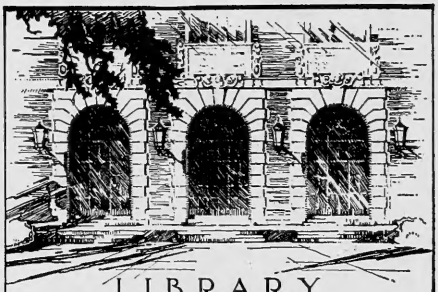

THE COCCIDIAN PARASITES (PROTOZOA, SPOROZOA) OF RODENTS

NORMAN D. LEVINE
and
VIRGINIA IVENS

ILLINOIS BIOLOGICAL MONOGRAPHS
33

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CONTENTS

INTRODUCTION

Coccidia are among the commonest and most important protozoan parasites of vertebrates. Several hundred species belonging to over 30 genera have been described. Almost two hundred species belonging to 9 genera are known to occur in rodents. The literature on them is scattered. Some have been described well, others poorly. No critical analysis of the coccidia of the whole order has ever been made, and, as a result, anyone who wishes to study them is faced with a difficult and time-consuming task. This was brought home to us when we began to study the coccidia of wild rodents in 1954, and the present monograph has grown out of that study.

TAXONOMY

Several schemes have been suggested for the classification of the coccidia (Wenyon, 1926; Reichenow, 1953; Grassé, 1953; Hall, 1953; Kudo, 1954; Cheissin, 1956; Hoare, 1933, 1957; Levine, 1961). The following classification, based on Levine (1961), includes the genera parasitic in rodents. The system of uniform endings for the names of higher taxa proposed by Levine (1959) is used. The ending, -asida, designates a class, -asina a subclass, -orida an order, and -orina a suborder.

Subphylum SPOROZOA (EUSPORA)

Class TELOSPORASIDA

Subclass GREGARINASINA

Mature trophozoite extracellular, large.

Subclass COCCIDIASINA

Mature trophozoite intracellular (with a few exceptions), small.

Order EUCOCCIDIORIDA

Life cycle involves both sexual and asexual phases; schizogony present in the latter.

Suborder ADELEORINA

Macrogamete and microgametocyte associated in syzygy during differentiation. Few microgametes usually produced.

Family ADELEIDAE

Sporocysts formed in oocyst. In epithelium of gut and its appended organs. Chiefly in invertebrates.

Genus KLOSSIA Schneider, 1875

Oocyst with many spherical sporocysts, each with three to ten sporozoites. Macrogametes not vermiform.

Family KLOSSIELLIDAE

Typical oocyst not formed; a number of sporocysts each with many sporozoites develop within a membrane which is perhaps laid down by the host cell. Two microgametes formed by microgametocyte. In kidney and other organs of host.

Genus KLOSSIELLA Smith and Johnson, 1902

With the characters of the family.

Suborder EIMERIORINA

Macrogamete and microgametocyte develop independently. Microgametocyte typically produces many microgametes. No syzygy.

Family CRYPTOSPORIDIIDAE

Development within cuticular layer of host cell and not in cell proper. Oocyst without sporocysts.

Genus CRYPTOSPORIDIUM Tyzzer, 1907

Oocyst with four naked sporozoites.

Family EIMERIIDAE

Development in host cell proper. Oocysts with none, one, two, four, or many sporocysts, each with one or more sporozoites.

Genus EIMERIA Schneider, 1875
Oocyst with four sporocysts, each with two sporozoites.
Genus ISOSPORA Schneider, 1881
Oocyst with two sporocysts, each with four sporozoites.
Genus DORISIELLA Ray, 1930
Oocyst with two sporocysts, each with eight sporozoites.
Genus CARYOSPORA Léger, 1904
Oocyst with one sporocyst containing eight sporozoites.
Genus WENYONELLA Hoare, 1933
Oocyst with four sporocysts, each with four sporozoites.
Genus TYZZERIA Allen, 1936
Oocyst with eight naked sporozoites.

LIFE CYCLE

The only genus of Adeleorina whose life cycle in rodents is known is *Klossiella*. Its life cycle is rather different from that of the Eimeriorina; it will be described in the systematic section below.

The life cycles of the Eimeriorina are similar, and can be illustrated by that of *Eimeria nieschulzi,* which occurs in the small intestine of the rat (Fig. 1). (See Roudabush, 1937, Dieben, 1924, and Levine, 1957.) The oocysts are passed in the feces; at this time they contain a single cell, the sporont. In the presence of oxygen this cell elongates somewhat, throws off a polar granule by reduction division, rounds up again, and then divides into four sporoblasts, each of which then forms a sporocyst containing two sporozoites. In *E. nieschulzi* the sporocysts contain a residual body while the oocysts do not; these bodies may be present or absent in other species. The sporulation process takes about three days in this species, but may take more or less time in other species.

When a rat eats the sporulated oocysts, they break, releasing the sporozoites. These can be found in the lumen of the small intestine three to four hours after the rat has been infected. They enter the cells of the intestinal epithelium and round up, becoming first-generation schizonts. These grow, and after about 36 hours form 20 to 36 first-generation merozoites by multiple fission. The merozoites break out of the epithelial cells, destroying them in the process. Each enters another cell, where it rounds up to form a second-generation schizont, grows, and produces 10

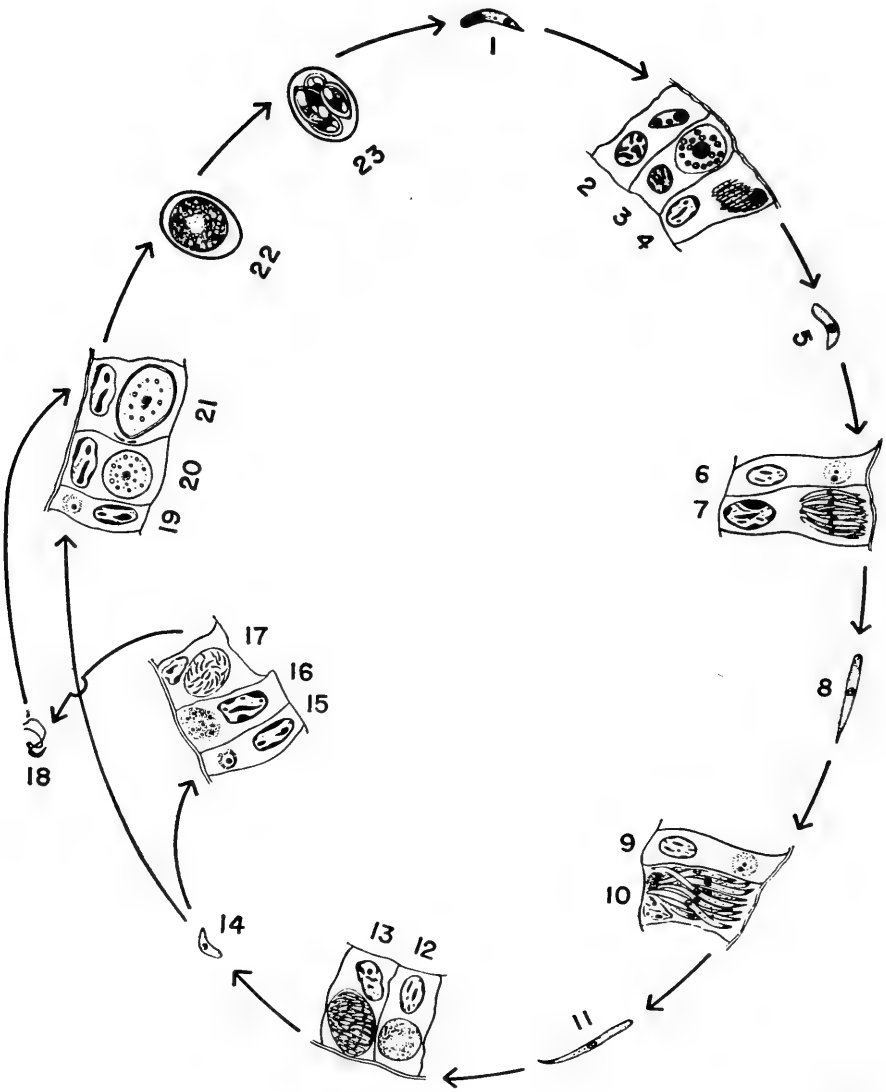

FIG. 1. Life cycle of *Eimeria nieschulzi* from *Rattus norvegicus* (from Levine. 1957).

to 14 second-generation merozoites two days after infection. This process is repeated twice more, third- and fourth-generation merozoites being produced three and four days, respectively, after infection.

The sporozoites are 10–12 μ long and contain a nucleus at the center

and an eosinophilic globule at either end. The merozoites do not have these globules nor do the sporozoites of all species of *Eimeria*. The first-generation merozoites are 7–10 μ, the second-generation 13–16 μ, the third-generation 17–22 μ, and the fourth-generation ones 4–7 μ long.

The sexual phase of the life cycle follows this asexual phase. The fourth-generation merozoites enter new epithelial cells, round up, and form either microgametocytes or macrogametes. The microgametocytes produce a large number of biflagellated microgametes by multiple fission. The macrogametes simply grow. They contain a number of plastic granules, which pass to their periphery, flatten out, and coalesce to form the oocyst wall after fertilization by a microgamete. The formation of this wall marks the transition of a fertilized macrogamete into an oocyst. The oocysts then break out of their host cells, enter the intestinal lumen, and pass out in the feces. The prepatent period, from the time of infection to the appearance of the first oocysts, is seven days. Oocysts continue to be discharged for four to five days, because the sporozoites do not all enter the host cells immediately, but may remain in the lumen of the intestine for four days before doing so.

In the absence of reinfection, coccidial infections are self-limiting. Asexual reproduction does not continue indefinitely as it does, for example, in *Plasmodium*. In *E. nieschulzi* four generations of merozoites are produced; in other species there may be one, two, or three generations. After this, the life cycle enters its sexual phase, the oocysts are formed and eliminated from the body, and the infection is over. Reinfection may take place, but the host develops more or less immunity following the primary infection.

GENERAL OOCYST MORPHOLOGY

Since most coccidian species are differentiated on the basis of the morphology of their oocysts, the characters of the sporulated oocyst deserve attention. These are shown in the drawing of a sporulated oocyst of *Eimeria* in Figure 2. Not all species have all the characters shown, and their presence or absence helps differentiate the species.

The oocysts vary in shape. The oocyst wall is made up of one, two, or rarely three layers. Within it there may or may not be a lining membrane.

A term which has been misused in descriptions of oocysts is "oval." This term means "egg-shaped," i.e., with one end broader than the other,

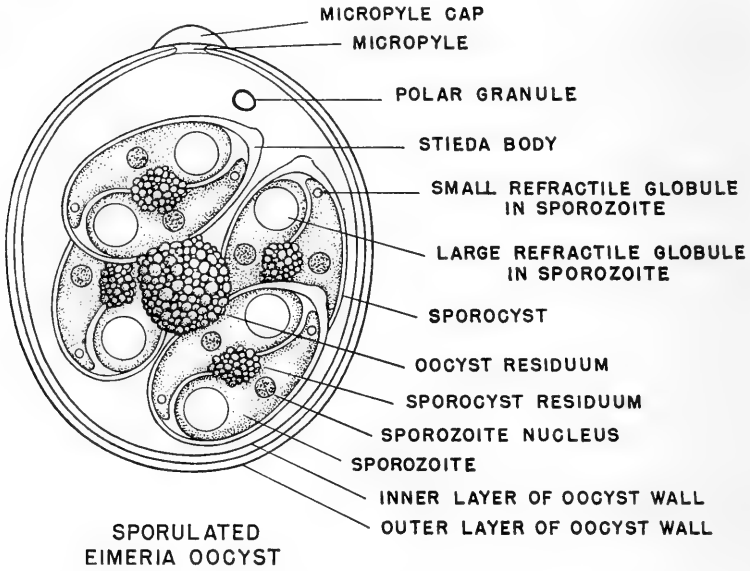

FIG. 2. Sporulated oocyst of *Eimeria* (from Levine, 1961a).

but it is often used when both ends of the oocyst are of equal width; the more proper term in this case is "ellipsoidal." We have used the term "ovoid" in place of "oval"; this, too, means egg-shaped. However, because of the erroneous meaning often attributed to these terms, it must be recognized that oocysts which some authors have described as oval or ovoid may actually be ellipsoidal. Occasionally, too, some authors even use the term "egg-shaped" instead of "ellipsoidal"; for instance, Musaev and Veĭsov (1961a) labeled the drawing of a subspherical oocyst of *Eimeria gliris* "oval'naya" (i.e., oval) and an ellipsoidal oocyst "yaitsevidnaya" (i.e., egg-shaped).

There may be a micropyle at one end which is covered by a micropylar cap in some species. Inside the oocyst are the sporocysts. In addition, a refractile polar granule and an oocyst residuum may be present. The oocyst residuum may be a compact body or may consist of a few to many, more or less scattered, granules or globules.

The sporocysts also vary in shape. The sporocyst wall may vary in thickness and may have a knob (the Stieda body) at one end. The sporozoites are found inside the sporocysts. A sporocyst residuum may also be present as a compact body or consisting of a few to many, more or less scattered, granules.

The sporozoites are usually elongate, with one end broader than the

other. The nucleus is either central or near one end. There may be one or two, more or less refractile, globules in each sporozoite; if there are two, they are usually of unequal size.

CRITERIA FOR SEPARATION OF SPECIES

Both morphological and biological characteristics are used to separate the species of coccidia. There are differences in the morphological characters of both the endogenous and exogenous stages of the life cycle. However, since the endogenous stages of many species are unknown, the structure of the oocyst is most commonly used.

As will be seen in the systematic section of this monograph, many descriptions of coccidian oocysts are sadly deficient. Too often nothing is said about the presence or absence of certain structures such as the Stieda body or sporocyst residuum, the shapes of the oocysts are not clearly described, those of the sporocysts are often not even mentioned, and the illustrations, if present, are so sketchy as to be almost useless. The number of layers in the oocyst wall may not be mentioned or may be stated ambiguously. In this connection, use of the term "double-contoured," should be discontinued. This phrase is extremely ambiguous. Some authors mean by it that the wall is composed of two layers, while others mean that there is a single layer whose inner and outer edges are heavily delineated.

With some microscopes, spherical aberration is such that it is difficult to be sure how many layers are present because one or more extra lines appear to be present around the wall. Even if a microscope with an apochromatic oil immersion objective is used, the best way to be sure of the number of layers is to crush the oocyst. The structural details of coccidian oocysts are often so fine that use of an apochromatic objective is desirable in all studies of them.

A second group of criteria used in differentiating coccidian species is the location of the endogenous stages in the host. Most species are found in the intestine, but some occur in other organs such as the liver and kidney. Within the intestine itself, different species are found in different regions. One may be limited to the cecum, another to the duodenum, another to the ileum, and still another may be found in more than one place.

The location of the parasites within the host tissues or cells may differ

with different species even in the same region of the intestine. Some may be found in the epithelial cells at the tips of the villi, others only in the crypts of Lieberkühn, and still others in the submucosa of the villi. Within the host cell, some species may occur above the host cell nuclei (i.e., between the nucleus and the lumen of the intestine), others beneath them, and still others within them.

Host specificity is a third criterion used in separating coccidian species. This varies wth the protozoan genus and to some extent wth the species. In general, the host range of *Isospora* is relatively broad. Several members of the same host order may be infected by the same *Isospora* species. For example, *Isospora bigemina* has been reported from the dog, cat, ferret, and mink. The host range of *Eimeria* is relatively narrow. A single species rarely infects more than one host genus unless the latter are closely related.

Cross-immunity studies are also used in differentiating the coccidia of a particular host species. Infection of a host animal with one species of coccidium produces immunity against that species but not against other species which occur in the same host.

The feeling is sometimes expressed that coccidia have so few structures that not many species can be distinguished morphologically. However, conservative calculation shows that at least 2,654,736 * morphologically different oocysts are possible in the genus *Eimeria* alone, to say nothing of differences in host, location in host, etc. (Levine, 1962).

PATHOGENICITY

While many species of coccidia are pathogenic, many others are not. Pathogenicity depends on a number of factors, some of which are probably still unknown. Among those which might be mentioned are the number of host cells destroyed per infecting oocyst (which depends upon the number of merozoite generations and the number of merozoites

* This figure is based on the assumption that the following numbers of possibilities exist for the characters named: Oocyst shape, 4; oocyst size, 2; oocyst color, 3; number of layers in oocyst wall, 2; thickness of oocyst wall, 2; texture of oocyst wall (smooth, rough, striated, etc.), 3; oocyst polar granule, 2; oocyst residuum presence and type, 3; micropyle presence and type, 4; micropyle cap, 2; sporocyst size, 2; sporocyst shape, 4; Stieda body presence and shape, 3: sporocyst residuum presence, 2; sporozoite position (lengthwise, crosswise, etc.), 2; sporozoite refractile globule presence, 2.

per generation) and the location of the parasites in the host tissues and within the host cells. The size of the infecting dose or doses, the degree of reinfection, and the degree of acquired or natural immunity of the host are also important.

If disease is present, the signs are those of a diarrheal enteritis. There may or may not be blood in the feces, depending on the parasite species and severity of infection. Affected animals gain weight poorly, become weak and emaciated, or may even die, depending again on the parasite species and the size of the infecting dose of oocysts.

Those animals which recover develop an immunity to the particular species which infected them. However, this is not an absolute immunity, and recovered adult animals are often continuously reinfected so that they carry light infections which do not harm them but which make them a source of infection for the young. In addition, under conditions of stress their immunity may be broken down and they may suffer from the disease again.

SYSTEMATIC SECTION

The genera of coccidia are taken up separately in this section. Within each protozoan genus, the species are arranged according to host genus. The rodent classifications of Ellerman (1940, 1941) and Simpson (1945) and the names employed by Ellerman and Morrison-Scott (1951) and Hall and Kelson (1959) are used. At the end of the section, the principal morphological characteristics of the oocysts of each species are tabulated.

Included in this monograph are some of the results of a study of the coccidia of wild Illinois rodents trapped during the spring and summer of 1958 in the vicinity of Sullivan, Illinois. They were collected as part of a leptospirosis survey under the direction of Drs. Deam H. Ferris and Lyle E. Hanson of the University of Illinois College of Veterinary Medicine and Dr. Rexford D. Lord, Jr. of the Illinois State Natural History Survey. Material from 16 deermice (*Peromyscus maniculatus* and *P. leucopus*), 4 voles (*Microtus ochrogaster*), 5 Franklin ground squirrels (*Spermophilus franklinii*), 11 Norway rats (*Rattus norvegicus*) and 42 house mice (*Mus musculus*) was examined. No coccidia were found in the voles and ground squirrels. The findings in the deermice have already been reported (Levine and Ivens, 1960). Those in the Norway rats and house mice are given below.

A study was also carried out on coccidia in fecal samples from 9 *Rattus hawaiiensis* collected in August, 1958, in the vicinity of Honokaa on the island of Hawaii and sent to us by Mr. Henri P. Minette, Bureau of Laboratories, State Department of Health, Hilo, Hawaii.

In studying the coccidia from Illinois rodents, the contents of the colons and ceca were obtained at autopsy and placed in 2.5% potassium bichromate solution, mixed thoroughly, placed in a thin layer in a petri dish, and kept at room temperature for a week in order to sporulate. If they had not done so in this time, they were allowed to remain for another week or more. They were then stored in a refrigerator. They were examined microscopically after sugar flotation, using a Leitz Ortholux microscope equipped with apochromatic objectives.

At the time of autopsy, segments of duodenum, jejunum, anterior ileum, posterior ileum and cecum were fixed in Zenker's fluid. They were later sectioned and stained with hematoxylin and eosin by Dr. Marjorie B. Losch, and examined histologically for endogenous stages of the coccidia.

The hosts were identified by Dr. Ferris or by Dr. Donald F. Hoffmeister, Department of Zoology, University of Illinois.

The fecal samples from *R. hawaiiensis* were mixed with 2.5% potassium bichromate before shipment to Urbana. Upon receipt, they were handled in the same way as the other material.

GENUS *EIMERIA* SCHNEIDER, 1875

This genus is characterized by the presence of four sporocysts, each containing two sporozoites, in each oocyst.

Host Suborder SCIUROMORPHA
Host Superfamily SCIUROIDEA
Host Family SCIURIDAE
Host Subfamily SCIURINAE
Host Tribe SCIURINI

EIMERIA SCIURORUM GALLI-VALERIO, 1922

(Plate 1, Figs. 1–4; Plate 33, Figs. 270, 271)

Eimeria sciurorum Galli-Valerio, 1922: 344–347; Yakimoff and Gousseff, 1935b: 740–741; Bornand, 1937: 509–514; Pellérdy, 1954a: 475–580; (?) Yakimoff, Sokoloff, and Rastegaieff, 1931: 487–490.

Eimeria sciuri Yakimoff and Terwinsky, 1931: 56–59 (an invalid emendation, with no nomenclatural status).

[*non*] *Eimeria sciurorum:* Möller, 1923: 1–23 (see *E. moelleri*); Knipling and Becker, 1935: 417–418 (see *E. kniplingi*); Roudabush, 1937a: 107–108 (see *E. parasciurorum*); Ryšavý, 1954: 131–174 (see *E. neosciuri*); Bond and Bovee, 1958: 225–229 (?) (see *Eimeria* sp. Bond and Bovee, 1958).

Description: Oocysts cylindroid, usually with parallel sides. Oocyst wall smooth, thin, colorless, probably composed of a single layer. Micropyle very small, seldom visible. Oocysts 24×15 μ according to Galli-Valerio (1922) or $26–29 \times 13–20$ μ, with a mean of 28×16 μ, according to Pellérdy (1954a). Mean length-width ratio 1.6 (Galli-Valerio) or 1.75 (Pellérdy). Unsporulated oocyst contains a round sporont 12 μ in diameter. Sporocysts oval, 10–14 × 6–8 μ (Pellérdy). Pellérdy (1954a) stated that the sporocysts have a fine micropyle; perhaps by this term he meant Stieda body. Yakimoff and Gousseff (1935b) did not illustrate a Stieda body, but their drawing is quite diagrammatic. One or two refractile polar granules present. Oocyst residuum absent. Neither Galli-Valerio (1922) nor Pellérdy (1954a) made any statement about the sporocyst residuum. According to Yakimoff and Gousseff (1935b), it is represented by some scattered granules.

Sporulation Time: Three or four days according to Pellérdy (1954a).

Schizogony and Gametogony: The details of schizogony and gametogony are unknown. Pellérdy (1954a) describes some of the intracellular stages in a mixed infection with three other species of *Eimeria,* but it is impossible to say which stages were those of *E. sciurorum.* All the parasites were found above the host cell nuclei.

Prepatent Period: According to Pellérdy (1954a), the prepatent period is seven days.

Type Host: Sciurus vulgaris var. *alpinus* (European alpine squirrel).

Other Hosts: Sciurus vulgaris (squirrel); "Eichhornchen."

Location: Small intestine. Pellérdy (1954a) found oocysts beginning a few inches from the pylorus.

Geographic Distribution: Europe (Switzerland, Italy, Hungary, USSR).

Pathogenicity: Galli-Valerio considered this species an important cause of death in wild squirrels. Pellérdy (1954a) observed diarrhea and slight dysorexia on the fourth to sixth days following experimental infection with mixed coccidia of which *E. sciurorum* was the most abundant. Bornand (1937) observed marked hyperemia of the small intestine in a heavily infected *S. vulgaris* which he examined.

Cross-Transmission Studies: Galli-Valerio (1922) attempted unsuccessfully to transmit this species from *Sciurus vulgaris* to the white rat.

Prevalence: No information.

Remarks: The original description of this species was so incomplete that a number of different forms from several species of squirrels have been assigned to it by different authors. While their more complete descriptions are not incompatible with Galli-Valerio's sketchy one, some of them are incompatible with each other.

E. sciurorum was originally described by Galli-Valerio (1922) from the alpine squirrel, *Sciurus vulgaris* var. *alpinus,* in Switzerland. He later (1930) listed *Sciurus vulgaris* var. *noire* as a host, but this varietal name is a vernacular and not a scientific one.

Of the six coccidia described by other authors under the name *Eimeria sciurorum,* a critical study indicates that only two should be assigned to this species. These are the *E. sciurorum* described by Pellérdy (1954a) from *Sciurus vulgaris* in Hungary, and probably *E. sciurorum* described by Yakimoff and Gousseff (1935b) from an *"Eichhornchen"* (no scientific name given) in Russia. The forms described under this name by Möller (1923) from *Sciurus* (syn., *Neosciurus) carolinensis* in a German zoological garden, by Yakimoff, Sokoloff, and Rastegaieff (1931) from *S. vulgaris* in Russia, by Knipling and Becker (1935) from *S. niger rufiventer* from Iowa, and by Roudabush (1937a) from the flying squirrel, *Glaucomys volans,* from Iowa, belong to different species.

Galli-Valerio's (1922) complete description was: *"Eimeria sciurorum* n. sp. Im Darme einer *Sciurus vulgaris* var. *alpina* aus St. Loup (Waadt) habe ich eine *Eimeria* vom 24 × 15 μ gefunden, deren Gestalt mehr zylindroid als ovoid war. Protoplasma als Kugel in der Mitte der Oocyste, von 12 μ. Mikropyle sehr klein. In Wasser gesetzt, haben die Oocysten 4 Sporen mit je 2 Sporozoiten ergeben. Die Gestalt dieser *Eimeria* war ganz verschieden von derjenigen der *E. stiedai."*

The form described under the name *E. sciurorum* Galli-Valerio by Möller (1923) from *Sciurus* (syn., *Neosciurus) carolinensis* in a German zoological garden differs from this species in possessing a large micropyle (4–6 × 1–1.5 μ) and in lacking an oocyst polar granule.

The form described as *E. sciurorum* by Yakimoff, Sokoloff, and Rastegaieff (1931) from *S. vulgaris* in Russia differs from this species in having a large micropyle 7.2 μ in diameter. However, it appears to agree with it in all other respects. Two of the oocysts in the rather crude drawings of Yakimoff, Sokoloff, and Rastegaieff (1931) are shown without micropyles, and the other two have a thickened wall at one end which might be supposed to represent a micropyle. Pending further study, it is considered best to list this form as a questionable *E. sciurorum.*

The form described as *E. sciurorum* by Knipling and Becker (1935)

from *S. niger rufiventer* in Iowa differs from this species in lacking oocyst polar refractile granules and in having an oocyst residuum and a large sporocyst residuum.

The form described as *E. sciurorum* by Roudabush (1937a) from *Glaucomys volans* in Iowa differs from this species in having a prominent sporocyst residual body and in lacking a micropyle. In addition, its host belongs to a different subfamily from that of *Sciurus;* since most rodent Eimerias seem to be quite host-specific, this increases the probability that it is a different species.

The form described by Bond and Bovee (1958) from *Sciurus carolinensis* under the name *E. sciurorum* (?) differs from *E. sciurorum* in having an oocyst residuum. A more complete description of this form is needed before its taxonomic position can be established.

EIMERIA BOTELHOI CARINI, 1932

Eimeria botelhoi Carini, 1932: 80–82.

Description: Although Carini (1932) described the oocysts as oval; they are actually illustrated as piriform in his drawing. Oocysts 36 × 28 μ with a large micropyle at the tapering end. Oocyst wall 3 μ thick, composed of three layers, of which the outermost is yellowish and rough. Sporocysts elongate ellipsoidal, 19 × 9 μ, without a Stieda body. Sporocyst residuum small, granular, lying between the two elongate, comma-shaped sporozoites. Oocyst residuum and polar granules absent.

Sporulation time: Several days in 1% chromic acid.

Schizogony: Schizogony takes place in the mucosal cells of the villi. The young schizonts in the cells are round, and occur above the host cell nucleus. They grow to a diameter of 25–30 μ and produce a variable number (generally 12–20) of merozoites. The merozoites are fusiform, 10–12 μ long, 4 μ wide, and have a nucleus in the center.

Gametogony: Gametogony takes place in the mucosal cells of the villi. The gametocytes lie above or beside the host cell nuclei. Each microgametocyte produces hundreds of intensely staining microgametes 4–5 μ long. The mature macrogametes have a central nucleus and vacuolar cytoplasm. After fertilization, the oocyst wall is laid down rapidly.

Prepatent period: Unknown.

Host: Sciurus (Guerlinguetus) ingrami (squirrel).

Location: Small intestine.

Geographic Distribution: Brazil.

Pathogenicity: Unknown. The parasitized cells are destroyed.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA FRANCHINII BRUNELLI, 1935

Eimeria franchinii Brunelli, 1935: 354–366.

Description: Oocysts piriform, with a prominent micropyle at the small end. Oocyst wall thick, rough, yellow, composed of two layers. Oocysts 24 × 15 μ (Hardcastle, 1943, gave the dimensions erroneously as 17.5 × 9.75 μ).

Sporulation Time: The oocysts failed to sporulate in 2.5% potassium bichromate after 24 days, although four sporoblasts formed in some.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Sciurus vulgaris (squirrel).

Location: Feces.

Geographic Distribution: Europe (Italy).

Pathogenicity: Unknown.

Prevalence: Unknown.

Remarks: Although this species is incompletely described, it clearly belongs to the *botelhoi* series, but differs from all the other species in squirrels by its small size.

EIMERIA LUISIERI (GALLI-VALERIO, 1935) REICHENOW, 1953

Jarrina luisieri Galli-Valerio, 1935: 643–644.

Eimeria (*Jarrina*) *luisieri* (Galli-Valerio). Reichenow, 1953: 1–850.

Description: Oocysts ovoid, with one end round and the other shaped like a bottleneck. Oocyst wall thick, rough, yellowish. Number of layers in oocyst wall not given. Micropyle very distinct. Oocysts 33×24 μ. Sporont of unsporulated oocysts 18 μ in diameter. Sporocysts almost spherical, 9 × 7.5 μ. Sporozoites piriform. Oocyst residuum present. Sporocyst residuum and oocyst polar granule not mentioned.

Sporulation time: Twenty days at room temperature on moist filter paper in a moist chamber.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Sciurus vulgaris var. *alpina* (alpine squirrel).

Location: Intestine.

Geographic Distribution: Europe (Switzerland).

Pathogenicity: Unknown. This species was described from the fluid intestinal contents of a squirrel which was found dead.

Prevalence: Unknown.

EIMERIA MIRA PELLÉRDY, 1954

(Plate 33, Fig. 272)

Eimeria piriformis Lubimov, 1934: 1–108 [*fide* Pellérdy, 1954a: 475–480] (a junior homonym of *E. piriformis* Kotlán and Pospesch, 1934).

Eimeria mira Pellérdy, 1954a: 475–480.

[*non*] *Eimeria piriformis:* Kotlán and Pospesch, 1934: 215–217; Marotel and Guilhon, 1941: 321–328.

Description: Oocysts piriform, with a short bottleneck at the end of which is a large micropyle 4–6 μ in diameter. Oocyst wall rough, brown, composed of two layers 3 μ thick. Oocysts 30–40 × 19–27 μ according to Pellérdy (1954a), or 35–37 × 24 μ according to Lubimov (1934). Oocyst residuum and polar granule absent. Sporocysts cigar-shaped, pointed at both ends, 19 × 6 μ, with a large amount of residual material. Sporozoites comma-shaped.

Sporulation time: Five to seven days.

Schizogony and Gametogony: The details of schizogony and gametogony are unknown. Pellérdy (1954a) described some of the intracellular stages in the ileum of a squirrel in a mixed infection with three other species of *Eimeria,* but it is impossible to say which stages were those of *E. mira.* All the parasites were found above the host cell nuclei.

Prepatent Period: Ten to eleven days.

Type Host: Sciurus vulgaris (squirrel).

Location: Small intestine. Pellérdy (1954a) found oocysts only in the ileum of a squirrel killed about 11 days after experimental infection.

Geographic Distribution: Hungary, USSR.

Pathogenicity: Unknown.

Cross-Transmission Studies: Pellérdy (1954a) was unable to infect three ground squirrels (*Spermophilus citellus*) or three dormice *(Glis glis)* with *E. mira* from *Sciurus vulgaris.*

Prevalence: Unknown.

Remarks: This species was first described by Lubimov (1934) from *Sciurus vulgaris* under the name *Eimeria piriformis.* Kotlán (1951), however, showed that this name was a homonym of *Eimeria piriformis* Kotlán and Pospesch, 1934 from the rabbit. Since he thought the squirrel species might be a synonym of *Eimeria eubeckeri* Hall and Knipling, 1935 from Franklin's ground squirrel, *Spermophilus franklinii,* Kotlán (1951) did not assign it a new name. Later, however, Pellérdy (1954a) showed that it differed from *E. eubeckeri* in the shape of its micropyle, and was unable to infect the European ground squirrel, *Spermophilus citellus,* with oocysts from *Sciurus vulgaris.* He therefore gave this form the name *Eimeria mira.*

The only differences between this species and *E. botelhoi* Carini, 1932 aside from the host and geographic locality are that *E. mira* has narrower sporocysts pointed at both ends and a larger amount of sporocyst residual material. However, Pellérdy did not illustrate his sporulated oocysts, nor did he refer to *E. botelhoi* or to Carini's paper, so it is possible that future research may show that these two forms belong to a single species.

EIMERIA ANDREWSI YAKIMOFF AND GOUSSEFF, 1935

(Plate 33, Figs. 273 and 275)

Eimeria andrewsi Yakimoff and Gousseff, 1935b: 740–741; Pellérdy, 1954a: 475–480.

Description: Oocysts oval, somewhat pointed at both ends, or subspherical to ellipsoidal. Oocyst wall smooth, composed of a single layer. Oval oocysts 19.8–22.5 × 14.4–16.2 μ (mean, 20.9 × 15.2 μ); subspherical oocysts 18.0–20.1 × 15.3–16.2 μ (mean, 18.5 × 15.4 μ). Length-width ratio of oval oocysts, 1.3–1.5 (mean, 1.4); length-width ratio of subspherical oocysts, 1.18–1.25 (mean, 1.20). The above dimensions are from Yakimoff and Gousseff (1935b). According to Pellérdy (1954a), the oocysts measure 19–25 × 14–16 μ. Oocyst polar granule present. Oocyst residuum absent. Sporocysts oval, 7.2 × 3.6 μ, without Stieda body or residuum.

Sporulation Time: Three days at room temperature, according to Pellérdy (1954a).

Schizogony and Gametogony: The details of schizogony and gametogony are unknown. Pellérdy (1954a) described some of the intracellular stages in a mixed infection with three other species of *Eimeria,* but it is impossible to say which stages were those of *E. andrewsi.* All of the parasites were found above the host cell nuclei.

Prepatent Period: According to Pellérdy (1954a), the prepatent period is six days.

Type Host: "Eichhörnchen" (presumably *Sciurus* sp.).

Other Hosts: Sciurus vulgaris (squirrel).

Location: Throughout small intestine.

Geographic Distribution: Europe (White Russia, Hungary, probably England).

Pathogenicity: Unknown.

Prevalence: Unknown.

Remarks: The unsporulated coccidium described and illustrated by Sheather (1923) from a squirrel in England probably belonged to this species. It was ellipsoidal, had a smooth, thin wall without a micropyle, and measured 21–25 × 12–16 μ.

EIMERIA SILVANA PELLÉRDY, 1954

(Plate 33, Fig. 276)

Eimeria silvana Pellérdy, 1954a: 475–480.

Description: Oocysts ellipsoidal or subspherical, 15–18 × 12–15 μ. Oocyst wall smooth, pale; number of layers not stated. Micropyle absent. Entire unsporulated oocysts filled by sporont. Sporocysts elongate. Oocyst residuum absent. No information given on oocyst polar granule, sporocyst residuum, or Stieda body.

Sporulation Time: One to two days.

Schizogony and Gametogony: Unknown. Pellérdy (1954a) described some of the intracellular stages in a mixed infection with three other species of *Eimeria,* but is impossible to say which stages were those of *E. silvana.* All the parasites were found above the host cell nuclei.

Prepatent Period: Seven days.

Type Host: Sciurus vulgaris (squirrel).

Location: Small intestine.

Geographic Distribution: Europe (Hungary).

Pathogenicity: Unknown.

Prevalence: Unknown.

EIMERIA SERBICA POP-CENITCH AND BORDJOCHKI, 1957

(Plate 1, Figs. 5 and 6)

Eimeria serbica Pop-Cenitch and Bordjochki, 1957: 73–75.
Eimeria serbca [*sic*]: *Ibid.*

Description: Oocysts described as oval and illustrated as ellipsoidal, yellowish rose, 21–35 × 12–25 μ. Oocyst wall 0.6–0.9 μ thick, illustrated as composed of a single layer. Micropyle absent. Oocyst residuum absent. Oocyst illustrated without polar granule. Sporocysts illustrated as ellipsoidal, without Stieda body. Sporocyst residuum present, 3.5 μ in diameter.

Sporulation Time: At least 12 days at 25C and 45 days at 5C.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Serbian squirrel (*Sciurus vulgaris* ?).

Location: Unknown. Oocysts found in feces.

Geographic Distribution: Yugoslavia.

Pathogenicity: Unknown.

Prevalence: Unknown.

Remarks: Although the description of this species is incomplete, and although Pop-Cenitch and Bordjochki (1957) were apparently unaware of any other squirrel coccidia except *Eimeria sciurorum,* their species appears to be different from the others reported from squirrels, except *E. parasciurorum* Bond and Bovee, 1957 (p. 45). However, the fact that the host of the latter, *Glaucomys volans,* belongs to a different subfamily from *Sciurus vulgaris* makes the probability of cross-transmission doubtful. This species is therefore retained pending a more detailed description and cross-transmission study.

EIMERIA MOELLERI N. SP.

Eimeria sciurorum Galli-Valerio. Möller, 1923: 1–23.
[*non*] *Eimeria sciurorum* Galli-Valerio, 1922: 345–347.

Description: Oocysts ellipsoidal, sometimes cylindrical, 22–28 × 14–18 μ. Oocyst wall smooth, composed of two layers. Micropyle 4–6 μ wide and 1–1.5 μ high. Sporocysts 10–14 × 6–8 μ, with a small micropyle (Stieda body?) at one end. Sporocyst residuum present. Oocyst polar granule and residuum absent. Sporozoites dumbbell-shaped with one end somewhat pointed, 8–14 × 4–5 μ.

Sporulation Time: Three days.

Schizogony and Gametogony: Möller (1923) described these processes in an experimentally infected *Sciurus vulgaris.* The schizonts are more or less round and about 18 μ in diameter. They enlarge the host cell, pushing its nucleus to one side. Each schizont forms 12 or more merozoites measuring 6–7 × 1–2 μ. The microgametocytes are round and 16–20 μ in diameter. They form a large number of slender, comma-shaped microgametes. The macrogametes are round and 16–20 μ in diameter, with a star- or thornapple-shaped nucleus.

Prepatent Period: Thirteen days.

Type Host: Sciurus (Neosciurus) carolinensis (gray squirrel).

Location: Small intestine, especially posterior part of jejunum. Parasitic in the tips of the villi.

Geographic Distribution: Europe (described from an American squirrel in the Berlin Zoological Garden).

Pathogenicity: Nonpathogenic.

Cross-Transmission Studies: Möller (1923) transmitted this coccidium experimentally to a European domestic squirrel (presumably *Sciurus vulgaris).*

Prevalence: Unknown.

Remarks: Although Möller (1923) called this form *E. sciurorum* and was followed by a number of other authors, it clearly belongs to a different species. It differs from *E. sciurorum* especially in possessing a large micropyle 4–6 μ in diameter rather than a generally inapparent one. In addition, it has no oocyst polar granule, while *E. sciurorum* does. It is also somewhat smaller.

The other species of squirrel *Eimeria* with a prominent micropyle are *E. botelhoi, E. franchinii, E. luisieri, E. petauristae,* and *E. mira,* but all of these have a thick, rough, yellowish to brownish wall, whereas that of Möller's species is thin, smooth, and apparently colorless.

The remaining named species of squirrel *Eimeria,* all of which have thin, smooth walls, all lack a micropyle. In addition, Möller's species differs from *E. andrewsi* in lacking an oocyst polar ganule, in having a sporocyst residuum, and in having larger sporocysts. It is much larger than *E. glaucomydis.* Finally, it differs from *E. silvana* in being much larger and in having a sporocyst residuum.

We are therefore assigning the name *Eimeria moelleri* n. sp. to the species described under the name *Eimeria sciurorum* by Möller (1923) from *Sciurus (Neosciurus) carolinensis.*

EIMERIA NEOSCIURI PRASAD, 1960

(Plate 1, Figs. 7–14; Plate 2, Figs. 15 and 16)

Eimeria neosciuri Prasad, 1960: 135–139.
Eimeria sciurorum Galli-Valerio. Ryšavý, 1954: 131–174.
[*non*] *Eimeria neosciuri:* Webster, 1960: 139–146 (see *E. ascotensis*).
[*non*] *Eimeria sciurorum* Galli-Valerio, 1922: 344–347.

Description: Oocysts ellipsoidal, 22–28 × 14–18 μ, with a length-width ratio of 1.55–1.58. Oocyst wall smooth, composed of two layers. Outer layer colorless or pale yellowish; inner layer dark brown. Micropyle absent. Oocyst polar granule present. Oocyst residuum absent. Sporocysts ovoid, with protruding Stieda body, 11–13 × 5–7 μ. Sporocyst residuum present. Sporozoites described as sickleshaped, 6 × 2–3 μ, illustrated as comma-shaped with a clear globule at the large end.

Sporulation Time: Thirty-six to forty-eight hours at 22C.

Schizogony and Gametogony: According to Prasad (1960), the schizonts are oval, 10–11 × 4–4.5 μ, and contain 10–13 nuclei. The merozoites are sausage-shaped, 5–5.5 × 1 μ, and have a central nucleus.

The microgametocytes are asymmetrical, ellipsoidal, or cylindrical, and measure 19–20 × 12 μ. They produce a large number of microgametes, which are arranged haphazardly around a central residual mass.

The macrogametes are ovoid or cylindroid, measure 5–17 × 5–12 μ, and have a central, vesicular nucleus and a series of plastic granules around their periphery.

The number of schizont generations and the length of the patent period are unknown. Prasad (1960) followed the wave of oocyst production in one squirrel after a relapse. It was highest from the sixth to the tenth days and then decreased gradually; no more oocysts were passed after about two weeks.

Prepatent Period: Unknown.

Type Host: Sciurus (Neosciurus) carolinensis (gray squirrel).

Other Host: Sciurus vulgaris (squirrel).

Location: Small intestine. According to Prasad (1960), all stages occur beneath the host cell nucleus in the epithelial cells of the villi of the upper part of the ileum.

Geographic Distribution: Europe (England, Czechoslovakia).

Pathogenicity: Prasad (1960) saw no macroscopic lesions, but remarked that the affected part of the ileum appeared slightly thinner than the noninfected part. Heavily infected squirrels showed no signs of illness, and their feces and appetites were normal.

Cross-Transmission Studies: None.

Prevalence: Prasad (1960) found this species in all of four squirrels which he examined in England.

Remarks: Ryšavý (1954) reported finding *"Eimeria sciurorum"* in *Sciurus vulgaris* in Czechoslovakia. However, the oocysts which he illustrated had a prominent Stieda body and resembled those of *E. neosciuri* more than they did those of *E. sciurorum*. They were ellipsoidal to ovoid and measured 24–32 × 14–19 μ, with a mean of 28 × 18 μ and a mean length-width ratio of 1.67. Their oocyst wall was thin and colorless and reported to be composed of a single layer. There was no distinct micropyle. An oocyst polar granule was present (but rarely) and an oocyst residuum was absent. The sporocysts were ovoid and 8–12 × 6–7 μ. A sporocyst residuum was present. The sporulation time was 72 hours, and the parasites were reported to occur in the small intestine.

EIMERIA ASCOTENSIS N. SP.

(Plate 2, Figs. 17–24)

Eimeria neosciuri Prasad. Webster, 1960: 139–146.
[*non*] *Eimeria neosciuri* Prasad, 1960: 135–139.

Description: Oocysts (illustrated as ellipsoidal) ovoid, 14–31 × 10–20 μ, with a mean of 24 × 15 μ. Oocyst wall apparently smooth, composed of three layers: outer layer pale yellow, 0.75 μ thick; middle layer brown, 1.0 μ thick; and inner layer pinkish orange, 0.6 μ thick (but the oocyst wall in the photomicrograph appears thinner than this and composed of only one layer). True micropyle absent, its place taken by an operculum 6–9 μ wide; in addition, at the end of the oocyst opposite the operculum is a rather indistinct, wavy line 5–7 μ long in the two inner layers of the wall, which Webster (1960) called a terminal cap, but which looks like a second operculum. Oocyst polar granule present. Oocyst residuum absent. Sporocysts ovoid, with a prominent Stieda body, 9–10 × 6–7 μ. Sporocyst residuum present. Sporozoites piriform, 9 × 3 μ, with a clear globule at the large end.

Sporulation Time: Ninety-five per cent sporulate in 76 hours at 20, 25, and 30C, in about 140 hours at 15C, and in about 192 hours at 10C. After 24 hours, about sixty-five per cent of the oocysts were sporulated at 30C, about forty-five per cent at 25C, and about five per cent at 20C. The oocysts died in 24 hours at 40C.

Schizogony and Gametogony: According to Webster (1960), the schizonts are 8–17 μ in diameter and contain 6 to 11 crescentic or banana-shaped merozoites measuring 4.5–6 × 1.5 μ.

The microgametes measure 2.5–3 × 0.6–0.9 μ. The macrogametes are

spherical and were said by Webster to be 6–8 μ in diameter; these were probably immature.

Prepatent Period: Unknown.

Type Host: Sciurus (Neosciurus) carolinensis (gray squirrel).

Location: Small intestine. According to Webster (1960), all the intracellular stages occur in the epithelial cells distal to the host cell nucleus.

Geographic Distribution: Europe (England).

Pathogenicity: According to Webster (1960), infected squirrels showed no signs of disease and their feces were normal. However, in all the squirrels he examined the duodenum was rather inflamed and the jejunum frequently had swollen lymph nodes and small hemorrhages. In one squirrel he noted that the gametogony phase of the infection was associated with a large collection of lymphocytes between the submucosa and the mucosa which appeared as an opaque white patch on the ileum.

Cross-Transmission Studies: None.

Prevalence: Webster (1960) found this species in all of six squirrels which he examined from Silwood Park, Sunninghill, Ascot, Berkshire, England.

Remarks: Webster (1960) considered this species to be *Eimeria neosciuri,* but his description differs from Prasad's (1960) description of *E. neosciuri* in several important respects. If both descriptions are correct, then the two forms must be different species. The oocysts of Webster's species had an operculum and a "terminal cap," while those of Prasad's species had neither. Webster said that his form had a three-layered oocyst wall whereas Prasad said that his had a two-layered wall. (It is possible that the outermost layer of Webster's oocysts may have been an optical illusion, since the operculum and terminal cap did not extend through it and since we have seen this optical illusion in many oocysts of various species which we ourselves have studied; therefore, we do not place much emphasis on this character.) The sporocysts of Webster's form are smaller than those of Prasad's. In addition, the location of the endogenous stages in the host cells differed. Prasad found these stages beneath the host cell nuclei, while Webster found them above the nuclei. Since Webster's description differs from those of all other species of *Eimeria* from squirrels, we are naming his form *Eimeria ascotensis* n. sp.; it is named after Ascot, where the infected squirrels were found.

E. ascotensis differs from all other squirrel Eimerias in having an operculum and "terminal cap." It differs further from *E. botelhoi, E.*

franchinii, E. luisieri, E. petauristae, and *E. mira* in lacking a thick, rough, yellowish to brownish wall and a true micropyle. It differs further from *E. sciurorum* in oocyst shape and in having a prominent Stieda body. It differs from *E. andrewsi* and *E. serbica* in having a prominent Stieda body. It differs further from *E. moelleri* in lacking a true micropyle and in having an oocyst polar granule. It differs further from *E. kniplingi* in oocyst shape, in having an oocyst polar granule, and in lacking an oocyst residuum. It differs further from *E. silvana* in oocyst size.

EIMERIA KNIPLINGI N. SP.

(Plate 3, Figs. 25–27)

Eimeria sciurorum Galli-Valerio. Knipling and Becker, 1935: 417–418.
[*non*] *Eimeria sciurorum* Galli-Valerio, 1922: 344–347.

Description: Oocysts cylindrical with rounded ends, 15.5–34.0 × 10.1–19.0 μ, with a mean of 24.2 × 14.2 μ; length-width ratio, 1.35–2.15, with a mean of 1.70. Oocyst wall smooth, tinted pinkish to orange, composed of a single layer. No micropyle visible, but oocyst wall appeared to be slightly thinner at one end. Sporont almost fills unsporulated oocyst. Sporocysts ellipsoidal, 13.1 × 6.7 μ, with a prominent Stieda body, a large sporocyst residual body, and additional residual material. Oocyst polar granule absent. Oocyst residuum present, small.

Sporulation Time: Fifty-seven to seventy hours in potassium bichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Sciurus niger rufiventer (fox squirrel).

Location: Cecum and large intestine; a few in small intestine.

Geographic Distribution: United States (Iowa).

Pathogenicity: Unknown.

Prevalence: Unknown.

Remarks: This coccidium was described from a single fox squirrel in Ames, Iowa. It was assigned somewhat hesitantly to *E. sciurorum,* but in view of the additional information now available on the latter species, it is clear that Knipling and Becker's form does not belong to it. It differs in lacking oocyst polar granules and in having an oocyst residuum, a large sporocyst residuum, and a prominent Stieda body. In addition, its habitat is primarily the large intestine, while that of *E. sciurorum* is the small intestine.

This species differs from *E. moelleri* in lacking a micropyle and in having an oocyst residuum and a prominent Stieda body. In addition, it occurs primarily in the large intestine, while *E. moelleri* occurs primarily in the jejunum.

It differs from *E. andrewsi* in shape, in lacking an oocyst polar granule,

in having both oocyst and sporocyst residua, and in having a Stieda body. In addition, the sporocysts are much larger.

It is larger than *E. silvana* and differs from it in shape. It differs also in having oocyst and sporocyst residua and a Stieda body.

It is larger than *E. glaucomydis* and differs from it in shape. It differs also in having an oocyst residuum and a Stieda body.

It differs from *E. serbica* and *E. parasciurorum* in having an oocyst residuum and a sporocyst Stieda body.

It differs from *E. neosciuri* in the location of its endogenous stages, in having an oocyst residuum, and in lacking an oocyst polar granule.

It differs from *E. botelhoi, E. franchinii, E. luisieri, E. petauristae,* and *E. mira* in lacking a micropyle and having a smooth, pale, thin wall, while all these have thick, rough, yellowish to brownish walls. There are other differential characters, but it is not necessary to give them.

We are therefore assigning the name, *Eimeria kniplingi* n. sp. to the species described under the name *Eimeria sciurorum* by Knipling and Becker (1935) from *Sciurus niger rufiventer.*

EIMERIA SP. HENRY, 1932

Eimeria sp. Henry, 1932a: 279–290.

Description: Oocyst ovoid, 22.4–32.0 × 16.0–19.2 μ, with a mean of 28.8 × 19.2 μ. Oocyst wall smooth. Micropyle present. Sporulated oocysts not described.

Sporulation Time: About two days.

Host: Sciurus griseus griseus (gray squirrel).

Location: Oocysts found in cecal contents.

Geographic Distribution: United States (California).

Prevalence: Unknown.

Remarks: This form was described from a single gray squirrel. Henry (1932) stated that it might be different from *E. sciurorum,* but that there was not sufficient evidence to differentiate it. She thought that it was similar to the unsporulated oocyst figured from a squirrel in England by Sheather (1923); this latter form was probably *E. andrewsi.* Further information is needed before Henry's form can be assigned to any species.

EIMERIA SP. BRUNELLI, 1935

Eimeria sp. Brunelli, 1935: 357–360.

Description: Oocysts ovoid, with a smooth, pearl gray double wall, 17.5 × 9.75 μ. A granular residual body is present at one of the poles, but it is not clear from Brunelli's description whether this is an oocyst or a sporocyst residuum.

Sporulation Time: Four to six days in 2.5% potassium bichromate.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.
Type Host: Sciurus vulgaris (squirrel).
Location: Feces.
Geographic Distribution: Europe (Italy).
Pathogenicity: Unknown.
Prevalence: Unknown.
Remarks: Further morphological information is needed before this form can be assigned to any species.

EIMERIA SP. BOND AND BOVEE, 1958

(Plate 3, Fig. 28)

Eimeria sciurorum (?) Galli-Valerio. Bond and Bovee, 1958: 225–229.

Description: Oocysts illustrated as ellipsoidal, with a single-layered wall. Oocysts 27×17 μ. Small micropyle present. Oocysts illustrated without polar body but with oocyst residuum. Sporocysts illustrated as elongate kidney-shaped, without Stieda body or sporocyst residuum.
Schizogony and Gametogony: Unknown.
Type Host: Sciurus carolinensis (grey squirrel).
Location: Feces.
Geographic Distribution: North America (Florida).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Unknown.
Remarks: Bond and Bovee (1958) made a drawing of this form but did not give a complete description. They mentioned its size and the presence of a small micropyle and said that it was almost identical in size and shape to *E. sciurorum* as described by Galli-Valerio (1922). However, it differs from this species in having an oocyst residuum and in lacking a polar granule. Bond and Bovee did not refer to Pellérdy's (1954a) work on squirrel coccidia. Their form does not agree with the description of any named species, but a more complete description is needed before its taxonomic position can be established.

Host Suborder SCIUROMORPHA
Host Superfamily SCIUROIDEA
Host Family SCIURIDAE
Host Subfamily SCIURINAE
Host Tribe TAMIASCIURINI

EIMERIA TAMIASCIURI LEVINE, IVENS, AND KRUIDENIER, 1957

(Plate 3, Fig. 29)

Eimeria tamiasciuri Levine, Ivens, and Kruidenier, 1957: 80–88; Bullock, 1959: 39–40; Dorney, 1962: 258–261.

Description: Oocysts elongate ellipsoidal, occasionally somewhat ovoid, rarely with one side slightly concave and the other convex. Oocyst wall smooth, colorless, composed of a single layer 1.5 μ thick. Micropyle absent. Fifty sporulated oocysts measured 26–40 × 16–21 μ, with a mean of 32.5 × 19.3 μ. Their length-width ratios ranged from 1.4–2.0, with a mean of 1.69. Sporocysts elongate ovoid, about 16 × 8 μ, very thin-walled at the sides, and broadly thickened at one end, and tapered to a blunt point at the other, thus forming a Stieda body. A single oocyst polar granule present, often lying among the sporocysts and difficult to see. Oocyst residuum absent. Sporozoites elongate and bent, embedded in a mass of residual material which fills the sporocyst. Sometimes this residual material forms a large body in the center of the sporocyst. Four hundred oocysts measured by Dorney (1962) from four Wisconsin red squirrels were 19–39 × 10–22 μ, with a mean of 26 × 15 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Tamiasciurus hudsonicus (red or spruce squirrel).

Location: Intestinal contents. Dorney (1962) found oocysts throughout the entire small intestine, with an especially large number in the "posterior quarter (ileum)."

Geographic Distribution: United States (Arizona, New Hampshire, Wisconsin).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was described from a single spruce squirrel from the south rim of Grand Canyon. Bullock (1959) found it in 2 road-killed *T. hudsonicus loquax* in New Hampshire. Dorney (1962) found it in 98 per cent of 50 *T. hudsonicus* in Wisconsin.

EIMERIA TODDI DORNEY, 1962

(Plate 3, Fig. 30)

Eimeria toddi Dorney, 1962: 258–261.

Description: Oocysts "oval" (illustrated as ellipsoidal). Fifty-one sporulated oocysts measured 36–45 × 27–36 μ, with a mean of 40 × 32 μ; their length-width ratios averaged 1.25. Oocyst wall composed of two layers, the outer one rough, deep yellow, about 2.4 μ thick; the inner one colorless, 0.6 μ thick. Micropyle absent. Zero to five (mean, 1.5) oocyst polar granules present. Oocyst residuum absent. Sporocysts ovoid, with prominent Stieda body and sporocyst residuum. Twenty sporocysts measured 16–20 × 7–13 μ, with a mean of 19 × 11 μ. Sporozoites each with one terminal and one central clear globules.

Sporulation Time: Unknown.

Schizogony and Gametogony: Unknown.

Prepatent Period: Not more than 12 days.
Type Host: Tamiasciurus hudsonicus (red squirrel).
Location: Intestinal contents.
Geographic Distribution: North America (Wisconsin).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Dorney (1962) found this species in 6 per cent of 36 *T. hudsonicus* in northeastern Wisconsin.

Host Suborder SCIUROMORPHA
Host Superfamily SCIUROIDEA
Host Family SCIURIDAE
Host Subfamily SCIURINAE
Host Tribe XERINI

EIMERIA GARNHAMI McMILLAN, 1958

(Plate 3, Figs. 31–35; Plate 4, Figs. 36 and 37)

Eimeria garnhami McMillan, 1958: 20–23.

Description: Oocysts spherical to subspherical. Oocyst wall smooth, pink, 0.7 μ thick, composed of an outer thin layer and an internal thick one. Oocysts 14–19 × 13–18 μ, with a mean of 15.5 × 14.7 μ. Micropyle absent. McMillan (1958) stated, "There are numerous refractile bodies, 0.5 μ in diameter, arranged at the periphery in two layers. These peripheral bodies are probably left over after the wall of the oocyst is laid down from the refractile bodies of the macrogametocyte." In his figures, however, these "refractile bodies" are shown within the cytoplasm of the sporont and not in the sporulated oocyst. They are therefore actually plastic granules rather than polar bodies, and a true polar body is absent. Oocyst residuum absent. Sporocysts spherical, smooth, 6.5 μ in diameter. Sporocyst residuum present. Sporozoites 5.8 × 1.8 μ, curved, slightly tapered at one end, with a central nucleus.

