probable pathogen.

Lachnosterna sp.

1236—Numerous nematodes from *Lachnosterna* and five adult lyctids from V. P. Rao; Bangalore, India, March 12, 1958; field-collected. Diagnosis: Nematode infection. *Rhabditis* sp., near *maupasi*.

Oryctes rhinoceros Linnaeus

629—One adult male beetle from E. A. Steinhaus; Ngerabeth Village, Koror, Palau Islands, June 6, 1951; removed from rotting palm stump. Diagnosis: Mycosis. *Metarrhizium anisopliae*.

631—One adult from E. A. Steinhaus; Melekogok on Babelthau, Palau Islands,

June 19, 1951; field collection. Diagnosis: Mycosis. *Metarrhizium anisopliae*.

632—Twelve dead larvae from E. A. Steinhaus; Koror, Palau Islands, June 21, 1951; larvae artificially infected with milky disease spores. Diagnosis: Spores of *Bacillus popilliae* not recovered from larvae.

636-638—Ten dead larvae from E. A. Steinhaus; Koror, Palau Islands, June 28, 1951; larvae artificially infected with *Bacillus popilliae* spores. Diagnosis: Larvae negative for milky disease. *Serratia marcescens* isolated from two specimens. (See Steinhaus, 1959a.)

644—Five dead larvae from E. A. Steinhaus; Koror, Palau Islands, July 10, 1951; larvae represent single specimens from different infectivity experiments with *Bacillus popilliae*, *Bacillus thuringiensis*, and *Aspergillus* sp. Diagnosis: Results negative or inconclusive.

648-651—Thirty dead larvae from E. A. Steinhaus; Koror, Palau Islands, July 16-24, 1951; larvae from various infectivity experiments, using *Beauveria bassiana*, *Bacillus popilliae* and *Bacillus thuringiensis*. Diagnosis: No conclusive evidence of pathogenicity from the various organisms applied.

655—Nineteen dead larvae from E. A. Steinhaus; Koror, Palau Islands, July 30, 1951; larvae from infectivity experiments using *Bacillus popilliae* and *Bacillus thuringiensis*. Diagnosis: Original pathogens not recovered although larvae died.

716—Three dead larvae from R. P. Owen; Melekiok, Palau, Caroline Islands, October 25, 1951; field-collected in area where milky disease spores were previously released by E. A. Steinhaus. Diagnosis: No pathogens isolated.

738—Twenty slides (smears) made from gut contents, submitted by J. L. Gressitt; Koror, Palau, Caroline Islands; December 17, 1951; to be examined for presence of mutualistic protozoa. Diagnosis: No protozoa or other mutualistic symbiotes found. Normal intestinal bacteria present. (See also Accession No. 757 below.)

757—Nine slides (smears) from J. L. Gressitt; Koror, Palau, Caroline Islands, February 25, 1952; to be examined for protozoan mutualists. Diagnosis: No protozoa observed. (See also Accession No. 738 above.)

852—Several larvae from H. A. Bess; Pago Pago, Samoa Islands, October 31,

1952; field-collected. Diagnosis: Mycosis. *Metarrhizium anisopliae*.

1137—One larva from T. V. Venkatraman; Tananarive, Madagascar, January 9, 1957; field collection. Diagnosis: Mycosis. *Cordyceps* sp.

1246—Liquid from triturated larvae from G. Dun; Keravat, New Britain, South Pacific, April 18, 1958; larvae collected in rubbish at base of oil palm. Suspected of having "blue disease." Diagnosis: No pathogens observed or isolated after extensive centrifugation and electron microscopy.

1248—Repetition of Accession No. 1246 above.

1668—Two fungus slants isolated from larvae collected by A. Muljikul and submitted by Sothorn Prasertphon; Bangkok, Thailand, October 12, 1960; isolated from field-collected larvae. Diagnosis: Mycosis. *Metarrhizium anisopliae*.

1719—Five lots of larvae from V. P. Rao; field collections from five different areas of India and Assam, March 14, 1961; larvae all black and sluggish when collected from manure heaps in each of the five localities. In each case, the extent of ailing larvae was restricted to those collected and the incidence of disease was considered to be rare. Diagnosis: No definite pathogen found from four lots of larvae. Bacteria, such as small gram-negative rods, cocci, and *Bacillus cereus* were present but reflected the nature of the collection site. However, larvae collected at Hajo, near North Gauhati, Assam, harbored large numbers of nematodes (*Rhabditis* sp.) some species of which are known to be parasitic.

Phyllophaga sp.

722—One pupa from J. H. Lilly; near Beaconsfield, Iowa, November 3, 1951; from pasture soil. Diagnosis: Mycosis. *Beauveria bassiana*.

Polyphylla barbata Cazier

582—Four larvae from W. Hazeltine; Mount Hermon, California, January 17, 1951; field collection. Diagnosis: Mechanical injury when insect was dug up from soil; bacteria present, some sporeformers and small gram-negative rods.

587—One larva from W. Hazeltine; Mount Hermon, California, February 8, 1951; from laboratory culture. Diagnosis: No pathogen found. Saprophytic bacteria isolated.

628—Two larvae from W. Hazeltine; Mount Hermon, California, June 9, 1951; field collection. Diagnosis: Mycosis. *Metarrhizium anisopliae*.

694—One larva from W. Hazeltine; Mount Hermon, California, September 20, 1951; field-collected, held in laboratory for rearing. Diagnosis: Bacteremia, gram-positive sporeformer predominated, also *Clostridium* sp. isolated.

817—Two larvae from W. Hazeltine; Mount Hermon, California, June 6, 1952; dug from soil and held in laboratory. Diagnosis: No pathogen found. Death probably caused by metabolic dysfunction. Opaque fat tissue contained some crystals.

828—Two larvae from W. Hazeltine; Mount Hermon, California, July 14, 1952; field-collected. Diagnosis: Bacteremia. Gram-positive coccus and small gram-negative, lactose-negative rod.

Polyphylla decemlineata (Say)

724—Three larvae from A. J. Walz; Wilder, Idaho, November 13, 1951; from sugarbeet field. Diagnosis: Bacteremia. *Bacillus cereus* and *Streptococcus* sp.

1551—Seven larvae from R. F. Wilkey; Mills, Sacramento County, California, March 7, 1960; specimens collected by W. G. Golden in a field which had been treated with aldrin approximately one year previously. Diagnosis: No pathogen observed or isolated. In cultures there occurred a light bacterial growth of a small gram-negative, lactose-negative rod.

Polyphylla fullo (Linnaeus)

1221—Many mites from insect larvae from K. Sidor; Cambridge, England, January 10, 1958; larvae collected in sandy soils; about 20 mites per larva which left when beetle died. Diagnosis: Mites of the family Laelaptidae. Potential predator. Specimens forwarded to J. O. Evans at the British Museum by A. E. Pritchard.

Popillia japonica Newman

580—Seven larvae from S. R. Dutky; Moorestown, New Jersey, January 11, 1951; insectary-reared, inoculated with "blue disease." Diagnosis: Septicemia. *Rickettsiella popilliae* very numerous.

675—Larva from F. W. Elder; Wooster, Ohio, August 30, 1951; specimen lost en route.

Fig. 17. The fungus *Cordyceps melolonthae* (Tulasne) Saccardo growing from two unidentified scarabaeid larvae collected in Guatemala City, Guatemala. (Acc. No. 1348, below.)

Schizonycha sp.

745—Several larvae from W. W. G. Büttiker; Salisbury, Southern Rhodesia, Africa, January 17, 1952; field collection. Diagnosis: No microbial pathogen found.

Unidentified spp.

749—One adult from J. W. MacSwain; Pleasant Hill, California, February 1, 1952; field collection. Diagnosis: Unidentified nematodes adhering to elytra of dung beetle.

773—Several larvae fixed in Carnoy alcohol from W. W. G. Büttiker; Salisbury, South Africa, March 20, 1952; field-collected. Diagnosis: Few bacteria present in sections; of no apparent significance. Otherwise nonmicrobial.

1206.—Five larvae from Pedro José Cuculiza; near Managua, Nicaragua, July 24, 1957; removed from soil. Diagnosis: Mycosis. *Cordyceps melolonthae* var. *rickii*.

1222—One larva from D. Burdick; Point Reyes, Marin County, California, January

20, 1958; removed from soil among grass roots; some fungal growth evident. Diagnosis: No pathogens associated with death. Only soil bacteria and *Mucor* sp. isolated.

1348—Ten larvae from Lucy Hastings de Gutiérrez; Guatemala City, Guatemala, October 27, 1958; collected by Carlos Tejada from his garden. Diagnosis: Mycosis. *Cordyceps melolonthae*. Verified by E. B. Mains. (See fig. 17, above.)

SCOLYTIDAE

Conophthorus lambertianae Hopkins

1114—Five larvae from H. Ruckes, Jr.; Lake Almanor, California, July 31, 1956; collected on *Pinus lambertiana*. Diagnosis: Possible mycosis. *Pullularia* sp. Silkworms not susceptible to infection by topical contact.

1118—Four larvae from H. Ruckes, Jr.; Hat Creek, Shasta County, California, August 21, 1956; removed from cones of *Pinus lambertiana*. Diagnosis: No microorgan-

isms of any kind in significant numbers. Abnormal amounts of concretions (urates) present in body cavity.

1154—Four adults from H. Ruckes, Jr.; Pinecrest, Tuolumne County, California, May 6, 1957; collected from sugar pine. Diagnosis: Microsporidiosis. *Nosema* sp. in one specimen. Other three overgrown with saprophytic fungi.

1171—Seven adults from H. Ruckes, Jr.; Miami Field Base, Mariposa County, California, May 20, 1957; field-collected from sugar pine. Diagnosis: Nonmicrobial death.

1179—Six larvae from H. Ruckes, Jr.; 40 miles northeast of Northfork, Madera County, California, July 5, 1957; larvae were dead on removal from sugar-pine cones. Diagnosis: Bacteriosis. Abundant gram-negative rods on culture. Direct smears also exhibited numerous pleomorphic rods; possibly symbiotes.

1183—Nineteen larvae from H. Ruckes, Jr.; Tuolumne County, California, July 16, 1957; collected from sugar-pine cones which were reported to have an abnormally high yeast flora. Diagnosis: One specimen infected with numerous unidentified nematodes. Others contained heavy yeast flora, while still others contained numerous uratic concretions in body cavity.

Conophthorus ponderosae Hopkins

1280—Numerous larvae from H. Ruckes, Jr.; Pinecrest, Tuolumne County, California, June 20, 1958; field-collected. Diagnosis: Bacteriosis. Numerous miscellaneous gram-negative rods and some unidentified crystals.

Dendroctonus brevicomis LeConte

682—Forty-one larvae from S. Hoyt; Lake Arrowhead, California, September 7, 1951; field collection. Diagnosis: Secondary bacteremia.

1296—One larva from G. M. Thomas; Placerville, California, July 17, 1958; collected by R. H. Smith in bark of ponderosa pine in fall of 1957. Stored at 40° C until June, 1958, and kept at prevailing room temperature for 6 days until death. Diagnosis: Mycosis. *Spicaria* sp.

Dendroctonus engelmanni Hopkins

914—Four adults from M. G. Thompson; Bolean Lake area, British Columbia, Canada, December 14, 1953; field-collected. Diagnosis: Nematode infection. *Tylenchinema*

sp.; internal parasite which prevents normal gonadal development.

931-932—Sixty-four adults dead and moribund from P. C. Johnson and J. C. Evenden; Kootenai National Forest, Montana, March 1 to 3, 1954; field-collected on Engelmann and Canada spruce, some held in bark in laboratory for 8 days. Diagnosis: Cause of death undetermined. Numerous saprophytic yeasts, miscellaneous bacteria, and wood-rot fungus present.

939—Twenty-four larvae from J. C. Evenden; St. Joe National Forest, Avery, Idaho, April 4, 1954; field-collected on Engelmann spruce. Diagnosis: Exact cause of death undetermined but excessive numbers of yeasts and coliform bacteria in alimentary tract and body cavity probably were partially responsible.

Dendroctonus monticolae Hopkins

772—Ten larvae from G. Struble; Fish Camp, California, March 19, 1952; found dead in galleries in sugar pine. Diagnosis: Two bacteria isolated: *Flavobacterium* sp., near *F. diffusum*, and a coliform. Probably not pathogenic.

1223—Several larvae and adults from A. Moore; Grass Valley, California, January 23, 1958; freshly dead larvae assumed reddish color as they lay in their burrows. Diagnosis: Bacterial septicemia. *Serratia marcescens*. (See Steinhaus, 1959a.) Bacterium readily isolated from all specimens examined.

Dendroctonus pseudotsugae Hopkins

892—Sixteen larvae in alcohol from V. F. McCowan; western Oregon, September 10, 1953; field collection. Diagnosis: No pathogen observed.

1117—Twenty-five adults from M. M. Furniss; Idaho, August 20, 1956; collected from phloem of *Pseudotsuga menziesii* where considerable mortality has been noted. Diagnosis: Bacteriosis. Small, gram-negative, lactose-negative rods recovered in large numbers.

1162—Twenty dead and seven normal adults from M. M. Furniss; Buckhorn Creek, 4 miles south of Krassel Ranger Station, Valley County, Idaho, May 14, 1957; overwintered callow adults removed from phloem area of Douglas fir; approximately 10 per cent mortality estimated in spring brood. Diagnosis: Nematode infection. Either *Tylenchinema* or *Aphelenchulus*. Only immature nematodes recovered. Mis-

cellaneous yeasts and bacteria also present.

1561—Eighteen larvae from R. L. Furniss; near Chehalis, Washington, and Camp Baker, Washington, April 18, 1960; field-collected from wind-thrown Douglas fir trees of the 1958 season; high mortality in overwintering larvae, some flaccid, others turgid. Diagnosis: No pathogen found. Most specimens with large numbers of saprophytic bacteria and yeasts. *Fusarium* sp. also found in some specimens.

Dendroctonus terebrans (Olivier)

1379—Numerous larvae from W. D. Buchanan; Eminence, Missouri, March 2, 1959; collected from short-leaf pine. Diagnosis: No pathogen found. Body cavity filled with, and fat tissue essentially replaced with, irregular calcareous bodies. Inclusions had no relationship with a virus disease; appeared to resemble products of a metabolic disturbance.

1548—Numerous specimens from W. D. Buchanan; Willow Springs, and Salem, Missouri, February 24, 1960; collected from short-leaf pine. Diagnosis: No pathogen found. Some unidentified gregarines present.

1565—Four larvae from W. R. Holt; Woolmarket, Mississippi (Biloxi, R. D. De Soto National Forest) April 29, 1960; about one half of larvae under bark of loblolly pine stump (*Pinus taeda*) infected with pupal cavities filled with white mycelium. Live larvae collected from same stump and from other trees in immediate area not infected and reared to maturity with no mortality. Diagnosis: Mycosis. *Mctarrhizium anisopliae*. (See Holt, 1961.)

Ips confusus (LeConte)

1528—One adult from A. Berryman; Berkeley, California, November 16, 1959; specimen found in sample of bark which was brought into a laboratory for rearing purposes. Diagnosis: Mycosis. *Beauveria bassiana*.

Scolytus multistriatus (Marshall)

1426—Numerous pupae from J. P. Kramer; Chicago, Illinois, June 18, 1959; sent in segment of American-elm bark. Diagnosis: Mycosis. *Beauveria bassiana* isolated from only one specimen. Other specimens with surface contaminants of *Penicillium* sp. and *Fusidium* sp. but no definite pathogen found.

Xyleborus fornicatus Eichhoff

827—Several specimens from G. O. Austin; Ratnapura, Ceylon, July 11, 1952; field-collected. Diagnosis: Bacteremia. *Brevibacterium* sp.; gram-positive coccus also present.

Unidentified sp.

1622—Fungus associated with scolytid galleries from R. C. Thatcher; Nacogdoches, Texas, August 8, 1960; section of loblolly pine with fungus under bark and in galleries; no beetles present but the organism is suspect because of observed brood mortality. Diagnosis: *Trichoderma* sp. Either *Trichoderma viride* or *Trichoderma koningi*. Significance in relation to the southern pine beetle unknown.

STAPHYLINIDAE

Philonthus brunneus (Gravenhorst)

1724—Two adults from M. I. Blenderman; Middle Island, Suffolk County, Long Island, New York, March 29, 1961; point-mounted specimens presumed to be infected with a fungus. Patches of funguslike material attached to the prothorax and on the mesosternum just anterior to the mesocoxae; superficially resembled tufts of a Laboulbeniales from a gross aspect. Adults collected from rotted melons. Diagnosis: Nematode association. Tufts represented sexually immature clusters of nematodes attached to the cuticle by their cephalic ends. A similar relationship was described by Triffitt and Oldham (1927), who found *Aphodius* infested with *Rhabditis coarctata* Leuckart. (See fig. 18, p. 393.)

TENEBRIONIDAE

Gnathocerus cornutus (Fabricius)

1725—Twenty-six larvae from F. K. Ho; Berkeley, California, March 31, 1961; Department of Genetics laboratory cultures. Check for Microsporidia requested. Diagnosis: No pathogen found. Microsporidiosis-negative. Microorganisms scarce, mainly gram-positive cocci, and a gram-positive, nonsporeforming, pleomorphic bacterium.

1762—Several late-instar larvae from F. K. Ho; Department of Genetics, University of California, Berkeley, June 27, 1961; occasional deaths noted in experimental laboratory culture. Diagnosis: No pathogen found or isolated. Some evidence of cannibalism.

Fig. 18. Immature rhabditoid nematodes from the staphylinid beetle *Philonthus brunneus* (Gravenhorst) where they form padlike clusters on the cuticle. Whole mount of a small cluster of dauer larvae radiating from the previously attached anterior ends. (Acc. No. 1724, p. 392.)

Tenebrio molitor Linnaeus

581—Haemolymph smear slides of two larvae from D. L. Shankland; Urbana, Illinois, January 15, 1951; insectary-reared. Diagnosis: Bacteriosis. Unidentified gram-positive cocci and gram-negative rods.

1173—One larva from J. Arnold; Berkeley, California, June 4, 1957; laboratory-reared. Diagnosis: No pathogen isolated. Cause of death probably nonmicrobial.

1189—One pupa from J. Arnold; Berkeley, California, July 30, 1957; laboratory-reared. Diagnosis: Bacterial septicemia. *Serratia marcescens*.

Tribolium castaneum (Herbst)

920—Thirty-two adults from J. Weiser; Praha, Czechoslovakia, December 18, 1953; laboratory culture. Diagnosis: Protozoan infection. *Farinocystis tribolii*; confirmation of Weiser's determination.

1310—Several adults, both dead and ailing, from F. K. Ho; Berkeley, California, August 5, 1958; laboratory stock from Genetics Department; original black mutant strain from Purdue University. First deaths noticed after having reared two generations in Berkeley. Diagnosis: Protozoan disease. Identified by J. Weiser as *Farinocystis tribolii*.

1566—Many adults from F. K. Ho; Berkeley, California, April 29, 1960; special laboratory-reared genetic strain, larvae appeared normal but adults died with genitalia partially extruded. Diagnosis: No pathogen observed or isolated in conjunction with observed symptoms.

1567—Numerous larvae and adults from F. K. Ho; Berkeley, California, May 3, 1960; different genetic strain and culture from that reported in Accession No. 1566 above; mortality heavy. Diagnosis: Microsporidiosis. *Nosema whitei*.

Tribolium confusum Jacquelin duVal

921—Twenty-four adults from J. Weiser; Praha, Czechoslovakia, December 18, 1953; laboratory culture. Diagnosis: Protozoan infection. *Adelina tribolii*, confirmation of Weiser's determination.

1723—Over forty pupae and adults from F. K. Ho; Berkeley, California, March 29, 1961; laboratory culture from Department of Genetics; check for microsporidiosis requested. Diagnosis: No pathogen found. Some gram-positive cocci present in small numbers. Death probably due to causes other than microorganisms.

1733—Numerous larvae and fragments of adults from R. W. Zwick; Pullman, Washington, April 13, 1961; heavy mortality in experimental laboratory cultures. Colony in question begun with ovipositing adults, January 20, 1961. Many first and second instars present but late instars did not survive to pupate. No F₁ generation produced. Late-instar larvae were abnormally white and distended, and movement was restricted or feeble. Many cadavers showed evidence of cannibalism. Diagnosis: Microsporidiosis. *Nosema* sp., probably *Nosema whitei*.

1739—Many larvae and adults from F. K. Ho; Berkeley, California, May 4, 1961; experimental culture from University of California, Department of Genetics; exhibited a higher than normal mortality. Considerable cannibalism noted as well. Diagnosis: Microsporidiosis. *Nosema whitei*. Light infection.

1744—Entire colony of larvae, pupae and adults from F. K. Ho; Berkeley, California, May 10, 1961; experimental culture from Department of Genetics, University of California, exhibiting considerable mortality over a prolonged period of time. Conditions were similar to those described for Accession No. 1739 above, but the present speci-

mens represented a different genetic strain of the insect, which had been isolated from the other strain. Diagnosis: Microsporidiosis. *Nosema whitei*.

1830—Five larvae and adults from F. K. Ho; Berkeley, California, December 28, 1961; laboratory culture from Genetics Department previously infected with *Nosema whitei*. Diagnosis: No pathogen associated with specimens.

Tribolium destructor Uyttenboogaart

1311—Numerous larvae and three adults from F. K. Ho; Berkeley, California, August 7, 1961; laboratory-reared for genetic studies. Protozoan diseases. Double infection with *Nosema whitei* and *Farinocystis tribolii*.

1763—More than fifty late-instar larvae from F. K. Ho; Department of Genetics, University of California, Berkeley, June 27, 1961; extremely high mortality. About 60 per cent of the specimens submitted had black and brown blotches scattered over the cuticle; others were completely discolored. Diagnosis: Microsporidiosis. *Nosema* sp., probably *Nosema whitei*.

Unidentified spp.

589—Specimen from R. E. Ryckman; Routes 60 and 70, 2 miles east of Colorado River, Arizona, February 14, 1951; field collection. Diagnosis: Nematode infection.

647—One live adult specimen from I. Wilsey; Jewel Lake near Berkeley, California, July 6, 1951; white growth on insect cuticle. Diagnosis: Colonial coelenterate.

719—One adult specimen, three larvae from H. L. Hansen; Farallon Islands, California, October 30, 1951; found under a rock. Diagnosis: Secondary bacteremia. Gram-positive streptococci.

COLLEMBOLA

SMINTHURIDAE

Sminthurus viridis (Linnaeus)

1212—Many specimens from M. M. H. Wallace; Waroona, Kelmscott, and Nedlands, Western Australia, October 4, 1957; drastic population decrease within 1-week period each year (August). Brown cuticular spots may or may not indicate disease. Diagnosis: Brown spots not associated with microorganisms. No pathogen observed or isolated.

1337-1338—Numerous adults from M. M. H. Wallace; 6 miles west of Waroona, Western Australia, September 24, 1958; adults found dead, lying on ground in an area which averaged 1,000 to 2,000 per 58 square inches. Diagnosis: No pathogen found. Body cavity filled with opaque white material composed of inorganic crystals.

DERMAPTERA

FORFICULIDAE

Forficula auricularia Linnaeus

614—Two histological slides from W. T. Walsh; Berkeley, California, May 1, 1951; field collection. Diagnosis: Gregarines, probably *Gregarina ovata*.

LABIDURIDAE

Anisolabis maritima (Géné)

1232—One ailing adult from J. Arnold; Berkeley, California, February 14, 1958; field-collected and reared in laboratory on dog food and glycerine in a covered dish containing damp cotton. Localized mycosis developed just behind head on ventral side. Insect weak and dying when submitted. Diagnosis: Mycosis. *Mucor* sp.; perhaps secondary to an injury.

DIPTERA

AGROMYZIDAE

Liriomyza agraria Frick

1014—Twelve pupae from E. R. Oatman; Albany, California, February 14, 1955; insectary-reared. Diagnosis: Nonmicrobial deaths.

1070—Forty-eight pupae from E. R. Oatman; Patterson, California, October 27, 1955; field-collected. Diagnosis: Nonmicrobial death.

Liriomyza pictella Thomson

1087—Seventeen pupae from E. R. Oatman; Berkeley, California, February 29, 1956; laboratory-reared on bush lima beans. Diagnosis: Mycosis. Undetermined saprophytic fungus present.

Phytomyza ulicis (Curtis)

1149—Ten larvae from E. C. Crafts; Amherst, Massachusetts, April 22, 1957; re-

moved from leaves of *Ilex glabra*. Diagnosis: No pathogen found.

ASILIDAE

Stenopogon sp. (*breviusculus* group)

1760—One adult from R. J. Lavigne; Glendo, Wyoming, June 21, 1961; found dead with caudal end sticking out of soil, and with a mite actively running about on its surface. Diagnosis: No pathogen found. Appears to have been trapped in puparial exuvia since the lower portion of the head, wings, and legs were still encased, with the dorsum free. Saprophytic *Mucor* sp. isolated from hollow body cavity. Mite associated with the asilid was a species of *Tarsotomus* which is predaceous on other mites and on small insects.

Unidentified spp.

829—One specimen from W. Hazeltine; locality unknown, July 21, 1952. Diagnosis: Mycosis. *Metarrhizium anisopliae*.

1700—Four larvae from R. J. Lavigne; Glendo and Guernsey, Wyoming, February 6, 1961; larvae dug up from soil survey samples taken in a range grass area. Larvae appeared to be mummified. Diagnosis: No specific pathogen isolated or observed. Orange chromogenic yeast present in large numbers along with *Penicillium* sp. and *Fusarium* sp.

1747—One dead larva from R. J. Lavigne and R. Pfadt; Glendo, Wyoming, May 18, 1961; larva removed from soil sample taken from an area on which prairie grass was growing. Appeared mummified. Diagnosis: No pathogen found. Larva filled with mycelium of a *Penicillium* sp. and an orange chromogenic yeast, both saprophytic.

BOMBYLIIDAE

Heterostylum robustum Osten Sacken

775—Several specimens from H. F. Menke; Wapat, Washington, April 1, 1952; collected from nesting site of *Nomia melanderi* Cockerell. Diagnosis: Spherical bodies (metabolic products) in fat tissue, otherwise negative.

784—Several normal larvae from H. F. Menke; Wapat, Washington, April 21, 1952; sent for comparative purposes with Accession No. 775 above. Diagnosis: Spherical, crystal-like bodies found in fat tissue; similar to that in Accession No. 775.

Unidentified sp.

1099—Specimen from K. E. Frick; Prosser, Washington, April 30, 1956; collected in association with *Nomia* parasitization. Diagnosis: No evidence of microbial infection.

BORBORIDAE

Unidentified sp.

709—One adult from S. J. Kirkwood; San Benito County, California, October 15, 1951; field collection. Diagnosis: Mycosis. *Entomophthora muscae*.

CALLIPHORIDAE

Calliphora sp.

1126—Eight moribund larvae from B. V. Travis; Ithaca, New York, November 9, 1956; laboratory-reared specimens. Diagnosis: No pathogen found. Saprophytic bacteria invaded body cavity from gut and may have hastened death.

Phormia regina (Meigen)

1492—Four dead and ten normal larvae from R. J. Lavigne; Glendo, Wyoming, August 26, 1959; collected from the decaying carcass of a calf. Diagnosis: No definite pathogen observed or isolated. Dead larvae with *Escherichia coli* fairly numerous in hemocoel.

Unidentified spp.

708—Several adults from J. H. Lilly; Omaha, Nebraska, October 13, 1951; thousands clinging to timothy heads in vacant lot. Diagnosis: Mycosis. *Entomophthora muscae*.

1709—Eighteen adults from B. Meksongsee; Bangkok, Thailand, February 20, 1961; dead adults found clinging to grass inflorescence. Diagnosis: Mycosis. *Entomophthora* sp. Conidia comparable with description of *E. muscivora*, but there were no resting spores present to confirm this tentative identification.

CHAMAIMYIIDAE

Leucopis puncticornis Meigen

1782—Six adults from V. P. Rao; Bangalore, India, August 14, 1961; insects found stuck to leaf surface at the abdomen with what appeared to be a yellow secretion at the sides. Diagnosis: Mycosis. *Entomophthora calliphorae*.

CHIRONOMIDAE

Tendipes plumosus (Linnaeus)

1631—Eight larvae from W. Hilsenhoff; Lake Winnebago, Winnebago County, Wisconsin, August 26, 1960; larvae collected from mud bottom at a depth of 18 to 20 feet. The population averaged about 250 per square foot. Eleven per cent had white patches under the cuticle. Diagnosis: Microsporidiosis. *Thelohania* sp.

1691—Five larvae from W. Hilsenhoff; Lake Winnebago, Winnebago County, Wisconsin, December 12, 1960; field-collected on October 7, 1960, and maintained in the laboratory. Fat body somewhat opaque and resembling a potential microsporidiosis. Diagnosis: No pathogen found. Fat body cells filled with numerous crystalline inclusions of a nonviral nature. May represent a physiological disorder.

CHLOROPIDAE

Oscinella sp.

875—Specimen from I. M. Newell; Honolulu, Hawaii, July 6, 1953. Diagnosis: *Penicillium* sp. and small gram-negative rods; probably not pathogenic.

CORDYLURIDAE

Scatophaga stercoraria (Linnaeus)

1249—One adult from J. Powell; Berkeley, California, April 28, 1958; field-collected. Diagnosis: Mycosis. *Entomophthora muscae*.

1254—Several adults from W. W. Middlekauff; Livermore, Alameda County, California, April 30, 1958; large numbers of dead flies clinging to grass and weeds. Diagnosis: Mycosis. *Entomophthora muscae*.

1258—Many adults from H. Graham; Corral Hollow, near Livermore, Alameda County, California, May 9, 1958; vegetation in an area of about an acre near a pond covered with dead flies. Diagnosis: Mycosis. *Entomophthora muscae*.

1260—Numerous specimens from R. L. Doult; Mount Diablo, Contra Costa County, California, May 12, 1958; mortality of epizootic proportion. Diagnosis: Mycosis. *Entomophthora muscae*.

1264—Two adults from R. F. Smith; 4 miles south of Dos Palos, Fresno County, California, May 15, 1958; field-collected. Diagnosis: Mycosis. *Entomophthora muscae*.

1386—One adult female from A. Panasenka; 15 miles south of Petaluma, Marin County, California, April 8, 1959; field-collected. Diagnosis: Mycosis. *Entomophthora muscae*.

Scopeuma stercorarium (Linnaeus)

612—Two adults from H. L. Hanson; Mount Hebron, California, April 30, 1951; field collection. Diagnosis: Mycosis. *Entomophthora* sp., near *muscae*.

CULICIDAE

Aedes nigromaculis (Ludlow)

1176—Numerous larvae and four adults from C. L. Judson; Fresno, California, June 19, 1957; collected from pools formed from irrigation and rain runoff. Diagnosis: Darkening in area of siphon not of microbial origin.

Aedes taeniorhynchus (Wiedemann)

1512—Ovarial tissue from adult taken in a light trap from P. T. M. Lum; Vero Beach, Florida, September 25, 1959; field-collected. Diagnosis: Mycosis. *Coelomomyces* sp., near *psorophorae*. Spores slightly small and with thinner wall than typical for this species of fungus.

1525—Triturated larval and adult tissue from P. T. M. Lum; Vero Beach, Florida, November 6, 1959; *Coelomomyces* infection suspected. Diagnosis: No pathogen found. Suspected bodies not fungus spores.

Anopheles benarrochi Gabaldon

1718—Histological slide from R. T. Taylor; Bogota, Columbia, March 14, 1961; portion of stomach stained with eosin Y and containing a peculiar cystlike body which did not resemble a *Plasmodium* oocyst. Diagnosis: Unable to make a positive determination of the cyst. Possibly represents a stage in the life history of another protozoan.

Anopheles freeborni Aitken

590—Two female stomachs containing fungus masses, from J. Stuntz; Yuba City, California, February 14, 1951; vial smashed in transit. Material too damaged to examine.

1572—Two bacterial slant cultures from C. G. Huff; Bethesda, Maryland, May 10, 1960; bacterial cultures isolated from mosquito salivary glands which were found to

be grossly contaminated with bacteria. Diagnosis: *Flavobacterium* sp., near *lutescens*. Enough differences present that it could be a distinct and undescribed species.

Anopheles funestus Giles and *A. gambiae* Giles

1161—Five microscope slides from M. E. C. Giglioli; Liberia, Africa, May 14, 1957; material infected with *Coelomomyces* sp. Diagnosis: Mycosis. The following data are extracted from a report of J. N. Couch: Larval whole mounts of *Anopheles funestus* from Balatva and Bailma, Liberia, infected with *Coelomomyces africanus* Walker. Two slides of ovaries of *A. funestus* from Kapeta, Liberia, infected with new species of *Coelomomyces* possibly related to *C. uranotaeniae* Couch. A slide of *A. gambiae* from Gbedin, Liberia, contained a further new species of *Coelomomyces*.

Anopheles pseudopunctipennis Theobald

1606—Two histological slides of stomach tissue of adults from J. R. Austin; San Salvador, El Salvador, July 10, 1960; of 225 dissections, 11 were infected with peculiar cysts of 19.4 to 138 μ which contain large numbers of lunulate bodies 5.4 μ long and 1.3 μ wide. In one case a stomach contained dark spores, as represented on the second slide. Diagnosis: Protozoan infection. Possibly an unnamed gregarine similar to that described by Johnson (1902). May also possibly represent a malarial form inhabiting one of the local native animals since it does not correlate with one of the well-known or familiar species. The black spores on the second slide are fungal in nature but further identification was not possible.

Anopheles sundaicus (Rodenwaldt)

1778—One dead and desiccated adult from D. A. Muir; Tjilatjap, Mid-Java, Indonesia, August 8, 1961; originally, as observed by submitter, abdomen greatly distended with clear fluid in coelom, stomach filled with blood. Malpighian tubules completely opaque white, insect had difficulty in moving; marked peristalsis in stomach wall from hind to front end. Diagnosis: No pathogen found in spite of thorough examination for pathogens relating to described abnormalities.

Culex tarsalis Coquillett

1215—Many dead and normal larvae from C. L. Judson; near Fresno, California,

October 24, 1957; collected as egg rafts in irrigated pasture, hatched and reared in laboratory. Excessive and rapid mortality unlike rearings from other collection sites. Diagnosis: No pathogenic microorganisms observed or cultured; only saprophytic water molds.

1672—Seven larvae from W. R. Kellen; Fresno, California, October 17, 1960; suspected virus due to cuboidal inclusions associated with thoracic fat body. Diagnosis: No definite pathogen observed or isolated. Virus particles not demonstrated.

Culex territans Walker

1394—Ten larvae from W. F. Pippin; Gunther Air Force Base, Alabama; appear to have funguslike growth. Diagnosis: Ciliatosis. *Vorticella* sp.

Culex sp.

952—Many larvae from T. C. Lawrence; Berkeley, California, May 26, 1954; field-collected. Diagnosis: No pathogens found.

Culiseta incidens (Thompson)

1428—Twenty larvae and pupae from R. Sluss; Davis, California, June 22, 1959; specimens preserved in Bouin's solution. Diagnosis: No pathogen found. Hyphae present but further identification not possible; fungus not representative of a pathogenic form.

Culiseta inornata (Williston)

1002—Three adults from A. Lee; La Mesa, California, December 27, 1954; field-collected. Diagnosis: No pathogen found. Saprophytic *Aspergillus* sp.

Culiseta melanura (Coquillett)

1394—Ten larvae from W. F. Pippin; Gunther Air Force Base, Alabama; appear to have funguslike growth. Diagnosis: Ciliatosis. *Vorticella* sp.

1568—Ten larvae from R. O. Hoyes; Bedford, Massachusetts, May 4, 1960; collected from cedar swamp; one fifth of the larvae exhibited enlargement of some type near the siphon, perhaps due to a diseased condition or detritus. Diagnosis: No pathogen found or isolated. Siphon enlargements consisted of inorganic and organic material bound together around the siphon setal tufts with Bryozoa.

Psorophora howardii Coquillett

1486—Tissue fragment from one larva from P. T. M. Lum; Vero Beach, Florida, August 13, 1959; sporangia present in field-collected fourth-instar larvae which failed to pupate normally and developed a deep-yellow to orange color. Fifteen of fifty larvae were infected. Diagnosis: Mycosis. *Coelomomyces* sp. near *psorophorae*.

Unidentified spp.

621—Twenty-five specimens from R. Holdenreid; Pleasant Grove, California, May 21, 1951; field-collected. Diagnosis: Several specimens with external hyphae; preserved in alcohol; further identification impossible.

787—Larvae from G. Loshbaugh; Salinas River, Camp Roberts, Monterey County, California, April 28, 1952; field-collected material; not held in laboratory. Diagnosis: Microsporidiosis. *Nosema* sp. (Identified as probably *Nosema culicis* by Lipa and Steinhilber, 1962.)

789—Larvae from G. Loshbaugh; Salinas River, Camp Roberts, Monterey County, California, April 30, 1952; field-collected; held in laboratory until signs evident. Diagnosis: Microsporidiosis. *Nosema* sp., as in Accession No. 787 above. Greatest mortality in fourth instar.

998—Specimens from Mario A. del Pinal J.; Guatemala, C. A., December 20, 1961; field-collected. Diagnosis: Nonmicrobial death.

1005—Adult specimens from Mario A. del Pinal J.; Guatemala, C. A., January 3, 1955; field-collected. Diagnosis: Nonmicrobial death.