Sporulation Time: Fourteen to sixteen days at 28–40C. No sporulation occurred at room temperature (21–22C).

Schizogony: Intracellular stages toward apex of host cell. Host cell nucleus seldom distorted. Mature schizonts with six to eight elongate, pointed merozoites measuring 7.5 × 1.2 μ.

Gametogony: Only early microgametocytes were seen. They measured up to 6.5 × 8.0 μ, but their multiple, rounded nuclei had not divided into microgametes. The macrogametes ("macrogametocytes") were spherical, 10.2 μ in diameter, with many spherical bodies 2.0 μ in diameter around the periphery.

Prepatent Period: Unknown.

Sporogony: Not described.

Type Host: Xerus (Euxerus) erythropus (African ground squirrel).

Location: Epithelial cells of villi of at least the proximal part of the small intestine.

Geographic Distribution: Africa (Katsina Province, Northern Nigeria).

Pathogenicity: McMillan (1958) observed neither signs of illness nor macroscopic or microscopic pathologic changes in the intestines of affected animals.

Cross-Transmission Studies: None.

Host Suborder SCIUROMORPHA

Host Superfamily SCIUROIDEA

Host Family SCIURIDAE

Host Subfamily SCIURINAE

Host Tribe MARMOTINI

EIMERIA MARMOTAE GALLI-VALERIO, 1923

Eimeria marmotae Galli-Valerio, 1923: 120–125; Bornand, 1937: 509–514.

Description: Oocysts ovoid with somewhat rounded ends, 51×42 μ, with a very distinct micropyle and containing a sporont 33 μ in diameter. Sporulated oocysts not described.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Marmota (syn., *Arctomys*) *marmota* (marmot).

Location: Intestine.

Geographic Distribution: Europe (Switzerland).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was described by Galli-Valerio (1923) from a single marmot. Bornand (1937) found it in two out of six *M. marmota* in Switzerland.

Remarks: Despite Galli-Valerio's sketchy description, this species can be differentiated from all others described from the genus *Marmota* by its large size. Bornand (1937) gave no further description.

EIMERIA ARCTOMYSI GALLI-VALERIO, 1931*

Eimeria arctomysi Galli-Valerio, 1931: 98–106.

Description: Oocysts cylindroid, 24×20 μ. Micropyle clearly visible and protruding a little. Sporont 16 μ in diameter. Sporulated oocysts not

* The genitive of *mys* is *myis*, not *mysi*. Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

described except to indicate that they contained four sporocysts each with two sporozoites.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Marmota (syn., *Arctomys*) *marmota* (marmot).

Location: Intestine.

Geographic Distribution: Europe (Switzerland).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

EIMERIA MONACIS FISH, 1930

(Plate 4, Figs. 38 and 39; Plate 33, Fig. 278)

Eimeria monacis Fish, 1930: 98–100; Iwanoff-Gobzem, 1934: 149–151.
Eimeria dura Crouch and Becker, 1931: 127–131.

Description: Oocysts spherical to subspherical, 17–23 × 15–21 μ, with a mean of 20.0 × 18.3 μ and a mean length-width ratio of 1.09, according to Fish (1930). Crouch and Becker (1931) reported that the oocysts were 14–20 μ in diameter. Oocyst wall smooth, colorless, composed of a single layer. Micropyle absent. Sporont fills unsporulated oocyst. Sporulated oocysts without polar granule but with rather small oocyst residuum. Sporocysts ovoid, with Stieda body and sporocyst residuum.

The form found by Iwanoff-Gobzem (1934) in *M. bobak* was ovoid, 17–21 × 13–18 μ, with a mean of 17.8 × 15.2 μ. An oocyst residuum was present. No other information was given.

Sporulation Time: Sixty to sixty-four hours at room temperature in 2% potassium dichromate solution according to Crouch and Becker (1931).

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Marmota monax (woodchuck).

Other Hosts: Marmota bobak (marmot).

Location: Intestine (found in feces and cecal contents).

Geographic Distribution: United States (Washington, D.C., Iowa); USSR (Kazakhstan).

Pathogenicity: Unknown. Hill (1952) reported that coccidiosis caused the death of a woodchuck (*M. monax*) in the London zoo, but did not describe the organism.

Cross-Transmission Studies: None.

Prevalence: Iwanoff-Gobzem (1934) reported this species from one out of two *M. bobak* in Kazakhstan.

Remarks: Crouch and Becker (1931) remarked that they had described this form in manuscript under the name *E. dura,* but that when Fish's (1930) description of *E. monacis* appeared they recognized that their form belonged to this species.

EIMERIA OS CROUCH AND BECKER, 1931

(Plate 34, Fig. 279)

Eimeria os Crouch and Becker, 1931: 127–131.

Description: Oocysts ovoid, 20–26 × 18–22 μ. Oocyst wall smooth, colorless, composed of a single layer. Micropyle distinct; sometimes the membrane lining the oocyst wall protrudes through the micropyle, forming a bulblike swelling. Sporulated oocysts without either polar granule or oocyst residuum. Sporocysts ovoid to ellipsoidal, with small Stieda body and sporocyst residuum, 9–13 by 5–8 μ.

Sporulation Time: Ninety to one hundred and five hours in 2% potassium bichromate.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Marmota monax (woodchuck).

Location: Intestine (found in feces and cecal contents).

Geographic Distribution: United States (Iowa).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

EIMERIA PERFOROIDES CROUCH AND BECKER, 1931

(Plate 34, Fig. 280)

Eimeria perforoides Crouch and Becker, 1931: 127–131.

Description: Oocysts ellipsoidal, 17–24 × 15–20 μ. Oocyst wall smooth, colorless, composed of a single layer. Micropyle absent. Sporont considerably contracted from oocyst wall even in fresh material. Sporulated oocysts without polar granule but with a small oocyst residuum. Sporocysts with Stieda body and sporocyst residuum, approximately 10 × 4 μ.

Sporulation Time: Seventy hours in 2% potassium bichromate solution at room temperature.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Marmota monax (woodchuck).

Location: Intestine (found in feces and cecal contents).

Geographic Distribution: United States (Iowa).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

EIMERIA CYNOMYSIS ANDREWS, 1928 *

(Plate 4, Fig. 40)

Eimeria cynomysis Andrews, 1928: 193–194.

Eimeria cynomysi [*sic*] *Ibid.*

* The genitive of *mys* is *myis,* not *mysis.* Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

Description: Oocysts broadly ellipsoidal, 33–37 × 28–32 μ, with a mean of 35.4–30.0 μ and a mean length-width ratio of 1.18. Oocyst wall 1.5–2.5 μ thick, composed of two layers, the outer one transparent, with a fibrous appearance and a very irregular outer surface, the inner layer faint orange-yellow. Micropyle 5–6 μ in diameter. Oocyst residuum absent. No oocyst polar granule mentioned or illustrated. Sporocysts seed-shaped, 13–17 × 8–12 μ, with an inconspicuous Stieda body. Sporocyst residuum coarsely granular. Sporozoites attenuated reniform, blunt at both ends, but with one end a trifle larger than the other.

Sporulation Time: Three to four days in moist feces at room temperature.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Cynomys ludovicianus (prairie dog).

Location: Intestine (found in feces).

Geographic Distribution: United States (in prairie dogs from an animal supply house in Ohio).

Pathogenicity: Unknown.

Cross-Transmission Studies: Andrews (1927) reported that *Eimeria* sp. (presumably *E. cynomysis)* from the prairie dog could not be transmitted to the cat.

Prevalence: This species was found in both of the two animals examined.

EIMERIA CITELLI KARTCHNER AND BECKER, 1930

(Plate 4, Figs. 41–44; Plate 5, Figs. 46–48; Plate 35, Fig. 291)

Eimeria citelli Kartchner and Becker, 1930: 90–94; Sassuchin and Rauschenbach, 1932: 646–650; Zasukhin and Tiflov, 1932: 129–132; Zasukhin and Tiflov, 1933: 437–442; Yakimoff and Sokoloff, 1935 (1934): 331–334; Zolotarev, 1938: 658–661; Pellérdy and Babos, 1953: 167–172; Ryšavý, 1957: 331–336; Svanbaev, 1962: 23–39.

Description: Oocysts subspherical, ellipsoidal, or ovoid, 15–33 × 14–19 μ, with a mean of 18.8 × 15.8 μ. The oocysts described by Sassuchin and Rauschenbach (1932) from *Spermophilus* (syn., *Citellus) pygmaeus* measured 17.4–26.1 × 14.5–19.6 μ, with a mean of 21.1 × 17.2 μ; the ovoid forms described by Yakimoff and Sokoloff (1934) from *S. pygmaeus* measured 17.0–21.6 × 14.4–18 μ, with a mean of 19.2 × 16.8 μ; the round forms described by Yakimoff and Sokoloff (1935) from the same host measured 14.4–23.4 μ, with a mean of 16.9 μ; the ovoid forms described by Zolotareff (1938) from *S. pygmaeus* measured 15–24 × 13–21 μ, with a mean of 19.2 × 16.2 μ; the round forms described by him from the same host measured 15–21 μ, with a mean of 17.1 μ; those described by Pellérdy

and Babos (1953) from *S. citellus* measured 15.0–22.9 × 14.0–20.3 μ; and the nonspherical ones described by Ryšavý (1957) from *S. citellus* measured 17–23 × 13–19 μ, with a mean of 20 × 16 μ, while the spherical ones were 13–19 μ in diameter, with a mean of 17 μ. Oocyst wall smooth, colorless, composed of an intermediate thick layer and thin endo- and ecto-membranes. Micropyle absent. Freshly sporulated oocysts contain an oocyst residuum which becomes inconspicuous within three or four days. Oocyst polar granule absent. Sporocysts 5–9 × 4–7 μ, with a small Stieda body. Sporocyst residuum present. Sporozoites 5–7.5 × 1.8–3.3 μ, with a large refractile globule at the broader, more rounded end.

Sporulation Time: Three days in 4% potassium bichromate.

Schizogony: Kartchner and Becker (1930) observed schizogony in *S. tridecemlineatus,* but did not describe it. In *S. citellus,* Pellérdy and Babos (1953) reported that the schizonts lie above the host cell nuclei. The mature schizonts are round or subspherical, 10–13 μ in diameter, and contain six to eight falciform merozoites with a central nucleus. The free merozoites measure 4–6 × 1.3–1.5 μ.

Gametogony: Although Kartchner and Becker (1930) did not describe gametogony in *S. tridecemlineatus,* they stated that the gametocytes usually lie above the host cell nucleus, but may be either below it or to the side. According to Pellérdy and Babos (1953), the mature macrogametes from *S. citellus* are oval, 16 × 11 μ, and have a row of eosinophilic granules around their periphery which later coalesce. The microgametocytes are not numerous. They are round or elliptical, and measure 12 × 9 μ. Each microgametocyte produces 50 to 70 microgametes measuring 2–3 × 0.3 μ; no flagella were seen.

Prepatent Period: Four to five days.

Type Host: Spermophilus (syn., *Citellus) tridecemlineatus* (thirteen-striped ground squirrel).

Other Hosts: Spermophilus (syn., *Citellus) pygmaeus, S. citellus, S. maximus* (ground squirrels).

Location: Kartchner and Becker (1930) stated that the parasitic stages occur in the mucosa of the cecum of *S. tridecemlineatus.* Pellérdy and Babos (1953) on the other hand, stated that while gametogony occurs sporadically in epithelial cells of the cecum and colon, the small intestine, and particularly the jejunum and ileum, is the most common site of infection in *S. citellus.*

Geographic Distribution: North America (Iowa), USSR (Kazakhstan, RSFSR, Saratoff, Krim, Daghestan), Europe (Hungary, Czechoslovakia).

Pathogenicity: Although Kartchner and Becker (1930) observed no unfavorable effects in natural and heavy experimental infections of *S. tridecemlineatus,* Pellérdy and Babos (1953) observed catarrhal enteritis

of the small intestine and in some cases of the large intestine in experimentally infected *S. citellus,* and noted diarrhea and inappetance in one animal and death in another. Zolotareff (1938), too, considered intestinal coccidiosis to be a cause of death in *S. pygmaeus.*

Cross-Transmission Studies: Kartchner and Becker (1930) were unable to infect white rats and mice with *E. citelli* from *S. tridecemlineatus.*

Prevalence: Kartchner and Becker (1930) found this species in 20.5 per cent of 78 *S. tridecemlineatus* in Iowa. Zasukhin and Tiflov (1932, 1933) reported that it was common in *S. pygmaeus* in southeastern RSFSR. Svanbaev (1962) found this species in 5 per cent of 43 *S. maximus* in southern Kazakhstan, USSR.

EIMERIA BEECHEYI HENRY, 1932

(Plate 33, Fig. 277)

Eimeria beecheyi Henry, 1932a: 279–290.
[*non*] *Eimeria beecheyi:* Tanabe and Okinami, 1940: 126–134 (see *E. asiatici*).

Description: Oocysts ovoid, 16–22 × 10–13 μ, with a mean of 19.2 × 16.0 μ. Oocyst wall smooth, colorless, composed of a single layer 1 μ thick. Micropyle absent. Oocyst polar granule present. Oocyst residuum absent. Sporocyst residuum absent.

Sporulation Time: Four to five days in 2% potassium bichromate.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Spermophilus (syn., *Citellus) beecheyi* (ground squirrel).

Location: Intestine. The oocysts were found in the contents of the cecum and large intestine.

Geographic Distribution: United States (California).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was described from two ground squirrels from Lake County and the vicinity of Nevada City, California.

Remarks: Tanabe and Okinami (1940) described an *Eimeria* from *Eutamias asiaticus* in Japan under the name *Eimeria beecheyi,* but its oocysts contained sporocyst residua, while those of *E. beecheyi* do not, and the difference in host also suggests that the two species are different. We are therefore assigning it the new name, *Eimeria asiatici* (see below).

EIMERIA BILAMELLATA HENRY, 1932

(Plate 5, Fig. 49; Plate 34, Figs. 285 and 286; Plate 35, Fig. 287)

Eimeria bilamellata Henry, 1932a: 279–290; Pellérdy and Babos, 1953: 167–172.
Eimeria eubeckeri Hall and Knipling, 1935: 128–129; Ryšavý, 1957: 331–336.

Description: Since this coccidium has been described from three different hosts, separate descriptions are given for each host. In the form

described by Henry (1932a) from *Spermophilus lateralis,* the oocysts are ovoid, 25–36×22–26 μ, with a mean of 32.0×25.6 μ. Oocyst wall composed of two layers: the outer one brown, thick, and rough; and the inner one clear, thin, and smooth. Micropyle present; oocyst wall thinner at the micropylar end. Sporulation time, less than ten days. Sporulated oocysts without oocyst residuum. Sporocysts 16.0×9.6 μ, with two sporozoites and a large amount of residual material.

In the form described by Pellérdy and Babos (1953) from *S. citellus,* the oocysts measure 30–41×22–28 μ, and have an oocyst polar granule but no oocyst residuum. Their sporulation time was seven to eight days. Pellérdy and Babos (1953) gave no further description of the oocysts, since they agreed with Henry's description.

In the form described by Ryšavý (1957) from *S. citellus,* the oocysts were said to measure 34.2 [*sic*]–38×25–27 μ, with a mean of 33.6 [*sic*]×26 μ; the majority were 30×27 μ. They were broadly ovoid with a rough, strong, brownish yellow wall, with a prominent micropyle 6 μ in diameter, without an oocyst residuum, with ovoid sporocysts 13×9.5 μ, and with a coarsely granular sporocyst residuum. Their sporulation time was 92 hours at 24C.

In the form described by Hall and Knipling (1935) from *S. franklinii,* the oocysts measure 28–40×21–32 μ, with a mean of 33.7×23.8 μ. They are ovoid, with a thick wall composed of two layers, the outer one very rough and brown, and the inner one smooth and pinkish. A pronounced micropyle is present. The sporulation time in 4% potassium bichromate was 10 to 11 days. Oocyst polar granule and oocyst residuum absent. Sporocyst Stieda body and a large sporocyst residuum present.

Sporulation Time: See above.

Schizogony and Gametogony: Unknown.

Prepatent Period: Pellérdy and Babos (1953) found this to be eight days in *S. citellus.*

Type Host: Spermophilus (syn., *Citellus) lateralis* (syn., *Callospermophilus chrysodeirus)* (golden-mantled ground squirrel).

Other Hosts: Spermophilus (syn., *Citellus) citellus* (ground squirrel); *S. franklinii* (Franklin ground squirrel).

Location: This species was found by Henry (1932a) in the feces of *S. lateralis.* It was found by Pellérdy and Babos (1953) in the small intestine, and particularly in the jejunum and ileum of *S. citellus,* and by Hall and Knipling (1935) in the cecum and large intestine of *S. franklinii.*

Geographic Distribution: United States (California, Iowa), Europe (Hungary, Czechoslovakia).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Remarks: This species was found by Henry (1932a) in two *S. lateralis* from Placer County, California, and by Hall and Knipling (1935) from a single *S. franklinii* in Iowa. The latter authors named their form *Eimeria eubeckeri,* but on the basis of the published descriptions and illustrations, it is morphologically indistinguishable from *E. bilamellata* and has approximately the same sporulation time. Hall and Knipling made no mention of Henry's paper, and were presumably unaware of it. Cross-transmission studies would be necessary to prove whether the forms from the three hosts are identical, but in the absence of any other differentiating characters, it is preferable to assign them to the same species.

EIMERIA CALLOSPERMOPHILI HENRY, 1932

(Plate 6, Fig. 54; Plate 34, Figs. 281 and 282)

Eimeria callospermophili Henry, 1932a: 279–290; Levine, Ivens, and Kruidenier, 1958: 291–298.

Eimeria callosphermophili [*sic*]: Svanbaev, 1962: 23–39 (in *Spermophilus maximus*).

[*non*] *Eimeria callosphermophili* [*sic*]: *Ibid.* (in *Meriones tamariscinus*) (see *E. assaensis*).

Description: According to Henry's (1932a) original description of this species from the type host, the oocysts are subspherical, 16.0–22.4 × 16.0–22.4 μ, with a mean of 19.2 × 16.0 μ. Oocyst wall slightly rough and yellowish, probably composed of two layers. Micropyle absent, sporont almost filling the unsporulated oocyst. Oocyst polar granule present. Oocyst residuum large, homogeneous, and clear or granular, 3–5 μ in diameter. Sporocysts almost round, pointed at one end, 10.2 × 8.5 μ, containing two sporozoites and a few residual granules.

In the form described by Levine, Ivens, and Kruidenier (1958) from *Spermophilus* (syn., *Citellus*) *spilosoma spilosoma* the oocysts are spherical to subspherical, 15–27 × 14–25 μ, with a mean of 20.1 × 19.0 μ; length-width ratios range from 1.0–1.1, with a mean of 1.06. Oocyst wall colorless to pale yellowish, slightly rough and pitted, composed of a single layer about 1.1 μ thick. Micropyle absent. Sporocysts lemon-shaped, about 9 × 7 μ, with Stieda body. Oocyst polar granule present. Oocyst residuum composed of several large, homogeneous bodies. Sporocyst residuum absent or composed of 1 to 15 or more round granules. Sporozoites often at the ends of the sporocysts but sometimes lying lengthwise in them.

Levine, Ivens, and Kruidenier (1958) also found oocysts which contained only two sporocysts each with two sporozoites and thus resembled *Cyclospora,* but they resembled *E. callospermophili* in all other characteristics. In addition, abnormal oocysts of other types were present; these included oocysts with three normal sporocysts, with two normal and one giant sporocyst, or with one, two, three, or four imperfectly

developed sporocysts. They therefore concluded that the *Cyclospora*-like forms were actually abnormal *E. callospermophili.*

Sporulation Time: Six to seven days in 2% potassium dichromate.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Spermophilus (syn., *Citellus) lateralis* (syn., *Callospermophilus chrysodeirus)* (ground squirrel).

Other Hosts: Spermophilus (syn., *Citellus) spilosoma spilosoma* (spotted ground squirrel), *Spermophilus* (syn., *Citellus) maximus* (suslik).

Location: Intestine. Henry (1932a) found the oocyst in the intestinal contents, particularly those of the cecum. Levine, Ivens, and Kruidenier (1958) found the oocysts in the intestinal contents.

Geographic Distribution: United States (California) (type host); Mexico (Aguascalientes) (*S. spilosoma);* USSR (Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1962) found this species in 14 per cent of 43 *S. maximus* in southern Kazakhstan.

Remarks: This species was first described from *S. lateralis* in Placer County, California. The form described by Levine, Ivens, and Kruidenier (1958) from *S. spilosoma* in Mexico differs from it somewhat. Its oocyst wall is composed of a single layer, while that of the form from *S. lateralis* was said to be "probably" composed of two layers, although they could not be separated. There is obviously an error in the figures for oocyst width given by Henry (1932a), but whether it is the range or the mean which is wrong cannot be determined. The sporocysts of the form from *S. lateralis* are somewhat larger than those from *S. spilosoma.* Finally, Henry's (1932a) description makes no mention of the Stieda body or of the position of the sporozoites in the sporocysts, and these cannot be determined from her photomicrographs. However, in the absence of a more detailed description of the form from the original host species, these differences do not appear to warrant the creation of a new species for the form from *S. spilosoma.*

Svanbaev (1962) described a coccidium under the name *E. callospher-mophili* [*sic*] from *Meriones tamariscinus.* It does not belong to this species, and we have assigned it the name *E. assaensis* (p. 90).

EIMERIA VOLGENSIS SASSUCHIN AND RAUSCHENBACH, 1932

(Plate 5, Fig. 50; Plate 34, Figs. 283 and 284)

Eimeria volgensis Sassuchin and Rauschenbach, 1932: 646–650; Zolotareff, 1938: 658–661; Zasukhin and Tiflov, 1932: 129–132; Zasukhin and Tiflov, 1933: 437–442.

[*non*] *Eimeria volgensis:* Svanbaev, 1956: 180–191 (see *E. kazakhstanensis*).

Description: Oocyst ovoid, sometimes with a sharply pointed end, 23–32 × 17–28 μ, with a mean of 27.2 × 21.9 μ. The oocysts measured by Zolotareff (1938) were 18–24 × 15–20 μ, with a mean of 21.2 × 16.4 μ. Oocyst wall smooth, clear, colorless or greenish, composed of two layers, 1.2 μ thick, becoming thinner at the micropylar end. Micropyle present, sometimes sharply pointed. If the micropyle is flat, it is 4–6 μ in diameter. Sassuchin and Rauschenbach (1932) saw no sporulated oocysts; the following description is taken from Zolotareff (1938). Oocyst residuum absent. Sporocysts pear-shaped, 9–12 × 4–6 μ. Sporocyst residuum present.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Spermophilus (syn., *Citellus) pygmaeus* (ground squirrel).

Location: Intestine.

Geographic Distribution: USSR (western Kazakhstan, RSFSR, Daghestan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Sassuchin and Rauschenbach (1932) found this species in 1 out of 242 rodents (most of which were *S. pygmaeus)* examined in western Kazakhstan. Zasukhin and Tiflov (1932, 1933) reported that this species was common in *S. pygmaeus* in southeastern RSFSR.

Remarks: Even though the form described by Zolotareff (1938) was smaller than that originally described by Sassuchin and Rauschenbach (1932), Zolotareff considered it to be the same species. Since the original authors saw no sporulated oocysts, their morphology cannot be compared, but the sharply pointed micropylar end of both forms and their occurrence in the same host and the same country tend to confirm Zolotareff's view.

Svanbaev (1956) described an *Eimeria* from the mole lemming, *Ellobius talpinus,* under the name *E. volgensis.* However, for the reasons given below, we do not consider it to belong to this species and have assigned it the name *E. kazakhstanensis* (p. 86).

EIMERIA BECKERI YAKIMOFF AND SOKOLOFF, 1935

(Plate 36, Fig. 292)

Eimeria beckeri Yakimoff and Sokoloff, 1935: 331–334; Zolotareff, 1938: 658–661; Svanbaev, 1956: 180–191 (in *Spermophilus pygmaeus*); Svanbaev, 1962: 23–29.

Eimeria ussuriensis Yakimoff and Sprinholtz-Schmidt, 1939: 117–123.

[*non*] *Eimeria beckeri:* Svanbaev, 1956: 180–191 (in *Ellobius talpinus*) (see *E. talpini*).

Description: Oocyst usually ovoid, sometimes spherical. Ovoid forms 18–24 × 15–23 μ, round forms 16–24 μ in diameter. The oocysts found by

Svanbaev (1956) in *Spermophilus pygmaeus* in Kazakhstan measured 22–28 × 19–24 μ, with a mean of 25.5 × 21.0 μ. Oocyst length-width ratio 1.1–1.4, with a mean of 1.20. Oocyst wall yellow, smooth, composed of two layers. Micropyle absent. Sporont almost fills unsporulated oocysts. Sporulation time unknown. Oocyst polar granule and oocyst residuum absent. Sporocysts ovoid, seldom piriform, 8–12 × 4–7 μ, without Stieda body, but with a sporocyst residuum about 4 μ in diameter.

The oocysts of the form described from *Spermophilus eversmanni* by Yakimoff and Sprinholtz-Schmidt (1939) under the name *Eimeria ussuriensis* were mostly ovoid and oval, but some were spherical or subspherical. The ovoid oocysts measured 22–24 × 18–20 μ, with a mean of 22.6 × 19.5 μ; the oval oocysts measured 21–28 × 18–23 μ, with a mean of 23.4 × 20.0 μ; the subspherical oocysts measured 21–25 × 19–22 μ, with a mean of 22.9 × 20.3 μ; the spherical oocysts measured 18–25 μ in diameter, with a mean of 22.1 μ. Oocyst wall yellow, composed of a single layer 1.2 μ thick. Micropyle absent. Oocyst polar granule and oocyst residuum absent. The authors stated that they did not know whether there was a sporocyst residuum.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Spermophilus (syn., *Citellus) pygmaeus* (ground squirrel).

Other Hosts: Spermophilus eversmanni (ground squirrel), *Spermophilus* (syn., *Citellus*) *maximus* (suslik).

Location: Intestine (oocysts found in feces).

Geographic Distribution: USSR (Crimea; Daghestan; Kazakhstan; Ussuri; Far Eastern Siberia).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: According to Zolotareff (1938), this species is widely distributed in ground squirrels in Daghestan. Svanbaev (1956) found it in 58 per cent of 19 *S. pygmaeus* in western Kazakhstan. Svanbaev (1962) found it in 9 per cent of 43 *S. maximus* in southern Kazakhstan.

Remarks: In their description of *E. ussuriensis,* Yakimoff and Sprinholtz-Schmidt (1939) stated that it resembled *E. beckeri* but could be distinguished from it by its larger dimensions, which reached 32.4 × 27.0 μ. However, this was the size of a single oocyst, and it was so exceptional that it was not even included in the series of ranges they listed. These ranges were similar to that of *E. beckeri.* Thus, there is no valid reason for considering this form a separate species on the basis of present evidence.

Svanbaev (1956) described an *Eimeria* from the mole lemming, *Ellobius talpinus,* under the name *E. beckeri.* However, for the reasons given

below, we do not consider it to belong to this species and have assigned it the name *E. talpini* (p. 86).

EIMERIA FRANKLINII HALL AND KNIPLING, 1935

(Plate 5, Fig. 51)

Eimeria franklinii Hall and Knipling, 1935: 128–129.

Description: Oocysts subspherical to ovoid, 19–24 × 13–18 μ, with a mean of 20.6 × 15.2 μ. Oocyst wall smooth, colorless, transparent, composed of two layers. Micropyle absent. Sporulated oocysts with two polar granules and an oocyst residuum. Oocyst residuum decreases in size with age. Sporocysts ellipsoidal to subovoid, 11.5 × 6 μ, with Stieda body. Sporocyst residuum present.

Sporulation Time: Three to four days at room temperature in potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Spermophilus (syn., *Citellus) franklinii* (Franklin ground squirrel).

Location: Intestine. Oocysts were found in the contents of the small intestine, cecum, and colon.

Geographic Distribution: United States (Iowa).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was described from a single ground squirrel at Ames, Iowa.

EIMERIA LATERALIS LEVINE, IVENS, AND KRUIDENIER, 1957

(Plate 6, Fig. 58)

Eimeria lateralis Levine, Ivens, and Kruidenier, 1957: 80–88.

Description: Oocysts ellipsoidal to somewhat ovoid. Fifty-nine oocysts measured 28–40 × 24–31 μ, with a mean of 35.1 × 26.8 μ; their length-width ratios ranged from 1.0–1.5, with a mean of 1.25. Oocyst wall 2 μ thick, yellowish brown, rough, pitted like a thimble, and composed of a single layer. A thin membrane lines the oocyst wall, making its inner margin appear heavier than its outer one. Micropyle absent. No completely sporulated oocysts were observed. The great majority contained a single cell, and most of those which had developed had done so abnormally and contained two, three, or sometimes four rounded or irregularly shaped bodies. Some oocysts, however, contained four sporocysts measuring about 16 × 10 μ, a granular oocyst residuum, and one or more polar granules. Sporocysts, with prominent Stieda body, were filled

with round residual granules and a few clear spherules. No definite sporozoites were observed.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Spermophilus (syn., *Citellus) lateralis* (mantled ground squirrel).

Location: Intestinal contents.

Geographic Distribution: United States (Grand Canyon National Park, Arizona).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

EIMERIA HOFFMEISTERI LEVINE, IVENS, AND KRUIDENIER, 1958

(Plate 5, Figs. 52 and 53)

Eimeria hoffmeisteri Levine, Ivens, and Kruidenier, 1958: 291–298; Ivens, Kruidenier, and Levine, 1959: 53–57.

Description: Oocysts subspherical. Oocyst wall colorless to pale yellowish, smooth, composed of a single layer about 1.0 μ thick. Micropyle absent. Seven sporulated oocysts measured 15–20 × 13–18 μ, with a mean of 17.7 × 16.1 μ. Their length-width ratios ranged from 1.0–1.2, with a mean of 1.10. Sporocysts elongate ovoid, about 11.5 × 6.0 μ; Stieda body absent or inconspicuous. Oocyst polar granule present. Oocyst residuum absent or composed of a few homogeneous bodies. Sporocyst residuum composed of a large amount of finely granular material. Sporozoites either at the ends of the sporocysts or lying somewhat longitudinally.

Twenty-nine sporulated oocysts measured by Ivens, Kruidenier, and Levine (1959) from a *Spermophilus spilosoma* from Chihuahua, Mexico, measured 17–23 × 16–19 μ, with a mean of 19.9 × 17.2 μ. Their length-width ratios ranged from 1.0–1.3, with a mean of 1.14. Very slight differences were noted in the appearance of the sporocyst residual material and Stieda body between these oocysts and those in the original host.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Spermophilus (syn., *Citellus) s. spilosoma* (spotted ground squirrel).

Location: Intestinal contents.

Geographic Distribution: Mexico. The original host was trapped near Rincon de Romos, Aguascalientes. The same species was later found by Ivens, Kruidenier, and Levine (1959) in a *S. spilosoma* from Barenda, Chihuahua.

Pathogenicity: Unknown.
Cross-Transmission Studies: None.

EIMERIA SUSLIKI N. SP.

Eimeria ussuriensis Yakimoff and Sprinholtz-Schmidt. Svanbaev, 1962: 23–29.
[*non*] *Eimeria ussuriensis* Yakimoff and Sprinholtz-Schmidt, 1939: 117–123 (see *E. beckeri*).

Description: Oocyst ellipsoidal or elongate ellipsoidal, 29–35 × 23–26 μ, with a mean of 32 × 25 μ. Oocyst length-width ratio 1.2–1.4, with a mean of 1.3. Oocyst wall smooth, 1.0–1.2 μ thick, greenish, lilac, or yellow-brown. Micropyle absent. Oocyst polar granule and residuum absent. Sporocysts ellipsoidal or short ellipsoidal, 9–13 × 7–10 μ, with a mean of 10 × 9 μ. Sporocyst residuum absent. Sporozoites comma-shaped, 6–9 × 3–5 μ, with a mean of 8 × 4 μ.

Sporulation Time: Unknown.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Spermophilus (syn., *Citellus) maximus* (suslik).
Location: Oocysts found in feces.
Geographic Distribution: USSR (southern Kazakhstan).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Svanbaev (1962) found this species in 5 per cent of 43 *S. maximus* in southern Kazakhstan.
Remarks: Svanbaev (1962) called this form *Eimeria ussuriensis.* However, *E. ussuriensis* is a synonym of *E. beckeri,* and the form that Svanbaev found resembles neither the original description of *E. beckeri,* nor Yakimoff and Sprinholtz-Schmidt's (1939) description of *E. ussuriensis,* nor the description of any other species of *Eimeria* heretofore reported from *Spermophilus.* Hence, it is necessary to give it a new name, and we are therefore calling it *Eimeria susliki* n. sp.

EIMERIA SP. LEVINE, IVENS, AND KRUIDENIER, 1957

Eimeria sp. Levine, Ivens, and Kruidenier, 1957: 80–88.

Description: Oocysts broadly ovoid to ellipsoid. A single oocyst measured 19 × 17 μ, with a length-width ratio of 1.1. Oocyst wall smooth, pale tan, 0.9 μ thick, composed of a single layer. Micropyle absent. Sporulated oocysts with a polar granule. Oocyst residuum consists of a large globule resembling an oil droplet. Sporocysts ellipsoidal, without Stieda body, with a good deal of residual material between the sporozoites.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.

Type Host: Spermophilus (syn., *Citellus) lateralis* (mantled ground squirrel).

Location: Intestinal contents.

Geographic Distribution: United States (Grand Canyon National Park, Arizona).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Remarks: Only three oocysts were found in the intestinal contents of the host ground squirrel. The oocysts differed from those of all other coccidia described from *Spermophilus* and other rodents of the tribe Marmotini. They resembled those of *Eimeria beckeri,* but differed from them in having an oocyst polar granule and a single-layered rather than a double-layered wall. However, in view of the paucity of material available, the designation of this form as a new species does not seem warranted.

EIMERIA (?) SP. LEVINE, 1952

Eimeria (?) sp. Levine, 1952(1951): 205–208.

Description: Unsporulated oocysts 19–21 × 21–25 μ, with a mean of 20.4 × 23.3 μ; length-width ratio 1.1–1.2, with a mean of 1.1. Oocyst wall smooth, composed of two layers, the inner one dark yellowish and the outer colorless. Micropyle absent. No sporulated oocysts were seen.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Spermophilus (syn., *Citellus) parryii* (Parry's ground squirrel).

Location: Feces.

Geographic Distribution: Canada (Arctic coast of Canadian Northwest Territories).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This form was found in five of seven *S. parryii.*

Remarks: Since no sporulated oocysts were seen, it is impossible to assign this form a specific name or even to be positive of its genus. However, it closely resembles *Eimeria beckeri* and may even belong to this species.

EIMERIA VILASI DORNEY, 1962

(Plate 6, Fig. 55)

Eimeria vilasi Dorney, 1962: 258–261.

Description: Oocysts subspherical, occasionally ellipsoidal or ovoid. Two hundred sporulated oocysts measured 11–23 × 7–19 μ, with a mean

of 18×14 μ; their mean length-width ratio was 1.23. Oocyst wall composed of two layers: the outer one smooth, yellow-green, 0.7 μ thick; the inner one dark tan, 0.3 μ thick. (Dorney said that the total thickness was 0.7–1.3 μ.) Micropyle absent. Zero to six (mean, 1.5) oocyst polar granules present. Oocyst residuum absent. Sporocysts ellipsoidal (illustrated as elongate ovoid); 25 sporocysts averaged 10×6 μ. Stieda body small. Sporocyst residuum present. Sporozoites side by side in sporocysts, with a clear globule at larger end.

Sporulation Time: Three to seven days at room temperature in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Tamias striatus (eastern chipmunk).

Location: Primarily posterior quarter of small intestine (ileum).

Geographic Distribution: North America (Wisconsin).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Dorney (1962) found this species in 99 per cent of 84 *T. striatus* in Vilas County, northeastern Wisconsin, and in south central Wisconsin.

EIMERIA WISCONSINENSIS DORNEY, 1962

(Plate 6, Fig. 56)

Eimeria wisconsinensis Dorney, 1962: 258–261.

Description: Oocysts ellipsoidal. Fifty sporulated oocysts measured 26–35×20–27 μ, with a mean of 31×24 μ; their mean length-width ratio was 1.27. Oocyst wall composed of two layers: the outer one rough, yellow-tan, and 1.4–1.5 μ thick; and the inner one colorless to pale pink and 0.3–0.4 μ thick. Micropyle absent. One or rarely two oocyst polar granules present. Oocyst residuum absent. Sporocysts lemon-shaped; eight sporocysts measured 14–16×9–10 μ, with a mean of 15×9 μ. Stieda body prominent. Sporocyst residuum present, spread among and over sporozoites.

Sporulation Time: Two to four weeks at room temperature in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Tamias striatus (eastern chipmunk).

Location: Middle part of small intestine.

Geographic Distribution: North America (Wisconsin).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Dorney (1962) found this species in 14 per cent of 84 *T. striatus* in Wisconsin.

EIMERIA EUTAMIAE LEVINE, IVENS, AND KRUIDENIER, 1957

(Plate 7, Fig. 59)

Eimeria eutamiae Levine, Ivens, and Kruidenier, 1957: 80–88.

Description: Oocysts ovoid. Sixty sporulated oocysts measured 24–30 × 19–23 μ, with a mean of 27.3 × 21.4 μ. Their length-width ratios ranged from 1.1–1.4, with a mean of 1.27. Oocyst wall smooth, composed of a very pale tan inner layer 0.4 μ thick and a colorless outer layer 1.0 μ thick. The inner layer disappears at the small end of the oocyst. Micropyle absent. Sporulated oocysts with a polar granule which usually lies among the sporocysts. Oocyst residuum absent. Sporocysts lemon-shaped, about 11 × 8 μ, with a fairly thick transparent wall. Stieda body and sporocyst residuum present. Most sporocysts seem to lie with their long axes perpendicular to the long axis of the oocyst, so that they are usually seen end on.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Eutamias dorsalis (cliff chipmunk).

Location: Intestinal contents.

Geographic Distribution: United States (Arizona).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in one of two *E. dorsalis* in the Grand Canyon National Park, Arizona.

EIMERIA ASIATICI N. SP.

Eimeria beecheyi Henry. Tanabe and Okinami, 1940: 126–134.

Description: Oocysts described as ovoid, but illustrated in the photomicrographs as ellipsoidal, 15–22 × 10–12 μ, according to Tanabe and Okinami (but the two oocysts illustrated in their photomicrographs were broader, measuring 17–19 × 14–15 μ, if their stated magnification is correct). Oocyst wall colorless, composed of two layers, the outer one thick and the inner one thin. Micropyle absent. Oocyst residuum absent. Sporocyst residuum present, spherical.

Sporulation Time: Three to four days.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Eutamias asiaticus (Asiatic chipmunk).

Location: Cecal contents.

Geographical Distribution: Japan (Keizyo).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was described from two out of 24 *E. asiaticus.*

Remarks: This species was reported by Tanabe and Okinami (1940) under the name *Eimeria beecheyi,* but it differs from that species in having a sporocyst residuum and also in occurring in *Eutamias* instead of *Spermophilus.* The only other species of *Eimeria* reported from *Eutamias* is *E. eutamiae* Levine, Ivens, and Kruidenier, 1957, from *Eutamias dorsalis* in the United States. The form from *E. asiaticus* is much smaller than this and is more ellipsoidal. Tanabe and Okinami's (1940) description is not complete enough to know whether there are other differentiating characters, but the oocysts in their photomicrographs do not resemble those of *E. eutamiae.*

Fifteen other species of *Eimeria* have been described from rodents of the tribe Marmotini. Five are from *Marmota,* one from *Cynomys,* and nine from *Spermophilus.* The form from *Eutamias asiaticus* differs from *E. bilamellata, E. volgensis, E. cynomysis, E. marmotae, E. arctomysi,* and *E. os,* among other characters, in lacking a micropyle. It differs from *E. lateralis, E. callospermophili, E. citelli, E. franklinii, E. monacis,* and *E. perforoides,* among other characters, in lacking an oocyst residuum. It differs from *E. hoffmeisteri* in having a two-layered wall and more elongate oocysts. It resembles *E. beckeri* more than any other species, but differs from it in having a colorless wall and more elongate oocysts. In view of these differences in morphology and host genus, it is considered best to assign the form from *E. asiaticus* to a new species, *Eimeria asiatici* n. sp.

Host Suborder SCIUROMORPHA

Host Superfamily SCIUROIDEA

Host Family SCIURIDAE

Host Subfamily PETAURISTINAE

EIMERIA GLAUCOMYDIS ROUDABUSH, 1937 *

(Plate 4, Fig. 45)

Eimeria glaucomydis Roudabush, 1937: 107–108.

Description: Oocysts ellipsoidal, 18.5–12.3 × 13.2–10.6 μ, with a mean of 16.2 × 11.5 μ. Oocyst wall smooth, number of layers not stated. Micropyle absent. Oocyst residuum absent. Oocyst polar granule not figured, presumably absent. Sporocysts ellipsoidal, without Stieda body. Sporocyst residuum present.

* The genitive of *mys* is *myis,* not *mydis.* Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

Sporulation Time: Slightly less than 20 hours.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Glaucomys volans (=volens) (flying squirrel).
Location: Intestine.
Geographic Distribution: United States (Iowa).
Pathogenicity: Unknown.

EIMERIA PARASCIURORUM BOND AND BOVEE, 1957

(Plate 6, Fig. 57; Plate 7, Figs. 61–65)

Eimeria parasciurorum Bond and Bovee, 1957: 225–229.
Eimeria sciurorum Galli-Valerio. Roudabush, 1937a: 107–108.
[*non*] *Eimeria sciurorum* Galli-Valerio, 1922: 344–347.

Description: Oocysts cylindrical, usually rounded at the ends but sometimes truncate. Fifty sporulated oocysts measured by Bond and Bovee (1957) in Florida were 22–36 × 12–20 μ, with a mean of 29.0 × 16.0 μ and a mean length-width ratio of 1.82. The oocysts measured by Roudabush (1937) in Iowa were 18–29 × 12–18 μ, with a mean of 23.8 × 13.7 μ. Oocyst wall smooth, light yellow-brown (according to Bond and Bovee) and 0.4–0.6 μ thick. Bond and Bovee stated that there is a dual membrane but illustrated the wall as composed of a single layer. Roudabush illustrated it similarly, but did not state the number of layers present. Micropyle absent. Oocyst polar granule and oocyst residuum absent. Sporocysts described by Bond and Bovee as egg-shaped and rounded at the end, but illustrated both by these authors and by Roudabush as ellipsoidal. Sporocysts 8–13 × 4–7 μ, with a mean of 11.2 × 6.2 μ and a mean length-width ratio of 1.81. Stieda body absent. Sporocyst residuum present. Sporozoites described by Bond and Bovee as piriform, but illustrated both by these authors and by Roudabush as elongate. Sporozoites 7–11 × 2–4 μ, with a mean of 10.0 × 3.2 μ and a mean length-width ratio of 3.11, according to Bond and Bovee.

Sporulation Time: Twenty-two to thirty-six hours according to Bond and Bovee, twenty-eight hours according to Roudabush.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Glaucomys volans (=volens) (flying squirrel).
Location: Intestine.
Geographic Distribution: United States (Iowa, Florida).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: This species was found in a female flying squirrel and a litter of several young at Gainesville, Florida, and in a single flying squirrel captured at Ames, Iowa.

Remarks: Roudabush (1937a) first described this species, but assigned it to *Eimeria sciurorum* Galli-Valerio, 1922, which had been described from the common squirrel, *Sciurus vulgaris*. In redescribing it, Bond and Bovee (1957) pointed out a number of morphological differences from *E. sciurorum* and assigned it the new name, *E. parasciurorum*. The fact that the hosts of these two species belong to different subfamilies gives additional justification, if such were necessary, for separating them.

EIMERIA DORNEYI N. SP.

Eimeria sp. Dorney, 1962: 258–261.

Description: Oocysts ellipsoidal, a few truncate at one end, colorless to pale pink; 100 sporulated oocysts measured 17–30 × 10–19 μ, with a mean of 26 × 15 μ; their mean length-width ratio was 1.7. Oocyst wall composed of a single layer, presumably smooth, light green under oil immersion. Micropyle absent. Oocyst polar granule present. Oocyst residuum absent. Sporocysts piriform; six sporocysts averaged 14 × 6 μ. Stieda body present, not nipple-shaped. Sporocyst residuum present, usually dispersed among sporozoites.

Sporulation Time: Unknown.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Glaucomys sabrinus macrotis (northern flying squirrel).

Location: Cecal contents.

Geographic Distribution: North America (Wisconsin).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Dorney (1962) found this species in a single *G. s. macrotis*.

Remarks: Dorney (1962) pointed out that this species differs morphologically from other species of *Eimeria* described from *Glaucomys,* and that it fitted the description of *E. sciurorum* from *Sciurus niger*. However, the description of *E. sciurorum* is incomplete; moreover, *Sciurus* belongs to a different subfamily than *Glaucomys*. In view of the failure of all cross-transmission experiments of rodent *Eimeria* from one genus to another, it appears justifiable to assign the form from *G. sabrinus* a new name. We are therefore calling it *Eimeria dorneyi* n. sp.

EIMERIA PETAURISTAE RAY AND SINGH, 1950

(Plate 7, Figs. 66–69)

Eimeria petauristae Ray and Singh, 1950: 65-70.

Description: Unsporulated oocysts flask-shaped, with a short neck and a dome-shaped "pseudomicropyle," which forms a transparent cap at the anterior end and which disappears, becoming concave, on sporulation.

Oocyst wall composed of two layers; the outer one rugged, deep brown, and 3.75–6.25 μ thick; the inner one thin, smooth, and transparent. The outer layer is readily broken away from the inner one by pressure. Oocysts measure 46.5–52.5 × 35.0–40.0 μ. Sporocysts naviculoid, with one end slightly broader than the other, but without Stieda body. Sporocysts 25.5–31.25 × 8.75–10.0 μ. Each sporocyst contains two club-shaped sporozoites with a vacuole at either end. Small oocyst residuum present. Oocyst polar granule absent. Sporocyst residuum present. The oocysts are heavier than those of most coccidia, since they cannot be floated up by centrifugation in sugar, salt, or zinc sulfate solutions.

Sporulation Time: Ten to twelve days in potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Petaurista petaurista (syn., *P. inornatus)* (Himalayan flying squirrel).

Location: Alimentary canal (found in feces).

Geographic Distribution: India (Mukteswar).

Pathogenicity: Unknown.

Cross-Transmission Studies: Ray and Singh (1950) failed to infect local Indian rabbits with this species.

Host Suborder SCIUROMORPHA

Host Superfamily GEOMYOIDEA

Host Family GEOMYIDAE

Host Subfamily GEOMYINAE

EIMERIA GEOMYDIS SKIDMORE, 1929 *

(Plate 7, Fig. 60)

Eimeria geomydis Skidmore, 1929: 183–184.

Description: Oocysts spherical to slightly ovoid, 12–15 × 12–13 μ, with a mean of 13.3 × 12.5 μ and a mean length-width ratio of 1.07. Oocyst wall smooth, colorless, 0.5 μ thick, composed of two layers. (Only a single layer appears in Skidmore's drawings.) Micropyle seen in only a few oocysts. Sporont almost fills unsporulated oocysts. Oocyst polar granule and oocyst residuum absent. Sporocysts 5–7 × 4–5 μ, without Stieda body but with sporocyst residuum.

Sporulation Time: Four days at room temperature in 2% potassium dichromate.

* The genitive of *mys* is *myis*, not *mydis*. Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Geomys bursarius (pocket gopher).
Location: Small and large intestines.
Geographic Distribution: United States (Nebraska).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: This species was described from a single pocket gopher in Lincoln, Nebraska.

EIMERIA THOMOMYSIS LEVINE, IVENS, AND KRUIDENIER, 1957 *

(Plate 8, Fig. 70)

Eimeria thomomysis Levine, Ivens, and Kruidenier, 1957: 80–88.

Description: Oocysts spherical to subspherical. Oocyst wall composed of a single layer, smooth, pale yellowish brown, 0.8 μ thick, lined by a thin membrane. Micropyle absent. Nineteen sporulated oocysts from two host animals measured 13–16 × 13–16 μ, with a mean of 14.2 × 13.9 μ. Their length-width ratios ranged from 1.0–1.1, with a mean of 1.01. Oocyst polar granule and oocyst residuum absent. Sporocysts 10 × 6 μ, with a small Stieda body and a few scattered residual granules. Sporocysts almost fill oocyst. Sporozoites lie head to tail in sporocyst and contain a large, spherical, clear, colorless body about 2 μ in diameter at the large end.

Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Thomomys bottae (pocket gopher).
Location: Intestinal contents.
Geographic Distribution: United States (Arizona).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: This species was found in two out of five *T. bottae* from Grand Canyon National Park, Arizona.

Host Suborder SCIUROMORPHA

Host Superfamily GEOMYOIDEA

Host Family HETEROMYIDAE

Host Subfamily PEROGNATHINAE

* The genitive of *mys* is *myis*, not *mysis*. Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

EIMERIA PEROGNATHI LEVINE, IVENS, AND KRUIDENIER, 1957

(Plate 8, Fig. 71)

Eimeria perognathi Levine, Ivens, and Kruidenier, 1957: 80–88.

Description: Oocysts ovoid. Oocyst wall composed of a single layer somewhat rough, yellowish brown, 1 μ thick. Micropyle absent. Five sporulated oocysts measured 19–22 × 15–16 μ, with a mean of 20.2 × 15.3 μ. Their length-width ratios ranged from 1.2–1.4, with a mean of 1.32. Oocyst polar granule absent. Oocyst residuum composed mostly of large, clear globules. Sporocysts 6–7 × 4–5 μ, with a small, flat Stieda body and a small amount of scattered residual material.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Perognathus intermedius (rock pocket mouse).

Location: Intestinal contents.

Geographic Distribution: United States (Arizona).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in one out of two *P. intermedius* from the Grand Canyon National Park, Arizona.

EIMERIA PENICILLATI IVENS, KRUIDENIER, AND LEVINE, 1959

(Plate 8, Fig. 78)

Eimeria penicillati Ivens, Kruidenier, and Levine, 1959: 53–57.

Description: Oocysts subspherical, ellipsoidal, or slightly ovoid. Oocyst wall pale brownish yellow or tan, smooth, composed of a single layer (confirmed by breaking the oocyst) about 0.6 μ thick. Micropyle absent. Six sporulated oocysts from the type host (*Perognathus penicillatus*) measured 16–20 × 14–16 μ, with a mean of 17.8 × 14.7 μ. Their length-width ratios ranged from 1.1–1.3, with a mean of 1.18. Sporocysts broadly lemon-shaped, 9 × 7 μ, with a length-width ratio of 1.33. Stieda body small, rounded. Oocyst residuum composed of one to several large, clear globules. Oocyst polar granule present. Sporocyst residuum composed of a number of large granules. Sporozoites oriented more or less lengthwise in sporocysts.

Three oocysts from a *P. flavus* measured 17–20 × 15–19 μ. They differed from those of *P. penicillatus* only in having either one or two polar granules instead of a single one.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Sporogony: Not described.

Type Host: Perognathus penicillatus (pocket mouse).
Other Host: Perognathus flavus (pocket mouse).
Location: Intestinal contents.
Geographic Distribution: Mexico (Sonora, Chihuahua).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

Host Suborder SCIUROMORPHA
Host Superfamily GEOMYOIDEA
Host Family HETEROMYIDAE
Host Subfamily DIPODOMYINAE

EIMERIA MOHAVENSIS DORAN AND JAHN, 1959

(Plate 8, Figs. 72–77; Plate 9, Figs. 79 and 80)

Eimeria mohavensis Doran and Jahn, 1949: 631–632; Doran and Jahn, 1952: 93–101; Doran, 1953: 31–60.

Description: Oocysts ellipsoidal. Oocyst wall composed of a single layer, smooth, light brown, 0.7–0.9 μ thick. Micropyle absent. Sporulated oocysts 22–26 × 14–18 μ, with a mean of 24.1 × 15.7 μ and a mean length-width ratio of 1.54. Sporont in unsporulated oocysts 12–15 × 12–16 μ, with a mean of 13.6 × 12.7 μ. Oocyst polar granule and oocyst residuum absent. Doran and Jahn (1952) gave the sporocyst dimensions as 6–10 × 5.5–8 μ, with a mean of 7.8 × 7.6 μ, but in their illustration (their Fig. 10) the sporocysts appear to be about 7 × 4 μ. Sporocysts without Stieda body, but with a residuum 4.0–4.5 μ long.

Sporulation Time: Twenty-four to sixty hours in 2–4% potassium dichromate at the optimum temperature, 23–27C; 64–117 hours at 9.5C; 44–78 hours at 40C. No sporulation at 2.5 or 45C.

Schizogony: Doran (1953) described the schizogonic part of the life cycle in detail. There are two sizes of schizonts and of merozoites. The small, early schizonts, 4.1–10.5 μ in diameter, are present on the second through the fifth days of the prepatent period. These produce 20 to 35 comma-shaped merozoites measuring 6.5–8.5 × 1.5–2.0 μ, with a central nucleus. The larger, later schizonts, 8.0–10.0 μ in diameter, are present on the sixth and seventh prepatent and first and second patent days. They produce 50 to 75 merozoites measuring 4.5–6.5 × 1.0–1.5 μ, with a central nucleus. Since the first gametes and gametocytes appear on the fifth prepatent day, one day before the first large schizonts, it is clear that some of the first-generation merozoites must produce gametes and gametocytes directly. Most, however, probably produce second-generation schizonts. Assuming that 33 of the 35 merozoites of the small schizonts developed into large schizonts, that 1 of these merozoites and 1 of those

produced by each large schizont developed into a microgametocyte, and that 1 of the small schizont merozoites and 74 of the large schizont merozoites developed into macrogametes, Doran (1953) calculated that the theoretical maximum yield of oocysts from an initial infection of 100 oocysts should be 1,954,400. He actually obtained an average oocyst yield of 9,710,000. It is obvious, therefore, that there must be more than two generations of schizonts and merozoites. Since the small schizonts are present for a longer time than the large ones, Doran considered that the additional generation or two is probably of this type. On the basis of his work, he considered the most likely pattern to be that some of the merozoites produced by the first-generation, small schizonts develop directly into gametes and gametocytes, while others develop into second-generation small schizonts and still others into second-generation large schizonts. The merozoites produced by the second-generation small schizonts then develop into third-generation large schizonts and probably also into gametes. The merozoites from both the second- and third-generation large schizonts probably develop only into gametocytes and gametes. Further study will be needed, however, to verify this scheme.

Gametogony: This has been described by both Doran and Jahn (1952) and Doran (1953). Gametocytes and gametes are found during the last two days of the prepatent and first to sixth days of the patent periods. The macrogametes are round and measure 10–16 μ in diameter. The microgametocytes are ellipsoidal, 17.0–18.5×21.0–22.5 μ, and produce a large number of microgametes.

Prepatent Period: The prepatent period following experimental infection is seven days. The patent period, during which oocysts are present in the feces, lasts nine to ten days.

Type Host: Dipodomys panamintinus mohavensis (kangaroo rat).

Other Hosts: No other natural hosts have been reported, but Doran (1953) produced experimental infections in *Dipodomys merriami, D. nitratoides, D. heermanni, D. deserti,* and *D. agilis.*

Location: The small schizonts are found throughout the small intestine and cecum, most being present in the distal part of the small intestine. The large schizonts are more prevalent in the cecum than in the small intestine. The gametes and gametocytes are found in the cecum. All stages are above the nuclei of the host epithelial cells.

Geographic Distribution: United States (southern California).

Pathogenicity: Unknown.

Cross-Transmission Studies: Doran (1951, 1953) successfully infected three other subspecies of *Dipodomys panamintinus, D. p. leucogenys, D. p. panamintinus,* and *D. p. caudatus.* He also infected 11 of 12 *D. merriami merriami,* 11 of 12 *D. nitratoides brevinasus,* 5 of 6 *D. heermanni mor-*

roensis, all of 6 *D. h. tularensis,* 1 *D. h. swarthi,* 1 *D. deserti deserti,* and 6 *D. agilis agilis.* He was unable to infect 8 *Perognathus longimembris,* 7 *P. formosus mohavensis,* 4 *Peromyscus boylii,* 12 *P. maniculatus,* 12 *P. californicus,* 7 *P. truei,* 5 *Onychomys torridus,* 4 *Neotoma lepida,* 8 *Spermophilus leucurus,* 4 *Mus musculus,* and 4 *Rattus norvegicus.* Thus this species appears confined to the genus *Dipodomys.*

It is of interest in this respect that, although *Dipodomys merriami merriami* was readily infected in the laboratory, natural infections were not found in any of 197 *D. m. merriami* trapped in the field. This was despite the fact that *D. m. merriami* is sympatric with *D. p. mohavensis,* that they have similar food habits and forage over the same range, that they have been taken in the same trap within half an hour, and that *D. m. merriami* frequently enters the burrows of other kangaroo rats, including presumably *D. p. mohavensis.*

Prevalence: E. mohavensis was found by Doran (1953) in 8.7 per cent of 251 *Dipodomys panamintus mohavensis* in southern California.

EIMERIA DIPODOMYSIS LEVINE, IVENS, AND KRUIDENIER, 1958 *

(Plate 10, Fig. 81)

Eimeria dipodomysis Levine, Ivens, and Kruidenier, 1958: 291–298.

Description: Oocysts ellipsoidal. Oocyst wall yellowish brown, rough, composed of two layers, the outer one 3.5 μ thick at the sides and 3.0 μ thick at the ends, the inner one 0.7 μ thick. Micropyle absent. Seventeen sporulated oocysts measured 47–61 × 38–42 μ, with a mean of 54.1 × 40.2 μ. Their length-width ratios ranged from 1.2–1.5, with a mean of 1.35. Sporocysts ovoid, about 16 × 11 μ. Stieda body shaped somewhat like a conical dome, i.e., excavated in the center. No oocyst polar granule could be distinguished. Oocyst residuum large, composed of a mass of homogeneous granules. In some oocysts these granules are few, large, and loosely aggregated, while in others they are small and numerous, forming a compact mass. Sporozoites embedded in a large amount of sporocyst residual material.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Dipodomys phillipsi (Mexican kangaroo rat).

Location: Intestinal contents.

Geographic Distribution: Mexico (Aguascalientes).

Pathogenicity: Unknown.

* The genitive of *mys* is *myis,* not *mysis.* Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

Cross-Transmission Studies: None.

Prevalence: This species was found in one out of three *D. phillipsi* from Aguascalientes and Jalisco, Mexico.

Host Suborder SCIUROMORPHA

Host Superfamily GEOMYOIDEA

Host Family HETEROMYIDAE

Host Subfamily HETEROMYINAE

EIMERIA LIOMYSIS LEVINE, IVENS, AND KRUIDENIER, 1958 *

(Plate 10, Fig. 83)

Eimeria liomysis Levine, Ivens, and Kruidenier, 1958: 291–298; Ivens, Kruidenier, and Levine, 1959: 53–57.

Description: Oocysts subspherical to ellipsoidal. Oocyst wall composed of two layers: the outer one 0.9 μ thick, pale yellow, slightly rough and pitted; and the inner one 0.3 μ thick and practically colorless. Micropyle absent. Seventy-five sporulated oocysts from two specimens of the type host (*Liomys pictus*) measured 15–24 × 14–21 μ, with a mean of 19.5 × 17.7 μ. Their length-width ratios ranged from 1.0–1.3, with a mean of 1.10. Forty-four sporulated oocysts from a *Liomys irroratus* measured 15–23 × 14–20 μ, with a mean of 18.2 × 17.2 μ. Their length-width ratios ranged from 1.0–1.1, with a mean of 1.06. Eight sporulated oocysts measured by Ivens, Kruidenier, and Levine (1959) from two *L. pictus* measured 18–23 × 17–21 μ, with a mean of 20.8 × 19.1 μ and a mean length-width ratio of 1.07. Sporocysts almost ellipsoidal to ovoid, about 10 × 7 μ, with a small Stieda body. Oocyst polar granule present. Oocyst residuum absent. Sporozoites usually at the ends of the sporocysts, with some relatively large residual granules between them.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Liomys pictus (painted spiny pocket mouse).

Other Host: Liomys irroratus (Mexican spiny pocket mouse).

Location: Intestinal contents.

Geographic Distribution: Mexico (Sinaloa, Jalisco, Nayarit).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found by Levine, Ivens, and Kruidenier (1958) in two *L. pictus* from Sinaloa, Mexico, and in one *L. irroratus* from Jalisco, Mexico. It was found by Ivens, Kruidenier, and Levine (1959) in a *L. pictus* from Nayarit, Mexico, and another from Sinaloa.

* The genitive of *mys* is *myis*, not *mysis*. Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of the name, so the error must be perpetuated.

EIMERIA PICTI LEVINE, IVENS, AND KRUIDENIER, 1958

(Plate 10, Fig. 84)

Eimeria picti Levine, Ivens, and Kruidenier, 1958: 291–298.

Description: Oocysts subspherical to ellipsoidal. Oocyst wall composed of two layers: the outer one brownish yellow, 1.3 μ thick, rough, and pitted; and the inner one brownish yellow and 0.4 μ thick. When the outer wall is broken, the inner wall usually remains intact. Micropyle absent. Fifty-three sporulated oocysts measured 22–32 × 19–28 μ, with a mean of 25.8 × 22.5 μ. Their length-width ratios ranged from 1.0–1.2, with a mean of 1.15. Sporocysts broadly lemon-shaped, 11–12 × 8–9 μ. Stieda body present. One to two oocyst polar granules present. Oocyst residuum usually composed of a number of large, clear, irregular granules, but sometimes a single, large, granular mass. Sporocyst residual material composed of a few to many granules. Sporozoites lie longitudinally, head to tail, in the sporocysts.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Liomys pictus (painted spiny pocket mouse).

Location: Intestinal contents.

Geographic Distribution: Mexico (Sinaloa).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in one of two *L. pictus* from Sinaloa, Mexico.

Host Suborder SCIUROMORPHA

Host Superfamily CASTOROIDEA

Host Family CASTORIDAE

Host Subfamily CASTORINAE

EIMERIA SPREHNI YAKIMOFF, 1934

Eimeria sprehni Yakimoff, 1934: 294.

Description: Oocysts ovoid (ellipsoidal in drawing), sometimes with one side concave. Oocyst wall "doppelt konturiert," but illustrated as composed of a single, apparently smooth layer. Micropyle absent. Thirty-five oocysts measured 16–20 × 11–14 μ, with a mean of 17.6 × 12.0 μ. Their length-width ratios ranged from 1.3–1.7, with a mean of 1.47. Oocyst polar granule and oocyst residuum present. Sporocysts elongate, apparently without Stieda body. Complete sporulation did not take place, and no sporozoites were seen.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Castor canadensis (Canadian beaver).
Location: Feces.
Geographic Distribution: USSR (presumably in a zoo).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Yakimoff (1934) found this species in one of three Canadian beavers in Voronezh.
Remarks: Although both Becker (1956) and Pellérdy (1956) listed *Castor fiber* as a host of this species in addition to *C. canadensis,* we have not found a report of it in the former host. Yakimoff (1934) examined 19 *C. fiber* from Russia without finding coccidia. His discussion, however, was misleading. He first stated that he examined "22 Bibern *(Castor fiber),"* and then went on to say that he found no coccidia in 19 from Voronezh, but did find a few coccidia in 1 out of 3 "kanadischer Biber." This must have been *C. canadensis,* although he did not use this scientific name in his paper. Yakimoff (1934) also stated that Sprehn (1932) found coccidia in "bibern (Sumpfbiberraten)," but the Sumpfbiberrat is the nutria (*Myocastor coypus*).

Host Suborder MYOMORPHA
Host Superfamily MUROIDEA
Host Family MURIDAE
Host Subfamily CRICETINAE
Host Tribe HESPEROMYINI

EIMERIA ORYZOMYSI CARINI, 1937 *

(Plate 36, Figs. 295–297)

Eimeria oryzomysi Carini, 1937a: 47–49; Carini, 1937b: 624–627.

Description: Oocysts ellipsoidal to ovoid. Oocyst wall with a double contour (illustrated as a single layer), smooth, light brown. Oocysts 22–25 × 17–19 μ, with a length-width ratio of 1.25. Micropyle absent. In freshly passed oocysts, the sporont completely fills the oocyst, but it shrinks away from the wall as it develops.

Oocyst polar granule apparently absent. Oocyst residuum at first 8–10 μ in diameter and granular, but as the sporocysts develop the granules tend to coalesce so that frequently a single clear globule of varying size results. Sporocysts ovoid, 11 × 8 μ, with a Stieda body and a sporocyst residuum composed of centrally located small, scattered granules. Sporozoites lie lengthwise in sporocysts.

* The genitive of *mys* is *myis,* not *mysi.* Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

Sporulation Time: Five to six days at 20–25C.

Schizogony: Schizogony takes place in the epithelial cells of the small intestine and especially of the duodenum. As the schizonts develop, they push the host cell nucleus aside and may come to lie below it. The schizonts form 15 to 20 banana-shaped merozoites measuring about 8×2–2.5 μ. The merozoites encountered free in the lumen of the intestine measured 10–11 × 3 μ. The above description is based on stages found 6 and 12 days after experimental infection.

Gametogony: Gametogony takes place in the small intestine. Carini (1937a,b) illustrated macrogametes and microgametocytes both above and below the host cell nuclei. The macrogametes have a central nucleus and a border of hematoxylin-staining plastic granules which disappear when the oocyst membrane is formed. The microgametocytes form a large number of microgametes 2–2.5 μ long.

Prepatent Period: Five days.

Type Host: Oryzomys sp. (rice rat).

Location: Small intestine.

Geographic Distribution: Brazil (São Paulo).

Pathogenicity: Unknown. One of two experimentally infected rice rats died on the twelfth day without previous signs of illness.

Cross-Transmission Studies: Carini (1937a,b) was unable to infect white or common mice with this species.

EIMERIA COUESII KRUIDENIER, LEVINE, AND IVENS, 1960

(Plate 10, Fig. 82)

Eimeria couesii Kruidenier, Levine, and Ivens, 1960: 100–101.

Description: Oocysts ellipsoidal, pale yellowish. Oocyst wall somewhat rough and pitted, heavy, composed of a single layer about 1.3 μ thick with weak radial striations. Five sporulated oocysts measured 20–23 × 17–20 μ, with a mean of 21.4×18.0 μ; their length–width ratio was 1.20. Micropyle absent. Oocyst residuum absent. Oocyst polar granule present. Sporocysts ovoid. Seven sporocysts measured $10–14 \times 7–8$ μ, with a mean of 11.7×7.7 μ; their length-width ratios ranged from 1.2–1.8, with a mean of 1.53. Stieda body present. Sporozoites oriented longitudinally in sporocysts, with what appears to be a large, clear, yellowish globule at the large end. Sporocyst residuum composed of some rather loose granules or absent.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Sporogony: Not described.

Type Host: Oryzomys c. couesi (rice rat).

Location: Feces.

Geographic Distribution: Mexico (Oaxaca).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

EIMERIA PEROMYSCI LEVINE, IVENS, AND KRUIDENIER, 1957

(Plate 11, Fig. 85)

Eimeria peromysci Levine, Ivens, and Kruidenier, 1957: 80–88.

Description: Oocysts ellipsoidal. Oocyst wall composed of two layers; the outer one 1.3 μ thick, yellowish brown, and rough; the inner one 0.4 μ thick and yellowish brown. Micropyle absent. Nineteen sporulated oocysts measured 26–32×21–27 μ, with a mean of 29.4×23.9 μ. Their length-width ratios ranged from 1.1–1.3, with a mean of 1.22. Sporulated oocysts with an oocyst polar granule and one to several large, clear, colorless residual globules up to 10 μ in diameter. Sporocysts about 15×9 μ, lemon-shaped, with a Stieda body at one end. Sporocyst wall about 0.4 μ thick. Sporocysts contain two sporozoites lying with the large end of one beside the small end of the other. A large number of coarse residual granules fill the space between the sporozoites.

Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Peromyscus truei (piñon mouse).
Location: Intestinal contents.
Geographic Distribution: United States (Arizona).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: This species was found in one out of four *P. truei* in Grand Canyon National Park, Arizona.

EIMERIA ARIZONENSIS LEVINE, IVENS, AND KRUIDENIER, 1957

(Plate 11, Figs. 87 and 88; Plate 12, Fig. 89)

Eimeria arizonensis Levine, Ivens, and Kruidenier, 1957: 80–88; Levine and Ivens, 1960: 207–212.

Description: This species has been reported from three species of *Peromyscus*. Since there are minor differences in the appearance of the oocysts from the different hosts, each form is described separately.

Form from type host, *Peromyscus truei:* Oocysts subspherical to ellipsoidal. Oocyst wall smooth, pale tan, composed of a single layer about 0.9 μ thick, lined by a thin membrane. Micropyle absent. Fifty sporulated oocysts from one host animal from the north rim of Grand Canyon measured 19–27×17–22 μ, with a mean of 21.7×19.2 μ. Their length-width ratios ranged from 1.0–1.2, with a mean of 1.13. Eight sporulated

oocysts from another host animal from the south rim of Grand Canyon measured 22–29 × 18–23 μ, with a mean of 25.2 × 20.7 μ. Their length-width ratios ranged from 1.1–1.3, with a mean of 1.22. Sporulated oocysts with an oocyst polar granule and usually with a single large, clear, colorless residual globule about 4 μ in diameter. Sporocysts almost fill oocyst. Sporocysts about 11 × 7 μ, lemon-shaped, with a Stieda body at one end. Sporocysts contain two sporozoites lying with the large end of one beside the small end of the other. Sporocyst residuum more or less compact, composed of coarse granules.

Form from *P. maniculatus:* Oocysts ellipsoidal. Oocyst wall light yellowish, slightly to moderately pitted, occasionally smooth, composed of a single layer (confirmed by crushing the oocyst) 1.3–1.7 μ thick. Micropyle absent. Forty sporulated oocysts measured 22–29 × 18–23 μ, with a mean of 26.1 × 20.8 μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.24. Oocyst polar granule present. Oocyst residuum composed of a cluster of large, homogeneous granules or globules 2–5 μ in diameter. Sporocysts lemon-shaped, with prominent Stieda body. Sporocyst wall 0.4 μ thick. Twenty-three sporocysts measured 11–13 × 7–9 μ with a mean of 12.2 × 8.0 μ; their length-width ratios ranged from 1.3–1.7, with a mean of 1.56. Sporozoites homogeneous, colorless, lying lengthwise in sporocysts. Sporocyst residuum composed of coarse granules which fill the space between the sporozoites.

Form from *P. leucopus:* Oocysts ellipsoidal to broadly ellipsoidal. Oocyst wall pale yellowish to yellowish, occasionally almost smooth but usually more or less pitted, composed of a single layer (confirmed by crushing the oocyst) 1.0–1.2 μ thick. Micropyle absent. Sixty-five sporulated oocysts from two host individuals measured 20–25 × 17–21 μ, with a mean of 22.4 × 19.4 μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.16. One or two oocyst polar granules present. Oocyst residuum present, usually a single, large, waxy-appearing globule about 4 μ in diameter. Sporocysts lemon-shaped to rather ovoid, with prominent Stieda body. Sporocyst wall rather thick. Twenty-two sporocysts measured 12–14 × 7–8 μ, with a mean of 12.6 × 7.2 μ; their length-width ratios ranged from 1.6–1.9, with a mean of 1.75. Sporocyst residuum composed of more or less scattered coarse granules. Sporozoites colorless, lying lengthwise, head to tail, in sporocysts.

Schizogony and Gametogony: Form from *P. truei:* Unknown.

Form from *P. maniculatus:* A few microgametocytes, macrogametes, and young oocysts were seen by Levine and Ivens (1960) in the epithelial cells of the villi of the anterior ileum. The macrogametes had a single layer of eosinophilic plastic granules. Their relation to the host cell nucleus was uncertain. They measured approximately 19 × 14 μ when

mature, but were shrunken. The young oocysts measured approximately 22×16 μ. A few macrogametes were also seen in the posterior ileum. No endogenous stages of this form were found in the duodenum, jejunum, or cecum.

Form from *P. leucopus:* A moderate number of macrogametes, microgametocytes, and oocysts were found by Levine and Ivens (1960) in the epithelial cells of the tips and sides of the villi, and very rarely in the crypts, of the jejunum. Fewer parasites were found in the anterior ileum, still fewer in the posterior ileum, and only a single macrogamete was seen in the duodenum. No endogenous stages were seen in the cecum. All stages were present both above and below the host cell nuclei; the older forms tended to lie below them. The macrogametes ranged in size up to about 14×10 μ, and had a single layer of eosinophilic plastic granules. The microgametocytes ranged in size up to about 15×8 μ. The oocysts ranged in size up to about 19×14 μ.

A very few schizonts were seen in the jejunum, and a single one was found in a detached piece of villus in the posterior ileum. They lay beneath the host cell nuclei in the epithelial cells at the sides of the villi, but too few were seen to be sure that this is their only location. They measured $9–12 \times 7–9$ μ. Most seemed to contain about 8 or perhaps a few more sausage-shaped merozoites about 1 μ in diameter, but one schizont contained perhaps 16 to 24; these may possibly have belonged to two different generations. There was no schizont residuum.

Prepatent Period: Unknown.

Type Host: Peromyscus truei (piñon mouse).

Other Hosts: Peromyscus maniculatus, P. leucopus (deer mice).

Location: Form from *P. truei:* Intestinal contents. Form from *P. maniculatus:* Anterior and posterior ileum. Form from *P. leucopus:* Jejunum, anterior ileum, posterior ileum, rarely duodenum.

Geographic Distribution: United States (Arizona, Illinois).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Levine, Ivens, and Kruidenier (1957) found this species in two of four *P. truei* in Grand Canyon National Park, Arizona. Levine and Ivens (1960) found it in one of nine *P. maniculatus* and two of seven *P. leucopus* from the vicinity of Sullivan, Illinois.

Remarks: Although there was a significant difference in size and shape of the oocysts from the two *P. truei,* they were not sufficient to merit taxonomic separation. It is of interest that one of these piñon mice came from the north rim of Grand Canyon and the other from the south rim. Both were *P. t. truei,* derived from the same general invading population. This subspecies lives in juniper rock habitats and does not occur in

the depths of Grand Canyon. However, according to D. F. Hoffmeister, intercommunication was highly probable during the Pleistocene and is possible even now.

The form from *P. maniculatus* differs from that from *P. truei* only in that its oocyst wall is thicker and is ordinarily more or less pitted, in that it lacks a membrane lining the oocyst wall, and in that its oocyst residuum is composed of a cluster of homogeneous globules rather than a single large one. The form from *P. leucopus* differs from that from *P. truei* only in that its oocyst wall is more or less pitted and in that it lacks a membrane lining the oocyst wall. The oocysts of the form from *P. leucopus* differ from those of the form from *P. maniculatus* only in having a thinner oocyst wall and in that the oocyst residuum is composed of a single, large, homogeneous globule rather than a cluster of them. Those endogenous stages of the forms from *P. maniculatus* and *P. leucopus* which were seen did not appear to differ morphologically. However, none was seen in the jejunum of *P. maniculatus,* while they were most common in this location in *P. leucopus.* Since so few were found in the former, this should not be considered a valid difference. The above differences do not appear sufficient to justify the establishment of new species, although future research may reveal differences in the endogenous stages, location in the host, or host-parasite relations which would do so.

EIMERIA EREMICI LEVINE, IVENS, AND KRUIDENIER, 1957

(Plate 12, Fig. 92)

Eimeria eremici Levine, Ivens, and Kruidenier, 1957: 80–88.

Description: Oocysts ellipsoidal. Oocyst wall smooth, composed of two layers, the outer one 1 μ thick and colorless, and the inner one 0.4 μ thick and pale tan. Micropyle absent. Fifty sporulated oocysts from one host animal measured 22–30 × 18–22 μ, with a mean of 25.3 × 20.8 μ. Their length-width ratios ranged from 1.1–1.4, with a mean of 1.21. Sporulated oocysts with one to three polar granules and a single, clear residual globule about 6–8 μ in diameter. (In 3 out of 50 oocysts these oocyst residua were granular rather than clear and homogeneous.) Sporocysts about 10 × 8 μ, lemon-shaped, with a relatively inconspicuous Stieda body at one end. The two sporozoites lie lengthwise in the sporocysts, which contain more or less coarsely granular residual material.

Schizogony: Unknown.

Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Peromyscus eremicus (cactus mouse).

Location: Intestinal contents.

Geographic Distribution: United States (Arizona).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: This species was found in one out of two *P. eremicus* in Grand Canyon National Park, Arizona.

EIMERIA LANGEBARTELI IVENS, KRUIDENIER, AND LEVINE, 1959

(Plate 11, Fig. 86)

Eimeria langebarteli Ivens, Kruidenier, and Levine, 1959: 53–57.

Description: Oocysts elongate ellipsoidal. Oocyst wall smooth, pale yellowish, composed of a single layer about 0.8 μ thick. Micropyle absent. Fifteen sporulated oocysts from two host animals measured 20–23 × 13–14 μ, with a mean of 21.0 × 13.6 μ. Their length-width ratios ranged from 1.4–1.7, with a mean of 1.55. Sporocysts elongate ellipsoidal, thin-walled. Ten sporocysts measured 8–10 × 5–6 μ, with a mean of 9.4 × 5.3 μ; their length-width ratios ranged from 1.6–2.0, with a mean of 1.78. Stieda body small. Oocyst polar granule present. Oocyst residuum absent. Sporozoites elongate, curled inside sporocysts, with many small granules so closely adherent to the sporozoites that it was not possible to be sure whether they were inside or outside the sporozoite membrane. Hence the presence of true sporocyst residual material was not definitely established.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Sporogony: Not described.
Type Host: Peromyscus boylii (deer mouse).
Location: Intestinal contents.
Geographic Distribution: Mexico (Chihuahua).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Ivens, Kruidenier, and Levine (1959) found this species in two of four *P. boylii* from near Cuauhtémoc, Chihuahua, Mexico.

EIMERIA CAROLINENSIS VON ZELLEN, 1959

(Plate 12, Fig. 91)

Eimeria carolinensis von Zellen, 1959: 104–105.

Description: Oocysts ellipsoidal, occasionally elongate ellipsoidal. Eighteen sporulated oocysts measured 14–19 × 10–13 μ, with a mean of 17.6 × 11.3 μ; their length-width ratios ranged from 1.2–1.6, with a mean of 1.43. Micropyle absent. Oocyst wall smooth, composed of an outer colorless layer 1 μ thick and an inner dark brown layer 0.5 μ thick. Oocyst polar granule present. Oocyst residuum absent. Sporocysts ovoid,

almost filling oocyst. Sporocysts about 8.5×4.5 μ, with a small Stieda body. Sporocyst residuum present on one side of the sporozoites, being partially concealed by them. Sporozoites lie lengthwise in sporocysts.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Peromyscus leucopus (white-footed mouse).

Location: Intestinal contents.

Geographic Distribution: United States (North Carolina).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Von Zellen (1959) found this species in 17 per cent of 53 *P. leucopus* from the vicinity of Durham, North Carolina, between January 12 and November 24, 1958.

EIMERIA DELICATA LEVINE AND IVENS, 1960

(Plate 12, Fig. 90)

Eimeria delicata Levine and Ivens, 1960: 207–212.

Description: Oocysts ellipsoidal. Oocyst wall very pale yellowish, smooth, composed of a single layer about 0.6 μ thick. Micropyle absent. Eleven sporulated oocysts measured 13–15×10–12 μ, with a mean of 14.2×11.3 μ; their length-width ratios ranged from 1.1–1.4, with a mean of 1.25. Oocyst polar granule present. Oocyst residuum absent. Sporocysts elongate ovoid with a rather pointed end bearing a tiny Stieda body, very thin-walled, 8×4–5 μ, with a length-width ratio of about 1.9. Sporozoites oriented lengthwise in sporocysts. Some sporocyst residual granules ordinarily present, although they may sometimes be absent.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Peromyscus maniculatus (deer mouse).

Location: Intestinal contents.

Geographic Distribution: United States (Illinois).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Levine and Ivens (1960) found this species in two out of nine *P. maniculatus* from the vicinity of Sullivan, Illinois.

EIMERIA ROUDABUSHI LEVINE AND IVENS, 1960

(Plate 12, Fig. 93)

Eimeria roudabushi Levine and Ivens, 1960: 207–212.

Description: Oocysts ellipsoidal. Oocyst wall smooth, almost colorless, composed of a single layer about 1.3 μ thick at the sides, grading to about 0.9 μ thick at the ends. Micropyle absent. Twenty sporulated

oocysts measured 20–26 × 17–20 μ, with a mean of 22.2 × 18.6 μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.19. Oocyst polar granule present. Oocyst residuum atypical, composed of a small amount of cobwebby-appearing material at both ends of the oocyst. Sporocysts ovoid, thin-walled, with a small Stieda body. Sporocysts 12–13 × 8 μ with a length-width ratio of 1.6–1.7. Sporocyst residuum large, compact. Sporozoites colorless, lying lengthwise, head to tail, in sporocysts, but so long that they are folded back upon themselves.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Peromyscus leucopus (deer mouse).

Location: Intestinal contents.

Geographic Distribution: United States (Illinois).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Levine and Ivens (1960) found this species in one out of seven *P. leucopus* from the vicinity of Sullivan, Illinois.

EIMERIA LEUCOPI VON ZELLEN, 1961

(Plate 13, Figs. 94–97; Plate 14, Figs. 98–101; Plate 15, Fig. 102)

Eimeria leucopi von Zellen, 1961: 134–138.

Description: Oocysts ellipsoidal, occasionally ovoid, rarely spherical. Oocyst wall uniformly thick, rough, composed of an outer, yellowish, transparent layer 0.5 μ thick and an inner, dark brown layer 1.0 μ thick. Micropyle absent. Three hundred and fifty-nine oocysts measured 14–24 × 14–21 μ, with a mean of 19 × 17 μ; their length-width ratios ranged from 1.0–1.6, with a mean of 1.1. Oocyst polar granule absent. Oocyst residuum usually composed of one to several clear, green globules up to 6 μ in diameter. Sporocysts 11–14 × 6–8 μ, with a mean of 12 × 7 μ. Stieda body present. Sporocyst residuum present, compact or diffuse. Sporozoites 4–7 × 2–3.5 μ, with a mean of 5 × 2.4 μ lying lengthwise in sporocysts.

Sporulation Time: Fifty-four to one hundred and twenty-eight hours on vaseline-ringed slides.

Sporogony: Von Zellen (1961) described sporogony of these oocysts in S/4 sodium chloride solution on vaseline-ringed slides, presumably at room temperature. The sporont of newly discharged oocysts completely fills the oocysts. It contracts after 3 hours. About 26 hours later, clear areas, never entirely devoid of granules, appear within the sporont. About 50 hours after the oocysts have been discharged, a "fertilization spindle" appears. This is followed by the buckelbildung or ball stage, in which the limiting membrane of the sporont fades, the protoplasmic mass loses its dark yellowish brown color and becomes largely colorless,

and the clear area surrounding it changes in color from yellowish to faint blue. Small, homogeneous, green globules appear within the granular portion of the sporont and quickly associate with the clear material of each developing bulge. This process of pyramid formation begins about 62 hours after oocyst discharge and lasts about 2.5 hours.

Schizogony and Gametogony: Unknown. According to von Zellen (1961), the patent period is six days.

Prepatent Period: Five to six days, according to von Zellen (1961).

Type Host: Peromyscus leucopus (deer mouse).

Location: Small intestine.

Geographic Distribution: North America (North Carolina).

Pathogenicity: Unknown.

Cross-Transmission Studies: Von Zellen (1961) was unable to infect the golden deermouse, *Peromyscus nuttalli,* with *E. leucopi.*

Prevalence: Von Zellen (1961) found *E. leucopi* in 13 per cent of 53 *Peromyscus leucopus* from the vicinity of Durham, North Carolina.

EIMERIA BAIOMYSIS LEVINE, IVENS, AND KRUIDENIER, 1958 *

(Plate 15, Fig. 103)

Eimeria baiomysis Levine, Ivens, and Kruidenier, 1958: 291–298; Kruidenier, Levine, and Ivens, 1960: 100–101.

Description: Oocysts ellipsoidal. Oocyst wall yellowish, quite rough and pitted, composed of a single layer 1.6 μ thick. Micropyle absent. Twenty-five sporulated oocysts measured 20–25 × 18–21 μ, with a mean of 22.9 × 19.3 μ. Their length-width ratios ranged from 1.0–1.3, with a mean of 1.19. Sporulated oocysts contain four ovoid sporocysts about 11.0–11.5 × 7–8 μ; Stieda body present. Oocyst polar granule present. Oocyst residuum a homogeneous body. Sporocyst residual material composed of coarse granules. Sporozoites lie lengthwise in sporocysts.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Baiomys taylori (pigmy mouse).

Other Host: Baiomys musculus (pigmy mouse).

Location: Intestinal contents.

Geographic Distribution: Mexico (Queretero, Oaxaca).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found by Levine, Ivens, and Kruidenier (1958) in one out of three *B. taylori* near Queretero, Queretero, Mexico,

* The genitive of *mys* is *myis,* not *mysis.* Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

and by Kruidenier, Levine, and Ivens (1960) in a *B. musculus* at Oaxaca, Mexico.

EIMERIA ONYCHOMYSIS LEVINE, IVENS, AND KRUIDENIER, 1957 *

(Plate 15, Fig. 104)

Eimeria onychomysis Levine, Ivens, and Kruidenier, 1957: 80–88.

Description: Oocysts subspherical to ellipsoidal. Oocyst wall slightly rough, pale tan, composed of a single layer about 0.5 μ thick. Micropyle absent. Six sporulated oocysts measured 20–21 × 17–20 μ, with a mean of 20.4–18.6 μ. Their length-width ratios ranged from 1.0–1.2, with a mean of 1.10. Sporulated oocysts with a polar granule and with one or several large, round, clear residual globules. Sporocysts about 11 × 8 μ, ovoid, with a Stieda body at one end. Sporocyst residuum formed of more or less compact coarse granules. Sporozoites lie with the large end of one beside the small end of the other.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Onychomys leucogaster (northern grasshopper mouse).

Location: Intestinal contents.

Geographic Distribution: United States (Arizona).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in one out of two *O. leucogaster* in Grand Canyon National Park, Arizona.

EIMERIA PHYLLOTIS GONZALES-MUGABURU, 1942

Eimeria phyllotis Gonzales-Mugaburu, 1942: 137–151.

Description: Oocysts elongate ellipsoidal, rose-colored. Micropyle absent. Seven hundred sporulated oocysts from three host animals measured 22–30 × 12–16 μ, with a mean of 26.2 × 14.0 μ and a mean length-width ratio of 1.87. Oocyst wall 0.8–1.0 μ thick. Sporont 13–16 μ in diameter. Oocyst residuum and polar granule absent. Sporocysts 10–12 × 3–4 μ, with granular residuum 3 μ in diameter. Presence of Stieda body uncertain. Sporozoites 9–10 × 2–2.5 μ.

Sporulation Time: Two to three days in 3–5% potassium dichromate.

Schizogony and Gametogony: Macrogametes 18–20 μ in diameter. Microgametocytes 20–22 μ in diameter. Microgametes 3 μ long. The host cell nucleus is displaced.

* The genitive of *mys* is *myis*, not *mysis*. Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

Prepatent Period: Five to eight days.

Type Host: Phyllotis amicus amicus (?).

Location: Epithelial cells of cecum.

Geographic Distribution: South America (Peru).

Pathogenicity: Unknown. Gonzales-Mugaburu (1942) found no gross lesions in infected rodents.

Cross-Transmission Studies: Gonzales-Mugaburu (1942) was unable to infect young rats and white mice.

Prevalence: Gonzales-Mugaburu (1942) found *E. phyllotis* in 38 per cent of 21 *P. amicus* from the Peru sierras.

EIMERIA WEISSI GONZALES-MUGABURU, 1946

Eimeria weissi Gonzales-Mugaburu, 1946: 91–100.

Description: Oocysts ovoid, reddish, with a double-membraned wall 1.2 μ thick. Seven hundred oocysts measured 16–32 × 13–24 μ, with a mean of 23.5 × 18.9 μ. Their mean length-width ratio was 1.22. Micropyle absent. Oocyst polar granule apparently absent. Oocyst residuum present, 6–8 μ in diameter, single at first and fragmenting later on. Sporocysts ellipsoidal, 10–11 × 6–7 μ. Sporocyst residuum present. Presence of Stieda body unknown. Sporozoites lie longitudinally in sporocysts.

Sporulation Time: Eight to nine days in 3 per cent potassium dichromate.

Schizogony and Gametogony: Unknown.

Prepatent Period: Four to six days.

Type Host: Phyllotis amicus amicus (?).

Location: Ileum and cecum.

Geographic Distribution: South America (Peru).

Pathogenicity: Unknown.

Cross-Transmission Studies: Gonzales-Mugaburu (1946) was unable to transmit this species to white mice and guinea pigs.

Prevalence: Gonzales-Mugaburu (1946) found this species in 9.5 per cent of 21 *P. a. amicus* from the Peruvian sierras.

EIMERIA NEOTOMAE HENRY, 1932

Eimeria neotomae Henry, 1932a: 279–290.

Description: Oocysts ellipsoidal. Oocyst wall smooth and transparent, apparently composed of a single layer. Henry (1932a) stated that the oocysts measured 16.0–22.4 × 12.8–19.2 μ, with a mean of 22.4 × 16.0 μ, but one of the figures she gave for length must be wrong. A small micropyle is sometimes visible. Sporocysts subspherical, about 7.5 × 6.8 μ, with an extremely thin wall which can be seen only with difficulty. Sporocysts just fill the oocyst without overlapping. Presence of oocyst

polar granule uncertain; Henry (1932a) stated that there are usually no granules in the oocyst following sporulation, but that she saw a granule in an occasional oocyst. Oocyst residuum absent. Presence of sporocyst residuum unknown.

Sporulation Time: Thirty-six to forty-eight hours in 2% potassium dichromate in small vials.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Neotoma fuscipes (wood rat).

Location: Intestinal contents.

Geographic Distribution: United States (California).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in 8 of 23 woodrats from the vicinity of Berkeley, California.

EIMERIA RESIDUA HENRY, 1932

(Plate 35, Fig. 288)

Eimeria residua Henry, 1932a: 279–290.

Description: Oocysts subspherical. Oocyst wall comparatively thick, made up of two layers, the outer one brown and very rough, and the inner one clear and transparent. Oocysts 22–29 × 19–26 μ, with a mean of 25.6 × 22.4 μ. Micropyle absent. Sporulated oocysts with one or more polar granules and with a large residuum about 6 μ in diameter composed of clear, homogeneous material. Sporocysts 10 × 7.5 μ, pointed at one end, with a Stieda body. Presence of sporocyst residuum unknown.

Sporulation Time: Eight to nine days in 2% potassium dichromate in small vials.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Neotoma fuscipes (woodrat).

Location: Intestinal contents.

Geographic Distribution: United States (California).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in 4 of 23 woodrats in the vicinity of Berkeley, California.

EIMERIA OPERCULATA LEVINE, IVENS, AND KRUIDENIER, 1957

Eimeria operculata Levine, Ivens, and Kruidenier, 1957: 80–88.

Description: Oocysts ellipsoidal. Oocyst wall smooth, pale tan, about 1 μ thick, composed of a single layer. Seven sporulated oocysts measured

31–33 × 19–21 μ, with a mean of 32.3 × 19.8 μ. Their length-width ratios ranged from 1.6–1.7, with a mean of 1.63. A circular suture around one end of the oocyst forms a cap or operculum about 7 μ in diameter. There is no surface irregularity at the line of demarcation between the operculum and the oocyst proper, and the line itself is so fine that it can be seen only under high magnification. The pale suture line is visible between the operculum and the oocyst proper in high or low focus, but it is sometimes difficult to distinguish the line of demarcation or to recognize the operculum at all when focusing on the middle of the oocyst. Oocyst polar granule and oocyst residuum absent. Sporocysts subspherical, without Stieda body, about 7 × 6 μ, containing two curled-up, banana-shaped sporozoites. Sporocyst residuum absent. Sporozoites released from the sporocysts measure about 11 × 2.2 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Neotoma stephensi (Stephens woodrat).

Location: Intestinal contents.

Geographic Distribution: United States (Arizona).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in one out of two *N. stephensi* in Grand Canyon National Park, Arizona.

EIMERIA ALBIGULAE LEVINE, IVENS, AND KRUIDENIER, 1957

(Plate 15, Fig. 105)

Eimeria albigulae Levine, Ivens, and Kruidenier, 1957: 80–88.

Description: Oocysts spherical to subspherical. Oocyst wall composed of two layers: the outer layer colorless, rough, and about 1 μ thick; the inner layer pale brownish, about 0.5 μ thick. Forty-one sporulated oocysts measured 19–26 × 17–23 μ, with a mean of 21.9 × 19.8 μ. Their length-width ratios ranged from 1.0–1.4, with a mean of 1.10 and a standard deviation of 0.028. Micropyle absent. Sporulated oocysts contain one or two polar granules. Oocyst residuum composed of one to several large, clear globules. Sporocysts ovoid, approximately 11 × 9 μ with one end slightly pointed and with a slightly thickened wall at that end forming a small Stieda body. Sporozoites rounded, at ends of sporocyst. Sporocyst residuum represented by a number of more or less scattered granules.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Neotoma albigula (white-throated woodrat).

Location: Intestinal contents.

Geographic Distribution: United States (Arizona).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in one of two *N. albigula* in Grand Canyon National Park, Arizona.

EIMERIA DAVISI IVENS, KRUIDENIER, AND LEVINE, 1959

(Plate 16, Fig. 106)

Eimeria davisi Ivens, Kruidenier, and Levine, 1959: 53–57.

Description: Oocysts subspherical to ellipsoidal. Oocyst wall composed of two layers: the outer one colorless to pale brownish yellow, smooth to slightly roughened, about 1.2–1.3 μ thick; the inner one pale brownish to brownish, about 0.4–0.5 μ thick. The layers can be separated by crushing the oocyst. Micropyle absent. Fifty-eight sporulated oocysts measured 22–32 × 21–24 μ, with a mean of 27.6 × 22.8 μ. Their length-width ratios ranged from 1.1–1.4, with a mean of 1.21. Sporocysts ovoid; 23 sporocysts measured 10–12 × 7–9 μ, with a mean of 11.1 × 8.3 μ; their length-width ratios ranged from 1.1–1.6, with a mean of 1.36. Oocyst polar granule present. Oocyst residuum composed of one to many clear globules up to 9 μ or more in diameter; among 38 oocysts in which this feature was recorded, there was 1 globule in 30, 2 to 3 in 7, and many small ones in one oocyst. Sporocyst Stieda body medium-sized. Scattered residual granules usually present in sporocyst. Sporozoites lie lengthwise in sporocysts.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Neotoma albigula (white-throated wood rat).

Location: Intestinal contents.

Geographic Distribution: Mexico (Sonora).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in one out of five *N. albigula* near Agua Prieta, Sonora, Mexico.

EIMERIA SP. BOYER AND SCORZA, 1957

Eimeria sp. Boyer and Scorza, 1957: 59–67.

Description: Oocysts 21 × 13 μ. Oocyst residuum very small. Sporozoites kidney-shaped. Sporocyst residuum present.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Zygodontomys brevicauda.

Location: Intestine.

Geographic Distribution: South America (Venezuela).

Pathogenicity: Unknown.
Cross-Transmission Studies: None.

EIMERIA SP. BOYER AND SCORZA, 1957

Eimeria sp. Boyer and Scorza, 1957: 59–67.

Description: Oocysts 16×12 μ. Oocyst residuum large. Sporozoites in the form of a closed C.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Zygodontomys brevicauda.
Location: Intestine.
Geographic Distribution: South America (Venezuela).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

Host Suborder MYOMORPHA
Host Superfamily MUROIDEA
Host Family MURIDAE
Host Subfamily CRICETINAE
Host Tribe CRICETINI

EIMERIA CRICETI NÖLLER, 1920 Emend. PELLÉRDY, 1956

Eimeria falciformis var. *criceti* Nöller, 1920: 180–182.
Eimeria criceti Pellérdy, 1956: 75–102.

Description: Oocysts spherical to subspherical, 11–22 μ in diameter. Oocyst residuum absent. Sporocysts quite plump.
Sporulation Time: Two to four days at room temperature.
Schizogony and Gametogony: Nöller (1920) did not describe these processes but stated that they were similar to those of *E. falciformis* of the mouse, except that they took place in the cecum and colon rather than in the small intestine.
Prepatent Period: Unknown.
Type Host: Cricetus cricetus (hamster).
Location: Cecum and colon. The schizonts and gametocytes are found in the epithelial cells adjacent to the intestinal lumen, and not in those in the crypts.
Geographic Distribution: Europe (Germany).
Pathogenicity: Unknown. Hill (1952) reported that coccidiosis caused the death of a hamster in the London zoo, but did not describe the organism.
Cross-Transmission Studies: None.
Prevalence: This species was found in over 50 per cent of the young

hamsters examined by Nöller (1920) in Thüringen. He never found it, however, in hamsters more than six weeks old, and animals found to be infected at two to four weeks of age were free of coccidia a few weeks later.

Remarks: Although Nöller (1920) described this species as a variety of *E. falciformis* whose host is *Mus musculus,* it occurs in a different part of the intestine, and in view of this and of the narrow host specificity of *Eimeria* species, Pellérdy (1956) rightly designated it *Eimeria criceti.* Since the specific name *criceti* was first used by Nöller (1920) as a varietal designation, nomenclatorial practice retains him as the author.

EIMERIA MIGRATORIA MUSAEV AND VEĬSOV, 1961

(Plate 16, Fig. 107)

Eimeria migratoria Musaev and Veĭsov, 1961: 971–975.

Description: Oocysts spherical or subspherical. Oocyst wall smooth, colorless, composed of a single layer 1.5 μ thick. Micropyle absent. Fifty-six sporulated oocysts from four specimens were 15–23 μ in diameter with a mean of 19 μ. Oocyst residuum absent. Two or sometimes three polar granules present. Sporocysts ovoid or spherical; ovoid sporocysts 6–11 × 4–9 μ, with a mean of 10 × 7 μ; spherical sporocysts 6–8 μ in diameter with a mean of 7 μ. Stieda body absent. Sporocyst residuum composed of small granules located mostly between the sporozoites; a larger refractile body is also present between the sporozoites. Sporozoites bean-shaped.

Sporulation Time: Two days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Cricetulus migratorius (grey hamster).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Musaev and Veĭsov (1961) found this species in 4 out of 64 specimens of *Cricetulus migratorius* from three regions of Nakhichevan ASSR, Azerbaĭdzhan SSR.

EIMERIA IMMODULATA MUSAEV AND VEĬSOV, 1961

(Plate 17, Figs. 111 and 112)

Eimeria immodulata Musaev and Veĭsov, 1961: 971–975.

Description: Oocysts ovoid or ellipsoidal. Oocyst wall smooth, yellow-brown, composed of a single layer 1.0–1.5 μ thick. Micropyle absent. Fifty-two sporulated oocysts from five specimens were 18–24 × 12–19 μ,

with a mean of 21×16 μ; their length-width ratios ranged from 1.2–1.6, with a mean of 1.4. Oocyst residuum absent. Oocyst polar granule sometimes present. Sporocysts ovoid, 6–10×4–8 μ, with a mean of 9×6 μ. Stieda body absent. Sporocyst residuum composed of small granules located in different parts of the sporocyst. Sporozoites pear-shaped, rarely bean-shaped, with a prominent refractile globule in the broad end.

Sporulation Time: Three days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Cricetulus migratorius (grey hamster).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Musaev and Veĭsov (1961) found this species in 5 out of 64 speciments of *C. migratorius* from three localities in Nakhichevan ASSR, Azerbaĭdzhan SSR.

EIMERIA CRICETULI MUSAEV AND VEĬSOV, 1961

(Plate 16, Fig. 108)

Eimeria cricetuli Musaev and Veĭsov, 1961: 971–975.

Description: Oocysts ovoid. Oocyst wall smooth, colorless, composed of a single layer 2 μ thick. Micropyle absent. Twenty-five sporulated oocysts from one specimen measured 30–35×24–31 μ, with a mean of 33×266.48 [*sic*] μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.2. Oocyst residuum absent. Oocyst polar granule present. Sporocysts ovoid, 10–15×6–11 μ, with a mean of 13×9 μ. Stieda body absent. Sporocyst residuum composed of small granules. Sporozoites bean-shaped.

Sporulation Time: Four days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Cricetulus migratorius (grey hamster).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Musaev and Veĭsov (1961) found this species in 1 out of 64 *C. migratorius* from the Yardymlin region of Azerbaĭdzhan.

EIMERIA JARDIMLINICA MUSAEV AND VEĬSOV, 1961

(Plate 16, Figs. 109 and 110)

Eimeria jardimlinica Musaev and Veĭsov, 1961: 971–975.

Description: Oocysts ovoid, rarely ellipsoidal. Oocyst wall smooth, colorless, composed of a single layer 1.5 μ thick. Micropyle absent. Fourteen sporulated oocysts from one specimen were 22–27 × 16–21 μ, with a mean of 24 × 19 μ; their length-width ratios ranged from 1.2–1.5, with a mean of 1.3. Oocyst residuum spherical or ovoid; ovoid residua 6–9 × 4–7 μ, with a mean of 8 × 6 μ; spherical residua 6–8 μ in diameter, with a mean of 7 μ. Oocyst polar granule absent. Sporocysts ovoid, 10–13 × 6–9 μ, with a mean of 11 × 7 μ. Stieda body absent. Sporocyst residuum composed of small granules often located between the sporozoites. Sporozoites comma-shaped, with a refractile globule in the broad end.

Sporulation Time: Two days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Cricetulus migratorius (grey hamster).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Musaev and Veĭsov (1961) found this species in 1 out of 64 *C. migratorius* from the Yardymlin region of Azerbaĭdzhan.

EIMERIA ARUSICA MUSAEV AND VEĬSOV, 1961

(Plate 17, Fig. 113)

Eimeria arusica Musaev and Veĭsov, 1961: 971–975.

Description: Oocysts spherical or subspherical, yellow. Oocyst wall smooth, composed of two layers each 1 μ thick, the outer layer colorless and the inner layer dark brown. Micropyle absent. Twenty-six sporulated oocysts from two specimens were 20–26 μ in diameter, with a mean of 23 μ. Oocyst residuum spherical or ovoid (illustrated as a homogeneous body); spherical residua 6–8 μ in diameter, with a mean of 7 μ; ovoid residua 8 × 6 μ. Oocyst polar granule absent. Sporocysts ovoid, 10–13 × 6–9 μ, with a mean of 11 × 7 μ. Stieda body present. Sporocyst residuum composed of small granules located between the sporozoites. Sporozoites comma- or bean-shaped.

Sporulation Time: Four days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.
Type Host: Cricetulus migratorius (grey hamster).
Location: Large intestine contents.
Geographic Distribution: USSR (Azerbaĭdzhan).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Musaev and Veĭsov (1961) found this species in 2 out of 64 *C. migratorius* from the outskirts of the village of Arus in the Yardymlin region of Azerbaĭdzhan.

Host Suborder MYOMORPHA
Host Superfamily MUROIDEA
Host Family MURIDAE
Host Subfamily MICROTINAE
Host Tribe LEMMINI

EIMERIA DICROSTONICIS LEVINE, 1952

(Plate 17, Fig. 120)

Eimeria dicrostonicis Levine, 1952 (1951): 205–208.

Description: Oocysts ellipsoidal. Oocyst wall composed of two layers: the outer one yellowish brown, a little more than 1 μ thick, with a rough, pitted surface; the inner layer colorless and about 0.5 μ thick. Micropyle absent. Twenty-nine oocysts from two lemmings measured 23–27 × 27–31 μ, with a mean of 24.8 × 29.1 μ. Their length-width ratios ranged from 1.1–1.3, with a mean of 1.2. One or occasionally two oocyst polar granules present. Oocyst residuum absent, occasionally represented by a few small granules. Sporocysts 7–9 × 13–15 μ, with a mean of 8.4 × 14.0 μ; sporocyst length-width ratio 1.5–1.8, with a mean of 1.7. Sporocysts ellipsoidal but slightly pointed at either end. Either no Stieda body or a very small one present. Sporocyst residuum absent, occasionally represented by a few small granules. Sporozoites lie lengthwise in the sporocysts, with the broad end of one beside the narrow end of the other.

Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Dicrostonyx groenlandicus richardsoni (varying lemming).
Location: Feces.
Geographic Distribution: North America (Canadian Northwest Territory).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Levine (1952) found this species in 5 of 14 *D. g. richardsoni* from the mouth of the Perry River on the Arctic Ocean.

Host Suborder MYOMORPHA
Host Superfamily MUROIDEA
Host Family MURIDAE
Host Subfamily MICROTINAE
Host Tribe MICROTINI

EIMERIA ARVICOLAE (GALLI-VALERIO, 1905) REICHENOW, 1921

Coccidium arvicolae Galli-Valerio, 1905: 519–522.

Eimeria arvicolae (Galli-Valerio) Reichenow, 1921: 1136–1277; Iwanoff-Gobzem, 1934: 149–151; Svanbaev, 1956: 180–191; Svanbaev, 1958: 183–186 (?).

Eimeria arvalis Iwanoff-Gobzem, 1934: 149–151 (an invalid emendation, with no nomenclatural status).

Eimeria musculi Yakimoff and Gousseff. Svanbaev, 1956: 180–191 (from *Microtus arvalis*).

[*non*] *Eimeria musculi* Yakimoff and Gousseff, 1938: 1–3; Svanbaev, 1956: 180–191 (from *Apodemus sylvaticus*—see *E. russiensis*) (from *Mus musculus*—see *E. musculi*).

[*non*] *Eimeria arvicolae:* Musaev and Veĭsov, 1960: 51–61 (see *E. batabatensis*).

Description: Oocysts spherical, 14–18 μ in diameter. Oocyst wall clear, with double contour. Sporont cytoplasm finely granular, somewhat yellowish. The above is all the information given by Galli-Valerio (1905) in his original description of this species from *Microtus nivalis.*

The form described by Iwanoff-Gobzem (1934) under this name from *M. arvalis* had ovoid oocysts, 13–28 × 11–21 μ, with a mean of 20.1 × 16.3 μ. Their length-width ratios ranged from 1.1–1.2, with a mean of 1.18. They lacked oocyst and sporocyst residua. No other information was given.

Svanbaev (1956) described two forms from *M. arvalis.* One form, designated *E. arvicolae,* had ovoid, greenish oocysts with a smooth, double-contoured wall 1.5 μ thick and without a micropyle. Its oocysts measured 22.5 × 18.8 μ. Oocyst polar granule and oocyst and sporocyst residua were absent. The sporocysts were ovoid and 12.3 × 8.8 μ. Svanbaev's second form, which he designated *E. musculi,* differed from the first form only in having spherical oocysts 22.0 μ in diameter, sporocysts 13.2 × 8.8 μ, and somewhat smaller sporozoites.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Microtus (syn., *Arvicola) nivalis* (snow vole).

Other Hosts: Microtus arvalis (common European vole); *Alticola strelzovi* (Strelzov's vole) (?).

Location: Intestine.

Geographic Distribution: Europe (Switzerland), USSR (Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Iwanoff-Gobzem (1934) found her form in 9 out of 22 *M. arvalis* in Kazakhstan. Svanbaev (1956) found both his spherical and ovoid forms in 2 out of 33 *M. arvalis* in western Kazakhstan; they were present in the same individuals.

Remarks: Although Iwanoff-Gobzem (1934) believed that the form she found in *Microtus arvalis* was identical with that described by Galli-Valerio (1950) from *M. nivalis,* it differed from it in being ovoid rather than spherical. However, both of their descriptions were very incomplete. Svanbaev (1956) found what he considered two species of *Eimeria* in *M. arvalis.* The only essential difference between them was in shape. He considered the ovoid form to be *E. arvicolae* and the spherical one *E. musculi.* However, if Galli-Valerio's (1905) original description had been followed, Svanbaev should have referred the spherical form to *E. arvicolae.* Furthermore, in view of the failure of all attempts at transmitting *Eimeria* from one rodent genus to another, it is highly unlikely that the same species would occur in two rodents of different subfamilies. *E. musculi* was originally described from *Mus musculus* (subfamily Murinae), while *Microtus* belongs to the subfamily Microtinae. Finally, the great similarity between Svanbaev's two forms from *M. arvalis* and the fact that they were both found in the same two voles out of 33 examined suggest that they most likely belong to the same species.

Svanbaev (1958) reported finding *E. arvicolae* oocysts in 4 of 43 Strelzov's voles *(Alticola strelzovi)* in Central Kazakhstan. He did not describe them.

EIMERIA MICROTINA MUSAEV AND VEĬSOV, 1959

(Plate 17, Fig. 114)

Eimeria microtina Musaev and Veĭsov, 1959: 45–50.

Description: Oocysts spherical, sometime slightly ovoid. Oocyst wall smooth, colorless, 0.8 μ thick, apparently composed of a single layer. Micropyle absent. Fifty sporulated oocysts from one animal were measured. The spherical ones were 16 μ in diameter and the ovoid ones were 12–18 × 11–16 μ, with a mean of 16 × 15 μ. Oocyst residuum present. Oocyst polar granule absent. Sporocysts ovoid, 5–8 × 4–5 μ, with a mean of 7 × 4 μ. Stieda body conspicuous. Sporocyst residuum present, composed of rather small granules. Sporozoites illustrated with a clear globule at the large end.

Sporulation Time: Three days in 2.5% potassium dichromate solution at 25–30C.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Sporogony: Not described.
Type Host: Microtus socialis (social vole).
Location: Intestinal contents.
Geographic Distribution: USSR. Musaev and Veĭsov (1959) found the host animal in a freight car carrying goods from Iran to Dzhul'fa, Azerbaĭdzhan.
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Unknown.

EIMERIA DZHULFAENSIS MUSAEV AND VEĬSOV, 1959

Eimeria dzhulfaensis Musaev and Veĭsov, 1959: 45–50.

Description: Oocysts spherical, sometimes slightly ovoid. Oocyst wall rough, composed of two layers, of which the outer is 1.2 μ thick and dark brown and the inner is 0.2 μ thick. Micropyle absent. Fifty sporulated oocysts were measured. The spherical ones were 24 μ in diameter and the ovoid ones were 21–25×20–24 μ, with a mean of 24×21 μ. Oocyst residuum and polar granule present. Sporocysts ovoid with a pointed end, 11–14×6–9 μ, with a mean of 12.5×8 μ. Stieda body prominent. Sporocyst residuum present, composed of fine granules. Sporozoites pear-shaped, with a small globule at the broad end.
Sporulation Time: Three days in 2.5% potassium dichromate solution at 25–30C.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Sporogony: Not described.
Type Host: Microtus socialis (social vole).
Location: Intestinal contents.
Geographic Distribution: USSR (Azerbaĭdzhan).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Musaev and Veĭsov (1959) found this species in 11 (6 per cent) of 169 voles from Dzhul'fin and other regions of Azerbaĭdzhan.

EIMERIA WENRICHI SAXE, LEVINE, AND IVENS, 1960

(Plate 17, Figs. 115 and 116)

Eimeria wenrichi Saxe, Levine, and Ivens, 1960: 61–63.
Eimeria species A. Saxe, 1952: 13.
Eimeria species B. Saxe, 1952: *Ibid.*

Description: Oocysts ellipsoidal to ovoid. Oocyst wall composed of a single layer. Micropyle absent. Oocysts of two nonoverlapping sizes but without any other morphological differences. Fifty-six of the larger

oocysts measured 16–22 × 12–16 μ, with a mean of 18.9 × 14.3 μ; their length-width ratios ranged from 1.1–1.6, with a mean of 1.32. Fourteen sporocysts of this form measured 9–11 × 5–8 μ, with a mean of 9.7 × 6.0 μ; their length-width ratios ranged from 1.3–2.0, with a mean of 1.62. Thirty-one oocysts of the smaller form measured 11–15 × 8–11 μ, with a mean of 12.8 × 9.8 μ; their length-width ratios ranged from 1.1–1.7, with a mean of 1.31. Ten sporocysts of this form measured 6.5–7.5 × 4 μ, with a mean of 6.9 × 4.0 μ; their length-width ratios ranged from 1.6–1.9, with a mean of 1.72. Oocyst polar granule present. Oocyst residuum absent. Sporocysts ovoid, with Stieda body. Sporocyst residuum present, compact.

Sporulation Time: Two to three days at room temperature (24–27C) in 1% chromic acid.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Microtus pennsylvanicus (meadow mouse).

Location: Cecal contents.

Geographic Distribution: United States (Pennsylvania).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in a single meadow mouse.

EIMERIA BOHEMICA RYŠAVÝ, 1957

(Plate 17, Figs. 117 and 118)

Eimeria bohemica Ryšavý, 1957: 331–336.

Description: Oocysts ellipsoidal, pale yellowish brown. Oocyst wall apparently smooth, illustrated as composed of a single layer. Micropyle prominent, 4–4.4 μ wide. Oocysts 19–23 × 11–13 μ, with a mean of 20 × 12 μ; most oocysts measured 21 × 11 μ. Oocyst residuum a small, dark, spherical body 2 μ in diameter. Oocyst polar granule apparently absent. Sporocysts ovoid, 9.5 × 6 μ. Sporocyst residuum present, finely granular. Stieda body not illustrated.

Sporulation Time: Three days in 2% potassium dichromate solution at 24C.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Arvicola terrestris (water vole).

Location: Feces.

Geographic Distribution: Europe (Czechoslovakia).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Ryšavý (1957) found this species in 3 out of 21 *A. terrestris* near Jindřichova Hradce, southern Czechoslovakia.

EIMERIA BATABATENSIS N. SP.

(Plate 17, Fig. 119)

Eimeria arvicolae Galli-Valerio. Musaev and Veĭsov, 1960: 51–61.

Description: Oocysts ovoid, colorless. Oocyst wall smooth, described as double-contoured but illustrated with a single layer, 1 μ thick. Micropyle absent. Forty-one sporulated oocysts measured 14–20 × 10–16 μ, with a mean of 19 × 15 μ; their length-width ratios ranged from 1.1–1.5, with a mean of 1.32. Oocyst residuum and polar granule absent. Sporocyst ovoid, rarely spherical; ovoid sporocysts 6–8 × 4–6 μ, with a mean of 7 × 4 μ; spherical sporocysts 4–6 μ in diameter, with a mean of 6 μ. Sporocyst residuum present, composed of small granules. Stieda body absent. Sporozoites comma-shaped, with a small globule at the large end.