CUTEREBRIDAE

Cuterebra horripilum Clark

1134—One pupa from G. E. Haas; Dane County, Wisconsin, December 26, 1956; collected in association with Mearns cotton-tail; submitted for fungus examination. Diagnosis: Mycosis. Fungus unidentified; not viable.

Dermatobia hominis (Linnaeus, Jr.)

1230. Numerous grubs from P. Kraemer; Nicaragua, February 11, 1958; collected from cattle. Diagnosis: No pathogen discernible.

DEUTEROPHLEBIIDAE*Deuterophlebia nielsoni* Kennedy

1524—About forty adult males from H. D. Kennedy; Convict Creek, Mono County, California, October 30, 1959; brown-pigmented objects in the abdominal cavity. Diagnosis: Cause of death and nature of bodies not determined. (See Accession No. 1335 below for additional data.)

Deuterophlebia sp.

1335—Several pupae and adults preserved in alcohol from H. D. Kennedy; Convict Creek, Mono County, California, September 19, 1958; field-collected; all males with peculiar objects visible in abdomen. Diagnosis: Dark objects in abdomen result of granular degeneration of fat body with accompanying pigmentation. No microorganisms were found to be associated with the diseased tissue.

DIXIDAE*Dixa californica* Johannsen

602—Several larvae from A. A. Hubert; locality unknown, April 13, 1951; laboratory stock. Diagnosis: Funguslike tuft at caudal end of larvae. Probably primitive Phycomycetes, near Eccrinales.

613—One larva from A. A. Hubert; Berkeley, California, April 30, 1951; laboratory stock. Diagnosis: Gelatinlike mass, caudal end of larva, composed of gram-negative, lactose-negative short rods and gram-negative yellow-pigmented rods (probably *Flavobacterium*).

DROSOPHILIDAE*Drosophila melanogaster* Meigen

671—Twenty adults with "diseased" wing condition from P. Shepard; Davis, California, August 27, 1951; laboratory culture. Diagnosis: Dark areas of intensified pigmentation on wings. No microorganisms involved.

Drosophila spp.

588—One adult from R. van den Bosch; Mount Tantalus, Honolulu, Hawaii, February 8, 1951; field collection. Condition of specimen too poor to render a diagnosis.

734—One adult from R. L. Bell; Lafayette, Indiana, December 4, 1951; labora-

tory culture. Diagnosis: Microsporidiosis. *Nosema* sp.

1072—Four adults from A. E. Michelbacher; Fresno, California, November 8, 1955; field-collected. Diagnosis: Mycosis. *Penicillium* sp.

LAUXANIIDAE

Unidentified sp.

1708—One adult from B. Meksongsee; Thailand, February 20, 1961; specimen with peculiar growth or sporophore issuing from the thorax. Diagnosis: Mycosis. *Cordyceps* sp., near *dipterigena*. Stromal head immature thus preventing positive identification.

MUSCIDAE*Fannia canicularis* (Linnaeus)

1200—Three adults from P. C. Steve; Amherst, Massachusetts, August 26, 1957; eight of 1,600 adults examined had intersegmental growths. Specimens shipped in water. Diagnosis: Mycosis. Probably *Entomophthora muscae*.

1204—Thirteen adults from P. C. Steve; Amherst, Massachusetts, September 9, 1957; laboratory-reared; represents continued occurrence of disease following initial observation (see Accession No. 1200 above.) Diagnosis: Mycosis. *Entomophthora muscae*.

1400—Three adults from W. M. Avdusson; Marysville, Yuba County, California, May 11, 1959; found adhering to leaves and twigs of prune trees. Diagnosis: Mycosis. *Entomophthora muscae*.

1407—Six adults from C. Davis; Marysville, Yuba County, California, May 20, 1959; field-collected. Diagnosis: Mycosis. *Entomophthora muscae*.

1559—Two adults from C. S. Davis; Orland, California, April 15, 1960; flies found sticking to a leaf and collected by R. B. Jeter. Diagnosis: Mycosis. *Entomophthora muscae*.

1605—One adult from D. D. Linsdale; Berkeley, California, July 6, 1960; specimen collected in home of J. Walker where it was noticed that some sort of red growth or substance was attached to the body and that the fly was having difficulty in flying. Diagnosis: Mycosis. Laboulbeniales, *Stigmatomyces*, apparently a new species.

1749—One adult from W. E. Ferguson; Pleasant Hill, California, May 24, 1961; caught alive flying in home. Patches of a reddish growth attached to the cuticle in brushlike clumps. Fly was easily caught and the growths may have had some inhibitory effect. Diagnosis: Mycosis. Laboulbeniales, *Stigmatomyces*, apparently a new species. (See figs. 19A, B, p. 401.)

Fannia spp.

1726—Ten adults from C. S. Davis; Sunnyvale, California, April 3, 1961; collected by B. Evans and sent to Extension entomologist for identification of the fly and the fungus responsible for death. Diagnosis: Mycosis. *Entomophthora muscae*.

1761—One adult from D. W. Roberts; Berkeley, California, June 23, 1961; collected flying in home and found to harbor red fungal patches of a Laboulbeniales. Diagnosis: Mycosis. *Stigmatomyces*, apparently a new species.

Hylemya antiqua (Meigen)

713—Histological slide from E. H. Strickland; southern Alberta, Canada, October 19, 1951; funguslike objects attached to eyes. Diagnosis: Pollinia, plant unknown.

1427—Numerous adults from G. Guyer; Plainwell, Michigan, June 19, 1959; field-collected. Diagnosis: Mycosis. *Entomophthora muscae*.

1498—Nine adults from D. R. Scott; Parma, Idaho, September 11, 1959; epizootic occurred during July in the field and the submitted specimens, which were held in cages in the laboratory, also died. Diagnosis: Mycosis. *Entomophthora muscae*.

Hylemya cilicrura (Rondani)

1405—Ten adults from P. C. Stone; Columbia, Missouri, May 15, 1959; flies found attached to twigs, leaves, grass, and terminal buds by mouthparts. Diagnosis: Mycosis. *Entomophthora muscae*.

1603—About thirty adults from E. H. Wheeler; Amherst, Massachusetts, June 27, 1960; first dead specimens observed attached to ornamentals and vegetables about June 14. Large numbers were observed on the 18th and 19th. Also, in 1959, all through the Connecticut Valley, *Hylemya antiqua* (Meigen) was attacked by a similar fungus. Diagnosis: Mycosis. *Entomophthora muscae*.

1656—More than fifty adults from S. S. Ristich; Port Jefferson, Long Island, New York, September 29, 1960; worst epizootic

in fifteen years; 10 to 200 adults could be found on one stalk of grass and literally thousands were seen in the field. One of the wettest spring and summer seasons in the history of Long Island. Diagnosis: Mycosis. *Entomophthora muscae*. Occasionally, resting spores of a bullate type were observed but were not correlated with a different conidial form.

1756—Numerous adults from A. M. Heimpel; Beltsville, Maryland, June 12, 1961; original collection by R. P. Mullett, May 19, 1961, at Knoxville, Tennessee, where the adults were found adhering to various shrubs. Diagnosis: Mycosis. *Entomophthora muscae*.

1757—About ten adults from A. M. Heimpel; Beltsville, Maryland, June 12, 1961; original collection by A. F. Schindler, June 3, 1961, in Montgomery County, Maryland, where they were found dead clinging to ends of leaves. Diagnosis: Mycosis. *Entomophthora muscae*.

Hylemya platura (Meigen)

1408—Numerous adults from P. H. Arnaud; collection data as follows: Orange, Orange County, California, R. B. Nesbitt, collector, insects found dead on Dutch iris; Santa Barbara, Santa Barbara County, California, M. Suskin, collector, insects found on orange-tree twig; Glendora, Los Angeles County, California, D. Dyer, collector. Diagnosis: Mycosis. *Entomophthora muscae*.

Hylemya spp.

1416—Two adults from D. W. Roberts; 5 miles east of Lancaster, Los Angeles County, California; found attached to alfalfa by mouthparts. Diagnosis: Mycosis. *Entomophthora muscae*.

1425—Thirteen adults from J. P. Kramer; area of Champaign-Urbana, Illinois, June 18, 1959; similarly infected flies had occurred throughout Champaign County for 2 weeks and had been reported by several individuals. Diagnosis: Mycosis. *Entomophthora muscae*.

1440—Many adults from R. L. Furniss; Hillsboro, Oregon, July 7, 1959; large numbers of flies clinging to flowering head of various grasses by their mouthparts. From one to ten dead flies per head. Diagnosis: Mycosis. *Entomophthora muscae*.

Musca domestica Linnaeus

907–908—Many adults from J. Menn; Berkeley, California, November 4, 1953;

Fig. 19. The little house fly, *Fannia canicularis* (Linnaeus), infested with a cuticular fungus, *Stigmatomyces*, apparently a new species. [Laboulbeniales]. A. Fly showing location of fungus on the mesofemur and metafemur, metatibia, and last abdominal segments. B. Enlargement of fungus patches on the mesotibia. (Acc. No. 1749, p. 400.)

laboratory-reared for toxicological bioassay. Diagnosis: The only bacteria isolated were identical to flora from normal flies; probable nonmicrobial death.

940—Twenty-four adults from D. R. Mad-dock; Phoenix, Arizona, April 1, 1954; laboratory cultures. Diagnosis: Mycosis. *Entomophthora muscae*.

946—One adult from Y. Tanada; Honolulu, Hawaii, May 11, 1954; found adhering to clothesline. Diagnosis: Mycosis. *Entomophthora muscae*; confirmation of collector's diagnosis.

1017—Four adults from R. L. Peffy; Saudi Arabia, February 28, 1955; field-collected. Diagnosis: No pathogen found. *Rhizopus nigricans*, secondary saprophyte.

1135—Two adults from R. Eastwood; San Jose, California, December 26, 1956; field-collected. Diagnosis: Mycosis. *Entomophthora muscae*.

1369—Several specimens from W. H. Sill, Jr.; locality unknown, December 16, 1958. Diagnosis: Mycosis. *Entomophthora muscae*.

1753—Approximately thirteen dead and ten normal, last-instar larvae from G. F. Shambaugh; Natick, Massachusetts, June 6, 1961; insecticide-susceptible laboratory culture. Last-instar larvae migrated to top of medium and died before contracting to form puparia. Dead larvae remained turgid and turned black. Diagnosis: No definite pathogen found. Culture yielded three different bacteria: a strain of *Escherichia freundii*; *Streptococcus* sp., probably *faecalis*; and a strain of *Micrococcus* sp. These might have been responsible for secondary infections.

Unidentified spp.

1201—Adult specimen from R. H. Goodwin; Sagehen, near Hobart Mills, California, September 4, 1957; field-collected. Diagnosis: Mycosis. *Entomophthora* sp.

1267—Specimens from R. Jeter; Orland, California, May 23, 1958; field-collected. Diagnosis: Mycosis. *Entomophthora muscae* probably present. Adults heavily contaminated with miscellaneous secondary saprophytic fungi.

1399—Six anthomyiid specimens from B. Bailey; Kahn Ranch near San Jose, California, May 6, 1959; field-collected on leaves of Payne walnut trees. Diagnosis: Mycosis. *Entomophthora muscae*.

1435—Anthomyiid specimens from L.

Chandler; Lafayette, Indiana, June 29, 1959; first dead flies noted May 28. Several thousand tachinids were observed dead on box-elder leaves along a stream. Later, anthomyiids were infected and occasional tipulids as well. Males seemed to dry and shrivel while females developed inflated abdomens. Diagnosis: Mycosis. *Entomophthora muscae*.

1515—Anthomyiid specimens from Y. Tanada; Davis, California; October 1, 1959; adults were found adhering to wire stakes in field plots of corn and were presumed to have been killed by *Entomophthora muscae*. Diagnosis: Mycosis. *Entomophthora muscae* confirmed.

1564—Twenty adult anthomyiid specimens from J. Powell; Chino Canyon, Riverside County, California, April 26, 1960; found clinging to grape leaves. Diagnosis: Mycosis. *Entomophthora muscae*.

1574—Anthomyiid specimens. Eight adults from W. Wiard, Jr.; Andrew Martin Ranch, Colusa County, California, May 12, 1960; large number of flies found attached to walnut leaves, apparently killed by fungus. Diagnosis: Mycosis. *Entomophthora muscae*.

1580—Anthomyiid specimens. Two adults from J. H. Poorbough; Manhattan, Kansas, June 3, 1960; heavy mortality observed in a small area. Diagnosis: Mycosis. *Entomophthora muscae*.

1771—Undetermined dipteran. Seventeen adults from O. H. Hammer; Midland, Michigan, July 13, 1961; dead flies commonly found attached to various plants apparently by a fungal growth. The same phenomenon has been observed on other occasions in previous years. Diagnosis: Mycosis. *Entomophthora muscae*.

1810—One adult from J. J. H. Szent-Ivany; Lowlands Agricultural Experiment Station, Keravat, near Rabaul, New Britain, Territory of New Guinea, October 20, 1961; a single specimen found attached to a lantana leaf by a fungus growth. Diagnosis: Mycosis. *Entomophthora* sp. near *E. americana*. Resting spores not present. (See fig. 20, p. 403.)

NYCTERIBIDAE

Basilia antrozoi (Townsend)

751—Giemsa-stained smears from S. Wood; San Joaquin Experimental Range, California, February 8, 1952; smears pre-

Fig. 20. Unidentified muscoid fly from New Guinea infected with *Entomophthora* sp., near *americana* (Thaxter). (Acc. No. 1810, p. 402.)

pared for blood parasite studies. Diagnosis: Intracellular symbiotes.

SCATOPSIDAE

Unidentified sp.

1681—Five adult specimens from C. E. Woodworth; Walla Walla, Washington, November 14, 1960; field-collected. Diagnosis: Mycosis. *Entomophthora muscae*.

SIMULIIDAE

Eusimulium aureum (Fries)

1445—One larva from B. V. Peterson; Kimball Creek, Snyderville, Utah, July 13, 1959; field-collected. Diagnosis: Microsporidiosis. *Thelohania* sp.

Eusimulium spp.

1439—Several larvae from D. M. Davies; Hopkins Bay Creek II, tip of Bruce Peninsula, Ontario, Canada, July 6, 1959; suspected of being infected with Microsporidia.

Diagnosis: Microsporidiosis. *Thelohania* sp. (Identified as *Thelohania fibrata* by Lipa and Steinhaus, 1962.)

1447—One larva from B. V. Peterson; Spring Outlet Creek, Salt Lake County, Utah, July 13, 1959; field-collected. Diagnosis: Microsporidiosis. *Thelohania* sp.

Prosimulium flaviantennus Stains & Knowlton

1448—Two larvae from B. V. Peterson; Chalk Creek Canyon, Utah, July 13, 1959; field-collected. Diagnosis: Microsporidiosis. *Thelohania* sp.

Prosimulium exigens Dyar & Shannon

1450—Five larvae from B. V. Peterson; Red Butte Canyon, Utah, July 13, 1959; field-collected. Diagnosis: Microsporidiosis. *Thelohania* sp.

Simulium arakawae Matsumura

1021—Nine preserved larvae from W. C. Bentinek; Kyoto, Japan, March 22, 1955;

field-collected. Diagnosis: Microsporidiosis. Preservative interfered with specific determination.

Simulium arcticum Malloch

1443—Thirteen lots of larvae from B. V. Peterson; several Utah localities, July 13, 1959; field-collected over a period of several years and preserved in alcohol. Diagnosis: Several specimens with a microsporidiosis (*Thelohania* sp.). One with a mermithid nematode, another with an unidentified nematode, and several in which no pathogen was found.

Simulium canadense Hearle

1449—Two lots of larvae from B. V. Peterson collected in Utah over a period of several years. Diagnosis: Microsporidiosis. *Thelohania* sp.

Simulium oitana Shiraki

1020—Eight preserved larvae from W. C. Bentinek; Kyoto, Japan, March 22, 1955; field-collected. Diagnosis: Microsporidiosis. *Plistophora* sp.

Simulium piperi Dyar & Shannon

1446—Nine locality lots of larvae from B. V. Peterson collected in Utah over a period of several years. Diagnosis: Microsporidiosis. *Thelohania* sp.

Simulium pugetense (Dyar & Shannon)

936—Two larvae preserved in alcohol from D. M. Davies; Whitehorse, Yukon Territory, Canada, March 15, 1954; field-collected. Diagnosis: Unidentified fungus in one specimen, otherwise nonmicrobial. Unable to identify fungus through cultivation because specimen preserved in alcohol.

Simulium venustum Say

882—Five larval smear slides from D. M. Davies; Hamilton, Ontario, Canada, August 11, 1953; field-collected. Diagnosis: Microsporidiosis. Several slides showed Microsporidia near *Thelohania bracteata*; one slide agrees with *Thelohania fibrata*.

Simulium vittatum Zetterstedt

1438—Several larvae from D. M. Davies; Costello Creek, Algonquin Park, Hamilton, Ontario, July 6, 1959; suspected of being infected with Microsporidia. Diagnosis: Microsporidiosis. *Thelohania* sp. (Identified as *Thelohania fibrata* by Lipa and Steinhaus, 1962.)

1444—Eight lots of larvae from B. V. Peterson; various Utah localities, collected over a period of several years and preserved in alcohol. Diagnosis: Microsporidiosis. *Thelohania* sp.

Simulium spp.

882—Five larval smear slides from D. M. Davies; Hamilton, Ontario, Canada, August 11, 1953; field-collected. Diagnosis: Microsporidiosis. Several slides showed Microsporidia near *Thelohania bracteata*; one slide agrees with *Thelohania fibrata*.

1019—Four preserved larvae from W. C. Bentinek; Kyoto, Japan, March 22, 1955; field collection. Diagnosis: Unidentified nematodes seen in body cavity.

1451—One larva from B. V. Peterson; Green Canyon, North East Logan, Utah, July 13, 1959; field-collected. Diagnosis: Microsporidiosis. *Thelohania* sp.

SYRPHIDAE

Eupeodes sp.

1263—Several adults from R. F. Smith; Oxalis, Fresno County, California, May 15, 1958; field-collected. Diagnosis: Mycosis. *Entomophthora muscae*.

Platychirus sp.

1262—Several adults from R. F. Smith; Oxalis, Fresno County, California, May 15, 1958; found adhering to native vegetation. Diagnosis: Mycosis. *Entomophthora muscae*.

Unidentified spp.

783—One adult from H. Graham; Irvington, California, April 19, 1952; collected in alfalfa field. Diagnosis: Mycosis. *Entomophthora muscae*.

793—Adult specimen from T. C. Lawrence; Berkeley, California, May 5, 1952; collected on rose bush. Diagnosis: Nonmicrobial; possible contact with insecticide.

801—Specimen from T. C. Lawrence; Berkeley, California, May 16, 1952; collected on rose bush. Diagnosis: Death resulted from nonmicrobial cause.

1213—Adult specimen from J. Arnold; Berkeley, California, October 14, 1957; found suspended from oak branch by web-like filament. Diagnosis: Mycosis. *Entomophthora muscae*.

1720—One or two early-instar larvae from V. P. Rao; Government Fruit Garden,

Shillong, Assam, March 14, 1961; attacked the woolly apple aphid *Eriosoma lanigerum* (Hausmann). Larvae turned black and died. Diagnosis: Bacteriosis. *Bacillus cereus* isolated in pure culture.

TABANIDAE

Chrysops sp. probably *C. silacca* Austen

904—One adult from R. M. Gordon; Lome, West Africa, October 19, 1953; field-collected. Diagnosis: Mycosis. Possible *Coelomomyces* sp.

TACHINIDAE

Dezilia vacua Fallén

707—Three adults from H. L. Parker; St. Germaine en Laye, October 10, 1951; found in laboratory. Diagnosis: Mycosis. *Entomophthora muscae*.

Lixophaga diatraca Townsend

1546—Eight adults from V. P. Rao; Bangalore, India, February 18, 1960; before death, the flies exhibited a general restlessness. Diagnosis: No pathogen observed or isolated.

1648—Several adults from V. P. Rao; Bangalore, India, September 20, 1960; reared from *Scirpophaga nivella* (sugarcane top-shoot borer) in the laboratory. Diagnosis: Mycosis. *Beauveria bassiana*.

Unidentified sp.

856—Pupae from P. D. Hurd; Point Barrow, Alaska, November 28, 1952; field collection. Diagnosis: Saprophytic *Penicillium* sp.; infectivity tests negative.

TEPHRITIDAE

Dacus cucurbitae Coquillett

579—Pupae and adults from K. S. Hagen and G. L. Finney; Honolulu, Hawaii, January 11, 1951; insectary-reared. Diagnosis: Microsporidiosis. *Nosema* sp. in all specimens; *Herpetomonas* sp. in one adult.

Dacus cucurbitae Coquillett and *D. dorsalis* Hendel

599—Serial sections on slides from S. Maeda; Honolulu, Hawaii, April 6, 1951; laboratory stock. Diagnosis: Possible vegetative stages of Microsporidia (*Nosema* sp.) in 2 of 25 slides. Otherwise negative.

Dacus dorsalis Hendel

608—Four histological slides from S. Maeda; Honolulu, Hawaii, April 20, 1951; laboratory culture, specimens inoculated with *Nosema* sp. from *Dacus cucurbitae*. Diagnosis: Microsporidiosis. Vegetative stages of *Nosema* sp.

766—Ten eggs from I. M. Newell; Oahu and Hawaii, March 10, 1952; field-collected under sterile conditions. Diagnosis: *Micrococcus* sp., *Bacillus* sp., and *Serratia marcescens* isolated from different eggs (see Steinhaus, 1959a). Five eggs with strain of *Penicillium* sp.

1127—Four adults from F. H. Haramoto; Honolulu, Hawaii, November 14, 1956; laboratory-reared. Diagnosis: Mycosis. *Beauveria bassiana*.

Rhagoletis cerasi (Linnaeus)

844—Several larvae and pupae from J. Bernard; Belgium, September 16, 1952; collected on cherry, specimens in alcohol. Diagnosis: Probably *Beauveria* sp. Cultivation and identification of fungus not possible because specimens chemically preserved.

Unidentified sp.

1158—Larvae from V. P. Rao; Kotagiri Road, Nilgiris, India, May 8, 1957; larvae became inactive and exhibited dark discoloration. Diagnosis: Mycosis. Unidentified entomophthoraceous fungus.

TIPULIDAE

Tipula simplex Doane

1701—Nine larvae from W. H. Lange; 7 miles west of Petaluma, Sonoma County, California, February 14, 1961; larvae dug from rangeland soil and returned to laboratory for rearing. Larvae began dying shortly after being held under laboratory conditions. Diagnosis: No definite pathogen found. Dead and partially decomposed specimens were heavily laden with miscellaneous saprophytic bacteria. Moribund and some live (motile) larvae contained large numbers of cephaline gregarines in the gut, both attached to the wall and free. Occasional larvae had gregarines in the hemocoel along with a heavy bacterial population.

1713—Numerous larvae from Y. Tanada; 7 miles west of Petaluma, Sonoma County, California, February 23, 1961; collected from field where larvae were destroying the

entire ground cover by feeding on the grass roots. Same conditions as in Accession No. 1701 above. Diagnosis: No definite pathogen isolated or observed. Heavy infestation of gregarines attached to gut wall and some in hemocoel of live material. Numerous bacteria present in moribund larvae and in those which had been dead several days.

1722—Four larvae from W. H. Lange; near Petaluma, California, March 29, 1961; larvae mummified with heavy internal mycelial growth; collected from range-grass soils. Diagnosis: No pathogen found. *Penicillium* sp. ("Carpentales series") isolated from surface sterilized material. *Fumago* sp. also isolated.

FAMILY UNKNOWN

Unidentified spp.

988—Specimens from F. D. Baker; Lawrence, Kansas, November 2, 1954; laboratory culture. Diagnosis: Bacteriosis. Miscellaneous bacteria; exact cause of disease not determined.

1010—Adult specimen from M. del Pinal J.; Guatemala, Central America, January 18, 1955; field-collected; wings distorted. Diagnosis: Nonmicrobial death. Abortive wings probably caused by accident during adult emergence.

1164—Larval specimens from D. Burdick; 4 miles west of Plantation, Sonoma County, California, May 16, 1957; field-collected. Diagnosis: No pathogen isolated.

1318—Adult specimens from W. E. Collins; Gibbsboro, New Jersey, August 12, 1958; field-collected. Diagnosis: Mycosis. *Entomophthora* sp., probably *E. americana*.

1688—Pupae from R. J. Lavigne; Glendo, Wyoming, November 23, 1960; pupae dug up from rangeland soil and transported to the laboratory for rearing. No adults had emerged. Diagnosis: Bacteriosis. *Bacillus cereus* isolated from body contents of specimens submitted.

EMBIOPTERA

EMBIIDAE

Enveja sp.

1465—Numerous nymphs in colony from E. Ross; 3 miles west of Abercorn, Rhodesia, July 29, 1959; field-collected and cultured in San Francisco. Nymphs were observed to come to the surface of the jar and exhibit paralysis and tremors. Diag-

nosis: No definite pathogen found. Cultures yielded heavy yeast growth.

ENTOTROPHI

JAPYRIDAE

Heterojapyx sp.

689—One specimen from M. F. Day; Canberra, Australia, September 14, 1951; histological slide, cross-section of head only. Diagnosis: No pathogen observed.

HEMIPTERA

ALEYRODIDAE

Aleurolobus barodensis Maskell

1157—Numerous specimens from V. P. Rao; Bobbili, Andhra, India, May 8, 1957; collected on sugarcane. Diagnosis: Mycosis. *Aschersonia* sp. (See fig. 21A, B, p. 407.)

Metalcurodicus minimus (Quaintance)

1006—One hundred immature specimens from G. N. Wolcott; Isabela, Puerto Rico, January 3, 1955; field-collected on *Psidium guajava*. Diagnosis: Mycosis. Fungus unidentified.

Unidentified spp.

835—Specimens from Y. Tanada; Kona, Hawaii, August 8, 1952; collected on beans. Diagnosis: No microbial pathogen found.

1193—Specimens from Y. Tanada; Half Moon Bay, California, August 10, 1957; collected on blackberry. Diagnosis: Mycosis. *Verticillium* sp.

1208—Specimen from Y. Tanada; Half Moon Bay, California, September 24, 1957; collected on blackberry leaves with fungus growth. Diagnosis: Mycosis. *Verticillium* sp.

ANTHOCORIDAE

Unidentified sp.

1273—Specimens from W. W. Middlekauff; El Cerrito, California, June 4, 1958; field-collected inside a twig gall of willow. Diagnosis: Mycosis. *Beauveria bassiana*.

APHIDAE

Aphis gossypii Glover

1767—Over 100 nymphs and adults from L. E. Caltagirone; Ocoá, Province of Val-

Fig. 21. Pulvinate stroma of the fungus (*Aschersonia* sp.) associated with the white fly *Aleurolobus barodensis* Maskell. A. Entire stroma showing surface configuration of pores and fissures. B. Several hand sections showing habit of the stroma covering the insect and the pycnidia. (Acc. No. 1157, p. 406.)

paraiso, Chile, July 6, 1961; more than 25 per cent of aphids in artichoke-growing area were fungus-infected. Aphid populations were very high with as many as 3,000 aphids on a single artichoke leaf. Diagnosis: Mycosis. *Entomophthora planchoniana*.

Aphis pomi DeGeer

1433—Many nymphs and adults from T. C. Lawrence; Berkeley, California, June 25, 1959; collected on *Cotoneaster* sp. Diagnosis: No pathogen found.

Brevicoryne brassicae (Linnaeus)

1237—Many specimens from A. D. Lowe; Ashburton, New Zealand, March 20, 1958; Diagnosis: Mycosis. *Entomophthora* sp.

1380—Numerous nymphs from A. Silveira Guido; Maipu, Chile, March 7, 1959; collected on *Brassica* sp. and suspected of being infected with fungus. Diagnosis: No pathogen found. Specimens harbored saprophytic fungi of the genus *Alternaria* sp. and *Fumago* sp.

1736—Two lots of nymphs and adults from A. D. Lowe; Lincoln and Ashley Dene, New Zealand, May 2, 1961; disease controlled more than 50 per cent of populations where they were high; onset coincided with both population density and climate. Diagnosis: Mycosis. *Entomophthora aphidis*.

Capitophorus fragaefolii (Cockerell)

1084—Six adults from G. Schaeffers; Morgan Hill, California, February 14, 1956; collected on strawberry. Diagnosis: Mycosis. Identified by I. M. Hall as *Entomophthora* sp.

Chromaphis juglandicola (Kaltenbach)

786—Several adults from W. Wade; Linden, California, April 28, 1952; specimens adhering to walnut leaves. Diagnosis: Mycosis. *Entomophthora* sp., closely approximates *E. planchoniana* but conidia are generally smaller.

1030—Several adults from E. R. Oatman; Linden, California, May 5, 1955; collected on Payne variety of English walnut. Diagnosis: Mycosis. Mycelia sterile and not viable.

1037—Two adults from A. E. Michelbacher; San Jose, California, May 18, 1955; collected on walnuts. Diagnosis: Nonmicrobial death.

Hyalopterus arundinis (Fabricius)

889—Many adults from D. Borden; Saratoga Road, Santa Clara County, California, August 20, 1953; collected on French prune. Diagnosis: No pathogen found.

Macrosiphum barri Essig

725—Several specimens from A. J. Walz; Parma, Idaho, November 13, 1951; collected from lettuce field. Diagnosis: Mycosis. *Entomophthora aphidis*.

Macrosiphum pisi (Harris)

600—Several specimens from C. E. Woodworth; Charlestown, Oregon, April 11, 1951; field-collected. Diagnosis: Contents of vial covered with saprophytic mold. Further identification impossible.

606—Many specimens from J. E. Swift; El Centro, California, April 17, 1951; field-collected. Diagnosis: Entomophthoraceous fungus; hyphae not viable; no conidia present for further identification.

743—Several specimens from H. Graham; Tracy, California, January 7, 1952; field-collected on alfalfa. Diagnosis: Mycosis. *Entomophthora* sp., near *aphidis*.

748—Several specimens from H. Graham; Centerville, California, January 29, 1952; collected on alfalfa. Diagnosis: Early Entomophthorales infection; conidia absent.

764—Twenty adults from H. Graham; Irvington, California, March 8, 1952; collected in alfalfa field. Diagnosis: Mycosis. Entomophthorales, probably *Entomophthora aphidis*.

1032—Several adults from T. Heffernan; Tulare County, California, May 5, 1955; field collection. Diagnosis: Mycosis. *Entomophthora aphidis*.

1033—Many specimens from A. A. Muka; Virginia, May 11, 1955; 75 to 80 per cent mortality in one 6-acre alfalfa field. Diagnosis: Mycosis. *Entomophthora aphidis*.

1036—Twenty-four adults from J. Freitag; Bakersfield, California, May 13, 1955; collected on alfalfa. Diagnosis: Mycosis. *Entomophthora aphidis*.

1096—Numerous adults from J. E. Swift; locality unknown, April 16, 1956; collected lying dead at base of grain plants. Diagnosis: No evidence of infectious agent present.

1299—Numerous aphids attached to lentil plants from H. C. Manis; near Moscow,

Latah County, Idaho, July 21, 1958; heavy fungus infection, effective in controlling field populations. Diagnosis: Mycosis. *Entomophthora aphidis*. Identified by I. M. Hall.

1577—Twelve nymphs from D. E. Howell; 17 miles east of Stillwater, Oklahoma, May 20, 1960; field-collected; found closely appressed to alfalfa leaves. Diagnosis: Mycosis. Double infection with *Entomophthora aphidis* and *Entomophthora thaxteriana*.

1682—Many nymphs and adults from C. E. Woodworth; Walla Walla, Washington, November 14, 1960; insects appeared to be fungus-infected. Diagnosis: No pathogen found. Various fungi were present, such as *Alternaria* sp., *Fusarium* sp., and *Stemphylium botryosum*, all of which were considered to be saprophytes.

1727—Numerous nymphs and some adults from D. E. Howell; Ravia, Johnston County, Oklahoma, April 3, 1961; cowpea aphid (*Aphis medicaginis* Koch) also occurred on the sample of alfalfa submitted. Only 1 per cent of the pea aphids were obviously infected. Weather just prior to collection was cool and damp (3 inches of rain in 7 days). Diagnosis: Mycosis. *Entomophthora aphidis*. Secondary saprophytes included: *Fusarium* sp., genus near *Monosporium*, sterile mycelia of the Dematiaceae, and miscellaneous small gram-negative bacterial rods in some specimens.

Macrosiphum rosae (Linnaeus)

800—Seven adults from T. C. Lawrence; Berkeley, California, May 14, 1952; attached to rose bush. Diagnosis: Mycosis. *Entomophthora aphidis*.

819—Several adults from T. C. Lawrence; Berkeley, California, June 12, 1952; field collection. Diagnosis: Secondary bacteremia; cause of death not determined.

821—Two moribund adults from T. C. Lawrence; Berkeley, California, June 17, 1952; field-collected. Diagnosis: Secondary bacteremia; gram-negative small rods.

Macrosiphum solanifolii (Ashmead)

1508—Thirteen nymphs in two separate lots from W. H. Day; Riverhead, New York, September 21, 1959; field material infected with fungus. Diagnosis: Mycosis. *Entomophthora aphidis* only in one lot; *Entomophthora thaxteriana* only in the second lot.

Myzus persicae (Sulzer)

831—Young and mature alates from F. E. Lawson; Oxford, North Carolina, July 25, 1952; collected on tobacco. Diagnosis: No pathogen found. Secondary bacteria and yeasts present.

999—Fifty adults from G. N. Wolcott; Cidra, Puerto Rico, December 21, 1954; field-collected on wild mustard (*Brassica* sp.). Diagnosis: Mycosis. *Entomophthora aphidis*.

1007—Fifteen adults from G. N. Wolcott; Orocovis, Puerto Rico, January 3, 1955; collected on wild mustard. Diagnosis: Mycosis. *Entomophthora aphidis*.

1024—Numerous adults from G. N. Wolcott; Cayey, Puerto Rico, April 11, 1955; collected on wild mustard. Diagnosis: Unidentified mycosis.

1507—Two individual lots of adults and nymphs from W. H. Day; Riverhead, New York, September 21, 1959; fungus-infected material collected in the field. Diagnosis: Mycosis. In one lot some specimens were infected with *Entomophthora aphidis* only. Other specimens had double infections of *Entomophthora aphidis* and *E. thaxteriana*. The second lot harbored only a saprophytic species of *Alternaria*.

1575—Many nymphs and adults from Duncan Carter; 2 miles west of Soledad, California, May 12, 1960; high incidence of disease in one field, another field one-half mile southeast showed no dead aphids at all. Diagnosis: Mycosis. *Entomophthora* sp. near *aphidis* and *Entomophthora chromaphidis*.

Pemphigus betae Doane

1071—Numerous pre-alates from W. H. Lange; Centerville, California, October 28, 1955; collected on under surface of lettuce leaves. Diagnosis: Mycosis. *Entomophthora* sp.

Pemphigus bursarius Linnaeus

1365—Five nymphs and adults from W. H. Lange; Alvarado, California, December 15, 1958; collected from lettuce roots where mortality reached nearly 100 per cent. Diagnosis: Mycosis. *Entomophthora* sp. *Stemphylium botryosum* also recovered.

Pentatrachopus fragaefolii (Cockerell)

1027—Eight adults from G. Schaefers; Albany, California, April 12, 1955; field col-

lection. Diagnosis: No pathogen found. *Hormodendrum* sp., saprophyte.

Rhopalosiphum fitchii (Sanderson)

1082—One adult from M. K. Hess; Fall Brook, San Diego County, California, January 9, 1956; collected on barley. Diagnosis: Mycosis. *Entomophthora* sp.

Rhopalosiphum maidis (Fitch)

1496—Few dead and many presumably normal nymphs and adults from D. E. Howell; Stillwater, Oklahoma, September 9, 1959; collected from sorghum field where observed mortality was less than 1 per cent. Other areas observed to have as much as 80 per cent mortality. Diagnosis: No pathogen observed or isolated. Live material held and reared to determine if disease occurred. Results negative.

Therioaphis maculata (Buckton)

1076—Numerous specimens from J. E. Dibble; McFarland, California, December 7, 1955; collected on alfalfa. Diagnosis: Mycosis. Unidentified species of *Entomophthora*.

1085—Thirty adults from D. F. Clower; Natchitoches, Louisiana, February 20, 1956; collected on alfalfa. Diagnosis: Mycosis. *Entomophthora exitialis*.

1140—Several adults from D. M. Irving; Monterey County, California, February 7, 1957; field-collected. About 20 per cent of sample fungus-infected. Diagnosis: Mycosis. *Entomophthora ignobilis*.

1141—Four adults from J. H. Lilly; Ames, Iowa, February 20, 1957; greenhouse reared; total culture lost in three days; insects fell off plants and shriveled. Diagnosis: No pathogenic microorganisms present. Adverse environmental humidity suspected cause of death.

1339—Several adults from F. D. Miner; Fayetteville, Arkansas, September 29, 1958; field-collected on alfalfa; submitter notes this is the first record of a fungus disease of aphids from the state of Arkansas. Diagnosis: Mycosis. *Entomophthora exitialis*.

1489—Numerous nymphs from D. E. Howell; Stillwater, Oklahoma, August 19, 1959; field collection from alfalfa. Diagnosis: No pathogen found. Saprophytic fungi present.