Sporulation Time: Two days in 2.5% potassium dichromate at 25–30C.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Arvicola terrestris (water vole).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan). Musaev and Veĭsov (1960) found this species in water voles on the summer pastures of Batabat (2400 m above sea level) in the Shakhbuz region of Nakhichevan, Azerbaĭdzhan SSR.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

Remarks: Although Musaev and Veĭsov (1960) called this form *Eimeria arvicolae,* it differs morphologically from that species in having a sporocyst residuum. In addition, it occurs in a different host genus. (The hosts of *E. arvicolae* are *Microtus nivalis* and *M. arvalis;* both of these voles were formerly thought to be members of the genus *Arvicola;* however, according to Ellerman and Morrison-Scott (1951), the only species now accepted in this genus is *A. terrestris.)* We are therefore naming it *Eimeria batabatensis* n. sp.

EIMERIA TERRESTRIS MUSAEV AND VEISOV, 1960

(Plate 18, Fig. 121)

Eimeria terrestris Musaev and Veĭsov, 1960: 51–61.

Descriptions: Oocysts ovoid, rarely ellipsoidal, colorless or light yellow. Oocyst wall smooth, tri-contoured and double-layered, 1.5–2 μ thick; outer layer colorless to yellowish, inner layer dark yellow or brown. Micropyle prominent. Fifty sporulated oocysts from six animals measured 18–22 × 12–16 μ, with a mean of 21 × 16 μ; their length-width ratios ranged from 1.2–1.5, with a mean of 1.37. Oocyst residuum and polar granule

absent. Sporocysts usually ovoid, rarely spherical, 6–8×4–6 μ, with a mean of 8×6 μ. Sporocyst residuum present, composed of small granules which often form a ball. Stieda body absent. Sporozoites pear-shaped, rarely comma-shaped.

Sporulation Time: Three to 3.5 days in 2.5% potassium dichromate at 25 to 30C.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Arvicola terrestris (water vole).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan). Musaev and Veĭsov (1960) found this species in water voles on the summer pastures of Batabat (2400 m. above sea level) in the Shakhbuz region of Nakhichevan, Azerbaĭdzhan SSR.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA TALISCHAENSIS MUSAEV AND VEĬSOV, 1960

(Plate 18, Fig. 122)

Eimeria talischaensis Musaev and Veĭsov, 1960: 51–61.

Description: Oocysts spherical, colorless. Oocyst wall smooth, tri-contoured and double-layered, 1.5–2 μ thick; each layer 1 μ thick; outer layer colorless, inner layer light yellowish brown. Micropyle absent. Ten sporulated oocysts were 18–22 μ in diameter, with a mean of 21 μ. Oocyst residuum absent. Oocyst polar granule present. Sporocysts spherical or ovoid; spherical sporocysts 4–8 μ in diameter, with a mean of 6 μ; ovoid sporocysts 4–8×2–8 μ, with a mean of 6×5.6 μ. Sporocyst residuum composed of small granules. Stieda body absent. Sporozoites comma-shaped, rarely pear-shaped, with a clear globule at the broad end.

Sporulation Time: Two days in 2.5% potassium dichromate at 25–30C.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Arvicola terrestris (water vole).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan). Musaev and Veĭsov (1960) found this species in water voles on the summer pastures of Batabat (2400 m. above sea level) in the Shakhbuz region of Nakhichevan and in the mountain zone of the Yadymlin region, both in Azerbaĭdzhan.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA SP. (RYŠAVÝ, 1954)

Eimeria falciformis (Eimer). Ryšavý, 1954: 131–174 (*pro parte*).
[*non*] *Eimeria falciformis* (Eimer, 1870) Schneider, 1875: xl–xlv.

Description: Uncertain.
Host: Microtus arvalis (vole).
Location: Feces.
Geographic Distribution: Czechoslovakia.
Remarks: Ryšavý (1954) reported *E. falciformis* from *Mus musculus, Apodemus flavicollis, A. sylvaticus, Microtus arvalis,* and *Clethrionomys glareolus* in Czechoslovakia. The description he gave was similar to that of *E. falciformis,* but he did not describe the forms from each host separately. He was apparently unaware of Galli-Valerio's (1932, 1940) and Pellérdy's (1954) descriptions of six species of *Eimeria* from *Apodemus* or of Iwanoff-Gobzem's (1934) report of *E. arvicolae* from *Microtus arvalis,* nor was he aware of Pellérdy's (1954) inability to transmit any of his *Apodemus* coccidia to *Mus musculus, Microtus arvalis, Clethrionomys* (syn., *Evotomys) glareolus,* or *Cricetus cricetus.* It is very doubtful that the forms Ryšavý saw in the hosts other than *M. musculus* were *E. falciformis.* However, since he did not describe them separately from each host, it is useless to attempt to assign names to them.

EIMERIA ONDATRAZIBETHICAE MARTIN, 1930 Emend.

Plate 35, Figs. 289 and 290)

Eimeria ondatrae-zibethicae Martin, 1930: 273–278; Svanbaev, 1962a: 206–207.
Eimeria stiedae (Lindemann) Kisskalt and Hartmann. Law and Kennedy, 1932.
[*non*] *Eimeria stiedae* (Lindemann, 1865) Kisskalt and Hartmann, 1907.

Description: Oocysts mostly ellipsoidal, but also spherical, ovoid, or cylindrical. Seventy-five oocysts measured 19–28 × 13–26 μ, with a mean of 22.3 × 18.0 μ. One spherical oocyst was 10 μ in diameter. Oocyst length-width ratio 1.0–1.7, with a mean of 1.14. Oocyst wall brownish, very thick, smooth, with a double contour, occasionally radially striated, sometimes with one end flattened. Micropyle well developed in some oocysts and not visible in others. Sporocysts 12–17 × 8–11 μ, with a mean of 13.9 × 9.7 μ. A small oocyst residuum may or may not be present. Oocyst polar granule not mentioned or illustrated. Sporocysts with Stieda body and small residuum. According to Svanbaev (1962a), the oocysts are ellipsoidal or spherical, 22–35 × 18–27 μ, with a mean of 28.5 × 22.5 μ; their length-width ratio ranges from 1.2–1.3, with a mean of 1.3; the oocyst wall is smooth, greenish to yellow-green, 1.3–1.8 μ thick, with a micropyle; an oocyst polar granule is absent; the sporocysts are spherical, ellipsoidal, or ovoid, 13–15 × 8–9 μ, with a mean of 14 × 8.5 μ; the sporocyst residuum is in the form of small granules; the sporozoites are comma-shaped or piriform, 8–11 × 3–5 μ, with a mean of 9.5 × 4 μ.

Sporulation Time: Five days in 5% potassium dichromate at 21–27C.

Schizogony and Gametogony: One microgametocyte measured by Martin (1930) was 10×11 μ and another was 22×23 μ. One macrogamete was 15×17 μ and another was 15×30 μ. These were apparently in epithelial cells of the jejunum.

Prepatent Period: Unknown.

Type Host: Ondatra zibethica (muskrat).

Location: Jejunum, liver.

Geographic Distribution: North America (Nebraska, Maryland, New York, Wisconsin, Ontario); USSR (Kazakhstan).

Pathogenicity: This species can be highly pathogenic. In an outbreak described by Martin (1930) among muskrats kept under a condition of semi-domestication in Nebraska, about 100 animals died in a comparatively short period. Deaths occurred most commonly among the young animals, and whole litters sometimes succumbed. Shillinger (1938) reported high mortality among wild muskrats in Wisconsin during a drought when the water level was low and the animals' passageways became muddy and contaminated with feces. LeCompte (1933) reported a death due to coccidiosis in a muskrat in Maryland.

Martin (1930) described the lesions caused by this species. He found an intense hemorrhagic enteritis of the jejunum. The intestinal lumen was filled with blood and debris. Microscopically, the intestinal epithelium was desquamated and in some instances almost completely denuded. There was extensive hemorrhage into the lumen of the intestine. Vascular congestion and round cell infiltration were noted. The liver contained many small, white foci up to 2 mm. in diameter. They were due to focal necrosis and vascular congestion. Oocysts were also found in the liver.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1962a) found this coccidum in 21 per cent of 38 *O. zibethica* in northern Kazakhstan.

Prevalence: Bump (1942) found *Eimeria* sp. (presumably *E. ondatra-zibethicae)* in 31 of 91 muskrats in New York. He did not describe them.

EIMERIA RYSAVYI N. SP.

(Plate 18, Figs. 123, 124, and 125)

Eimeria apodemi Pellérdy. Ryšavý, 1957: 331–336.

[*non*] *Eimeria apodemi* Pellérdy, 1954: 187–191.

Eimeria hindlei Yakimoff and Gousseff. Ryšavý, 1954: 131–174 (*pro parte*); Černa, 1962: 1–13.

[*non*] *Eimeria hindlei* Yakimoff and Gousseff, 1938: 1–3.

Description: According to Ryšavý (1957), the oocysts are broadly ellipsoidal, a few almost subspherical, and some rather asymmetrical, $23–29 \times 18–23$ μ, with a mean of 25×20 μ; most of the oocysts were

25×19 μ. Oocyst wall rather thick, pale yellowish brown, illustrated as smooth and composed of a single layer. Micropyle absent. Sporocysts ovoid. Sporocyst residuum large and prominent. Ryšavý (1957) gave no other morphological information; he illustrated an unsporulated oocyst.

According to Černa (1962), the oocysts were mostly ellipsoidal ("oval"), sometimes ovoid, 20–30×17–21 μ; the oocyst wall was smooth, illustrated as composed of a single layer, yellowish to light brown; a micropyle was absent. The sporocysts were ellipsoidal ("oval"), 11–12×6–7 μ, illustrated without a Stieda body. Oocyst polar granule and oocyst residuum were absent, but a small amount of sporocyst residual material was present. The sporozoites lay lengthwise in the sporocysts; each contained a clear globule at one end.

Sporulation Time: Four to five days in 2% potassium dichromate solution.

Schizogony: Unknown.

Gametogony: According to Černa (1962), gametogony occurs primarily in the duodenum and jejunum, and only occasionally in the ileum. The sexual stages are found in the mucosa and submucosa. The mature microgametocytes measured 29–44×18–33 μ. The microgametes were about 2 μ long. The mature macrogametes measured 16–23×17.5 μ.

Prepatent Period: Unknown.

Type Host: Clethrionomys glareolus (common red-backed vole).

Location: Sexual stages in duodenum, jejunum, and occasionally ileum.

Geographic Distribution: Czechoslovakia.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Ryšavý (1957) found this species in 2 out of 14 *C. glareolus* from the vicinity of Jindřichova Hradce, southern Czechoslovakia. Černa (1962) found it in Můstek, Šumava, Czechoslovakia.

Remarks: Ryšavý (1957) reported this species in the red-backed vole under the name *Eimeria apodemi.* Since, however, Pellérdy (1954) was unable to transmit *E. apodemi* from *Apodemus* to *Clethrionomys,* this identification cannot be correct, and we are naming Ryšavý's form *Eimeria rysavyi* n. sp.

Ryšavý (1954) also described what was undoubtedly the same form under the name *Eimeria hindlei* from *C. glareolus* and *Apodemus sylvaticus* in Czechoslovakia. He did not differentiate between the forms from the two hosts, the oocysts failed to sporulate, and he was apparently unaware at that time of Galli-Valerio's (1932, 1940) and Pellérdy's (1954) descriptions of six species of *Eimeria* from *Apodemus* or of Pellérdy's inability to transmit any of his *Apodemus* coccidia to *Mus musculus* or *C. glareolus.* Since the type host of *E. hindlei* is *Mus musculus,* it is clear that Ryšavý's form does not belong to this species.

Černa (1962) gave further information regarding what was undoubtedly the same species from *C. glareolus,* referring it to Ryšavý's *"E. hindlei"* from this host.

EIMERIA CERNAE N. SP.

(Plate 19, Fig. 132)

Eimeria schueffneri Yakimoff and Gousseff. Černa, 1962: 1–13.
[*non*] *Eimeria schueffneri* Yakimoff and Gousseff, 1938: 1–3.

Description: Oocysts 13–23 × 11–17 μ, ellipsoidal, with a very thin wall. Micropyle absent. Oocyst residuum absent. Oocyst polar granule sometimes present. Sporocysts mostly ellipsoidal ("oval"), 9–15 × 4–7 μ; occasionally spherical, 6 μ. Sporocyst residuum and Stieda body absent. Sporozoites illustrated as lying longitudinally in sporocysts.

Sporulation Time: Two to four days in 1.5% potassium dichromate solution.

Schizogony: Unknown.

Gametogony: According to Černa (1962), gametogony occurs in the epithelium of the cecum. The mature microgametocytes are 8–15 × 6–11 μ and the mature macrogametes 11–15 × 6–12 μ.

Prepatent Period: Unknown.

Type Host: Clethrionomys glareolus (common red-backed vole).

Location: Cecum.

Geographic Distribution: Czechoslovakia.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

Remarks: Černa (1962) described this species under the name *E. schueffneri.* However, the latter is a parasite of *Mus musculus,* and, for the reasons given under *E. rysavyi,* this identification cannot be correct; therefore, we are naming Černa's form *Eimeria cernae* n. sp.

Černa (1962) said in her text that she found the same form in *Apodemus sylvaticus,* and in her table she listed it in *Microtus arvalis* and *"P. subterraneus."* However, in the absence of any description of the forms from these hosts, it is impossible to know what species she was dealing with.

EIMERIA SP. (RYŠAVÝ, 1954)

Eimeria falciformis (Eimer). Ryšavý, 1954: 131–174 (*pro parte*); Černa and Daniel, 1956: 19–23 (*pro parte*).
[*non*] *Eimeria falciformis:* Schneider, 1875: xl–xlv.

Description: Uncertain.

Host: Clethrionomys glareolus (common red-backed vole).

Location: Feces.

Geographic Distribution: Czechoslovakia.

Remarks: Ryšavý (1954) reported *E. falciformis* from *Mus musculus, Apodemus flavicollis, A. sylvaticus, Microtus arvalis,* and *Clethrionomys glareolus* in Czechoslovakia. For the reasons given in the discussion of these forms in *Microtus arvalis* (p. 81) it is very doubtful that the forms Ryšavý saw in the hosts other than *M. musculus* were *E. falciformis,* but it is useless to attempt to assign names to them.

Černa and Daniel (1956) reported *E. falciformis* from *Clethrionomys glareolus* and *Apodemus flavicollis* in Czechoslovakia. They gave the same dimensions as Ryšavý, but mentioned that the oocyst wall was more than 1 μ thick. For the same reasons, these forms were undoubtedly not *E. falciformis,* but cannot be assigned separate names.

EIMERIA (?) SP. ČERNA and DANIEL, 1956

Eimeria sp. Černa and Daniel, 1956: 19–23.

This form, which failed to sporulate, was found by Černa and Daniel (1956) in *Clethrionomys glareolus* and *Apodemus flavicollis* in Czechoslovakia. For further information see its description under *A. flavicollis* (p. 115).

Host Suborder MYOMORPHA

Host Superfamily MUROIDEA

Host Family MURIDAE

Host Subfamily MICROTINAE

Host Tribe ELLOBIINI

EIMERIA ELLOBII SVANBAEV, 1956

(Plate 36, Fig. 293)

Eimeria ellobii Svanbaev, 1956: 180–191.

Description: Oocysts ovoid, greenish, 30.1 × 24.2 μ, with a smooth wall 1.3–1.7 μ thick composed of two layers. Oocyst length-width ratio 1.25. Micropyle absent. Oocyst polar granule present. Oocyst residuum absent. Sporocysts spherical, 8.8 μ in diameter. Stieda body presumably absent. Sporocyst residuum present. Sporozoites kidney-shaped, 6.5 × 5.6 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Ellobius talpinus (mole lemming).

Location: Feces.

Geographic Distribution: USSR (western Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1956) found this species in three out of ten *E. talpinus* in western Kazakhstan. The same three individuals were infected with *Eimeria talpini* and *E. kazakhstanensis.*

EIMERIA KAZAKHSTANENSIS N. SP.

Eimeria volgensis Sassuchin and Rauschenbach. Svanbaev, 1956: 180–191. [*non*] *Eimeria volgensis* Sassuchin and Rauschenbach, 1932: 646–650.

Description: Oocysts ovoid, greenish to occasionally yellowish brown, with a smooth, colorless [*sic*], single-layered wall 1.6 μ thick. Oocysts 27.5×24.2 μ. Oocyst length-width ratio 1.14. Micropyle at narrow end of oocyst, small. Oocyst polar granule present in unsporulated oocyst. Oocyst residuum absent. Sporocysts ovoid or pear-shaped, 11–13×7–8 μ, with a mean of 12.2×7.2 μ. Stieda body not mentioned. Sporocyst residual granules present. Sporozoites oval, 8.4×5.9 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Ellobius talpinus (mole lemming).

Location: Feces.

Geographic Distribution: USSR (western Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1956) found this species in three out of ten *E. talpinus* in western Kazakhstan. The same three individuals were infected with *Eimeria ellobii* and *E. talpini.*

Remarks: Svanbaev (1956) described this species under the name *E. volgensis* Sassuchin and Rauschenbach, 1932. He did not give an illustration. While it was similar in general to this species, it had a small rather than a large micropyle and apparently did not have the pointed micropylar end characteristic of *E. volgensis.* Furthermore, the two hosts belong to widely separate rodent groups. *Spermophilus,* the host genus of *E. volgensis,* is a member of the suborder Sciuromorpha, while *Ellobius* is a member of the suborder Myomorpha. Cross-transmission of *Eimeria* between these genera is extremely doubtful, and in the absence of proof to the contrary should be ruled out. Hence we have assigned this form the name *Eimeria kazakhstanensis* n. sp.

EIMERIA TALPINI N. SP.

Eimeria beckeri Yakimoff and Sokoloff. Svanbaev, 1956: 184–185 (in *Ellobius talpinus*).

Description: Oocysts spherical, 24.2 μ in diameter. Oocyst wall smooth, colorless, 1.5 μ thick, composed of two layers. Micropyle absent. Oocyst polar granule absent. Oocyst residuum absent. Sporocysts oval, 11.0×8.8 μ. Stieda body not mentioned. Sporocyst residual granules present.

Sporozoites 6.5×3.7 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Ellobius talpinus (mole lemming).

Location: Feces.

Geographic Distribution: USSR (western Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1956) found this species in three out of ten *E. talpinus* in western Kazakhstan. The same three individuals were infected with *Eimeria ellobii* and *E. kazakhstanensis.*

Remarks: Svanbaev (1956) described this species under the name *E. beckeri* Yakimoff and Sokoloff. He did not give an illustration. While it was similar in general to this species, it was always spherical rather than ovoid to spherical. Furthermore, the two hosts belong to widely separate rodent groups. *Spermophilus,* the host genus of *E. beckeri,* is a member of the suborder Sciuromorpha, while *Ellobius* is a member of the suborder Myomorpha. For the reasons given under *E. kazakhstanensis* (p. 86), we are assigning this form the name *E. talpini* n. sp.

Host Suborder MYOMORPHA

Host Superfamily MUROIDEA

Host Family MURIDAE

Host Subfamily GERBILLINAE

EIMERIA MERIONIS MACHUL'SKIĬ, 1949

Eimeria merionis Machul'skiĭ, 1949.

Eimeria marionis [*sic*]: Svanbaev, 1956: 180–191; Svanbaev, 1962: 23–39.

Description: Original form from *Meriones unguiculatus:* Oocysts ovoid, 17–23×15–19 μ, with a mean of 19.1×15.3 μ. Oocyst wall 1.0–1.2 μ thick, double-contoured, composed of a single layer, orange. Micropyle not mentioned. Oocyst polar granule present. Oocyst and sporocyst residua present. Sporocysts 8–10×6 μ.

Form from *M. tamariscinus:* The following description is from Svanbaev (1962): Oocysts ellipsoidal or subspherical, 19–21×17–18 μ, with a mean of 21×17.5 μ; length-width ratio 1.2. Oocyst wall smooth, yellow-orange or yellow-brown, 0.9–1.3 μ thick. Micropyle absent. Oocyst polar granule usually present. Oocyst residuum a large, granular sphere between the sporoblasts. Sporocysts ellipsoidal or subspherical, 9–13×6–8 μ, with a mean of 11×7 μ. Sporozoites comma-shaped, 5–7×2–4 μ, with a mean of 6×3 μ. Sporocyst residuum in form of small granules.

Schizogony and Gametogony: Presumably unknown.

Prepatent Period: Presumably unknown.

Prevalence: Svanbaev (1956) found this species in three out of ten *E. talpinus* in western Kazakhstan. The same three individuals were infected with *Eimeria talpini* and *E. kazakhstanensis.*

EIMERIA KAZAKHSTANENSIS N. SP.

Eimeria volgensis Sassuchin and Rauschenbach. Svanbaev, 1956: 180–191. [*non*] *Eimeria volgensis* Sassuchin and Rauschenbach, 1932: 646–650.

Description: Oocysts ovoid, greenish to occasionally yellowish brown, with a smooth, colorless [*sic*], single-layered wall 1.6 μ thick. Oocysts 27.5×24.2 μ. Oocyst length-width ratio 1.14. Micropyle at narrow end of oocyst, small. Oocyst polar granule present in unsporulated oocyst. Oocyst residuum absent. Sporocysts ovoid or pear-shaped, 11–13×7–8 μ, with a mean of 12.2×7.2 μ. Stieda body not mentioned. Sporocyst residual granules present. Sporozoites oval, 8.4×5.9 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Ellobius talpinus (mole lemming).

Location: Feces.

Geographic Distribution: USSR (western Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1956) found this species in three out of ten *E. talpinus* in western Kazakhstan. The same three individuals were infected with *Eimeria ellobii* and *E. talpini.*

Remarks: Svanbaev (1956) described this species under the name *E. volgensis* Sassuchin and Rauschenbach, 1932. He did not give an illustration. While it was similar in general to this species, it had a small rather than a large micropyle and apparently did not have the pointed micropylar end characteristic of *E. volgensis.* Furthermore, the two hosts belong to widely separate rodent groups. *Spermophilus,* the host genus of *E. volgensis,* is a member of the suborder Sciuromorpha, while *Ellobius* is a member of the suborder Myomorpha. Cross-transmission of *Eimeria* between these genera is extremely doubtful, and in the absence of proof to the contrary should be ruled out. Hence we have assigned this form the name *Eimeria kazakhstanensis* n. sp.

EIMERIA TALPINI N. SP.

Eimeria beckeri Yakimoff and Sokoloff. Svanbaev, 1956: 184–185 (in *Ellobius talpinus*).

Description: Oocysts spherical, 24.2 μ in diameter. Oocyst wall smooth, colorless, 1.5 μ thick, composed of two layers. Micropyle absent. Oocyst polar granule absent. Oocyst residuum absent. Sporocysts oval, 11.0×8.8 μ. Stieda body not mentioned. Sporocyst residual granules present.

Sporozoites 6.5×3.7 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Ellobius talpinus (mole lemming).

Location: Feces.

Geographic Distribution: USSR (western Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1956) found this species in three out of ten *E. talpinus* in western Kazakhstan. The same three individuals were infected with *Eimeria ellobii* and *E. kazakhstanensis.*

Remarks: Svanbaev (1956) described this species under the name *E. beckeri* Yakimoff and Sokoloff. He did not give an illustration. While it was similar in general to this species, it was always spherical rather than ovoid to spherical. Furthermore, the two hosts belong to widely separate rodent groups. *Spermophilus,* the host genus of *E. beckeri,* is a member of the suborder Sciuromorpha, while *Ellobius* is a member of the suborder Myomorpha. For the reasons given under *E. kazakhstanensis* (p. 86), we are assigning this form the name *E. talpini* n. sp.

Host Suborder MYOMORPHA

Host Superfamily MUROIDEA

Host Family MURIDAE

Host Subfamily GERBILLINAE

EIMERIA MERIONIS MACHUL'SKIĬ, 1949

Eimeria merionis Machul'skiĭ, 1949.

Eimeria marionis [*sic*]: Svanbaev, 1956: 180–191; Svanbaev, 1962: 23–39.

Description: Original form from *Meriones unguiculatus:* Oocysts ovoid, 17–23×15–19 μ, with a mean of 19.1×15.3 μ. Oocyst wall 1.0–1.2 μ thick, double-contoured, composed of a single layer, orange. Micropyle not mentioned. Oocyst polar granule present. Oocyst and sporocyst residua present. Sporocysts 8–10×6 μ.

Form from *M. tamariscinus:* The following description is from Svanbaev (1962): Oocysts ellipsoidal or subspherical, 19–21×17–18 μ, with a mean of 21×17.5 μ; length-width ratio 1.2. Oocyst wall smooth, yellow-orange or yellow-brown, 0.9–1.3 μ thick. Micropyle absent. Oocyst polar granule usually present. Oocyst residuum a large, granular sphere between the sporoblasts. Sporocysts ellipsoidal or subspherical, 9–13×6–8 μ, with a mean of 11×7 μ. Sporozoites comma-shaped, 5–7×2–4 μ, with a mean of 6×3 μ. Sporocyst residuum in form of small granules.

Schizogony and Gametogony: Presumably unknown.

Prepatent Period: Presumably unknown.

Type Host: Meriones unguiculatus (Mongolian gerbil).
Other Host: Meriones tamariscinus (tamarisk gerbil).
Location: Presumably intestine.
Geographic Distribution: USSR (Buryat Mongolia, Kazakhstan).
Pathogenicity: Presumably unknown.
Cross-Transmission Studies: Presumably none.
Prevalence: Svanbaev (1962) found this species in one out of seven *M. tamariscinus* from southern Kazakhstan.
Remarks: Machul'skiĭ's (1949) paper is not obtainable in this country, and the above description of the form from *M. unguiculatus* is taken from Svanbaev (1956) and Musaev and Veĭsov (1960).

EIMERIA MARKOVI SVANBAEV, 1956

(Plate 35, Fig. 294)

Eimeria markovi Svanbaev, 1956: 180–191.

Description: Oocysts ovoid, 22–48 × 21–35 μ, with a mean of 32.4 × 25.9 μ. Oocyst length-width ratio 1.1–1.4, with a mean of 1.25. Oocyst wall smooth, greenish to yellowish green, with a double contour (but illustrated as a single layer), 1.4–1.6 μ thick. Micropyle absent. Oocyst polar granule, oocyst residuum, and sporocyst residuum absent. Sporocysts described as ovoid but illustrated as ellipsoidal, 10–16 × 7–11 μ, with a mean of 12.2 × 8.7 μ. No Stieda body illustrated. Sporozoites comma-shaped, lying longitudinally in sporocysts.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Meriones tamariscinus (tamarisk gerbil).
Location: Feces.
Geographic Distribution: USSR (western Kazakhstan).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Svanbaev (1956) found this species in 23 per cent of 22 *M. tamariscinus* in western Kazakhstan. The same individuals were infected with *E. tamariscini.*

EIMERIA TAMARISCINI N. SP.

Eimeria musculi Yakimoff and Gousseff. Svanbaev, 1956: 180–191 (from *Meriones tamariscinus*).
[*non*] *Eimeria musculi* Yakimoff and Gousseff, 1938: 1–3; Svanbaev, 1956: 180–191 (from *Apodemus sylvaticus* and *Microtus arvalis*).

Description: Oocysts subspherical, 19.1 × 18.6 μ in diameter. Length-width ratio 1.03. Oocyst wall smooth, greenish, double-contoured, 1.4 μ thick. Micropyle absent. Oocyst polar granule absent. Oocyst and sporocyst residua absent. Sporocysts ovoid, 6.6 × 4.1 μ.

Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Meriones tamariscinus (tamarisk gerbil).
Location: Feces.
Geographic Distribution: USSR (western Kazakhstan).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Svanbaev (1956) found this species in 23 per cent of 22 *M. tamariscinus* in western Kazakhstan. The same individuals were infected with *E. markovi.*
Remarks: Svanbaev (1956) described coccidia from western Kazakhstan under the name *Eimeria musculi* not only from its type host, *Mus musculus,* but also from *Apodemus sylvaticus, Microtus arvalis,* and *Meriones tamariscinus.* The form he described from *M. tamariscinus* had smaller oocysts than *E. musculi,* although it resembled it in those other characters which he mentioned. However, in view of the failure of various investigators to transmit *Eimeria* from one genus of rodent to another even within the same subfamily, and in view of the fact that *Meriones* and *Mus* belong to different rodent families, it is considered best to assign a new specific name to the form from *M. tamariscinus.*

EIMERIA PESCHANKAE N. SP.

Eimeria kriygsmanni [*sic*] Yakimoff and Gousseff. Svanbaev, 1962: 23–39.
[*non*] *Eimeria krijgsmanni* Yakimoff and Gousseff, 1938: 1–3.

Description: Oocysts ellipsoidal, subspherical, or spherical, 19–27 × 19–24 μ, with a mean of 22 × 21 μ; length-width ratio 1.1. Oocyst wall smooth, 1.3–2.1 μ thick, yellow-green or yellow-brown. Micropyle absent. Oocyst polar granule not always seen. Oocyst residuum absent. Sporocysts ellipsoidal or spherical, 7–12 × 6–9 μ, with a mean of 9 × 8 μ. Sporocyst residuum absent. Sporozoites comma-shaped.
Sporulation Time: Unknown.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Meriones tamariscinus (tamarisk gerbil).
Location: Feces.
Geographic Distribution: USSR (Kazakhstan).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Svanbaev (1962) found this species in two out of seven *M. tamariscinus* in southern Kazakhstan.
Remarks: Svanbaev (1962) described this species under the name *"Eimeria kriygsmanni"* (a misspelling for *E. krijgsmanni).* However, the

latter species was originally described from *Mus musculus,* and, for the reasons given under *E. tamariscini* above, we consider it a different species and have named it *Eimeria peschankae;* peschanka is the Russian word for gerbil.

EIMERIA ASSAENSIS N. SP.

Eimeria callosphermophili [*sic*] Henry. Svanbaev, 1962: 23–39 (in *Meriones tamariscinus*).

[*non*] *Eimeria callospermophili* Henry, 1932a: 279–290.

Description: Oocysts subspherical or spherical, 25–30 × 23–26 μ, with a mean of 28 × 25 μ. Length-width ratio 1.1–1.2, with a mean of 1.1. Oocyst wall smooth, 1.2–1.4 μ thick, greenish, yellow-green, or yellow-brown. Micropyle absent. Oocyst polar granule present. Oocyst residuum present in form of a large, granular ball. Sporocysts subspherical or ellipsoidal, 11–13 × 8–10 μ, with a mean of 11.5 × 9 μ. Sporocyst residuum absent. Sporozoites comma-shaped.

Sporulation Time: Unknown.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones tamariscinus (tamarisk gerbil).

Location: Feces.

Geographic Distribution: USSR (Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1962) found this species in one out of seven *M. tamariscinus* in southern Kazakhstan.

Remarks: Svanbaev (1962) described this species under the name *"Eimeria callosphermophili"* (a misspelling for *E. callospermophili).* However, the latter species was originally described from *Spermophilus lateralis,* and, for the reasons given under *E. tamariscini* above, we consider it a different species and have named it *Eimeria assaensis;* the species name is derived from Assa, the region in southern Kazakhstan where Svanbaev found this coccidium.

EIMERIA NORASCHENICA MUSAEV AND VEĬSOV, 1960

(Plate 18, Fig. 126)

Eimeria noraschenica Musaev and Veĭsov, 1960a: 67–75.

Description: Oocysts ovoid, rarely subspherical. Oocyst wall smooth, colorless to yellowish, composed of a single layer 1 μ thick. Micropyle absent. Seventy-three sporulated oocysts from six animals measured 16–28 × 14–26 μ, with a mean of 23 × 21 μ; their length-width ratios ranged

from 1.0–1.3, with a mean of 1.1. Oocyst residuum and polar granule absent. Sporocysts ovoid or spherical. Ovoid sporocysts 6–12×4–10 μ, with a mean of 10×7 μ. Spherical sporocysts 6–12 μ in diameter, with a mean of 8 μ. Stieda body illustrated as absent. Sporocyst residuum composed of small granules located mainly between the sporozoites. Sporozoites lemon-shaped, illustrated without internal globules.

Sporulation Time: Two days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones persicus (Persian jird).

Location: Large intestine contents.

Geographic Distribution: USSR (Norashen and Ordubad regions of Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA SALASUZICA MUSAEV AND VEĬSOV, 1960

(Plate 18, Fig. 131)

Eimeria salasuzica Musaev and Veĭsov, 1960a: 67–75.

Description: Oocysts ovoid, sometimes subspherical. Oocyst wall rough, granulated, with jagged surface, dark brown, composed of a single layer 1.5 μ thick. Micropyle absent. Twenty-one sporulated oocysts 22–26× 20–24 μ, with a mean of 24×21 μ; their length-width ratios ranged from 1.0–1.2, with a mean of 1.1. Oocyst residuum homogeneous, ovoid, or spherical, 6–7.5 μ in diameter, with a mean of 7 μ. Oocyst polar granule present. Sporocysts ovoid, 10–13×7–8 μ, with a mean of 12×7 μ. Stieda body prominent. Sporocyst residuum composed of small granules. Sporocyst refractile granule present. Sporozoite shape variable. Sporozoites illustrated without internal globules.

Sporulation Time: Not given.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones persicus (Persian jird).

Location: Large intestine contents.

Geographic Distribution: USSR (Shakhbuz region of Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA DISAENSIS MUSAEV AND VEĬSOV, 1960

(Plate 18, Figs. 127 and 128)

Eimeria disaensis Musaev and Veĭsov, 1960a: 67–75.

Description: Oocysts ovoid or subspherical. Oocyst wall smooth, colorless, composed of a single layer 1.0–1.2 μ thick. Micropyle prominent; Musaev and Veĭsov (1960a) found a small caplike body in the center of the micropyle of three oocysts. Fifteen sporulated oocysts from one host measured 18–24 × 16–22 μ, with a mean of 23 × 18 μ; their length-width ratios ranged from 1.0–1.2, with a mean of 1.1. Oocyst residuum and polar granule absent. Sporocysts ovoid, rarely spherical, 8–12 × 6–10 μ, with a mean of 11 × 9 μ. Stieda body absent. Sporocyst residuum composed of small granules mainly located between the sporozoites. Sporozoites ovoid, with a small globule in the broad end.

Sporulation Time: Two days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones persicus (Persian jird).

Location: Large intestine contents.

Geographic Distribution: USSR (Ordubad region of Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA LERIKAENSIS MUSAEV AND VEĬSOV, 1960

(Plate 18, Figs. 129 and 130)

Eimeria lerikaensis Musaev and Veĭsov, 1960a: 67–75.

Description: Oocysts ovoid or spherical. Oocyst wall smooth, composed of two layers, the inner being dark yellow and 1.0 μ thick and the outer one colorless and 0.5–1.0 μ thick. Micropyle absent. Ninety-seven sporulated oocysts from six animals were measured. Seventy ovoid oocysts measured 14–22 × 12–20 μ, with a mean of 19 × 16 μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.14. Twenty-seven spherical oocysts measured 14–22 μ in diameter, with a mean of 19 μ. Oocyst residuum absent. Oocyst polar granule present. Sporocysts spherical or ovoid; ovoid sporocysts 6–10 × 4–8 μ, with a mean of 9 × 7 μ; spherical sporocysts 4–8 μ in diameter, with a mean of 7.7 μ. Stieda body absent. Sporocyst residuum composed of small granules. Sporozoites piriform, illustrated without internal globules.

Sporulation Time: Three to four days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Meriones persicus (Persian jird).
Location: Large intestine contents.
Geographic Distribution: USSR (Lerik, Yardymlin, Shakhbuz, and Norashen regions of Nakhichevan ASSR, Azerbaĭdzhan SSR).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Unknown.

EIMERIA SCHACHTACHTIANA MUSAEV AND VEĬSOV, 1960

(Plate 19, Fig. 133)

Eimeria schachtachtiana Musaev and Veĭsov, 1960b: 79–85.

Description: Oocyst ovoid (illustrated as ellipsoidal). Oocyst wall smooth, colorless, composed of a single layer 1.0–1.25 μ thick. Micropyle absent. Forty-four sporulated oocysts from four animals measured 16–30 × 14–24 μ, with a mean of 24 × 20 μ; their length-width ratios ranged from 1.0–1.4, with a mean of 1.2. Oocyst residuum absent. Oocyst polar granule present. Sporocysts ovoid (illustrated as ellipsoidal), 6–16 × 4–10 μ, with a mean of 11 × 8 μ. Stieda body absent. Sporocyst residuum composed of small granules. Sporozoites, illustrated at the ends of the sporocysts, with a prominent globule at the broad end.
Sporulation Time: Two to three days at 25–30C in 2.5% potassium dichromate solution.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Meriones shawi (syn., *M. tristrami)* (Shaw's jird).
Location: Large intestine contents.
Geographic Distribution: USSR (Dzhul'fin and Norashen regions of Nakhichevan ASSR, Azerbaĭdzhan SSR).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Unknown.

EIMERIA NEHRAMAENSIS MUSAEV AND VEĬSOV, 1960

(Plate 19, Fig. 134)

Eimeria nehramaensis Musaev and Veĭsov, 1960b: 79–85.

Description: Oocysts subspherical or spherical. Oocyst wall smooth, colorless, composed of a single layer 1 μ thick. Micropyle absent. Seventy-three sporulated oocysts were measured: the subspherical ones were 14–26 × 12–24 μ, with a mean of 20 × 18 μ, and length-width ratios of 1.0–1.2, with a mean of 1.05; the spherical oocysts were 14–22 μ, with a

mean of 18 μ. Oocyst residuum oval, illustrated as homogeneous, 4–8 × 3–6 μ, with a mean of 6 × 5 μ; or spherical, 2.5–6 μ in diameter, with a mean of 5 μ. Oocyst polar granule present. Sporocysts ovoid, 5–12 × 5–8 μ, with a mean of 9 × 7 μ. Stieda body present. Sporocyst residuum present, composed of a mass of small granules situated between the sporozoites. Sporozoites comma-shaped, with a prominent globule at the broad end.

Sporulation Time: Two days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones shawi (syn., *M. tristrami)* (Shaw's jird).

Location: Large intestine contents.

Geographic Distribution: USSR (Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA DZHAHRIANA MUSAEV AND VEĬSOV, 1960

(Plate 19, Fig. 135)

Eimeria dzhahriana Musaev and Veĭsov, 1960b: 79–85.

Description: Oocysts spherical or subspherical. Oocyst wall rough, dark brown, with a tuberculated surface, composed of a single layer 1.5 μ thick. Micropyle absent. Twenty-one sporulated oocysts from one animal were measured: eleven subspherical ones measured 19–23 × 17–20 μ, with a mean of 21 × 19 μ, and length-width ratios of 1.1–1.2, with a mean of 1.1; ten spherical oocysts were 17.5–20 μ in diameter, with a mean of 19 μ. Oocyst residuum granular, spherical, 2–5 μ in diameter, with a mean of 4 μ. Oocyst polar granule present. Sporocysts ovoid, 6–10 × 4–6 μ, with a mean of 9 × 5 μ. Stieda body absent. Sporocyst residuum composed of small granules. Sporozoites vary in shape, with a refractile globule.

Sporulation Time: Three days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones shawi (syn., *M. tristrami)* (Shaw's jird).

Location: Large intestine contents.

Geographic Distribution: USSR (village of Dzhagri, Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA ARAXENA MUSAEV AND VEĬSOV, 1960

(Plate 19, Fig. 136)

Eimeria araxena Musaev and Veĭsov, 1960b: 79–85.

Description: Oocysts ovoid. Oocyst wall rough, dark brown, composed of a single layer 1.5–2 μ thick. Micropyle absent. Forty-three sporulated oocysts from one animal measured 20–26 × 16–20 μ, with a mean of 23 × 19 μ; their length-width ratios ranged from 1.1–1.4, with a mean of 1.2. Oocyst residuum homogeneous, ovoid, rarely spherical: the ovoid residua measure 6–8 × 5–6 μ, with a mean of 7 × 6 μ; the spherical residua are 5–6 μ in diameter, with a mean of 6 μ. Oocyst polar granule present. Sporocysts ovoid, rarely ellipsoidal, 9–13 × 5–8 μ, with a mean of 11 × 6 μ. Stieda body absent. Sporocyst residuum composed of small granules. Sporozoites piriform, with a refractile globule in the broad end.

Sporulation Time: Three and one-half to four days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones shawi (syn., *M. tristrami*) (Shaw's jird).

Location: Large intestine contents.

Geographic Distribution: USSR (Araksa region of Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA ASTRACHANBAZARICA MUSAEV AND VEĬSOV, 1960

(Plate 19, Fig. 137)

Eimeria astrachanbazarica Musaev and Veĭsov, 1960b: 79–85.

Description: Oocysts subspherical, ovoid, rarely spherical. Oocyst wall smooth, composed of two layers of which the outer is colorless and 1 μ thick and the inner yellowish and 1 μ thick. Micropyle absent. One hundred and twenty-four sporulated oocysts measured 15–30 × 14–26 μ, with a mean of 22 × 19 μ; their length-width ratios ranged from 1.0–1.4, with a mean of 1.1. Oocyst residuum absent. Oocyst polar granule present. Sporocysts ovoid, 6–14 × 4–10 μ, with a mean of 9 × 7 μ. Stieda body absent. Sporocyst residuum composed of small granules. Sporozoites comma-shaped, rarely piriform, with a refractile globule in the broad end.

Sporulation Time: Three to 3.5 days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones shawi (syn., *M. tristrami*) (Shaw's jird).

Location: Large intestine contents.

Geographic Distribution: USSR (Nakhichevan ASSR and Astrakhan-bazar and Yardymlin regions of Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA VINOGRADOVI VEĬSOV, 1961

(Plate 20, 139)

Eimeria vinogradovi Veĭsov, 1961: 25–35.

Description: Oocysts ovoid or ellipsoidal. Oocyst wall smooth, colorless, composed of a single layer 1.0–1.5 μ thick. Micropyle absent. Three hundred and twenty-three sporulated oocysts measured 16–34 × 14–30 μ, with a mean of 22 × 19 μ; their length-width ratios ranged from 1.1–1.6, with a mean of 1.3. Oocyst residuum absent. Oocyst polar granule very rarely seen. Sporocysts ovoid, ellipsoidal, and rarely spherical. The ovoid and ellipsoidal sporocysts measured 6–16 × 4–12 μ, with a mean of 12 × 9 μ; the spherical sporocysts were 6–12 μ in diameter, with a mean of 9 μ. Stieda body absent. Sporocyst residuum composed of small granules, mainly between the sporozoites. Sporozoites comma-shaped, ovoid, or occasionally irregular, with a refractile globule in the broad end.

Sporulation Time: Two days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones vinogradovi (Vinogradov gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA ZULFIAENSIS VEĬSOV, 1961

(Plate 19, Fig. 138)

Eimeria zulfiaensis Veĭsov, 1961: 25–35.

Description: Oocysts ovoid. Oocyst wall smooth, colorless, composed of a single layer 1.0–1.25 μ thick. Micropyle absent. One hundred and eighty-five sporulated oocysts measured 17–32 × 16–28 μ, with a means of 25 × 20 μ; their length-width ratios ranged from 1.0–1.4, with a mean of 1.2. Oocyst residuum homogeneous, ovoid, or spherical: the ovoid residua measured 6–12 × 4–10 μ, with a mean of 8 × 7 μ; the spherical

residua were 4–12 μ in diameter, with a mean of 7 μ. Oocyst polar granule very rarely seen. Sporocysts ovoid, 6–13 × 5–10 μ, with a mean of 11 × 7 μ. Stieda body usually prominent. Sporocyst residuum composed of small granules between the sporozoites. Sporozoites comma-shaped, with a refractile globule in the broad end.

Sporulation Time: Two days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones vinogradovi (Vinogradov gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (Shakhbuz, Dzhul'fin, Norashen, and Nakhichevan regions of Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA SADARAKTICA VEĬSOV, 1961

(Plate 20, Fig. 141)

Eimeria sadaraktica Veĭsov, 1961: 25–35.

Description: Oocysts ovoid. Oocyst wall smooth, colorless, composed of a single layer 1.4 μ thick. Micropyle present. Sixty-two sporulated oocysts measured 18–24 × 16–22 μ, with a mean of 23 × 19 μ; their length-width ratios ranged from 1.1–1.4, with a mean of 1.2. Oocyst residuum absent. Oocyst polar granule present. Sporocysts ovoid, 6–12 × 4–8 μ, with a mean of 10 × 7 μ. Stieda body absent. Sporocyst residuum composed of a group of small granules in the center of the sporocyst. Sporozoites comma-shaped, with a refractile globule in the broad end.

Sporulation Time: Three days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones vinogradovi (Vinogradov gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (vicinity of village of Sadarak, Norashen region of Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA JURSCHUAENSIS VEĬSOV, 1961

(Plate 20, Fig. 140)

Eimeria jurschuaensis Veĭsov, 1961: 25–35.

Description: Oocysts ovoid. Oocyst wall rough, dark brown, composed of a single layer 2.3 μ thick, which appears segmented and contains granules. Micropyle absent. Twenty-six sporulated oocysts measured 30–36 × 24–30 μ, with a mean of 34 × 27 μ; their length-width ratios ranged from 1.2–1.4, with a mean of 1.3. Oocyst residuum homogeneous, subspherical, 10–12 μ in diameter, with a mean of 11 μ. Oocyst polar granule absent. Sporocysts ovoid, 12–16 × 8–12 μ, with a mean of 15 × 10 μ. Stieda body absent. Sporocyst residuum composed of a group of small granules in the center of the sporocyst. Sporozoites comma-shaped, with a refractile globule in the broad end.

Sporulation Time: Three days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones vinogradovi (Vinogradov gerbil).

Geographic Distribution: USSR (vicinity of village of Yurchi, Norashen region of Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA MUSAJEVI VEĬSOV, 1961

(Plate 21, Fig. 145)

Eimeria musajevi Veĭsov, 1961: 25–35.

Description: Oocysts ovoid, illustrated as ellipsoidal. Oocyst wall rough, tuberculated, dark brown, composed of a single layer 1.5–1.8 μ thick dotted with small granules. Micropyle absent. Eighty-five sporulated oocysts measured 21–36 × 19–30 μ, with a mean of 28 × 25 μ; their length-width ratios ranged from 1.0–1.4, with a mean of 1.3. Oocyst residuum granular, ovoid or spherical; the ovoid residua measure 6–12 × 5–10 μ, with a mean of 9 × 8 μ; the spherical residua are 6–12 μ in diameter, with a mean of 10 μ. Oocyst polar granule absent. Sporocysts ovoid, 8–14 × 5–11 μ, with a mean of 12 × 9 μ. Stieda body absent. Sporocyst residuum composed of small scattered graules. Sporozoites piriform, with a refractile globule in the broad end.

Sporulation Time: Four days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones vinogradovi (Vinogradov gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Unknown.

EIMERIA TASAKENDICA VEĬSOV, 1961

(Plate 21, Fig. 144)

Eimeria tasakendica Veĭsov, 1961: 25–35.

Description: Oocysts ovoid, illustrated as ellipsoidal. Oocyst wall rough, colorless, composed of a single layer 1.2–1.4 μ thick, with cross-striations. Micropyle absent. Sixty-six sporulated oocysts measured 19–26 × 17–23 μ, with a mean of 23 × 21 μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.1. Oocyst residuum homogeneous, ovoid or spherical: the ovoid residua measure 6–8 × 5–7 μ, with a mean of 7 × 6 μ; the spherical ones are 6–8 μ in diameter, with a mean of 7 μ. Oocyst polar granule present. Sporocysts ovoid, 8–13 × 5–9 μ, with a mean of 12 × 7 μ. Stieda body prominent. Sporocyst residuum composed of a group of small granules in the center of the sporocyst. Sporozoites comma-shaped, with a refractile globule in the broad end.

Sporulation Time: Two days at 25–35C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Meriones vinogradovi (Vinogradov gerbil).
Location: Large intestine contents.
Geographic Distribution: USSR (Nakhichevan region and Tazakend and other villages in the Norashen region of Nakhichevan ASSR, Azerbaĭdzhan SSR).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Unknown.

EIMERIA BISTRATUM VEĬSOV, 1961

(Plate 20, Fig. 142)

Eimeria bistratum Veĭsov, 1961: 25–35.

Description: Oocysts ovoid or spherical. Oocyst wall smooth, composed of two layers, the outer one colorless to light yellow and 1 μ thick, the inner one yellow-brown and 1 μ thick. Micropyle absent. Two hundred and sixty-three ovoid oocysts measure 14–28 × 12–26 μ, with a mean of 20 × 19 μ; their length-width ratios ranged from 1.1–1.4, with a mean of 1.25. One hundred and twenty-five spherical oocysts ranged from 14–24 μ in diameter, with a mean of 19 μ. Oocyst residuum and polar granule absent. Sporocysts ovoid or spherical: the ovoid ones measured

6–12×4–10 μ, with a mean of 9×7 μ; the spherical ones ranged from 4–11 μ in diameter, with a mean of 10 μ. Stieda body absent. Sporocyst residuum composed of small granules located between the sporozoites. Sporozoites varied in shape, without a refractile globule.

Sporulation Time: Two or three days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones vinogradovi (Vinogradov gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERA ARABIANA VEĬSOV, 1961

(Plate 20, Fig. 143)

Eimeria arabiana Veĭsov, 1961: 25–35.

Description: Oocysts ovoid. Oocyst wall smooth, composed of two layers, the outer one colorless and 0.7 μ thick, the inner one brownish and 1.5 μ thick. Micropyle absent. One hundred and forty-seven sporulated oocysts measured 16–32×12–26 μ, with a mean of 25×20 μ; their length-width ratios ranged from 1.1–1.4, with a mean of 1.25. Oocyst residuum granular, spherical, 6–10 μ in diameter, with a mean of 8 μ. Oocyst polar granule absent. Sporocysts ovoid or piriform, 6–14×4–10 μ, with a mean of 10×7 μ. Stieda body absent. Sporocyst residuum composed of small granules. Sporozoites varied in shape, without a refractile globule.

Sporulation Time: Three days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones vinogradovi (Vinogradov gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (Nakhichevan region and vicinity of village of Arabengidzha in the Norashen region of Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA POLJANSKII VEĬSOV, 1961 Emend.

(Plate 22, Fig. 154)

Eimeria poljanski Veĭsov, 1961: 25–35.

Description: Oocysts spherical or ovoid. Oocyst wall rough, colorless, composed of two layers: the outer one containing small granules and 0.6 μ thick; the inner one containing small granules, corrugated, and 1.6 μ thick. Micropyle absent. Forty-seven sporulated oocysts were measured. The ovoid ones were 30–34 × 28–32 μ, with a mean of 33 × 32 μ; their length-width ratios ranged from 1.0–1.1, with a mean of 1.1. The spherical ones were 28–34 μ in diameter, with a mean of 32 μ. Oocyst residuum homogeneous, spherical, 5–8 μ in diameter, with a mean of 7 μ. Oocyst polar granule absent. Sporocysts ovoid, 10–14 × 6–10 μ, with a mean of 13 × 9 μ. Stieda body prominent. Sporocyst residuum composed of small granules located between the sporozoites. Sporozoites comma-shaped, with a refractile globule at the broad end.

Sporulation Time: Four days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones vinogradovi (Vinogradov gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (Nakhichevan ASSR, Azerbaĭdzhan SSR).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

EIMERIA ERYTHROURICA MUSAEV AND ALIEVA, 1961

(Plate 21, Fig. 146)

Eimeria erythrourica Musaev and Alieva, 1961: 53–59.

Description: Oocysts usually ovoid, sometimes spherical. Oocyst wall smooth, bright yellow to bright crimson, composed of a single layer 1.0–2.0 μ thick. Micropyle absent. Three hundred and eighty-three sporulated oocysts from 92 specimens measured 14–32 × 12–26 μ, with a mean of 21 × 18 μ; their length-width ratios ranged from 1.1–1.6, with a mean of 1.2. Oocyst residuum absent. Oocyst polar granule present. Sporocysts ovoid or spherical. Ovoid sporocysts 6–14 × 4–10 μ, with a mean of 9 × 7 μ; spherical sporocysts 6–10 μ in diameter, with a mean of 8 μ. Stieda body absent. Sporocyst residuum composed of small granules. Sporozoites pear- or bean-shaped, with a prominent spherical globule in the broad end.

Sporulation Time: Two to four days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones libycus (syn., *M. erythrourus*) (red-tailed gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Musaev and Alieva (1961) found this species in 92 specimens from 315 *M. libycus* from seven localities in Azerbaĭdzhan.

Remarks: E. erythrourica resembles *E. schachtachtiana* from *Meriones shawi,* but differs from it in the fact that its sporozoites lie lengthwise in the sporocysts rather than at their ends. It also resembles *E. vinogradovi* from *M. vinogradovi,* but differs from it in oocyst color, in having a polar granule, and in having a longer sporulation time.

EIMERIA SCHAMCHORICA MUSAEV AND ALIEVA, 1961

(Plate 21, Fig. 147)

Eimeria schamchorica Musaev and Alieva, 1961: 53–59.

Description: Oocysts ovoid, rarely spherical. Oocyst wall smooth, colorless or sometimes with a yellow-crimson tinge, composed of a single layer 1.0–2.0 μ thick. Micropyle absent. One hundred and thirty-three sporulated oocysts from 41 specimens measured 16–32 × 14–28 μ, with a mean of 24 × 20.5 μ; their length-width ratios ranged from 1.0–1.4, with a mean of 1.2. Oocyst residuum homogeneous, 4–12 μ in diameter, with a mean of 8 μ; spherical sporocysts 6–10 μ in diameter, with a mean of 9 μ. Stieda body absent. Sporocyst residuum composed of small granules. Sporozoites pear- or bean-shaped, with a globule in the broad end.

Sporulation Time: Three to four days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones libycus (syn., *M. erythrourus)* (red-tailed gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Musaev and Alieva (1961) found this species in 41 specimens from 315 *M. libycus* from Shamkhor and four other regions of Azerbaĭdzhan.

EIMERIA ACHBURUNICA MUSAEV AND ALIEVA, 1961

(Plate 21, Fig. 148)

Eimeria achburunica Musaev and Alieva, 1961: 53–59.

Description: Oocysts ovoid. Oocyst wall smooth, colorless, composed of a single layer 1.0–1.5 μ thick. Micropyle prominent. Thirty-one sporulated oocysts from 11 specimens measured 14–24 × 12–21 μ, with a mean of 20 × 17 μ; their length-width ratios ranged from 1.1–1.4, with a mean of 1.2. Oocyst residuum absent. Oocyst polar granule rarely present. Sporocysts ovoid, rarely spherical. Ovoid sporocysts 6–10 × 4–8 μ, with a mean of 9 × 7 μ; spherical sporocysts 6–8 μ in diameter, with a mean of 8 μ. Stieda body absent. Sporocyst residuum composed of small granules. Sporozoites bean-shaped, with a globule in the broad end.

Sporulation Time: Unknown.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones libycus (syn., *M. erythrourus*) (red-tailed gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Musaev and Alieva (1961) found this species in 11 specimens from 315 *M. libycus* from the village of Agburun in the Martunin region of Azerbaĭdzhan.

Remarks: E. achburunica resembles *E. sadaraktica* from *Meriones vinogradovi,* but differs from it in normally lacking a polar granule.

EIMERIA SUMGAITICA MUSAEV AND ALIEVA, 1961

(Plate 21, Fig. 149)

Eimeria sumgaitica Musaev and Alieva, 1961: 53–59.

Description: Oocysts ovoid, sometimes subspherical. Oocyst wall smooth, 1.5–2.0 μ thick, composed of two layers, of which the outer is bright yellow and the inner is dark yellow. Micropyle absent. Thirty-six sporulated oocysts from eight specimens measured 16–26 by 14–24 μ, with a mean of 22 × 19 μ; their length-width ratios ranged from 1.1–1.4, with a mean of 1.14. Oocyst residuum absent. Oocyst polar granule present in some. Sporocysts ovoid, rarely spherical. Ovoid sporocysts 6–10 × 4–8 μ, with a mean of 9 × 7 μ; spherical sporocysts 6–8 μ in diameter, with a mean of 8 μ. Stieda body absent. Sporocyst residuum composed of small granules. Sporozoites pear-shaped, with a small globule.

Sporulation Time: Three to four days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones libycus (syn., *M. erythrourus*) (red-tailed gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Musaev and Alieva (1961) found this species in eight specimens from 315 *M. libycus* from Sumgait and three other regions of Azerbaĭdzhan.

Remarks: E. sumgaitica closely resembles *E. astrachanbazarica* from *Meriones shawi,* differing only in that the oocyst polar granule is not always present and in the fact that the outer layer of the oocyst wall is yellow rather than colorless; further study may show that it is a synonym. *E. sumgaitica* also resembles *E. lerikaensis* from *M. persicus,* but differs in having globules in the sporozoites.

EIMERIA MARTUNICA MUSAEV AND ALIEVA, 1961

(Plate 21, Fig. 150)

Eimeria martunica Musaev and Alieva, 1961: 53–59.

Description: Oocysts ovoid. Oocyst wall smooth, 2 μ thick, composed of two layers, of which the outer is bright yellow and the inner is dark yellow. Micropyle absent. Fifteen sporulated oocysts from four specimens measured 18–34 × 16–28 μ, with a mean of 26 × 22 μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.14. Oocyst residuum spherical, granular, 4–12 μ in diameter, with a mean of 9 μ. Oocyst polar granule absent. Sporocysts ovoid, 8–14 × 6–10 μ, with a mean of 11 × 8 μ. Stieda body observed in some sporocysts. Sporocyst residuum composed of small granules. Sporozoites pear- or bean-shaped, illustrated without globules.

Sporulation Time: Three to four days at 25–30C in 2.5% potassium dichromatic solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Meriones libycus (syn., *M. erythrourus*) (red-tailed gerbil).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Musaev and Alieva (1961) found this species in four

specimens from 315 *M. libycus* from Martunin and two other regions of Azerbaïdzhan.