Therioaphis riehmii (Börner)

1794—Numerous specimens from G. R. Maughitz; Lincoln, Nebraska, September

25, 1961; from 19 to 35 per cent of the field of sweet clover infected. Diagnosis: Mycosis. *Entomophthora sphacrosperma*.

Therioaphis trifolii (Monell)

1031—Three adults from J. E. Swift; near Bakersfield, California, May 5, 1955; field collection. Diagnosis: Mycosis. *Entomophthora aphidis*.

1034-1035—Many adults from J. E. Swift; East Bakersfield, California, May 13, 1955; collected on alfalfa. Diagnosis: Bacteriosis. Miscellaneous small gram-negative rods present.

1074—Numerous specimens from J. E. Swift; Tracy, California, November 15, 1955; collected on alfalfa. Diagnosis: Mycosis. *Entomophthora* sp.

Thoracaphis umbellulariae Essig

698—Numerous specimens from T. C. Lawrence; Berkeley, California, September 26, 1951; collected on *Umbellularia* leaves. Diagnosis: Harboring *Penicillium* sp., but probably saprophytic.

966—Seventeen adults from T. C. Lawrence; Berkeley, California, July 16, 1954; collected on California laurel, *Umbellularia californica*. Diagnosis: *Hormodendrum* sp. and *Mucor* sp. present as saprophytes. No pathogen found.

Toxoptera graminum (Rondani)

639—Several specimens from R. H. Painter; Decatur County, Kansas, July 5, 1951; collected on wheat stems. Diagnosis: Resting spores of *Entomophthora*. Unable to culture for further identification.

929—Ten adults from N. E. Daniels; Amarillo, Texas, February 15, 1954; greenhouse-reared on wheat in glass cages with high humidity. Diagnosis: Mycosis. *Verticillium* sp.

1412—Many nymphs from G. W. Thomas; Holt, Missouri, May 28, 1959; field-collected from spring oats; specimens greatly swollen and distorted. Diagnosis: Mycosis. *Entomophthora aphidis*.

1554—Many nymphs and adults from D. E. Howell; near Perkins, Payne County, Oklahoma, March 21, 1960; infected aphids brought into the greenhouse rapidly spread the infection to healthy specimens in the same pot. Temperatures for 5 previous weeks had been below normal and humidity had been high. Diagnosis: Mycosis. Majority of specimens infected with *Entomoph-*

thora sp. near *E. thaxteriana*, *E. ignobilis*, and *E. obscura*. Fungi were not fully developed for positive identification. One specimen harbored a heavy saprophytic growth of *Fusarium* sp. as well as fifteen nematodes (*Diplogaster* sp., near *acrivora*).

Unidentified spp.

785—Many adults from W. W. Stanley; Knoxville, Tennessee, April 28, 1952; field collection. Diagnosis: Mycosis. *Entomophthora aphidis*.

792—Specimen from T. C. Lawrence; Berkeley, California, May 5, 1952; collected on rose bush. Diagnosis: Nonmicrobial death.

870—Specimen from F. R. Lawson; Greenhouse, California. Diagnosis: No pathogen found.

915—Specimens from N. C. Hayslip; Hendry County, Florida, December 21, 1953; collected on Pangola grass. Diagnosis: *Fusarium* sp. near *F. chlamydo-sporum*; fungus probably present as saprophyte.

997—Fifty adults from J. E. Roberts; Jackson County, Arkansas, December 17, 1954; collected on turnips. Diagnosis: Mycosis. *Entomophthora aphidis*.

1045—Specimens from A. V. Garzon; Sayago, Montevideo, Uruguay, June 14, 1955. Diagnosis: Mycosis. *Entomophthora* sp.

1090—Specimens from T. C. Lawrence; Berkeley, California, March 14, 1956; collected on *Cotoneaster*. Diagnosis: No pathogen present.

1705—About thirty nymphs from B. Meksongsee; Thailand, February 20, 1961; collected from *Calotropis gigantea* and harboring a fungus growth. Diagnosis: No pathogen found. Fungus found covering the nymphs was a saprophytic *Fusarium* sp.

1740—Several nymphs and adults from T. C. Lawrence; Berkeley, California, May 4, 1961; material field-collected on weed grass stems and blades in a relatively small area of a back yard. A 2-day period of rain preceded the fungus attack. Diagnosis: Mycosis. *Entomophthora thaxteriana*.

ARADIDAE

Mezira pacifica Usinger

1124—Several adults from J. A. Chemsak; Berkeley, California, October 24, 1956;

brought in to examine for presence of gastric caeca. Diagnosis: No caeca evident.

AREOPODIDAE

Saccharosydne saccharivora (Westwood)

1397—Six nymphs and adults from F. D. Bennett; Usine Madelaine Sugar Estate, Trinidad, West Indies, May 4, 1959; field-collected on sugarcane where the specimens were attached by fungus growth. Diagnosis: No pathogen found. Fungi present presumably saprophytic; *Fusarium* sp. and *Aspergillus niger*.

1493—Nine adults from F. D. Bennett; Jamaica, West Indies, September 1, 1959; numerous fungus-infected insects, field-collected. Diagnosis: Mycosis. All specimens infected with *Hirsutella citriformis* (or a closely related species). One specimen harbored *Fusarium* sp. (See fig. 22, p. 412.)

BELOSTOMATIDAE

Unidentified sp.

1773—One adult from R. L. Usinger; Department of Entomology, University of California, Berkeley, California, July 31, 1961; collected by A. Berlowitz, Santa Cruz, California, and sent to Usinger by J. W. Tilden, San Jose, California. Small red cuticular appendages occurred on the head and ventral areas. Possibly a fungus or mite. Diagnosis: Mite infestation. Immature stages of an hydrachnellid or halocharid.

CERCOPIDAE

Aeneolamia varia Fabricius

1804—Over fifty adults from F. D. Bennett; St. Augustine, Trinidad, West Indies, October 19, 1961; adults found dead on ground and on sugarcane; covered with white fungus which eventually turned green. Diagnosis: Mycosis. *Metarrhizium anisopliae*.

Aeneolamia sp.

1359—Three Sabouraud maltose agar slants with fungus isolates from Carlota Ma. Riess de González; La Joya, Campeche, Mexico, November 21, 1958; isolated from field-collected adults. Diagnosis: Mycosis. *Fusarium* sp.

Fig. 22. An adult fulgorid, *Saccharosydne saccharivora* (Westwood), from Jamaica, West Indies, infected with the fungus *Hirsutella citriformis* Speare. (Acc. No. 1493, p. 411.)

CHERMIDAE

Chermes picea (Ratzeburg)

1641—Four adults from A. T. Drooz; Mount Mitchell, near Asheville, North Carolina, September 6, 1960; field-collected by G. Amman. Diagnosis: Mycosis. Early developmental stages of *Septobasidium* sp.

CICADELLIDAE

Colladonus geminatus (Van Duzee)

855—One adult from G. H. Kaloostian; Logan, Utah, November 24, 1952. Diagnosis: No pathogen found.

Empoasca fabalis DeLong

1079—Four adults from G. N. Wolcott; Cayey, Puerto Rico, January 3, 1956; field-collected. Diagnosis: Unidentified saprophytic fungi only.

Typhlocyba quercus (Fabricius)

950—One nymph from M. Mulla; Santa Clara, California, May 19, 1954; field-collected and held in laboratory. Diagnosis: Local fungus infection invading tissues at abdomen and leg tips. *Penicillium* sp.

Unidentified spp.

1706—Five adults from B. Meksongsee;

Thailand, February 20, 1961; found attached to vegetation by fungal growth. Diagnosis: Possible mycosis. *Verticillium* sp., not viable for culturing. Relationship with insect not known.

1707—Four adults from B. Meksongsee; Thailand, February 20, 1961; found attached to vegetation of *Solanum elongata* by fungus. Diagnosis: Possible mycosis. *Verticillium* sp., not viable for culturing. Relationship with insect not known.

CIMICIDAE

Cimex lectularius Linnaeus

583—Normal mated and virgin female adults from R. L. Usinger; Berkeley, California, January 17, 1951; laboratory-reared, submitted to determine if spermatozoa could easily be confused with symbiotes. Diagnosis: Spermatozoa are morphologically distinct from symbiotes.

665—Four adults to be examined for presence of symbiotes, from R. L. Usinger; Berkeley, California, August 20, 1951; examined by M. E. Martignoni. Diagnosis: Mycetomes and symbiotes present.

1735—Numerous nymphs from R. L. Usinger; Berkeley, California, April 19, 1961; laboratory culture of hybrid cross

representing F_2 generation of Berkeley strain $\times$ *Cimex lectularius columbarus* Jenyns. Possibility of lethal factor existed, assuming no pathogen was involved in the observed mortality of the colony. Diagnosis: No pathogen found. No evidence of abnormal histopathology nor evident micro-organisms, primary or secondary. Gut contents composed of various casts, crystals (hematin), and a few small gram-negative bacteria.

1754—Five dead and one ailing second- and third-instar nymphs and adults from R. L. Usinger; laboratory culture of Pittsburgh strain with about fifty bugs per vial; reared at 27° C and about 70 per cent R. H. Diagnosis: Mycosis. *Aspergillus flavus*. Other colonies later became infected with over 70 per cent mortality. (See Cockbain & Hastie, 1961, for a similar case in England.)

Haematosiphon inodorus (Dugès)

659—Three adults, one nymph from R. L. Usinger; Norco, California, August 7, 1951; collected from owl nest. Referred to M. E. Martignoni who determined presence of mycetomes and symbiotes. Diagnosis: Mycetomes present in both male and female, lateral to gonads. In the male the mycetomes were connected with the testes, but in the female there was no visible connection with the ovaries. Apparently there was no membrane surrounding the mycetome. Symbiotes not clearly discernible in sections.

Oeciacus vicarius Horvath

666—Three adults to be examined for presence of symbiotes, from R. L. Usinger; California, August 20, 1951; examined by M. E. Martignoni. Diagnosis: Mycetomes contained what appeared to be rod-shaped symbiotes.

Primicimex cavernis Barber

1048—Ten normal adults from R. L. Usinger and R. E. Ryckman; near Bandera, Medina County, Texas, July 11, 1955; submitted for symbiote examination. These insects apparently have no mycetome. Diagnosis: Symbiotes present in smears of gut tissue.

CIXIIDAE

Oliarus sp.

878—Several specimens from P. W. Weber; Wahiawa Forest Reserve, Oahu

Island, Hawaii, July 28, 1953; field-collected. Diagnosis: Saprophytic fungi, otherwise nonmicrobial.

COCCIDAE

Coccus viridis (Green)

604—From J. W. Beardsley; Honolulu, Hawaii, April 17, 1951; field-collected on *Psidium guajava*. Diagnosis: No pathogens found.

619—Infested leaves from J. W. Beardsley; Waikakalua Gulch, Oahu, Hawaii, May 15, 1951; field collection. Diagnosis: Negative, no pathogens found.

774—Two fungus cultures from J. W. Beardsley; Honolulu, Hawaii, March 28, 1952; isolated from scale insect. Diagnosis: Unidentified saprophyte.

1120—Several adults from P. Surany; Peradeniya, Ceylon, October 19, 1956; collected from coffee plant. Diagnosis: Mycosis. *Beauveria tenella*.

1139—Specimen from V. P. Rao; Bangalore, India, February 1, 1957; collected from guava and mango. Diagnosis: Mycosis. *Fusarium* sp.

Coccus spp.

620—Material from S. E. Flanders collected by J. L. Gressitt; Japan, May 21, 1951; field collection. Diagnosis: No pathogen found.

664—Numerous specimens from G. N. Wolcott; San Juan, Puerto Rico, August 9, 1951; collected on mango. Diagnosis: Saprophytic fungus.

Lecanium corni Bouché

1015—One hundred adult specimens from M. E. Martignoni and E. A. Steinhaus; Otelfingen, Switzerland, September, 1954; field-collected on young walnut (*Juglans regia* and *J. nigra*). Diagnosis: Mycosis. *Cordyceps clavulata*. Immature forms known as *Hymenostilbe lecaniicola*.

Lecanium cerasorum Cockerell

1253—One dead specimen from A. E. Michelbacher; Linden, California, April 30, 1958; field-collected. Diagnosis: Saprophytic fungus present. Hymenopterous parasites emerged also.

Lecanium sp.

1371—Seven whole-mount slides from J. Skelsey; Bruno Orchard, Napa, California,

January 7, 1959; submitter noticed scale insects containing some spores and mycelium; requested identification. Diagnosis: Saprophytic fungi, *Alternaria* sp. and *Puccinia pruni-spinosae*.

Pulvinaria psidii Maskell

1128—Twelve adults from V. P. Rao; Kengeri, near Bangalore, India, November 16, 1956; collected from guava (*Psidium guajava*) tree. Diagnosis: Mycosis. *Cladosporium* sp.

1139—Specimen from V. P. Rao; Bangalore, India, February 1, 1957; collected from guava. Diagnosis: Mycosis. *Cladosporium* sp.

1626—Several scales from V. P. Rao; Nandi Hills, Mysore State, India, August 15, 1960; field-collected on *Psidium guajava*. Diagnosis: Mycosis. *Aschersonia* sp.

Saissetia hemisphaerica (Targioni-Tozzetti)

991—Twenty-five specimens from G. D. Peterson; Agana, Guam, November 19, 1954; field-collected. Diagnosis: Probable mycosis. *Aspergillus* sp. (Specimens fumigated; this apparently also killed the fungus.)

Saissetia oleae (Bernard)

1420—Numerous adults from A. Silveira Guido; Montevideo, Uruguay, June 10, 1959; collected on citrus. Diagnosis: Mycosis. *Cephalosporium* sp., possibly *C. lecanii*.

Unidentified sp.

1083—Specimens from G. N. Wolcott; Luquillo Mountains, Puerto Rico, January 23, 1956. Diagnosis: Mycosis. *Aschersonia* sp.

DIASPIDIDAE

Aonidiella aurantii (Maskell)

937—Four adults from S. E. Flanders; Hong Kong, March 26, 1954; collected on citrus. Diagnosis: Fungi saprophytic, growing on all specimens; some *Myriangium* sp. may be present.

1538—Several specimens *in situ* on twig from V. P. Rao; Kalimpong (West Bengal), India, January 6, 1960; collected on mulberry; scale heavily infected with a fungus which is referred to as *Atractium indica*. Diagnosis: Mycosis. *Atractium indica*. (See Chona, 1955.)

Aonidiella citrina (Coquillett)

1652—Numerous scales from I. Tateishi; Kyushu, Japan, September 27, 1960; collected from *Podocarpus macrophyllus*. Diagnosis: Mycosis. *Fusarium episphaeria* f. *coccophila*.

Aspidiotus perniciosus Comstock, and *A. forbesi* Johnson

622—Insects from H. S. McConnell; Berlin, Maryland, May 22, 1951; collected on nursery stock. Diagnosis: *Fusarium* sp., probably saprophytic or secondary.

Aspidiotus sp.

1664—Herbarium sheet containing portion of citrus branch from J. J. H. Szent-Ivany; Port Moresby, Papua, October 10, 1960; field-collected by R. Manudaba in 1958. Submitted to D. Shaw, principal plant pathologist of the Department of Agriculture, Stock and Fisheries, Konedobu, Papua, for identification of what was assumed to be a fungus growth attacking citrus. Considered to be an entomogenous fungus and resubmitted by J. J. H. Szent-Ivany. Diagnosis: Mycosis. *Septobasidium* sp. Only upright masses of crowded sterile hyphae, known as pillars, which support the hymenium, or roof, remained.

Pseudaulacaspis pentagona (Targioni-Tozzetti)

597—One microscope slide from R. Potts; Japan, March 15, 1951; taken at San Francisco quarantine. Diagnosis: Brown spots within bodies artifacts, not associated with microorganisms.

Toumeyella liriodendri (Gmelin)

1793—Agar slants of fungi isolated from the tulip tree scale by F. Lewis; Ohio, September 25, 1961; Diagnosis: Mycosis. Conidial stage of *Sphaerostilbe flammea*.

Unidentified spp.

609—Specimens from J. L. Gressitt; Hagashima, Japan, April 20, 1951; collected on *Citrus* sp. Diagnosis: *Fusarium* sp. present, but not certain this was cause of death.

618—Specimens from S. E. Flanders collected by J. L. Gressitt in China; locality unknown, May 14, 1951; field collection. Diagnosis: Negative, nonmicrobial.

916—Specimen from D. C. Hamilton; St. Croix, Virgin Islands, December 22, 1953;

collected on citrus trees. Diagnosis: Mycosis. *Microcera coccophila*, the imperfect stage of *Sphaerostilbe flammea*.

1396—Scale insect on citrus from F. D. Bennett; Trinidad, West Indies, May 4, 1959; field-collected. Diagnosis: Mycosis. Scales infected with *Aschersonia aleyrodis* fide E. B. Mains. There is some doubt concerning the identity of the host since this fungus occurs on whiteflies. The only recognizable insects present were several non-infected scale insects loose in the package which proved to be *Selenaspidus articulatus* (Morgan).

EURYMELIDAE

Idiocerus sp.

1139—Specimen from V. P. Rao; Bangalore, India, February 1, 1957; collected from guava and mango. Diagnosis: Mycosis. *Beauveria* sp.

LYGAEIDAE

Lygus lineolaris (Palisot de Beauvois)

1619—Two adults from C. S. Koehler; Ithaca, New York, August 5, 1960; laboratory-reared specimens were maintained at rather high humidities. Daily observations indicated that they were in apparent good health one day, and dead with mycelium protruding from the body on the next. Diagnosis: Mycosis. *Entomophthora aphidis*.

Oncopeltus fasciatus (Dallas)

742—Several specimens from G. G. Stetson; Durham, New Hampshire, January 5, 1952. Diagnosis: Septicemia. *Pseudomonas fluorescens*.

MARGARODIDAE

Icerya sp.

1136—Several specimens from G. N. Wolcott; Poplar, Montana, January 3, 1957; field-collected. Diagnosis: Mycosis. *Beauveria tenella*.

MEMBRACIDAE

Micrutalis dorsalis (Fitch)

1219—Several diseased and several normal adults from J. M. Simons; Belle Glade, Florida, December 16, 1957; collected in greenhouse. Entire colony infected with entomogenous fungus. Occasional cases previously observed under natural conditions. Diagnosis: Mycosis. *Beauveria bassiana*.

MIRIDAE

Pycnoderes heidemanni Reuter

1079—Two adults from G. N. Wolcott; Cayey, Puerto Rico, January 3, 1956; field-collected. Diagnosis: Unidentified saprophytic fungi only.

NABIDAE

Nabis ferus (Linnaeus)

1556—Five adults from M. D. De Silva; Berkeley, California, March 29, 1960; mortality occurred at the fourth or middle of fifth instar. Specimens were reared on pea aphids. Diagnosis: No pathogen observed or isolated. Culture yielded only a few scattered colonies of a chromogenic (yellow-orange) yeast.

PENTATOMIDAE

Euschistus conspersus Uhler

633—Seven early instars from A. H. Retan; Berkeley, California, May 22, 1951; laboratory culture. Diagnosis: Light internal mycosis; unable to culture for identification.

653—Three adults and one fourth instar from A. H. Retan; Berkeley, California, July 26, 1951; laboratory culture. Diagnosis: *Crithidia* in hemolymph. Unidentified species, possibly new.

660—Five dead adults from A. H. Retan; Berkeley, California, August 7, 1951; laboratory-reared. Diagnosis: No pathogen found. *Pseudomonas* sp. isolated, but this probably represented the bacterial symbiote from the caeca of this insect (Steinhaus, Batey, and Boerke, 1956).

672—Ten adults from A. H. Retan; Berkeley, California, August 27, 1951; field collection. Diagnosis: No specific cause of death determined.

802—Egg mass from H. Madsen; Berkeley, California, May 19, 1952; eggs fertile, failed to hatch in laboratory. Diagnosis: Probable infection by *Vibrio* sp., near *V. percolans*. Also, saprophytic fungus, pink yeast, and yellow bacterium.

PSEUDOCOCCIDAE

Ferrisia virgata (Cockerell)

1751—Six mealybugs still attached to leaves on which they were collected by O. S. Bindra; Agricultural Research Institute, Gwalior (R. S.), India, June 5, 1961; mealy-

bugs field-collected at Bhanpuria (Mand-saur District) M. P., India, and laboratory-reared on betel vine. High mortality due to fungus infection. Diagnosis: Mycosis. *Aspergillus parasiticus*.

Unidentified spp.

1629—Specimens from J. J. H. Szent-Ivany; Sum Sum Plantation, Morobe District, New Guinea, August 22, 1960; field-collected on coffee by A. Catley. Diagnosis: Unidentified imperfect fungus. Mycelia sterile, not penetrating insect bodies.

1661—Specimens from S. V. Parthasarathy; Vadapathimangalam, Tanjore District, Madras, South India, October 10, 1960; fungus associated with sugarcane mealybug preserved in alcohol. Diagnosis: Mycosis. *Aspergillus* sp. (*flavus* group), possibly *A. parasiticus*.

PSYLLIDAE

Psylla pyricola Förster

1431—Several adults from H. Madsen; Placerville, California, June 23, 1959; noticed honeydew was being produced in excess amounts and shortly turned cloudy. Diagnosis: Material checked for virus and found to be negative. Clouding of exudate caused by evaporation and crystallization.

Trioza bakeri Crawford

1092—One pupa from D. D. Jensen; San Pablo, California, March 28, 1956; collected on *Rhamnus californica*. Diagnosis: Bacteriosis. No pathogen isolated.

PYRRHOCORIDAE

Dysdercus nigrofasciatus Stål

788—Fifteen nymphs from Q. A. Geering; Kampala, Uganda, East Africa, April 30, 1952; laboratory-reared on cotton. Diagnosis: Possible septicemia caused by a coliform (*Citrobacter*) bacterium.

REDUVIIDAE

Arilus cristatus (Linnaeus)

1392—One fourth-instar nymph from John William Neal; Columbia, Missouri, April 24, 1959; reared from egg mass; evident external powdery growth or exudate. Diagnosis: Lipoidal body exudate.

Rhodnius prolixus Stål

1148—Three adults and eight nymphs from C. Mendis; Berkeley, California, April 8, 1957; laboratory-reared. Diagnosis: No evidence of microbial death. Abundant crystal inclusions present.

SCUTELLERIDAE

Eurygaster pacifica Lattin

1415—Thirteen adults from Samad Vojdani; Pacheco Pass, California, June 3, 1959; brought into laboratory for rearing. Diagnosis: Possible mycosis. *Fusarium* sp. isolated from hemocoel of all submitted specimens.

HYMENOPTERA

ANDRENIDAE

Andrena n. sp.

1505—One adult collected by J. R. Quezada and submitted by J. W. MacSwain; 4 miles northwest of Quetzaltepeque, El Salvador, September 21, 1959; peculiar funguslike structure resembling the genus *Cordyceps* growing from or attached to the pronotum. Diagnosis: Orchid pollinium attached to the pronotum.

Panurginus chalybioides (Viereck)

1091—One adult from J. W. MacSwain; Berkeley, California, March 26, 1956; *Ranunculus californicus*. Diagnosis: Mycosis. Unidentified primitive fungus.

Panurginus melanocephala Timberlake

930—Two adults from J. W. MacSwain; Berkeley, California, February 25, 1954; field-collected on *Ranunculus californicus* Benthams, with fungus pad on thorax. Diagnosis: Localized cutaneous mycosis. Unidentified Phycomycete; no penetration of cuticle; not cultivable on usual media.

949—Five dead and ailing larvae from J. W. MacSwain; Berkeley, California, May 13, 1954; collected on *Ranunculus* sp., held in laboratory for rearing. Diagnosis: Infestation with predaceous mites.

1089—One alcohol-preserved adult from J. W. MacSwain; Berkeley, California, March 16, 1956; collected on *Ranunculus californicus*. Diagnosis: Mycosis. Phycomycete.

ANTHOPHORIDAE

Anthophora bomboides stanfordiana
Cockerell

1354—Six prepupae from J. W. MacSwain; Fort Cronkheit, Marin County, California, November 4, 1958; field-collected. Diagnosis: One specimen with *Fusarium* sp. Two others harboring hyphae but would not grow in culture. One with small gram-negative rod in great abundance. Two with no apparent microorganisms.

Anthophora occidentalis Cresson

1381—One dead prepupa from W. E. Ferguson; Moscow, Idaho, March 13, 1959; field-collected by W. Barr and brought to Berkeley, California, for rearing. Diagnosis: Hemocoel filled with yeast cells.

Diadasia evenata (Cresson)

1637—Numerous prepupae still enclosed within earthen cell from G. E. Bohart; Logan, Utah, September 6, 1960; prepupae exuded fluid from mouth, anterior end turned dark, then flaccid. Pollen balls harbored a fungus growth. Diagnosis: No pathogen found. Pollen balls contained a *Fusarium* sp. Prepupae with light numbers of small gram-negative rods and heavy yeast growth.

Diadasia vallicola Timberlake

1346—Several larvae from W. E. Ferguson; Hopkin's Well, Riverside County, California, October 16, 1958; larvae field-collected and sent to laboratory for rearing. Diagnosis: No pathogen found. Some larvae harboring external growth of *Fusarium* sp. Others with saprophytic bacteria.

1389—One prepupa from W. E. Ferguson; Hopkin's Well, Riverside County, California, April 16, 1959; field-collected October 10, 1958, and reared in the laboratory. Diagnosis: Mycosis. *Aspergillus flavus*. Light secondary growths of *Aspergillus flavipes* and a *Mucor* sp.

Melitoma sp.

894—Twenty-two larvae and earthen cells from J. W. MacSwain; Chiapas, Mexico, September 22, 1953; field collection. Diagnosis: Mycoses (varying according to specimen). *Aspergillus flavus*, *A. versicolor* and miscellaneous saprophytic fungi. Also microsporidiosis in some specimens.

APIDAE

Apis mellifera Linnaeus

735—Agar slant of bacterial culture from P. Hauduroy; Europe, December 6, 1951. Diagnosis: *Alcaligines* sp.

868—Several specimens from L. H. Townsend; Lexington, Kentucky, February 12, 1953. Diagnosis: No pathogen found.

958—One adult from H. H. Laidlaw; Davis, California, June 24, 1954; queen artificially inseminated and held in copper screen cage; queen died one day after initial laying, blood became gelatinous, muscles and oviducts blackened. Diagnosis: *Bacillus subtilis* group, probable source from glucose used in insemination.

1054—One adult from H. F. Menke; Five Points, California, August 2, 1955; healthy specimen with "white material" on notum. Specimen damaged in mails. "White material" no longer evident for diagnosis.

1269—Several larvae from R. E. Ryckman; Loma Linda, California, May 29, 1958; submitted to check for foulbrood. Beekeeper had been manipulating his colonies considerably for royal jelly production. Diagnosis: No bacteria indicative of foulbrood. Peculiar eosinophilic bodies abundant in some larvae.

1370—Two adults from R. B. McPherson; Santa Cruz County, California, January 6, 1959; bees found dead in large numbers in front of two hives. Diagnosis: No pathogen isolated.

1421—Two microscope slides with smears from larvae submitted by F. R. Shaw; Amherst, Massachusetts, June 10, 1959; observation hive fed *Bacillus thuringiensis*. Diagnosis: *Bacillus thuringiensis* present in smear material.

1695—Numerous adults from J. E. Eckert; Davis, California, December 28, 1960; paralysis noted in one experimental hive. Diagnosis: No definite pathogen found. Specimens nearly void of microorganisms. Additional material requested for a non-inclusion virus examination. See Accession No. 1738 below.

1738—About thirty dead and ten ailing adults from J. E. Eckert; Davis, California, May 4, 1961; live adults appeared paralyzed and exhibited restricted, jerky movements. None were able to fly when provoked nor able to right themselves when placed on their dorsum. Diagnosis: Possible non-inclusion virus. Small particles that possibly

represented a virus (or noninfectious nucleoprotein) were demonstrated with the electron microscope.

ARGIDAE

Arge pectoralis (Leach)

1477—Aqueous suspension of triturated larvae from the S. M. Sager collection.^a Diagnosis: Nuclear polyhedrosis.

Sericocera krugii (Cresson)

996—Several specimens from G. N. Wolcott; Central Cambalache, Arecibo, Puerto Rico, December 7, 1954; field-collected on sea grape (*Coccolobis* sp.). Diagnosis: Mycosis. *Beauveria bassiana*.

BRACONIDAE

Apanteles glomeratus Linnaeus

970—Twenty-two pupae and adults from H. Blunck; Bad Godesberg, Germany, July 23, 1954; laboratory-reared from *Pieris brassicae*. Diagnosis: Microsporidiosis. Light *Nosema* infection, probably *N. polyvora*.

Aphidius sp.

1509—Four adults from W. H. Day; Riverhead, New York, September 21, 1959; specimens with sparse mycelium; adults failed to emerge from the host mummy. Diagnosis: No pathogen found. Mycelium represented saprophytic species of *Mucor* and *Penicillium*.

Bracon hebetor Say (= *Bracon juglandis* Ashmead)

1523—One adult from C. Gonzales; Albany, California, October 19, 1959; adult reared from *Anagasta kühniella* infected with *Mattesia dispersa*. Diagnosis: Protozoan infection. *Mattesia dispersa*.

Bracon xanthonotus Ashmead

1111—Four larvae from E. F. Dailey; Kamiak Butte State Park, near Pullman, Washington, July 10, 1956; larvae found under host, *Malacosoma pluviale* (Dyar), near parasite cocoon mass. Diagnosis: No microorganisms evident. Some large crystallike bodies present.

Chelonus annulipes Wesmael

642—Four adults from K. D. Arbuthnot; Des Moines, Iowa, July 6, 1951; reared from field-collected *Pyrausta nubilalis* (Hübner)

kept in cold storage over winter. Diagnosis: Double infection of *Beauveria bassiana* and microsporidian, *Perezia pyraustae*. Source of infection probably from lepidopterous host.

CEPHIDAE

Cephus pygmaeus (Linnaeus)

756—Several larvae from H. L. Parker; Grignon, France, February 20, 1952; collected on wheat. Diagnosis: *Verticillium* sp.

776—Several larvae from H. L. Parker; Rueil-Malmaison, France, April 2, 1952; field collection. Diagnosis: Mycosis. *Beauveria bassiana*.

994—Eight larvae from H. L. Parker; Eure et Loir, France, November 22, 1954; field-collected material. Diagnosis: Mycosis. *Beauveria bassiana*.

CHRYSIDIDAE

Unidentified sp.

643—One adult from C. T. Parsons; Burlington, Vermont, July 9, 1951; found attached to apple leaf in orchard. Diagnosis: Resting spores of *Entomophthora*, conidia absent for positive identification.

CRABRONIDAE

Lindenius columbianus (Kohl)

1634—Three prepupae from H. Court; Soda Springs, California, near Sierra Summit, Highway 50, Nevada County, August 26, 1960; fungus covering pupal cases. Diagnosis: No pathogen found. Fungi present were saprophytic *Fusarium* sp. and a *Mucor* sp.

EURYTOMIDAE

Eurytoma orchidearum (Westwood)

799—One larva from W. Carter; Honolulu, Hawaii, May 14, 1952; removed from gallery in orchid pseudobulb. Diagnosis:

^a As has been explained elsewhere (Steinhaus, 1960), prior to his death in 1959, S. M. Sager, while a graduate student at the University of California, assembled a number of small lots of insects suspected of having polyhedrosis. These were later incorporated with material being routinely diagnosed in our laboratory. Unfortunately, the precise sources of these materials are not available to us, but they apparently came from localities in western Canada and the United States, and were collected during the years 1957–1959. This applies to all accessions ascribed to Mr. Sager in this publication.

Acronium sp., probable saprophytic fungus.

FORMICIDAE

Veromessor andrei (Mayr)

984—One larva from T. C. Lawrence; Berkeley, California, September 24, 1954; laboratory-reared. Diagnosis: Saprophytic fungi present. *Alternaria* sp. and *Fusarium* sp.

HALICTIDAE

Lasioglossum (Sphecodogastra) sp.

808-809—Two larvae from P. D. Hurd; Antioch, California, May 24, 1952; field collection, dug from soil. Diagnosis: Non-microbial death.

Nomia melanderi Cockerell

634—Several specimens from H. F. Menke; Harrah, Washington, June 25, 1951; field collection. Diagnosis: *Aspergillus flavus* isolated from most specimens.

646—Fifteen dead adults from H. F. Menke; Harrah, Washington, July 13, 1951; bees exhibited paralysis. Diagnosis: Examination made for noninclusion virus; no virus particles evident with electron microscope.

1203—Many larvae from W. D. Fronk; Riverton, Wyoming, September 6, 1957; field-collected from earthen cells; some specimens had pink coloration at time of collection. Diagnosis: No definite pathogen associated with mortality. Some coliform bacteria isolated but these were probably saprophytes.

1743—Thirteen prepupae from G. E. Bohart; Logan, Utah, May 9, 1961; specimens dug from soil in nesting sites and earthen pupal cells opened for examination and rearing in the laboratory. Most were partially or wholly greenish brown to black in color. Diagnosis: No specific pathogen found or isolated. Some specimens with large numbers of enteric bacteria; others with few bacteria but with an excess of optically active crystals in fat body.

Nomia sp.

1462—Three pupae and four pollen balls from W. D. Fronk; Riverton, Wyoming, July 27, 1959; some mycelium present on the pollen balls. Diagnosis: No pathogen found. The saprophytic genus *Mucor* oc-

curred on the pollen balls while the larvae harbored an external growth of a *Fusarium* sp. Larval tissue was not invaded.

ICHNEUMONIDAE

Gelis transfuga Foerster

956—Three adults from H. Blunck; Bad Godesberg, Germany, June 9, 1954; parasites reared from *Pieris brassicae* (Linnaeus). Diagnosis: Nonmicrobial death.

967-968—Both pupae and adults from H. Blunck; Bad Godesberg, Germany, July 20-21, 1954; laboratory-reared from *Pieris brassicae*. Diagnosis: Microsporidiosis. Very light infection with *Nosema polyvora* probably obtained from the lepidopterous host.

970—Twenty-two pupae and adults from H. Blunck; Bad Godesberg, Germany, July 23, 1954; laboratory-reared from *Pieris brassicae*. Diagnosis: Microsporidiosis. Light *Nosema* infection, probably *N. polyvora*.

MEGACHILIDAE

Unidentified sp.

695—One larva from L. E. Wallace; Klamath Falls, Oregon, September 21, 1951; field collection. Diagnosis: Bacteriosis. Sporeforming bacteria (*Bacillus*) isolated; possibly responsible for death of larva. Saprophytic fungi (*Mucor*) also present.

SIRICIDAE

Sirex areolatus Cresson

990—One adult from W. W. Middlekauff; Eureka, California, November 18, 1954; field-collected. Diagnosis: No pathogen found. *Mucor* sp., secondary saprophyte, present.

TENTHREDINIDAE

Euura (Pontania) resinicola (Marlatt)

1322—One larva from L. Caltagirone; San Rafael, Marin County, California, August 18, 1958; field-collected. Diagnosis: No pathogen isolated or observed.

Hoplocampa testudinea (Klug)

890—Three pupae from L. W. Bou-langer; Poughkeepsie, New York, August

24, 1953; field-collected, overwintering. Diagnosis: Mycosis. *Beauveria bassiana*.

Neodiprion demoides Ross

1255—Many early instar larvae from D. Dahlsten; Howard Forest, Willits, Mendocino County, California, May 6, 1958; specimens reared on pine in greenhouse. Excessive heat suspected of producing mortality. Diagnosis: No pathogens observed or isolated.

1351—Two pupae from D. Dahlsten; Howard Forest, Willits, Mendocino County, California, October 27, 1958; field-collected and reared in laboratory. Diagnosis: No indication of microbial disease. No pathogen found.

1352—Five prepupae and pupae from D. Dahlsten; Howard Forest, Willits, Mendocino County, California; field-collected and laboratory-reared. Diagnosis: Mycosis. *Beauveria bassiana*.

1378—Four first-instar larvae from D. Dahlsten; Howard Forest, Willits, Mendocino County, California, February 18, 1959; field-collected and returned to insectary for rearing. Diagnosis: No pathogen observed or isolated. Submitter indicated high temperature may have caused mortality.

1398—Eight larvae from D. Dahlsten; Berkeley, California, May 4, 1959; laboratory-reared specimens. Diagnosis: No pathogen observed or isolated. Moderate numbers of small gram-negative rods present.

1401—Thirteen larvae and some eggs from D. Dahlsten; Berkeley, California, May 11, 1959; laboratory-reared. Diagnosis: No pathogen found. Hymenopterous parasites in eggs. Miscellaneous saprophytic bacteria in some larvae.

1414—Six larvae from D. Dahlsten; Willits, California, June 1, 1959; collected from *Pinus* sp. and brought into laboratory for rearing. Diagnosis: No pathogen found. Saprophytic fungus (*Helminthosporium* sp.) isolated from all larvae.

Neodiprion exitans Rohwer

1361—Sixteen larvae from A. Peterson; Perry, Florida, December 5, 1958; collected from loblolly pines near the center of a heavy infestation. Numerous diseased larvae were noted. Diagnosis: Nuclear polyhedrosis. Appeared to be restricted to mid-gut cells.

Neodiprion mundus Rohwer

624—Several dead larvae from V. D. Roth; Corvallis, Oregon, May 25, 1951; field collection on ponderosa pine. Diagnosis: Probably polyhedrosis, confirmation required with additional specimens.

Neodiprion taedae linearis Ross

1772—About twenty late-instar larvae from R. G. Rennels; near Blair, Randolph County, Illinois, July 14, 1961; large numbers of larvae found dead on the ground beneath *Pinus echinata*, as well as normal specimens which had pupated. Diagnosis: No specific pathogen found. Several larvae harbored dipterous larval parasites which may have accounted for part of the observed mortality.

Neodiprion spp.

965—Two hundred prepupae and pupae in cocoons from R. L. Furniss; Big Lake, Oregon, Deschutes National Forest, July 12, 1954; removed from soil under defoliated lodgepole pines. Diagnosis: No definite evidence of disease. Most specimens alive. Some parasite emergence.

972—One hundred larvae from M. M. Furniss; Joseph Creek, Modoc County, California, July 26, 1954; collected on *Abies concolor* and reared in laboratory where unexplained deaths occurred. Diagnosis: No evidence of microbial disease.

1288—Numerous larvae from W. D. Buchanan; Missouri, June 24, 1958; dead larvae concentrated around base of short-leaf pines which were between 95 and 100 per cent defoliated. Diagnosis: No pathogen observed or isolated. Secondary mycosis (*Fusarium* sp.) and bacteriosis.

1442—Thirteen larvae from R. L. Furniss; Puyallup, Washington, July 9, 1959; collected hanging on Douglas fir foliage where a local epizootic was in progress. Diagnosis: Mycosis. *Entomophthora sphacrosperma*.

1467—Seven larvae from P. W. Orr; three localities in the Snoqualmie National Forest area, Washington, July 31, 1959; specimens field-collected and returned to laboratory where they became sluggish and were dead or near death within two days. Diagnosis: No pathogen observed or isolated.

1616—Fourteen larvae from D. Dahlsten; Mount Shasta City, Siskiyou County, California, August 1, 1960; field-collected

on *Pinus ponderosa*. Diagnosis: No pathogen found. Larvae hardened and nearly amicrobial. The majority with some portion of the cuticle covered with pine resins.

1674—Six prepupae from A. T. Drooz; Paulding County, Georgia, October 24, 1960; material found harboring fungus during routine examinations of cocoons for entomophagous insects. Diagnosis: Mycosis. *Beauveria bassiana*.

1745—About twenty-five eggs inserted in Ponderosa pine needles from D. Dahlsten; Mount Shasta City, Siskiyou County, California, May 10, 1961; inserted eggs were laid in fall and overwintered. Submitter noticed that the oviposition sites would begin to expand or swell as if ready to hatch, and then would collapse and form a dark spot on the cuticle of the needle. Environmental conditions (several weeks of extreme cold and unseasonal snow fall) suspected of causing the mortality. Diagnosis: No pathogen found or isolated. Both living and dead eggs nearly free of microorganisms. Two of thirty egg slits examined contained dead and decomposed first-instar larvae which harbored numerous coliform bacteria.

1755—Seven larvae from D. Dahlsten; Mount Shasta City, Siskiyou County, California, June 9, 1961; larvae collected from *Pinus ponderosa* over a 1-month period; dead specimens never abundant and usually found singly. Diagnosis: No definite pathogen found. One larva with full gut trapped in resin exuding from egg slit. Others greenish black and partially decomposed internally. Moderate numbers of small gram-negative, rod-shaped bacteria present. Two larvae trapped in larval exuvia.

Pristiphora erichsonii (Hartig)

1563—Four prepupae from A. T. Drooz; near Lock Haven and Renovo, Pennsylvania, April 25, 1960; field-collection from Japanese larch plantation, cocoons opened and fungus found associated with specimens. Diagnosis: Mycosis. *Beauveria tenella*.

1612—Three prepupae from A. T. Drooz; between Renovo and Lock Haven, Pennsylvania, July 25, 1960; field-collected. Diagnosis: Mycosis and nematode infection. One specimen in early stage of mummification with aerial hyphae just beginning to be produced. Infected with *Beauveria tenella*. Other decomposed prepupae filled with nematodes, *Diplogaster* sp., as well as a gram-positive *Bacillus*, a gram-positive coccus, and numerous gram-negative small rods.

1628—Four prepupae from A. T. Drooz; Renovo, Pennsylvania, August 22, 1960; fungus-covered specimens discovered during routine examinations of cocoons for entomophagous parasites. Diagnosis: No definite pathogen found. Two specimens harbored a *Verticillium* sp., near *terrestre*. One had *Trichoderma viride* in association with a *Mucor* sp. of the "Hiemalis group," and the last harbored a saprophytic *Trichoderma*.

1636—Six pupae from A. T. Drooz; from a swamp 2 miles south of Kalkaska, Michigan, September 6, 1960; field-collected. Diagnosis: Mycosis. *Beauveria* sp., near *bassiana*. Nematode infection. *Diplogaster* sp.

1640—Nine prepupae from A. T. Drooz; Kalkaska, Michigan, September 6, 1960; field-collected. Diagnosis: Mycosis. Three of four specimens with obvious external mycelium infected with *Isaria farinosa*. The fourth harbored a *Mucor* sp. The five remaining specimens were dried out, forming a dark scale within the cocoon. A *Bacillus* sp., and various coliforms, were present but no definite pathogen was isolated. (See Drooz, 1961.)

1786—Thirteen prepupae from A. T. Drooz; Renovo, Pennsylvania, September 11, 1961; field-collected. Diagnosis: Mycosis. *Spicaria* sp.

Unidentified sp.

1146—Larvae from D. Burdick; Arroyo Seco, Monterey County, California, April 1, 1957; field-collected. Diagnosis: No pathogen found.

TRICHOGRAMMATIDAE

Trichogramma minutum Riley

981—Several egg cards from L. M. Sibley; Baton Rouge, Louisiana, September 14, 1954; no parasite emergence from eggs of *Sitotroga cerealella* (Olivier). Parasitized under laboratory conditions. Diagnosis: Nonmicrobial death.

VESPIDAE

Polistes olivaceus (DeGeer) [= *P. hebraeus* (Fabricius)]

1777—Two adults from A. D. Hinckley; near Nausori on Viti Levu, Koronivia, Fiji, July 31, 1961; one found clinging to a coconut frond, the other on a light cord; both presumably killed by a fungus. Diagnosis: No pathogen found or isolated. Only

fungi present on the surface were isolated patches of saprophytic *Aspergillus* and *Penicillium* sp.

Polistes sp.

1597—Four adults from R. Lavigne; Glendo, Wyoming, June 15, 1960; specimens found bunched together in a sandbank following a rain storm. Diagnosis: No pathogen found. White mycelium of a saprophytic *Penicillium* sp. partially covering the surface of the adults.

Ropalidia marginata sundaica Van Der Vecht

717—One adult from R. P. Owen; Koror, Palau, Caroline Islands, October 25, 1951; field collection. Diagnosis: *Hirsutella* sp.

Vespa crabro germana (Christ)

1332—Nest containing numerous larvae from R. Lavigne; Amherst, Massachusetts, September 15, 1958; some capped cells contained a black substance presumably of a bacterial nature. Nest had been saturated with malathion but deaths had occurred earlier than treatment. Diagnosis: Bacteriosis. Predominant bacteria were a *Proteus* and a peculiar streptococcuslike form. No virus found by electron microscopy.

XYELIDAE

Xyela sp.

1163—Three larvae from D. Burdick; 4 miles west of Plantation, Sonoma County, California, May 15, 1957; collected from *Pinus muricata*. Diagnosis: No evidence of pathogens present.

XYLOCOPIDAE

Ceratina dupla Say

1558—Two adults from L. Chandler; West Lafayette, Indiana, April 6, 1960; specimens were recovered from blackberry canes in which they had hibernated and were found associated with mycelial growth. Other adults were active and unaffected. Diagnosis: Saprophytic fungus, *Fusarium* sp.

Ceratina sp.

1737—One adult female from L. Chandler; Lafayette, Indiana, May 2, 1961; female adult dead when removed from winter hibernating burrow in raspberry cane; covered with white mycelium invading in-

ternal cavity but no evident mummification. Appears to have entered after death. Diagnosis: No pathogen found. Fungus a saprophytic *Fusarium* sp., near *F. chlamydosporum*.

FAMILY UNKNOWN

Unidentified spp.

1145—Larva from D. Burdick; Arroyo Seco, Monterey County, California, April 1, 1957; field-collected. Diagnosis: Non-microbial cause of death.

1759—Miscellaneous cells and larvae of assorted Hymenoptera from F. Parker; various California and Nevada localities, June 15, 1961; specimens taken from elderberry stems (*Sambucus* sp.) with some fungal growth of various types. Diagnosis: Mycosis. Some larvae with *Beauveria bassiana*. In most cases, however, the fungi were all adventitious saprophytes and were not responsible for the death of the specimens. Fungi represented: *Mucor* sp., *Fusarium* sp., *Penicillium* sp., *Aspergillus* sp. (not the *flavus* group), and an *Alternaria* sp. Other than the fungi, there were no microorganisms present which were recognized as insect pathogens; the cause of death in these cases remained unknown.

ISOPTERA

KALOTERMITIDAE

Cryptotermes brevis (Walker)

1023—Several specimens from G. N. Wolcott; Puerto Rico, April 11, 1955; field-collected. Diagnosis: Nonmicrobial death.

TERMITIDAE

Reticulitermes flavipes (Kollar)

1635—About thirty nymphs and adults from L. Chandler; Lafayette, Indiana, August 30, 1960; laboratory colony collected at Allerton, Illinois. Heavy mortality; first indication of disease was a black patch which appeared on the cuticle and spread rapidly. Diagnosis: Mycosis. *Entomophthora* sp., near *grylli* and *coronata*.

Reticulitermes virginicus (Banks)

1336—Several specimens from L. Chandler; Jackson, Mississippi, September 17, 1958; dark patches noted on heads and bodies of workers when collected in field;

thought to be dirt. The growth did not appear to affect the termites, and chemical toxicity tests were comparable for both normal and infected insects. Diagnosis: Mycosis. *Termitaria snyderi*. (See figs. 23A, B, C, pp. 424-425.)

Reticulitermes sp.

1644—Several specimens from V. K. Smith; Gulfport, Mississippi, September 16, 1960; some fungus-covered termites were submitted in a decayed wood and sawdust medium used to rear them in the laboratory. Diagnosis: No pathogen isolated. Fungi present: a saprophytic *Mucor* sp. and a *Penicillium* sp.

LEPIDOPTERA

ACROLOPHIDAE

Acrolophus sp.

1765—Four larvae from R. L. Rabb; Cary, North Carolina, July 5, 1961; field-collected and apparently killed by a fungus organism. Gross examination of the specimens on arrival showed no external signs of fungus; however, microscopic examination verified the presence of a fungus. Diagnosis: Mycosis. *Entomophthora* sp. near *E. virescens*.

AEGERIIDAE

Ramosia bibionipennis (Boisduval)

1243—Two larvae from R. G. Rosenstiel; Dundee, Oregon, April 7, 1958; removed from boysenberry crowns. Diagnosis: Mycosis. *Spicaria* sp.

Ramosia tipuliformis (Clerck)

811—One larva from F. E. Taschenberg; Fredonia, New York, May 27, 1952; field collection. Diagnosis: Mycosis. *Hirsutella subulata*.

Vitacca polistiformis (Harris)

1817—Five larvae from G. N. Clark; Columbia, Missouri, November 3, 1961; four larvae recovered from burrows in grapevine roots; one died of a mycosis while being reared in the laboratory. Diagnosis: Mycosis. *Metarrhizium anisopliae* infecting one of the field-collected larvae. *Beauveria bassiana* infecting the remainder. *Trichoderma* sp. isolated as a saprophyte.

AGONOXENIDAE

Agonoxena pyrogramma Meyrick

1225—Ten larvae from R. W. Paine; Lae, New Guinea, January 31, 1958; field-collected. Diagnosis: No evidence of pathogenic microorganisms present.

AMATHUSIIDAE

Brassolis isthmiae Bates

1642—One late-instar larva from E. McConnell; Cumbres, Panama, September 7, 1960; several larvae found dead on coconut palm. When collected the following day all but one were covered with a fungus growth. Diagnosis: Mycosis. *Beauveria bassiana*.

Caligo teucer Linnaeus

1527—One pupa from F. Malo; Tenguel, Ecuador, November 16, 1959; possible fungus infection. Diagnosis: No pathogen found. Saprophytic *Penicillium* sp. the only fungus recovered from isolations.

ANTHELIDAE

Pterolocera amplicornis Walker

896—Ten larvae from M. F. Day; Canberra, Australia, October 5, 1953; laboratory-infected with polyhedrosis virus. Diagnosis: Nuclear polyhedrosis; diagnosis of M. F. Day confirmed.

ARCTIIDAE

Diacrisia virginica (Fabricius)

955—Twenty-six larvae from I. Barber; Berkeley, California, June 9, 1954; laboratory-reared from eggs. Diagnosis: Heavy bacterial contamination.

Ecpantheria icasia (Cramer)

1693-1694—Numerous larvae, pupae, and one egg mass from C. S. Stephens; Changuinola, Panama, December 20-22, 1960; material field-collected from ground cover in banana plantation. Egg mass harbored a fungus. Pupae brought into laboratory for rearing failed to develop, and most of the larvae ceased feeding, migrated to vegetation tips, became limp, and exhibited a milky fluid in the body cavity when opened. Diagnosis: Mycosis. Eggs infected with *Beauveria bassiana*. All larvae exhibited varying degrees of infection with a granu-

losis. In some cases, bacterial growth tended to mask the presence of the capsules. One virus-infected specimen also harbored a tachinid parasite. The pupae were infected with *Beauveria bassiana* in some cases, and with *Aspergillus flavus* in others. (See fig. 32E, p. 470.)

Ecpantheria muzina Oberthur

1614—One larva from J. L. Nickel; Olanchito, Yoro, Honduras, July 27, 1960; field-collected and reared on banana peel in the laboratory at 27° C where it contracted a

fungus disease. Many larvae were reared previous to this without incident. Diagnosis: Mycosis. *Aspergillus* sp. (*flavus* group). Growth form somewhat resembled that of *A. parasiticus*.

Ecpantheria sp.

1602—One larva from C. S. Stephens; Almirante, Panama, June 24, 1960; single specimen found weakly crawling on the ground cover of a banana plantation with a white discharge issuing from the anus. Diagnosis: Nuclear polyhedrosis.

Fig. 23. The termite *Reticulitermes virginicus* (Banks) harboring several colonies of the cuticular fungus *Termitaria snyderi* Thaxter. A. Workers showing various sites of fungus growth. The black outline of the fungus growth is natural; the photograph has not been retouched. B. Photomicrographic cross-section of an entire fungus colony showing the dense palisade nature of the growth. C. Enlarged view showing full details and individual sporophores of the same colony. (Acc. No. 1336, p. 423.)

Estigmene acrea (Drury)

986—Numerous larvae from N. F. McCalley; Salinas, California, October 12, 1954; collected in lettuce field, high mortality. Diagnosis: Mycosis. *Entomophthora aulicae*. One specimen was infected with a granulosis virus, and one other specimen was infected with Microsporidia.

1211—One larva from W. E. Ferguson; Clarksburg, California, October 3, 1957; field-collected from alfalfa field. Diagnosis: Mycosis. *Entomophthora aulicae*.

1325—Numerous larvae from J. J. Menn; Mountain View, California, August 22, 1958; laboratory-reared larvae. Diagnosis: Microsporidiosis. *Nosema* sp.

1342—One larva from J. E. Swift; Woodville, Tulare County, California, October 10, 1958; removed from asparagus fern. Diagnosis: No evidence of microbial infection. Bacteria present but probably saprophytes.

1344—Several larvae from J. E. Swift; Vincent Ranch, Cotton Center, Tulare County, California, October 15, 1958; collected on asparagus. Diagnosis: Mycosis. *Entomophthora aulicae*. Other specimens were heavily parasitized with tachinid larvae.

1345—Several larvae from J. E. Swift; Roberts Ranch, Woodville, Tulare County, California, October 15, 1958; collected from asparagus. Diagnosis: Mycosis. *Entomophthora aulicae*.

1347—Three larvae from R. L. Langston; 4 miles north of King City, Monterey County, California, October 24, 1958; field-collected. Diagnosis: Mycosis. *Entomophthora aulicae*.

1497—Two larvae from F. R. Cole; Berkeley, California, September 10, 1959; collected in home garden. Diagnosis: Mycosis. One specimen heavily infected with *Entomophthora aulicae*. The other specimen contained four tachinid larvae which proved to be *Blepharipeza adusta* Lowe when reared to adults.

1521—One larva from C. Gonzales; Tracy, California, October 19, 1959; forty presumably healthy larvae were field-collected and returned to the laboratory. One specimen died 24 hours later with a fungus disease. Diagnosis: Mycosis. *Entomophthora aulicae*.

1696—Several larvae from J. J. Menn; Mountain View, California, January 9,

1961; insectary-reared for purposes of insecticide bioassay. Moderate mortality over extended period of time. Diagnosis: Microsporidiosis. *Nosema* sp.

1829—Four larvae from I. N. McDaniel; Highmoor Farm, Monmouth, Maine, December 28, 1961; larvae crawled up on plants to die and remained attached; a fungus growth appeared on the ventral surface. Cool weather preceded the epizootic. Diagnosis: Mycosis. *Entomophthora aulicae*.

Halisidota argentata Packard

1028—Seven larvae from W. J. Chamberlin; Corvallis, Oregon, April 25, 1955; laboratory-reared. Diagnosis: Nonmicrobial death.

1395—Three dead and four presumably normal larvae from R. C. Bechtel; Zephyr Cove, Lake Tahoe, Douglas County, Nevada, April 30, 1959; three larvae found hanging on limb by prolegs. Fourteen others on same limb appeared to be normal. Diagnosis: No pathogen found. Live larvae reared through with no obvious disease symptoms.

1483—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote p. 418.) Diagnosis: Nuclear polyhedrosis.

Hyphantria cunea (Drury)

703-706—Many larvae, prepupae and pupae from E. P. Breakey; Bellingham, Lynden, Issaquah, and Puyallup, Washington, October 5, 1951; all field collections. Diagnosis: Nuclear polyhedrosis.

925—Three larvae from J. Weiser; Praha, Czechoslovakia, December 18, 1953. Diagnosis: Microsporidiosis. *Theclohania* sp., probably *T. hyphantriae*.

Unidentified sp.

779—Thirty larvae from J. R. Brazzel; Baton Rouge, Louisiana, April 8, 1952; disease extensive, keeping population at low level. Diagnosis: Mycosis. *Entomophthora* sp., probably *E. aulicae*.

CRAMBIDAE

Chilo loftini Dyar

592—One larva from R. S. Woglum; Los Mochis, Sinaloa, Mexico, February 21, 1951; in sugarcane stalk. Diagnosis: Cause

of death undetermined, fungus present a saprophyte.

Chilo suppressalis (Walker)

1658—Ten larvae from I. Tateishi; Kōkura City, Kyushu, Japan, September 29, 1960; larvae mummified, yellow brown, and friable. Body filled with highly sculptured (reticulate) resting spores. Diagnosis: Mycosis. *Myiophagus ucrainicus*.

1692—Two diseased and one normal larva from I. Tateishi; Kokubunji chikushinomachi, Fukuoka-ken, 3 kilometers from Futsukaichi, Japan, December 13, 1960; presence of disease localized and not common even though there were an estimated 15,000 to 20,000 larvae per ten acres of rice field. Diseased larvae turned milky white in color. Diagnosis: Granulosis.

Chilo zonellus Swinhoe

1547—Two larvae from V. P. Rao; Hardoi, India, February 18, 1960; black spots appeared on the larval cuticle a few days before death. Diagnosis: Mycosis. Larvae mummified and filled with hyphae of a *Fusarium* sp.

1625—Many larvae from V. P. Rao; Hardoi, Uttar Pradesh, India, August 15, 1960; collected from *Sorghum vulgare*. Some larvae are white, others brown, and some black and flaccid. Diagnosis: No specific pathogen isolated or observed. Some larvae harboring large numbers of small gram-negative rods as well as *Bacillus cereus*.

1649—One larva from V. P. Rao; Bangalore, India, September 20, 1960; laboratory-reared on *Sorghum vulgare*. Occasional larva turned brown and became limp. Diagnosis: No pathogen found. Miscellaneous saprophytic bacteria.

Crambus topiarius Zeller

1651—One larva from C. S. Crawford; Pullman, Washington, September 20, 1960; laboratory-reared on Merion bluegrass with four larvae per container. Body covered with white mycelium. All internal tissues completely invaded with hyphae; some sporulation in the hemocoel. Diagnosis: Mycosis. *Fusarium* sp.

1660—One larva from C. S. Crawford; Kootenai County, Idaho, near Spokane, Washington, September 30, 1960; collected 1 inch below soil surface in field of Merion bluegrass. Posterior segment with black

necrotic area on cuticle and darkening of surrounding internal area. Diagnosis: Mycosis. *Mucor* sp., *Hiemalis* group. Organ systems were being invaded with hyphae radiating from the posterior injury.

Crambus vulgivagellus Clemens

1673—Three larvae from C. S. Crawford; Pullman, Washington, October 19, 1960; laboratory-reared on Delta bluegrass (*Poa pratensis*). Larvae partially paralyzed, lying on side; twitching in localized areas such as prolegs and pinacula; slightly flaccid. Diagnosis: Bacteriosis, possibly a mixed septicemia. *Bacillus cereus* and small gram-negative, lactose-negative rods.

Diatraea saccharalis (Fabricius)

899—Two larvae from R. Mathes; Houma, Louisiana, October 9, 1953; field-collected. Diagnosis: Mycosis. *Cordyceps* sp.

1078—One larva from S. D. Hensley; Stillwater, Oklahoma, December 20, 1955; laboratory-reared specimens from a shipment collected in Houma, Louisiana. Death occurred 8 days after arrival in laboratory. Diagnosis: Mycosis. *Beauveria bassiana*.

1647—Seven larvae from W. H. Long; Baton Rouge, Louisiana, September 19, 1960; larvae individually reared in laboratory in glass vials on stems of corn or sugarcane at 27° to 30° C died at or near maturity. Diagnosis: Granulosis. (New record.)

Zeadiatreia grandiosella (Dyar)

884-886—One larva from K. D. Arbuthnot; Stillwater, Oklahoma, May 7, 1953; field-collected. Diagnosis: Small gram-negative, lactose-negative, rod-shaped bacterium, nonpathogenic to laboratory test insects.

DANAIDAE

Danaus plexippus (Linnaeus)

895—One chrysalis from M. Doudoroff; locality unknown, September 24, 1953; field-collected. Diagnosis: *Penicillium* sp., probably saprophytic.

926—One chrysalis from M. Doudoroff; Berkeley, California, February 5, 1954. Diagnosis: No pathogen found.

987—One pupa from A. L. Hopf; New York, New York, September 23, 1954; insectary-reared specimen. Diagnosis: *Penicillium* sp. isolated from interior of pupal case.

DIOPTIDAE*Phryganidia californica* Packard

1323-1324—One larva from M. E. Martignoni; Redwood Road, Contra Costa County, California, August 19 and 21, 1958; field-collected and held in laboratory; died within 4 days. Diagnosis: Mycosis. *Entomophthora* sp., possibly *E. exitalis*.

1326—Three dead larvae from M. E. Martignoni; Redwood Road, Contra Costa County, California; laboratory culture received in order to study *Entomophthora* infection. The dead larvae were limp and body contents were dissolved. Diagnosis: Nuclear polyhedrosis.

1502—Thirteen pupae from C. Reiner; Live Oak Camp, Mount Diablo State Park, California, September 15, 1959; collected from *Quercus* sp. and returned to the laboratory for rearing. Diagnosis: Mycosis. *Beauveria bassiana*.

EPIPASCHIIDAE*Tetralopha scortealis* (Lederer)

1053—Seven larvae from W. F. Chamberlain; Clemson, South Carolina, July 25, 1955; field-collected. Diagnosis: Nuclear polyhedrosis. (See Steinhause, 1957.)

GALLERIIDAE*Galleria mellonella* (Linnaeus)

1081—Several specimens from F. L. Howbridge; Churubusco, Indiana, January 6, 1956; insectary-reared. Diagnosis: Nonmicrobial death.

1088—Several larvae from F. L. Howbridge; Churubusco, Indiana, March 13, 1956; insectary-reared for commercial purposes. Diagnosis: No evidence of infectious agents present.

1576—Twelve larvae from M. Shapiro; Ithaca, New York, May 17, 1960; black spots appeared when larvae held at 7° C but not when held at higher temperatures. Spots gradually enlarged and began covering entire cuticle. Diagnosis: No specific pathogen found. Mycelium isolated from under black patches. Culture produced only sterile hyphae.

GELECHIIDAE*Gnorimoschema gallaesolidaginis* (Riley)

686—One larva from W. E. Miller; Pickaway County, Ohio, September 12, 1951;

taken from goldenrod gall. Diagnosis: Mycosis. *Beauveria bassiana*.

690—One larva from W. E. Miller; Dover, Ohio, September 17, 1951; field collection from goldenrod. Diagnosis: Possible metabolic disturbance, many prepupal crystalline bodies and miscellaneous bacteria.

715—Seven pupae and larvae from W. E. Miller; Ohio, October 23, 1951; field collection. Diagnosis: No pathogen found. Cause of death undetermined.

731—One larva from W. E. Miller; Apple Creek, Ohio, November 29, 1951; field collection. Diagnosis: Double infection: septicemia and mycosis. *Serratia marcescens* (see Steinhause, 1959a) and *Beauveria bassiana* (*globulifera* strain).

876—Several larvae from W. E. Miller; Wellston, Ohio; collected on goldenrod. Diagnosis: Mycosis. *Beauveria bassiana*.

Pectinophora gossypiella (Saunders)

897—One larva from T. Heffernan; Taft, California, October 2, 1953; field-collected. Diagnosis: Heavy yeast infection, tentatively identified as *Torulopsis* sp. Pathogenicity not tested.

Recurvaria milleri Busck

740—Approximately 500 larvae from J. H. McLeod; Yosemite National Park, California, December 26, 1951; field collection. Diagnosis: Granulosis.

780—Ninety-two larvae from J. H. McLeod; Minidoka, Idaho, April 11, 1952; field-collected. Diagnosis: Electron-microscopic examination negative for virus; no pathogen found.

872—Several larvae from G. R. Struble; Tenaya Lake, California, June 3, 1953; field collection. Diagnosis: Granulosis.

883—One hundred adults from R. C. Hall; Delaney Creek, Yosemite National Park, August 11, 1953; collected on pine, held in insectary; females did not lay eggs. Diagnosis: Nonmicrobial; no evident histopathology to explain abnormality.

1044—Thirty larvae from G. R. Struble; Tuolumne Meadows, California, June 10, 1955; field-collected on lodgepole pine. Diagnosis: Possible granulosis; capsules present in very few numbers in some specimens. One specimen infected with *Serratia marcescens*.

1113—Eight second- and third-instar larvae from G. R. Struble; Tuolumne Mea-

dows area, Yosemite National Park, California, July 23, 1956; collected from lodgepole pine. Diagnosis: No pathogen present in all larvae, but one specimen may have been infected with a granulosis.

Segasta bosqueella (Chambers)

1317—Several second- and third-instar larvae from K. D. Arbutnot; Stillwater, Oklahoma, August 11, 1958; laboratory-reared from eggs; mortality 80 to 100 per cent; some larvae showed evidence of fungous infection. Diagnosis: Mycosis. *Aspergillus* sp.

GEOMETRIDAE

Anthelia hyperborea Hulst

1485—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Nuclear polyhedrosis.

Calospilos miranda Butler

1655—Five larvae from T. Kawarabata; Hakozaki, Fukuoka, Kyushu, Japan, September 27, 1960; specimens collected from *Euonymus japonica*. Some specimens exhibited external mycelial growth, others showed no signs of external growth but grasped vegetation with the prolegs, turned black, and hung down, resembling a nuclear polyhedrosis infection. Diagnosis: Mycosis. *Entomophthora sphaerosperma* present in all specimens. Negative for a virus infection. (See fig. 24, p. 430.)

Caripeta divisata Walker

1481—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Nuclear polyhedrosis.

Ectropis crepuscularia Schiffermuller

1473—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Possible polyhedrosis.

Enyppia venata Grote

1470—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Nuclear polyhedrosis.

Eulype hastata (Linnaeus)

1327-1328—Numerous specimens from G.

L. Downing; 302-mile marker on Richardson Highway southeast of Fairbanks, Alaska, August 25 and 28, 1958; insect occurring over several hundred-thousand acres, causing serious defoliation of white birch; epizootic occurred in third and fourth instar where dead and dying larvae were reported hanging limply from vegetation; summer had been unusually wet and humid. Diagnosis: Mycosis, microsporidiosis, and virus disease. The following results are from Accession No. 1327: Six larvae with double infection of *Entomophthora* sp. and *Nosema* sp. Seven larvae with a double infection of *Nosema* sp. and a granulosis. One specimen died of a granulosis. All the larvae from Accession No. 1328 were infected with a granulosis virus. (See Steinhaus, 1959b.)

Eupithecia longipalpata Packard

1482—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Nuclear polyhedrosis.

Melanolophia imitata Walker

1476—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Nuclear polyhedrosis.

Nepytia phantasmaria (Strecker)

1475—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Nuclear polyhedrosis.

Nyctobia sp.

1471—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Possible polyhedrosis.

Pero behrensarius Packard

1469—Aqueous suspension of triturated larvae from the S. M. Sager collection. Diagnosis: Nuclear polyhedrosis. (See Steinhaus, 1960, for published report on accessions 1469-1485.)

Sabulodes caberata Guenée

797—Five larvae from N. L. H. Krauss; La Habra, California, May 13, 1952; collected on avocado leaves. Diagnosis: Granulosis.

1409—One larva from G. A. Marsh; Berkeley, California, May 25, 1959; field-

Fig. 24. *Calospilos miranda* Butler from Hakozaki, Fukuoka, Kyushu, Japan, infected with the fungus *Entomophthora sphaerosperma* Fresenius. Note external resemblance to a larva infected with a nuclear polyhedrosis virus. (Acc. No. 1655, p. 429.) (Photo courtesy of T. Kawarabata.)

collected on English ivy. Diagnosis: Granulosis.

Selidosema suavis (Butler)

1194—Two disintegrated larvae from G. B. Rawlings; Kariori Forest, North Island, and Balmoral Forest, South Island, New Zealand, August 13, 1957; sent for confirmation of a suspected virus disease. Diagnosis: Nuclear polyhedrosis. (Reported by Steinhaus, 1960.)

Synaxis pallulata Hulst

1472—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Nuclear polyhedrosis.

Unidentified spp.

830—Larva from K. Snyder; San Antonio, Texas, July 21, 1952; field-collected. Diagnosis: Bacteremia. *Bacillus cereus* var.

mycoides, and a small gram-negative, lactose-negative rod.

1144—Larva from J. A. Powell; near Pittsburg, Contra Costa County, California, March 25, 1957; collected on wild rose. Diagnosis: *Hormodendrum* sp. isolated, but not considered pathogenic.

1587—Four lots from E. F. Legner; Door County, Wisconsin, June 13, 1960; field-collected during the summer of 1959. Diagnosis: Two lots harbored an *Aspergillus* sp. (*flavus* group). One was a deformed pupa trapped in larval skin. Remaining material contained varying amounts of optically active birefringent crystals.

GRACILARIIDAE

Lithocolletis crataegella Clemens

832—One larva from F. de Tar; Placerville, California, July 25, 1952; field-collected. Diagnosis: No pathogen found.

HEPIALIDAE

Oncopera intricata Walker

1252—Fungus culture from L. W. Miller; Ouse, Southern Tasmania, April 29, 1958; isolated from field-collected larvae. Diagnosis: Unidentifiable mycosis. Culture tube smashed in transit. Attempts to reisolate from the remains unsuccessful.

1281—Fungus on agar slant from L. W. Miller; Hobart, Tasmania, June 23, 1958. Diagnosis: Mycosis. *Cephalosporium* sp.

Porina sp.

1806—Two late-instar larvae from G. A. H. Helson; Karori, Wellington, New Zealand, October 11, 1961; field-collected from ryegrass (*Lolium* sp.) in a damp habitat. The disease is enzootic. Diagnosis: Mycosis. One larva infected with *Beauveria bassiana*. The second infected with a nuclear polyhedrosis representing a new host record and the first time an insect virus has been demonstrated from the primitive lepidopterous family Hepialidae. (See fig. 25, p. 432.)

HESPERIIDAE

Erynnis plautus (Scudder)

1432—One larva from J. M. Burns; Hualapai Mountains, Arizona, June 24, 1959; collected on *Quercus gambelii* and

maintained for 2 weeks in the laboratory in Berkeley, California, on *Quercus lobata* before death. Diagnosis: Mycosis. *Beauveria bassiana*.

Erynnis sp., probably *clitus* Edwards

1517—One last-instar larva from J. M. Burns; Berkeley, California, October 1, 1959; originally taken from *Quercus arizonica* and reared in the laboratory; began developing dark spots on the cuticle and died prior to pupation. Diagnosis: Mycosis. *Beauveria bassiana*.

Eudamus sp.

1018—One larva preserved in alcohol from R. F. Ruppel; Medellin, Antioquia, Colombia, March 2, 1955; collected on bean plant. Diagnosis: No pathogens discernible. Preservation precluded culture.

Hesperia columbia Boisduval

909—One pupa from C. D. MacNeill; Mount Tamalpais, Marin County, California, November 11, 1953; specimen laboratory-reared from field-collected eggs. Diagnosis: Hemocoel filled with gram-negative, slow lactose-fermenting, short, rod-shaped bacteria. Probable normal gut form causing septicemia.

Hesperia harpalus idaho (Edwards)

1004—One larva from C. D. MacNeill; Modoc County, California, January 3, 1955; laboratory-reared from field-collected adults. Diagnosis: Septicemia. Nonlactose-fermenting, small, gram-negative rod.

Hesperia pahaska Leussler

1065—One larva from C. D. MacNeill; Berkeley, California, October 6, 1955; laboratory-reared. Diagnosis: Bacteriosis. Small gram-negative rod.

1068—Two second-instar larvae from C. D. MacNeill; Berkeley, California, October 22, 1955; laboratory-reared. Diagnosis: Cause of death undetermined. No microbial pathogens found.

1073—One third-instar larva from C. D. MacNeill; Berkeley, California, November 11, 1955; laboratory-reared. Diagnosis: No pathogen isolated.

Pelopidas agna Moore

1781—One larva from M. Z. Alam; Agricultural Experiment Station, Tejaon, East Pakistan, August 9, 1961; field-collected

Fig. 25. Electron micrograph of a polyhedrosis virus of *Porina* sp. from New Zealand. These particles are considerably longer than the usual virus rod. In this case the size of the rod is approximately $540\text{ m}\mu \times 72\text{ m}\mu$. (Acc. No. 1806, p. 431.)

from rice. Diagnosis: Mycosis. *Aspergillus flavus* the dominant growth. *Rhizopus* sp. and *Fusarium* sp. also present, but these were assumed to be saprophytic.

HYPONOMEUTIDAE

Hyponomeuta padella (Linnaeus)

645—Twenty-five larvae and pupae from H. L. Parker; Seine et Oise, France, July 13, 1951; field collection. Diagnosis: Heavy secondary bacteremia, otherwise no pathogens found.

LASIOCAMPIDAE

Dicogaster coronado Barnes

576—One larva from T. W. Hower; Orange, California, January 3, 1951; from mass colony. Diagnosis: Bacteriosis. Gram-negative, lactose-negative, small rod.

Lasiocampa quercus (Linnaeus)

1039—One larva from L. Bognar; Cap-Ferret (Alps Maritimes), France, May 20, 1955; insectary-reared. Diagnosis: Mycosis. *Beauveria bassiana*.

Malacosoma constricta Stretch

877—Several specimens from G. Pronin; Salem, Oregon. Diagnosis: One larva infected with unidentified microsporidian, one with *Beauveria bassiana*, and several with a nuclear polyhedrosis virus.

Malacosoma disstria Hübner

605—One dead larva from E. A. Steinhäus; Walnut Creek, California, April 17, 1951; field-collected. Diagnosis: Bacteremia, unidentified sporeformer (*Bacillus* sp.).

640—Over 100 larvae from E. P. Breakey; Puyallup, Washington, July 5, 1951. Diagnosis: Nuclear polyhedrosis.

816—Fifteen larvae from E. F. Dailey; Puyallup, Washington, June 6, 1952; collected on alder leaves. Diagnosis: A few miscellaneous bacteria of possible secondary importance; no pathogen found.

874—Several larvae from A. C. Hodson;

Itasca State Park, northern Minnesota, July 6, 1953; field-collected. Diagnosis: Nuclear polyhedrosis.

Malacosoma fragile (Stretch)

617—Many larvae from H. T. Osborn; Sonora Pass, California, May 11, 1951; field collection. Diagnosis: Virus etiology negative; nonmicrobial.

635—Many larvae from J. W. MacSwain; Pinecrest, California, June 25, 1951; field-collected on *Ceanothus* sp. Diagnosis: Heavily parasitized with entomophagous insect.

1178—Six diseased and six normal larvae from R. C. Hall; between Chester and Westwood, California, July 3, 1957; field-collected. Diagnosis: No pathogen found.