Host Suborder MYOMORPHA

Host Superfamily MUROIDEA

Host Family MURIDAE

Host Subfamily TACHYORYCTINAE

EIMERIA TACHYORYCTIS VAN DEN BERGHE AND CHARDOME, 1956

(Plate 22, Fig. 157)

Eimeria tachyoryctis van den Berghe and Chardome, 1956a: 67–69.

Description: Oocysts described as ovoid but illustrated as ellipsoidal, averaging 23 × 17 μ. Oocyst wall quite thick (illustrated as composed of a single layer), colorless, apparently very resistant to pressure. Micropyle absent. Oocyst residuum nearly 6 μ in diameter. Oocyst polar granule not mentioned. Sporocysts 12 × 8 μ, illustrated as ovoid and without Stieda body. Sporocyst residuum dark, quite large, polar. Sporozoites 8.5 × 3.5 μ, reniform.

Sporulation Time: Four to six days in 1% chromic acid.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Sporogony: The sporont divides into two round, granular masses 11 μ in diameter. Each of these subdivides to form two sporocysts, leaving an oocyst residuum.

Type Host: Tachyoryctes ruandae (fuku).

Location: Probably intestine.

Geographic Distribution: Africa (Belgian Congo).

Pathogenicity: Unknown.

Cross-Transmission Studies: Attempts to infect two half-grown white rats and two mice failed.

Prevalence: This species was found in about 3 per cent of the *T. ruandae* at Tshibati, Lwiro (Kivu), Belgian Congo.

Host Suborder MYOMORPHA

Host Superfamily MUROIDEA

Host Family MURIDAE

Host Subfamily MURINAE

EIMERIA MURIS GALLI-VALERIO, 1932

Eimeria muris Galli-Valerio, 1932: 129–142.

[*non*] *Eimeria muris:* Pellérdy, 1954: 187–191 (see *E. hungaryensis*); Černa, 1962: 1–13 (see *E. hungaryensis*).

Description: Oocysts ovoid, with micropyle borne on a slight projec-

tion at narrow end. Oocysts 21 × 15 μ, with a spherical sporont 12 μ in diameter. Sporocysts ovoid, 9 × 6 μ. Oocyst residuum and polar granule not mentioned. Sporocyst residuum present. Sporozoites piriform.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Apodemus (syn., *Mus*) *sylvaticus* (field mouse).

Location: Intestine.

Geographic Distribution: Europe (Switzerland).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Remarks: Pellérdy (1954) reported *E. muris* from *Apodemus flavicollis* in Hungary, but his description does not agree with Galli-Valerio's, and we are assigning it a new name (p. 108). The form reported by Černa (1962) as *E. muris* was apparently the same as that described by Pellérdy.

EIMERIA NAYE GALLI-VALERIO, 1940

Eimeria naye Galli-Valerio, 1940: 387–392.

Description: Oocysts cylindroid, with one end convex and the other flattened. Micropyle at flattened end. Oocysts 18–21 × 12–13.5 μ. Sporont 10.5 μ in diameter. Sporocysts spherical, 6 μ in diameter. Oocyst residuum and polar granule not mentioned. Sporocyst residuum present. Sporozoites piriform.

Sporulation Time: Four days on moist filter paper.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Apodemus (syn., *Mus*) *sylvaticus* (field mouse).

Location: Intestine.

Geographic Distribution: Europe (Switzerland).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Galli-Valerio (1940) found this species in two out of seven *A. sylvaticus* in Switzerland.

EIMERIA APIONODES PELLÉRDY, 1954

(Plate 22, Fig. 151)

Eimeria apionodes Pellérdy, 1954: 187–191.

Description: Oocysts short, piriform, somewhat tapered at both ends, 17–23 × 13–18 μ, with a mean of 20 × 17 μ. Oocyst wall relatively delicate ("zart"), pale, and smooth. No micropyle illustrated or mentioned. Sporont round, finely granular. Oocyst residuum absent or composed at most of a few refractile granules. Polar granule absent. Sporocysts 12 × 8 μ. Sporocyst residuum coarsely granular, so large (often 6 μ in

diameter) that it deforms the sporocyst, giving it an irregular appearance. Sporocyst Stieda body not mentioned or illustrated.

Sporulation Time: Two to four days at room temperature in 2% potassium dichromate.

Schizogony and Gametogony: Not described. Both the schizonts and gamonts are found in the epithelial cells of the small intestine mucosa.

Prepatent Period: Eight to ten days.

Type Host: Apodemus flavicollis (field mouse).

Location: Small intestine.

Geographic Distribution: Europe (Hungary).

Pathogenicity: Unknown. Heavy mixed infections with this species and *E. hungaryensis, E. rugosa,* and *E. apodemi* caused catarrhal enteritis.

Cross-Transmission Studies: Pellérdy (1954) was unable to transmit this species to *Mus musculus, Microtus arvalis, Clethrionomys* (syn., *Evotomys*) *glareolus,* and *Cricetus cricetus.*

Prevalence: Pellérdy (1954) found *E. apionodes* and/or *E. hungaryensis, E. rugosa,* and *E. apodemi* in 23 per cent of 239 *A. flavicollis* in Hungary.

EIMERIA APODEMI PELLÉRDY, 1954

(Plate 22, Figs. 152 and 153)

Eimeria apodemi Pellérdy, 1954: 187–191; Černa and Daniel, 1956: 19–23; Černa, 1962: 1–13.

[*non*] *Eimeria apodemi:* Ryšavý, 1957: 331–336 (see *E. rysavyi*).

Description: Oocysts broadly ellipsoidal, often asymmetrical, 21–27 × 15–22 μ, with a mean of 24 × 20 μ (23–30 × 20–26 μ, according to Černa and Daniel, 1956). Oocyst wall brownish, composed of two layers. The outer brown layer is often detached during concentration in glycerol, revealing a lighter inner layer. Micropyle absent. Sporont round, not completely filling oocyst. Oocyst residuum absent. Polar granule absent. Sporocysts 12 × 7 μ according to Černa and Daniel (1956). Sporocyst residuum present, finely granular. Stieda body not mentioned or illustrated.

Sporulation Time: Three to five days at room temperature in 2% potassium dichromate.

Schizogony and Gametogony: Not described.

Prepatent Period: Six to seven days.

Type Host: Apodemus flavicollis (field mouse).

Other Host: Apodemus sylvaticus (field mouse).

Location: Small intestine.

Geographic Distribution: Europe (Hungary, Czechoslovakia).

Pathogenicity: Unknown. Heavy mixed infections with this species and *E. hungaryensis, E. rugosa,* and *E. apionodes* caused catarrhal enteritis.

Cross-Transmission Studies: Pellérdy (1954) was unable to transmit this species to *Mus musculus, Microtus arvalis, Clethrionomys* (syn., *Evotomys*) *glareolus,* and *Cricetus cricetus.*

Prevalence: Pellérdy (1954) found *E. apodemi* and/or *E. hungaryensis, E. apionodes,* and *E. rugosa* in 23 per cent of 239 *A. flavicollis* in Hungary.

Remarks: Ryšavý (1957) reported finding *E. apodemi* in *Clethrionomys glareolus* in Czechoslovakia. Since, however, Pellérdy (1954) was unable to transmit *E. apodemi* from *Apodemus* to *Clethrionomys,* this identification cannot be correct, and we have named Ryšavý's form *E. rysavyi* (see above).

EIMERIA RUGOSA PELLÉRDY, 1954

(Plate 23, Fig. 158)

Eimeria rugosa Pellérdy, 1954: 187–191.

Description: Oocysts piriform, 23–27 × 15–19 μ, with a mean of 24 × 16 μ. Oocyst wall yellowish brown, somewhat thicker than usual. Under high magnification, the micropylar end appears wrinkled. Micropyle distinct. Sporont spherical, finely granular. Polar granule absent. Oocyst residuum large, usually more than 6 μ in diameter. Sporocysts slender, 16 × 10 μ. Sporocyst residuum small, finely granular.

Sporulation Time: Two to four days at room temperature in 2% potassium dichromate.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Apodemus flavicollis (field mouse).

Location: Intestine.

Geographic Distribution: Europe (Hungary).

Pathogenicity: Unknown. Heavy mixed infections with this species and *E. hungaryensis, E. apionodes,* and *E. apodemi* caused catarrhal enteritis.

Cross-Transmission Studies: Pellérdy (1954) was unable to transmit this species to *Mus musculus, Microtus arvalis, Clethrionomys* (syn., *Evotomys*) *glareolus,* and *Cricetus cricetus.*

Prevalence: Pellérdy (1954) found *E. rugosa* and/or *E. hungaryensis, E. apionodes,* and *E. apodemi* in 23 per cent of 239 *A. flavicollis* in Hungary.

EIMERIA HUNGARYENSIS N. SP.

(Plate 22, Figs. 155 and 156)

Eimeria muris Galli-Valerio. Pellérdy, 1954: 187–191; Černa, 1962: 1–13.
[*non*] *Eimeria muris* Galli-Valerio, 1932: 129–142.

Description: The following description was given by Pellérdy (1954)

of the form in *Apodemus flavicollis:* Oocysts round or subspherical, 17–23 × 16–19 μ, with a mean of 20 × 18 μ. Oocyst wall quite thick, light yellowish brown, with a somewhat rough surface. Sporont finely granular, completely filling unsporulated oocyst. Micropyle absent. Oocyst residuum and polar granule absent. Sporocysts 15 × 9 μ, pointed at one end (apparently with a Stieda body) and rounded at the other. Sporocyst residuum present.

The following description was given by Černa (1962) for the form in *A. sylvaticus:* Oocysts broadly ellipsoidal (described as "oval") or spherical, 14–24 × 14–16 μ. Oocyst wall illustrated with a single layer. Micropyle absent. Oocyst polar granule and oocyst residuum absent. Sporocysts elongate ovoid, 9–13 × 4–8 μ, with a Stieda body at the pointed end. Sporocyst residuum present.

Sporulation Time: Two to three days in 2% potassium dichromate at room temperature according to Pellérdy (1954), four to five days according to Černa (1962).

Schizogony and Gametogony: Not described by Pellérdy (1954). According to Černa (1962), the sexual stages occurred in the epithelium of the posterior part of the small intestine (ileum). The mature microgametocytes measured 13–17 × 8–14 μ, and the mature macrogametes measured 12–21 × 11–14 μ.

Prepatent Period: Four and one-half to five days.

Type Host: Apodemus flavicollis (field mouse).

Other Host: Apodemus sylvaticus (field mouse).

Location: Mucosa of small intestine.

Geographic Distribution: Europe (Hungary, Czechoslovakia).

Pathogenicity: Unknown. Heavy mixed infections with this species and *E. apionodes, E. apodemi,* and *E. rugosa* were reported by Pellérdy (1954) to cause catarrhal enteritis.

Cross-Transmission Studies: Pellérdy (1954) was unable to transmit this species to *Mus musculus, Microtus arvalis, Clethrionomys* (syn., *Evotomys*) *glareolus,* and *Cricetus cricetus.*

Prevalence: Pellérdy (1954) found this species and/or *E. apionodes, E. rugosa,* and *E. apodemi* in 23 per cent of 239 *A. flavicollis* in Hungary. He remarked that it was the most common of the four species.

Remarks: Pellérdy (1954) described this species under the name *Eimeria muris* Galli-Valerio, 1932, but it differs markedly from it in most of the few morphological features which Galli-Valerio mentioned. *E. hungaryensis* lacks a micropyle, it is less elongate than *E. muris,* its sporont completely fills the unsporulated oocyst, and its sporocysts are much larger. *E. hungaryensis* differs from *E. naye* Galli-Valerio, 1940 in lacking a micropyle, in being subspherical rather than cylindroid, and

in having elongate rather than spherical sporocysts. As shown by Pellérdy (1954), it also differs from *E. apionodes, E. apodemi,* and *E. rugosa.* We are therefore assigning it a new name.

Černa (1962) described what was probably the same species under the name *E. muris* from *Apodemus sylvaticus* in Czechoslovakia. She also stated that the same form occurred in *Mus musculus,* but did not describe it; this identification is highly unlikely.

EIMERIA PRASADI N. SP.

Eimeria hindlei Yakimoff and Gousseff. Svanbaev, 1956: 180–191.
[*non*] *Eimeria hindlei* Yakimoff and Gousseff, 1938: 1–3.

Description: Oocysts ovoid, 26.2 × 19.8 μ. Oocyst wall smooth, double-contoured, 1.6 μ thick. Oocyst length-width ratio 1.32. Micropyle absent. Oocyst polar granule present (occasionally absent) in unsporulated oocyst. Oocyst residuum absent. Sporocysts ovoid, 8.8 × 6.6 μ. Sporocyst residuum present.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Apodemus sylvaticus (common field mouse).

Location: Feces.

Geographic Distribution: USSR (western Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Remarks: Svanbaev (1956) described this species under the name *E. hindlei.* He was unaware of Pellérdy's (1954) descriptions of four species of *Eimeria* from *A. flavicollis* in Hungary or of Galli-Valerio's (1932, 1940) descriptions of *E. muris* and *E. naye,* respectively, from *A. sylvaticus* in Switzerland. Pellérdy (1954) was unable to transmit any of his *Apodemus* coccidia to *Mus musculus, Microtus arvalis, Clethrionomys* (syn., *Evotomys*) *glareolus,* or *Cricetus cricetus.*

Svanbaev's description does not agree with those of the above six *Eimeria* species. His form differs from *E. muris* Galli-Valerio, 1932 in lacking a micropyle. It differs from *E. naye* Galli-Valerio, 1940 in shape, in lacking a micropyle, and in having ovoid rather than spherical sporocysts. It differs from *E. apionodes* Pellérdy, 1954 in shape; in addition, it is larger but has smaller sporocysts. It differs from *E. apodemi* Pellérdy, 1954 in shape and color, and in having a polar granule. It differs from *E. hungaryensis* n. sp. (see above) in shape, in having a smooth, greenish wall rather than a thick, yellowish brown rough wall, in having a polar granule, and in having much smaller sporocysts. It differs from *E. rugosa* Pellérdy, 1954 in shape, in not having a yellowish brown wall wrinkled at one end, in having a polar granule, in lacking

an oocyst residuum and a micropyle, and in having much smaller sporocysts. In view of these morphological differences and of the failure of Pellérdy's cross-transmission attempts, it is considered best to assign this form a new name.

EIMERIA SVANBAEVI N. SP.

(Plate 23, Fig. 159)

Eimeria kriygsmanni [*sic*] Yakimoff and Gousseff. Svanbaev, 1956: 180–191 (from *Apodemus sylvaticus*).

(?) *Eimeria krijgsmani* [*sic*]: Ryšavý, 1954: 131–174.

[*non*] *Eimeria krijgsmanni* Yakimoff and Gousseff, 1938: 1–3.

[*non*] *Eimeria kriygsmanni* [*sic*]: Svanbaev, 1956: 180–191 (from *Mus musculus*).

Description: Oocysts ovoid, colorless or occasionally greenish, with a smooth, double-contoured wall 1.6–1.8 μ thick, 24–26 × 20–22 μ, with a mean of 24.9 × 20.5 μ and a mean length-width ratio of 1.22. Micropyle absent. Oocyst polar granule present. Oocyst and sporocyst residua absent. Sporocysts ovoid, 9–13 × 7–9 μ, with a mean of 10.3 × 7.7 μ. Sporozoites comma-shaped.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Apodemus sylvaticus (field mouse).

Location: Feces.

Geographic Distribution USSR (western Kazakhstan), Czechoslovakia (?).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Remarks: Svanbaev (1956) described this species under the name *E. kriygsmanni* Yakimoff and Gousseff, 1938 *(lapsus* for *E. krijgsmanni).* See *Remarks* under *E. prasadi* (p. 110) for a discussion of this paper.

Svanbaev's description does not agree with those of any other *Apodemus* coccidia. It differs from *E. muris* Galli-Valerio, 1932 in lacking a sporocyst residuum and a micropyle. It differs from *E. naye* Galli-Valerio, 1940 in shape and size, in lacking a micropyle and sporocyst residuum, and in shape of the sporocysts. It differs from *E. apionodes* Pellérdy, 1954 in shape, in having a thicker wall, and in lacking a sporocyst residuum. It differs from *E. apodemi* Pellérdy, 1954 in shape, in the color of the oocyst wall, in having an oocyst polar granule, and in lacking a sporocyst residuum. It differs from *E. rugosa* Pellérdy, 1954 in shape, in the character of the oocyst wall, in having an oocyst polar granule, and in lacking a micropyle and oocyst and sporocyst residua. It differs from *E. hungaryensis* n. sp. in shape, in the character of the oocyst wall, in having an oocyst polar granule, and in lacking a sporocyst

residuum. It differs from *E. prasadi* n. sp. in lacking a sporocyst residuum. In view of these morphological differences and of the failure of Pellérdy's (1954) cross-transmission attempts, it is considered best to assign this form the name, *Eimeria svanbaevi* n. sp.

Ryšavý (1954) described an *Eimeria* from the intestine of *A. sylvaticus* in Czechoslovakia under the name *E. krijgsmani (lapsus* for *E. krijgsmanni)* Yakimoff and Gousseff, 1938. He, too, was unaware of the papers of Galli-Valerio and Pellérdy cited above. The oocysts of his form were described as oval, broadly rounded at either end, and stretched out; they were illustrated as ellipsoidal. They measured 16–27 × 12–16 μ, with a mean of 20.2 × 15.1 μ. Their length-width ratios ranged from 1.0–1.8, with a mean of 1.35. The oocyst wall was thin, colorless, and easily broken. There was no micropyle. The sporocysts measured 10–12 × 5–6 μ. No information was given on the oocyst or sporocyst residua or the polar granule. This form appears to resemble *E. svanbaevi* more than the other species of *Eimeria* described from *Apodemus,* although it differs from it in some respects. However, until a better description is available, we do not feel justified in establishing a new name for it, and for the present assign it with a question mark to *E. svanbaevi.*

EIMERIA RUSSIENSIS N. SP.

Eimeria musculi Yakimoff and Gousseff. Svanbaev, 1956: 180–191 (from *Apodemus sylvaticus*).

[*non*] *Eimeria musculi* Yakimoff and Gousseff, 1938: 1–3; Svanbaev, 1956: 180–191 (from *Mus musculus*—see *E. musculi*) (from *Microtus arvalis*—see *E. arvicolae*) (from *Meriones tamariscinus*—see *E. tamariscini*).

Description: Oocysts spherical, greenish, smooth, with a double-contoured wall 1.5–2.0 μ thick, 21.7 μ in diameter. Micropyle absent. Polar granule present, occasionally absent. Oocyst and sporocyst residua absent. Sporocysts oval or spherical, 8.7 × 8.6 μ. Sporozoites comma-shaped, 6 × 4 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Apodemus sylvaticus (field mouse).

Location: Feces.

Geographic Distribution: USSR (western Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Remarks: Svanbaev (1956) described this species under the name *E. musculi* Yakimoff and Gousseff, 1938. See *Remarks* under *E. prasadi* (p. 110) for a discussion of his paper. Svanbaev's description does not agree with those of any of the *Apodemus* coccidia so far named. It differs from *E. muris* Galli-Valerio, 1932 and from *E. naye* Galli-Valerio, 1940

in shape and in lacking a sporocyst residuum and a micropyle. It differs from *E. apionodes* Pellérdy, 1954 in oocyst and sporocyst shape and in lacking a sporocyst residuum. It differs from *E. apodemi* Pellérdy, 1954 in oocyst shape. in the character of the oocyst wall, in lacking a sporocyst residuum, and in having a polar granule. It differs from *E. rugosa* Pellérdy, 1954 in oocyst shape, in the character of the oocyst wall, in having a polar granule, and in lacking a micropyle and oocyst and sporocyst residua. It differs from *E. hungaryensis* n. sp. in the character of the oocyst wall, in having a polar granule, in lacking a sporocyst residuum, and in the shape of the sporocysts. It differs from *E. prasadi* n. sp. in oocyst and sporocyst shape and in lacking a sporocyst residuum. It differs from *E. svanbaevi* n. sp. in oocyst and sporocyst shape. In view of these morphological differences and of the failure of Pellérdy's (1954) cross-transmission attempts, it is considered best to assign this form the name *Eimeria russiensis* n. sp.

EIMERIA SP. (RYŠAVÝ, 1954)

Eimeria falciformis (Eimer). Elton *et al.*, 1931: 657–721; Ryšavý, 1954: 131–174 (*pro parte*); Černa and Daniel, 1956: 19–23 (*pro parte*).

[*non*] *Eimeria falciformis* (Eimer, 1870) Schneider, 1875: xl–xlv.

Description: Uncertain.

Hosts: Apodemus sylvaticus, A. flavicollis (field mice).

Location: Feces.

Geographic Distribution: England, Czechoslovakia.

Remarks: Ryšavý (1954) reported *E. falciformis* from *Mus musculus, Apodemus flavicollis, A. sylvaticus, Microtus arvalis,* and *Clethrionomys glareolus* in Czechoslovakia. The description he gave was similar to that of *E. falciformis.* For the reasons given in the discussion of these forms in *Microtus arvalis* (p. 81), it is very doubtful that the forms Ryšavý saw in the hosts other than *M. musculus* were *E. falciformis.* However, since he did not describe them separately from each host, it is useless to attempt to assign names to them.

Černa and Daniel (1956) reported *E. falciformis* from *Apodemus flavicollis* and *Clethrionomys glareolus* in Czechoslovakia. They gave the same dimensions as Ryšavý, but mentioned that the oocyst wall was more than 1 μ thick. For the reasons given above, these forms were undoubtedly not *E. falciformis,* but cannot be assigned separate names.

Elton *et al.* (1931) reported finding *E. falciformis* in 38 per cent of 380 wild *Apodemus sylvaticus* in England. They did not describe the oocysts. These coccidia were undoubtedly not *E. falciformis,* which is a parasite of the house mouse and not of *Apodemus,* but cannot be assigned to any species.

EIMERIA SP. (RYŠAVÝ, 1954)

(Plate 23, Figs. 160 and 161)

Eimeria keilini Yakimoff and Gousseff. Ryšavý, 1954: 131–174; Černa and Daniel, 1956: 19–23; Černa, 1962: 1–13.

[*non*] *Eimeria keilini* Yakimoff and Gousseff, 1938: 1–3.

Description: Oocysts described by Ryšavý (1954) from *Apodemus sylvaticus* as ellipsoidal, narrow at both ends. Oocyst wall thin, transparent, colorless, composed of a single layer. Oocysts 24–29 × 16–20 μ, with a mean of 26.0 × 20.7 [*sic*] μ. Micropyle absent. The oocysts did not sporulate. Černa and Daniel (1956) described what was probably the same form from *A. flavicollis* in Czechoslovakia. Its oocysts measured 25–28 × 16–20 μ, were narrow at both ends, and had a thin, colorless wall and no micropyle. The sporocysts measured 8–9 × 6–7 μ. Nothing was said about oocyst or sporocyst residua or oocyst polar granules, but these were not visible in the rather hazy photomicrograph.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Apodemus sylvaticus (field mouse).

Other Host: Apodemus flavicollis (field mouse).

Location: Intestine.

Geographic Distribution: Czechoslovakia.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This form was found by Ryšavý (1954) in 2 *A. sylvaticus* and by Černa and Daniel (1956) in 1 out of 16 *A. flavicollis.*

Remarks: Ryšavý (1954) described this form under the name *E. keilini.* See *Remarks* under *Eimeria* sp. from *Microtus arvalis* (p. 81) for a discussion of his paper. Ryšavý's oocysts did not sporulate. Černa and Daniel (1956) and Černa (1962) found the same form in *Apodemus flavicollis* in Czechoslovakia. Their oocysts sporulated. The sporocysts were smaller than those of *E. keilini,* which measure 12 × 6 μ. In addition, its wall was colorless rather than yellowish. In view of these differences and of the failure of Pellérdy's (1954) cross-transmission experiments, it is unlikely that Ryšavý's form is *E. keilini,* whose type host is *Mus musculus.* Its shape is unlike that of any of the species of *Eimeria* so far described from *Apodemus,* but in the absence of more information it is not considered desirable to assign it a specific name.

EIMERIA (?) SP. (RYŠAVÝ, 1954)

Eimeria hindlei Yakimoff and Gousseff. Ryšavý, 1954: 131–174 (*pro parte*).

[*non*] *Eimeria hindlei* Yakimoff and Gousseff, 1938: 1–3.

Description: Oocysts oval. Oocyst wall thin, pale yellow, composed

of a single layer. Micropyle absent. Oocysts 23–27 × 18–20 μ, with a mean of 25.0 × 18.4 μ. Oocyst length-width ratio 1.2–1.5, most often 1.4. The oocysts did not sporulate.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Apodemus sylvaticus (field mouse).

Location: Feces.

Geographic Distribution: Czechoslovakia.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Remarks: Ryšavý (1954) described this form under the name *E. hindlei* from *A. sylvaticus* and *Clethrionomys glareolus* in Czechoslovakia. He did not differentiate between the forms from the two hosts and the oocysts failed to sporulate. See *Remarks* under *Eimeria* sp. from *Microtus arvalis* (p. 81) for a discussion of his paper. Since the type host of *E. hindlei* is *Mus musculus,* it is clear that Ryšavý's form does not belong to this species. As a matter of fact, it is unlikely that Ryšavý's forms from *A. sylvaticus* and *C. glareolus* belong to the same species. Furthermore, since they did not sporulate, they may not even be *Eimeria.*

EIMERIA (?) SP. ČERNA AND DANIEL, 1956

Eimeria sp. Černa and Daniel, 1956: 19–23.

Description: Oocysts broadly ovoid to spherical, 11–14 × 10–13 μ. Oocyst wall very delicate. Micropyle absent. The oocysts failed to sporulate.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Apodemus flavicollis and *Clethrionomys glareolus.*

Location: Intestine.

Geographic Distribution: Czechoslovakia.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Černa and Daniel (1956) found this form in 1 out of 16 *A. flavicollis* and 1 out of 31 *C. glareolus.*

Remarks: Although Černa and Daniel (1956) assigned this form to *Eimeria,* its failure to sporulate makes it impossible to be certain of its genus.

EIMERIA VINCKEI RODHAIN, 1954

(Plate 37, Fig. 300)

Eimeria vinckei Rodhain, 1954: 327–329.

Description: Oocysts cylindroid, colorless, with a thin, double-contoured wall, 20–24 × 12–15 μ, with a mean of 22.0 × 13.2 μ. Length-width

ratio 1.7. Micropyle absent. Sporont in unsporulated oocysts 13.2 μ in diameter. Oocyst residuum absent. Oocyst polar granule not mentioned or illustrated. Sporocysts 7×4 μ (illustrated as round), apparently without Stieda body. Sporocyst residuum present.

Sporulation Time: Seven to eight days.

Schizogony and Gametogony: Six to ten merozoites are produced by schizogony. The mature macrogametes are round and about 9 μ in diameter. The microgametocytes are oval, 14×9 μ.

Prepatent Period: Eleven days.

Type Host: Thamnomys surdaster surdaster.

Location: Cecum. The parasites are found in the superficial epithelial cells bordering the folds of the mucosa.

Geographic Distribution: Africa (Haut Katanga, Belgian Congo).

Pathogenicity: Nonpathogenic.

Cross-Transmission Studies: Rodhain (1954) was unable to transmit this species to laboratory mice or rats.

Prevalence: Rodhain (1954) found *E. vinckei* in 12 out of 38 *T. s. surdaster* in Haut Katanga.

EIMERIA DASYMYSIS LEVINE, BRAY, IVENS, AND GUNDERS, 1959 *

(Plate 23, Fig. 162)

Eimeria dasymysis Levine, Bray, Ivens, and Gunders, 1959: 215–222.

Description: Oocysts subspherical, ellipsoidal, sometimes slightly ovoid. Oocyst wall colorless to pale yellowish, smooth, composed of a single layer about 0.8 μ thick. Micropyle absent. Thirty-eight oocysts from one host animal measured 17–23×15–21 μ, with a mean of 19.8×17.0 μ; their length-width ratios ranged from 1.0–1.4, with a mean of 1.16. Oocyst polar granule present. Oocyst residuum absent. Sporocysts 10–11× 6 μ; sporocyst length-width ratio 1.6–1.9, with a mean of 1.75. Sporocysts slightly ovoid, with a tiny, buttonlike Stieda body. Sporocyst wall very thin. Sporocyst residuum present, granular. Sporozoites homogeneous, more or less curled up in sporocysts.

Sporulation Time: Three days at room temperature in Liberia.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Dasymys incomptus rufulus.

Location: Lower jejunum. The macrogametes and immature parasites lie in the epithelial cells below the host cell nuclei (i.e., distal to the lumen).

* The genitive of *mys* is *myis*, not *mysis*. Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

Geographic Distribution: Liberia.
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Levine, Bray, Ivens, and Gunders (1959) found this species in two animals in Harbel, Liberia.

EIMERIA ARVICANTHIS VAN DEN BERGHE AND CHARDOME, 1956

(Plate 37, Fig. 301)

Eimeria arvicanthis van den Berghe and Chardome, 1956: 65–66.

Description: Oocysts described as ovoid but illustrated as ellipsoidal, 23–24 × 10–14 μ. Oocyst wall thin, rose-colored, number of layers not given. Micropyle presumably absent. Oocyst residuum composed of some rare granules. Oocyst polar body not mentioned, presumably absent. Sporocysts 10–11 × 7 μ, illustrated as ellipsoidal without Stieda body. Sporocyst residuum composed of about 20 granules arranged in a rosette. Sporozoites 7 × 3 μ, with one end broader than the other.
Sporulation Time: Seventy-eight hours in 1% chromic acid.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Arvicanthis abyssinicus rubescens.
Location: Probably intestine.
Geographic Distribution: Africa (Belgian Congo). The animal(s?) was captured at Tshibati (Lwiro), Kivu.
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

EIMERIA PUTEVELATA BRAY, 1958

(Plate 23, Fig. 164)

Eimeria putevelata Bray, 1958: 81–83.

Description: Oocysts ovoid, 22–30 × 17–22 μ, with a mean of 26.5 × 19.9 μ; mean length-width ratio, 1.26. Oocyst wall composed of a thick, yellow outer layer covered with small, well-defined pits and a thin inner layer. Micropyle absent. Occasional oocyst polar granules present. Oocyst residuum absent. Sporocysts 10–13 × 8–10 μ, with a mean of 11.5 × 8.3 μ, ovoid, with a very small Stieda body which is only a slight thickening of the wall at the narrow end. Sporocyst residuum usually but not always present. Sporozoites 10 × 3 μ, banana-shaped.
Sporulation Time: Ten days.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Lemniscomys striatus striatus (striped grass mouse).

Location: Ileum. Bray (1958) found macrogametes in the epithelial cells of the posterior third of the small intestine.

Geographic Distribution: Africa (Liberia).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

EIMERIA LEMNISCOMYSIS LEVINE, BRAY, IVENS, AND GUNDERS, 1959 *

(Plate 23, Fig. 163)

Eimeria lemniscomysis Levine, Bray, Ivens, and Gunders, 1959: 215–222.

Description: Oocysts broadly spindle-shaped with somewhat flattened ends. Oocyst wall brownish yellow, moderately rough and pitted, composed of a single layer about 1.2 μ thick at the sides and 0.8 μ thick at the ends. A thin membrane lines the wall. Micropyle absent. Three sporulated oocysts measured 27–30 × 18–19 μ, with a mean of 28.3 × 18.8 μ; their length-width ratios were 1.5–1.6. Oocyst polar granule present. Oocyst residuum absent. Sporocysts 16 × 8 μ, elongate ovoid, pointed at one end; Stieda body small or absent. Sporocyst residuum present, finely granular. Sporozoites lie more or less diagonally in sporocyst. Oocysts collapse rather quickly in Sheather's sugar solution.

Sporulation Time: Three days at room temperature in Liberia.

Schizogony and Gametogony: Macrogametes contain eosinophilic granules concentrated at their periphery.

Prepatent Period: Unknown.

Type Host: Lemniscomys striatus striatus (striped grass mouse).

Location: Macrogametes and microgametocytes in epithelial cells of upper jejunum and lower duodenum, lying between host cell nucleus and lumen.

Geographic Distribution: Liberia.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

EIMERIA MIYAIRII OHIRA, 1912

(Plate 23, Figs. 165 and 166; Plate 24, Figs. 167–181; Plate 37, Figs. 302–312)

Eimeria miyairii Ohira, 1912: 1045–55; Roudabush, 1937: 135–163.

Eimeria myiarii [*sic*]: Ryšavý, 1954: 131–174.

Eimeria carinii Pinto, 1928: 127–128; Becker and Burroughs, 1933: 123; Becker, 1934; Matubayasi, 1938: 144–163.

[*non*] *Eimeria miyairii:* Pérard, 1926: 120–124; Becker, Hall, and Hager, 1932: 299–316; Becker, 1934; Yakimoff and Gousseff, 1935: 261–265.

Description: Oocysts spherical to subspherical, with a thick, rough,

* The genitive of *mys* is *myis*, not *mysis*. Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

yellowish brown, radially striated wall. According to Matubayasi (1938), the wall is composed of two layers, the outer one thin and rough, and the inner one thick and radially striated. On the basis of Pinto's (1928) illustration, there may be two layers in the oocyst wall. Oocysts 17–29 × 16–26 μ, with a mean of 24 × 22 μ and a mean length-width ratio of 1.10, according to Becker and Burroughs (1933). Micropyle absent. Oocyst polar granule and oocyst residuum absent. Sporocysts 16–18 × 9–10 μ according to Pinto (1928). Sporocyst residuum present.

Sporulation Time: Four to five days (six days, according to Matubayasi, 1938).

Schizogony: Roudabush (1937) described the endogenous stages of *E. miyairii* in detail. The sporozoites are most abundant in the small intestine about 12 hours after infection. They are banana-shaped, 12–17 μ long (mean, 14.5 μ) and 2–3 μ wide, with a siderophilic, refractile globule at each end. The nucleus has a marginal chromatic ring and a central karyosome, and lies anterior to the middle of the sporozoite.

The sporozoite enters an intestinal cell and rounds up to form a first-generation schizont. This produces 12 to 24 first-generation merozoites and a residual mass. These merozoites measure 6–7 × 1–2 μ, with a mean of 6.6 × 1.3 μ. They have a central nucleus with a central karyosome, but no refractile globules. They leave the host cell in two days, enter new host cells, and form second-generation schizonts. Each second-generation schizont produces 8 to 16 second-generation merozoites plus a residuum on the third day. These merozoites measure 8–11 × 1–2 μ, with a mean of 9.2 × 1.4 μ. The nucleus is in the posterior fourth of the body; there are usually one or two large granules anterior to it. The second-generation merozoites enter new host cells and form third-generation schizonts. These produce 20 to 24 third-generation merozoites and a large residuum on the fourth day of infection. These merozoites measure 4–5 × 1–2 μ, with a mean of 4.4 × 1.2 μ, and have a central nucleus.

Gametogony: The third-generation merozoites enter new host cells. Roudabush (1937) considered that they formed microgametocytes and macrogametocytes, but the cells he considered macrogametocytes are actually macrogametes. The young "gametocytes" are indistinguishable and have a central vacuolated area containing an eccentric chromatin mass. The microgametocyte nucleus divides repeatedly, and the nuclei thereby produced migrate to the periphery of the cell, where the microgametes form. A large residual body is left. The microgametes measure 3 × 0.75 μ and have two flagella at their anterior end.

As the macrogametes develop, large, eosinophilic plastic granules and very small hematoxylinophilic granules form in their cytoplasm. The plastic granules migrate to the periphery, and fuse to form the outer wall of the oocyst. Roudabush (1937) found microgametes in the tissues

around these developing macrogametes, and believed that fertilization takes place while the latter are still in their host cells. Mature oocysts appear 5.5 days after infection.

Roudabush (1937) calculated that *E. miyairii* could produce 25,360 to 73,728 (mean, 38,016) oocysts per oocyst fed. According to Becker and Burroughs (1933), oocysts continue to be discharged for five days after a single inoculation, and for six to seven days after repeated inoculations. The average number of oocysts discharged during the patent period following repeated inoculation was 1.99×10^7.

Prepatent Period: Six days (six to eight days, according to Matubayasi, 1938).

Type Host: Rattus norvegicus (Norway rat).

Other Host: Rattus rattus (?). Matubayasi (1938) found this species in 4 of 33 wild rats (*R. norvegicus* and *R. rattus)* which he examined in Japan. However, he did not specify whether it occurred in one or both host species.

Location: Small intestine. *E. miyairii* occurs almost exclusively in the epithelial cells of the villi, but has been found occasionally in the glands. A striking difference between it and other rat coccidia is its tendency to cause parasitized cells to be pushed out of the epithelial layer toward the tunica propria. In addition, it frequently causes double or even multiple infections of cells, especially in the later stages of its life cycle. Roudabush's (1937) figures show that the parasites may be found beneath, above, or beside the host cell nucleus. Ohira's (1912) figures indicate that they are usually beneath the host cell nucleus.

Geographic Distribution: Worldwide.

Pathogenicity: Apparently unknown.

Cross-Transmission Studies: None.

Remarks: The synonymy of this species indicates the confusion which has existed regarding its correct name. The first authentic description of a coccidium from the rat was Ohira's (1912) description of *E. miyairii.* Ohira described only the endogenous stages and did not see the oocysts. His description was in Japanese, and was not available to most workers, who were guided by a German abstract of his paper. Pérard (1926) accepted the name *E. miyairii,* for the coccidium with which he worked, believing that *E. nieschulzi* Dieben, 1924 was a synonym. Subsequent workers followed his lead. Pinto (1928) described the oocysts of *E. miyairii* for the first time; he believed it to be a new species to which he gave the name, *E. carinii.* Roudabush (1937) finally straightened out the nomenclatural tangle. He studied the endogenous stages of the three commonest rat coccidia, compared them with the figures in Ohira's (1912) paper, and concluded that Pérard's *E. miyairii* was actually *E.*

nieschulzi, while Pinto's *E. carinii* was actually *E. miyairii.* We ourselves obtained a copy of Ohira's (1912) paper, had it translated, and are able to confirm Roudabush's interpretation. Without being aware of Roudabush's paper, Matubayasi (1938) made a study of this species and came to the same conclusion, but nevertheless continued to use the name *E. carinii* for *E. miyairii* and the name of *E. miyairii* for *E. nieschulzi.*

EIMERIA NIESCHULZI DIEBEN, 1924

(Plate 25, Figs. 182–187; Plate 26, Figs. 194–208; Plate 27, Figs. 209–214; Plate 38, Figs. 313–325; Plate 47, Figs. 438–443; Plate 48, Figs. 444–449)

Eimeria nieschulzi Dieben, 1924; Roudabush, 1937: 135–163.

Eimeria falciformis (Eimer) Schneider *pro parte. Auctores.*

Eimeria miyairii Ohira. Pérard, 1926: 120–124; Becker, Hall, and Hager, 1932: 299–316; Becker, 1934; Yakimoff and Gousseff, 1935: 261–265; Matubayasi, 1938: 144–163; Beltrán and Pérez, 1950: 71–78.

Eimeria myiairii [*sic*]: Yakimoff and Gousseff, 1936a: 504–508.

Eimeria halli Yakimoff, 1935: 81–83; Yakimoff and Gousseff, 1936a: 504–508.

Description: Oocysts ellipsoidal to ovoid, tapering at both ends. Oocyst wall smooth or granular, colorless to yellowish, composed of a single layer about 1.1 μ thick. Becker, Hall, and Hager (1932) illustrated the wall as composed of two layers, and Becker (1934) and Dieben (1924) stated that it was composed of two layers; on the other hand, Matubayasi (1938), reported only one layer, Pérard (1926) illustrated a single layer, and we ourselves found only a single layer in the forms from *R. norvegicus* and *R. hawaiiensis* which we studied. The oocysts described by Becker, Hall, and Hager (1932) from Iowa rats measured 16–26 × 13–21 μ, with a mean of 22.5 × 17.8 μ; their length-width ratios ranged from 1.0–1.5, with a mean of 1.26. Sixteen oocysts from a wild *R. norvegicus* in Illinois measured 18–24 × 15–17 μ, with a mean of 20.7 × 16.5 μ; their length-width ratios ranged from 1.1–1.4, with a mean of 1.25. Oocyst polar granule present. Oocyst residuum absent. Sporocysts elongate ovoid, with very small Stieda body. Sporocyst wall thin. Five sporocysts from a wild *R. norvegicus* in Illinois measured 11–12 × 7 μ, with a mean of 11.8 × 7.0 μ; their length-width ratios ranged from 1.6–1.8, with a mean of 1.64. Sporocyst residuum present, compact. Sporozoites lie lengthwise, head to tail, in sporocysts. Sporozoites with a pale yellowish, clear globule at the large end.

Sporulation Time: Two and one-half to three days (two days according to Matubayasi, 1938; three and one-half days according to Dieben, 1924).

Schizogony: Roudabush (1937) described the endogenous stages of *E. nieschulzi* in detail. The sporozoites may be found in the lumen of the small intestine three to four hours after infection, and may remain in

the intestine in the infective condition for as long as four days. They measure 10–12 × 1–2 μ, with a mean of 11.3 × 1.8 μ, and have a siderophilic, eosinophilic refractile globule at either end. The nucleus has a central karyosome.

The sporozoite enters an intestinal cell and rounds up to form a first-generation schizont; this schizont differs from those of later generations in containing a large, refractile, eosinophilic globule. The first-generation schizont produces 20 to 36 (mean, 26) first-generation merozoites in about 36 hours. These merozoites measure 7–10 × 1–2 μ, with a mean of 8.6 × 1.6 μ, and have a small eosinophilic (but not siderophilic) globule at either end. They break out of the host cell and enter other intestinal cells, where they round up to form second-generation schizonts. These mature about 48 hours after infection, forming 10 to 14 (mean, 12) second-generation merozoites which measure 13–16 × 1 μ, with a mean of 14.4 × 1.2 μ; these do not have eosinophilic globules. The second-generation merozoites break out of the host cell and enter new intestinal cells, where they round up to form third-generation schizonts which mature about 72 hours after infection, giving rise to 8 to 20 (mean, 15) third-generation merozoites. These measure 17–22 × 1 μ, with a mean of 19.1 × 1.2 μ, and are usually U- or J-shaped. The third-generation merozoites enter new intestinal cells, where they round up to form fourth-generation schizonts. These mature in four days after infection, giving rise to 36 to 60 (mean, 50) fourth-generation merozoites which measure 4–7 × 1–2 μ, with a mean of 5.5 × 1.4 μ.

Gametogony: The fourth-generation merozoites enter new intestinal cells. Roudabush (1937) considered that they formed microgametocytes and macrogametocytes, but the cells he called macrogametocytes are actually macrogametes. The young "gametocytes" are first seen about 5.5 days after infection, but cannot be distinguished until later. They consist of a central mass of chromatin surrounded by a crescentic, non-granular area which is in turn surrounded by rather densely granular cytoplasm.

The microgametocyte nucleus divides repeatedly, the nuclei migrate to the periphery of the gametocyte, their chromatin becomes elongate, and they form comma-shaped microgametes with two anterior flagella. The microgametes measure 4.4 × 0.1 μ, and their flagella are 9.2 μ long.

The macrogametes contain two types of granules. The larger ones are eosinophilic and the smaller ones are basophilic and hematoxylinophilic. The eosinophilic granules, known as plastic granules, migrate to the periphery of the gamete, where they flatten out in a rather thick layer which forms the outer wall of the oocyst. The basophilic granules, which stain blue with eosin-methylene blue, follow the eosinophilic

granules to the periphery of the gamete, where they flatten out and form a thinner layer inside the outer one. A third group of granules arises within the cytoplasm later; they resemble the plastic granules and migrate toward the periphery but do not reach it. Roudabush (1937) believed that they might take part in the formation of the sporocyst walls. Roudabush (1937) did not observe fertilization. He found microgametes in the tissues around the macrogametes, but was uncertain whether fertilization instigated oocyst wall formation.

Roudabush (1937) calculated that *E. nieschulzi* could produce 460,800 to 4,819,200 oocysts per oocyst fed. Hall's (1934) data showed that the total numbers of oocysts actually produced per oocyst fed were 62,000 when 1 oocyst was fed; 1,455,000 when 6 oocysts were fed; 1,389,000 when 15 oocysts were fed; 1,098,000 when 75 oocysts were fed; 1,029,666 when 150 oocysts were fed; and 144,150 when 2,000 oocysts were fed. According to Hall (1934) and Becker (1934), oocysts continue to be discharged for five to six days after a single inoculation, and for five to eight days after repeated inoculations.

Prepatent Period: Seven to eight days.

Sporogony: Dieben (1924) described sporogony in the developing oocysts; he studied living, unstained material. After about half an hour the protoplasm of the new oocyst has contracted into a globule, the sporont. After a little more than one day, a clear line appears in the sporont; it extends lengthwise through the whole sporont. Dieben (1924) thought this might indicate "chromosomes-conjugation" after fertilization. Very often a little body appears to leave the sporont; Dieben (1924) believed that this might indicate reduction division. The sporont then becomes irregular, and bright granules appear at four corners. The sporont becomes rectangular, growing into the so-called "Buckel" or "stringed" stage. The grooves between the corners deepen so that four daughter-globules are formed, each containing a bright granule. The latter forms the top of a transparent pyramid which appears on each globule. These pyramids diminish a little, forming a "pseudopyramid" stage. They then increase in size, forming the pyramid stage. Four rounded sporoblasts and an oocyst residuum are then formed. The sporoblasts become ovoid and form sporocysts, each containing two sporozoites and a residuum.

Landers (1960) attempted to induce excystation in vitro by treating sporulated oocysts with pepsin, trypsin, pancreatin, pancreatic lipase, beef, dog, and rat bile, leuco methylene blue-methylene blue, ethanol-acetaldehyde, 30 pounds air pressure, vacuum (−28 inches of mercury), and fresh blood, but without success. However, the oocysts excysted and produced typical infections following injection directly into the skeletal muscle or peritoneal cavity.

Type Host: Rattus norvegicus (Norway rat).

Other Hosts: Rattus rattus (black rat), *Rattus hawaiiensis* (found in the present study).

Location: Small intestine, particularly the middle part thereof. According to Roudabush (1937), *E. nieschulzi* occurs in the epithelial cells along the base of the villi and in the glands, but usually not as far as the fundi of the glands or in the Paneth cells. The schizonts are usually above the host cell nuclei, while the great majority of the macrogametes are beneath them. (According to Matubayasi, 1938, the first stage of the schizont is beneath the nucleus and pushes it up to the surface as it grows.)

Geographic Distribution: Worldwide.

Pathogenicity: According to Pérard (1926), *E. nieschulzi* may produce severe diarrhea or even death in young rats less than six months old. Becker (1934) found that the size of the infecting dose determines the severity of the symptoms. If a rat is fed up to 2,000 oocysts daily for five days, it will become immune without developing clinical evidence of severe disease. However, 30,000 to 100,000 oocysts will produce severe diarrhea on about the seventh day and may cause death. Becker and his associates studied the effects of various constituents of the ration on oocyst production by *E. nieschulzi* (Becker, 1939, 1941, 1942; Becker and Dilworth, 1941; Becker, Manresa, and Smith, 1943; Becker and Smith, 1942). They found, among other things, that thiamin and riboflavin decreased oocyst production, while pantothenic acid increased it and nicotinic acid had no effect.

Cross-Transmission Studies: Dieben (1924) transmitted this species from *Rattus norvegicus* to *R. rattus* and vice versa, but was unable to transmit it to the house mouse, guinea pig, or domestic rabbit. Pérard (1926) was unable to infect the house mouse or domestic rabbit with *E. nieschulzi.*

Prevalence: Dieben (1924) reported that all the young wild *R. norvegicus* and *R. rattus* he examined in the Netherlands were infected. Pérard (1926) noted that this organism caused considerable loss among rats in the Pasteur Institute in Paris. However, Becker (1934) found it in only 1 of 12 wild *R. norvegicus* near Ames, Iowa, and did not find it in 500 to 600 laboratory rats at Iowa State College. Beltrán and Pérez (1950) found it in 1 per cent of 200 wild *R. norvegicus* in Mexico City. We found *E. nieschulzi* in the present study of 1 out of 9 *R. hawaiiensis* from the vicinity of Honokaa on the island of Hawaii and in 3 out of 11 *R. norvegicus* from farms in the vicinity of Sullivan, Illinois. Bonfante, Faust, and Giraldo (1961) reported finding *E. nieschulzi* in 66 per cent

of 71 wild *R. norvegicus* and 69 per cent of 16 wild *R. rattus* in Cali, Colombia.

Remarks: The confusion regarding the correct specific names for the coccidia of *Rattus norvegicus* has been discussed under *E. miyairii* (p. 118).

Yakimoff (1935) described a coccidium from the Norway rat in Russia under the name *E. halli*. Its oocysts were ovoid, subspherical, or spherical, with a smooth, yellowish wall, no micropyle, no oocyst residuum or polar granule, but with a sporocyst residuum. The ovoid forms measured 18–32 × 13–22 μ, with a mean of 24.0 × 17.2 μ, the subspherical forms measured 14–27 × 12–24 μ, and the spherical forms measured 18–20 μ. Yakimoff and Gousseff (1936a) reported this species from a black rat in White Russia. This form does not differ significantly from *E. nieschulzi*. Roudabush (1937) was dubious about its validity, and we consider it a synonym.

Becker and Hall (1933) found that there was no cross-immunity between *E. nieschulzi* and *E. separata*. Rats which had developed immunity to one species as the result of previous infection were not immune to the other.

EIMERIA SEPARATA BECKER AND HALL, 1931

(Plate 25, Figs. 188–193; Plate 27, Figs. 215–227; Plate 38, Figs. 326–332)

Eimeria separata Becker and Hall, 1931: 131; Becker, Hall, and Hager, 1932: 299–316; Becker, 1934; Yakimoff and Gousseff, 1935: 261-265; Yakimoff and Gousseff, 1936a: 504–508; Roudabush, 1937: 135–163; Matubayasi, 1938: 144–163; Beltrán and Pérez, 1950: 71–78; Ryšavý, 1954: 131–174; Levine, Bray, Ivens, and Gunders, 1959: 215–222.

Description: Oocysts predominantly ellipsoidal, although subspherical and ovoid forms may also occur. Oocyst wall smooth, colorless to pale yellowish, composed of a single layer about 0.6 μ thick. The oocyst wall was illustrated by Becker, Hall, and Hager (1932) as apparently composed of two layers, but this was probably due to the manner of drawing; they did not mention the number of layers in their description, and we found only a single layer in the forms from *R. norvegicus* which we studied. Oocysts 13–19 × 11–17 μ, with a mean of 16.1 × 13.8 μ and a mean length-width ratio of 1.16, according to Becker, Hall, and Hager (1932). Ninety oocysts from three *R. norvegicus* from Illinois measured by us in the present study were 10–16 × 10–14 μ, with a mean of 13.4 × 11.6 μ; their length-width ratios ranged from 1.0–1.4, with a mean of 1.15. Micropyle absent. One to three oocyst polar granules present. Oocyst residuum absent. Sporocysts ellipsoidal, with a tiny Stieda body. Twelve sporocysts from *R. norvegicus* from Illinois meas-

ured by us in the present study were 8–10×5–6 μ, with a mean of 9.0×5.1 μ; their length-width ratios ranged from 1.6–1.9, with a mean of 1.76. Sporocyst wall very thin. Sporozoites elongate, often with a clear globule at one end, lying lengthwise, head to tail, in the sporocysts. Sporocyst residuum small and compact, sometimes not discernible.

Sporulation Time: Less than 36 hours (three days at room temperature in Liberia for the strain from *R. defua*).

The following description was given by Levine, Bray, Ivens, and Gunders (1959) of the form they found in *Rattus (Dephomys) defua* in Liberia: Oocysts subspherical, ellipsoidal, or slightly ovoid. Oocyst wall smooth, colorless to pale yellowish or greenish, composed of a single layer about 1 μ thick. Micropyle absent. Twenty sporulated oocysts measured 16–21×15–17 μ, with a mean of 18.4×15.8 μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.16. Oocyst polar granule present. Oocyst residuum absent. Oocyst wall collapses rather quickly in Sheather's sugar solution. Sporocysts 11×7 μ, almost ellipsoidal, with a small Stieda body. Sporocyst wall thin. Sporocyst residuum present, small. Some sporozoites appear to have a clear globule at one end. Sporozoites lie lengthwise in sporocysts but are curled at the ends.

The form found in *Rattus hawaiiensis* in the present study had the following characteristics: Oocysts ellipsoidal to subspherical. Oocyst wall smooth, pale yellowish, composed of a single layer 0.6–0.8 μ thick. Micropyle absent. Thirty sporulated oocysts measured 12–16×10–13 μ, with a mean of 13.5×11.6 μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.16. One to two oocyst polar granules present. Oocyst residuum absent. Sporocysts almost ellipsoidal, with a small, somewhat flat Stieda body. Four sporocysts measured 8–9×5 μ, with a mean of 8.8×5.1 μ; their length-width ratios ranged from 1.6–1.7, with a mean of 1.68. Sporocyst residuum small to very small or absent. Sporozoites oriented longitudinally, head to tail, in sporocysts, with a pale yellowish globule at the large end.

Schizogony: Roudabush (1937) described the endogenous stages of *E. separata* in detail. Sporozoites are found in the lumen of the cecum as early as six hours after infection, but some may also be found as long as three days after infection. They measure 8–10×2–3 μ, with a mean of 9.5×2.3 μ. The nucleus is central and has a central karyosome; there is a siderophilic, refractile globule at either end of the sporozoite.

The sporozoite enters an intestinal cell and rounds up to form a first-generation schizont. This divides by multiple fission to form 6 to 12 (mean, 8) first-generation merozoites; there is no residuum. These merozoites measure 11–13×2–3 μ, with a mean of 11.9×2.2 μ, and have a central nucleus with a central karyosome and granular cytoplasm with-

out refractile globules. They break out of the host cell in one day, enter new host cells, round up and form second-generation schizonts. Each of these produces 4 to 6 (mean, 5.5) second-generation short, broad merozoites measuring 6–9 × 2–3 μ, with a mean of 7.7 × 2.3 μ. These break out of the host cell in two days after infection and enter new host cells, where they round up to form third-generation schizonts. Each third-generation schizont forms 2 to 6 (mean, 4) third-generation merozoites by the third day after infection. They measure 13–15 × 2–3 μ, with a mean of 13.6 × 2.6 μ. No residuum is left. The third-generation merozoites differ from the previous two not only in size but also in the fact that their anterior end stains an intense red with eosin-methylene blue or brownish yellow with iron hematoxylin.

Gametogony: The third-generation merozoites enter new host cells. Roudabush (1937) considered that they formed microgametocytes and macrogametocytes, but the cells he considered macrogametocytes are actually macrogametes. The young "gametocytes" are indistinguishable and have an oval vacuolated area which contains an eccentric chromatin mass. The microgametocyte nucleus divides repeatedly, and the nuclei thereby produced migrate to the periphery of the cell. Here the microgametes form; they are 2–3 μ long and less than 0.5 μ wide at the anterior end, and taper to a point posteriorly; they have two flagella.

The macrogametes contain both eosinophilic plastic granules and hematoxylinophilic granules. These pass to the periphery of the cell and flatten out, the eosinophilic granules forming the outer oocyst wall and the hematoxylinophilic granules the thin inner membrane of the oocyst. Meanwhile, a second set of plastic granules forms. They migrate to just within the inner wall, where they still remain when the oocyst leaves the host cell; their further development has not been followed. Roudabush (1937) believed that fertilization takes place in the tissues during the early oocyst wall formation. Mature oocysts appear five to six days after infection.

Roudabush (1937) calculated that *E. separata* could produce 384 to to 3,456 (mean, 1,536) gametocytes per oocyst fed. The numbers of oocysts produced would be these figures minus the numbers of microgametocytes. According to Becker, Hall, and Hager (1932), oocysts continue to be discharged for three to four days after a single inoculation, and from four to six days after repeated inoculations. The average number of oocysts discharged during the patent period following repeated inoculations was 2.46×10^6.

Prepatent Period: Five to six days.

Type Host: Rattus norvegicus (Norway rat).

Other Hosts: Rattus rattus (?). Matubayasi (1938) found this species

"often" in wild rats (*R. norvegicus* and *R. rattus)* which he examined in Japan. However, he did not specify whether it occurred in one or both host species.

Rattus (Dephomys) defua. Levine, Bray, Ivens, and Gunders (1959) reported *E. separata* from this species in Harbel, Liberia.

Rattus hawaiiensis. Found in the present study.

Location: Cecum and colon. According to Roudabush (1937), infection is heavier in the cecum. *E. separata* occurs exclusively in the cells of the surface epithelium, and not in the epithelium of the glands. The schizonts, gametocytes, and gametes are found below the host cell nuclei. Roudabush found some stages, especially the macrogametes, below the epithelial layer, but thought this may have been due to the plane in which the sections were cut. A similar appearance was noted by Matubayasi (1938).

Geographic Distribution: North America (Iowa, Illinois, Mexico), Hawaii, Europe (Russia, Czechoslovakia), Japan, Africa (Liberia).

Pathogenicity: According to Becker (1934), *E. separata* is not pathogenic enough to cause clinical symptoms even when heavy infective doses are administered. However, some hyperemia of the cecal and colon walls was noted when the rats were killed on about the sixth day of infection.

Cross-Transmission Studies: None.

Prevalence: Beltrán and Pérez (1950) found this species in 11 per cent of 200 wild *R. norvegicus* in Mexico City. In the present study, we found it in 10 of 11 wild *R. norvegicus* from farms in the vicinity of Sullivan, Illinois. Levine, Bray, Ivens, and Gunders (1959) found it in the only *Rattus defua* which they examined from Harbel, Liberia. It was found in the present study in 2 out of 9 *R. hawaiiensis* from the vicinity of Honokaa on the island of Hawaii.