1196—About ten larvae from G. F. Kraft; near South Bend, Deschutes County, Oregon, August 15, 1957; field-collected. Diagnosis: Nuclear polyhedrosis.

Malacosoma plumbea (Dyar)

640—Over 100 larvae from E. P. Breakey; Puyallup, Washington, July 5, 1951. Diagnosis: Nuclear polyhedrosis.

782—Two larvae from E. Clark; Albany, California, April 18, 1952; field collection. Diagnosis: Mycosis. *Beauveria bassiana*.

805-806—Several larvae from E. F. Dailey; Puyallup and Bothell, Washington, May 23, 1952; collected on alder. Diagnosis: Nuclear polyhedrosis.

813—Many larvae from E. F. Dailey; Seattle and Bothell, Washington, June 2, 1952; field-collected on apple and alder. Diagnosis: One lot with nuclear polyhedrosis; remainder nonmicrobial deaths.

815—Fifteen larvae from E. F. Dailey; Puyallup, Washington, June 6, 1952; collected on alder leaves. Diagnosis: A few miscellaneous bacteria of possible secondary importance; no pathogen found.

959—Six larvae from E. F. Dailey; near Puyallup, Washington, June 25, 1954; field-collected from an area in final stages of polyhedrosis virus epizootic. Diagnosis: Two larvae with nuclear polyhedrosis virus, two larvae with *Entomophthora* sp., one larva with unidentified imperfect fungus, and one nonmicrobial death.

1046—Seven larvae from E. F. Dailey; Kamiak Butte State Park, near Pullman, Washington, June 24, 1955; dead larvae collected hanging limply on the outside and inside "nest" webbing on native rose. Diag-

nosis: Nuclear polyhedrosis, with heavy secondary bacterial infestation.

1047—One larva from E. F. Dailey; near Pullman, Washington, July 1, 1955; field-collected on native rose and reared in the laboratory in glass jars with high humidity. Diagnosis: Mycosis. *Beauveria bassiana*.

1049—One larva from E. F. Dailey; Pullman, Washington, July 7, 1955; laboratory-reared. Diagnosis: Mycosis. *Beauveria bassiana*.

1051—One larva from E. F. Dailey; Pullman, Washington, July 12, 1955; laboratory-reared. Diagnosis: Mycosis. *Beauveria bassiana*.

1105—Twenty larvae from E. F. Dailey; Kamiak Butte State Park, near Pullman, Washington, June 12, 1956; collected on wild rose. Diagnosis: Small round bodies in fat-tissue cells of two specimens; probably protozoan in nature. Other specimens showed saprophytic bacteria in body cavity.

1599—Five lots of over thirty larvae from F. W. Stehr; California, June 20, 1960; some of the material collected near Ukiah, California, and reared in an insectary trailer in cages where mortality was high. Diagnosis: Two lots exhibiting "wilt" symptoms were all infected with a nuclear polyhedrosis. The remaining three lots were suspected of being infected with a noninclusion virus but the particles were not demonstrated. As noted by the submitter, the larvae ceased to feed but continued to wander about the cage very actively. The body then began to shrivel or shorten and feces clung to the recurved posterior. Complete desiccation and death occurred in 3 to 5 days at 29.4° to 32.2° C.

LIMACODIDAE

Natada nararia (Moore)

625—Several larvae from G. D. Austin; Passara, Ceylon, May 29, 1951; collected in tea plantation. Diagnosis: Granulosis.

Sibine apicalis Dyar

1520—Eight larvae from F. Malo; Tenguel, Ecuador, October 9, 1959; fungus infection primarily infecting first- to third-instar larvae in banana plantations. As high as 90 per cent mortality occasionally observed. Diagnosis: Mycosis. *Beauveria bassiana*.

1526—Thirty-four larvae and pupae from F. Malo; Tenguel, Ecuador, November 16,

1959; field-collected from banana plantation. Diagnosis: Mycosis. *Beauveria basiana*.

LYMANTRIIDAE

Euproctis signata (Blanchard)

794—Twelve larvae from M. A. Qaiyum; Quetta, Baluchistan, India, May 9, 1952; field-collected. Diagnosis: Bacteremia. Coliform and *Flavobacterium* sp.

Hemerocampa pseudotsugata McDunnough

1115—Twelve larvae from P. C. Johnson; Flathead Lake, 10 miles north of Polson, Montana, August 6, 1956; heavy field mortality. Of sixty live larvae returned to the laboratory, seven remained alive after 8 days. Diagnosis: Nuclear polyhedrosis.

1233—Many pupae from W. E. Cole; Owyhee Mountains near Silver City, Owyhee County, Idaho, February 18, 1958; material collected in association with *Pseudotsuga menziesii* var. *glauca* and *Abies lasiocarpa*; pupal case filled with black fluid; disease present in epizootic proportions. Diagnosis: Nuclear polyhedrosis.

1241—Numerous male cocoons and new egg masses from W. E. Cole; Owyhee Mountains near Silver City, Idaho, March 31, 1958; material collected from new area of infestation on Douglas fir; requested check for virus. Diagnosis: Virus not present in submitted material. No apparent pathogens present.

1251—Many first-instar larvae from W. E. Cole; Boise, Idaho, April 29, 1958; laboratory-reared from eggs collected in the same locality as Accession No. 1241 above. Virus check requested. Diagnosis: Negative for virus. No pathogen found.

1455—Numerous first-instar larvae from P. C. Johnson and H. R. Dodge; Missoula, Montana, July 16, 1959; egg masses collected in Arizona and New Mexico and reared in laboratory. High mortality following hatching. Virus suspected. Diagnosis: No pathogen observed or cultured. Virus inclusions negative.

1460—Fifteen early-instar larvae from H. R. Dodge; Missoula, Montana, July 22, 1959; larvae represent an older stage of laboratory-reared material which was submitted for diagnosis as Accession No. 1455 above. Diagnosis: Possible mycosis. All specimens harbored mycelia of *Aspergillus flavus*. Presence of virus checked and found to be negative.

Lymantria incerta Walker

1532—Four larvae from V. P. Rao; Bapatla (Andhra Pradesh), India, December 7, 1959; field-collected from *Casuarina* sp. Heavy mortality has been reported during certain seasons of the year. Diagnosis: Nuclear polyhedrosis.

Orgyia badia Hy. Edwards

1484—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Nuclear polyhedrosis. (See fig. 32B, p. 470.)

Orgyia turbata Butler

1770—Eight dead larvae from B. Mek-songsee; Bangkok, Thailand, July 20, 1961; diseased larvae discovered while being reared in insectary. Virus suspected and preliminary tests indicated a high virulence since artificially infected larvae died within 3 days. Diagnosis: Nuclear polyhedrosis confirmed.

Porthetria dispar (Linnaeus)

922—One larva from J. Weiser; Praha, Czechoslovakia, December 18, 1953. Diagnosis: Nuclear polyhedrosis.

Stilpnotia salicis (Linnaeus)

924—One larva from J. Weiser; Praha, Czechoslovakia, December 18, 1953. Diagnosis: Nuclear polyhedrosis.

Unidentified spp.

1513—Prepupa from V. P. Rao; Bapatla (Andhra Pradesh), India, September 29, 1959; collected from *Casuarina equisetifolia*. Diagnosis: No definite pathogen found. Some yeasts and *Bacillus cereus* isolated.

1818—One larva from J. J. H. Szent-Ivany; Port Moresby, Papua, November 4, 1961; specimen ceased to feed, crawled about restlessly ejecting a brown fluid, became moribund, and died shortly. Diagnosis: Bacteriosis. *Bacillus cereus* isolated in pure culture.

LYONETIIDAE

Leucoptera coffeella (Guérin-Ménéville)

667—Numerous eggs and twelve larvae from R. G. Oakley; Retalhuleu, Guatemala, August 22, 1951; collected on coffee leaves. Diagnosis: No evidence of microorganisms

other than saprophytic fungus and *Flavobacterium* sp.

Leucoptera sp.

723—Several larvae from R. G. Oakley; Retalhuleu, Guatemala, November 7, 1951; from Bordeaux-treated field. Diagnosis: Miscellaneous saprophytic fungi isolated, otherwise nonmicrobial.

MEGALOPYGIDAE

Megalopyge opercularis (J. E. Smith)

1075—Six lots of larvae from H. A. Dean; Weslaco and McAllen, Texas, December 1, 1955; field-collected on grapefruit, guava, and laurel. Diagnosis: Granulosis.

NEPTICULIDAE

Nepticula juglandifoliella Clemens

1353—Several larvae from M. Wasbauer; King City, Monterey County, California, October 30, 1958; specimens in mines in walnut leaves which were field-collected and brought into laboratory. Many parasitized, others dying for no apparent reason. Diagnosis: No pathogen found.

NOCTUIDAE

Achaea janata (Linnaeus)

1662—Several specimens from B. Meksongsee; Bangkok, Thailand, October 10, 1960; laboratory-reared on castor bean. Became inactive for a day or so, then died and were found hanging from the wire cage by their prolegs. Diagnosis: Symptomatology that of a nuclear polyhedrosis. However, not typical and no virus particles demonstrated with the electron microscope.

1667—Triturated larval suspension from Sothorn Prasertphon; Saraburi Province, Thailand, October 12, 1960; nuclear polyhedrosis suspected. Diagnosis: Atypical inclusions present but unable to demonstrate the presence of virus rods or particles.

1704—Several larvae and a triturated suspension of larvae from B. Meksongsee; Thailand, February 20, 1961; suspected of being infected with a virus disease. Diagnosis: No pathogen recovered. Inclusions present which resembled a nuclear polyhedrosis, but virus particles not demonstrated with the electron microscope.

Acontia dacia Druce

1050—Ten larvae from D. F. Martin; College Station, Texas, July 11, 1955; collected from cotton plants. Diagnosis: Bacteriosis. Gram-positive sporeformer and gram-negative small rods.

Actebia fennica (Tauscher)

1279—Three larvae from R. H. Washburn; Palmer, Alaska, June 18, 1958; field-collected specimens. Diagnosis: two larvae apparently died of a bacterial disease caused by a gram-negative small rod.

1287—One larva from R. H. Washburn; Palmer, Alaska, July 2, 1958; field-collected. Diagnosis: No discernible pathogen present in larva.

1290—One larva from R. H. Washburn; Palmer, Alaska, July 7, 1958; field-collected. Diagnosis: No pathogen found associated with death. Secondary bacteriosis only.

Agrotis ipsilon (Hufnagel)

962—Bacterial cultures isolated by S. B. Chattopadhyay; Calcutta, India, July 6, 1954; from *Agrotis ipsilon*. Cultures identified as *Pseudomonas* sp. and *Serratia marcescens*. (See Steinhaus, 1959a.)

1238—Nine decayed larvae from Y. Tanada; Kahua Ranch, Kohala, Hawaii, March 21, 1958; field-collected; fruiting bodies of fungus apparent on surface when collected. Diagnosis: No pathogen found; saprophytic fungi (*Mucor* sp.) only.

Agrotis orthogonia Morrison

1150—One larva from L. O. Sanchez; Clovis, New Mexico, April 23, 1957; field-collected. Diagnosis: Bacteriosis. *Bacillus* sp. of *B. cereus* type.

1261—Five larvae from K. P. Pruess; North Platte, Nebraska, May 12, 1958; field-collected on winter barley and reared in laboratory. Diagnosis: No pathogen found. Saprophytic bacteria isolated.

1276—One larva and one pupa from K. P. Pruess; North Platte, Nebraska, June 16, 1958; laboratory-reared on wheat from material which had been field-collected 4 months prior. Diagnosis: Bacteriosis. Small gram-negative rods abundant.

Agrotis subterranea (Fabricius)

1501—One late-instar larva from G. A. Marsh; Berkeley, California, September 15,

1959; found dead on the surface of a dichondra lawn. Diagnosis: Granulosis. (See Steinhaus and Marsh, 1960.)

1506—Eighteen larvae from P. S. Jorgensen; Stockton, California, September 21, 1959; hundreds of larvae dead and dying on surface of a mixed clover-dichondragrass lawn. Occurred in sufficient numbers to create an unpleasant smell in the yard. Diagnosis: Granulosis. (See Steinhaus and Marsh, 1960.)

1514—One late-instar larva from Mariece Batey; Berkeley, California, September 30, 1959; found in the garden. Diagnosis: Granulosis. (See Steinhaus and Marsh, 1960.)

1790—One late-instar larva from L. G. Holman; Granada Hills, Los Angeles County, California, September 21, 1961; found moribund on surface of dichondra lawn. Diagnosis: Granulosis. Southernmost known extension of virus in California.

Alabama argillacea (Hübner)

729—One larva from H. M. Armitage; West Laredo, Texas, November 28, 1951; preserved in alcohol. Diagnosis: Possible nuclear polyhedrosis; preservative and condition of insect rendered further study impossible.

1207—Fifteen larvae from R. C. Dobson; 5 miles south of Mesilla Park, New Mexico, September 24, 1957; 100 per cent mortality in 2-acre cotton plot with no evidence of first-instar leafworms which were beginning to occur in neighboring fields where disease was not evident. Diagnosis: Nuclear polyhedrosis.

Anticarsia gemmatilis Hübner

1112—Six larvae from J. E. Wille; Chancay Valley, north of Lima, Peru, July 16, 1956; larvae were collected from alfalfa field. Diagnosis: Virus disease and mycosis. Nuclear polyhedrosis. Species may have been infected since they were disintegrated within the vial. One specimen infected with *Beauveria bassiana*.

Autographa californica (Speyer)

795—One larva from R. van den Bosch; San Diego, California, May 12, 1952; field collection. Diagnosis: Entomophagous parasite; spheroidal structures in hemolymph, resembling teratocytes.

804—One larva from R. van den Bosch; Riverside, California, May 22, 1952; field-collected. Diagnosis: Small, gram-negative,

lactose-negative bacterium, probably secondary to primary nonmicrobial cause.

812—Four larvae from R. van den Bosch; Lancaster, California, May 28, 1952; field collection on alfalfa. Diagnosis: Granulosis. New record (Published: Steinhaus, 1957).

951—One larva from J. E. Swift; Kern County, California, May 25, 1954; collected on alfalfa. Diagnosis: Nuclear polyhedrosis.

1106—One larva from K. E. Frick; Prosser, Washington, June 18, 1956; laboratory-reared on mint. Diagnosis: Granulosis.

1177—Many larvae from H. H. Crowell; Willamette Valley, Oregon, June 24, 1957; larvae in many fields died; turned greenish-white, then liquefied; disease apparently widespread. Diagnosis: Nuclear polyhedrosis.

1271—One larva from C. Johansen; Columbia River basin near Quincy, Washington, June 2, 1958; specimen collected in July, 1957, and held in refrigerator. Disease occurred each year at Quincy and near Moses Lake, Washington, where the larvae looked white and lumpy when collected. Diagnosis: Granulosis.

1334—One larva from J. E. Swift; Sutter Basin, Sutter County, California, September 19, 1958; collected from standard pink bean plant. Diagnosis: Nonmicrobial death. Body filled with larval entomophagous parasites.

1686—Three larvae from C. Gonzales; Patterson, California, November 17, 1961; low larval population in alfalfa field. Larvae exhibited tremors and twitching mainly in the anterior portion of the body. Diagnosis: Body filled with tachinid larvae.

Busseola fusca Fuller

1716—Twenty-six larvae from K. M. Harris; Zaria, Northern Nigeria, March 10, 1961; larvae field-collected from *Sorghum vulgare* in November, 1960, and artificially maintained in pith-sealed glass tubing exposed to normal climatic conditions. Fifty-five of 400 larvae reared individually died during February, 1961. Specimens became moribund and turned black. Diagnosis: Bacteriosis. *Bacillus thuringiensis* isolated from over one half the number of larvae. (New record for natural infection; see Accession No. 1731 below.) Others harbored *Bacillus cereus*, a coliform, and a secondary fungus, *Fusarium* sp.

1731—Thirty-two larvae from K. M. Harris; Zaria, Northern Nigeria, April 13,

1961; larvae field-collected from Guinea corn (*Sorghum vulgare*) and then laboratory-reared in pith-stoppered glass tubing which was exposed to normal climatic conditions. Of 650 larvae reared individually during March, 120 died. Diagnosis: Bacteriosis. *Bacillus thuringiensis* responsible for infection in over one half of submitted specimens. (See Accession No. 1716 above.) Two larvae were infected with *Aspergillus flavus*, four harbored an *Acremonium* sp., and two larvae which were trapped in molted exuviae appeared to have died from a nonmicrobial cause.

Catabena esula Druce

1001—Four larvae from Y. Tanada; Honolulu, Hawaii, December 23, 1954; field-collected. Diagnosis: Nuclear polyhedrosis. (See Tanada, 1956.)

Chorizagrotis auxiliaris (Grote)

954—Twenty larvae from J. L. Hoerner; Monte Vista, Colorado, June 9, 1954; field-collected. Diagnosis: Mixed infections of nuclear polyhedrosis virus and microsporidiosis (*Nosema* sp.).

1041—Five larvae from W. F. Barr; Grangeville, Idaho, May 26, 1955; heavy populations damaging alfalfa and grain crops. Diagnosis: Granulosis. (See Steinhaus, 1957.)

1259—Thirty-two larvae from K. P. Pruess; North Platte, Nebraska, May 12, 1958; field-collected on winter barley and reared in laboratory. Diagnosis: Coliform bacteria isolated from body cavity of eight specimens; two specimens were infected with the fungus *Beauveria bassiana*, and two were infected with a microsporidian (*Nosema*).

1266—Undetermined number of decayed larvae and pupae from K. P. Pruess; North Platte, Nebraska, May 22, 1958; laboratory-reared specimens. Diagnosis: Bacteriosis. Coliform abundant. Otherwise, no pathogens observed or cultured.

1569—Eight larvae from K. P. Pruess; Cheyenne County, Nebraska, May 4, 1960; field-collected on wheat; incidence of disease was about 5 per cent in fields which had low infestations, less than one larva per 5 square feet. Diagnosis: Granulosis. One specimen with a tachinid parasite.

Euxoa messoria (Harris)

1101—One larva from J. E. Swift; California, May 8, 1956; field-collected. Diagnosis: Bacteriosis. Coliform bacterium.

1752—Several larvae from A. F. Hagen; Mitchell, Nebraska, June 6, 1961; specimens collected on alfalfa and also from laboratory-reared material. Diagnosis: No specific pathogen isolated. Decomposing larvae were heavily contaminated with saprophytic gut-inhabiting bacteria. Many septate fungal hyphae were present but were not cultivable.

Euxoa ochrogaster (Guenée)

1108—Several larvae from H. C. Manis; 3 miles west of Lakefork, Valley County, Idaho, June 25, 1956; collected from heavy population on alsike clover. Diagnosis: Bacteriosis. Small gram-negative rods abundant.

1279—Three larvae from R. H. Washburn; Palmer, Alaska, June 18, 1958; field-collected specimens. Diagnosis: Virus disease. Granulosis present in one specimen. The other two larvae apparently died of a bacterial disease caused by a gram-negative small rod.

1284—Many larvae from R. H. Washburn; Matanuska Valley, Palmer, Alaska, June 26, 1958; field-collected. Diagnosis: Granulosis. (See Steinhaus, 1959b.)

1286—Six larvae from R. H. Washburn; Alaska, several localities, July 2, 1958; field-collected. Diagnosis: Granulosis. (See Steinhaus, 1959b.)

1291—Two larvae from R. H. Washburn; Palmer, Alaska, July 7, 1958; field-collected. Diagnosis: Granulosis.

1295—Two larvae from R. H. Washburn; Palmer, Alaska, July 17, 1958; field-collected. Diagnosis: Microsporidiosis and virus disease. One larva with *Nosema* sp.; the other with a granulosis.

1417—Two larvae from R. H. Washburn; Palmer, Alaska, June 4, 1959; field-collected. Diagnosis: Granulosis.

1434—Three larvae from R. H. Washburn; Palmer, Alaska, June 29, 1959; larvae crawled up objects where they died and became mummified. Twelve-inch field stakes were a common source of dead larvae. Diagnosis: Mycosis. *Entomophthora* sp. Only vegetative hyphae present.

Faronta diffusa (Walker)

1298—Six larvae and one pupa from K. P. Pruess; Garden and Lincoln Counties, Nebraska, July 21, 1958; field-collected on rye and reed meadow foxtail grasses and brought into laboratory for rearing. Incidence of disease low. Diagnosis: Mycosis.

Beauveria bassiana in two larvae from Garden County. One larva from Lincoln County contained large numbers of a sporeforming, saprophytic *Bacillus*. The remaining specimens were not associated with any known insect pathogen.

Feltia subterranea (Fabricius)

1670—Six dead and 28 ailing larvae from H. Mackenzie; Sacramento, California, October 14, 1960; hundreds of larvae dead and dying on the surface of a lawn. Submitted specimens were picked up during the evening where they were migrating toward the patio lights. Diagnosis: Granulosis.

Heliothis virescens (Fabricius)

836—Several larvae from J. R. Brazzel; Baton Rouge, Louisiana, August 18, 1952; laboratory-reared. Diagnosis: Septicemia. *Bacillus cereus*.

858—Several larvae from J. R. Brazzel; Baton Rouge, Louisiana, December 2, 1952; laboratory-reared. Diagnosis: *Bacillus cereus*. Negative infectivity when tested with *Heliothis zea*.

941—Twenty-five larvae from L. D. Newsum; Baton Rouge, Louisiana, April 5, 1954; laboratory-reared. Diagnosis: Nuclear polyhedrosis.

1613—Three larvae from R. L. Rabb; Raleigh, North Carolina, July 27, 1960; field-collected as eggs and reared in the laboratory where they became slightly distended, discolored, and liquefied. Diagnosis: Bacterial septicemia. *Serratia marcescens*. In addition to the *Serratia*, there were smaller gram-negative rods and a lesser number of gram-positive cocci.

1617—Eight larvae from R. L. Rabb; Raleigh, North Carolina, August 3, 1960; larvae were artificially fed a suspension of crushed diseased larvae (see Accession No. 1613 above) which was applied to tobacco foliage in the laboratory and proved to be lethal. Diagnosis: Bacteriosis. *Serratia marcescens* predominant but not pure culture. Some enteric small gram-negative rods also present.

Heliothis zea (Boddie)

824—Several larvae from J. R. Brazzel; Baton Rouge, Louisiana, June 25, 1952; laboratory-reared. Diagnosis: Microsporidiosis. *Nosema* sp.; numerous bacteria also present. (Identified as *Nosema heliothidis* by Lipa and Steinhaus, 1962.)

942—Three larvae from F. H. Harries; Phoenix, Arizona, April 19, 1954; laboratory-reared. Diagnosis: Heavy bacteremia, but negative infectivity when fed to normal host larvae.

977—One larva from the Agricultural Commission; Bakersfield, California, August 25, 1954; found dead in cotton field previously treated with DDT-S. Diagnosis: Nonmicrobial death. Saprophytic fungus (*Rhizopus*) present.

983—Two larvae from A. A. Muka; Montross, Westmoreland County, Virginia, September 27, 1954; collected in soybean field. Diagnosis: Mycosis. *Beauveria bassiana*.

985—One larva from F. D. Carlsgaard; Orland, California, September 30, 1954; field-collected. Diagnosis: Nonmicrobial death.

1061—One larva from J. H. Lilly; Clarinda, Page County, Iowa, September 12, 1955; found dead at tip of corn ear in exposed position. Diagnosis: Bacterial septicemia. *Serratia marcescens*. (See Steinhaus, 1959a.) Secondary saprophytic fungus also present.

1063—Five dead larvae from J. H. Lilly; near Britt, Hancock County, Iowa, September 23, 1955; field-collected from corn field which was exposed to a killing frost. Larvae found dead in husks. Diagnosis: Bacteriosis. Gram-negative small rod.

1195—Ten dead and ten normal larvae from W. H. Whitcomb; Fayetteville, Arkansas, August 14, 1957; laboratory-reared specimens. Diagnosis: No pathogen isolated. Numerous yeasts present.

1468—Six larvae from Y. Tanada; University of California, Gill Tract, Albany, California, August 7, 1959; field-collected at Davis, California, from sweet corn. Diagnosis: All specimens but one had a heavy bacteremia caused primarily by a gram-negative small, nonlactose-fermenting bacterium. One specimen was infected with *Serratia marcescens*.

1488—Two late-instar larvae from A. E. Michelbacher; Patterson, California, August 18, 1959; collected from sweet corn. Field had been treated with a toxaphene-methion mixture but a pathogen was suspected. Diagnosis: Bacteremia. Larvae heavily laden with a small gram-negative nonsporeforming rod which did not ferment lactose. Identical to the isolates from Accession No. 1468 above. Infectivity tests were negative.

1511—One larva from C. Gonzales; Paterson, California, September 23, 1959; collected from field corn. Diagnosis: Nuclear polyhedrosis.

Laphygma exigua (Hübner)

1062—Several larvae from J. E. Swift; 6 miles south of Modesto, California, September 15, 1955; field-collected. Diagnosis: Granulosis. (See Steinhaus, 1957.)

1504—Two larvae from J. E. Swift; Dos Palos, California, September 21, 1959; collected from alfalfa fields. Diagnosis: Nuclear polyhedrosis.

1812—Two larvae from N. Shi; Berkeley, California, October 20, 1961; insectary-reared on solanaceous plant. Diagnosis: Nuclear polyhedrosis.

Laphygma frugiperda (J. E. Smith)

906—Four larvae from W. L. Thompson; Lake Placid, Florida, November 2, 1953; no pathogen found. Unidentified spherical bodies in blood (2 to 5 microns in diameter); idiopathic condition.

1102–1103—Twenty-nine larvae from Carlos Carmona B.; Medellin, Colombia, May 21, 1956; collected from corn. Diagnosis: Several specimens with granulosis. One with double infection of unidentified microsporidian and a granulosis. Others with heavy bacteriosis of secondary nature.

1343—Several larvae from Carlos Carmona B.; Medellin, Colombia, October 13, 1958; insectary-reared. Diagnosis: Mycosis. *Spicaria rileyi*.

1687—Fifteen larvae from D. F. Clower; Baton Rouge, Louisiana, November 22, 1960; disease responsible for controlling a very severe fall armyworm outbreak. Diagnosis: Nuclear polyhedrosis in the majority of larvae. Four were infected with a granulosis, and one larva was doubly infected with both a granulosis and a nuclear polyhedrosis.

Melipotis sueta Grote

810—Four larvae from D. F. Hardwick; Marin County, California, May 26, 1952; collected on *Lupinus* sp. Diagnosis: Septicemia, several bacterial species involved, either primary or secondary. Not possible to run infectivity tests in same insect species.

Nephelodes emmedonia (Cramer)

1104—Eight larvae from G. W. Thomas; Clay County, Missouri, May 21, 1956; field-

collected. Diagnosis: Double infection of granulosis and nuclear polyhedrosis virus. Secondary bacteria present in most specimens.

Panthea portlandia Grote

1479—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Nuclear polyhedrosis.

Pericyma cruegeri Butler

1272—Many pupae from J. J. H. Szent-Ivany; Port Moresby, Territory of Papua and New Guinea, June 4, 1958; larvae completely defoliated *Poinciana regia* trees. Pupae submitted are those remaining from 1,000 specimens field-collected in which there was no parasite emergence in the laboratory. Diagnosis: No pathogen found associated with pupal death.

1274—Many larvae from J. J. H. Szent-Ivany; Port Moresby, Territory of Papua and New Guinea, June 11, 1958; large numbers of larvae fell from poinciana trees to the ground where ants attacked them. Drop was not due to complete defoliation which was common. Diagnosis: *Serratia marcescens* isolated from some field specimens. (See Steinhaus, 1959a.) Gram-positive sporeformer present which would not grow in culture. Infectivity tests using *Peridroma* (both by microfeeding and puncture inoculating with the sporeforming *Bacillus*) were negative.

Peridroma margaritosa (Haworth)

791—Several larvae from J. R. Brazzel; near Lafayette, Louisiana, May 5, 1952; collected on white Dutch clover. Diagnosis: Granulosis.

803—Two larvae from R. van den Bosch; San Diego and San Luis Rey, California, May 22, 1952; field-collected. Diagnosis: Granulosis.

871—Two specimens from H. L. Chada; Denton, Texas, May 25, 1953; collected on alfalfa and vetch. Diagnosis: Nuclear polyhedrosis.

1093—One larva from T. C. Lawrence; Berkeley, California, April 2, 1956; field-collected. Diagnosis: Nonmicrobial death.

1265—Two larvae from L. D. Newsom; Baton Rouge, Louisiana, May 19, 1958; larvae appeared to differ from those with a granulosis virus submitted several years previously. Diagnosis: Granulosis in one

specimen only. Other larva harbored small, gram-negative rods in large numbers.

1277—One larva from K. P. Pruess; Lincoln County, Nebraska, June 16, 1958; field-collected and brought to laboratory; died within 7 days. About 3 per cent of the larvae collected died in the laboratory. Diagnosis: Microsporidiosis. *Nosema* sp.

1282—Two larvae from K. P. Pruess; Lincoln County, Nebraska, June 24, 1958; collected from alfalfa where populations averaged about ten per square feet. Diagnosis: Entomophagous parasites. Probably *Euplectrus plathypenae*.

1578—Ten larvae from G. Wittig; Beltsville, Maryland, May 31, 1960; deaths began occurring in fifth- and sixth-instar after insects were brought into laboratory from temperature- and humidity-controlled room, and changed from an alfalfa to a potato diet. Bacteria present in large numbers. Diagnosis: Bacterial septicemia. *Bacillus cereus* isolated in large numbers; *Pseudomonas* sp. occasionally present.

Persectania ewingii Westwood

848—Several larvae from H. F. Lower; South Australia, October 23, 1952. Diagnosis: Granulosis.

1155—Undetermined number of larvae from J. M. Kelsey; Ashburton, New Zealand, May 7, 1957; nearly 100 per cent mortality over thousands of acres; when collected, a halo of spores formed on glass around insects. Diagnosis: No evidence of fungus on arrival. Contents completely liquefied. Saprophytic bacteria present in large numbers. Negative for viruses.

1172—Fourteen dead larvae from J. M. Kelsey; Ashburton, New Zealand, May 27, 1957; heavy mortality over widespread area from a fungus disease. Diagnosis: Mycosis. *Entomophthora* sp. Secondary gram-negative bacteria abundant.

Plusia eriosoma Doubleday

1711—Five larvae from M. D. De Silva; Peradeniya, Ceylon, February 21, 1961; fungus-infected larvae, field-collected on cabbage under highly humid conditions. Conidia formed a pale green mat over the entire larval cuticle. Diagnosis: Mycosis. *Spicaria rileyi*.

Plusia gamma Linnaeus

918—One specimen from J. Weiser; Praha, Czechoslovakia, December 18, 1953;

field-collected. Diagnosis: Mycosis. *Entomophthora* sp., thought to be *E. macrospora* by Weiser.

Plusia orichalcea Fabricius

1791—One larva from M. A. Ghani; Rawalpindi, Pakistan, September 25, 1961; field-collected on *Xanthium* sp. and died under laboratory conditions. Diagnosis: Nuclear polyhedrosis. (See fig. 32A, p. 470.)

Prodenia eridania (Cramer)

1676—Several larvae from J. S. Barker; Bristol, Pennsylvania, October 26, 1960; laboratory culture appeared normal but within about 1 month all the late-instar larvae had died just prior to or after pupation. The first sign was reduced feeding. Young larvae did not show any significant change and appeared healthy. Diagnosis: Microsporidiosis. *Nosema* sp., near *heliethidis*.

Prodenia ornithogalli (Guenée)

859—Fourteen adults from R. van den Bosch; Riverside, California, December 9, 1952. Diagnosis: Nuclear polyhedrosis.

861—Several larvae from R. van den Bosch; Blythe, California, December 15, 1952; collected on lettuce. Diagnosis: Nuclear polyhedrosis.

862-864—Many larvae from R. van den Bosch; Riverside, California, December 29, 1952; reared from eggs in laboratory. Diagnosis: Nuclear polyhedrosis.

Prodenia praefica Grote

880—Several larvae from F. V. Lieberman; Newton, Utah, August 10, 1953; collected on alfalfa. Diagnosis: Nuclear polyhedrosis. *Borrelinavirus olethria*.

1110—Four larvae collected at Chico, California, May 5, 1956. Diagnosis: Nuclear polyhedrosis.

1609—Several larvae from E. H. Wood; Marysville, California, July 20, 1960; field-collected. Diagnosis: Nuclear polyhedrosis.

1610—Five larvae from C. Gonzales; Linden, California, July 21, 1960; taken from tomato field which had been sprayed July 14 with "Thuricide" dust at 30 pounds per acre. In addition to the submitted larvae, it was noted that the flea beetle (*Chrysomelidae*) populations were considerably lower in the test plots than in the check plots. Diagnosis: Bacteriosis. *Bacillus thuringiensis* positive. No other microorganisms found.

1627—Eleven larvae from Duncan Carter; 7 miles north of Rio Vista, Sonoma County, California, August 18, 1960; field mortality estimated at about 10 per cent at date of collection. Larval populations the largest since 1957. Specimens collected from sugarbeets. Diagnosis: Nuclear polyhedrosis.

1779—Two larvae from C. Gonzales; Linden, California, August 8, 1961; field-collected on tomato plants where the larvae had disintegrated the leaves. Diagnosis: Nuclear polyhedrosis.

Prodenia terriicola (Fabricius)

1121—Two pupae and triturated larvae suspension from P. Surany; Peradeniya, Ceylon, October 19, 1956; specimens field-collected. Diagnosis: Nuclear polyhedrosis from larvae. Saprophytic *Penicillium* sp. isolated from pupae.

1168—Three vials of liquid larval homogenate from P. Surany; Peradeniya, Ceylon, May 20, 1957; field-collected. Diagnosis: Virus disease. Nuclear polyhedrosis. Virus rods demonstrated with electron microscope. (See fig. 26, p. 442.)

Prodenia sp.

1766—Several larvae from G. Wittig; Beltsville, Maryland, July 5, 1961; heavy mortality in laboratory-reared stock originally submitted by J. S. Barker, Bristol, Pennsylvania. Diagnosis: Microsporidiosis. *Nosema* sp. Also heavy bacteriosis of primarily small gram-negative rods.

Pseudaletia unipuncta (Haworth)

777—Five larvae from R. van den Bosch; San Diego, California, April 3, 1952; field collection. Diagnosis: Nuclear polyhedrosis.

796—One larva from R. van den Bosch; San Diego, California, May 12, 1951; field-collected. Diagnosis: Nuclear polyhedrosis.

873—Several larvae from E. V. Walter; Lafayette, Indiana, June 30, 1953. Diagnosis: Nuclear polyhedrosis.

957—Several larvae from D. L. Goleman; Franklin County, Ohio, June 21, 1954; collected attached to cereal grain stalks. Diagnosis: Entomophthorales, primary agent, reproductive forms not evident for further identification.

973—Thirteen larvae from W. D. Fronk; Torrington, Wyoming, August 2, 1954; found dead in oat fields. Diagnosis: Secondary bacteriosis. Also, most specimens

exhibited gut blockage with plant material. Exact cause of death not determined.

1187—Eight larvae from C. Davis; Orland, California, July 24, 1957; collected from sudangrass. Five of the larvae were alive when collected. Diagnosis: No pathogens observed or isolated. Subsequent information indicates field had been sprayed with heptachlor.

1283—Four larvae from K. P. Pruess; Lincoln County, Nebraska, June 24, 1958; field-collected from wheat where population averaged one per square foot. Brought into laboratory where larvae died within 3 days. Diagnosis: Mycosis. *Entomophthora* sp.

1541—Five larvae from A. Silveira Guido; San José, Uruguay, January 22, 1960; 18.2 per cent of the population infected with a fungus. Diagnosis: Mycosis. *Beauveria bassiana*.

1550—One larva from Y. Tanada; Kamuela, Hawaii, March 4, 1960; field examination showed presence of large motile rods. Diagnosis: No specific pathogen isolated. *Bacillus cereus* var. *mycoides* present, and might possibly have caused a bacterial septicemia. Also, numerous gram-negative small rods, a gram-variable rod, and a yeast were present.

1683A—Five lots of larvae from I. Tateishi; Kurume, Fukuoka-ken, Japan, November 14, 1960; field-collected on *Phragmites communis*, July 18, 1960, near river bank. Diseased larvae were not common although a few were found limp and hanging from the rushes. Diagnosis: Nuclear polyhedrosis.

1683B—One adult from I. Tateishi; Ukiha-mura, Japan, November 14, 1960; collected October 2, 1960, on a rice plant. Nematode in body cavity. Diagnosis: Nematode infection. Mermithidae, near *Mermis albicans*.

1683C—Several larvae from I. Tateishi; Kurume, Fukuoka-ken, Japan, November 14, 1960; collected from rice plant in water-filled field, October 21, 1960. Other larvae with a similar green fungus were not common in the area. Diagnosis: Mycosis. *Spicaria rileyi*.

1683D—Three larval lots from I. Tateishi collected in three following localities: Ogori-machi, Fukuoka-ken; Miwamura, Asakura-gun; and Amagishi, Japan. The larvae were collected over a period of 2 weeks in late October and early November.

Fig. 26. Electron micrograph of virus particles causing nuclear polyhedrosis of *Prodenia terriicola* (Fabricius). Approximate size of virus rods: $300 \times 60 \text{ m}\mu$. (Acc. No. 1168, p. 441.)