Remarks: Becker and Hall (1933) found that there was no cross-immunity between *E. separata* and *E. nieschulzi.* Rats which had developed immunity to one species as the result of previous infection were not immune to the other.

EIMERIA HASEI YAKIMOFF AND GOUSSEFF, 1936

(Plate 38, Figs. 333 and 334)

Eimeria hasei Yakimoff and Gousseff, 1936a: 504–508.

Description: Oocysts ovoid, ellipsoidal, or spherical. Oocyst wall smooth, illustrated as composed of a single layer. Spherical oocysts 12–24 μ in diameter, with a mean of 16.1 μ. Other oocysts 16–20 × 12–17 μ, with a length-width ratio of 1.1–1.4. Micropyle absent. Oocyst polar granule present. Oocyst and sporocyst residua absent. Sporocysts 8.5 × 5 μ.

Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Rattus rattus (black rat).
Location: Intestine.
Geographic Distribution: USSR (White Russia).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Yakimoff and Gousseff (1936a) found this species in 2 per cent of 47 black rats in White Russia.

EIMERIA NOCHTI YAKIMOFF AND GOUSSEFF, 1936

(Plate 39, Fig. 335)

Eimeria nochti Yakimoff and Gousseff, 1936a: 504–508; Ryšavý, 1954: 131–174 (?).

Description: Oocysts ovoid. Oocyst wall smooth, described by Yakimoff and Gousseff (1936) as "doppelkonturige," but illustrated as composed of a single layer. Oocysts 15–24 × 12–22 μ, with a mean of 17.2 × 14.2 μ. Oocyst length-width ratio 1.1–1.4, with a mean of 1.22. Micropyle absent. Oocyst polar granule absent. Oocyst and sporocyst residua absent.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Rattus rattus (black rat).
Other Host: Rattus norvegicus (Norway rat) (?).
Location: Intestine.
Geographic Distribution: USSR (White Russia), Europe (Czechoslovakia?).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Yakimoff and Gousseff (1936a) found this species in 2 per cent of 47 black rats in White Russia.
Remarks: Ryšavý (1954) reported *E. nochti* from *Rattus norvegicus* in Czechoslovakia. The oocysts of his form measured 14–25 × 13–20 μ, with a mean of 19.4 × 13.8 μ. However, they differed from both *E. nochti* and the other coccidia reported from *Rattus* in shape, being pointed at both ends.

EIMERIA RATTI YAKIMOFF AND GOUSSEFF, 1936

(Plate 39, Fig. 336)

Eimeria ratti Yakimoff and Gousseff, 1936a: 504–508.

Description: Oocysts cylindrical to ovoid. Oocyst wall smooth, described by Yakimoff and Gousseff (1936a) as "doppelkonturige," but illustrated as composed of a single layer. Oocysts 16–28 × 15–16 μ, with

a mean of 23×15 μ. Oocyst length-width ratio 1.1–1.9, with a mean of 1.61. Micropyle absent. Oocyst residuum absent. Oocyst polar granule present. Sporocyst residuum present.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Rattus rattus (black rat).

Location: Intestine.

Geographic Distribution: USSR (White Russia).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Yakimoff and Gousseff (1936a) found this species in 4 per cent of 47 black rats in White Russia.

Remarks: This species appears to differ from *E. separata* Becker and Hall, 1931 only in size and in the fact that some of its oocysts are cylindrical. However, only ten oocysts were measured. Future work may indicate that *E. ratti* is a synonym of *E. separata.*

EIMERIA PRAOMYSIS LEVINE, BRAY, IVENS, AND GUNDERS, 1959 *

(Plate 28, Fig. 228)

Eimeria praomysis Levine, Bray, Ivens, and Gunders, 1959: 215–222.

Description: Oocysts subspherical to ellipsoidal. Oocyst wall pale yellowish to brownish, smooth to somewhat rough, composed of a single layer (confirmed by breaking oocyst) approximately 1 μ thick. Micropyle absent. Thirty-one oocysts measured 17–24×16–23 μ, with a mean of 20.6×19.1 μ; their length-width ratios ranged from 1.0–1.3, with a mean of 1.08. One or two oocyst polar granules present. Oocyst residuum absent. Sporocysts ellipsoidal to slightly ovoid, with Stieda body. Six sporocysts measured 10–12×6–7 μ, with a mean of 11.2×6.5 μ; their length-width ratios ranged from 1.6–1.8, with a mean of 1.72. Sporocyst residual granules present, rather coarse. Sporozoites lie more or less lengthwise in sporocysts.

Sporulation Time: Six days at room temperature in Liberia.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Rattus (Praomys) tullbergi rostratus.

Location: Intestinal contents.

Geographic Distribution: Liberia.

Pathogenicity: Unknown.

* The genitive of *mys* is *myis,* not *mysis.* Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

Cross-Transmission Studies: None.

Prevalence: This species was found in one of three rats examined from Harbel, Liberia.

EIMERIA SP. FANTHAM, 1926

Eimeria sp. Fantham, 1926: 560–570.

Description: Oocysts oval, 16–21 × 15–16 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Rattus (Mastomys) coucha (syn., *Mus coucha)* (multimammate mouse).

Location: Chiefly jejunum and ileum.

Geographic Distribution: South Africa.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Unknown.

Remarks: Fantham (1926) stated that this species might be a variety of *Eimeria falciformis,* but this is unlikely.

EIMERIA FALCIFORMIS (EIMER, 1870) SCHNEIDER, 1875

(Plate 28, Figs. 229–240; Plate 39, Figs. 337–339)

Gregarina falciformis Eimer, 1870.

Eimeria falciformis (Eimer, 1870) Schneider, 1875: xl–xlv; Wenyon, 1926; Yakimoff, Gousseff, and Suz'ko, 1945: 172–183; Koffman, 1946: 424–442; Cordero del Campillo, 1959: 351–368; Černa, 1962: 1–13 (?).

Coccidium falciforme (Eimer, 1870) Schuberg, 1892.

Gregarina muris Rivolta, 1878: 220–235.

Pfeifferia schubergi (Labbé, 1896) Labbé, 1899.

Eimeria schubergi (Labbé, 1896) Doflein, 1916.

Eimeria-like species. Clarke, 1895: 277–283.

[*non*] *Eimeria schubergi* (Schaudinn, 1900)

[*non*] *Eimeria falciformis:* Elton *et al.,* 1931: 657–721 [see *Eimeria* sp. (Ryšavý, 1954)—p. 113]; Ryšavý, 1954: 131–174 (*pro parte*) [see *Eimeria* sp. (Ryšavý, 1954)—pp. 81 and 113]; Černa and Daniel, 1956: 19–23 [see *Eimeria* sp. (Ryšavý, 1954)—p. 113]; Ring, 1959: 381–401.

Description: Oocysts broadly ovoid to subspherical or spherical, 16–21 × 11–17 μ. Oocyst wall smooth, apparently colorless. Micropyle absent. Oocyst residuum either absent or present. Sporocyst Stieda body present, although not always illustrated. Sporocyst residuum present. Sporozoites lie longitudinally in sporocysts.

The above description is based on the earlier literature. A more complete description, based on a laboratory strain obtained from Weybridge, England, was given by Cordero del Campillo (1959). Unfortunately, he gave no drawing but only a rather blurred photomicrograph. According

to his description, the oocysts are ellipsoidal, with a smooth, colorless wall without a micropyle. He made a biometric study of the dimensions of 1,527 oocysts during a 20-day period. They ranged from 15–26 × 13–24 μ; their means varied on different days from 19–22 × 16–19 μ, and the mean of an "ideal" oocyst was considered to be 21 × 18 μ. The oocysts tended to increase in size from the first to the fifth or sixth days of the patent period and then decreased in size. The oocyst length-width ratio ranged from 1.1–1.2, with a mean of 1.17. There were one or two cylindrical oocyst polar granules measuring 3 × 1.5 μ, but no oocyst residuum. The sporocysts measured 10–12 × 6–8 μ and had a conspicuous Stieda body (which he called a micropyle). The sporocyst residuum was subspherical and measured 4–6 × 3–5 μ. The sporozoites had a large, refractile globule 3 μ in diameter.

The following description is of oocysts found in the present study in a *Mus musculus* from Illinois and assigned to this species: Oocysts subspherical to spherical. Oocyst wall smooth, almost colorless to pale yellowish, composed of a single layer about 1 μ thick. Eight sporulated oocysts measured 15–18 × 13–16 μ, with a mean of 16.7 × 14.6 μ; their length-width ratios ranged from 1.1–1.2, with a mean of 1.14. Micropyle absent. Oocyst polar granule absent. Oocyst residuum absent. Sporocysts elongate ovoid, about 11 × 7 μ, thin-walled, with a tiny Stieda body. Sporocyst residuum present, usually compact, finely granular. Sporozoites with a large, homogeneous yellowish globule at the large end. Sporozoites lie lengthwise in sporocysts.

In addition to the above, found in the same mouse was about an equal number of oocysts which differed from the above description only in having an oocyst polar granule. Ten of these oocysts measured 14–17 × 12–16 μ, with a mean of 16.1 × 14.1 μ; their length-width ratios ranged from 1.0–1.2, with a mean of 1.15. Although the older descriptions of *E. falciformis* omit mention of an oocyst polar granule, Cordero del Campillo (1959) found one. Some earlier authors mentioned an oocyst residuum and it is possible that they used this term instead of polar granule. That a polar granule may be formed and then disappear later on in the course of sporogony may account for the difference we observed. All our material was used up in making these observations. Clarification of this point must await further studies, but in the meantime it is considered best not to assign our two forms to different species.

Sporulation Time: Five to six days according to Wenyon (1926), three days according to Nieschulz and Bos (1931), Koffman (1946), and Cordero del Campillo (1959).

Schizogony: Although schizogony has not been studied in detail, some stages have been described by Eimer (1870), Schneider (1875), Schuberg

(1892), (1895), Clarke (1895), Reich (1913), Reichenow (1921), Reimer (1923), Wenyon (1926), Kiedrowski (1925), and Nieschulz and Bos (1931). The protozoa are found in the epithelial cells of the small intestine, but they may also occur in the stomach and large intestine. The generations of merozoites have not been differentiated. The mature schizonts may produce from 8 or possibly fewer to 30 or more elongate, falciform merozoites which often lie around a central residual mass of cytoplasm like the ribs of a barrel; they may also spiral somewhat. Merozoites appear in the feces three days after experimental infection and persist until the twelfth day, being most numerous on the fourth day after infection.

Gametogony: Gametogony has been described particularly by Reich (1913) and also by Wenyon (1926). The microgametocytes are large, irregularly shaped cells on the surface of which numerous nuclei develop. Each nucleus gives rise to a comma-shaped biflagellate microgamete.

The macrogametes are ovoid to subspherical and contain a central nucleus and numerous plastic granules. These coalesce to form the oocyst wall, but leave a micropyle at one end. Fertilization then takes place according to Reich (1913), after which the micropyle disappears. The oocysts then pass out of the body.

Prepatent Period: Oocysts first appear in the feces on the fourth day after infection according to Reimer (1923) or on the fifth day according to Nieschulz and Bos (1931) and Cordero del Campillo (1959). According to Nieschulz and Bos, they reach their maximum between the sixth and twelfth days, and by the fifteenth day half the experimentally infected mice are no longer shedding oocysts.

Type Host: Mus musculus (house mouse).

Location: Epithelial cells of the small and large intestines. Clarke (1895) and Reich (1913) reported it also from the stomach, but Becker (1934) considered that it remained to be established whether the stomach forms were *Eimeria* rather than *Cryptosporidium muris.* According to Reimer (1923), the parasites are found in the crypts but not in the tips of the villi of the small intestine and in the mucosa of the large intestine.

Geographic Distribution: Worldwide.

Pathogenicity: Light infections have little effect, but heavy ones may cause diarrhea and even death. A catarrhal enteritis may occur, together with desquamation of the intestinal epithelium and hemorrhage. The feces may contain blood. According to Nieschulz and Bos (1931), mortality is highest from the fourth to the eighth day after infection. Cordero del Campillo (1959) saw no clinical signs in mice infected with 55,000 oocysts; mice infected with 100,000 to 500,000 oocysts lost their appetites; mice infected with 2 million oocysts had dysentery and hemorrhages in the small intestine.

Cross-Transmission Studies: Nöller (1920) was unable to infect the rat or dog with *E. falciformis,* and Pérard (1926) was unable to infect the rat with it.

Prevalence: E. falciformis is apparently much commoner in Europe than in the United States. Wenyon (1926) stated that it was common in England, and Yakimoff, Gousseff, and Suz'ko (1945) found it in 3 out of 18 wild *M. musculus severtzovi* in Tadzhikistan. On the other hand, Becker (1934) saw it only once in a laboratory mouse, and examined nearly 50 wild house mice in Iowa without finding any coccidia. We found it in 1 out of 42 wild *M. musculus* captured on farms in the vicinity of Sullivan, Illinois, but we failed to find it in several laboratory mouse colonies and in half a dozen wild house mice captured in Urbana, Illinois. Bonfante, Faust, and Giraldo (1961) reported finding *E. falciformis* in all of the 5 wild *Mus musculus* they examined in Cali, Colombia.

Remarks: Ryšavý (1954) reported *E. falciformis* from *Mus musculus, Apodemus flavicollis, A. sylvaticus, Microtus arvalis,* and *Clethrionomys glareolus* in Czechoslovakia. The description he gave was similar to that of *E. falciformis,* but he did not describe the forms from each host separately. For the reasons given in the discussion of these forms in *Microtus arvalis* (p. 81), it is very doubtful that the forms Ryšavý saw in the hosts other than *M. musculus* were *E. falciformis.* However, since he did not describe them separately from each host, it is useless to attempt to assign names to them.

Černa and Daniel (1956) reported *E. falciformis* from *Apodemus flavicollis* and *Clethrionomys glareolus* in Czechoslovakia. They gave the same dimensions as Ryšavý, but mentioned that the oocyst wall was more than 1 μ thick. For the reasons given above, these forms were undoubtedly not *E. falciformis* either, but cannot be assigned separate names.

Černa (1962) reported finding *E. falciformis* not only in *Mus musculus* but also in *Apodemus flavicollis* and *A. sylvaticus.* She studied the coccidia in experimentally infected *M. musculus,* but her description differed in some ways from the descriptions of all other coccidia from this host, and it is uncertain whether she was dealing with a pure infection. Hence, the information in her paper is summarized below, but without attempting to establish the species involved. Most of the oocysts were broadly "oval," 14–23 × 14–20 μ; often slightly narrowed toward one or both poles. They sporulated in two to three days at room temperature in 1.5% potassium dichromate solution. The sporocysts measured 4–5 × 3–4 μ (according to Černa's text) or 7–8 × 4.5 μ (according to her table). A small polar body was occasionally (according to Černa's text) or usually (according to her table) present. She found endogenous

stages only in the mucosa and submucosa of the colon and cecum, and never in the small intestine. She described two schizogonic stages. The first schizonts appeared as early as the second day after infection, measured 4–7 × 4–6 μ, and gave rise to only 4 merozoites. The second-generation schizonts measured 19–25 × 13–18 μ and produced 12 to 16 merozoites. The merozoites were slender, 9–10 × 2–3 μ, slightly narrowed at both ends, with an excentric nucleus. The mature microgametocytes measured 11–16 × 6–11 μ, and the mature macrogametes measured 12–18 × 12–15 μ.

Elton *et al.* (1931) and Ring (1959) reported finding *Eimeria falciformis* in *Apodemus sylvaticus, Clethrionymus glareolus,* and *Microtus agrestis hirtus* in England. They did not describe the coccidia, which were undoubtedly not *E. falciformis* but species characteristic of their several hosts.

EIMERIA HINDLEI YAKIMOFF AND GOUSSEFF, 1938

(Plate 37, Fig. 298)

Eimeria hindlei Yakimoff and Gousseff, 1938: 1–3; Svanbaev, 1956: 180–191 (from *Mus musculus*).

[*non*] *Eimeria hindlei:* Svanbaev, 1956: 180–191 (from *Apodemus sylvaticus*—see *E. prasadi*); Ryšavý, 1954: 131–174 (see *E. rysavyi*); Černa, 1962: 1–13 (see *E. rysavyi*).

Description: Oocysts ovoid, smooth, 22–27 × 18–21 μ (28.4 × 22.0 μ and greenish in color according to Svanbaev, 1956). Oocyst length-width ratio 1.2–1.4. Micropyle absent. Oocyst polar granule present. Oocyst residuum absent. Sporocysts ovoid; according to Svanbaev (1956) they measure 8.6 × 6.4 μ. Sporozoites illustrated with a clear globule at one end.

The situation regarding the sporocyst residuum requires discussion. In the paper in which they described *E. hindlei,* Yakimoff and Gousseff (1938) also described four other species of *Eimeria* from *Mus musculus: E. keilini, E. krijgsmanni, E. musculi,* and *E. schueffneri.* Their statements regarding the sporocyst residua of these five species were respectively: "We could not find residual bodies in the sporocysts," "We could not distinguish any residual bodies in the sporocysts," "We were unable to discover whether the sporocysts had residual bodies," and (for the last two) "The presence of a residual body in the sporocysts was uncertain." They showed no residual bodies in the rough sketches which illustrated their paper. In his description of *E. hindlei* from *Mus musculus,* Svanbaev (1956) stated that a sporocyst residual body was present. The question arises whether the *E. hindlei* seen and named by Yakimoff and Gousseff (1938) actually lacked a sporocyst residuum or whether they meant by their statements that they were unable to determine whether one was present or not. If the former is the case, Svanbaev's

form should not be assigned to this species. If the latter is the case, it could be. Until this point has been investigated further, it is considered better to assign them to the same species.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Mus musculus (house mouse).

Location: Feces.

Geographic Distribution: USSR (White Russia, western Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Yakimoff and Gousseff (1938) found *E. hindlei* in 1 of 20 mice examined in White Russia.

Remarks: Svanbaev (1956) described an *Eimeria* under the name *E. hindlei* from the field mouse, *Apodemus sylvaticus,* in western Kazakhstan. It did not belong to this species, and we have named it *Eimeria prasadi* (see p. 110).

Ryšavý (1954) described an *Eimeria* under the name *E. hindlei* from *Apodemus sylvaticus* and *Clethrionomys glareolus* in Czechoslovakia. He did not differentiate between the forms from the two hosts, the oocysts failed to sporulate, and Ryšavý made no mention of Galli-Valerio's or Pellérdy's work cited on page 110. On the basis of the meager morphological information supplied, this form(s?) does not disagree with the description of *E. hindlei,* but in view of the failure of Pellérdy's cross-transmission attempts, it is unlikely that it is this species; as a matter of fact, Ryšavý was probably dealing with a different species in each host. The form from *Apodemus sylvaticus* agrees most closely with *E. prasadi* from the same host, but under the circumstances it is considered best not to assign it to any species. Ryšavý (1957) gave further information regarding the form from *C. glareolus,* and Černa (1962) described its oocysts and sexual stages. We have named this form *Eimeria rysavyi* (see page 82).

EIMERIA KEILINI YAKIMOFF AND GOUSSEFF, 1938

(Plate 40, Fig. 347)

Eimeria keilini Yakimoff and Gousseff, 1938: 1–3.

[*non*] *Eimeria keilini:* Ryšavý, 1954: 131–174 [see *Eimeria* sp. (Ryšavý, 1954)—p. 113]; Černa and Daniel, 1956: 19–23 [see *Eimeria* sp. (Ryšavý, 1954)—p. 113]; Černa, 1962: 1–13 [see *Eimeria* sp. (Ryšavý, 1954)—p. 113].

Description: Oocysts smooth, yellowish, pointed at both ends. Micropyle absent. Oocysts 24–32 × 18–21 μ, with a mean of 28.8 × 19.4 μ. Oocyst length-width ratio 1.2–1.7, with a mean of 1.54. Oocyst polar granule and oocyst residuum absent. Sporocysts 12.2 × 6.1 μ. The authors stated, "We

could not distinguish any residual bodies in the sporocysts." See the description of *E. hindlei* (p. 135), for a discussion of the meaning of this statement. Stieda body not mentioned and not shown in the rather sketchy illustration.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Mus musculus (house mouse).

Location: Feces.

Geographic Distribution: USSR (White Russia).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Yakimoff and Gousseff (1938) found *E. keilini* in 1 of 20 mice examined in White Russia.

Remarks: Ryšavý (1954) described a coccidium from *Apodemus sylvaticus* in Czechoslovakia under the name *Eimeria keilini.* While the shape of its oocysts as shown in his illustration resembled that of *E. keilini,* the oocysts did not sporulate. Černa and Daniel (1956) and Černa (1962) found what was presumably the same form in *A. flavicollis* in Czechoslovakia. It sporulated, and its sporocysts were smaller than those of *E. keilini,* measuring 8–9 × 6–7 μ. In addition, its wall was colorless. In view of these differences, of Pellérdy's (1954) failure to transmit four species of *Eimeria* from *Apodemus flavicollis* to *Mus musculus,* and of the failure of various attempts to transmit *Eimeria* between *Mus* and *Rattus,* it is doubtful whether Ryšavý's form is *E. keilini.* Its shape is unlike that of any of the six species of *Eimeria* so far described from *Apodemus.* In the absence of more information, it is discussed on page 113 as *Eimeria* sp. (Ryšavý, 1954).

EIMERIA KRIJGSMANNI YAKIMOFF AND GOUSSEFF, 1938

(Plate 42, Fig. 376)

Eimeria krijgsmanni Yakimoff and Gousseff, 1938: 1–3.

Eimeria kriygsmanni [*sic*]: Svanbaev, 1956: 180–191 (from *Mus musculus*).

[*non*] *Eimeria krijgsmani* [*sic*]: Ryšavý, 1954: 131–174 (see *E. svanbaevi*).

[*non*] *Eimeria kriygsmanni* [*sic*]: Svanbaev, 1956: 180–191 (from *Apodemus sylvaticus*—see *E. svanbaevi*); Svanbaev, 1958: 183–186 (from *Ochotona pallas?*); Svanbaev, 1962: 23–39 (see *E. peschankae*).

Description: Oocysts described as "oval," but illustrated as ellipsoidal, smooth, colorless or yellowish. Micropyle absent. Oocysts 18–23 × 13–16 μ, with a mean of 21.9 × 14.8 μ (25.4 × 18.8 μ, according to Svanbaev, 1956). Oocyst length-width ratio 1.2–1.6, with a mean of 1.37 (1.35, according to Svanbaev, 1956). Oocyst polar granule present. Oocyst residuum absent. Sporocysts ovoid, 12.3 × 8.7 μ according to Svanbaev (1956). Sporocyst residuum absent according to Svanbaev (1956). (Yakimoff and

Gousseff (1938) stated, "We were unable to discover whether the sporocysts had residual bodies.")

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Mus musculus (house mouse).

Location: Feces.

Geographic Distribution: USSR (White Russia, western Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Yakimoff and Gousseff (1938) found this species in 7 of 20 mice in White Russia.

Remarks: Svanbaev (1956) described an *Eimeria* under the name *"E. kriygsmanni" (lapsus* for *E. krijgsmanni)* from *Apodemus sylvaticus* in western Kazakhstan. It did not belong to this species, and we have named it *Eimeria svanbaevi* (see p. 111).

Svanbaev (1958) described an *Eimeria* under the name *"E. kriygsmanni" (lapsus* for *E. krijgsmanni)* from the Mongolian pika, *Ochotona pallasi,* in Kazakhstan. However, since *Ochotona* is a lagomorph rather than a rodent, it is very doubtful that the pika form belongs to this species.

Svanbaev (1962) described an *Eimeria* under the name *"E. kriygsmanni"* from the tamarisk gerbil, *Meriones tamariscinus,* in Kazakhstan. However, it did not belong to this species, and we have named it *Eimeria peschankae* (see p. 89).

Ryšavý (1954) described an *Eimeria* under the name *"E. krijgsmani" (lapsus* for *E. krijgsmanni)* from *Apodemus sylvaticus* in Czechoslovakia. He, too, was unaware of Galli-Valerio's (1932, 1940) and Pellérdy's (1954) work. His description was so incomplete that it is not certain what species he was dealing with. We are tentatively assigning it to *Eimeria svanbaevi* (p. 111).

Černa (1962) considered *E. krijgsmanni* to be a synonym of *E. schueffneri;* however, her reasons were inadequate and based only on disagreement with Yakimoff and Gousseff's interpretation.

EIMERIA MUSCULI YAKIMOFF AND GOUSSEFF, 1938

(Plate 37, Fig. 299)

Eimeria musculi Yakimoff and Gousseff, 1938: 1–3; Svanbaev, 1956: 180–191 (from *Mus musculus*).

[*non*] *Eimeria musculi:* Svanbaev, 1956: *Ibid.* (from *Apodemus sylvaticus*—see *E. russiensis*) (from *Microtus arvalis*—see *E. arvicolae*) (from *Meriones tamariscinus*—see *E. tamariscini*); Svanbaev, 1958: 183–186 (from *Ochotona pallasi*?).

Description: Oocysts spherical, smooth, greenish, 21–26 μ in diameter. Micropyle absent. Polar granule absent. Oocyst residuum absent. Sporo-

cysts broadly ovoid (10×9 μ according to Svanbaev, 1956). Sporocyst residuum absent according to Svanbaev (1956). (Yakimoff and Gousseff, 1938 stated, "The presence of a residual body in the sporocysts was uncertain.")

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Mus musculus (house mouse).

Location: Feces.

Geographic Distribution: USSR (White Russia, western Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Yakimoff and Gousseff (1938) found this species in 1 of 20 mice in White Russia.

Remarks: Svanbaev (1956) described coccidia from western Kazakhstan under the name *Eimeria musculi* not only from *Mus musculus* but also from *Apodemus sylvaticus, Microtus arvalis,* and *Meriones tamariscinus.* (See *Remarks* under *E. prasadi,* p. 110, for a discussion of his paper). The form which he described from *A. sylvaticus* is *E. russiensis* (p. 112), that from *M. arvalis* is *E. arvicolae* (p. 75), and that from *M. tamariscinus* is *E. tamariscini* (p. 88).

Svanbaev (1958) described an *Eimeria* under the name *E. musculi* from the Mongolian pika, *Ochotona pallasi,* in Kazakhstan. However, since *Ochotona* is a lagomorph rather than a rodent, it is very doubtful that the pika form belongs to this species.

EIMERIA SCHUEFFNERI YAKIMOFF AND GOUSSEFF, 1938

(Plate 40, Fig. 346)

Eimeria schueffneri Yakimoff and Gousseff, 1938: 1–3.

[*non*] *Eimeria schueffneri:* Černa, 1962: 1–13 (see *E. cernae*).

Description: Oocysts cylindrical (illustrated with rounded ends), smooth, colorless. Micropyle absent. Oocysts 18–26×15–16 μ. Oocyst length-width ratio 1.5–1.9. Oocyst polar granule and oocyst residuum absent. Sporocysts ovoid. The authors stated, "The presence of a residual body in the sporocysts was uncertain."

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Mus musculus (house mouse).

Location: Feces.

Geographic Distribution: USSR (White Russia).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Yakimoff and Gousseff (1938) found *E. schueffneri* in 1 out of 20 mice examined in White Russia.

Remarks: Černa (1962) described a coccidium from *Clethrionomys glareolus* under the name *E. schueffneri*. It does not belong to this species, and we are assigning it the name *E. cernae* (p. 84).

EIMERIA HANSONORUM N. SP.

(Plate 28, Fig. 241)

Description: Oocysts subspherical. Oocyst wall smooth, pale yellowish, composed of a single layer 0.8 μ thick. Fifteen sporulated oocysts measured 15–22×13–19 μ, with a mean of 17.9×15.8 μ; their length-width ratios ranged from 1.1–1.2, with a mean of 1.13. Micropyle absent. Oocyst polar granule present. Oocyst residuum absent. Sporocysts ovoid, thick-walled, with a broad, thick Stieda body. Sporocysts about 9×7 μ, with a length-width ratio of about 1.4. Sporocyst residuum composed of loose, coarse granules. Sporozoites pale, lying longitudinally in sporocysts.

Schizogony and Gametogony: Unknown. No intestinal sections were examined from the host animal.

Prepatent Period: Unknown.

Type Host: Mus musculus (house mouse).

Location: Intestinal contents.

Geographic Distribution: United States (Illinois).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in 1 out of 42 *M. musculus* captured on farms in the vicinity of Sullivan, Illinois.

Remarks: Seven species of *Eimeria* have been named from rodents of the genus *Mus;* six of these have been named from *M. musculus.* Despite the fact that the descriptions of most of these are incomplete, *E. hansonorum* appears to differ from all of them. It differs from *E. falciformis* in the shape of its sporocysts, in the size and shape of its Stieda body, and in lacking clear globules in the sporozoites. It also differs from the classical *E. falciformis* in having an oocyst polar granule. It differs from *E. hindlei* in oocyst size and shape. It differs from *E. krijgsmanni* in oocyst shape. It differs from *E. keilini* in oocyst size and shape, in having a polar granule, and in sporocyst size. It differs from *E. musculi* and *E. schueffneri* in oocyst shape and in having an oocyst polar granule. In addition, it may differ in sporocyst characters from the last five species, but they were so poorly described and illustrated that it is impossible to determine this. It differs from *E. musculoidei* in sporocyst shape and in having a prominent Stieda body.

This species is named in honor of Dr. Harold C. Hanson, Illinois State Natural History Survey, Urbana, and Dr. Lyle E. Hanson, College of Veterinary Medicine, University of Illinois, Urbana.

EIMERIA FERRISI N. SP.

(Plate 29, Fig. 242)

Description: Oocysts ellipsoidal to subspherical. Oocyst wall smooth, colorless to very pale yellowish, composed of a single layer about 0.9 μ thick. Ten sporulated oocysts from a single host animal measured 17–20 × 14–16 μ, with a mean of 17.8 × 15.4 μ; their length-width ratios ranged from 1.1–1.2, with a mean of 1.15. Micropyle absent. One to three oocyst polar granules present. Oocyst residuum absent. Sporocysts elongate ovoid, thin-walled, with a small Stieda body. Sporocysts 10–11 × 5–6 μ, with a length-width ratio of 1.8–1.9. Sporozoites elongate, lying lengthwise head to tail in sporocysts, but bent over at the smaller end. Sporozoites with a colorless globule at the large end. Sporocyst residuum absent, or in a few cases represented by a few tiny granules.

Schizogony and Gametogony: Macrogametes, microgametocytes, young oocysts and a few schizonts were found in the epithelial cells of the tips of the villi of the cecum. None were in the crypts. All stages were present both above and below the host cell nuclei. The zygotes and young oocysts tended to be more often below than above the host cell nuclei. In some cases the host cells appeared to be displaced somewhat toward the interior of the villus. Macrogametes ranged in size up to 16 × 12 μ, with a single row of hematoxylin-staining plastic granules. Microgametocytes ranged in size up to 12 × 10 μ. Oocysts ranged in size up to 17 × 13 μ. The few schizonts seen measured up to about 12 × 9 μ and contained about 10 to 16 elongate, curved, sausage-shaped merozoites measuring about 13 × 2 μ. There was no schizont residuum.

Prepatent Period: Unknown.

Type Host: Mus musculus (house mouse).

Location: Cecum. No endogenous stages were found in the duodenum, jejunum, anterior ileum, or posterior ileum.

Geographic Distribution: United States (Illinois).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in 2 out of 42 *M. musculus* captured on farms in the vicinity of Sullivan, Illinois.

Remarks: Eight species of *Eimeria* have been named from rodents of the genus *Mus;* seven of these have been named from *M. musculus.* Despite the fact that the descriptions of most of these are incomplete, *E. ferrisi* appears to differ from all of them. It differs from *E. falciformis* in lacking a sporocyst residuum and from the classical *E. falciformis* in having an oocyst polar granule. It differs from *E. hindlei* in oocyst size and shape. It differs from *E. keilini, E. krijgsmanni, E. musculi, E. schueffneri, E. hansonorum,* and *E. musculoidei* in having a clear globule

in the sporozoites. It differs further from *E. keilini* in oocyst size and shape and in having an oocyst polar granule. It differs further from *E. musculi* in oocyst size and shape, in having an oocyst polar granule, and in sporocyst shape. It differs further from *E. schueffneri* in oocyst shape and in having an oocyst polar granule. It may differ further from *E. hindlei, E. keilini, E. krijgsmanni, E. musculi,* and *E. schueffneri* in other sporocyst characters, but they were so poorly described and illustrated that it is impossible to determine this. It differs further from *E. hansonorum* in sporocyst shape and size and in the size and shape of the Stieda body. It differs further from *E. musculoidei* in sporocyst shape, in the character of the Stieda body, and in lacking a sporocyst residuum.

This species is named in honor of Dr. Deam H. Ferris, College of Veterinary Medicine, University of Illinois, Urbana.

EIMERIA MUSCULOIDEI LEVINE, BRAY, IVENS, AND GUNDERS, 1959

(Plate 29, Fig. 243)

Eimeria musculoidei Levine, Bray, Ivens, and Gunders, 1959: 215–222.

Description: Oocysts subspherical to ellipsoidal. Oocyst wall pale yellowish to yellowish brown, smooth, composed of a single layer about 1 μ thick. Micropyle absent. Thirty-three sporulated oocysts from one mouse measured 17–22 × 15–19 μ, with a mean of 19.7 × 16.9 μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.16. One to several oocyst polar granules present. Oocyst residuum absent. Sporocysts lemon-shaped, without Stieda body or with a small, rather flat one. Eight sporocysts measured 10–12 × 7 μ, with a mean of 10.3 × 6.9 μ; their length-width ratios ranged from 1.4–1.6, with a mean of 1.49. Sporocyst residual granules coarse. Sporozoites lie more or less lengthwise in sporocysts.

Sporulation Time: Two to four days at room temperature in Liberia.

Schizogony and Gametogony: Schizonts and macrogametes in epithelial cells of upper ileum, usually between host cell nucleus and lumen. Mature schizonts averaged 10 × 8 μ, with 28 to 36 merozoites. Macrogametes wtih a central nucleus but without eosinophilic granules.

Prepatent Period: Unknown.

Type Host: Mus (Leggada) musculoides.

Location: Upper ileum.

Geographic Distribution: Liberia.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in four *M. musculoides* from Harbel, Liberia.

EIMERIA LOPHUROMYSIS LEVINE, BRAY, IVENS, AND GUNDERS, 1959 *

(Plate 29, Fig. 244)

Eimeria lophuromysis Levine, Bray, Ivens, and Gunders, 1959: 215–222.

Description: Oocysts ellipsoidal to ovoid. Oocyst wall yellowish to brownish yellow, smooth, composed of a single layer 0.8 μ thick. Micropyle absent. Six oocysts measured 19–23 × 13–15 μ, with a mean of 20.7 × 14.2 μ; their length-width ratios ranged from 1.3–1.8, with a mean of 1.45. Oocyst polar granule tiny or absent. Oocyst residuum absent. Sporocysts elongate ellipsoid to slightly ovoid, with very thin wall. Stieda body very small, often no more than a thickening of one end of sporocyst. Sporocysts 11 × 6–7 μ, with a length-width ratio of 1.6–1.7. Sporocyst residuum absent. Sporozoites yellowish, with a large, yellowish refractile globule about 3 μ in diameter at one end and a small one about 1 μ in diameter at the other. Sporozoites lie lengthwise in sporocysts.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Lophuromys s. sikapusi.

Location: Intestinal contents.

Geographic Distribution: Africa (Liberia).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

EIMERIA SIKAPUSII LEVINE, BRAY, IVENS, GUNDERS, 1959

(Plate 29, Fig. 245)

Eimeria sikapusii Levine, Bray, Ivens, and Gunders, 1959: 215–222.

Description: Oocysts subspherical to ellipsoidal. Oocyst wall pale yellowish, smooth to slightly pitted, composed of a single layer about 1 μ thick. Oocyst wall often collapses rather quickly in Sheather's sugar solution. Micropyle absent. Thirteen oocysts from two host animals measured 20–23 × 15–18 μ, with a mean of 21.2 × 17.4 μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.22. One to four large, brownish yellow oocyst polar granules present. Oocyst residuum absent. Sporocysts football-shaped, without Stieda body, 10–12 × 7–8 μ, with a length-width ratio of 1.4–1.5. Sporocyst residual material abundant, composed of relatively large granules. Sporozoites clear, without refractile globules, lying more or less lengthwise or at the ends of the sporocysts.

* The genitive of *mys* is *myis*, not *mysis*. Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Lophuromys s. sikapusi.
Location: Intestinal contents.
Geographic Distribution: Africa (Liberia).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

EIMERIA LIBERIENSIS LEVINE, BRAY, IVENS, AND GUNDERS, 1959

(Plate 29, Fig. 246)

Eimeria liberiensis Levine, Bray, Ivens, and Gunders, 1959: 215–222.

Description: Oocysts ellipsoidal. Oocyst wall pale yellowish, smooth, composed of a single layer about 0.9 μ thick. Micropyle absent. Nine oocysts from two host animals measured 20–27 × 14–20 μ, with a mean of 23.7 × 17.0 μ; their length-width ratios ranged from 1.3–1.7, with a mean of 1.39. Oocyst polar granule present. Oocyst residuum absent. Sporocysts 10 × 5 μ, with a length-width ratio of 2.0, ellipsoidal, thin-walled, without Stieda body. Sporozoites lie slantwise or curled longitudinally in sporocysts, with a compact, granular sporocyst residuum between them. Sporozoites without refractile globules.

Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Lophuromys s. sikapusi.
Location: Intestinal contents.
Geographic Distribution: Africa (Liberia).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

EIMERIA HARBELENSIS LEVINE, BRAY, IVENS, AND GUNDERS, 1959

(Plate 30, Fig. 248)

Eimeria harbelensis Levine, Bray, Ivens, and Gunders, 1959: 215–222.

Description: Oocysts ovoid. Oocyst wall smooth, composed of two yellowish brown layers. The inner layer is ellipsoidal, 1.5 μ thick at one end, but becoming progressively thinner along the sides until it reaches a thickness of about 0.9 μ at the other end. The outer layer is 1 μ thick at the thick end of the inner layer and maintains this width for a little more than two-thirds of the length of the oocyst; it then narrows rapidly, forming a shoulder, and seems to disappear anteriorly. Only a single oocyst was studied; it measured 32 × 23 μ, with a length-width

ratio of 1.4. It was not certain whether a micropyle was present; there was a broad, dimplelike indentation 6 μ in diameter at the large end of the oocyst which may have been a micropyle. Oocyst polar granule absent. Oocyst residuum absent. Sporocysts 14×8 μ, football-shaped, rather thin-walled, with a medium-sized Stieda body. Sporocyst residuum composed of large granules. Sporozoites very granular, with a large, clear globule at one end. Sporozoites lie lengthwise in sporocysts.

Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Lophuromys s. sikapusi.
Location: Intestinal contents.
Geographic Distribution: Africa (Liberia).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

EIMERIA AFRICANA LEVINE, BRAY, IVENS, AND GUNDERS, 1959

(Plate 29, Fig. 247)

Eimeria africana Levine, Bray, Ivens, and Gunders, 1959: 215–222.

Description: Oocysts subspherical to ellipsoidal. Oocyst wall colorless to pale yellowish, smooth, composed of a single layer about 0.9 μ thick. Oocyst wall collapses rather quickly in Sheather's sugar solution. Micropyle absent. Twenty-five oocysts from four host animals measured 14–21×11–16 μ, with a mean of 17.0×13.8 μ; their length-width ratios ranged from 1.1–1.4, with a mean of 1.23. Oocyst polar granule present. Oocyst residuum absent. Sporocysts ovoid, very thin-walled, with small Stieda body. Five sporocysts measured 8–11×6 μ, with a mean of 9.8×6.0 μ; their length-width ratios ranged from 1.5–1.8, with a mean of 1.63. Small amount of finely granular sporocyst residual material usually present. Sporozoites crowded and curled in sporocysts, lying either lengthwise or at the ends of the sporocysts. Sporozoites contain a large, pale yellowish globule at one end and a small one at the other.

The oocysts had four sporoblasts when passed.

Sporulation Time: Twelve hours at room temperature in Liberia.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Lophuromys s. sikapusi.
Location: Intestinal contents.
Geographic Distribution: Africa (Liberia).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

EIMERIA KRUIDENIERI LEVINE, BRAY, IVENS, AND GUNDERS, 1959

(Plate 31, Fig. 259)

Eimeria kruidenieri Levine, Bray, Ivens, and Gunders, 1959: 215–222.

Description: Oocysts somewhat ellipsoidal, but narrowed and flattened at both ends. Oocysts sometimes asymmetrical. Oocyst wall yellowish brown, slightly to moderately roughened, sometimes pitted, composed of a single layer about 1.3 μ thick at the sides and narrowing to 0.6–0.7 μ thick at both ends. Micropyle absent. Twenty-three oocysts from a single host animal measured 27–31 × 19–21 μ, with a mean of 28.7 × 19.4 μ; their length-width ratios ranged from 1.3–1.6, with a mean of 1.48. Oocyst polar granule present, often splinterlike. Oocyst residuum absent. Sporocysts 15 × 8 μ, with a length-width ratio of 1.8, elongate ovoid, rounded at one end and truncate at the other. Stieda body absent. Sporocyst residuum present in some sporocysts but absent in others. Sporozoites somewhat granular, with a large refractile globule at one end.

Sporulation Time: Three days at room temperature in Liberia.

Schizogony and Gametogony: Macrogametes and oocysts in epithelial cells of jejunum, lying between host cell nucleus and lumen. Macrogametes contain numerous eosinophilic granules concentrated around their periphery.

Prepatent Period: Unknown.

Type Host: Lophuromys s. sikapusi.

Location: Jejunum.

Geographic Distribution: Africa (Liberia).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

EIMERIA SCHOUTEDENI VAN DEN BERGHE AND CHARDOME, 1957

(Plate 30, Fig. 249)

Eimeria schoutedeni van den Berghe and Chardome, 1957: 1–3.

Description: Oocysts ovoid, 14–15 × 11–13 μ. Oocyst wall illustrated as a single layer, 0.5 μ thick, whitish, presumably smooth. Micropyle absent. Oocyst polar granule presumably absent. Oocyst residuum composed of a small amount of fine powder. Sporocysts 7 × 5.6 μ, illustrated without a Stieda body. Sporocyst residuum composed of fine powder. Sporozoites 6 × 2 μ, reniform, with coarse granulations about 0.7 μ in diameter on their surface.

Sporulation Time: Five to ten days in 1% chromic acid solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.
Sporogony: The sporont divides into two masses, each of which divides again to form two sporocysts.
Type Host: Cricetomys dissimilis (hamster rat).
Location: Unknown; oocysts found in feces.
Geographic Distribution: Africa (Kivu, Congo).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

EIMERIA SP. FANTHAM, 1926

Eimeria sp. Fantham, 1926: 560–570.

Description: Oocyst thin-walled and frail, 15–17 × 10–13 μ.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Tatera lobengulae (Lobengula's gerbille).
Location: Ileum.
Geographic Distribution: South Africa.
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

EIMERIA (?) SP. (YAKIMOFF, GOUSSEFF, AND SUZ'KO, 1945)

Eimeria halli (?) Yakimoff. Yakimoff, Gousseff, and Suz'ko, 1945: 172–183.

Description: Oocysts ovoid, colorless, without micropyle, 22–31 × 15–23 μ, with a mean of 26.3 × 19.9 μ; length-width ratio 1.1–1.6, with a mean of 1.33. The oocysts failed to sporulate.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Nesokia indica huttoni (scaly-toothed rat).
Location: Feces.
Geographic Distribution: USSR (Tadzhikistan).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Yakimoff, Gousseff, and Suz'ko (1945) found this form in 1 out of 47 *N. i. huttoni* from Tadzhikistan.
Remarks: On the basis of its size, Yakimoff, Gousseff, and Suz'ko (1945) believed that this form resembled *E. nieschulzi* (syn., *E. halli*). However, since it failed to sporulate, it is impossible to assign it a specific name.

Host Suborder MYOMORPHA

Host Superfamily GLIROIDEA

Host Family MUSCARDINIDAE

Host Subfamily GLIRINAE

EIMERIA GLIRIS MUSAEV AND VEĬSOV, 1961

(Plate 39, Fig. 341)

Eimeria gliris Musaev and Veĭsov, 1961a: 1085–88.

Description: Oocysts ovoid. Oocyst wall smooth, composed of two layers each 1.25 μ thick, the inner layer dark brown and the outer yellowish. Micropyle absent. Fifty-five sporulated oocysts from three specimens were 14–23 × 12–17 μ, with a mean of 21 × 16 μ; their length-width ratios ranged from 1.1–1.5, with a mean of 1.2. Oocyst residuum absent. Oocyst polar granule present. Sporocysts ovoid, 6–10 × 4–8 μ, with a mean of 9 × 7 μ. Stieda body absent. Sporocyst residuum composed of many small granules and one large, refractile body. Sporozoites pear-shaped.

Sporulation Time: Three days at 25–30C in 2.5% potassium dichromate solution.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Glis glis (common dormouse).

Location: Large intestine contents.

Geographic Distribution: USSR (Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Musaev and Veĭsov (1961a) found this species in three out of eight *Glis glis* from the Astarin region of Azerbaĭdzhan.

EIMERIA MYOXI GALLI-VALERIO, 1940

Eimeria myoxi Galli-Valerio, 1940: 352–358.

Description: Oocysts ovoid, 18 × 15 μ, with a spherical sporont 12 μ in diameter. Oocyst wall relatively thin at the micropylar end. Micropyle poorly visible. Sporocysts ovoid, 7.5 × 6 μ. Sporozoites piriform. Oocyst and sporocyst residua presumably absent, although this is not certain. After discussing the sporocysts, Galli-Valerio (1940) stated simply, "Point de reliquat," without indicating whether he was referring to the sporocyst residuum, the oocyst residuum, or both.

Sporulation Time: Seven days on moist filter paper.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Eliomys (syn., *Myoxus) quercinus* (garden dormouse).

Location: Presumably intestine.

Geographic Distribution: Europe (Switzerland).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

EIMERIA DYROMIDIS ZOLOTAREV, 1935 *

Eimeria dyromidis Zolotarev, 1935; Musaev and Veĭsov, 1959a: 535–539.
(Plate 30, Fig. 250)

Description: Oocysts ovoid, rarely spherical. The ovoid oocysts described by Zolotarev (1935) measured 16–30 × 13–24 μ, with a mean of 22 × 19 μ; the spherical ones were 15–25 μ in diameter, with a mean of 19 μ. Thirty-three oocysts were measured by Musaev and Veĭsov (1959a); the ovoid ones were 16–24 × 14–22 μ, with a mean of 23 × 19 μ and a mean length-width ratio of 1.2; the spherical ones were 20–22 μ in diameter, with a mean of 21 μ. Oocyst wall smooth, double-contoured, apparently composed of a single layer 1 μ thick; according to Musaev and Veĭsov (1959a), it is colorless. Micropyle absent. Oocyst residuum absent. Oocyst polar granule absent according to Zolotarev (1935), but present according to Musaev and Veĭsov (1959a). Sporocysts ovoid; 7–12 × 6–9 μ according to Zolotarev (1935), 10–14 × 6–9 μ, with a mean of 13 × 8 μ, according to Musaev and Veĭsov (1959a). Stieda body apparently absent although Musaev and Veĭsov (1959a) illustrated the sporocysts as pointed at one end. Sporocyst residuum present. Sporozoites pear-shaped, with a spherical globule at the broad end according to Musaev and Veĭsov (1959a) but without such a body according to Zolotarev (1935).

Sporulation Time: Two days at 25–30C in 2.5% potassium dichromate according to Musaev and Veĭsov (1959a).

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Dryomys nitedula (forest dormouse) (According to Simpson, 1945, the correct name for this genus is *Dryomys* Thomas, 1906; however, Thomas (1907) introduced the generic name *Dyromys* for it under the mistaken impression that *Dryomys* was preoccupied.)

Location: Intestinal contents.

Geographic Distribution: USSR (Daghestan and Nakhichevan regions of Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Zolotarev (1935) found this species in all of ten *D. nitedula* examined from Daghestan. Musaev and Veĭsov (1959a) found it in one or two of five forest dormice from the Nakhichevan region of Azerbaĭdzhan.

Remarks: Although the oocysts found by Musaev and Veĭsov (1959a) differed from those described by Zolotarev (1935) from the same host in

* The genitive of *mys* is *myis*, not *midis*. Unfortunately, the 1961 International Code of Zoological Nomenclature does not permit a change in spelling of this name, so the error must be perpetuated.

being colorless and in having an oocyst polar granule and a spherical globule in the sporozoites, the former authors considered both to belong to the same species.

EIMERIA NACHITSCHEVANICA MUSAEV AND VEĬSOV, 1959

(Plate 30, Fig. 251)

Eimeria nachitschevanica Musaev and Veĭsov, 1959a: 535–539.

Description: Oocysts ovoid. Sixteen sporulated oocysts measured 20–26 × 17–20 μ, with a mean of 24 × 19 μ and a mean length-width ratio of 1.3. Oocyst wall smooth, colorless, apparently composed of a single layer 1.3 μ thick. Micropyle prominent, with a micropylar cap. Oocyst residuum and polar granule absent. Sporocysts ovoid, with a well-developed Stieda body, 10–13 × 6–9 μ, with a mean of 12 × 7 μ. Sporozoites comma-shaped, with a spherical globule at the broad end. Sporocyst residuum present, consisting of small, scattered granules.

Sporulation Time: Three days at 25–30C in 2.5% potassium dichromate solution according to Musaev and Veĭsov (1959a).

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Dryomys nitedula (forest dormouse). (See the note under *Eimeria dyromidis* above for an explanation of this spelling.)

Location: Intestinal contents.

Geographic Distribution: USSR (mountain region of Nakhichevan Azerbaĭdzhan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Host Suborder MYOMORPHA

Host Superfamily DIPODOIDEA

Host Family DIPODIDAE

Host Subfamily DIPODINAE

EIMERIA ALLACTAGAE IWANOFF-GOBZEM, 1934 Emend. SVANBAEV, 1956

Eimeria alactagae Iwanoff-Gobzem, 1934: 149–151.
Eimeria allactagae: Svanbaev, 1956: 180–191.

Description: The oocysts in the type host as described by Iwanoff-Gobzem (1934) are spherical, with a single-layered, thick, uniform wall, measure 22–26 μ in diameter, with a mean of 24.4 μ, and have an oocyst refractile granule and lack a sporocyst residuum. She did not mention any other morphological characters. The oocysts described by Svanbaev (1956) from *Allactaga elator* are ovoid, with a double-contoured, smooth,

colorless wall 1.7 μ thick, measure 22.0×18.4 μ, have an oocyst polar granule (which is occasionally absent), oval sporocysts measuring 8.8×7.2 μ, and lack a micropyle and oocyst and sporocyst residua.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Allactaga major (syn., *A. jaculus)* (great jerboa).

Other Hosts: Allactaga elator (small, five-toed jerboa).

Location: Feces.

Geographic Distribution: USSR (Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1956) found this species in one out of four *A. elator* in western Kazakhstan.

EIMERIA LAVIERI YAKIMOFF AND GOUSSEFF, 1936

(Plate 40, Fig. 348)

Eimeria lavieri Yakimoff and Gousseff, 1936: 447–448; Svanbaev, 1962: 23–39.

Description: Oocysts spherical, yellowish orange, 17–18 μ in diameter (mean, 17.4 μ). Micropyle absent. Sporocysts broadly oval (illustrated as ellipsoidal), 9×8 μ. Oocyst polar granule and residuum absent. Sporocyst residuum present. Sporozoites comma-shaped, lying lengthwise in sporocysts. According to Svanbaev (1962), the oocysts are subspherical or spherical, 19–27×18–22 μ, with a mean of 21×19 μ; their length-width ratio is 1.1–1.2, with a mean of 1.1; the oocyst wall is smooth, 1.0–1.2 μ thick, yellow or yellow-brown, without a micropyle; oocyst polar granule is absent; the sporocysts are ellipsoidal or subspherical, 8–9×7–8 μ, with a mean of 8.5×7 μ; a sporocyst residuum is present in the form of small granules; and the sporozoites are comma-shaped.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Allactaga major (syn., *A. jaculus*) (great jerboa).

Location: Feces.

Geographic Distribution: USSR (Black Azow-Mer, north of Don River; southern Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1962) found this coccidium in one out of four *A. major* in southern Kazakhstan.

EIMERIA JOYEUXI YAKIMOFF AND GOUSSEFF, 1936

(Plate 40, Fig. 349)

Eimeria joyeuxi Yakimoff and Gousseff, 1936: 447–448; Svanbaev, 1962; 23–39.

Description: Oocysts subspherical, yellow, 24–28 × 21 μ (mean 26.4 × 21.4 μ), length-width ratio 1.1–1.3 (mean 1.23). Micropyle illustrated as absent. Sporocysts 13.6 × 10.6 μ, broadly ovoid. Oocyst polar granule absent. Oocyst residuum present. Sporocyst residuum absent. Sporozoites comma-shaped, lying lengthwise in sporocysts. According to Svanbaev (1962), the oocysts are ellipsoidal, subspherical, or spherical, 22–29 × 21–27 μ, with a mean of 25 × 23 μ; their wall is smooth, yellow-brown or orange-brown, 1.3–1.7 μ thick, without a micropyle; an oocyst polar granule is absent; the oocyst residuum is in the form of a large, granular mass; the sporocysts are ellipsoidal, subspherical, or spherical, 8–14 × 7–9 μ, with a mean of 10 × 8 μ; a sporocyst residuum is absent; and the sporozoites are comma-shaped and measure 7–8 × 2–3 μ, with a mean of 7 × 3 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Allactaga major (syn., *A. jaculus)* (great jerboa).

Location: Feces.

Geographic Distribution: USSR (Black Azow-Mer, north of Don River; Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1962) found this coccidium in two out of four *A. major* in southern Kazakhstan.

Host Suborder HYSTRICOMORPHA

Host Superfamily CAVIOIDEA

Host Family CAVIIDAE

Host Subfamily CAVIINAE

EIMERIA CAVIAE SHEATHER, 1924

(Plate 31, Fig. 254; Plate 40, Figs. 350–357; Plate 41, Figs. 358–71)

"Kokzidien" of Bugge and Heinke, 1921: 41–42.

Eimeria caviae Sheather, 1924: 243–246; Alves de Souza, 1931: 11–14; Henry, 1932: 211–268; Yakimoff, Senyushkina, and Machul'skiĭ, 1940: 391–401; Lapage, 1940: 144–154, 190–202, 242–254, 280–295; Ryšavý, 1954: 131–174.

Description: Oocysts ovoid, ellipsoid, or subspherical, smooth, often brownish, 13–26 × 12–23 μ. Micropyle absent. Oocyst wall composed of two layers according to Lapage (1940). Oocyst polar granule absent. Oocyst residuum present according to Lapage (1940), who was the only one to mention this structure specifically. Sporocysts 11–13 × 6–7 μ. Sporocyst residuum present.

Sporulation Time: Two to three days according to Henry (1932), five to eight days at room temperature according to Sheather (1924) and

Bugge and Heinke (1921), or nine to eleven days at 18–22C according to Lapage (1940).

Schizogony and Gametogony: These stages have been described in some detail by Lapage (1940) and to a lesser extent by Henry (1932). However, they did not determine the number of merozoite generations. The schizonts produce 12 or less to 32 merozoites which range from 6–16 μ in length. There may or may not be a residual body in the schizont. The young microgametocyte is indistinguishable from a young schizont. When it matures it produces a large number of curved, spindle-shaped microgametes 3 μ long, each with two flagella 6–9 μ long. The young macrogametes (which Henry and Lapage called macrogametocytes) can be distinguished from schizonts or microgametocytes by the fact that their cytoplasm contains clusters of small spherical granules. These increase in number and size as development proceeds. They stain black with iron hematoxylin, dark blue with Mayer's haemalum or Delafield's hematoxylin, or yellow, orange, or red with Heidenhain's azan or Mallory's triple stain. The red granules flatten out and coalesce to form the outer wall of the oocyst, after which the yellow granules move to the periphery and form the inner wall. Fertilization is believed to take place before the oocyst wall is laid down.

Prepatent Period: Eleven to twelve days, according to Henry (1932) and Lapage (1940).

Type Host: Cavia porcellus (domestic guinea pig).

Other Hosts: Cavia aperea (wild guinea pig, aperea). The only report of *E. caviae* in wild guinea pigs is that of Alvez de Souza (1931), who found it in a single animal in Brazil.

Location: Colon. In addition, Henry (1932) reported that the ceca were occasionally infected and that she found a few isolated coccidia in the small intestines of some guinea pigs. The parasites are found in the epithelial cells of the crypts of Lieberkühn or, in heavy infections, throughout the mucosa.

Geographic Distribution: Worldwide.

Pathogenicity: Infected guinea pigs most often show no symptoms and are apparently not much affected. In some cases, however, the coccidia may cause diarrhea and even death. In such animals the colon contains small white or yellowish white plaques and petechial hemorrhages in the mucosa. Sometimes the entire mucosa may be destroyed.

Cross-Transmission Studies: None.

Prevalence: Bugge and Heinke (1921) found coccidia in 73 per cent of 180 guinea pigs examined in Germany. According to Lapage (1940), *E. caviae* is common and widely distributed in England. Henry (1932) apparently had no difficulty finding infected guinea pigs in California.

However, Nie (1950) failed to find coccidia in 56 guinea pigs in Pennsylvania.