Diseased larvae were scarce at the first-mentioned locality, which was a dry field, but accounted for as high as 90 per cent mortality in the other two localities, where the fields were flooded after a rain of several days. Diagnosis: Mycosis. *Entomophthora grylli* (= *E. aulicae*).

1683E—Larvae from I. Tateishi; Tanu-shimaru-machi, Japan; collected from millet, October 2, 1960. About 8 per cent of the larvae examined harbored nematodes. Diagnosis: Nematode infection. Mermithidae. *Mermis* sp., near *M. albicans*.

Rachiplusia nu Guenée

866—Thirteen larvae from R. Cortés; Santiago, Chile, January 19, 1953; insectary-reared. Diagnosis: Nuclear polyhedrosis.

1227—Three larvae from Aquiles Silveira Guido; Montevideo, Uruguay, February 7,

1958; field-collected. Diagnosis: Mycosis. *Entomophthora* sp. Only resting spores present.

Sesamia cretica Lederer

1366—Many larvae from H. N. Plaut; Nve-Yaar, Israel, December 15, 1958; larvae maintained in laboratory in wire cages with sorghum stalks; mortality gradual, about 1,000 larvae within 5 to 6 weeks; found both within and outside stalks. No overt mortality noted in field population. Diagnosis: Granulosis.

1383—Eleven larvae from H. N. Plaut; Nve-Yaar, Israel, March 23, 1959; field-collected from sorghum, some with black cuticular spots, others with small round egglike objects on the cuticle. Diagnosis: Black spots superficial and not associated with microorganisms. White egglike objects represented swollen abdomens of female

mites of genus *Pyemotes* sp. Mites were predaceous, not parasitic.

Synographa selecta (Walker)

1474—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Nuclear polyhedrosis. (See fig. 32C, p. 470.)

Tiracola plagiata Walker

1825—Eleven larvae from J. J. H. Szent-Ivany; Northern District, Territory of Papua and New Guinea. Some larvae collected from cacao plantation with evident mycosis, others filled with brown fluid. Diagnosis: Mycosis. *Spicaria rileyi*. No pathogen found in association with other larvae. (See fig. 27, p. 444.)

Trichoplusia ni (Hübner)

860—Five larvae from R. van den Bosch; Blythe, California, November 29, 1952; collected on lettuce. Diagnosis: Nuclear polyhedrosis.

879—Twenty-five larvae from V. M. Stern; Phoenix, Arizona, July 31, 1953; collected on lettuce. Diagnosis: Nuclear polyhedrosis.

1058—Disintegrated larvae from M. Semel; Riverhead, New York, August 29, 1955; epizootic effectively controlling field populations. Diagnosis: Nuclear polyhedrosis.

1080—Several specimens from E. L. Nigh; Mexicali, Mexico, January 3, 1956; field-collected. Diagnosis: Nuclear polyhedrosis.

1216—Several larvae from F. L. McEwen; Geneva, New York, October 25, 1957; field-collected. Diagnosis: Nuclear polyhedrosis.

1360—Thirteen larvae from L. W. Getzin; Weslaco, Texas, December 2, 1958; field-collected. Diseased looper became mummified and white; found hanging from underside of leaves by prolegs. After sporulation cadaver became grayish green. Fungus also pathogenic for *Rachiplusia ou* (Guenée). Diagnosis: Mycosis. *Spicaria rileyi*.

1516—Numerous larvae in two lots from J. H. Paullus; Rochelle, Illinois, October 1, 1959; one larval lot from experimental plot artificially sprayed with a commercially produced *Bacillus thuringiensis*. The other lot of larvae were from the control plot. Both experimental and control larvae died in all plots. Diagnosis: *Bacillus thurin-*

giensis was isolated from experimental lot larvae and one was infected with a nuclear polyhedrosis. Control plot larvae were infected with a nuclear polyhedrosis and were negative for *Bacillus thuringiensis*.

1663—Triturated larval suspension from B. Meksongsee; Bangkok, Thailand, October 10, 1960; suspected of being infected with a polyhedrosis virus. Diagnosis: Nuclear polyhedrosis confirmed.

1666—Triturated larval suspension from Sothorn Prasertphon; Nakornrajasima Province, Thailand, October 12, 1960; field-collected. Diagnosis: Nuclear polyhedrosis.

1803—Five larvae from R. L. Rabb; Elizabeth City, North Carolina, October 9, 1961; insect widespread in eastern North Carolina where populations had been drastically reduced with a fungus disease. Diagnosis: Mycosis. *Spicaria rileyi*. (See fig. 28, p. 445.)

Xylomyges sp.

1112—Six larvae from J. E. Wille; Chancay Valley north of Lima, Peru, July 16, 1956; larvae were collected from alfalfa field. Diagnosis: Virus disease and mycosis. Nuclear polyhedrosis. May have been infected since they were disintegrated within the vial. One specimen infected with *Beauveria bassiana*.

Unidentified spp.

616—Two larvae from A. J. Walz; Parma, Idaho, May 11, 1951; field-collected. Diagnosis: Material preserved in alcohol, no obvious spores or inclusion bodies.

790—Specimen from R. van den Bosch; El Centro, California, May 5, 1952; collected on cotton. Diagnosis: Septicemia. Motile, gram-negative, lactose-negative rod.

1095—Adult specimen from G. N. Wolcott; Aibonito, Puerto Rico, April 13, 1956; found adhering to tangerine tree branch. Diagnosis: Mycosis. Miscellaneous Fungi Imperfecti present. *Beauveria* suspected, but culture sterile.

1143—Larva from J. A. Powell; Point Reyes, Marin County, California, March 10, 1957; collected on beach. Diagnosis: No pathogen found.

1245—Specimen from R. H. Washburn; Palmer, Alaska, April 14, 1958; laboratory-reared. Diagnosis: Nuclear polyhedrosis.

1247—Specimen from J. W. MacSwain; 20 miles east of Bakersfield, California,

Fig. 27. Three aspects of larvae of *Tiracola plagiata* Walker from Papua infected with the entomogenous fungus *Spicaria rileyi* (Farlow) Charles. (1) Fungus sporulated; (2) no external mycelium; (3) presporulation stage of fungus. (Acc. No. 1825, p. 443.)

April 21, 1958; field-collected. Diagnosis: Nuclear polyhedrosis.

1256—Larva from R. J. Lavigne; Amherst, Massachusetts, May 6, 1958; larva alive when sent but dead on arrival. Diagnosis: No pathogen found.

1293—Specimen from R. H. Washburn; Palmer, Alaska, July 10, 1958; field-collected. Diagnosis: Granulosis.

1358—Larvae from Ernesto Arange Uribe; Medellin, Colombia, November 20, 1958; field-collected. Diagnosis: No pathogen found. Several bacterial strains isolated. Many polyhedral-like bodies present but these were not viral-inclusion bodies.

1581—One pupa from T. C. Lawrence; Berkeley, California, June 3, 1960; found dead and covered with mycelium when dug from soil. Diagnosis: All cultured material of a saprophytic nature: *Fusarium* sp., *Stemphylium botryosum*, and *Gliocladium* sp. near *penicilloides*.

NOLIDAE

Roeselia lugens (Walker)

1356—Numerous larvae from K. Camp-

bell forwarded by M. F. Day; near Barham, New South Wales, Australia, November 12, 1958; causing heavy damage to *Eucalyptus camaldulensis*. Diagnosis: Mycosis. *Beauveria bassiana*. Other specimens exhibited external signs of granulosis but no virus was demonstrable with the electron microscope.

1377—Numerous first-instar larvae from M. F. Day; Millewa State Park, New South Wales, Australia, February 13, 1959; larvae sent still adhering to leaves with dense fungal growth. Diagnosis: Mycosis. *Aspergillus flavus*.

NOTODONTIDAE

Heterocampa guttivitta (Walker)

1116—Nine larvae from E. R. Oatman; Ephraim, Door County, Wisconsin, August 20, 1956; larvae found hanging limply over twigs and stripped leaf ribs in heavily populated area. Diagnosis: Mycosis. Unidentified *Entomophthora* sp. Resting spores only.

Fig. 28. Mummified larvae of the cabbage looper, *Trichoplusia ni* (Hübner), killed by an infection with *Spicaria rileyi* (Farlow) Charles. (Acc. No. 1803, p. 443.)

Heterocampa manteo (Doubleday)

847—Several larvae from P. C. Stone; Lake of the Ozarks, near Bagnell Dam, Missouri, October 23, 1952; field-collected. Diagnosis: Probable bacterial infection caused by *Bacillus cereus*.

Schizura concinna (J. E. Smith)

1107—Several larvae from F. M. Charles; near Lodi, California, June 25, 1956; collected from cherry trees. Diagnosis: No pathogens observed or isolated. All specimens but one were heavily parasitized with entomophagous insect, the parasites emerging in transit.

1677—Three larvae from C. Gonzales; 10 miles south of Stockton, California, October 24, 1960; larvae appeared to be flaccid but with peculiar undulating movements. Diagnosis: Entomophagous parasite. Bodies filled with hymenopterous parasites which gave the impression that the host was still alive and ailing.

Schizura ipomoeae Doubleday

934—One dead larva from H. Madsen; Marysville, California, March 12, 1954; field-collected. Diagnosis: Bacteriosis. *Bacillus cereus* var. *mycoides*.

975—Three larvae from G. Schaefer; Berkeley, California, August 5, 1954; laboratory-reared on prune. Diagnosis: Bacteriosis. Gram-negative small rod.

NYCTEMERIDAE

Tyria jacobaeae (Linnaeus)

1226—Numerous larvae, pupae and one adult from G. F. Bornemissza; Victoria, Australia, February 4, 1958; collected from experimental plot. Diagnosis: Mycosis. *Spicaria* sp.

1235—Seven lots of larvae and pupae from G. F. Bornemissza; last-instar larvae field-collected on ragwort, *Senecio jacobaeae*, and brought into laboratory for pupation. Mycoses accounted for about 3 per cent of observed mortality both in the field and laboratory. Diagnosis: Mycosis.

Individual larvae were infected with *Beauveria bassiana* and a *Spicaria* sp. Other larvae were infected with an unidentified moniliaceous fungus. Pupae were negative for pathogens other than external growth of miscellaneous saprophytic fungi.

1376—Numerous larvae from G. F. Bornemissza; Gunyah, Victoria, Australia, February 11, 1959; approximately 76,000 larvae died, the majority prior to 2 weeks of extremely high temperature. Deaths occurred 5 to 6 days after initial signs of sluggishness and cuticular darkening were observed. Diagnosis: Nuclear polyhedrosis.

1764—Three larvae from L. A. Andres; U. S. Department of Agriculture, Entomology Research Division laboratory, Rome, Italy, July 3, 1961; larvae originally collected near Paris, France, June 17, 1961, and transported to Rome where they were reared in the laboratory on *Senecio jacobaeae* and *S. vulgaris*. Specimens developed normally until they ceased feeding and died. Diagnosis: Microsporidiosis. *Nosema* sp.

NYMPHALIDAE

Polygona satyrus Edwards

1480—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Nuclear polyhedrosis.

Vanessa sp.

1064—Two larvae from R. O. Schuster; Colusa, California, September 30, 1955; field-collected. Diagnosis: Nuclear polyhedrosis.

OLETHREUTIDAE

Carpocapsa pomonella (Linnaeus)

710—Several larvae from H. L. Parker; Rueil-Malmaison, France, October 16, 1951; collected on apple. Diagnosis: Microsporidiosis. *Phistophora* sp.

1257—Many larvae from P. W. Geier; near Canberra, Australia, May 9, 1958; material was collected alive in nature from trap bands on apple trees. Diagnosis: Various mycoses. One larva infected with *Spicaria* sp. Other larvae harbored a *Fusarium* sp. and *Verticillium cinnabarinum*. In addition, all larvae also harbored *Gliocladium roseum* even after thorough surface sterilization.

1357—Numerous larvae and pupae from P. W. Geier; near Canberra, Australia,

November 20, 1958; material submitted as part of a project to determine spread of mycoses during winter months when larvae hibernate. Samples were sent from three areas of apple trees: exposed trunks and limbs, ground litter at tree foot, and central crotch formed by main limbs. Diagnosis: Mycosis. The dominant pathogen was a *Spicaria* sp. which occurred on larvae from all three habitats. One lot from ground litter harbored *Beauveria bassiana*, one lot from exposed surfaces contained *Verticillium* sp. (probably *cinnamomeum* or *cinnabarinum*), and one additional lot from ground litter maintained a double infection of both *Spicaria* and *Verticillium*.

1362—Ten larvae from P. W. Geier; near Canberra, Australia, December 10, 1958; collected from apple trees as overwintering larvae. Specimens limp, sluggish, with hardened fecal pellets attached to tip of abdomens. Tissue collapse began caudally and spread forward gradually, provoking death. Diagnosis: Large numbers of gram-negative bacteria recovered from larvae. Fecal pellets yielded pure culture of *Aspergillus niger*. *A. niger* also recovered from lumen of hind-gut.

1373—Three larvae from B. Bailey; Berkeley, California, February 4, 1959; larvae collected near Sacramento, California, and reared in laboratory. Diagnosis: Mycosis. *Beauveria bassiana*. *Aspergillus flavus* isolated from external surface.

1404—Numerous larvae from E. R. Oatman; Door County, Wisconsin, May 14, 1959; collected from overwintering sites under corrugated cardboard bands on the trunks of apple trees. Total mortality about 55 per cent from all causes. Diagnosis: Mycosis. *Beauveria bassiana* isolated from all specimens but one which was infected with *Isaria farinosa*.

1456—Numerous larvae and pupae from E. R. Oatman; Door County, Wisconsin, July 20, 1959; larvae and pupae represented dead overwintering material which was screened for parasite emergence. Parasitism accounted for only 10.7 per cent of observed mortality. Diagnosis: Mycosis. *Beauveria bassiana* occurred in most specimens although some specimens were negative for the presence of a pathogen.

1671—More than twenty larvae from D. F. Bray; Newark, Delaware, October 17, 1960; field-collected on apple. An estimated 50 per cent of larvae on one tree were either dead or dying. Some assumed a charac-

teristic "J" shape and became covered with a gray-green through dull-yellow to weak-orange fungus. Others became flaccid shortly after death. Diagnosis: Mycosis. *Metarrhizium anisopliae*. Bacteriosis: Enterobacteriaceae.

1697—About fifty larvae and pupae from E. R. Oatman; Door County, Wisconsin, January 19, 1961; material collected at weekly intervals on apple trees throughout the growing season by placing corrugated cardboard bands on the trees. Bands removed at weekly intervals were then placed in an outside screened insectary and opened and examined after one year for parasite studies. Diagnosis: Mycosis. *Beauveria bassiana*. Secondary, small gram-negative rods (Enterobacteriaceae) present in some larvae.

Hedulia injectiva Heinrick

1174—One dead larva from H. Ruckes, Jr.; Tuolumne County, California, June 4, 1957; collected on Jeffrey pine. Diagnosis: Suspected virus diseases; negative both in transmission experiment and with electron microscope.

1210—Many larvae from H. Ruckes, Jr.; Cuyamaca State Park, San Diego County, California, October 1, 1957; collected from *Pinus jeffreyi* cones. Diagnosis: No pathogen observed or cultured. Only saprophytic gram-negative, small rods isolated.

1234—Many larvae from H. Ruckes, Jr.; Deadman Area, Inyo National Forest, Mono County, California, February 19, 1958; cones of *Pinus jeffreyi* field-collected and brought into laboratory for rearing insects. Diagnosis: No pathogens associated with general mortality. Only three specimens harbored *Serratia marcescens* which may be pathogenic under certain conditions.

Laspeyresia sp.

1180—Eleven larvae from H. Ruckes, Jr.; Modoc County, California, July 5, 1957; collected from mature cones of previous season. Diagnosis: Mycosis. Unable to culture for identification.

Rhyacionia buoliana (Schifferrmüller)

1710—Thirty larvae from R. G. Rennels; Urbana, Illinois, February 20, 1961; collected from hibernacula associated with red pine. In fifty hibernaculae opened, only eight living larvae were found. Diagnosis: No definite pathogen observed or isolated. Birefringent crystals present in most speci-

mens. Miscellaneous gram-negative, short rods present (*Escherichia* sp.), probably secondary invaders.

1746—Several larvae from R. G. Rennels; Urbana, Illinois, May 10, 1961; apparent mortality in overwintering larvae on *Pinus resinosa* about 85 per cent. Diagnosis: No pathogen found or isolated. Larvae harbored large numbers of crystals and concretions which were not typical of known virus inclusions.

Rhyacionia sp.

833—Several larvae from G. R. Struble; Madera County, California, July 29, 1952; from laboratory stock. Diagnosis: No pathogen found.

Spilonota ocellana (Denis & Schifferrmüller) form *lariciana* Heinemann

733—Four larvae from J. Maksymov; Engadin, Switzerland, November 30, 1951; preserved in alcohol. Diagnosis: No pathogen found; marked postmortem tissue disintegration.

1585—Thirty lots of larvae and pupae from E. F. Legner; Door County, Wisconsin, June 13, 1960; specimens collected over a period of 4 months in 1959 on Red Delicious and Cortland apple trees. Diagnosis: No definite insect pathogen found. Some specimens harbored large numbers of bacteria (gram-negative small rods) and fungi (for example, *Aspergillus*) which were saprophytic in nature.

1611—Forty-nine lots of larvae from E. F. Legner; Door County, Wisconsin, July 21, 1960; collected on apple from June 6 to July 15, 1960. Diagnosis: A number of specimens harbored *Aspergillus* sp. (*flavus* group). Other fungi present but considered as secondary were a *Mucor* sp. and a *Fusarium* sp. A large number of specimens contained varying numbers of primarily small gram-negative rods. One harbored a large number of *Bacillus cereus*. The remaining material contained unusually large numbers of uratic crystals and concretions with very few microorganisms of any kind.

1618—Twenty-two lots of larvae from E. F. Legner; Door County, Wisconsin, August 3, 1960; field-collected from July 18, 1960, to July 27, 1960. Diagnosis: Three lots were infected with *Aspergillus* sp., *flavus* group. Two lots harbored a *Mucor* sp. The majority of the specimens harbored miscellaneous bacteria such as: *Bacillus cereus* var. *mycoides* and *Bacillus cereus*. Others

contained moderate numbers of small gram-negative rods, both lactose positive and negative. Otherwise, no specific pathogens were noted or isolated.

1630—Twenty-seven lots of larvae from E. F. Legner; Door County, Wisconsin, August 22, 1960; field-collected from apple. Diagnosis: No specific entomogenous pathogens involved. The majority of larvae contained an admixture of urate crystals and small gram-negative rods. Occasionally a specimen would contain moderate numbers of spores of *Bacillus cereus*. Fungi were occasionally present: *Mucor* sp., *Fusarium* sp., *Alternaria* sp., and *Aspergillus* sp. (*flavus* group).

1645—Seven lots of larvae from E. F. Legner; Door County, Wisconsin, September 16, 1960; field-collected on apple. Diagnosis: Mycosis. Two larval lots infected with *Aspergillus* sp. (*flavus* group). No specific pathogen noted or isolated from other larval lots. Mainly light secondary bacteriosis, and formation of birefringent crystals.

1750—Three lots of early-instar larvae from E. R. Oatman; Door County, Wisconsin, May 29, 1961; larvae found dead in overwintering hibernaculæ appeared blackened and shriveled, brown and flaccid, or covered with mycelia. Diagnosis: No definitive pathogen found. Miscellaneous small gram-negative, rod-shaped bacteria present in small numbers. One larva did harbor a saprophytic fungus (*Sphaeropsis* sp., possibly *S. malorum*) which caused the cuticle to appear somewhat wartlike.

Zeiraphera diniana Guenée

732—Twenty-eight larvae from J. Maksymov; Engadin, Switzerland, November 30, 1951; preserved in alcohol. Diagnosis: Pyknosis, karyolysis, and postmortem disintegration acute. No microbial pathogen found.

Unidentified sp.

843—Specimen from D. D. Questel; Belle Glade, Florida, September 8, 1952; field collection. Diagnosis: Mycosis. *Beauveria bassiana*.

PAPILIONIDAE

Papilio rutulus Boisduval

1633—One early fourth-instar larva from J. Powell; San Leandro, California, August 26, 1960; laboratory-reared on cherry leaves. Ceased feeding on August 23, began

to decrease in length and arch up at death. Diagnosis: Microsporidiosis. *Nosema* sp. Malpighian tubes and silk glands occluded with spores. Hind-gut compacted with feces and both mid-gut and hemocoel filled with *Bacillus cereus*.

PHYCITIDAE

Anagasta kühnella (Zeller)

770—Several larvae from J. C. Ortega; Colton, California, March 17, 1952; laboratory stock. Diagnosis: Possible septiemia. *Bacillus cereus* var. *mycoides*.

919—Twelve larvae from J. Weiser; Praha, Czechoslovakia, December 18, 1953; laboratory culture. Diagnosis: Protozoan infection. *Mattesia dispora*; confirmation of Weiser's determination.

1522—Two larvae from C. Gonzales; Albany, California, October 19, 1959; insectary culture artificially exposed to braconid parasites for demonstration in classroom. Wet mounts revealed the presence of spores in the larvae. Diagnosis: Protozoan infection. *Mattesia dispora*.

Cactoblastis cactorum (Berg)

754—Four dead larvae from Q. C. Chock; Honolulu, Hawaii, February 15, 1952; field-collected. Diagnosis: *Beauveria bassiana*.

Ephestia cautella (Walker)

1748—About twenty larvae from D. H. Burges; Pest Infestation Laboratory, London Road, Slough, Bucks, England, May 19, 1961; up to 25 per cent mortality in any given laboratory culture during a 2-month period. Larval immobility was followed by slow blackening and death of mature or nearly mature specimens, some of which had formed cocoons. Cadavers dried rapidly. Diagnosis: Bacteriosis. *Bacillus thuringiensis*. (New record.)

Paramyelois transitella (Walker)

1811—One larva from H. F. Madsen; Walnut Creek, California, October 20, 1961; one specimen found dead among large numbers of postharvest ground nuts. Diagnosis: No pathogens found. Large numbers of enteric bacteria present which invaded various tissues.

1821—Two larvae from D. Gerling; Berkeley, California, November 14, 1961; mummified larvae found in almond. Diagnosis: No pathogen found. *Cephalosporium* sp. and *Mucor* sp. isolated from surface sterilized specimen.

1832—Four larvae and a pupa from H. F. Madsen; Linden, California, December 18, 1961; found dead inside walnut shells. Diagnosis: No pathogen found. All specimens but one exhibited signs of mechanical injuries.

Paramyelois venipars (Dyar)

586—One larva from W. H. Wade; Gustine, California, January 30, 1951; field collection on almonds. Diagnosis: No pathogen found. Saprophytic bacteria isolated.

718—One pupa from W. H. Wade; Berkeley, California, October 29, 1951; laboratory culture. Diagnosis: Secondary infection with saprophytic *Aspergillus* and *Penicillium* sp.; otherwise negative.

781—Five larvae and pupae from R. Eastwood; Riverside, California, April 17, 1952; removed from walnut fruit. Diagnosis: Septicemia. *Bacillus cereus* var. *mycoides*.

887—Two larvae from W. H. Wade; Berkeley, California, August 12, 1953; laboratory-reared. Diagnosis: No pathogen found.

1510—One larva from C. Gonzales; Linden, California, September 23, 1959; found dead in English walnut shell. Diagnosis: No pathogen found. Specimen had cuticular rupture brought about by mechanical pressure from the fractured walnut shell.

1545—Two larvae from A. E. Michelbacher; Linden, California, February 17, 1960; removed from English walnut shell with obvious fungus growth. Diagnosis: No specific pathogen observed or isolated. The associated fungus was a *Fusarium* sp., and presumably saprophytic.

1582—One larva from A. E. Michelbacher and G. R. Pieper; Linden, California, June 3, 1960; recovered from English walnut shell. Diagnosis: Mycosis. *Beauveria basiana*.

1596—Two larvae from A. E. Michelbacher; Linden, California, June 14, 1960; field-collected on walnuts; one larva mummified, the other with the last four abdominal segments turning black and becoming flaccid. Diagnosis: Mycosis. *Beauveria basiana*. Bacteriosis: *Bacillus cereus* group.

1601—Four larvae from A. E. Michelbacher; Linden, California, June 22, 1960; larvae found dead in a sticktight walnut. One specimen was mummified and pink, the others were flaccid and ivory white with some darkening areas. Diagnosis: Mycosis.

Beauveria sp., possibly *B. tenella*. Growth slow, primarily sterile. Conidial production sparse.

1659—One larva from C. Gonzales; Linden, California, September 30, 1960; removed from Payne variety walnut. Head capsule fractured at juncture of first thoracic segment; cuticle with rose-pink cast. Diagnosis: Bacteriosis. Small gram-negative rods. *Serratia* negative.

Plodia interpunctella (Hübner)

923—One larva from J. Weiser; Praha, Czechoslovakia, December 18, 1953; laboratory culture. Diagnosis: Microsporidiosis. *Nosema* sp.

1052—Several larvae from J. Menn; Berkeley, California, July 25, 1955; laboratory-reared. Diagnosis: Bacteriosis. *Bacillus thuringiensis*.

1217—Eleven larvae from R. F. Phillips; Rahway, New Jersey, November 1, 1957; laboratory-infected with *Bacillus thuringiensis* spore preparation. Diagnosis: Bacteriosis. *Bacillus thuringiensis* cause of death.

1490—Thirty-one dead larvae from H. Court; Berkeley, California, August 21, 1959; laboratory colony with evident crowding. Diagnosis: No pathogen observed or found.

1570—Fourteen larvae from B. H. Kantack; Lincoln, Nebraska, May 10, 1960; laboratory colony reared on whole wheat flour; entire colony died with no possible exposure to insecticides. Diagnosis: Bacteriosis. *Bacillus entomocidus* var. *entomocidus*.

1653—Three histological slides with serial sections of larvae from Y. Waku; Kyoto, Japan, September 27, 1960; laboratory culture. Diagnosis: Protozoan infection. Fat body with few schizogregarine cysts representing early schizogony. No spores evident. Possibly *Mattesia* sp. Also, nerve cord at anterior end infiltrated with lymphocytes which walled off an area containing three small bodies on the surface of the cord. The bodies resembled embryos of insect parasites.

1698—Two lots of about thirty larvae from Y. Waku; Kyoto, Japan, January 20, 1961; laboratory cultures fed on bran and maintained at 20° C. Younger larvae appeared healthy but succumbed to disease when mature and diapausing. Mortality averaged about 33 per cent. Diagnosis: Bac-

teriosis. *Bacillus thuringiensis*. Larvae from the second lot were infected with the schizogregarine *Mattesia dispersa*.

1715—Fourteen dead and eight normal larvae and pupae from A. B. P. Page; Ashurst Lodge, Sunninghill, Ascot, Berkshire, England, February 28, 1961; small laboratory mass culture held at 26° C with variable humidity and fed on ground meal and raisins packed in small cardboard cartons, some of which were treated with pyrethrum. Dead larvae were discovered lodged in the corrugations of the untreated boxes while the normal larvae were removed from the fruit. Diagnosis: Bacteriosis. *Bacillus thuringiensis*.

Vitula edmandsae serratilineella Ragonot

767—Several larvae from R. E. Ryckman; Loma Linda, California, March 11, 1952; laboratory culture. Diagnosis: Nonpathogenic yeast, miscellaneous molds, and bacteria isolated from dead larvae. Microorganisms probably not true pathogens.

PIERIDAE

Colias eurytheme Boisduval

684—Several larvae from L. Anderson; western Colorado, September 10, 1951; widespread epizootic in alfalfa fields. Diagnosis: Nuclear polyhedrosis.

1011—Six adults from R. Langston; Albany, California, January 20, 1955; laboratory-reared females produced infertile eggs; male testes appeared infected with bacteria. Diagnosis: Bacteremia. Gram-negative small rod: coliform.

Colias lesbia (Fabricius)

763—Ten larvae from J. C. Nicolini; Argentina, March 6, 1952; field-collected. Diagnosis: Nuclear polyhedrosis. *Colias eurytheme* Boisduval susceptible to this virus. (See Steinhaus, 1952.)

1384—Several larvae from Joaquin Carbonell Bruhn; near Montevideo, Uruguay, April 4, 1959; field-collected from alfalfa field where specimens were black, desiccated, and still adhering to alfalfa stems. Mortality roughly 66 per cent. Diagnosis: Nuclear polyhedrosis.

Pieris brassicae (Linnaeus)

948—Many larvae from H. Blunck; Bad Godesberg, Germany, May 11, 1954; laboratory-reared. Diagnosis: Microsporidiosis. *Nosema* sp. Larval parasites, *Apanteles*

glomeratus (Linnaeus), also infected with *Nosema* sp. Probably *Nosema polyvora*.

982—Several larvae and pupae from H. Blunck; Bad Godesberg, Germany, September 27, 1954; laboratory-reared specimens. Diagnosis: Bacteriosis. Miscellaneous non-pathogenic, gram-negative and gram-positive bacteria.

989—Several larvae from M. A. Quaiyum; Quetta, Pakistan, November 9, 1954; laboratory-reared specimens exhibiting considerable prepupal and pupal mortality. Diagnosis: Bacteriosis. *Micrococcus* sp. and few miscellaneous yeasts.

992—Several specimens from H. Blunck; Bad Godesberg, Germany, November 22, 1954; laboratory-reared material. Diagnosis: Microsporidiosis. *Nosema* sp., apparently *N. polyvora*.

Pieris rapae (Linnaeus)

699—Several larvae from T. O. Thatcher; Fort Collins, Colorado, September 26, 1951; field collection on turnip leaves. Diagnosis: Granulosis.

1097—Sixteen larvae and two pupae from J. M. Kelsey; Ashburton, New Zealand, April 17, 1956; laboratory-reared specimens. Diagnosis: Granulosis.

1350—Suspension of triturated larvae from F. Wilson; Canberra, Australia, October 27, 1958. Diagnosis: Granulosis. *Bergoldiavirus virulenta*.

1368—Six larvae from F. Wilson; Canberra, Australia, December 15, 1958; larvae collected from field treated with suspected virus suspension. Diagnosis: Granulosis. *Bergoldiavirus virulenta*.

1684—Two lots of larvae from I. Tateishi; Kurumeshi, Japan, November 14, 1960; occasional specimens seen hanging from cabbage vegetation. Diagnosis: Granulosis.

Unidentified sp.

1393—Specimens from R. Langston; Albany, California, April 28, 1959; laboratory-reared. Diagnosis: Bacterial septicemia. Small gram-positive coccus.

PSYCHIDAE

Acanthopsyche junodi (Helyaerts)

677—Three larvae and one slide from L. B. Ripley; Richmond, Natal, South Africa, August 31, 1951; suspected microsporidiosis. Diagnosis: Microsporidiosis negative; no pathogen found.

Oiketicus kirbyi (Goulding)

1552—Several larvae, both healthy and diseased from C. S. Stephens; Palmar, Costa Rica, March 8, 1960; bagworms became serious defoliators in certain banana plantations for the first time in 1959. Numerous deaths observed in all instars both in the field and in laboratory material. Larvae remained in their bags, ceased feeding, were inactive, became darker and softer, and finally disintegrated. Diagnosis: Microsporidiosis. *Nosema* sp. One specimen in a separate container was infected with the fungus *Beauveria bassiana*.

1555—One larva from C. S. Stephens; Palmar, Costa Rica, March 21, 1960; field-collected from banana plantation. Diagnosis: Microsporidiosis. *Nosema* sp.

1560—One larva from C. S. Stephens; Palmar, Costa Rica, April 15, 1960; laboratory specimen reared on *Croton* sp. for several months before death and mummification. Mummified specimens only occasionally found under field conditions. Diagnosis: No definitive pathogen found. Fungus present was *Acrostalagmus* sp., near *cinnabarinus*; probably acting as a saprophyte.

1598—Three larvae from C. S. Stephens; Almirante, Panama, June 20, 1960; field-collected on banana and brought into the laboratory for rearing. The larvae had dwarfed "bags," ceased to feed, and died within 2 to 3 days, turning flaccid and dark. Diagnosis: No specific pathogen noted or isolated. Cadavers filled with miscellaneous gram-negative small rods, a gram-positive coccus, and a *Bacillus* sp. (*cereus* group).

1742—Two late-instar larvae from C. S. Stephens; Changuinola, Panama, May 8, 1961; larvae collected from banana plantation; some fungal growth on the cuticle. Diagnosis: No pathogen found. A saprophytic *Penicillium* sp. was present on both specimens.

Thyridopteryx ephemeriformis (Haworth)

1689—Twelve larvae from R. G. Rennels; Beardstown, Illinois, November 28, 1960; large populations attacking both white and jack pine suddenly decreased over a 2-week period with no evidence of parasitism or predation. Diagnosis: Potential nuclear polyhedrosis. Inclusions typical but demonstration of virus particles negative with the electron microscope.

PTEROPHORIDAE

Platyptilia carduidactyla (Riley)

854—Ten larvae from R. van den Bosch; Oso Flaco, San Luis Obispo County, California, November 3, 1952; collected on artichoke. Diagnosis: Miscellaneous secondary bacteria, death probably of nonmicrobial causes.

PYRALIDAE

Blepharomastix acutangulalis (Snellen)

947—Entomogenous fungus culture from Y. Tanada; Honolulu, Hawaii, May 11, 1954; sent for confirmation of identity. Diagnosis: *Beauveria bassiana*.

Cnaphalocrocis medinalis Guenée

1776—Three larvae from A. D. Hinckley; near Nausori on Viti Levu, Koronivia, Fiji, July 31, 1961; premortem symptomatology similar to milky disease of scarab larvae in that the leaf-roller larvae turned partially white, and when opened were filled with a milky fluid. Diagnosis: Granulosis. (See fig. 32D, p. 470.)

Coniesta ignefusalis (Hampson)

1717—Six larvae from K. M. Harris; Zaria, Northern Nigeria, March 10, 1961; larvae field-collected from bulrush millet, *Pennisetum typhoideum*, in November and December, 1960, and artificially maintained in pith-sealed segments of glass tubing exposed to normal climatic conditions. Nine of 120 larvae reared individually died during February, 1961. Appeared to have died during ecdysis. Diagnosis: No pathogen noted or isolated. Each larva showed evidence of being trapped in its larval cuticle. Miscellaneous saprophytic bacteria present, mostly coliforms.

1732—Five larvae from K. M. Harris; Samaru, Zaria, Northern Nigeria, April 13, 1961; larvae field-collected from bulrush millet (*Pennisetum typhoideum*) stems, and then laboratory-reared in pith-stoppered glass tubing which was exposed to normal climatic conditions. Twelve of 150 larvae died during March. Diagnosis: No pathogenic microorganism observed or isolated. Only miscellaneous bacteria of secondary importance present.

Dasypyga alterno squamella Ragonot

1813—One larva from J. Hamai; Mount Diablo, California, October 24, 1961; larva collected from dwarf mistletoe (*Arceutho-*

bium campylopodum) became moribund shortly after return to laboratory. Diagnosis: Entomophagous arthropod. One moderately large hymenopterous larva removed from hemocoel where it had ruptured the mid-gut wall.

Nacoleia octosema Meyrick

1220—One larva from R. W. Paine; Fiji Islands, December 27, 1957; laboratory-reared specimens. Occasional deaths in individually reared larvae, not of epizootic proportions. Diagnosis: Nuclear polyhedrosis.

1225—Ten larvae from R. W. Paine; Lae, New Guinea, January 31, 1958; field-collected. Diagnosis: No evidence of pathogenic microorganisms present.

Proccras indicus Kapur

1463—One larva from V. P. Rao; Bangalore, India, July 28, 1959; 10 per cent of laboratory stock became black and the bodies hardened. Diagnosis: No specific pathogen observed or isolated. The larva submitted was secondarily invaded with hyphae belonging to the genus *Fusarium*.

1801—Two larvae from S. V. Parthasarathy; Panangattangudi, South India, October 9, 1961; occasional specimens on sugarcane infected with fungus. Diagnosis: Mycosis. *Aspergillus flavus*.

1815—One larva from S. V. Parthasarathy; Panangattangudi, South India, November 4, 1961; occasional specimens found on sugarcane and covered with fungus growth. Diagnosis: Mycosis. *Aspergillus flavus*.

Scirpophaga nivella Fabricius

1181—Three larvae from V. P. Rao; Bangalore, India, July 8, 1957; collected from sugarcane; larvae became sluggish and portions of cuticle darkened. Diagnosis: No pathogenic microorganisms isolated.

1464—Five larvae from V. P. Rao; Bangalore, India, July 28, 1959; laboratory-reared stock, with varying symptomatology, accumulated over a 3-month period. Diagnosis: One lot accounting for about 50 per cent mortality was infected with *Aspergillus parasiticus*. A second lot representing about 10 per cent mortality, with larvae which became pinkish-brown at death, were infected with *Beauveria bassiana*. The remaining specimens contained

large numbers of a gram-negative bacterium (*Aerobacter* sp.).

1650—Two larvae from V. P. Rao; Mandya, India, September 20, 1960; found dead among larval borings from sugarcane. Diagnosis: No definite pathogen found. *Fusarium* sp. and saprophytic bacteria present.

1685—Several larvae from V. P. Rao; Bangalore, India, November 14, 1960; laboratory-reared. Diagnosis: No pathogen found.

Susumia sp., near *exigua* Butler

1775—Three larvae from A. D. Hinckley; near Nausori on Viti Levu, Koronivia, Fiji, July 31, 1961; this species was formerly considered to be *Marasmia venilalis*. Each larva had different appearance. Diagnosis: Mycosis. One larva infected with *Spicaria rileyi*, a second with *Aspergillus flavus*. The third larva was infected with *Nosema* sp.

PYRAUSTIDAE

Loxostege similalis (Guenée)

1340—Several larvae from R. R. Cogburn; College Station, Texas, September 29, 1958; suspected of being diseased. Diagnosis: No pathogens were found associated with the death of the insects.

Loxostege sticticalis (Linnaeus)

846—Several larvae from R. van den Bosch; Shafter, California, September 26, 1952; field collection. Diagnosis: No pathogen found.

Pyrausta nubilalis (Hübner)

585—Eighteen larvae from K. D. Arbuthnot; Des Moines, Iowa, January 29, 1951; field-collected and laboratory-reared at 29.4° C. Diagnosis: All specimens were infected with *Beauveria bassiana*. In addition, one larva contained both *Beauveria* and a microsporidian, eleven had a secondary bacteremia, and five contained *Beauveria*, a microsporidian, and a secondary bacteremia. The microsporidian was identified by Lipa and Steinhaus (1962) as *Perezia pyraustae*.

603—Twenty larvae from K. D. Arbuthnot; Des Moines, Iowa, April 14, 1951; field-collected. Diagnosis: All infected with *Beauveria bassiana*. One larva with double infection of *Beauveria* and unidentified microsporidian.

607—Five larvae from K. D. Arbuthnot; Des Moines, Iowa, April 19, 1951; field-collected. Diagnosis: Microsporidiosis. *Perezia pyraustae*.

611—Thirteen larvae from K. D. Arbuthnot; Des Moines, Iowa, April 25, 1951; field-collected. Diagnosis: Several larvae with mycosis (*Beauveria bassiana*). Three with microsporidiosis and bacteremia.

657—One larva from K. D. Arbuthnot; Ankeny Field Station, Des Moines, Iowa, August 2, 1951; laboratory stock. Diagnosis: Microsporidiosis. *Nosema* sp.

688—One larva from K. D. Arbuthnot; Ankeny, Iowa, September 12, 1951; field collection. Diagnosis: Mycosis. *Beauveria bassiana*.

720—Four larvae from K. D. Arbuthnot; South Dakota, October 31, 1951; field collection. Diagnosis: Double infection; microsporidiosis and mycosis. *Perezia pyraustae* and *Beauveria bassiana*.

727—One larva from K. D. Arbuthnot; Brookings County, South Dakota, November 15, 1951; field collection. Diagnosis: Unidentified yeast abundant. No definite pathogen.

741—One larva from K. D. Arbuthnot; Ankeny, Iowa, December 29, 1951; field collection. Diagnosis: Mycosis. *Beauveria bassiana*.

746—One larva from K. D. Arbuthnot; Ankeny, Iowa, January 22, 1952; field collection. Diagnosis: Microsporidiosis. *Plis-tophora* sp. or *Thelohania* sp.; vegetative forms lacking.

750—One fungus culture on Sabouraud's dextrose agar from R. Baird; Chatham, Ontario, Canada, February 7, 1952. Diagnosis: *Verticillium* sp.

752—Three larvae from K. D. Arbuthnot; Des Moines, Iowa, February 13, 1952; field collection, held in laboratory at 27.8° C and high humidity. Diagnosis: *Perezia pyraustae*.

759–760—Three larvae from K. D. Arbuthnot; Des Moines, Iowa, February 28, 1952; laboratory-reared. Diagnosis: *Perezia pyraustae* and secondary bacteremia.

762—One larva from K. D. Arbuthnot; Des Moines, Iowa, March 5, 1952; laboratory specimen. Diagnosis: Microsporidiosis. *Perezia pyraustae*.

768—Five adults from K. D. Arbuthnot; Des Moines, Iowa, March 13, 1952; laboratory-reared. Diagnosis: Microsporidiosis. *Perezia pyraustae*.

865—Several adults from H. Parker; Bergano, Italy, January 2, 1953; laboratory-reared. Diagnosis: Mycosis. *Beauveria bassiana*.

911—One specimen from K. D. Arbuthnot; Stillwater, Oklahoma, November 14, 1953; laboratory-reared. Diagnosis: Mycosis. *Beauveria bassiana*.

1022—One larva from G. W. Thomas; Bates County, Missouri, April 4, 1955; field-collected on corn. Diagnosis: Nematode infection with accompanying secondary bacteremia.

1060—Eight egg clusters from S. D. Beck; Madison, Wisconsin, September 6, 1955; eggs failed to hatch or larvae died shortly after eclosion. Eggs produced in laboratory from field-collected adults. Diagnosis: Bacteriosis. *Pseudomonas aeruginosa*, and a small gram-negative, lactose-negative rod.

1734—Five larvae from M. A. Ghani; Rawalpindi, Pakistan, April 16, 1961; larvae from laboratory culture showed swellings on the thoracic and, in some cases, abdominal segments. They ultimately became sluggish and died. Diagnosis: No definitive pathogen isolated. Localized integumental swellings caused by restricted foci of hyphae which developed between the epidermis and fat body. Fungus involved was a *Penicillium* sp. (monoverticillate group) which is normally a saprophyte. Growing on other larvae were saprophytic species of *Fusarium* and *Aspergillus*.

Sylepta derogata (Fabricius)

1721—About twenty-six larvae and pupae from M. A. Ghani; Changamanga, Pakistan, March 16, 1961; field-collected and laboratory-reared on *Urena lobata*. Deaths occurred in the laboratory. Diagnosis: No pathogen noted or isolated from the majority of the larvae. Several specimens harbored an *Aspergillus* sp. of the *flavus* group which closely approximated *A. parasiticus*. Other larvae contained a *Mucor* sp. which appeared to be of a saprophytic nature.

SATURNIIDAE

Actias luna (Linnaeus)

1341—Two larvae from P. C. Stone; Columbia, Missouri, September 30, 1958; 98 larvae reared on walnut leaves exhibited 90 per cent mortality in 2 weeks; initial sign of disease was a gradually spreading discolored area. Diagnosis: No evidence of microbial disease. Larvae contained large numbers of crystals and crystal-like forms, some of which were urates.

Anisota senatoria (J. E. Smith)

1355—Two pupae from S. W. Hitchcock; New Haven, Connecticut, November 11, 1958; field-collected and tentatively identified as *Cordyceps* sp. Diagnosis: Mycosis. *Cordyceps militaris*. (See fig. 29, p. 455.)

Antheraea eucalypti Scott

1109—Fungus culture isolated from one larva from R. Close; Palmerston North, New Zealand, June 27, 1956; specimen collected from eucalyptus. Diagnosis: Mycosis. *Beauveria bassiana*.

Antheraea polyphemus (Cramer)

1500—Seven larvae from J. Wyatt; New Haven, Connecticut, September 14, 1959; insect reared for experimental purposes. Diagnosis: No pathogen observed or isolated. A *Fusarium* sp. was found to invade tissue.

1646—One late-instar larva from P. D. Hurd, Jr.; San Lorenzo, California, September 19, 1960; field-collected. Diagnosis: Bacteriosis. *Bacillus cereus*. Mid-gut partially hardened with a spongy growth of tissue extending into the hemocoel and resembling a tumor. Tissue filled with *Bacillus cereus* rods.

Antheraea sp.

1364—Several larvae from B. N. R. Chowdhury; Chaibasa, Bihar, India, December 15, 1958; field-collected. Diagnosis: No pathogen found. Vial smashed in transit and material in too poor condition for effective examination.

1495—Four fourth-instar larvae from B. N. R. Chowdhury; Chaibasa, India, September 3, 1959; heavy mortality under natural field conditions. Diagnosis: Possible cytoplasmic polyhedrosis.

1675—Several larvae from B. N. R. Chowdhury; Bihar, India, October 26, 1960; occasional field mortality, with more deaths occurring under laboratory conditions. Diagnosis: No definitive pathogen observed. Large numbers of small gram-negative rods (apparently saprophytes) present within cadavers.

Coloradia pandora Blake

1098—Nine larvae from H. Ruckes; Mount Laguna, San Diego County, California, April 17, 1956; collected on Jeffrey pine. Diagnosis: Nuclear polyhedrosis.

1224—Six larvae from C. B. Eaton; Berkeley, California, January 30, 1958; reared in the Bay Area from eggs collected at Mount Laguna, San Diego County, California. Reared in outdoor cages. Diagnosis: No pathogen found.

1437—Four larvae from V. M. Carolin; Sisters, Oregon, July 6, 1959; field-collected. Diagnosis: Cytoplasmic polyhedrosis suspected but not confirmed by electron-microscope examination. Otherwise, no pathogen found.

Dirphia (Catocephala) amphione
(Fabricius)

1009—Two larvae from G. Olalquiaga F.; Angol, Chile, January 12, 1955; field-collected. Diagnosis: Mycosis. *Entomophthora aulicae*.

Eudia pavonia (Linnaeus)

1152—One adult male from E. Masera; Padova, Italy, March 16, 1957; material sent as 2-milliliter suspension of ground tissue. Diagnosis: Cytoplasmic polyhedrosis. Diagnosis made by M. E. Martignoni.

Hemileuca tricolor Packard

853—One larva from R. F. Smith; 40 miles southeast of Ajo, Arizona, November 3, 1952; collected on mesquite. Diagnosis: Nuclear polyhedrosis.

Hyalophora cecropia (Linnaeus)

1499—Two larvae from J. Wyatt; New Haven, Connecticut, September 14, 1959; insect mass-reared as a laboratory animal. Diagnosis: No pathogen observed or isolated. A *Fusarium* sp. was found to invade tissue in both specimens. Also, a small gram-negative, nonlactose-fermenting bacterium (a yellow chromogen) was isolated from hemolymph in large numbers.

1699—Three pupae from G. R. Wyatt; New Haven, Connecticut, January 23, 1961; pupae from which nervous tissue was surgically removed became dark and flaccid 1 to 2 months after the operations when they were being stored at 25° C and 55 to 60 per cent R. H. Operations had been performed for several years with little mortality until these specimens died. Diagnosis: Bacteriosis. *Pseudomonas* sp., near *aeruginosa*; miscellaneous Enterobacteriaceae, and *Bacillus cereus* present in varying numbers.

Fig. 29. The fungus *Cordyceps militaris* (Fries) Link growing from pupa of the orange-striped oakworm, *Anisota senatoria* (J. E. Smith). (Acc. No. 1355, p. 454.)

Philosamia ricini Hutton

1758—Seven pupae and adults from J. N. Talukdar; Titabar, Assam, India, June 15, 1961; laboratory-reared material infected with a microsporidiosis (*Nosema* sp.). Infectivity tests with *Bombyx mori* were negative for transmission of this species of *Nosema* although the spore measurements are similar to those of *Nosema bombycis*. Diagnosis: Microsporidiosis. *Nosema* sp. confirmed. (See Talukdar, 1960, 1962.)

Pseudohazis eglanterina Boisduval

1478—Aqueous suspension of triturated larvae from the S. M. Sager collection. (See footnote, p. 418.) Diagnosis: Possible polyhedrosis.

Samia cynthia (Drury)

1712—Three pupae from G. R. Wyatt; New Haven, Connecticut, February 22, 1961; nervous tissue surgically removed to maintain permanent experimental diapause in pupae. Mortality usually very low. However, many pupae currently died for no ap-

parent reason. Diagnosis: Bacteriosis. *Pseudomonas* sp., near *aeruginosa*.

Samia sp.

1202—One larva from E. L. Smith; Mono Lake, California, September 6, 1957; field-collected on antelope brush, *Purshia tridentata*, and transported to Berkeley, California, laboratory where it was reared on *Ceanothus* sp. Died during spinning when a funguslike growth appeared. Diagnosis: Mycosis. *Alternaria* sp.

SPHINGIDAE

Celerio lineata (Fabricius)

807—Three ailing larvae, one normal from G. Loshbaugh; San Luis Obispo County area of Camp Roberts, California, May 23, 1952; field collection. Diagnosis: Bacterial infection. *Bacillus cereus* var. *mycoides*.

Erinnyis alope Drury

755—One pupa from W. N. Stoner; Port Mayaca, Florida, February 18, 1952; col-

lected on wild papaya. Diagnosis: Nonmicrobial.

Paonias excaecata Smith & Abbot

980—Two larvae from A. L. Hopf; Upper Black Eddy, Pennsylvania, August 27, 1954; collected on willow and ironwood, reared from eggs in glass jars. Diagnosis: No pathogens isolated.

Protoparce sexta (Johannson)

1639—Six larvae from R. L. Rabb; Raleigh, North Carolina, September 6, 1960; laboratory-reared. Diagnosis: Bacterial septicemia. *Serratia marcescens* and *Cloaca* sp.

1768—Several larvae and pupae from R. L. Rabb; Raleigh, North Carolina, July 11, 1961. Insects died during attempts to establish a colony of hornworms at 24° C and 80 per cent R. H. Development was normal until about the fourth or fifth instar when a dysenteric condition developed. Some larvae died, others lingered on, producing small or deformed pupae. Diagnosis: Bacteriosis. *Clostridium saprogenes*.

1774—Several larvae from W. M. Brooks; Raleigh, North Carolina, July 28, 1961; larvae exhibited same conditions as discussed in Accession No. 1768 above. Diagnosis: Bacteriosis. *Clostridium saprogenes*.

Unidentified sp.

1190—Two larvae from C. Hamilton; Fort Myers, Florida, July 31, 1957; larvae died 32 hours after feeding on leaves of plant host, *Euphorbia pulcherima*, which had been sprayed with a solution of *Bacillus thuringiensis*. Diagnosis: *Bacillus thuringiensis* not recovered in culture. Only coliforms present. However, death possibly due solely to the toxic crystals of the bacillus.

TINEIDAE

Nephantis serinopa Meyrick

1573—One larva from V. P. Rao; Ernakulam, India, May 11, 1960; larva appeared to be paralyzed. A bright red spot was seen on the ventral side of the abdomen which gradually spread to the rest of the body. Diagnosis: Tissue and body fluids filled with the large sporeforming *Bacillus megaterium*. Infectivity tests were inconclusive. An occasional specimen of silkworm died with similar symptoms.

1604—Eight larvae from V. P. Rao; Ernakulam, India, June 27, 1960; larvae

both from laboratory cultures and from the field became limp and assumed a reddish color. This condition had occurred rather commonly since the beginning of the monsoon rains. Diagnosis: Bacterial septicemia. *Serratia marcescens* present in most specimens. Other isolates were a few colonies of the *Bacillus megaterium-cereus* group as well as considerable numbers of gram-positive small rods.

TORTRICIDAE

Acleris variana (Fernald)

960—Several larvae from W. F. McCambridge; Juneau, Alaska, June 25, 1954; initially collected for parasite examination which proved negative. Diagnosis: No pathogens found.

961—Ten larvae from W. F. McCambridge; Juneau, Alaska, June 29, 1954; collected on western hemlock. Diagnosis: Bacteriosis. *Pseudomonas* sp. consistently isolated.

963—Ten larvae from W. F. McCambridge; Juneau, Alaska, July 8, 1954; collected on western hemlock. Diagnosis: Bacteriosis. *Pseudomonas* sp. consistently isolated from the larvae.

969—Thirteen larvae from W. F. McCambridge; Juneau, Alaska, July 21, 1954; collected on hemlock. Diagnosis: Saprophytic *Penicillium* sp. only. No pathogen found.

974—Eighteen larvae from W. F. McCambridge; Juneau, Alaska, August 3, 1954; collected on western hemlock. Diagnosis: Saprophytic bacteria and fungi isolated. No pathogen found.

976—Twenty larvae from W. F. McCambridge; Juneau, Alaska, August 24, 1954; field-collected on hemlock. Diagnosis: Non-microbial death.

979—Several pupae from W. F. McCambridge; Sitka, Alaska, August 27, 1954. Diagnosis: Unidentified protozoan cysts (20 to 30 microns in diameter) found in body cavity and in disintegrating tissues.

1294—Six diseased and six normal larvae from R. L. Furniss; Buck Creek Road, Snoqualmie National Forest, Washington, July 15, 1958; submitted larvae represent two man-hours of handpicking where the infestation had shown a spectacular decline. Diagnosis: Microsporidiosis. *Thelohania* sp.

1308—Numerous larvae from R. C. Hall; White Mountains, Inyo National Forest, California, July 30, 1958; collected on bit-

terbrush and *Ribes*; those on *Ribes* exhibited abnormal frass condition where ribbons of the material extended from anus. No pathogen found.

Amelia pallorana (Robinson)

627—Dead and dying larvae from G. E. Bohart; Logan, Utah, June 7, 1951; field collection on alfalfa, heavy larval mortality of epizootic magnitude. Diagnosis: Granulosis.

670—Thirty moribund larvae from G. E. Bohart; Logan, Utah, August 22, 1951; field collection on alfalfa. Diagnosis: Granulosis.

Archips argyrospilus (Walker)

1589—One lot of pupae from E. F. Legner; Door County, Wisconsin, June 13, 1961; collected from apple July 1, 1959. Diagnosis: No pathogen found. Microorganisms almost entirely lacking.

Archips infumata Zeller

1270—Many larvae from W. T. Soink; Melville, Louisiana, June 2, 1958; collected on pecan trees. Contents of vial completely liquefied on arrival. Diagnosis: Small, gram-negative rods present. Condition of disintegrated larvae such that further conclusions could not be made.

Argyrotaenia velutinana (Walker)

654—One larva from E. R. Oatman; Columbia, Missouri, July 31, 1951; field collection on apple. Diagnosis: Secondary gram-positive, yellow-pigmented bacterium and sporeforming bacterium (*Bacillus*) isolated.

658—Two larvae from E. R. Oatman; Columbia, Missouri, August 2, 1951; collected on apple. Diagnosis: Gram-positive, yellow-pigmented bacterium and sporeforming bacterium (*Bacillus*) isolated. Probably secondary.

668—Ten larvae from W. J. Schoene; Blacksburg, Virginia, August 22, 1951; field collection on apple leaf. Diagnosis: Granulosis.

679–680—Three larvae from E. R. Oatman; Marionville, Missouri, September 4, 1951; field collection. Diagnosis: One specimen with granulosis virus. First known report from Missouri. Others with coliform bacteria.

702—Several larvae from E. R. Oatman; Marionville, Missouri, October 4, 1951; field collection. Diagnosis: Granulosis.

714—Six larvae from W. J. Schoene; Blacksburg, Virginia, October 20, 1951; field-collected. Diagnosis: Granulosis.

814—Three larvae from E. R. Oatman; Columbia, Missouri, June 2, 1952; field collection. Diagnosis: Saprophytic fungus and yeast present, otherwise nonmicrobial.

818—One larva from E. R. Oatman; Columbia, Missouri, June 10, 1952; field-collected. Diagnosis: Bacteremia. *Bacillus cereus* var. *mycoides*; also gram-negative small rod, lactose-negative.

822—Three larvae from W. J. Schoene; Blacksburg, Virginia, June 24, 1952; collected on apple leaf. Diagnosis: Granulosis.

845—Several pupae from W. J. Schoene; Blacksburg, Virginia, September 17, 1952; field collection. Diagnosis: Nonmicrobial; numerous parasite exit holes.

964—Four ailing larvae from E. H. Glass; Geneva, New York, July 9, 1954; laboratory material reared on leaves treated with suspension of suspected granulosis-diseased, field-collected larvae. Diagnosis: Granulosis. *Bergoldiavirus clistorhabdion*.

1594—Two lots of larvae and pupae from E. F. Legner; Door County, Wisconsin, June 13, 1960; field-collected on apple, September 8, 1959. Diagnosis: Granulosis. The larvae were all infected. The pupae were not infected and no pathogen was found. Urate crystals were present in large numbers.

Choristoneura fumiferana (Clemens)

747—Several hundred larvae and pupae from H. A. Jaynes; Cross Lake, Maine, and Chesnimnus, Oregon, January 23, 1952; removed from wire and cloth-covered trees. Diagnosis: Probable mycosis. Unidentified fungus which resisted culture attempts.

1125—Several larvae from W. E. Cole; Boise, Idaho, November 1, 1956; heavy fourth-instar mortality of larvae on alpine fir. Diagnosis: Possible virus disease. Material in too poor condition to make positive identification.

1182—Five larvae from J. Powell; Modoc County, California, July 15, 1957; collected on white fir and transported to laboratory in Berkeley, California. One-fourth of larvae collected died following day, possibly because of high temperatures during transport. Diagnosis: No pathogens present or isolated. Apparently nonmicrobial death.

1795—Two fungus cultures from A. M. Heimpel; Masardis, Maine, September 25,

1961; original isolate by F. Lewis. Diagnosis: *Mucor* sp.

Clipsis buschana Keifer

1239—One ailing larva from J. Powell; Golden Gate Park, San Francisco, California; collected on *Scrofularia* sp. and returned to laboratory for rearing. Specimen died 11 days after collection when it had black spots all over body. Diagnosis: Mycosis. *Beauveria bassiana*.

Cnephasia longana (Haworth)

626—Several dozen larvae from H. L. Parker; Port l'Abbé, France, June 5, 1951; field collection. Diagnosis: Mycosis. *Beauveria bassiana* present in most specimens.

Cnephasia sp.

630—Many larvae from H. L. Parker; Seine et Oise, France, June 13, 1951; field collection. Diagnosis: Mycosis. *Beauveria bassiana*.

Platynota rostrana Walker

1741—Seven lots of egg masses, larvae and pupae from C. S. Stephens; Changuinola, Panama, May 8, 1961; white fungus found on egg masses which may also be parasitized with *Trichogramma pretiosum* Riley. Larvae were field-collected from a banana plantation and reared in the laboratory. Pupae were field-collected from ground litter under banana and held in the laboratory for parasite emergence. Diagnosis: Egg mass harbored saprophytic fungus (*Fusarium* sp.). Some larvae harbored *Fusarium* sp., others appeared infected with *Aspergillus flavus*. From pupae no definite pathogen was isolated, except some *Aspergillus flavus* found on the insect. Otherwise miscellaneous gram-negative bacteria, a *Fusarium* sp., and a heavy infestation by a saprophytic mite, *Tyrophagus putrescentiae*, were noted.

Tortrix pallorana (Robinson)

1040—Two larvae from H. H. Neuzig; Ithaca, New York, May 24, 1955; field-collected on birdsfoot trefoil. Diagnosis: Mycosis. *Isaria* sp.

Unidentified sp.

1592—One specimen from E. F. Legner; Door County, Wisconsin, June 13, 1960; collected August 18, 1959, on apple. Diagnosis: No pathogen found. Body filled with bacterial spores which proved to be *Bacil-*

lus cereus, but with no evidence that this was the cause of death.

ZYGAENIDAE

Harrisina brillians Barnes & McDunnough

623—Several larvae from O. J. Smith; Riverside, California, May 24, 1951; insectary-reared. Diagnosis: General bacteremia, *Bacillus cereus*, present but insufficient to explain mortality.

652—Many larvae from R. Langston; La Mesa, California, July 25, 1951; insectary-reared stock. Diagnosis: Large motile spore-former (*Bacillus*) isolated, but probably secondary.

674—Approximately 100 larvae from R. Langston; La Mesa, California, August 29, 1951; insectary-reared material. Diagnosis: Granulosis.

681—Several lots of frass from presumably granulosis-infected larvae, from R. Langston; La Mesa, California, September 5, 1951. Diagnosis: Presence of virus capsules in frass inconclusive. Low concentration if present.

769—Several larvae from O. J. Smith; La Mesa, California, March 14, 1952; insectary stock. Diagnosis: Granulosis. One larva harbored dead, fragmented nematodes.

837-838—Several larvae from O. J. Smith; San Diego, California, August 26, 1952; collected on cultivated grape. Diagnosis: No pathogen found.

898—Fifty larvae from O. J. Smith; Riverside, California, October 8, 1953; field-collected. Diagnosis: Granulosis in both dried and fresh specimens.

FAMILY UNKNOWN

Unidentified spp.

591—Several specimens of a fungus (*Cordyceps*) from E. Dresner; Chungking Province, China, February 16, 1951. Diagnosis: Specimens are *Cordyceps sinensis*.

820—Specimen from J. W. MacSwain; Artois, California, June 16, 1952; from nest of wasp (*Sphex* sp.). Diagnosis: Secondary bacteremia; heavy soil contamination rendered accurate diagnosis impossible.

825—Larvae from W. N. Stoner; Belle Glade, Florida, June 26, 1952; field-collected. Diagnosis: Nuclear polyhedrosis.

850—Larva from D. D. Questel; Belle Glade, Florida, October 28, 1952; collected

on corn. Diagnosis: Mycosis. *Spicaria* sp., probably *S. rileyi*.

971—One larva from M. M. Furniss; Happy Camp, Siskiyou County, California, July 21, 1954; collected in Douglas fir cone. Diagnosis: No pathogenic forms observed, although numerous saprophytic bacteria present.

1156—Larva from V. P. Rao; Kotagiri Road, Nilgiris, India, May 8, 1957; larva found motionless on citrus leaf, anterior portion darkened, only one specimen found. Diagnosis: Bacteriosis. Small gram-negative rod.

1175—Three larvae from J. Powell; Al-pine Lake, Marin County, California, June 10, 1957; collected on manzanita. Diagnosis: Nematode infection. One larva contained a mermithid; the other two showed no signs of any pathogen.

1586—Two lots of lepidopterous larvae ("fruitworm") from E. F. Legner; Door County, Wisconsin, June 13, 1960; field-collected from apple trees in June of 1959. Diagnosis: No definitive pathogen found. One specimen harbored an *Aspergillus* sp. (*flavus* group). The other contained large amounts of crystalline urates in body cavity, presumably arising in the fat body.

1588—One lot of "buckeye worm" from E. F. Legner; Door County, Wisconsin, June 13, 1960; field-collected June 17, 1959, on apple. Diagnosis: Bacteriosis. Miscellaneous bacteria, primarily small gram-negative rods.

1590—Specimen from E. F. Legner; Door County, Wisconsin, June 13, 1960; collected July 9, 1959, on apple. Diagnosis: No specific pathogen found. Body cavity filled with numerous optically active crystals; otherwise negative for microorganisms.

1591—Eight lots of larvae and pupae from E. F. Legner; Door County, Wisconsin, June 13, 1960; field-collected during the summer of 1959. Diagnosis: No specific pathogens found. The majority of the specimens were found to contain large numbers of birefringent crystals with no apparent association with any microorganism. Occasional specimens harbored large numbers of small gram-negative rods, the significance of which was not specifically determined.

1593—Two lots of pupae from E. F. Legner; Door County, Wisconsin, June 13, 1960; field-collected on apple during the summer of 1959. Diagnosis: No definite pathogen found. One pupal case contained

a fully formed adult ready for emergence. Others contained optically active crystals. Saprophytic fungus (*Alternaria* sp.) on one pupa.

1595—Two lots of lepidopterous larvae ("trumpet leaf miner") from E. F. Legner; Door County, Wisconsin, June 13, 1960; field-collected on apple during the summer of 1959. Diagnosis: No definite pathogen found.

1805—One larva from Mrs. M. C. Holman; Granada Hills, Los Angeles, California, October 10, 1961; dead, disintegrating specimen found in garden hanging over branch of *Plumbago* sp. Diagnosis: Nuclear polyhedrosis.

1824—Two larvae from M. A. Ghani; Rawalpindi, Pakistan, November 22, 1961; field-collected; died when returned to laboratory for rearing. Diagnosis: Bacteriosis. Several enteric strains isolated from disintegrated larval contents.

NEUROPTERA

CHRYSOPIDAE

Chrysopa californica Coquillett

601—Several larvae from W. Kelson; Albany, California, April 12, 1951; insectary-reared. Diagnosis: Large number of deaths without distinctive symptomatology. Only saprophytic bacteria isolated.

ORTHOPTERA

ACRIDIDAE

Aecoloprus turnbullii Scudder

1615—Over forty adults from L. Seaton; Albuquerque, New Mexico, July 27, 1960; large numbers of specimens found climbing up and grasping weeds and other vegetation where they later died and remained attached. Diagnosis: Mycosis. *Entomophthora grylli*.

Ageneotettix deorum (Scudder)

661—Four adults from R. E. Pfadt; Laramie, Wyoming, August 7, 1951; laboratory specimens died during feeding tests with western wheatgrass. Diagnosis: Septicemia. *Pseudomonas* sp.

1320—One adult from R. E. Pfadt; Glendo, Wyoming, August 14, 1958; field-

collected. Diagnosis: No apparent pathogen found associated with death.

Amphitornus coloradus (Thomas)

1197—Ten adults from J. R. Dutton; near Cody, Wyoming, August 19, 1957; field-collected on forage crops. Diagnosis: Mycosis. *Entomophthora grylli*.

1315—One adult from R. E. Pfadt; Glendo, Wyoming, August 8, 1958; moribund when collected. Diagnosis: No pathogen found associated with death.

Aulocara elliotti (Thomas)

641—One nymph from R. E. Pfadt; Laramie, Wyoming, July 5, 1951; laboratory culture. Diagnosis: Bacterial septicemia. Gram-negative, nonlactose-fermenting rod.

1304—One adult from R. E. Pfadt; Glendo, Wyoming, July 24, 1958; field-collected; darkened thoracic area, otherwise no visible external signs of disease. Diagnosis: Microsporidiosis. *Nosema* sp., probably *N. locustae*.

1305—Three adults from R. E. Pfadt; Glendo, Wyoming, July 25, 1958; field-collected in conjunction with a rangeland study. Diagnosis: No pathogens observed or isolated. Heavy infection of gregarines near *Gregarina locustae* but slightly smaller in over-all dimensions.

1309—One adult from R. E. Pfadt; Glendo, Wyoming, July 31, 1958; within 1 week there was a 50 per cent drop in the grasshopper population. Diagnosis: Microsporidiosis. *Nosema* sp., probably *N. locustae*.

1313—Seven adults from R. E. Pfadt; Glendo, Wyoming, August 7, 1958; field-collected, some held in field cages and artificially fed young wheat leaves. Diagnosis: Microsporidiosis. Five specimens with *Nosema* sp., probably *N. locustae*, as well as gregarines and some miscellaneous bacteria. Two specimens with only gram-negative small rods (coliforms) and some gram-positive sporeforming rods of the *Bacillus cereus* type.

1316—Eight adults from R. E. Pfadt; Glendo, Wyoming, August 8, 1958; maintained in field cages. Diagnosis: Microsporidiosis. *Nosema* sp., probably *N. locustae*.

1321—Three adults from R. E. Pfadt; Glendo, Wyoming, August 15, 1958; reared in field cage. Diagnosis: Microsporidiosis. *Nosema* sp., probably *N. locustae*.

1638—Four adults from R. E. Pfadt; Guernsey, Wyoming, September 6, 1960; of twenty-six field-collected adults, two were sick and two were dead 24 hours after they were returned to the laboratory. Diagnosis: Microsporidiosis. *Nosema* sp. All four specimens were heavily infected.

1657—Several adults from R. E. Pfadt; Guernsey, Wyoming, September 29, 1960; laboratory-reared. Diagnosis: Microsporidiosis. *Nosema* sp.

Camnula pellucida (Scudder)

842—Several adults from L. White; Cedarville, California, September 5, 1952; field-collected. Diagnosis: Mycosis. *Beauveria bassiana*.

881—Fifty nymphs and adults from W. J. Spicer; Carson National Forest, New Mexico, August 10, 1953; specimens found dead or dying, attached to grass stems; estimated kill was 1 per cent. Diagnosis: Mycosis. *Entomophthora grylli*.

1228—Two adults from W. W. Middlekauff; Table Mountain Ranch, Oroville, Butte County, California, February 10, 1958; field-collected. Diagnosis: No pathogen found.

1242—One adult preserved in alcohol from W. W. Middlekauff; 2 miles north of Oroville, Butte County, California, March 31, 1958; field-collected. Diagnosis: Bacteriosis. Large numbers of gram-negative, small rods.

Cordillacris occipitalis (Thomas)

1303—Two adults from R. E. Pfadt; Glendo, Wyoming, July 24, 1958; collected under the same circumstances as in Accession No. 1302 on page 463. Diagnosis: Microsporidiosis. *Nosema* sp., probably *N. locustae*.

1306—Four adults from R. E. Pfadt; Glendo, Wyoming, July 25, 1958; field-collected. Diagnosis: No primary pathogen found associated with death. *Gregarina* sp. was observed in two adults.

1314—One adult from R. E. Pfadt; Glendo, Wyoming, August 7, 1958; field-collected. Diagnosis: Bacteremia. Usual gut forms present in hemocoel.

Dissosteira spurcata (Saussure)

1188—Numerous nymphs and adults from R. M. Thompson; Tejon Ranch, Kern County, California, July 24, 1957; collected on range grasses. Diagnosis: Bacteriosis. *Aerobacter cloacae* var. *acridiorum*.

Fig. 30. Photomicrograph of a cleared whole mount of an immature juvenile acanthocephalan removed from the hemocoel of the grasshopper *Hadrotettix trifasciatus* Scudder. The central dark area represents a mass of hooks on the retracted proboscis. (Acc. No. 1831, below.)

1250—One adult preserved in alcohol from W. W. Middlekauff; Table Mountain Ranch, Oroville, Butte County, California, April 29, 1958; field-collected. Diagnosis: Secondary mycosis and bacteriosis. *Alter-naria* sp. and numerous bacteria.

Hadrotettix trifasciatus Scudder

1831—Eight unidentified, small, white foreign bodies dissected from grasshoppers submitted by R. J. Lavigne; Guernsey, Wyoming, December 18, 1960; bodies found during routine dissections of acridids. Diagnosis: Juvenile acanthocephalans. Species and vertebrate host unknown. (See fig. 30, above.)

Melanoplus bivittatus (Say)

594—Sixteen adults from J. R. Parker; Bozeman, Montana, March 12, 1951; laboratory-reared. Diagnosis: Double infection with *Malameba locustae* and *Nosema* sp., probably *N. locustae*.

598—Egg pods, nymphs, and adults from J. R. Parker; Bozeman, Montana, March 26, 1951; laboratory colony. Diagnosis: All nymphs and egg pods were negative.

663—One live adult from R. Pratt; Clyde Park, Montana, August 9, 1951; field col-

lection. Diagnosis: Bacteremia. *Streptococcus* sp.

676—Number of adults and nymphs from K. R. Bakke; Fort Collins, Colorado, August 31, 1951; field collection on field clover. Diagnosis: Heavily infected with resting spores of *Entomophthora grylli*.

678—Fifty specimens from O. Pearson; Western Kittson County, Minnesota, September 4, 1951; widespread epizootic covering several miles noted by collector, 100 per cent mortality. Diagnosis: Mycosis, bodies filled with *Entomophthora grylli* resting spores.

683—Several specimens from K. R. Bakke; near Lyons, Boulder County, Colorado, September 10, 1951; field collection. Diagnosis: Mycosis. *Entomophthora grylli*; resting spores. *Melanoplus femurrubrum* comprised 80 per cent of the grasshoppers in epizootic area, but none were infected, only the species submitted.

696-697—Several adults from J. R. Parker; near Bozeman, Montana, September 24, 1951; laboratory culture. Diagnosis: Mycosis. *Entomophthora grylli*, heavy infection with resting spores.

737—Egg pods from J. R. Parker; Bozeman, Montana, December 10, 1951; from

laboratory stock. Diagnosis: Nonmicrobial mortality.

765—Two adults from G. R. York; Bozeman, Montana, March 10, 1952; laboratory-reared. Diagnosis: Triple infection: *Nosema* sp., *Malameba locustae*, and *Cloaca cloacae* var. *acridiorum* (= *Coccobacillus acridiorum*).

840—Numerous adults from G. T. York; area near Twin Falls, Idaho, August 29, 1952; field-collected. Diagnosis: Microsporidiosis. *Nosema* sp. Some individuals infected with the fungus *Entomophthora grylli*.

891—Fifty adults and nymphs from K. E. Evans; Twin Falls, Idaho, August 28, 1953; field-collected, 25 hoppers per square yard with 5 per cent mortality. Diagnosis: Mycosis. *Entomophthora grylli*.

935—One live adult from R. C. Newton; Bozeman, Montana, March 15, 1954; laboratory-reared. Diagnosis: Microsporidiosis. Probably *Nosema locustae*.

993—Several early nymphs and egg pods from F. T. Cowan; Bozeman, Montana, November 22, 1954; laboratory culture. Diagnosis: Microsporidiosis. *Nosema locustae*.

1184—Many adults from K. E. Evans; 5 miles southwest of Joseph Bridge, south of Whitebird, Idaho County, Idaho, July 18, 1957; approximately five grasshoppers per square yard infected. Diagnosis: Mycosis. *Entomophthora grylli*.

Melanoplus dawsoni (Scudder)

598—Egg pods, nymphs, and adults from J. R. Parker; Bozeman, Montana, March 26, 1951; laboratory colony. Diagnosis: Adults with dual infection of *Nosema* sp. and *Malameba locustae*. All nymphs and egg pods were negative.

Melanoplus devastator Scudder

1188—Numerous nymphs and adults from R. M. Thompson; Tejon Ranch, Kern County, California, July 24, 1957; collected on range grasses. Diagnosis: Bacteriosis. *Aerobacter cloacae* var. *acridiorum*.