Host Suborder HYSTRICOMORPHA

Host Superfamily CAVIOIDEA

Host Family CAVIIDAE

Host Subfamily DOLICHOTINAE

EIMERIA DOLICHOTIS MORINI, BOERO, AND RODRIGUEZ, 1955

(Plate 30, Figs. 252 and 253)

Eimeria dolichotis Morini, Boero, and Rodriguez, 1955: 83–89; Zwart and Strik, 1961: 58–59.

Description: Oocysts subspherical to ellipsoidal. Oocyst wall smooth, colorless, illustrated as composed of a single layer. Oocysts 22–26 × 18–19 μ, with a mean of 24 × 18.5 μ and a mean length-width ratio of 1.3 (16–27 × 14–22 μ, with a mean of 21 × 18 μ, according to Zwart and Strik, 1961). Micropyle absent. Oocyst residuum and polar granule absent. Sporocysts approximately 11 × 7 μ (based on figure), with Stieda body. Sporocyst residuum present. Sporozoites about 9–9.5 μ long (8–13 × 5–7 μ, with a mean of 11 × 6 μ, according to Zwart and Strik (1961), with a refractile globule.

Sporulation Time: Seventy-two to eighty hours.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Dolichotis patagonum patagonum (marra).

Location: Small intestine, possibly large intestine.

Geographic Distribution: Argentina, Netherlands (zoological gardens).

Pathogenicity: The marras in which Morini, Boero, and Rodriguez (1955) found this parasite had an enteritis. At autopsy, catarrhal inflammation, ulcerated and necrotic areas, and edema of the small intestine were observed. The trichostrongylid, *Graphidiodes affinis,* was also present. Zwart and Strik (1961) observed a hemorrhagic enteritis of the colon with many oocysts in one of three infected animals.

Cross-Transmission Studies: Zwart and Strik (1961) were unable to infect six young, coccidia-free guinea pigs with *E. dolichotis.*

Prevalence: According to Morini, Boero, and Rodriguez (1955), the marra is almost extinct, being maintained in zoological gardens. Here there is more crowding than normal, so that the transmission rate is high.

Host Suborder HYSTRICOMORPHA

Host Superfamily CAVIOIDEA

Host Family HYDROCHOERIDAE

Host Subfamily HYDROCHOERINAE

EIMERIA CAPIBARAE CARINI, 1937

(Plate 39, Fig. 342)

Eimeria capibarae Carini, 1937: 367–369.

Description: Oocysts oval (illustrated as ellipsoidal), 25–33 × 20–28 μ, with a mean of 30 × 26 μ and a length-width ratio of 1.1–1.25. Oocyst wall yellowish, described as double but illustrated as a single layer, 2 μ thick, with fine radial striations. Micropyle absent. Oocyst polar granule and residuum absent. Sporocysts ovoid, 14–15 × 8 μ, with Stieda body and sporocyst residuum.

Sporulation Time: Twelve days in 1% chromic acid at room temperature.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Hydrochoerus hydrochoerus (syn., *H. capibara)* (capybara).

Location: Feces.

Geographic Distribution: Brazil (São Paulo).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

EIMERIA HYDROCHOERI CARINI, 1937

(Plate 39, Fig. 343)

Eimeria hydrochoeri Carini, 1937: 367–369.

Description: Oocysts ovoid, 20–22 × 16–18 μ, with a length-width ratio of 1.1–1.3. Oocyst wall smooth, colorless, 0.8 μ thick, described as double-contoured but illustrated as a single layer. Micropyle absent. Oocyst polar granule and residuum absent. Sporocysts ovoid, 10–11 × 6–7 μ, with a small Stieda body which is not always clearly visible. Sporocyst residuum present, composed of some granules.

Sporulation Time: Twelve days in 1% chromic acid at room temperature.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Hydrochoerus hydrochoerus (syn., *H. capibara)* (capybara).

Location: Feces.

Geographic Distribution: Brazil (São Paulo).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Host Suborder HYSTRICOMORPHA

Host Superfamily CAVIOIDEA
Host Family DASYPROCTIDAE
Host Subfamily CUNICULINAE

EIMERIA (?) *NOELLERI* (RASTEGAIEFF, 1930) BECKER, 1956

(*Gen?*) *nölleri* Rastegaieff, 1930: 377–404.
(?) *Eimeria nölleri:* Becker, 1956: 85–139.

Description: Oocysts spherical, 19 μ in diameter. No sporulated oocysts were seen.

Schizogony: Schizonts measuring 10×7 μ containing merozoites 1.4 μ wide were seen in smears of fecal mucus.

Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Cuniculus (syn., *Coelogenus) paca* (paca).

Location: Feces.

Geographic Distribution: South America (zoo in Pyatigorsk, USSR).

Pathogenicity: Unknown. Hill (1952) reported that coccidiosis caused the death of a paca (*C. paca)* in the London zoo, but did not describe the organism.

Cross-Transmission Studies: None.

Host Suborder HYSTRICOMORPHA
Host Superfamily CAVIOIDEA
Host Family DASYPROCTIDAE
Host Subfamily DASYPROCTINAE

EIMERIA PARAENSIS CARINI, 1935

(Plate 39, Fig. 345)

Eimeria paraensis Carini, 1935: 342–344.

Description: Oocysts spherical or slightly ovoid, 33–40×30–35 μ (mean given as 36×36 μ in his summary table). Oocyst wall brownish yellow, 2 μ thick, composed of two layers, the outer one with a rough, punctate surface and the inner one radially striated. Micropyle absent in illustration. Oocyst residuum and polar granule absent. Sporocysts ovoid, 20×11 μ, with a residuum and a slightly prominent Stieda body.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Dasyprocta aguti (syn., *"Cotia vermelha (Aguti aguti)"* of Carini, 1935) (cotia or agouti).

Location: Feces.

Geographic Distribution: Brazil.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Remarks: Carini (1935) gave the host as *"Cotia vermelha (Aguti aguti)."* However, "Cotia vermelha" is simply the Portuguese for red cotia, and was probably italicized because Carini's paper was written in French.

EIMERIA COTIAE CARINI, 1935

(Plate 39, Fig. 344)

Eimeria cotiae Carini, 1935: 342–344.

Description: Oocysts ovoid (illustrated as ellipsoidal), 28 or 29×18 μ (there is a discrepancy between Carini's text description and his summary table). Oocyst wall slightly striated; sometimes quite thick, very slightly rough, and pale brownish yellow; sometimes thinner, smooth, and colorless. Oocyst wall illustrated as composed of a single layer. Micropyle absent. Oocyst residuum and polar granule apparently absent. Sporocysts ovoid, 13×8–9 μ, with Stieda body and residuum composed of scattered granules.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Dasyprocta aguti (syn., *"Cotia vermelha (Aguti aguti)"* of Carini, 1935) (cotia or agouti).

Location: Feces.

Geographic Distribution: Brazil.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Remarks: See *Remarks* under *E. paraensis* for discussion of host name.

EIMERIA AGUTI CARINI, 1935

(Plate 39, Fig. 340)

Eimeria aguti Carini, 1935: 342–344.

Description: Oocysts spherical, 16–17 μ in diameter. Oocyst wall thin, smooth, colorless. Micropyle absent in illustration. Oocyst residuum and polar granule apparently absent. Sporocysts 10×6 μ, with small residuum and illustrated with what might be a very small Stieda body.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Dasyprocta aguti (syn., *"Cotia vermelha (Aguti aguti)"* of Carini, 1935) (cotia or agouti).

Location: Feces.

Geographic Distribution: Brazil.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Remarks: See Remarks under *E. paraensis* for discussion of host name.

Host Suborder HYSTRICHOMORPHA
Host Superfamily OCTODONTOIDEA
Host Family ECHIMYIDAE

EIMERIA MYOPOTAMI YAKIMOFF, 1933

(Plate 31, Fig. 255)

Eimeria myopotami Yakimoff, 1933: 189–190; Seidel, 1954: 759–764; Hohner, 1955: 337–342; Zajíček, 1955: 29–38; Seidel, 1956: 117–126; Prasad, 1960a: 207–210.

Description: Oocysts ovoid, sometimes ellipsoidal, very seldom spherical or subspherical. Ovoid and ellipsoidal oocysts 22–27 × 18–23 μ, with a mean of 24.0–20.4 μ and a length-width ratio of 1.1–1.25, with a mean of 1.19. Subspherical oocysts 22–25 × 20–23 μ, with a length-width ratio of 1.1–1.2. Spherical oocysts 22–23 μ in diameter. The above dimensions are those of Yakimoff (1933). Seidel's (1954, 1956) measurements differed from these. In his first paper (1954), he gave the mean dimensions as 21.7–24.8 × 18.6 μ, and stated that there are two forms; the range of measurements given for the larger form was 21.7–32.5 × 18.6–27.5 μ; the range of measurements given for the smaller form was 15.5–18.6 × 12.4–21.7 μ. In his second paper (1956) Seidel gave the same mean dimensions, but combined the two sizes, giving the range as 15.5–32.5 × 12.4–27.5 μ. According to Prasad (1960), the oocysts measure 21–26 × 12–17 μ, with a mean of 23 × 14 μ. Pellérdy (1960) believed that the ovoid oocysts described by Yakimoff (1933) were actually those of *E. pellucida*. Oocyst wall composed of three layers (two, according to Prasad, 1960a), of which the outer one is fragile (relatively thin, according to Prasad, 1960a). Oocyst wall smooth and yellowish brown according to Prasad (1960a). Micropyle absent. (Seidel (1954) stated that there is a micropyle on one side—"an einer Längsseite.") Oocyst residuum and polar granule absent. Sporocysts pointed at one end, presumably with Stieda body (Prasad, 1960a stated that there was no Stieda body, but his illustration showed one), with sporozoites lying longitudinally and with sporocyst residuum. Sporocysts 9–12 × 6 μ, according to Seidel (1954).

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Myocastor coypus (nutria, coypu or swamp beaver).

Location: Feces.

Geographic Distribution: USSR, England, Germany, Czechoslovakia.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Yakimoff (1933) found this species in 20 per cent of 10 nutria on one fur farm, in 59 per cent of 17 nutria on another, and in

none of 58 on a third farm, all in Russia. Seidel (1954) and Hohner (1955) saw it in Germany. Prasad (1960a) found it in 2 out of 18 nutrias in England. Zajíček (1955) reported finding it on 4 nutria farms in Czechoslovakia.

Remarks: The descriptions of this species by different authors are not entirely in accord. This fact and the lack of certainty of the difference between *E. myopotami* and *E. coypi* (see below) make a restudy of the oocysts of these and other nutria coccidia an obvious necessity.

EIMERIA PELLUCIDA YAKIMOFF, 1933

Eimeria pellucida Yakimoff, 1933:189–190; Seidel, 1954: 759–764; Seidel, 1956: 117–126; Hohner, 1955: 337–342; Zajíček, 1955: 29–38; Pellérdy, 1960: 327–335.

Description: Oocysts ovoid or almost cylindroid, often with a flat micropyle. Oocyst wall pale lilac-colored when alive, yellow when dead. Oocyst wall presumably smooth, illustrated with two layers. Living oocysts 30–40 × 20–23 μ, with a length-width ratio of 1.6–1.7. Dead oocysts 29–40 × 16–25 μ, with a length-width ratio of 1.6–2.0. Seidel (1954, 1956) gave the dimensions as 28–31 × 15.5–19 μ.

No sporulated oocysts were described by the above authors. Pellérdy redescribed the oocysts of *E. pellucida,* but his description differed somewhat from the previous ones. He said that the oocysts are bean-shaped, with one side convex and the other straight or concave; while some of the oocysts appeared oval or cylindrical, their true shape could be demonstrated by rolling them. They measured 21–33 × 12–16 μ and had a smooth, colorless, thin wall composed of two layers. A micropyle was present and the oocyst residuum was absent. The sporocysts were piriform and measured 9 × 6 μ. There was a sporocyst residuum.

Sporulation Time: Two or three days at room temperature, according to Pellérdy (1960).

Schizogony and Gametogony: The endogenous stages have been described by Pellérdy (1960), but he saw no schizogonic stages. The sexual stages were found in the small intestine from the duodenum through the ileum; the largest numbers were in the ileum. The macrogametes enter the mucous membrane and then come to lie deep under the epithelial layer, where they cause the host cell nuclei to become hypertrophied and flattened. When mature, they measure 22 × 15 μ. Pellérdy was unable to differentiate between the microgametocytes of *E. pellucida* and those of *E. seideli,* which were also present.

Prepatent Period: Pellérdy (1960) found the prepatent period in an experimentally infected animal which already carried a slight infection was 11 to 12 days.

Type Host: Myocastor coypus (nutria).

Geographic Distribution: USSR, Germany, Czechoslovakia, Hungary.

Pathogenicity: Pellérdy (1960) stated that *E. pellucida* may be harmful if it is present in susceptible animals in sufficiently large numbers.

Cross-Transmission Studies: None.

Prevalence: Yakimoff (1933) found this species in 12 per cent of 17 nutria on a fur farm in Russia; he did not find it on 2 other nutria farms. Seidel (1954) and Hohner (1955) saw it in Germany. Zajíček (1955) reported finding it on 4 nutria farms in Czechoslovakia, and Pellérdy (1960) found it in Hungary.

Remarks: Pellérdy (1960) thought that the oval oocysts described by Yakimoff (1933) as those of *E. myopotami* were actually those of *E. pellucida* which were not oriented to show their true shape.

The conflicting descriptions of *E. pellucida* given above necessitate a restudy of the oocysts of this and other nutria coccidia.

EIMERIA COYPI OBITZ AND WADOWSKI, 1937

Eimeria coypi Obitz and Wadowski, 1937: 98–99; Seidel, 1954: 759–764; Seidel, 1956: 117–126.

Description: Oocysts ovoid, with a thick, transparent, presumably smooth wall illustrated as composed of a single layer. Oocysts 21–26 × 12–16 μ, with a mean of 22.8 × 14.7 μ, according to Obitz and Wadowski (1937). According to Seidel (1954, 1956), the oocysts are spherical, have a fragile wall, and measure 12.5–17.5 μ in diameter. Micropyle absent. Oocyst polar granule present. Oocyst residuum absent. Sporocysts ellipsoidal, 9–12 × 5–7 μ, with a mean of 10.6 × 6 μ, without Stieda body, with sporocyst residuum.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Myocastor coypus (nutria).

Location: Feces.

Geographic Distribution: Poland, Germany (?).

Pathogenicity: According to Obitz and Wadowski (1937), this species seems to be pathogenic in some degree for young animals.

Cross-Transmission Studies: None.

Prevalence: Obitz and Wadowski (1937) found this species in 40 per cent of 50 nutria examined.

Remarks: The description given by Seidel (1954, 1956) for *E. coypi* differs so much from that of Obitz and Wadowski (1937) that it seems doubtful whether it is the same species. However, Seidel gave no information other than that presented above, and this is not sufficient to warrant the establishment of a new species. Prasad (1960a) thought that *E. coypi* was a synonym of *E. myopotami,* and Pellérdy (1960) suspected that

either *E. coypi* or *E. myopotami* was a nomen nudum. They may well be right; however, neither saw coccidia which conformed to the original description of *E. coypi,* so we consider it best to retain this species for the present.

EIMERIA SEIDELI PELLÉRDY, 1957

(Plate 42, Figs. 372–374)

Eimeria seideli Pellérdy, 1957: 591; Pellérdy, 1960: 327–335; Pellérdy, 1960a: 389–399.

Eimeria (*Globidium*) *fulva* Seidel, 1954: 759–764.

Eimeria fulva: Seidel, 1954a: 190–191; Seidel, 1956: 117–126.

Eimeria (*Globidium*) *perniciosa* Sprehn *in* Seidel, 1954: 759–764; Seidel, 1954a: 190–191.

[*non*] *Eimeria fulva* Farr, 1963: 336–340.

[*non*] *Eimeria* (*Tyzzeria*) *perniciosa* (Allen, 1936) Seidel, 1954: 759–764.

Description: Oocysts spherical, 38–45 μ in diameter, or subspherical, 45–48 × 38–42 μ, with a length-width ratio of 1.2. Oocyst wall composed of three layers: the outer one (present only in young oocysts) thin and whitish; the middle one light to dark brown, almost opaque, thick, and very rough ("gekörnt"); and the inner layer colorless and thin. According to Pellérdy (1960), the wall is 2–5 μ thick, and the outer layer may peel or chip off easily. Micropyle, oocyst residuum and polar granule absent. Sporocysts piriform to ovoid, 26–29 × 13 μ, with a Stieda body. Sporozoites bean-shaped, 10 μ long according to Seidel (1954). Free sporozoites 14–16 × 4 μ according to Pellérdy (1960). Sporocyst residuum present.

Sporulation Time: Thirty-seven days in 0.5% potassium bichromate solution at room temperature according to Seidel (1954); twelve days according to Pellérdy (1960).

Schizogony: Pellérdy (1960a) studied the endogenous development of *E. seideli* in experimentally infected animals. He found schizogony in a single nutria killed eight days after infection. He thought that there was only a single generation of schizonts. They are found in the epithelial cells of the middle and terminal parts of the small intestine, generally in the depths of the crypts and rarely in the epithelial cells of the villi. They are ovoid to ellipsoidal, measure 15–20 × 14 μ, and contain 10–25 crescentic banana-shaped merozoites which taper to a point at both ends and are up to 16–18 μ long. Colonies of schizonts up to 50 μ in diameter may occur.

Gametogony: Pellérdy (1960a) found the gamonts beneath the epithelium throughout the small intestine. The young stages occur beneath the epithelium of the villi, and the older ones are found in the lacteals, within the connective tissue supporting the villi. Occasionally they are deep, near the muscularis mucosae. The host cell nucleus is hypertrophied,

indented by the parasite, first becoming bean-shaped and then rather flattened and elongated. Pellérdy thought that the host cell was an epithelial cell which had been dislodged and had migrated into a subepithelial position after having been invaded, but he was not sure of this and thought it possible that the host cell might be of mesenchymal origin instead.

The young macrogametes are 5–6 μ in diameter, with a deep blue nucleus and a red, eccentric karyosome. When they are 15–20 μ in diameter, a deep blue, caplike structure appears near the nucleus and seems to migrate toward the periphery of the cell, where its outlines become blurred and it finally disintegrates into granules. Small, deep blue plastic granules appear in the cytoplasm. They enlarge, take on a red stain, migrate toward the periphery of the cell and eventually coalesce to form the oocyst wall. Pellérdy believed that the granules formed from the nuclear cap play no part in oocyst wall formation but simply disappear. According to Seidel (1954, 1956), the mature macrogametes measure 32–38 × 29–35 μ.

The young microgametocytes are indistinguishable from the young macrogametes. When they are about 20 μ in diameter, their nucleus divides repeatedly and the resultant nuclei are distributed throughout the cytoplasm. The microgametocytes continue to enlarge, reaching a diameter of 50–70 μ and containing a very great number of minute nuclei. These then combine in groups to form islets of varying size. The nuclei presumably continue to divide in these islets and come to lie on their periphery. The islets may attain a diameter of 10–15 μ, and the microgametocytes may eventually reach a diameter of 100 μ, although they average 40-60 μ and are usually elongated, ovoid, or ellipsoidal. They contain no residuum.

The microgametes are dark blue, comma-shaped, and 3–5 μ long. Pellérdy saw no flagella.

Prepatent Period: Fourteen days according to Pellérdy (1960a).

Type Host: Myocastor coypus (nutria).

Location: Throughout small intestine.

Geographic Distribution: Europe (Germany, Hungary).

Pathogenicity: Seidel (1954, 1956) considered *E. seideli* to be pathogenic, and Pellérdy (1960) considered it the most pathogenic species in the nutria. Seidel found it in 4- to 5-month-old nutrias which had died with inflammatory changes in the intestine, but other coccidian species, *Strongyloides* sp. and *Trichuris* sp. were also present. Pellérdy (1960) produced the disease experimentally in a 6-month-old nutria by feeding about 500,000 oocysts. He described erythema, edema, and a whitish coating on the walls of the duodenum, jejunum, and especially of the

ileum, but it is not clear whether these were due exclusively to *E. seideli* or to it and *E. pellucida.*

Cross-Transmission Studies: None.

Prevalence: Seidel (1954, 1956) found this species in 15 of 73 young nutrias which had died on a fur farm in Germany.

Remarks: Seidel (1954, 1956) described this species under the name *Eimeria (Globidium) fulva.* However, this is a homonym of *Eimeria fulva* Farr, 1953 from the Canada goose, *Branta canadensis,* and Pellérdy (1957) assigned the new name *E. seideli* to Seidel's species.

Seidel (1954, 1956) mentioned that Sprehn in a personal communication had suggested the name *Eimeria (Globidium) perniciosa* for this species, but that this name could not be used because it would be a homonym of *"Eimeria (Tyzzeria) perniciosa* Allen, 1936" of the domestic duck. However, Allen (1936) named her species *Tyzzeria perniciosa,* and Seidel's designation appears to be a new combination. This combination, however, is not acceptable. *Tyzzeria* is not congeneric with *Eimeria.* Its oocysts contain eight naked sporozoites without any sporocysts, while those of *Eimeria* contain four sporocysts each with two sporozoites. Nevertheless, Seidel's action makes it impossible to use the specific name, *perniciosa,* for any species of *Eimeria.*

EIMERIA NUTRIAE PRASAD, 1960

(Plate 31, Figs. 256 and 257)

Eimeria nutriae Prasad, 1960a: 207–210.

Description: Oocysts broadly ovoid or subspherical. Oocyst wall yellowish, pitted like a thimble, composed of a single layer. Micropyle absent. Oocysts 19–23 × 15–18 μ, with a mean of 20 ± 1.9 × 16 ± 1.4 μ; their length-width ratios ranged from 1.2–1.5, with a mean of 1.3. Oocyst polar granule present. Oocyst residuum absent. Sporocysts ovoid, without Stieda body, 10–12 × 4–6 μ, with a mean of 11 × 5 μ. Sporocyst residuum present. Sporozoites spindle-shaped, 9–11 × 2–3 μ, with a central nucleus and a refractile globule at one end.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Myocastor coypus (nutria).

Location: Feces.

Geographic Distribution: England.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Prasad (1960a) found this species in 8 out of 18 fecal samples from nutrias from Norfolk and Sussex, England.

EIMERIA MYOCASTORI PRASAD, 1960

(Plate 31, Fig. 258)

Eimeria myocastori Prasad, 1960a: 207–210.

Description: Oocyst broadly ovoid. Oocyst wall smooth, colorless, composed of two layers of which the outer is thinner than the inner. Micropyle conspicuous. Fifty oocysts measured 13–15 × 11–13 μ, with a mean of 14 × 12 μ; their length-width ratios averaged 1.1. Oocyst residuum and polar granule absent. Sporocysts cigar-shaped, 9–11 × 3–5 μ, with a mean of 10 × 4 μ. Stieda body absent. Sporocyst residuum present. Sporozoites spindle-shaped, 9–11 × 2.5–3 μ, with a refractile globule.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Myocastor coypus (nutria).

Location: Feces.

Geographic Distribution: England.

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Prasad (1960a) found this species in 4 out of 18 fecal samples from nutrias from Norfolk and Sussex, England.

Host Suborder HYSTRICOMORPHA

Host Superfamily BATHYERGOIDEA

Host Family BATHYERGIDAE

EIMERIA HETEROCEPHALI N. SP.

Eimeria muris Galli-Valerio, 1932 of Porter, 1957: 515–527.

[*non*] *Eimeria muris* Galli-Valerio, 1932: 129–142.

Description: Oocysts ovoid. Small sporocyst residuum present. Sketch of unsporulated oocyst shows no micropyle. No other oocyst characteristics given.

Schizogony: Unknown.

Gametogony: Macrogametes with "chromatoid and plastinoid particles."

Prepatent Period: Unknown.

Type Host: Heterocephalus glaber (naked mole rat).

Location: Epithelial cells of cecum. Double infections of these cells with schizonts and macrogametes were frequent.

Geographic Distribution: London Zoo (animal originally from Somaliland or Kenya).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Remarks: Porter (1957) assigned this species to *Eimeria muris* with

the statement, "Comparison with *Eimeria muris* from rats, mice, striped rats (*Arvicanthus*) and other rodents showed such strong correspondence that the parasite of *Heterocephalus glaber* must be considered to be *E. muris,* the Naked Mole Rat being a new host." However, the only valid host of *E. muris is Apodemus sylvaticus.* Furthermore, even though Porter's description is extremely sketchy and her drawing crude, they are enough to show that the form from *H. glaber* is not *E. muris,* since the latter has a micropyle on a slight projection, while the former does not.

No other coccidia have been reported from the genus *Heterocephalus* (of which *H. glaber* is the sole species) or from any other member of the superfamily Bathyergoidea, to which it belongs. Porter's description, sketchy though it is, is enough for the recognition of this form. Hence, we are assigning it the name *Eimeria heterocephali.*

GENUS *ISOSPORA* SCHNEIDER, 1881

In this genus, the oocyst has two sporocysts, each containing four sporozoites.

ISOSPORA CITELLI LEVINE, IVENS, AND KRUIDENIER, 1957

(Plate 32, Fig. 266)

Isospora citelli Levine, Ivens, and Kruidenier, 1957a: 143–144.

Description: Oocysts subspherical. Two oocysts measured 22–23 × 21–22 μ, with a mean of 22.4 × 21.5 μ and a mean length-width ratio of 1.04. Oocyst wall smooth, composed of two very pale tan layers, the outer one 1 μ and the inner one 0.4 μ thick. Micropyle absent. Oocyst refractile globule present; this looks like an oil droplet; it goes to the top when the oocyst is rolled over. Oocyst residuum absent. Sporocysts broadly lemon-shaped, approximately 15 × 10 μ, with a small Stieda body. Sporocysts completely filled by the four sporozoites and residual material composed of granules of different sizes. The sporozoites lie in no particular order in the sporocysts. In Fig. 266, the sporocysts are shown end-on, so that no Stieda body is visible.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Spermophilus (syn., *Citellus) variegatus* (rock squirrel).

Location: Intestinal contents.

Geographic Distribution: United States (Grand Canyon National Park, Arizona).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

ISOSPORA FREUNDI YAKIMOFF AND GOUSSEFF, 1935

(Plate 42, Fig. 375)

Isospora freundi Yakimoff and Gousseff, 1935a: 485.

Description: Oocysts spherical or subspherical. Spherical oocysts 13–24 μ in diameter, with a mean of 19.8 μ. Subspherical oocysts 20–27 × 17–24 μ, with a length-width ratio of 1.1–1.25. Oocyst wall smooth, double-contoured (illustrated as a single layer). Micropyle absent. Oocyst polar granule and residuum absent. Sporocysts in the spherical oocysts 14 × 8–9 μ. Sporocysts illustrated without Stieda body or sporocyst residuum.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Cricetus cricetus (hamster).

Location: Feces.

Geographic Distribution: USSR (White Russia).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in one out of four hamsters.

ISOSPORA TERES IWANOFF-GOBZEM, 1934

Isospora teres Iwanoff-Gobzem, 1934: 149–151.

Description: Oocysts spherical, 24–36 μ in diameter. Micropyle absent. Oocyst polar granule present. Oocyst and sporocyst residua absent. Sporocysts 16–21 × 8–13 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Lagurus lagurus.

Location: Intestine.

Geographic Distribution: USSR (Kazakhstan).

Pathogenicity: Unknown. Hyperemia of the intestinal mucosa was observed in three rodents infected with this species and *I. laguri.*

Cross-Transmission Studies: None.

Prevalence: Iwanoff-Gobzem (1934) found this species in 3 out of 40 *L. lagurus* examined, but it is not clear whether she looked for coccidia in animals without intestinal lesions.

ISOSPORA LAGURI IWANOFF-GOBZEM, 1934

Isospora laguri Iwanoff-Gobzem, 1934: 149–151; Svanbaev, 1962: 23–39 (?).
Isospora laguris [*sic*] Iwanoff-Gobzem, 1934: *Ibid.*

Description: Oocysts ovoid, 24–32 × 16–22 μ. Oocyst wall thick. Micropyle absent. Sporulated oocysts with large oocyst residuum, without polar granule. Sporocysts 16–21 × 8–13 μ. Sporocyst residuum absent.

Sporulation Time: Three days.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Lagurus lagurus (steppe lemming).

Other Host: Spermophilus (syn., *Citellus) maximus* (?, see *Remarks* below).

Location: Intestine.

Geographic Distribution: USSR (Kazakhstan).

Pathogenicity: Unknown. Hyperemia of the intestinal mucosa was observed in three rodents infected with this species of *I. teres.*

Prevalence: Iwanoff-Gobzem (1934) found this species in 3 out of 40 *L. lagurus* examined, but it is not clear whether she looked for coccidia in animals without intestinal lesions.

Remarks: Svanbaev (1962) reported finding a coccidium which he called *Isospora laguri* in 2 (5 per cent) of 43 susliks *(Spermophilus maximus)* in southern Kazakhstan. The oocysts were ellipsoidal, subspherical, or spherical, greenish, yellow-green, or brown, with a smooth wall 1.5–2.0 μ thick and without a micropyle. The oocysts measured 18–29 × 18–24 μ, with a mean of 23.5 × 21 μ; their length-width ratio was 1.1. An oocyst polar granule was absent, but an oocyst residuum was present in the form of a large granular ball situated between the sporoblasts. The sporocysts were ellipsoidal or spherical, 8–13 × 7–11 μ, with a mean of 10 × 6.4 [*sic*] μ. The sporozoites were comma-shaped, 5–7 × 3–4 μ, with a mean of 6 × 3 μ.

The above description differs from that of *I. laguri* from *Lagurus lagurus* in shape and in having considerably smaller sporocysts. In addition, *Spermophilus* belongs to a different rodent suborder from that of *Lagurus.* However, in the absence of more complete descriptions of the forms from both hosts, we are unable to decide whether they belong to the same or different species.

Svanbaev (1962) also reported finding a coccidium which he called *Isospora laguri* in two of seven tamarisk gerbils *(Meriones tamariscinus)* in southern Kazakhstan. The oocysts were ellipsoidal or subspherical, yellow-green, with a smooth wall 1.5–1.9 μ thick and without a micropyle. The oocysts measured 21–30 × 20–26 μ, with a mean of 27 × 19.7 [*sic*] μ; their length-width ratio was 1.1 × 1.2, with a mean of 1.35 [*sic*]. An oocyst polar granule was absent, but an oocyst residuum was present in the form of a granular mass. The sporocysts were ellipsoidal or ovoid, 12–14 × 7-10 μ, with a mean of 13 × 9 μ. The sporozoites were comma-

shaped or ellipsoidal, 5–6 × 2–3 μ, with a mean of 5.5 × 3 μ. A sporocyst residuum was absent.

The above description differs from that of *I. laguri* from *Lagurus lagurus* in shape and in having smaller sporocysts. In addition, *Meriones* belongs to a different rodent suborder from that of *Lagurus*. However, in the absence of more complete descriptions of the forms from both hosts, we are unable to decide whether they belong to the same or different species.

ISOSPORA MCDOWELLI SAXE, LEVINE, AND IVENS, 1960

(Plate 31, Fig. 261)

Isospora mcdowelli Saxe, Levine, and Ivens, 1960. J. Protozool. 7:61–63.
Isospora sp. Saxe, 1952. Proc. Soc. Protozool. 3:13.

Description: Oocysts spherical to subspherical. Oocyst wall composed of a single layer. Fifty-three sporulated oocysts measured 9–11 × 8–10 μ, with a mean of 10 × 9 μ; their length-width ratios ranged from 1.0–1.3, with a mean of 1.10. Micropyle absent. Oocyst polar granule and oocyst residuum absent. Sporocysts more or less ellipsoidal; 34 sporocysts measured 6–8 × 4–5 μ, with a mean of 7 × 5 μ; their length-width ratios ranged from 1.3–1.7, with a mean of 1.47. Sporocyst residuum present, compact.

Sporulation Time: Three to five days at room temperature (24 to 27C) in 1% chromic acid.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Microtus pennsylvanicus (meadow mouse).

Location: Cecal contents.

Geographic Distribution: United States (Pennsylvania).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

ISOSPORA BATABATICA MUSAEV AND VEĬSOV, 1960

(Plate 31, Fig. 262)

Isospora batabatica Musaev and Veĭsov, 1960: 51–61.

Description: Oocysts almost spherical or ovoid, colorless. Oocyst wall smooth, double-contoured, composed of a single layer 1 μ thick. Micropyle absent. Ten sporulated oocysts measured 20–24 × 19–21 μ, with a mean of 23 × 21 μ; their length-width ratios ranged from 1.0–1.2, with a mean of 1.1. Oocyst residuum and polar granule absent. Sporocysts ovoid, 9–14 × 6–9 μ, with a mean of 13 × 8 μ. Stieda body prominent. Sporocyst residuum present, composed of fine granules. Sporozoites ovoid.

Sporulation Time: Two days in 2.5% potassium dichromate at 25–30C.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Arvicola terrestris (water vole).
Location: Large intestine contents.
Geographic Distribution: USSR (Azerbaĭdzhan). Musaev and Veĭsov (1960) found this species in water voles at Batabat in the alpine zone of the Shakhbuz region of Nakhichevan ASSR, Azerbaĭdzhan SSR.
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Unknown.

ISOSPORA ORDUBADICA MUSAEV AND VEĬSOV, 1960

(Plate 32, Fig. 269)

Isospora ordubadica Musaev and Veĭsov, 1960a: 67–75.

Description: Oocysts ovoid or subspherical, colorless. Ten sporulated oocysts measured 18–20 × 14–18 μ, with a mean of 20 × 17 μ; their length-width ratios ranged from 1.1–1.3, with a mean of 1.2. Oocyst wall smooth, composed of a single layer 1 μ thick. Micropyle absent. Oocyst residuum and polar granule absent. Sporocysts ovoid (illustrated as ellipsoidal), without Stieda body, 10–12 × 8–10 μ, with a mean of 12 × 10 μ. Sporocyst residuum present, in the form of small granules. Sporozoites relatively small, ovoid.
Sporulation Time: Two to three days at 25–30C in 2.5% potassium dichromate solution.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Meriones persicus (Persian jird).
Location: Intestinal contents.
Geographic Distribution: USSR (Nakhichevan region of Azerbaĭdzhan).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: Unknown.

ISOSPORA URALICAE SVANBAEV, 1956

(Plate 42, Fig. 379)

Isospora uralicae Svanbaev, 1956: 180–191.

Description: Oocysts ovoid, 26.4 × 22.5 μ. Oocyst wall smooth, greenish, 1.6 μ thick, described as double-contoured and illustrated as composed of a single layer. Micropyle absent. Oocyst polar granule present. Oocyst residuum absent. Sporocysts ovoid, 13.8 × 9.1 μ, illustrated without Stieda body. Sporocyst residuum absent. Sporozoites comma-shaped, 6.9 × 3.7 μ.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Sporogony: The sporont divides into two masses, each of which becomes a sporocyst containing four sporozoites.

Type Host: Apodemus sylvaticus.

Location: Feces.

Geographic Distribution: USSR (western Kazakhstan).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Svanbaev (1956) found this species in 4 of 18 *A. sylvaticus* in western Kazakhstan.

ISOSPORA RATTI N. SP.

(Plate 32, Fig. 267)

Description: Oocysts subspherical. Two sporulated oocysts measured 22–24×20–21 μ. Oocyst wall smooth, pale tan to tan, composed of a single layer about 1 μ thick. Micropyle absent. Oocyst residuum absent. Two oocyst polar granules present. Sporocysts asymmetrical, broadly ovoid, 16×11 μ. Stieda body present. Sporocyst residuum present, compact. Sporozoites colorless, not arranged in any particular order in sporocysts.

Schizogony and Gametogony: Unknown. No endogenous stages were found in the duodenum, jejunum, anterior ileum, posterior ileum, or cecum of the host animal.

Prepatent Period: Unknown.

Type Host: Rattus norvegicus (Norway rat).

Location: Intestinal contents.

Geographic Distribution: North America (Illinois).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in 1 of 11 wild *R. norvegicus* in Moultrie County, Illinois. The host animal was trapped on a farm about two miles north of Sullivan, Illinois.

Remarks: The species of *Isospora* reported from rodents have been described above. None has been reported heretofore from *Rattus. I. ratti* differs from *I. citelli* in having a one- rather than a two-layered oocyst wall and in the shape of its sporocysts. It differs from *I. freundi* in having an oocyst polar granule, Stieda body, and sporocyst residuum. It differs from *I. teres* in having a sporocyst residuum. It differs from *I. laguri* in having an oocyst polar granule and sporocyst residuum and in lacking an oocyst residuum. It differs from *I. mcdowelli* in size, in having an oocyst polar granule, and in the shape and size of its sporo-

cysts. It differs from *I. uralicae* in oocyst and sporocyst shape, in sporocyst size, and in having a sporocyst Stieda body and sporocyst residuum.

GENUS *DORISIELLA* RAY, 1930

In this genus, the oocyst has two sporocysts, each containing eight sporozoites.

DORISIELLA ARIZONENSIS LEVINE, IVENS, AND KRUIDENIER, 1955

(Plate 32, Fig. 268)

Dorisiella arizonensis Levine, Ivens, and Kruidenier, 1955: 52–53.

Description: Oocysts spherical or subspherical. Oocyst wall smooth, composed of two layers, the outer one 1 μ thick and colorless, the inner one 0.5 μ thick and pale tan. Micropyle absent. Oocysts 21–28×21–22 μ, with a mean of 21.8×21.0 μ; oocyst length-width ratio 1.00–1.05, with a mean of 1.04. Oocyst residuum absent. One to three oocyst polar granules present. Sporocysts lemon-shaped, thin-walled, 11–13×9–10 μ, with a mean of 12.7×9.2 μ. Sporocysts with Stieda body and a few to many scattered, round, clear residual granules or bodies varying in diameter from a fraction of a micron up to 5 μ. Sporozoites often oriented more or less lengthwise in sporocysts, sometimes spiralling somewhat around a large, clear central residual body. Sporozoites and residual material completely fill sporocysts.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Neotoma lepida (desert woodrat).

Location: Feces.

Geographic Distribution: North America (Arizona).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

GENUS *WENYONELLA* HOARE, 1933

In this genus, the oocyst has four sporocysts each containing four sporozoites.

WENYONELLA HOAREI RAY AND DAS GUPTA, 1935

(Plate 42, Figs. 380–382)

Wenyonella hoarei Ray and Das Gupta, 1935: 112–113; Ray and Das Gupta, 1937: 117–120.

Description: Oocysts spherical, 14–18.5 μ in diameter. Number of layers in oocyst wall not specified. Micropyle absent. Oocyst polar granule and oocyst residuum absent. Sporocysts ovoid, 10×8 μ, with prominent Stieda body. Sporozoites usually lie in pairs around sporocyst residuum with a regular "head to tail" arrangement.

Sporulation Time: Seven days in 1% chromic acid at room temperature.

Sporogony: The first sign of development occurs after two days, when four lobes project from the center of the sporont. At the tip of each of these are four homogeneous prominences which Ray and Das Gupta (1937) believed to be precociously forming sporozoites. The sporoblasts do not separate until the fourth day. The sporocysts are formed on the fifth day, and become mature on the seventh.

Schizogony: Schizogony takes place in the epithelial cells of the small intestine. Six to eight merozoites are formed, but Ray and Das Gupta (1937) were unable to determine whether there was more than one merozoite generation. There are two types of merozoites. One type is 6×2 μ, hyaline, with a granule near the nucleus which stains darkly with hematoxylin. The other type is 8×2 μ, more opaque, and with numerous, irregularly scattered, darkly staining granules. Both types are broad and rounded at one end and pointed at the other; the pointed region stains darkly with hematoxylin. Ray and Das Gupta (1937) believed that the smaller merozoites gave rise to microgametocytes and the larger ones to "macrogametocytes."

Gametogony: The young microgametocytes are 6–8 μ in diameter. After they have grown, a large number of nuclei are found at their periphery. Each nucleus lies in a cytoplasmic protuberance and has a basal granule above it. Two flagella are formed; in the mature microgamete one of these is directed backwards. A large number of microgametes is formed, leaving a small cytoplasmic residuum. The microgametes break from the residuum and swim actively, congregating at the "micropylar" end of the macrogametes.

Ray and Das Gupta (1937) did not describe macrogamete formation in detail. They stated merely that as the "macrogametocyte" increased in size, the number of granules in the cytoplasm also increased, the nucleus shifted toward one pole, and its karyosome enlarged and then disintegrated.

Prepatent Period: Unknown.
Type Host: Sciurus sp. (Indian squirrel).
Location: Small intestine.
Geographic Distribution: India (Bengal).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.
Prevalence: This species was seen in three squirrels.

WENYONELLA UELENSIS VAN DEN BERGHE, 1938

(Plate 42, Fig. 377)

Wenyonella uelensis van den Berghe, 1938: 275–277.

Description: Oocysts described as ovoid but illustrated as ellipsoidal, 26–30 × 19–20 μ. Oocyst wall thick. Micropyle absent. Oocyst polar granule absent. Oocyst residuum present at first, but disappears almost completely by fifth day of sporulation. Sporocysts 11 × 8 μ, illustrated as ellipsoidal, without Stieda body. Sporocyst residuum present, insignificant. Sporozoites banana-shaped.
Sporulation Time: Five days (?) in 1% chromic acid.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Funisciurus anerythrus.
Location: Probably intestine.
Geographic Distribution: Africa (Belgian Congo).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

WENYONELLA PARVA VAN DEN BERGHE, 1938

(Plate 42, Fig. 378)

Wenyonella parva van den Berghe, 1938: 275–277.

Description: Oocysts subspherical, 15 × 13 μ. Oocyst wall thick, composed of two layers. Micropyle absent. Oocyst polar granule absent. Oocyst residuum absent. Sporocysts 8 × 5 μ, illustrated as ellipsoidal, without Stieda body. Sporocyst residuum absent.
Sporulation Time: Seven days in 1% chromic acid.
Schizogony and Gametogony: Unknown.
Prepatent Period: Unknown.
Type Host: Tamiscus emini.
Location: Probably intestine.
Geographic Distribution: Africa (Belgian Congo).
Pathogenicity: Unknown.
Cross-Transmission Studies: None.

GENUS *CARYOSPORA* LÉGER, 1904

In this genus the oocyst has a single sporocyst containing eight sporozoites.

CARYOSPORA MICROTI SAXE, LEVINE, AND IVENS, 1960

(Plate 31, Fig. 263; Plate 32, Fig. 264)

Caryospora microti Saxe, Levine, and Ivens, 1960: 61–63.
Caryospora sp. Saxe, 1952: 13.

Description: Oocysts spherical to subspherical. Oocyst wall composed of a single layer. Micropyle absent. Twelve sporulated oocysts measured 9–10.5 × 8.5–10 μ, with a mean of 10 × 9 μ; their length-width ratios ranged from 1.0–1.2, with a mean of 1.08. Oocyst polar granule and oocyst residuum absent. Sporocysts spherical to subspherical. Twelve sporulated sporocysts measured 7–8.5 × 6–7 μ, with a mean of 7 × 6.5 μ; their length-width ratios ranged from 1.0–1.4, with a mean of 1.12. Stieda body absent. Sporocyst residuum present, compact.

Sporulation Time: Ten days or more at room temperature (24 to 27C) in 1% chromic acid.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Microtus pennsylvanicus (meadow mouse).

Location: Cecal contents.

Geographic Distribution: United States (Pennsylvania).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: This species was found in a single meadow mouse.

GENUS *TYZZERIA* ALLEN, 1936

In this genus the oocyst contains eight naked sporozoites.

TYZZERIA PEROMYSCI LEVINE AND IVENS, 1960

(Plate 32, Fig. 265)

Tyzzeria peromysci Levine and Ivens, 1960: 207–212.

Description: This species was reported from two species of *Peromyscus.* Since there are minor differences in the appearance of the oocysts from these hosts, each form is described separately.

Form from type host, *Peromyscus maniculatus:* Oocysts ellipsoidal. Oocyst wall colorless to very pale yellowish, smooth, composed of a single layer about 0.6 μ thick. Micropyle absent. Forty sporulated oocysts from two host animals measured 11–14 × 9–11 μ, with a mean of 12.6 × 10.1 μ; their length-width ratios ranged from 1.1–1.4, with a mean of 1.24. One or two polar granules present. Sporozoites banana-shaped, crescent-shaped, or lanceolate, about 3.5 μ wide and 9–11 μ long. Sporozoites clustered together in a ball without orientation in any particular direction, sometimes with 1 or 2 sporozoites separated from the others. Sporozoites often with fine granules in cytoplasm except in central region where the nucleus is; sporozoites sometimes without granular cytoplasm. No oocyst residuum seen, but it is possible that a small one might have been concealed inside the ball of sporozoites.

Form from *P. leucopus:* Oocysts ellipsoidal. Oocyst wall very pale yellowish, smooth, composed of a single layer about 0.6 μ thick. Micropyle absent. Twenty sporulated oocysts measured 14–17 × 11–12 μ, with a mean of 15.2 × 11.2 μ; their length-width ratios ranged from 1.3–1.5, with a mean of 1.36. One or two polar granules present. Sporozoites banana-shaped, crescentic, or lanceolate, clustered together in a ball without orientation in any particular direction, sometimes with 1 or 2 sporozoites separated from the others. A small, compact oocyst residuum 3–4 μ in diameter was seen in some oocysts in which the sporozoites were sufficiently well separated, and one may have been present but hidden by the sporozoites clustered around it in most or all of the other oocysts.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Peromyscus maniculatus (deer mouse).

Other Host: Peromyscus leucopus (deer mouse).

Location: Intestinal contents.

Geographic Distribution: United States (Illinois).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

Prevalence: Levine and Ivens (1960) found this species in two of nine *P. maniculatus* and one of seven *P. leucopus* from the vicinity of Sullivan, Illinois.

Remarks: The form from *P. maniculatus* differs from that from *P. leucopus* only in that it is slightly smaller and broader and in that no oocyst residuum was seen in it. However, as mentioned above, an oocyst residuum might have been present in the center of the ball of sporozoites. These differences do not appear sufficient to justify the establishment of separate species, although future research may reveal differences in the endogenous stages or host-parasite relations which would do so.

GENUS *CRYPTOSPORIDIUM* TYZZER, 1907

In this genus the oocyst contains four naked sporozoites.

CRYPTOSPORIDIUM MURIS TYZZER, 1907

(Plate 43, Figs. 383–403)

Cryptosporidium muris Tyzzer, 1907: 12–13; Tyzzer, 1910: 487–510.

Description: Oocysts ovoid, ellipsoidal, or spherical, with a knoblike attachment organ at some point on their surface. The attachment organ is bluntly conoidal and often has a delicate, threadlike process extending outward from its apex. Oocyst wall smooth, apparently composed of a single layer. Oocysts measure approximately 7×5 μ. Sporocysts absent. Micropyle absent. Oocyst residuum present.

Schizogony: The schizonts, like the oocysts and macrogametes, have an attachment organ. Their cytoplasm stains dark blue with Wright's or Giemsa's stain, and contains no granules. Their maximum size is 7×6 μ. The nucleus divides three times to form eight daughter nuclei. These become grouped at the end of the schizont farthest from its point of attachment. The cytoplasm then cleaves, and eight banana-shaped merozoites are formed. They extend from one pole of the schizont to the other, and have a slight spiral twist. A globule of residual material is left near the organ of attachment. The merozoites are 5–8 μ thick, with an oval nucleus about one-third of the way from the large end and often a tiny hematoxylin-staining granule between it and the small end. Some merozoites are short and thick, while others are relatively slender. The merozoites break out of the schizont, become attached to the surface of the gastric epithelium by one end and round up. A fat globule appears in the merozoite after it becomes attached to the epithelium. The number of asexual generations is unknown.

Gametogony: The microgametocytes are similar in morphology and mode of development to the schizonts, but are smaller and contain a relatively large amount of chromatin. They have a thin limiting membrane, an attachment organ, and one or more fat globules. Their maximum size is 5×3.5 μ. The nucleus divides repeatedly to form 16 chromatin masses which become more and more dense, elongate, and push out from the surface of the microgametocyte. A relatively large residual mass is left. The microgametes are composed of a rod of chromatin with a small amount of faintly staining material about as long as the chromatin rod trailing off from it; there are no flagella.

The macrogametes can be distinguished from the schizonts and microgametocytes by the presence of oval refractile granules which stain

reddish brown to deep purple with iodine and red with Giemsa's stain after formol fixation. The macrogametes are spherical to ellipsoidal, with an attachment organ at one end which makes them appear flask-shaped. Their limiting membrane becomes thick and impervious to blood stains when they are mature. Fertilization was not observed, although microgametes were occasionally found on the surface of the macrogametes. After fertilization the limiting membrane becomes thicker and forms a dense cyst wall. The nuclear changes could not be followed.

Sporogony: The protoplasm of the oocyst becomes massed at the distal end of the organism, while the remaining portion is occupied by food granules. The protoplasm segments into four masses which elongate and develop into sporozoites, leaving a mass of residual material containing iodophilic granules, lipoid globules, and some material which stains deeply with Giemsa and hematoxylin. Sporogony takes place within the host. Free sporozoites are often found in the stomach. They are boomerang-shaped, with a thin, pointed anterior end with a rod-shaped nucleus near it. They can be distinguished from merozoites by their greater length and by the shape of their nuclei.

Type Host: Mus musculus (house mouse) (reported only from laboratory strains and not from wild mice).

Other Hosts: Elton *et al.* (1931) reported finding *C. muris* in *Apodemus sylvaticus* and *Clethrionomys glareolus* in England, but gave no descriptions.

Location: Stomach. *C. muris* develops either attached to the surface of the epithelium of the gastric glands or free in their lumen. It never penetrates the host cells, but is attached to them by means of the attachment organ described above.

Geographic Distribution: United States. Tyzzer (1910) believed this parasite to have a wide geographic distribution, but it has apparently not been reported from house mice elsewhere, although forms seen by Clarke (1895) and Wenyon (1926) in England may have been this species. In addition, Elton *et al.* (1931) reported finding *C. muris* in *Apodemus sylvaticus* and *Clethrionomys glareolus* in England but did not describe it.

Pathogenicity: According to Tyzzer (1910), *C. muris* is only slightly pathogenic. The only marked histological change he found was dilatation of the gastric glands in severe infections and a slight increase in the collections of lymphoid cells, but he saw nothing in the nature of acute inflammation.

Cross-Transmission Studies: Tyzzer (1910) infected laboratory mice experimentally with *C. muris,* but was unable to infect a white *Rattus norvegicus* with it.

Prevalence: According to Tyzzer (1910), this parasite is frequently found in laboratory mice.

CRYPTOSPORIDIUM PARVUM TYZZER, 1912

(Plate 43, Figs. 404–406; Plate 44, Figs. 407–422)

Cryptosporidium parvum Tyzzer, 1912: 394–412.

Description: Oocysts ovoid or spherical, 4–5 × 3 μ. Oocyst wall smooth, composed of a single layer, with a small, knoblike attachment organ which may be blunt and rounded, may have a blunt conoidal point, or may sometimes be drawn out and slender. A delicate shred or filament which may possibly be derived from the host cell is occasionally found projecting from the attachment organ. Micropyle absent. Sporocysts absent. Oocyst residuum present. Sporozoites slender, bow- or boomerang-shaped, 5.5–6 μ long, with rod-shaped, slender nucleus near the anterior end.

Schizogony: Schizonts at first no more than 1.5 μ in diameter, with an attachment organ. They are attached to the cell surface or embedded in its striated border. They frequently contain one or two small vacuoles. The mature schizonts are 3–5 μ in diameter. The nucleus divides three times to form eight daughter nuclei, which come to lie at the surface of the organism opposite the attachment organ. Cytoplasmic cleavage then takes place, and eight falciform merozoites and a small residual mass are formed. The merozoites are 2.5–5 μ long and 0.5–0.7 μ wide, with a spherical to ellipsoidal nucleus near the thicker end and often with a granule between the nucleus and the posterior end. There is a minute vacuole in the cytoplasm of the larger merozoites.

Gametogony: The microgametocytes are smaller than the schizonts but contain a relatively large amount of chromatin. They have an attachment organ. They give rise to 16 tiny microgametes and a spherical mass of residual material which frequently contains a vacuole. The microgametes are composed of chromatin rods about 1 μ long and not more than 0.4 μ wide and some faintly staining material with no distinct form. No flagella were seen.

The macrogametes are larger than the schizonts and microgametocytes and can be distinguished from them by the presence of tiny, refractile granules which stain reddish brown with iodine and darkly with Giemsa's stain. They have a thin, dense limiting membrane and an attachment organ.

Tyzzer (1912) saw a rod-shaped mass of chromatin in addition to the nucleus in a few small macrogametes, which he interpreted as a microgamete nucleus following fertilization.

Sporogony takes place inside the host.

Type Host: Mus musculus (house mouse) (reported only from laboratory strains and not from wild mice).

Location: Small intestine from the pylorus to the ileocecal valve; usually more numerous below the region of Brünner's glands. The parasites are usually distributed over the entire surface of the intestinal villi, but are never found in the glands. They are less frequent near the bases of the villi than near the tips, where they often occur in large numbers in the irregular depressions which indent this part of the epithelial surface. All growing forms are attached to the surface of the mucosa, where they either indent or are buried in the striated border of the cells. They do not penetrate the cell cytoplasm. Tyzzer (1912) considered *C. parvum* to form a link between the strictly extracellular *C. muris* and the other coccidia which live within the host cell cytoplasm.

Geographic Distribution: United States.

Pathogenicity: According to Tyzzer (1912), the injury due to this species is insignificant, probably amounting to no more than a loss of enough material from the striated border of the cell to accommodate the organisms. There is no inflammation.

Cross-Transmission Studies: None.

Prevalence: According to Tyzzer (1912), this parasite is frequently found in laboratory mice.

GENUS *KLOSSIA* SCHNEIDER, 1875

In this genus the oocysts contain many spherical sporocysts, each with three to ten sporozoites. The macrogametes are not vermiform.

KLOSSIA PERPLEXENS LEVINE, IVENS, AND KRUIDENIER, 1955

(Plate 31, Fig. 260)

Klossia perplexens Levine, Ivens, and Kruidenier, 1955a: 623–629.

Description: Oocysts ellipsoidal, with smooth wall composed of two layers. Outer layer colorless, transparent, about 2 μ thick. Inner wall pale brown, 0.5 μ thick. Micropyle absent. Oocysts 42–53 × 35–44 μ, with a mean of 47.9 × 39.9 μ; standard deviation of length, 3.53, of width 2.99. Oocyst length-width ratio ranges from 1.17–1.22, with a mean of 1.20 and a standard deviation of 0.018. Oocyst polar granule absent. Oocyst residuum composed of about a dozen round, colorless, homogeneous

globules 3–6 μ in diameter scattered among the sporocysts. Twelve sporocysts present in each of four oocysts carefully counted. Sporocysts packed so tightly in oocysts that counting them is difficult. Sporocysts spherical, without Stieda body, with colorless wall 0.5 μ thick. Sporocysts 13–14 μ in diameter, with a mean of 13.3 μ. Each sporocyst contains four sausage-shaped, colorless sporozoites arranged in no particular order. Colorless, spherical granules about 1.2–1.5 μ in diameter in constant Brownian movement fill the remaining space in the sporocysts. One or two larger granules about 3 μ in diameter similar to those in oocysts are sometimes present in sporocysts.

Schizogony and Gametogony: Unknown.

Prepatent Period: Unknown.

Type Host: Peromyscus maniculatus (deer mouse).

Location: Feces.

Geographic Distribution: North America (Arizona).

Pathogenicity: Unknown.

Cross-Transmission Studies: None.

GENUS *KLOSSIELLA* SMITH AND JOHNSON, 1902

In this genus typical oocysts are not formed, but a number of sporocysts, each with many sporozoites, develops within a membrane which is perhaps laid down by the host cell.

KLOSSIELLA MURIS SMITH AND JOHNSON, 1902

(Plate 45, Figs. 423–429; Plate 46, Figs. 430–437)

Klossiella muris Smith and Johnson, 1902: 303–316; Woodcock, 1904: 153–163; Brugnatelli, 1908: 121–126; Sangiorgi, 1911: 523–526; Stevenson, 1915: 127–135; Maisin, 1923: 1219–21; Twort and Twort, 1923: 219–242; Bonne, 1925: 1190–92; Wenyon, 1926; Sternberg, 1929: 419–421; Cannarella, 1931: 670–684; Gard, 1945: 427–434; Otto, 1957: 41–48.

Klossiella sp. Pfeiffer, 1891.

Coccidium klossiella Elaut, 1932: 1012–14.

Coccidia. Smith, 1889: 211–217.

Description: It is not certain whether true oocysts are present in this genus. The sporocysts develop from a sporont within a vacuole in the host cell. They are surrounded by a membrane, but this may be a host cell structure. Wenyon (1926) stated, "It is doubtful if a true oöcyst is formed." However, Reichenow (1953) considered oocysts to be present.

The morphological features of the various stages in the life cycle are given below.

Schizogony: Schizogony takes place in the glomeruli of the kidneys. Smith and Johnson (1902) described schizogonic forms in the epithelium —usually the visceral layer—of Bowman's capsule. Stevenson (1915) found two types, one in the endothelial cells of the kidney arterioles and the other in the cells forming the capillaries in the kidney glomeruli and also in the endothelial cells of the kidney arterioles. Otto (1957) found schizogonic forms almost exclusively in cysts in the glomeruli; they were primarily in the endothelial cells. Bonne (1925) reported them in addition in the endothelial cells of the capillaries of the lungs and spleen. Twort and Twort (1923) made microscopic examinations of the kidneys of several hundred mice, the adenomatous and hyaline thyroid glands of 150 mice, and other organs of a large number of mice in the course of a study of diseases of 60,000 experimental mice in England. They found *K. muris* in 90 per cent of the kidneys, 7 per cent of the brains, 15 per cent of the suprarenal glands, 5 per cent of the lungs, 15 per cent of the thyroids, 2 per cent of the spleens and 1 per cent of the lymph glands and pituitary glands. The protozoa were usually in the capillaries.