1229—Two adults from W. W. Middlekauff; Table Mountain Ranch, Oroville, Butte County, California, February 10, 1958; field-collected. Diagnosis: Protozoan infection. *Gregarina* sp.

1329—Five adults from R. M. Thompson; Arvin area of Kern County, California, September 2, 1958; collected from a plot

which had been treated 4 months prior with dieldrin at 2 ounces per acre. Diagnosis: No evidence of microbial disease although one specimen did harbor an abundance of bacteria, but these were probably saprophytes or secondary invaders.

1494—One adult from M. M. Poyner; Willits, Mendocino County, California, September 3, 1959; field-collected specimen with an apparent growth in the prothoracic region. Grasshoppers having this type of growth had been observed numerous times during the past season. Diagnosis: The "growth" which protruded between the head and the prothorax was, in fact, a distended portion of the grasshopper's gut which had emerged through an integumental rupture in the region of the insect's "neck," the membranous cervical cuticula. The portion emerging was the posterior third of the crop, all of the proventriculus, and part of the gastric caeca and cardia. The main mass was composed of the distended proventriculus which was filled with undigested plant material.

1519—Two adults from M. M. Poyner; Herald, California, October 8, 1959; milky white substance found surrounding eggs during a routine check for presence of eggs. Diagnosis: No pathogen associated with observed symptoms. White fluid composed of birefringent aciculate crystals.

Melanoplus differentialis (Thomas)

676—Number of adults and nymphs from K. R. Bakke; Fort Collins, Colorado, August 31, 1951; field collection on field clover. Diagnosis: Heavily infected with resting spores of *Entomophthora grylli*.

683—Several specimens from K. R. Bakke; near Lyons, Boulder County, Colorado, September 10, 1951; field collection. Diagnosis: Mycosis. *Entomophthora grylli*; resting spores. *Melanoplus femurrubrum* comprised 80 per cent of the grasshoppers in epizootic area but none were infected; only the two species submitted were infected (*M. bivittatus* and *M. differentialis*).

1059—Twenty adults from G. M. Boush; Clark County, Kentucky, September 2, 1955; large numbers of dead and dying grasshoppers were clinging to vegetation and fence wire. Diagnosis: Mycosis. *Entomophthora grylli*.

1491—Many adults from J. R. Dutton; Albuquerque, New Mexico, August 25, 1959; field-collected. Diagnosis: Mycosis. *Entomophthora grylli*.

Melanoplus femurrubrum (DeGeer)

676—Number of adults and nymphs from K. R. Bakke; Fort Collins, Colorado, August 31, 1951; field collection on field clover. Diagnosis: Heavily infected with resting spores of *Entomophthora grylli*.

Melanoplus foedus Scudder

1319—One adult from R. E. Pfadt; Glendo, Wyoming, August 14, 1958; field-collected. Diagnosis: Small gram-negative rods moderately abundant; saprophytes or secondary invaders.

Melanoplus mexicanus (Saussure)

598—Egg pods, nymphs, and adults from J. R. Parker; Bozeman, Montana, March 26, 1951; laboratory colony. Diagnosis: Adults with dual infection of *Nosema* sp. and *Malameba locustae*. All nymphs and egg pods were negative.

701—Ten specimens from J. R. Parker; Bozeman, Montana, October 1, 1951; laboratory culture. Diagnosis: Nonmicrobial cause of death. Subsequent information indicated that lack of water was cause of death.

736—Egg pods from J. R. Parker; Bozeman, Montana, December 10, 1951; from laboratory stock. Diagnosis: Nonmicrobial mortality.

891—Fifty adults and nymphs from K. E. Evans; Twin Falls, Idaho, August 28, 1953; field-collected, 25 hoppers per square yard with 5 per cent mortality. Diagnosis: Mycosis. *Entomophthora grylli*.

1374—Two adults from D. K. Scharff; Park County, Montana, February 4, 1959; originally collected in August and held in deepfreeze, since both specimens were noted to have contained peculiar spores. Diagnosis: Protozoan disease. Schizogregarine, possibly belonging to the genus *Caulleryella* because of groupings of eight spores.

1454—Three dead and nine ailing nymphs from D. K. Scharff; 24 miles west of Polson, Montana, July 15, 1959; field-collected. Diagnosis: No specific pathogen found. Most specimens with gregarines, *Gregarina rigida*.

Melanoplus occidentalis (Thomas)

1302—Five adults from R. E. Pfadt; Glendo, Wyoming, July 24, 1958; no epizootic noticed; regularly found a few dead individuals which, upon examination, were found to contain no large entomophagous

parasites. Diagnosis: No microorganism present which appeared to be pathogenic. Some saprophytic bacteria present.

1312—One adult from R. E. Pfadt; Glendo, Wyoming, August 7, 1958; field-collected on range grasses. Diagnosis: Bacteriosis. Small gram-negative rods; probably saprophytes or secondary invaders. Otherwise no pathogen in evidence.

Melanoplus sp.

685—Several adults from L. Anderson; western Colorado, September 10, 1951; field collection. Diagnosis: Mycosis. *Entomophthora grylli*.

1278—Numerous adults from J. R. Dutton; locality unknown, June 18, 1958; field-collected by R. M. Thompson and forwarded from U. S. Department of Agriculture, Pest Control Division, Oakland, California. Diagnosis: Mycosis. *Entomophthora grylli*.

1297—Several adults from J. R. Dutton; east of Ethete, Wyoming, July 18, 1958; collected from very heavy infestation on edge of severely damaged wheat field by W. Shockley. Diagnosis: Mycosis. *Entomophthora grylli*.

1702—Thirteen ailing and nine normal adults from F. T. Cowan; Bozeman, Montana, February 15, 1961; laboratory-reared adults suspected of harboring protozoa. Some had deformed or abnormal wings; otherwise appeared normal and responded normally to stimuli. Diagnosis: No specific pathogen found. Presence of protozoans negative. Internal organ systems and flora identical in both the normal and deformed adults. *Aerobacter cloacae* present in gut contents as well as other small gram-negative rods; however, no bacteremia or septicemia present. Deformation possibly caused by genetic or physical factors.

Oedaleonotus enigma (Scudder)

891—Fifty adults and nymphs from K. E. Evans; Twin Falls, Idaho, August 28, 1953; field-collected, 25 grasshoppers per square yard with 5 per cent mortality. Diagnosis: Mycosis. *Entomophthora grylli*.

1188—Numerous nymphs and adults from R. M. Thompson; Tejon Ranch, Kern County, California, July 24, 1957; collected on range grasses. Diagnosis: Bacteriosis. *Aerobacter cloacae* var. *acidiorum*.

Oxya bidentata Williams

1557—Fifteen adults from B. S. Chahal; Ludhiana, Punjab, India, March 31, 1960;

laboratory specimens died during an experiment where environmental conditions were maintained at 30° and 27° C with 90 and 70 per cent R.H. After death the thorax and first three abdominal segments turned from green to red. Diagnosis: Bacterial septicemia. *Serratia marcescens*.

Unidentified spp.

673—Twenty adults from K. E. Evans; near Twin Falls, Idaho, August 27, 1951; field-collected, epizootic (20 dead hoppers per square yard). Microsporidiosis (*Nosema* sp.) and mycosis (*Entomophthora*); double infection.

1363—Specimens from F. E. Skoog; Bozeman, Montana, December 11, 1958; laboratory-reared specimens exhibiting unusually heavy mortality. Diagnosis: Bacteriosis. *Aerobacter cloacae*.

1406—Several species from J. E. Burnett; Edison and Arvin, Kern County, California, May 18, 1959; field-collected and brought into laboratory where they showed symptoms of nervousness. Diagnosis: Mycosis. Five nymphs infected with *Entomophthora grylli*. Five adults negative for fungus but harboring large numbers of *Aerobacter* sp.

1503—Numerous adults from F. T. Cowan; Fort Benton, Chouteau County, Montana, September 18, 1959; collected in the field and brought into the laboratory where they began dying shortly after being caged. Diagnosis: Bacterial septicemia. *Cloacae cloacae* abundant in most specimens. There was also a low incidence of a schizogregarine which closely resembles the genus *Cauleryella*.

1665—Two adults from Sothorn Prasertphon; Udon Province, Thailand, October 12, 1960; field-collected. Diagnosis: Mycosis. *Entomophthora grylli*.

GRYLLACRIDIDAE

Ceuthophilus spp.

577—Adults from T. C. Lawrence; Berkeley, California, January 4, 1951; field collection. Diagnosis: Mycosis. *Entomophthora grylli*.

578—Adults from C. Hanson; South San Francisco, California, January 4, 1951; fungus-covered; large numbers clinging to heather. Diagnosis: Mycosis. *Entomophthora grylli*.

GRYLLIDAE

Acheta domesticus (Linnaeus)

778—Twenty-five specimens from M. H. Haymans; Metter, Georgia, April 7, 1952; reared on cricket farm. Diagnosis: No pathogen found; death apparently caused by toxic food materials.

888—Several specimens from D. F. Denney; Athens, Georgia, August 17, 1953; reared on cricket farm; epizootic killing 3,000 to 6,000 crickets, both nymphs and adults, in 5 days. Diagnosis: No obvious gross pathology, protozoanlike cells in fat body and Malpighian tubes; probably protozoan disease of unknown character. Unable to run infectivity test or obtain more fresh material.

912—Six nymphs and adults from E. Warner; South Whitley, Indiana, November 23, 1953; commercially reared specimens. Diagnosis: Bacteremia. Gram-negative rods present in great abundance.

933—Two adults from P. C. Stone; Columbia, Missouri, January 4, 1954; 48-day-old adults fed lettuce, no water, and held at 32.2° C, 65 per cent R.H. Diagnosis: Possible bacteriosis. Gram-negative, small rods abundant.

1003—Twelve nymphs and one adult from C. Bowling; Fayetteville, Arkansas, December 27, 1954; insectary-reared, disease affected all ages but was not of epizootic proportions. Diagnosis: Septicemia. Two strains of gram-negative small rods, both lactose-positive; coliforms.

1029—Twelve adults from L. J. Sutton; Savannah, Georgia, May 5, 1955; mass reared on cricket farm. Diagnosis: No pathogenic organisms seen. Distinct pathology of fat body, with cell membranes broken down and peculiar particles in cytoplasm. Noninclusion virus may be involved; however, electron micrographs showed nothing definite. Insufficient material for thorough study.

1042—Ten dead adults from E. Warner; Whitley, Indiana, June 3, 1955; insectary-reared for fish bait after being field-collected in northern Florida. Diagnosis: Specimens chemically preserved. No examination possible. Probably bacterial disease.

1419—One adult from C. R. Jordan; Toccoa, Georgia, June 8, 1959; high mortality in cricket hatchery. Diagnosis: No specific pathogen found. Numerous gram-negative bacteria present.

1459—Many adults from Nelson's Cricket Ranch; Memphis, Tennessee, July 22, 1959; mass-reared in insectary for fish bait. Diagnosis: No pathogen observed or isolated. Miscellaneous saprophytic bacteria present.

HENICIDAE

Deinacrida rugosa Buller

1055—Two second-instar nymphs from G. W. Ramsay; Wellington, New Zealand, August 2, 1955; laboratory-reared specimens sent in preservative. Diagnosis: Mycosis. Unidentifiable Entomophthorales.

STENOPELMATIDAE

Unidentified sp.

1372—Five adult specimens from P. C. Stone; Columbia, Missouri, January 30, 1959; large numbers of crickets dying in crowded cultures. Cause of death unknown unless related to crowding. Diagnosis: No evidence of microbial disease.

TETTIGONIDAE

Anabrus simplex Haldeman

711—One adult from A. Bartel; Sonora Pass, California, October 15, 1951; field collection. Diagnosis: Unidentified nematode protruding from anus.

Clinoppleura melanoppleura (Scudder)

1188—Numerous nymphs and adults from R. M. Thompson; Tejon Ranch, Kern County, California, July 24, 1957; collected on range grasses. Diagnosis: Bacteriosis. *Aerobacter cloacae* var. *acridiorum*.

Unidentified spp.

700—One specimen from T. C. Lawrence; Berkeley, California, September 27, 1951; field collection. Diagnosis: Saprophytic fungus and *Escherichia coli*; the latter probably caused a secondary septicemia.

726—One nymph from J. W. MacSwain; Berkeley, California, November 15, 1951; found clinging to yew twig. Diagnosis: No pathogen found.

SIPHONAPTERA

CERATOPHYLLIDAE

Ceratophyllus gallinae (Schränk)

662—Six adults from F. G. A. M. Smit; 1956; deformed sclerites and darkened ab-

Eggelshoven, Holland, August 7, 1951; collected from nesting box of tit, *Parus* sp. Body cavity contained unidentified small spherical bodies possibly of endoparasitic nature. Diagnosis: Males containing these bodies appeared to be castrated. Spherical bodies were determined not to be microorganisms. They appeared to be aggregations of crystalline material or abnormal developments of the chitinous walls of the trachea.

669—Three slide-mounted adults from F. G. A. M. Smit; Heerlen, Holland, August 22, 1951; same type of material as submitted for Accession No. 662 above. Diagnosis: See Accession No. 662.

Foxella ignota (Baker)

771—Two adults on slides from W. L. Jellison; Butte County, Idaho, March 18, 1952; taken on pocket gopher. Diagnosis: Round bodies in body cavity; one or two appeared to be germinated; possible fungus.

Opisocrostitis bruneri (Baker)

1218—Five slide-mounted adults from G. E. Haas; Dane County, Wisconsin, December 2, 1957; collected on Mearns cottontail rabbit. Diagnosis: Two specimens with unidentified internal fungus spores. Two specimens contained disintegrated nematodes. One specimen contained fluke-like organisms.

Thrassis sp.

1038—One slide-mounted adult from E. S. Ross; Palmdale, California, May 19, 1955; collected in *Dipodomys* nest. Diagnosis: Small internal bodies superior to spermatheca. Not identified.

HISTRICHOPSYLLIDAE

Catallagia wymani (C. Fox)

1000—One adult female from L. Kartman; near Colma, California, December 22, 1954; collected on *Microtus californicus*. Diagnosis: Unidentified round bodies simulating fungus spores but no mycelium; possibly an artifact arising from ingested blood.

PULICIDAE

Cediopsylla simplex (Baker)

1129—Nine adults from G. E. Haas; Dane County, Wisconsin, November 19,

dominal area. Fleas preserved in alcohol. Diagnosis: Mycosis. Body cavity filled with thick-walled spores of fungus; unidentifiable because of preservation.

1131—One adult female from G. E. Haas; Dane County, Wisconsin, December 4, 1956; collected from a Mearns cottontail rabbit; some sporelike bodies in hemocoel as in Accession No. 1129 above. Diagnosis: Mycosis. Culture attempts negative. (See Haas and Dicke, 1959.)

1218—Five slide-mounted adults from G. E. Haas; Dane County, Wisconsin; col-

lected on Mearns cottontail rabbit. Diagnosis: Two specimens with unidentified internal fungus spores. Two specimens contained disintegrated nematodes. One specimen contained fluke-like organisms.

1600—Numerous adults from G. E. Haas; Dane County, Wisconsin, June 21, 1960; fleas with peculiar sporelike bodies in the hemocoel, collected from Mearns cottontail. Specimens preserved in alcohol. See Accession Nos. 1129, 1131, and 1218 above for additional data. Diagnosis: Possible mycosis. Unable to identify sporelike bodies.

Arachnida

ACARINA

DERMANYSSIDAE

Hirstionyssus sp.

1012—One slide-mounted adult from D. Furman; Provo, Utah, February 4, 1955; collected on the weasel *Mustella frenata*. Diagnosis: Mycosis. Laboulbeniales.

ERIOPHYIDAE

Phyllocoptes olivora (Ashmead)

1067—Five whole-mount slides of adults from H. A. Dean; Weslaco, Texas, October 10, 1955; collected on grapefruit leaves. Diagnosis: No pathogen observed.

1729—Rust mites from A. W. Cresson; near Vista, San Diego County, California, April 10, 1961; collected on Valencia oranges by F. Munger. Previous to collection, populations of the mite were reported to be very high but no live mites and very few dead ones were located in the same area. Excessively low humidity (4 per cent R. H.) the previous few days was suspected of causing desiccation and death, but a disease diagnosis was requested. Diagnosis: No pathogen found. One mite had a few non-viable strands of fungus present on its surface; these appeared to be those of a saprophyte.

IXODIDAE

Unidentified sp.

849—Specimen from D. J. Gould; Chong'song'ni', Korea, October 24, 1952; field collection on *Apodemus agrarius*. Diagnosis: Mycosis. *Torrubiella* sp.

PHYTOSEIDAE

Typhlodromus sp.

1534—Four adults from T. Buchelos; Berkeley, California, December 11, 1959; laboratory-reared material suspected of being diseased. Diagnosis: No pathogen observed or found which would account for mortality.

SPERCHONIDAE

Sperchon sp.

1418—One adult water mite from D. M. Davies; Costello Creek, Algonquin Park, Ontario, Canada, June 5, 1959; gravid female appeared to be parasitized with microsporidia. Diagnosis: Microsporidiosis. *No-sema* sp.

TETRANYCHIDAE

Eutetranychus banksi McGregor

1066—Whole-mount slides of nine adults from H. A. Dean; Weslaco, Texas, October 10, 1955; collected on grapefruit. Diagnosis: No pathogen observed.

Oligonychus aceris (Shimer)

1191—Numerous nymphs and adults from C. C. Hamilton; New Brunswick, New Jersey, August 1, 1957; collected on maple leaves; considerable fluctuations in population density noted. Diagnosis: Mycosis. Unable to culture for identification.

1205—Many adults from C. C. Hamilton; New Brunswick, New Jersey, September 11, 1957; collected on maple leaves. Diagnosis: Saprophytic fungi (*Monilia* sp.) present, but no pathogen.

Oligonychus ununguis (Jacot)

1138—Three whole-mount slides of adults from J. G. Matthyse; New York and Westport, Canada, January 29, 1957; collected on spruce and juniper. Diagnosis: Possible mycosis. Unable to identify on basis of fragments present on slides.

1367—Numerous adults from S. W. Meso; Ithaca, New York, December 15, 1958; reared in insectary; spot check revealed all stages dead; previous check time not indicated. Diagnosis: Various yeasts, bacteria, and ciliate protozoa present. Material not suitable for accurate diagnosis because sent in distilled water.

Panonychus citri (McGregor)

595—Several adults from C. A. Fleschner; Riverside, California, March 12, 1951; insectary-reared. Diagnosis: One mite infected with *Entomophthora*. Insufficient material to make specific determination.

758—Ten slides from L. R. Jeppson; southern California, February 25, 1952; field-collected. Diagnosis: Infested with septate fungus; material insufficient for further identification.

Panonychus ulmi (Koch)

1057—Several specimens from A. E. Michelbacher; San Jose, California, August 16, 1955; collected on walnut leaves. Diagnosis: No pathogen found.

1457—Numerous nymphs and adults from C. Gonzales; Linden, California, July 20, 1959; mites were observed adhering to leaves by a sticky excrement exuded from the anal aperture while others appeared to be paralyzed and quivering on their sides. Diagnosis: Probable noninclusion virus infection. (See Steinhaus, 1959c.)

1458—Numerous nymphs and adults from C. Gonzales; San Jose, California, July 20, 1959; collected on walnut leaves; symptoms similar to those indicated in Accession No. 1457 above. Diagnosis: Probable noninclusion virus infection.

1621—Many nymphs and adults from C. Gonzales; Anderson Walnut Orchard, Jack Tone Road, near Linden, California, August 5, 1960; specimens show signs of a possible noninclusion virus which was investigated. (See Accession Nos. 1457, 1458 above.) Diagnosis: No pathogen found. Infectivity test negative.

Paratetranychus citri McGregor

753—Three slides from C. A. Fleschner;

Riverside, California, February 15, 1952; mites died with abdomens stuck to leaves. Diagnosis: Nonmicrobial, crystal-inclusion aggregates.

Paratetranychus ununguis (Jacot)

1069—Slide material from M. E. Martignoni; Zurich, Switzerland, October 28, 1955; laboratory-reared and field-collected. Diagnosis: Unable to identify microorganism; possibly one of the primitive fungi.

Tetranychus canadensis (McGregor)

1138—Three whole-mount slides of adults from J. G. Matthyse; New York and Westport, Canada, January 29, 1957; collected on spruce and juniper. Diagnosis: Possible mycosis. Unable to identify on basis of fragments present on slides.

Tetranychus pacificus McGregor

610—Slide-mounted material from L. M. Smith; Davis, California, April 23, 1951; field-collected. Diagnosis: Mycosis. *Entomophthora* resting spores.

Tetranychus urticae Koch

905—Many nymphs and adults from N. Plaut; Haifa, Israel, October 20, 1953; collected on bean leaves. Diagnosis: Fungus, *Hormodendrum* sp., probably saprophytic.

Unidentified sp.

798—Specimens from B. B. Fulton; Raleigh, North Carolina, May 13, 1952; collected on strawberries. Diagnosis: Mites covered with saprophytic fungus, otherwise nonmicrobial.

TRACHYTIDAE

Unidentified sp.

1553—Specimen from G. Singer; Lawrence, Kansas, March 16, 1960; ensheathed nematodes attached to mite cuticles. Diagnosis: Nematosis. *Rhabditis* sp. See Accession No. 1724 (p. 392) for further information.

TROMBICULIDAE*Trombicula* sp.

841—Ten slide-mounted adults from C. Spitzer; South Korea, September 13, 1952; collected on voles. Diagnosis: No pathogen observed; cause of death not determined.

FAMILY UNKNOWN

Unidentified sp.

761—Specimen from P. T. Johnson; Malaya or Borneo, March 4, 1952; odd "growth" in head region. Diagnosis: "Growth" was actually the protrusion of tissues from injury caused by loss of head. No pathogen observed.

ARANEIDA**ARGIOPIDAE**

Unidentified sp.

1654—One spider from C. Ohkuma; Aosima Islet, Miyazaki Prefecture, S.

Kyushu, Japan, September 27, 1960; attached to leaf with mycelial growth. Diagnosis: Mycosis. *Gibellula araneorum*.

FAMILY UNKNOWN

Unidentified sp.

1539—Specimen from V. P. Rao; Lopheu Tea Estate, Darjeeling District, India, January 6, 1960; found infected with fungus in field. Diagnosis: Mycosis. *Akanthomyces araneorum*; fide E. B. Mains.

ANNELIDA**Oligochaeta****PLESIOPORA****ENCHYTRAIDAE**

Enchytraeus fragmentosus Bell

1780—Two axenic cultures of worms from E. C. Dougherty; Department of Nutritional Sciences, University of California, Berkeley, August 8, 1961; some worms in submitter's cultures lysed when reared under certain (unspecified) environmental conditions. Diagnosis: No pathogen found in routine examinations. Light microscopy was negative for any microorganisms that could have been responsible. Ultracentrifugation and electron microscopy were negative, but possible virus particles may have been eliminated in prior filtration.

1828—A xenic and an axenic culture of worms from E. C. Dougherty; Department of Nutritional Sciences, University of California, Berkeley, December 12 and 19, 1961; worms lysed under conditions apparently associated with crowding. Diagnosis: Possible virosis. Rod-shaped particles observed in electron microscope preparations. (See fig. 31, p. 469.)

OPISTHOPORA**LUMBRICIDAE**

Lumbricus terrestris Linnaeus

1487—Numerous worms from O. H. Parker; Union City, Tennessee, August 18,

1959, mass-produced in commercial worm beds for fish bait. Diagnosis: No pathogen found. Mortality related to high temperatures and humidity.

Lumbricus spp.

584—Three specimens from C. H. Sherwood; Juneau, Alaska, January 18, 1951. Diagnosis: Yeast (*Saccharomyces*) isolated, otherwise amicrobial.

1013—Fifty earthworms from P. Manell; Willow Springs, Missouri, February 10, 1955; heavy mortality in breeding pits. Diagnosis: Bacteriosis. Abundant gram-negative coliform and *Streptococcus* sp. isolated from disintegrating internal tissues.

1192—Numerous mature earthworms from O. H. Parker; Union City, Tennessee, August 9, 1957; normal development until clitellum was produced; it turned white and worms died. Diagnosis: Submitted material remained alive and healthy for several weeks; no disease apparent.

1623—Several specimens from L. Adams; Willow Springs, Missouri, August 8, 1960; specimens reared in commercial beds which were relatively free from deaths for three years. Several thousand died in a short period of time, rising to the surface and decaying. Diagnosis: No pathogen found; noninclusion virus possibly involved.

Fig. 31. Electron micrograph of rod-shaped particles, possibly a noninclusion virus, found in centrifuged fraction of autolysed, diseased *Enchytraeus fragmentosus* Bell, an oligochaete. Approximate size of particles $270 \times 50 \text{ m}\mu$. (Acc. No. 1828, p. 468.)

NEMATODA

Secernentea

TYLENCHIDA

HOPLOLAIMIDAE

Meloidogyne javanica (Treub) Chitwood

728—One adult female from M. Allen; Japan, November 20, 1951; slide mount. Diagnosis: Apparently infected with protozoanlike organism. Unable to identify further because of nature of material.

Fig. 32. Electron micrographs of virus particles. A. Polyhedrosis virus of *Plusia orichalcea* Fabricius. (Acc. No. 1791, p. 440.) B. Polyhedrosis virus of *Orgyia badia* H. Edwards. (Acc. No. 1484, p. 434.) C. Polyhedrosis virus of *Syngrapha selecta* (Walker). (Acc. No. 1474, p. 443.) D. Granulosis virus of *Cnaphalocrocis medinalis* Guenée. (Acc. No. 1776, p. 451.) E. Granulosis virus of *Ecpantheria icasia* (Cramer). (Acc. No. 1693, p. 423.)

SUMMARY

During the eleven-year period from January 1, 1951, through December 31, 1961, our diagnostic laboratory received a total of 1,257 accessions of diseased insects. (This is in addition to 575 accessions received prior to this time and already reported in a previous publication.) The diagnoses reported in the present paper are essentially brief statements as to the source of the diseased insect and the identity of the etiology involved. In order to provide a more detailed diagnosis, a new approach to diagnosis has been initiated which involves the use of more precise procedures, the use of more detailed forms for recording the results of the various examinations and tests, and a more efficient method of collating the data obtained. Accordingly, the report of past diagnostic findings is preceded by a section explaining the new methods of recording diagnostic data and of keeping diagnostic records.

The pathogens found in the submitted insects, and other invertebrates, are tabulated according to the type of pathogen concerned and according to the order and family of insect host (table 1). From the 1,257 accessions received during the period concerned, the microbial pathogens isolated, including repeats, totaled 148 viruses (97 nuclear polyhedrosis viruses, 46 granulosis viruses, 5 noninclusion viruses), 145 bacteria, 408 fungi, 112 protozoa (82 Microsporidia, 30 other types), and 34 nematodes. Entomophagous arthropods were found in 14 accessions. In 338 accessions no microbial pathogens were involved; in many of these cases the disease was a noninfectious one. New records of pathogens, insect hosts, and distribution are noted in the text.

TABLE 1
PATHOGENS FOUND IN INSECTS AND OTHER INVERTEBRATES SUBMITTED FOR DIAGNOSIS
Hosts arranged alphabetically according to order and family

Order and family	Viruses			Bacteria	Fungi	Protozoa		Nematodes	Entomophagous arthropods	No microbial pathogens
	Polyhedrosis	Granulosis	Noninclusion			Microsporidia	Others			
INSECTA										
BLATTARIA										
Blattidae.....	..	..	..	2	1	..	..	..	..	1
Polyphegidae.....	..	..	..	..	..	..	..	1	..	..
Subtotal.....	..	..	..	2	1	..	..	1	..	1
COLEOPTERA										
Anobiidae.....	..	..	..	..	..	..	..	..	..	2
Cerambycidae.....	..	..	..	8	23	..	..	3	1	6
Chrysomelidae.....	..	..	..	2	8	..	1	1	..	2
Coccinellidae.....	..	..	..	1	..	1	..	1	..	5
Curculionidae.....	..	..	..	3	20	..	..	2	..	8
Dermestidae.....	..	..	..	..	..	1	2	..	..	..
Elaeteridae.....	..	..	..	..	4	..	..	2	..	1
Hydrophilidae.....	..	..	..	..	1	..	..	..	..	..
Lucanidae.....	..	..	..	..	..	..	..	..	..	1
Nitidulidae.....	..	..	..	..	2	..	..	..	..	1
Scarabaeidae.....	..	..	..	8	9	..	1	5	..	15
Scolytidae.....	..	..	..	8	5	1	1	3	..	7
Staphylinidae.....	..	..	..	..	..	..	..	1	..	..
Tenebrionidae.....	..	..	..	2	1	6	3	..	..	8
Unidentified.....	..	..	..	..	..	..	..	1	..	..
Subtotal.....	..	..	..	32	73	9	8	19	1	56
COLLEMBOLA										
Sminthuridae.....	..	..	..	..	..	..	..	..	..	1
Subtotal.....	..	..	..	..	..	..	..	..	..	1
DERMAPTERA										
Forficulidae.....	..	..	..	..	..	..	1	..	..	..
Labiduridae.....	..	..	..	..	1	..	..	..	..	..
Subtotal.....	..	..	..	..	1	..	1	..	..	..

DIPTERA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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TABLE 1—Continued

Order and family	Viruses			Bacteria	Fungi	Protozoa		Nematodes	Entomophagous arthropods	No. microbial pathogens
	Polyhedrosis	Granulosis	Noninclusion			Microsporidia	Others			
Belostomatidae.....	..	..	..	..	..	..	..	..	1	..
Cercopidae.....	..	..	..	..	2	..	..	..	..	..
Chermidae.....	..	..	..	..	1	..	..	..	..	..
Cicadellidae.....	..	..	..	..	4	..	..	..	..	2
Cimicidae.....	..	..	..	..	1	..	..	..	..	6
Cixiidae.....	..	..	..	..	..	..	..	..	..	1
Coccidae.....	..	..	..	..	..	..	..	..	..	7
Diaspididae.....	..	..	..	..	6	..	..	..	..	1
Eriosomatidae.....	..	..	..	..	1	..	..	..	..	..
Eurymelidae.....	..	..	..	..	1	..	..	..	..	..
Lygaeidae.....	..	..	..	..	1	..	..	..	..	..
Margarodidae.....	..	..	..	..	1	..	..	..	..	..
Membracidae.....	..	..	..	..	1	..	..	..	..	..
Nabidae.....	..	..	..	2	..	..	1	..	..	1
Pentatomidae.....	..	..	..	..	1	..	..	..	..	1
Pseudococcidae.....	..	..	..	..	3	..	..	..	..	1
Psyllidae.....	..	..	..	..	..	..	..	..	..	2
Reduviidae.....	..	..	..	..	..	..	..	..	..	2
Scutelleridae.....	..	..	..	..	1	..	..	..	..	..
Unidentified.....	..	..	..	..	1	..	..	..	..	..
Subtotal.....	..	..	..	2	83	..	1	..	1	47
HYMENOPTERA										
Andrenidae.....	..	..	..	..	5	..	..	..	1	1
Anthophoridae.....	..	..	..	..	1	..	..	..	..	3
Apidae.....	..	..	1	4	..	..	..	..	..	5
Argidae.....	1	..	..	..	1	..	..	..	..	..
Braconidae.....	..	..	..	..	2	1	1	..	..	1
Cephidae.....	..	..	..	..	1	..	..	..	..	..
Ceratinidae.....	..	..	..	..	..	..	..	..	..	1
Crabronidae.....	..	..	..	..	1	..	..	..	..	..
Eurytomidae.....	..	..	..	..	1	..	..	..	..	..
Formicidae.....	..	..	..	..	..	..	..	..	..	1
Halictidae.....	..	..	..	..	1	..	..	..	..	5
Ichneumonidae.....	..	..	..	..	..	..	..	..	..	1
Siricidae.....	..	..	..	..	..	..	2	..	..	1

Tenthredinidae.....	1	..	..	..	8	..	..	..	..	2	..	14
Trichogrammatidae.....	..	..	..	..	..	..	..	..	..	..	..	1
Vespidae.....	..	..	1	..	1	..	..	..	..	..	..	..
Xyelidae.....	..	..	..	..	..	..	..	..	..	..	..	1
Xylocopidae.....	..	..	..	..	..	..	..	..	..	..	..	1
Unidentified.....	..	..	..	..	1	..	..	..	..	..	..	1
Subtotal.....	2	1	5	23	1	3	2	37	2	..	..	..
ISOPTERA												
Kalotermitidae.....	..	..	..	..	..	..	..	..	..	..	..	1
Rhinotermitidae.....	..	..	..	1	..	..	..	..	..	..	..	..
Termitidae.....	..	..	..	1	..	..	..	..	..	..	..	1
Subtotal.....	..	..	..	2	..	..	..	2	..	..	..	2
LEPIDOPTERA												
Acrolophidae.....	..	..	..	1	..	..	..	..	..	..	..	..
Aegeridae.....	..	..	..	2	..	..	..	..	..	..	..	..
Amathusiidae.....	..	..	..	1	..	..	..	..	..	..	..	1
Anthelidae.....	1	..	..	..	..	..	..	..	..	..	..	..
Arctiidae.....	2	3	1	11	4	..	..	..	..	..	1	3
Crambidae.....	..	2	2	6	..	..	..	..	..	..	..	3
Danaidae.....	..	..	..	1	..	..	..	..	..	..	..	2
Diopidae.....	1	..	..	4	..	..	..	..	..	..	..	..
Epipaschidae.....	1	..	..	..	..	..	..	..	..	..	..	..
Galleridae.....	..	..	..	..	..	..	..	..	..	..	..	3
Gelechiidae.....	2 (1)*	..	2	4	..	..	..	..	..	..	..	6
Geometridae.....	9 (1)	3	1	3	1	..	..	..	..	..	..	1
Gracilariidae.....	..	..	..	..	..	..	..	..	..	..	..	..
Hepialidae.....	1	..	..	3	..	..	..	..	..	..	..	..
Hesperiidae.....	..	..	3	2	1	..	..	..	..	..	..	2
Hyponomeutidae.....	..	..	..	..	..	..	..	..	..	..	..	1
Lasiolepididae.....	7	1	2	7	1	..	..	..	..	..	1	3
Lymantriidae.....	1	1	..	2	..	..	..	..	..	..	..	..
Lyonetidae.....	7	..	1	1	..	..	..	..	..	..	..	5
Megalopygidae.....	..	1	..	..	..	..	..	..	..	..	..	2
Nepticulidae.....	..	..	..	..	..	..	..	..	..	..	..	1
Noctuidae.....	39 (2)	24	27	20	8	..	..	..	..	3	4	21
Notodontidae.....	..	..	4	..	..	..	..	..	..	..	2	..
Nolidae.....	..	..	..	2	..	..	..	..	..	..	..	..
Nyctemeridae.....	1	..	..	2	..	..	..	..	..	..	..	..
Nymphalidae.....	2	..	1	..	..	..	..	..	..	..	..	..

* Figures in parentheses represent instances in which virus etiology was indicated but could not be determined with certainty.

Order and family	Viruses			Bacteria	Fungi	Protozoa		Nematodes	Entomophagous arthropods	No microbial pathogens
	Polyhedrosis	Granulosis	Noninclusion			Microsporidia	Others			
Olethreutidae.....	..	..	..	3	13	1	..	..	..	8
Papilionidae.....	..	..	..	..	..	1	..	..	..	..
Phycitidae.....	..	..	..	10	4	1	4	..	..	9
Pieridae.....	3	5	..	4	..	2	..	..	..	..
Psychidae.....	(1)	..	..	..	1	2	..	..	..	4
Pterophoridae.....	..	..	..	..	..	..	..	..	..	1
Pyralidae.....	1	1	..	..	5	1	..	..	..	7
Pyraustidae.....	..	..	..	2	10	11	..	1	..	4
Saturniidae.....	3	3	..	4	4	1	..	..	..	4
Sphingidae.....	..	..	..	5	..	..	..	..	..	4
Tineidae.....	..	..	..	2	..	..	..	..	..	..
Tortricidae.....	8	2 (1)	(1)	6	6	1	1	..	..	13
Zygaenidae.....	..	..	..	2	..	..	..	..	..	2
Unidentified.....	1	..	..	1	1	..	..	..	1	7
Subtotal.....	95	46	2	83	116	36	5	6	9	117
NEUROPTERA										
Chrysopidae.....	..	..	..	..	..	..	..	..	..	1
Subtotal.....	..	..	..	..	..	..	..	..	..	1
ORTHOPTERA										
Acrididae.....	..	..	..	9	20	12	9	1	..	11
Gryllacrididae.....	..	..	..	..	2	..	..	..	..	..
Gryllidae.....	..	..	..	4	3	..	..	..	..	4
Henicidae.....	..	..	..	..	1	..	..	..	..	..
Stenopelmaticidae.....	..	..	..	..	..	..	..	..	..	1
Tettigoniidae.....	..	..	..	1	..	..	..	1	..	2
Subtotal.....	..	..	..	14	26	12	9	2	..	18
SIPHONAPTERA										
Ceratophyllidae.....	..	..	..	..	4	..	..	..	..	1
Histiropsyllidae.....	..	..	..	..	1	..	..	..	..	..
Pulicidae.....	..	..	..	..	3	..	..	..	..	..
Subtotal.....	..	..	..	..	8	..	..	..	..	1

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