Infection presumably takes place by ingestion of sporocysts, and the sporozoites presumably pass by way of the blood stream. Stevenson (1915) found a small gregariniform body about 12 μ long in the peripheral blood of a mouse which had no parasites in the kidneys but which had lived in a cage with others that were passing sporocysts.

Of the two types of schizogony described by Stevenson (1916), the type which he considered to be the earlier occurs in the endothelial cells of the kidney arterioles. In this type each schizont forms 8 to 12 merozoites. The second type of schizogony is much more common, and occurs in the endothelial cells of the kidney capillaries and arterioles; this is also the type which Smith and Johnson (1902) found in the epithelium of Bowman's capsule and Bonne (1925) reported from the lungs and spleen. In this type 40 to 60 more or less falciform merozoites each approximately 7×2 μ are formed. The mature schizont occupies quite a large portion of Bowman's capsule. It breaks, releasing the merozoites into the lumen of the kidney tubule.

Gametogony: The merozoites enter the epithelial cells of the convoluted tubules of the kidney where they become gamonts and where gametogony and sporogony take place. Gametogony has been described by Smith and Johnson (1902), Stevenson (1915), Sternberg (1929), and Gard (1945), to whom reference may be made for other reports. A macrogamete and microgametocyte are found together within a vacuole in the host cell. The microgametocyte divides to form two microgametes.

Fertilization then takes place, and the fertilized macrogamete or zygote becomes a sporont or "mother sporoblast" which may reach a diameter of 40 μ.

Sporogony: The sporont contains 10 to 20 plastin granules about 1.5 μ in diameter. It divides by multiple fission to form 12 to 16 sporoblasts and a residual body. Within each sporoblast about 25 to 34 banana-shaped sporozoites and a sporocyst residuum are formed by multiple fission. The resulting sporocyst is subspherical to spherical, approximately 16×13 μ, and has a very thin wall. The sporozoites lie side by side in the sporocyst. As mentioned above, all authorities do not agree as to whether there is a true oocyst. The sporocysts are released into the lumen of the kidney tubules by rupture of the host cell, and pass out in the urine.

Prepatent Period: Unknown. It is presumably long, since sporocysts are not shed by mice less than six months old.

Type Host: Mus musculus (house mouse).

Location: Schizogony in epithelial cells of capillaries and arterioles in kidney, lungs, spleen, and other organs; gametogony and sporogony in epithelial cells of convoluted tubules of kidney.

Geographic Distribution: Probably worldwide. This species has been reported from the United States, England, France, Germany, Belgium, Holland, Italy, Austria, Roumania, and Sweden.

Pathogenicity: According to Smith and Johnson (1902), in heavy infections the kidneys have minute greyish spots over their entire surface. These spots represent foci of necrobiotic changes in the cortex, followed by marked cell proliferation. Otto (1957) described a perivascular, follicular, lymphocytic infiltration in the region of the medullary cortex which he considered of diagnostic significance. The epithelium of the infected kidney tubules is destroyed, and the tubules come to look like elongated, contorted bags filled with sporocysts. In the later stages, intertubular foci are formed by round cell proliferation. There is no inflammatory reaction. Giant cells and polymorphonuclear leucocytes are absent. Fatal infections have not been reported.

Cross-Transmission Studies: Cannarella (1931) claimed to have transmitted *K. muris* to the guinea pig. She fed sporocysts in mouse urine to a single guinea pig, and found *Klossiella* in its kidneys 30 days later. However, she used no controls, and this claim has not been confirmed.

Prevalence: The true prevalence of *K. muris* in laboratory mice is unknown. In the laboratory colonies in which it was found, from 20–100 per cent of the mice were infected. Elaut (1932) studied the relation of age to incidence of infection. He found no infections in the kidneys of mice less than 6 months old, but found that the incidence increased

with age up to 100 per cent in animals one year old or more. Twort and Twort (1923) stated that they expected to find evidence of *Klossiella* nephritis in at least 90 per cent of their animals by the time they were 12 months old, and that as they grew older, probably very few animals escaped infection. Banciu, Dincolesco, and Petrovici (1958) found it in the kidneys of 3 per cent of 397 white mice bred in their laboratory in Roumania.

The only report of *K. muris* in wild house mice was that of Smith and Johnson (1902), who found it in a considerable number caught in their animal room.

KLOSSIELLA COBAYAE SEIDELIN, 1914

Klossiella cobayae Seidelin, 1914: 553–564; Stevenson *in* Wenyon, 1926.
Klossiella sp. Pearce, 1916: 431–442; Bonciu *et al.*, 1957: 131–143.
Klossia caviae Sangiorgi, 1916: 49–53.
Coccidium. Pianese, 1901: 350–367.
Coccidia. Alves de Souza, 1931: 11–14.

Description: The following description of the various stages in the life cycle is based primarily on that of Stevenson as given in Wenyon (1926).

Schizogony: The sporozoites are released from the sporocysts in the lumen of the guinea pig intestine and make their way to the endothelial cells of the capillaries, where the first schizogonic multiplication takes place. The capillaries most commonly affected are those of the kidney glomeruli, but those of other organs may also be involved. Each sporozoite forms a small rounded body within the endothelial cell. This schizont attains a diameter of about 2.5 μ. Its nucleus then divides repeatedly until eight are present. Merozoites are formed around the nuclei, where they lie in a vacuole and make the host cell bulge into the lumen of the capillary. The merozoites measure 2×1 μ. They are released into the blood by rupture of the host cell and invade other endothelial cells where the cycle is presumably repeated. Eventually some of them enter the lumen of the kidney tubules and pass to the convoluted portion, where they penetrate the tubule cells. They become schizonts which produce about a hundred merozoites. The host cell is greatly enlarged, almost filling the lumen of the tubule. It ruptures and the merozoites are released into the lumen.

Gametogony: The merozoites pass down to the straight kidney tubules or loops of Henle, where they enter the endothelial cells. They occur here typically in pairs, one being a microgametocyte and the other a macrogamete. Sometimes there are two or even three microgametocytes associated with a macrogamete. The microgametocyte divides once to

form two microgametes, one of which then fertilizes the macrogamete. The resultant zygote grows, becoming a sporont and causing its host cell to swell until the lumen of the kidney tubule is completely occluded. At this time the sporont has a diameter of 30–40 μ.

Sporogony: The sporont nucleus divides repeatedly during the sporont's growth to form 30 or more daughter nuclei. A sporoblast is formed around each one by a process of budding from the sporont surface. A residuum is left. According to Stevenson and Wenyon, it is doubtful if a true oocyst is formed, but Reichenow (1953) considered that there is one. The sporoblasts become slightly elongated, and a sporocyst wall is formed around each. About 30 sporozoites are formed in each sporocyst. The sporulated sporocysts rupture the host cell, pass down the kidney tubules and escape in the urine, becoming available to infect another host.

Prepatent Period: Unknown.

Type Host: Cavia porcellus (domestic guinea pig).

Other Host: Cavia aperea (wild guinea pig, aperea). The only report of this species in wild guinea pigs is that of Alves de Souza (1931), who found it in a single animal in Brazil.

Location: The first schizogony takes place in the endothelial cells of capillaries in the kidney and other organs. The last schizogonic cycle takes place in the endothelial cells of the convoluted portion of the kidney tubules. Gametogony and sporogony take place in the endothelial cells of the straight kidney tubules and loops of Henle.

Geographic Distribution: Presumably worldwide. Seidelin (1914) found this species in two guinea pigs in Nigeria, Pianese (1901) and Sangiorgi (1916) found it in Italy, Stevenson in Wenyon (1926) in England, Bonciu *et al.* (1957) in Roumania, Alves de Souza (1931) in a wild guinea pig in Brazil, Pearce (1916) in 12 guinea pigs from Pennsylvania and New Jersey, and C. C. Morrill and the authors (unpublished) found it in laboratory guinea pigs in Illinois.

Pathogenicity: K. cobayae apparently causes no clinical signs. According to Pearce (1916), the pathologic changes in the kidney are slight. They consist of an irregular accumulation of round cells and fibroblasts around some of the glomeruli. There is slight involvement of the labyrinthine tissue adjacent to the glomeruli and apparently none at all in the lower or inner half of the kidney cortex where most of the parasites are found. On the other hand, Bonciu *et al.* (1957) said that 88 per cent of their cases had slowly developing subacute nephritis with degenerative lesions, either simple or combined with proliferative lesions infiltrated with mononuclear cells, fibroblasts, and sometimes plasmocytes

and eosinophiles; sclerotic chronic nephritis was present in 2 per cent. They also described nodular perivascular mononuclear infiltration of the lungs and deposition of blood pigment in the red pulp of the spleen and in the reticular zone of the adrenal cortex. They found parasites only in the kidneys, however.

Cross-Transmission Studies: None.

Prevalence: In a study of 976 guinea pigs in Roumania, Bonciu *et al.* (1957) found *Klossiella* in an average of 60.5 per cent of the adult animals (its prevalence ranging from 13 to 65 per cent in different groups), and in 17 per cent of the aged guinea pigs. The youngest infected animals were three weeks old. The maximum infection rate (91 per cent) occurred in the summer and the minimum (43–49 per cent) in the winter.

KLOSSIELLA SP. (HARTMANN AND SCHILLING, 1917) NÖLLER, 1921

Hepatozoon jaculi (?) Hartmann and Schilling, 1917.
Klossiella sp. Nöller in Reichenow, 1921; Wenyon, 1926.

Description: Uncertain.

Type Host: Jaculus jaculus (jerboa).

Remarks: Hartmann and Schilling (1917) described schizogonic forms in the endothelial cells of the capillaries of the lung, liver, spleen, and other internal organs of the jerboa which they believed to be part of the life cycle of *Hepatozoon balfouri* (syn., *H. jaculi*). However, Nöller examined their preparations and informed Reichenow (1921) that they were developmental stages of a *Klossiella*. Wenyon (1926) also saw this parasite in the jerboa from the Sudan in 1906 and agreed that it is not *H. balfouri* but a *Klossiella*. The only forms he saw appeared to be schizogonic stages in the kidney tubules.

DISCUSSION

In Tables 1 through 29 are summarized the known morphological characters of the known species of coccidia from rodents. Tables 1 through 21 give the characters of the species of *Eimeria,* arranged by host family or subfamily, while Tables 22 through 29 give the characters of the other genera of coccidia.

Numbers of Species of Rodent Coccidia

A total of 196 named species of coccidia is included in this monograph. *Eimeria* is by far the most common genus, with 176 named species. In addition, 9 species of *Isospora,* 3 of *Wenyonella,* 2 each of *Cryptosporidium* and *Klossiella,* and 1 each of *Dorisiella, Caryospora, Tyzzeria,* and *Klossia* have been named.

While this is quite a large number, it is only a small percentage of the number of species which must actually occur in rodents. In Table 30 are listed the numbers of genera and species in each rodent family together with the numbers of species of *Eimeria* which have been described from them. *Eimeria* has been described from only 15 per cent of the 337 genera and 4 per cent of the 2,688 species of rodents. *Eimeria* and other coccidia have been described from only 12 of the 24 rodent families listed. No coccidia have been named from such large rodent genera as *Acomys* (26 species), *Dendromus* (29 species), *Otomys* (26 species), *Rhipidomys* (27 species), *Thomasomys* (40 species), *Akodon* (62 species), *Reithrodontomys* (27 species), *Gerbillus* (52 species), *Tatera* (42 species), *Pitymus* (32 species), *Cryptomys* (46 species), *Ctenomys* (51 species), *Coendou* (25 species), *Callosciurus* (65 species), and *Graphiurus* (39 species).

We know that many hosts have more than 1 species of *Eimeria.* For example, 8 have been described from *Sciurus vulgaris,* 5 from *Apodemus sylvaticus,* 8 from *Mus musculus,* 6 from *Lophuromys sikapusi,* and 6 from *Myocastor coypus.* On the other hand, we also know that some species of coccidia occur in more than 1 host. Assuming that there is an average of 1 *Eimeria* species per rodent species, we can estimate that there may be about 2,700 species of *Eimeria* alone in rodents. The number already described is about 6.5 per cent of this.

In addition, our information on most of the named species is meager. In most cases all that we have is a description of the oocysts, and many of these descriptions are incomplete. The location in the host is known for only 45 species of *Eimeria* (26 per cent of those named), the endogenous stages are known for only 25 species (14 per cent of those named), and complete life cycles have been worked out for only 4 species of *Eimeria (E. mohavensis, E. miyairii, E. nieschulzi,* and *E. separata).*

Relation of Eimeria Oocyst Morphology to Host Family

In an attempt to determine whether there is any morphological character or group of characters which might be used to differentiate the oocysts of *Eimeria* of one group of rodents from those of another group (or to differentiate the oocysts of rodent Eimerias from those of other

host orders or classes), the known morphological characters of the oocysts of *Eimeria* species were tabulated by host family or subfamily in Table 31.

In general, it can be said that the oocysts of rodent *Eimeria* species usually lack a micropyle (82 per cent of 176 species), lack an oocyst residuum (65 per cent of 171 species), may or may not have a polar granule (57 per cent of 156 species have one) or a sporocyst Stieda body (60 per cent of 126 species have one), and usually have a sporocyst residuum (89 per cent of 166 species).

Rodent coccidia cannot be differentiated from the coccidia of other hosts on the basis of the presence or absence of any of these characters.

A micropyle is more common in the *Eimeria* species from the Sciuridae (36 per cent of 42 species) than in those from other rodent families (13 per cent of 134 species). An oocyst polar granule is more common in the coccidia from the Muridae (66 per cent of 96 species) than in those from other rodent families (43 per cent of 60 species). Aside from these, there are no noteworthy differences in distribution of characters between *Eimeria* species from different host families. Certainly there is no evidence of parallel evolution between hosts and parasites among the rodent coccidia. The morphological characteristics of the coccidian species have not changed progressively, but appear to have arisen more or less at random.

Cross-Infection Studies

The cross-infection experiments which have been carried out with the species of *Eimeria* from rodents are summarized in Table 32. Such experiments have been carried out with only 20 species of *Eimeria* (12 per cent of the named species) from 16 species of donor hosts (17 per cent of the number from which *Eimeria* has been described). A total of 61 donor-receptor combinations was investigated, not including those involving subspecies of the same species. Of these, 56 were rodent-to-rodent, 3 rodent-to-lagomorph, and 2 rodent-to-carnivore. Of the rodent-to-rodent combinations, 9 were from one species to another in the same genus, while 47 were from one genus to another. Eight of the nine attempts to transfer *Eimeria* between species of the same genus were successful, but none of the attempts to transfer it to a species in a different genus, even within the same family, succeeded. While many more cross-infection studies should be carried out, those which have already been done indicate that the species of *Eimeria* in rodents are highly host-specific.

The only valid cross-infection experiment carried out with the other genera of rodent coccidia was an unsuccessful attempt to infect rats with *Cryptosporidium muris* from the mouse.

SUMMARY

This monograph summarizes the known information on taxonomy, morphology, life cycle, hosts, location in the host, pathogenicity, geographic distribution, and cross-transmission studies of the 196 named species of coccidia of rodents. These include 176 species of *Eimeria,* 9 of *Isospora,* 3 of *Wenyonella,* 2 each of *Cryptosporidium* and *Klossiella,* and 1 each of *Dorisiella, Caryospora, Tyzzeria,* and *Klossia.* In addition, similar data are given for those forms for which insufficient information is available to justify assigning them names.

Eimeria, which is the commonest genus, has been described from only 15 per cent of the 337 genera and 4 per cent of the 2,688 species of rodents. The location in the host is known for 45 species of *Eimeria* (26 per cent of those named), the endogenous stages are known for 25 species (14 per cent of those named), and complete life cycles have been worked out for only 4 species. Among the other coccidian genera, the location in the host, endogenous stages and life cycles are known only for *Cryptosporidium, Klossiella,* and 1 species of *Wenyonella.*

In general, the oocysts of rodent *Eimeria* usually lack a micropyle (82 per cent of 176 species in which the presence or absence of this character has been mentioned), lack an oocyst residuum (65 per cent of 171 species), may or may not have a polar granule (57 per cent of 156 species have one) or a sporocyst Stieda body (60 per cent of 126 species have one), and usually have a sporocyst residuum (89 per cent of 166 species). Rodent Eimerias cannot be differentiated from the Eimerias of other hosts on the basis of the presence or absence of any of these characters. No evidence of parallel evolution between hosts and parasites was observed among rodent Eimerias. The morphological characters of the parasite species have not changed progressively, but appear to have arisen more or less at random.

Cross-infection experiments have been carried out with 20 species of *Eimeria* from 16 donor hosts. Eight out of 9 attempts to transfer *Eimeria* between species of the same rodent genus were successful, but none of 47 attempts to transfer it to a species in a different rodent genus, even within the same family, succeeded.

The following new species of coccidia are described for the first time: *Eimeria hansonorum* n. sp. and *E. ferrisi* n. sp. from the wild house mouse *(Mus musculus);* and *Isospora ratti* n. sp. from the wild Norway rat *(Rattus norvegicus).*

The following are established as new species of *Eimeria: E. moelleri* n. sp. for the form described from *Sciurus carolinensis* by Möller (1923)

and assigned by him to *E. sciurorum; E. ascotensis* n. sp. for the form described from *Sciurus carolinensis* by Webster (1960) and assigned by him to *E. neosciuri; E. kniplingi* n. sp. for the form described from *Sciurus niger rufiventer* by Knipling and Becker (1935) and assigned by them to *E. sciurorum; E. asiatici* n. sp. for the form described from *Eutamias asiaticus* by Tanabe and Okinami (1940) and assigned by them to *E. beecheyi; E. batabatensis* n. sp. for the form described from *Arvicola terrestris* by Musaev and Veĭsov (1960) and assigned by them to *E. arvicolae; E. rysavyi* n. sp. for the form described by Ryšavý (1957) from *Clethrionomys glareolus* and assigned by him to *E. apodemi; E. kazakhstanensis* n. sp. for the form described from *Ellobius talpinus* by Svanbaev (1956) and assigned by him to *E. volgensis; E. talpini* n. sp. for the form described from *Ellobius talpinus* by Svanbaev (1956) and assigned by him to *E. beckeri; E. tamariscini* n. sp. for the form described from *Meriones tamariscinus* by Svanbaev (1956) and assigned by him to *E. musculi; E. hungaryensis* n. sp. for the form described from *Apodemus flavicollis* by Pellérdy (1954) and assigned by him to *E. muris; E. prasadi* n. sp. for the form described from *Apodemus sylvaticus* by Svanbaev (1956) and assigned by him to *E. hindlei; E. svanbaevi* n. sp. for the form described from *Apodemus sylvaticus* by Svanbaev (1956) and assigned by him to *E. krijgsmanni; E. russiensis* n. sp. for the form described from *Apodemus sylvaticus* by Svanbaev (1956) and assigned by him to *E. musculi; E. heterocephali* n. sp. for the form described from *Heterocephalus glaber* by Porter (1957) and assigned by her to *E. muris; E. cernae* n. sp. for the form described from *Clethrionomys glareolus* by Černa (1962) and assigned by her to *E. schueffneri; E. susliki* n. sp. for the form described from *Spermophilus maximus* by Svanbaev (1962) and assigned by him to *E. ussuriensis; E. peschankae* n. sp. for the form described from *Meriones tamariscinus* by Svanbaev (1962) and assigned by him to *E. krijgsmanni; E. assaensis* n. sp. for the form described from *Meriones tamariscinus* by Svanbaev (1962) and assigned by him to *E. callospermophili;* and *E. dorneyi* n. sp. for the form described from *Glaucomys sabrinus macrotis* by Dorney (1962) and called *Eimeria* sp. by him.

The following species of *Eimeria* are redescribed: *E. nieschulzi* from *Rattus norvegicus* in Illinois and from *R. hawaiiensis* in Hawaii (new host record); *E. separata* from *Rattus norvegicus* in Illinois and from *R. hawaiiensis* in Hawaii (new host record); and *E. falciformis* from *Mus musculus* in Illinois.

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TABLE 1

EIMERIA OF RODENT SUBFAMILY SCIURINAE (SCIUROMORPHA; SCIUROIDEA; SCIURIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
				Tribe SCIURINI						
sciurorum	*Sciurus vulgaris*	24–39×13–20 M 28×16	Cylindroid	Smooth, thin, colorless, prob. 1 layer	V. small, seldom visible	+	–	10–14×6–8		+?
botelhoi	*Sciurus ingrami*	M 36×28	Ovoid, piriform	3 μ thick; 3 layers of which outer is yellowish and rough	+ Large	–	–	M 19×9	–	+
franchinii	*Sciurus vulgaris*	M 24×15	Piriform	Thick, rough, yellow, 2 layers	+ Large					
luisieri	*Sciurus vulgaris*	M 33×24	Ovoid, 1 end round, other shaped like bottleneck	Thick, rough, yellowish	+		+	M 9×7.5		
mira	*Sciurus vulgaris*	30–40×19–27	Piriform, with short bottleneck	3 μ thick, rough, brown, 2 layers	+ 4–6 μ diam.	–	–	M 19×6		+
andrewsi	*Sciurus vulgaris* "Einhornchen"	19–25×14–16	Ovoid, somewhat pointed at both ends, or subspherical to ellipsoidal	Smooth, 1 layer		+	–	M 7×4	–	–

TABLE 1 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
silvana	*Sciurus vulgaris*	15–18×12–15	Ellipsoidal, subspherical	Smooth, pale	–		–	Elongate		
serbica	*Sciurus vulgaris* (?)	21–35×12–25	Ellipsoidal ("oval")	Smooth (?), 0.6–0.9 μ thick, yellowish rose	–		–		Absent (?)	+
moelleri	*Sciurus carolinensis*	22–28×14–18	Ellipsoidal, sometimes cylindrical	Smooth, 2 layers	+ 4–6 μ diam.	–	–	10–14×6–8	+?	
neosciuri	*Sciurus carolinensis*, *Sciurus vulgaris*	22–28×14–18	Ellipsoidal	Smooth, 2 layers, outer colorless to pale yellowish, inner dark brown	–	+	–	11–13×5–7 ovoid	+	+
ascotensis	*Sciurus carolinensis*	14–31×10–20	Ellipsoidal to ovoid	3 layers: outer pale yellow, 0.75 μ thick; middle brown, 1 μ thick; inner pinkish orange, 0.6 μ thick	+ (operculum; also a "terminal cap" at opposite end)	+	–	9–10×6–7 ovoid	+	+
kniplingi	*Sciurus niger*	15–34×10–19 M 24×14	Cylindrical, rounded ends	Smooth, pinkish to orange, 1 layer	–	–	+	M 13×7	+	+
sp. Henry, 1932	*Sciurus griseus*	22–32×16–19 M 29×19	Ovoid	Smooth	+					

sp. Brunelli, 1935	*Sciurus vulgaris*	M 17.5×10	Ovoid	Smooth, pearl-gray, double						
sp. Bond & Bovee, 1958	*Sciurus carolinensis*	M 27×17	Ellipsoidal	1 layer	+	−	+		−	−
				Tribe TAMIASCIURINI						
tamiasciuri	*Tamiasciurus hudsonicus*	26–40×16–21 M 32×19	Elongate ellipsoidal, oc. somewhat ovoid, rarely with 1 side sl. concave	Smooth, colorless, 1.5 μ thick, 1 layer	−	+	−	M 16×8	+	+
toddi	*Tamiasciurus hudsonicus*	36–45×27–36 M 40×32	Ellipsoidal, "oval"	2 layers: outer deep yellow, 2.4 μ thick, rough; inner colorless, 0.6 μ thick	−	+	−	16–20×7–13 M 19×11 ovoid	+	+
				Tribe XERINI						
garnhami	*Xerus (Euxerus) erythropus*	14–19×13–18 M 16×15	Spherical to subspherical	Smooth, pink, 2 layers, 0.7 μ thick	−	−	−	6.5 diam., spherical	−	+
				Tribe MARMOTINI						
marmotae	*Marmota marmota*	51×42	Ovoid with somewhat rounded ends		+					
arctomysi	*Marmota marmota*	24×20	Cylindroid		+					

TABLE 1 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
monacis	*Marmota monax*, *M. bobak*	14–23×13–21 M 20×18	Spherical, subspherical	Smooth, colorless, 1 layer	–	–	+		+	+
os	*Marmota monax*	20–26×18–22	Ovoid	Smooth, colorless, 1 layer	+	–	–	9–13×5–8	+	+
perforoides	*Marmota monax*	17–24×15–20	Ellipsoidal	Smooth, colorless, 1 layer	–	–	+	M 10×4	+	+
cynomysis	*Cynomys ludovicianus*	33–37×28–32 M 35×30	Broadly ellipsoidal	1.5–2.5 μ thick, 2 layers; outer transparent, fibrous, v. irregular surface; inner layer faint orange-yellow	+	–	–	13–17×8–12	+	+
citelli	*Spermophilus tridecemlineatus*, *S. pygmaeus*, *S. citellus*, *S. maximus*	14–33×13–21	Subspherical, ellipsoidal, ovoid, occas. spherical	Smooth, colorless, 3 layers, middle one thick, outer and inner ones thin membranes	–	–	+	5–9×4–7	+	+
beecheyi	*Spermophilus beecheyi*	16–20×10–13 M 19×16	Ovoid	Smooth, colorless, 1 layer, 1 μ thick	–	+	–			–
bilamellata	*Spermophilus lateralis*, *S. citellus*, *S. franklinii*	25–41×21–32	Ovoid	2 layers: outer rough, brown, thick, inner clear, thin	+	±	–	16×10	+	+

callo-spermophili	*Spermophilus lateralis, S. spilosoma S. maximus*	15–27×14–25 M 20×19	Spherical to subspherical	1 layer (2?), sl. rough and pitted, colorless to pale yellowish, 1.1 μ thick	−	+	+	9×7	+	±
volgensis	*Spermophilus pygmaeus*	18–32×15–28	Ovoid, sometimes with sharply pointed end	2 layers, smooth, clear, colorless or greenish, 1.2 μ thick, becoming thinner at micropylar end	+		−	9–12×4–6 pear-shaped		+
beckeri	*Spermophilus pygmaeus, S. eversmanni*	18–28×15–23	Ovoid, subspherical, or spherical	2 layers (1?), smooth, yellow, 1.2 μ thick	−	−	−	8–12×4–7 ovoid, seldom piriform	−	+
franklinii	*Spermophilus franklinii*	19–24×13–18 M 21×15	Subspherical to ovoid	2 layers, smooth, colorless	−	+	+	11.5×6 ellipsoidal to subovoid	+	+
lateralis	*Spermophilus lateralis*	28–40×24–31 M 35×27	Ellipsoidal to somewhat ovoid	1 layer, rough, pitted, yellowish brown, 2 μ thick, lined by thin membrane	−	+	+	16×10	+	
hoffmeisteri	*Spermophilus spilosoma*	15–20×13–18 M 18×16	Subspherical	1 layer, smooth, colorless to pale yellowish, 1 μ thick	−	+	∓	11.5×6 elongate ovoid	− or inconspic.	+

TABLE 1 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESID-UUM	SIZE (Microns)	STIEDA BODY	RESID-UUM
susliki	*Spermophilus maximus*	29–35×23–26 M 32×25	Ellipsoidal or elongate ellipsoidal	Smooth, 1.0–1.2 μ thick, greenish, lilac or yellowish-brown	–	–	–	9–13×7-10 M 10×9 ellipsoidal or short ellipsoidal		–
sp. Levine, Ivens, and Kruidenier, 1957	*Spermophilus lateralis*	19×17	Ovoid to ellipsoidal	1 layer, smooth, pale tan, 0.9 μ thick	–	+	+	ellipsoidal	–	+
eutamiae	*Eutamias dorsalis*	24–30×19–23 M 27×21	Ovoid	2 layers: outer smooth, colorless, 1 μ thick; inner very pale tan, 0.4 μ thick, disappearing at small end of oocyst	–	+	–	11×8 lemon-shaped	+	+
asiatici	*Eutamias asiaticus*	15–22×10–15	Ovoid or ellipsoidal	2 layers: outer thick, colorless; inner thin	–		–			+
(?) sp. Levine, 1951	*Spermophilus parryii*	21–25×19–21 M 23×20		2 layers: outer smooth, colorless; inner dark yellowish	–					

vilasi	*Tamias striatus*	11–23×7–19 M 18×14	Subspherical, oc. ellipsoidal or ovoid	2 layers: outer smooth, yellow-green, 0.7 μ thick; inner dark tan, 0.3 μ thick	–	+	–	10×6 "ellipsoidal," elongate ovoid	+	+
wisconsinensis	*Tamias striatus*	26–35×20–27 M 31×24	Ellipsoidal	2 layers: outer rough, yellow-tan, 1.4–1.5 μ thick; inner colorless to pale pink, 0.3–0.4 μ thick	–	+	–	14–16×9–10 M 15×9 lemon-shaped	+	+

TABLE 2

EIMERIA OF RODENT SUBFAMILY PETAURISTINAE (SCIUROMORPHA; SCIUROIDEA; SCIURIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
glaucomydis	*Glaucomys volans*	12–18×11–13 M 16×12	Ellipsoidal	Smooth	–	–	–	Ellipsoidal	–	+
parasciurorum	*Glaucomys volans*	22–36×12–20 M 29×16	Cylindrical, usually rounded at ends, but sometimes truncate	Smooth, light yellow-brown, 0.4–0.6 μ thick	–	–	–	8–13×4–7 M 11×6 ellipsoidal	–	+
dorneyi	*Glaucomys sabrinus*	17–30×10–19 M 26×15	Ellipsoidal, a few truncate at 1 end, colorless to pale pink	1 layer, light green	–	+	–	14×6 piriform	+	+
petauristae	*Petaurista petaurista*	46–53×35–40	Flask-shaped, with short neck and domed "pseudomicropyle" which forms a transparent cap and disappears, becoming concave on sporulation	2 layers: outer rugged, deep brown, 4–6 μ thick; inner thin, transparent	–	–	+	25–31×9–10 naviculoid	–	+

TABLE 3

EIMERIA OF RODENT SUBFAMILY GEOMYINAE (SCIUROMORPHA; GEOMYOIDEA; GEOMYIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
geomydis	*Geomys bursarius*	12–15×12–13 M 13×12	Spherical to sl. ovoid	2 layers (?), smooth, colorless, 0.5 μ	∓	–	–	5–7×4–5	–	+
thomomysis	*Thomomys bottae*	13–16×13–16 M 14×14	Spherical to subspherical	1 layer, smooth, pale yellowish brown, 0.8 μ thick, lined by thin membrane	–	–	–	10×6	+	+

TABLE 4

EIMERIA OF RODENT SUBFAMILY PEROGNATHINAE (SCIUROMORPHA; GEOMYOIDEA; HETEROMYIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
perognathi	*Perognathus intermedius*	19–22×15–16 M 20×15	Ovoid	1 layer, somewhat rough, yellowish brown, 1.0 μ thick	–	–	+	6–7×4–5	+	+
penicillati	*Perognathus penicillatus, Perognathus flavus*	16–20×14–16 M 18×15	Subspherical, ellipsoidal, or slightly ovoid	1 layer, smooth, pale brownish yellow or tan, 0.6 μ thick	–	+	+	9×7 broadly lemon-shaped	+	+

TABLE 5

EIMERIA OF RODENT SUBFAMILY DIPODOMYINAE (SCIUROMORPHA; GEOMYOIDEA; HETEROMYIDAE)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
mohavensis	*Dipodomys panamintinus mohavensis,* (*D. merriami,*[a] *D. nitratoides,*[a] *D. heermanni,*[a] *D. deserti,*[a] *D. agilis* [a])	22–26×14–18 M 24×16	Ellipsoidal	1 layer, smooth, light brown, 0.7–0.9 μ thick	–	–	–	7×4 (?)	–	+
dipodomysis	*Dipodomys phillipsi*	47–61×38–42 M 54×40	Ellipsoidal	2 layers, rough, yellowish brown: outer 3.5 μ thick at sides and 3.0 μ thick at ends; inner 0.7 μ thick	–	–	+	16×11 ovoid	+	+

[a] Experimental.

TABLE 6

EIMERIA OF RODENT SUBFAMILY HETEROMYINAE (SCIUROMORPHA; GEOMYOIDEA; HETEROMYIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
liomysis	*Liomys pictus*, *Liomys irroratus*	15–24×14–21 M 20×18	Subspherical to ellipsoidal	2 layers: outer slightly rough and pitted, pale yellow, 0.9 μ thick; inner practically colorless, 0.3 μ thick	–	+	–	10×7 ovoid	+	+
picti	*Liomys pictus*	22–32×19–28 M 26×23	Subspherical to ellipsoidal	2 layers: outer rough, pitted, brownish yellow, 1.3 μ thick; inner brownish yellow, 0.4 μ thick	–	+	+	11–12×8–9 lemon-shaped	+	+

TABLE 7

EIMERIA OF RODENT SUBFAMILY CASTORINAE (SCIUROMORPHA; CASTOROIDEA; CASTORIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
sprehni	*Castor canadensis*	16–20×11–14 M 18×12	Ovoid or ellipsoid, sometimes with 1 side concave	1 layer (?), smooth	–	+	+	Elongate	–	

TABLE 8

EIMERIA OF RODENT SUBFAMILY CRICETINAE (MYOMORPHA; MUROIDEA; MURIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
				Tribe HESPEROMYINI						
oryzomysi	*Oryzomys* sp.	22–25×17–19	Ellipsoidal to ovoid	Smooth, light brown	–	–	+	11×8 ovoid	+	+
couesii	*Oryzomys c. couesi*	20–23×17–20 M 21×18	Ellipsoidal	1 layer, somewhat rough and pitted, with weak radial striations, 1.3 μ thick	–	+	–	10–14×7–8 M 12×8 ovoid	+	±
peromysci	*Peromyscus truei*	26–32×21–27 M 29×24	Ellipsoidal	2 layers: outer rough, yellowish brown, 1.3 μ thick; inner yellowish brown, 0.4 μ thick	–	+	+	15×9 lemon-shaped	+	+
arizonensis	*Peromyscus truei*	19–27×17–22 M 22×19	Subspherical to ellipsoidal	1 layer, smooth, pale tan, 0.9 μ thick, lined by thin membrane	–	+	+	11×7 lemon-shaped	+	+
arizonensis	*Peromyscus maniculatus*	22–29×18–23 M 26×21	Ellipsoidal	1 layer, sl. to mod. pitted, oc. smooth, light yellowish, 1.3–1.7 μ thick	–	+	+	11–13×7–9 M 12×8 lemon-shaped	+	+

arizonensis	*Peromyscus leucopus*	20–25×17–21 M 22×19	Ellipsoidal to broadly ellipsoidal	1 layer, more or less pitted, pale yellowish to yellowish, 1.0–1.2 μ thick	–	+	+	12–14×7-8 M 13×7 lemon-shaped to rather ovoid	+	+
eremici	*Peromyscus eremicus*	22–30×18–22 M 25×21	Ellipsoidal	2 layers: outer smooth, colorless, 1.0 μ thick; inner pale tan, 0.4 μ thick	–	+	+	10×8 lemon-shaped	+	+
langebarteli	*Peromyscus boylii*	20–23×13–14 M 21×14	Elongate ellipsoidal	1 layer, smooth, pale yellowish, 0.8 μ thick	–	+	–	8–10×5–6 M 9×5 elongate ellipsoidal	+	+
carolinensis	*Peromyscus leucopus*	14–19×10–13 M 18×11	Ellipsoidal, occas. elongate ellipsoidal	2 layers: outer smooth, colorless, 1 μ thick; inner dark brown, 0.5 μ thick	–	+	–	8.5×4.5 ovoid	+	+
delicata	*Peromyscus maniculatus*	13–15×10–12 M 14×11	Ellipsoidal	1 layer, smooth, v. pale yellowish, 0.6 μ thick	–	+	–	8×4–5 elongate ovoid	+	+
roudabushi	*Peromyscus leucopus*	20–26×17–20 M 22×19	Ellipsoidal	1 layer, smooth, almost colorless, 1.3 μ thick at sides, 0.9 μ thick at ends	–	+	+	12–13×8 ovoid	+	+

TABLE 8 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
leucopi	*Peromyscus leucopus*	14–24×14–21 M 19×17	Ellipsoidal, oc. ovoid, rarely spherical	Rough, 2 layers: outer yellowish, 0.5 μ thick; inner dark brown, 1.0 μ thick	–	–	+	11–14×6–8 M 12×7	+	+
baiomysis	*Baiomys taylori, Baiomys musculus*	20–25×18–21 M 23×19	Ellipsoidal	1 layer, rough, pitted, yellowish, 1.6 μ thick	–	+	+	11–12×7–8 ovoid	+	+
onychomysis	*Onychomys leucogaster*	20–21×17–20 M 20×19	Subspherical to ellipsoidal	1 layer, slightly rough, pale tan, 0.5 μ thick	–	+	+	11×8 ovoid	+	+
phyllotis	*Phyllotis amicus amicus* (?)	22–30×12–16 M 26×14	Elongate ellipsoidal	Rose-colored	–	–	–	10–12×3–4	?	+
weissi	*Phyllotis amicus amicus* (?)	16–32×13–24 M 24×19	Ovoid	Reddish, 1.2 μ thick	–	–?	+	10–11×6–7 ellipsoidal	?	+
neotomae	*Neotoma fuscipes*	16–22×13–19 M 22×16 ?	Ellipsoidal	Smooth, transparent	+	?	–	7.5×7 subspherical		?
residua	*Neotoma fuscipes*	22–29×19–26 M 26×22	Subspherical	2 layers: outer v. rough, brown; inner clear, transparent	–	+	+	10×7.5	+	?

operculata	*Neotoma stephensi*	31–33×19–21 M 32×20	Ellipsoidal	1 layer, smooth, pale tan, 1 μ thick	+ (operculum)	–	–	7×6 subspherical	–	–
albigulae	*Neotoma albigula*	19–26×17–23 M 22×20	Spherical to subspherical	2 layers: outer rough, colorless, 1 μ thick; inner pale brownish, 0.5 μ thick	–	+	+	11×9 ovoid	+	+
davisi	*Neotoma albigula*	22–32×21–24 M 28×23	Subspherical to ellipsoidal	2 layers: outer smooth to sl. roughened, colorless to pale brownish yellow, 1.2–1.3 μ thick; inner pale brownish to brownish, 0.4–0.5 μ thick	–	+	+	10–12×7–9 M 11×8 ovoid	+	+
sp. Boyer and Scorza, 1957	*Zygodontomys brevicauda*	21×13					+			+
sp. Boyer and Scorza, 1957	*Zygodontomys brevicauda*	16×12					+			
				Tribe CRICETINI						
criceti	*Cricetus cricetus*	11–22×11–22	Spherical to subspherical		?	?	–	Quite plump	?	?
migratoria	*Cricetulus migratorius*	15–23 M 19	Spherical, subspherical	Smooth, colorless, 1 layer 1.5 μ thick	–	+	–	Ovoid: 6–11×4–9 M 10×7 Spherical: 6–8, M7	–	+

TABLE 8 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
immodulata	*Cricetulus migratorius*	18–24×12–19 M 21×16	Ovoid, ellipsoidal	Smooth, yellow-brown, 1 layer 1.0–1.5 μ thick	–	±	–	Ovoid: 6–10×4–8 M 9×6	–	+
cricetuli	*Cricetulus migratorius*	30–35×24–31 M 33×26	Ovoid	Smooth, colorless, 1 layer 2 μ thick	–	+	–	Ovoid: 10–15×6–11 M 13×9	–	+
jardimlinica	*Cricetulus migratorius*	22–27×16–21 M 24×19	Ovoid, rarely ellipsoidal	Smooth, colorless, 1 layer 1.5 μ thick	–	–	+	Ovoid: 10–13×6–9 M 11×7	–	+
arusica	*Cricetulus migratorius*	20–26 M 23	Spherical, subspherical	Smooth, 2 layers: inner dark brown, 1 μ thick; outer colorless, 1 μ thick	–	–	+	Ovoid: 10–13×6–9 M 11×7	+	+

TABLE 9

EIMERIA OF RODENT SUBFAMILY MICROTINAE (MYOMORPHA; MUROIDEA; MURIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
				Tribe LEMMINI						
dicrostonicis	*Dicrostonyx groenlandicus richardsoni*	27–31×23–27 M 29×25	Ellipsoidal	2 layers: outer rough, pitted, yellowish brown, sl. more than 1 μ thick; inner colorless, 0.5 μ thick	–	+	∓	13–15×7–9 M 14×8 ellipsoidal, sl. pointed at one end	– or tiny	∓
				Tribe MICROTINI						
arvicolae	*Microtus nivalis, Microtus arvalis*	13–28×11–21 M 20×16	Spherical, ovoid	Smooth, clear	–	–	–			–
microtina	*Microtus socialis*	Spherical: M 16 Ovoid: 12–18×11–16 M 16×15	Spherical, sometimes ovoid	Smooth, colorless, 0.8 μ thick	–	–	+	Ovoid: 5–8×4–5 M 7×4	+	+
dzhulfaensis	*Microtus socialis*	Spherical: M 24 Ovoid: 21–25×20–24 M 24×21	Spherical, sometimes ovoid	Rough, 2 layers: outer dark brown, 1.2 μ thick; inner 0.2 μ thick	–	+	+	Ovoid: 11–14×6–9 M 12.5×8	+	+

TABLE 9 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
wenrichi	*Microtus pennsylvanicus*	11–22×8–16	Ellipsoidal to ovoid	1 layer	−	+	−	6–11×4–8 ovoid	+	+
bohemica	*Arvicola terrestris*	19–23×11–13 M 20×12	Ellipsoidal	Pale yellowish brown, smooth, 1 layer	+ 4–4.4 μ	−	+	Ovoid: 9.5×6		+
batabatensis	*Arvicola terrestris*	14–20×10–16 M 19×15	Ovoid	Smooth, 1 μ thick, colorless	−	−	−	Ovoid: 6–8×4–6 M 7×4 Rarely spherical: 4–6, M 6	−	+
terrestris	*Arvicola terrestris*	18–22×12–16 M 21×16	Ovoid, rarely ellipsoidal	Smooth, colorless or light yellow; 2 layers 1.5–2μ thick (outer layer colorless to yellowish, inner layer dark yellow or brown)	+	−	−	Ovoid, rarely spherical 6–8×4–6 M 8×6	−	+
talischaensis	*Arvicola terrestris*	18–22 M 21	Spherical	Smooth, colorless, 2 layers 1.5–2μ thick; inner layer light yellowish brown, outer layer colorless	−	+	−	Spherical: 4–8, M 6 or Ovoid: 4–8×2–8 M 6×5.6	−	+

sp. Ryšavý, 1954	*Microtus arvalis*		Description uncertain							
ondatra-zibethicae	*Ondatra zibethica*	19–28×13–26 M 22×18	Ellipsoidal, spherical, ovoid, or cylindrical	Brownish, very thick, smooth, oc. radially striated, sometimes with 1 end flattened	+ or –		±	12–17×8–11 M 14×10	+	+
rysavyi	*Clethrionomys glareolus*	20–30×17–23 M 25×20	Broadly ellipsoidal, sometimes ovoid, some rather asymmetrical	Pale yellowish brown, smooth, 1 layer, rather thick	–	–	–	Ovoid, ellipsoidal 11–12×6–7	–	+
cernae	*Clethrionomys glareolus*	13–23×11–17	Ellipsoidal	Wall very thin	–	±	–	Ellipsoidal: 9–15×4–7 Spherical: 6	–	–
sp. Ryšavý, 1954 (syn., *E. falciformis* (Eimer) of Ryšavý, 1954 *pro parte*)	*Clethrionomys glareolus*	Description uncertain								
Eimeria (?) sp. Černa and Daniel, 1956	*Clethrionomys glareolus, Apodemus flavicollis*	11–14×10–13	Broadly ovoid to spherical	Very delicate		–		Did not sporulate		
Tribe ELLOBIINI										
ellobii	*Ellobius talpinus*	30×24	Ovoid	2 layers, smooth, greenish, 1.3–1.7 μ thick	–	+	–	9 diam. spherical	Presum. –	+

TABLE 9 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESID-UUM	SIZE (Microns)	STIEDA BODY	RESID-UUM
kazakhstanensis	*Ellobius talpinus*	28×24	Ovoid	1 layer, smooth, colorless (?), 1.6 μ thick	+	+ in unspor. oocyst	–	11–12×7–8 M 12×7 ovoid or piriform		+
talpini	*Ellobius talpinus*	24×24	Spherical	2 layers, smooth, colorless, 1.5 μ thick	–	–	–	11×9 oval		+

TABLE 10

EIMERIA OF RODENT SUBFAMILY GERBILLINAE (MYOMORPHA; MUROIDEA; MURIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
merionis	*Meriones unguiculatus* *M. tamariscinus*	17–23×15–19 M 19×15	Ovoid	Orange, 1 layer 1.0–1.2 μ thick	–	+	+	8–10×6	?	+
markovi	*Meriones tamariscinus*	22–48×21–35 M 32×26	Ovoid	Smooth, greenish- to yellowish green, 1.4–1.6 μ thick	–	–	–	10–16×7–11 M 12×9 ovoid to ellipsoidal		–
tamariscini	*Meriones tamariscinus*	M 19×19	Subspherical	Smooth, greenish, 1.4 μ thick	–	–	–	7×4 ovoid		–
peschankae	*Meriones tamariscinus*	19–27×19–24 M 22×21	Ellipsoidal, subspherical, spherical	Smooth, 1.3–2.1 μ thick, yellow-green or yellow-brown	–	±	–	7–12×6–9 M 9×8 ellipsoidal, spherical		–
assaensis	*Meriones tamariscinus*	25–30×23–26 M 28×25	Subspherical, spherical	Smooth, 1.2–1.4 μ thick, greenish, yellow-green, or yellow-brown	–	+	+	11–13×8–10 M 11.5×9 subspherical, ellipsoidal		–
noraschenica	*Meriones persicus*	16–28×14–26 M 23×21	Ovoid, subspherical	Smooth, colorless to yellowish, 1 μ thick	–	–	–	Ovoid: 6–12×4–10 M 10×7 Spherical: 6–12, M 8	–	+

TABLE 10 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
salasuzica	*Meriones persicus*	22–26×20–24 M 24×21	Ovoid, subspherical	Rough, granulated, with jagged surface, dark brown, 1 layer 1.5 μ thick	–	+	+	Ovoid: 10–13×7–8 M 12×7	+	+
disaensis	*Meriones persicus*	18–24×16–22 M 23×18	Ovoid, subspherical	Smooth, colorless, 1 layer 1.0–1.3 μ thick	+ sometimes with cap	–	–	Ovoid, rarely spherical 8–12×6–10 M 11×9	–	+
lerikaensis	*Meriones persicus*	Ovoid: 14–22×12–20 M 19×16 Spherical: 14–22, M 19	Ovoid, spherical	Smooth, 2 layers: inner one dark yellow or brown, 1.0 μ thick; outer one colorless, 0.5–1.0 μ thick	–	+	–	Spherical: 4–8 M 8 (*sic*) Ovoid: 6–10×4–8 M 9×7	–	+
schachtachtiana	*Meriones shawi*	16–30×14–24 M 24×20	Ovoid, ellipsoidal	Smooth, colorless, 1 layer 1.0–1.25 μ thick	–	+	–	Ovoid, ellipsoidal 6–16×4–10 M 11×8	–	+
nehramaensis	*Meriones shawi*	Subspherical: 14–26×12–24 M 20×18 Spherical: 14–22, M 18	Subspherical, spherical	Smooth, colorless, 1 layer 1 μ thick	–	+	+	Ovoid: 5–12×5–8 M 9×7	+	+

dzhahriana	*Meriones shawi*	Subspherical: 19–23×17–20 M 21×19 Spherical: 17–20, M 19	Spherical, subspherical	Rough, dark brown, 1 layer 1.5 μ thick, tuberculated surface	−	+	+	Ovoid: 6–10×4–6 M 9×5	−	+
araxena	*Meriones shawi*	20–26×16–20 M 23×19	Ovoid	Rough, dark brown, 1 layer 1.5–2.0 μ thick	−	+	+	Ovoid, rarely ellipsoidal 9–13×5–8 M 11×6	−	+
astrachan-bazarica	*Meriones shawi*	15–30×14–26 M 22×19	Subspherical, ovoid, rarely spherical	Smooth: 2 layers, outer colorless, 1 μ thick; inner yellowish, 1 μ thick	−	+	−	Ovoid: 6–14×4–10 M 9×7	−	+
vinogradovi	*Meriones vinogradovi*	16–34×14–30 M 22×19	Ovoid, ellipsoidal	Smooth, colorless, 1 layer 1.0–1.5 μ thick	−	∓	−	Ovoid, ellipsoidal, rarely spherical Ovoid: 6–16×4–12 M 12×9 Spherical: 6–12, M 9	−	+
zulfiaensis	*Meriones vinogradovi*	17–32×16–28 M 25×20	Ovoid	Smooth, colorless, 1 layer 1.0–1.25 μ thick	−	∓	+	Ovoid: 6–13×5–10 M 11×7	+	+
sadaraktica	*Meriones vinogradovi*	18–24×16–22 M 23×19	Ovoid	Smooth, colorless, 1 layer 1.4 μ thick	+	+	−	Ovoid: 6–12×4–8 M 10×7	−	+

TABLE 10 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
jurschuaensis	*Meriones vinogradovi*	30–36×24–30 M 34×27	Ovoid	Rough, dark brown, 1 layer 2.3 μ thick, appearing segmented and containing granules	–	–	+	Ovoid: 12–16×8–12 M 15×10	–	+
musajevi	*Meriones vinogradovi*	21–36×19–30 M 28×25	Ovoid, ellipsoidal	Rough, tuberculated, dark brown, 1 layer 1.5–1.8 μ thick dotted with small granules	–	–	+	Ovoid 8–14×5–11 M 12×9	–	+
tasakendica	*Meriones vinogradovi*	19–26×17–23 M 23×21	Ovoid, ellipsoidal	Rough, colorless, 1 layer 1.2–1.4 μ thick, with cross-striations	–	+	+	Ovoid: 8–13×5–9 M 12×7	+	+
bistratum	*Meriones vinogradovi*	Ovoid: 14–28×12–26 M 20×19 Spherical: 14–24, M 19	Ovoid, spherical	Smooth, 2 layers: outer colorless to light yellow, 1 μ thick; inner yellow-brown, 1 μ thick	–	–	–	Ovoid: 6–12×4–10 M 9×7 Spherical: 4–11, M 10	–	+
arabiana	*Meriones vinogradovi*	16–32×12–26 M 25×20	Ovoid	Smooth, 2 layers: outer colorless, 0.7 μ thick; inner brownish, 1.5 μ thick	–	–	+	Ovoid, piriform 6–14×4–10 M 10×7	–	+

poljanskii	*Meriones vinogradovi*	Ovoid: 30–34×28–32 M 33×32 Spherical: 28–34, M 32	Spherical, ovoid	Rough, colorless, 2 layers: outer with small granules, 0.6 μ thick; inner with small granules and corrugated, 1.6 μ thick	–	–	+	Ovoid 10–14×6–10 M 13×9	+	+
erythrourica	*Meriones libycus*	14–32×12–26 M 21×18	Ovoid, sometimes spherical	Smooth, yellow to crimson, 1 layer 1–2 μ thick	–	+	–	Ovoid: 6–14×4–10 M 9×7 Spherical: 6–10, M 8	–	+
schamchorica	*Meriones libycus*	16–32×14–28 M 24×20.5	Ovoid, rarely spherical	Smooth, colorless to pale yellow-crimson, 1 layer 1–2 μ thick	–	±	+	Ovoid: 6–16×4–10 M 12×8 Spherical: 6–10, M 9	–	+
achburunica	*Meriones libycus*	14–24×12–21 M 20×17	Ovoid	Smooth, colorless, 1 layer 1.0–1.5 μ thick	+	∓	–	Ovoid: 6–10×4–8 M 9×7 Spherical: 6–8, M 8	–	+
sumgaitica	*Meriones libycus*	16–26×14–24 M 22×19	Ovoid, subspherical	Smooth, 1.5–2.0 μ thick, 2 layers, outer bright yellow, inner dark yellow	–	±	–	Ovoid: 6–10×4–8 M 9×7 Spherical (rare): 6–8, M 8	–	+
martunica	*Meriones libycus*	18–34×16–28 M 26×22	Ovoid	Smooth, 2 μ thick, 2 layers, outer bright yellow, inner dark yellow	–	–	+	Ovoid: 8–14×6–10 M 11×8	±	+

TABLE 11

EIMERIA OF RODENT SUBFAMILY TACHYORYCTINAE (MYOMORPHA; MUROIDEA; MURIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
tachyoryctis	*Tachyoryctes ruandae*	M 23×17	Ovoid (ellipsoidal?)	Quite thick, colorless	–		+	12×8		+

TABLE 12

EIMERIA OF RODENT SUBFAMILY MURINAE (MYOMORPHA; MUROIDEA; MURIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
muris	*Apodemus sylvaticus*	21×15	Ovoid, with slight projection at narrow end		+			9×6 ovoid		+
naye	*Apodemus sylvaticus*	18–21×12–14	Cylindroid, one end convex and other flattened		+			6 diam. spherical		+
apionodes	*Apodemus flavicollis*	17–23×13–18 M 20×17	Short, piriform, somewhat tapered at both ends	Smooth, pale, delicate	–	–	– or+	12×8 irregular shape	–	+

apodemi	*Apodemus flavicollis*, *Apodemus sylvaticus*	21–30×15–26 M 24×20	Broadly ellipsoidal, often asymmetrical	2 layers: outer brown; inner lighter	–	–	–			+
rugosa	*Apodemus flavicollis*	23–27×15–19 M 24×16	Piriform	Rather thick, yellowish brown, wrinkled at micropylar end	+	–	+	16×10 slender		+
hungaryensis	*Apodemus flavicollis*, *Apodemus sylvaticus*	17–23×16–19 M 20×18 (*A. flav.*) 14–24×14–16 (*A. sylv.*)	Spherical or subspherical	Quite thick, light yellowish brown, somewhat rough surface	–	–	–	15×9 (*A. flav.*) 9–13×4–8 (*A. sylv.*) pointed at one end	+	+
prasadi	*Apodemus sylvaticus*	26×20	Ovoid	Smooth, 1.6 μ thick	–	+ in unsporul. oocyst	–	9×7		+
svanbaevi	*Apodemus sylvaticus*	24–26×20–22 M 25×21	Ovoid	Smooth, colorless to occas. greenish, 1.6–1.8 μ thick	–	+	–	9–13×7–9 M 10×8 ovoid		–
russiensis	*Apodemus sylvaticus*	22 diam.	Spherical	Smooth, greenish, 1.5–2.0 μ thick	–	+	–	9×9 oval or spherical		–
sp. Ryšavý, 1954 (syn., *E. falciformis* (Eimer) of Ryšavý, 1954)	*Apodemus sylvaticus*, *Apodemus flavicollis*	Description uncertain								

TABLE 12 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
Eimeria sp. of Ryšavý, 1954 (syn., *Eimeria keilini* Yakimoff and Gousseff of Ryšavý, 1954)	*Apodemus sylvaticus*, *Apodemus flavicollis*	24–29×16–20	Ellipsoidal, narrow at both ends	1 layer, thin, transparent, colorless	–			8–9×6–7		
Eimeria (?) sp. of Ryšavý, 1954 (syn., *Eimeria hindlei* Yakimoff and Gousseff of Ryšavý, 1954)	*Apodemus sylvaticus*	23–27×18–20 M 25×18	Ovoid	1 layer, thin, pale yellow	–			Did not sporulate		
Eimeria (?) sp. Černa and Daniel, 1956	*Apodemus flavicollis*, *Clethrionomys glareolus*	11–14×10–13	Broadly ovoid to spherical	Very delicate	–			Did not sporulate		
vinckei	*Thamnomys surdaster surdaster*	20–24×12–15 M 22×13	Cylindroid	Thin, colorless	–		–	7×14		+
dasymysis	*Dasymys incomptus rufulus*	17–23×15–21 M 20×17	Subspherical, ellipsoidal, sometimes sl. ovoid	1 layer, smooth, colorless to pale yellowish, 0.8 μ thick	–	+	–	10–11×6 sl. ovoid	+	+

arvicanthis	*Arvicanthis abyssinicus rubescens*	23–24×10–14	Ovoid (ellipsoidal?)	Thin, rose-colored			+	10–11×7		+
putevelata	*Lemniscomys s. striatus*	22–30×17–22 M 26×20	Ovoid	2 layers: outer thick, with small pits, yellow; inner thin	−	+	−	10–13×8–10 M 12×8 ovoid	+ small	+
lemniscomysis	*Lemiscomys s. striatus*	27–30×18–19 M 28×19	Broadly spindle-shaped with somewhat flattened ends	1 layer 1.2 μ thick at sides and 0.8 μ thick at ends, moderately rough and pitted, brownish yellow, with thin lining membrane	−	+	−	16×8 elongate ovoid, pointed at one end	± small if present	+
miyairii	*Rattus norvegicus*, *Rattus rattus* (?)	17–29×16–26 M 24×22	Spherical to subspherical	Prob. 2 layers, thick, rough, radially striated, yellowish brown	−	−	−	16–18×9–10		+
nieschulzi	*Rattus norvegicus*, *Rattus rattus*, *Rattus hawaiiensis*	16–26×13–21 M 23×18	Ovoid, tapering toward both ends	1 layer about 1.1 μ thick, smooth or granular, yellowish	−	+	−	11–12×7 elongate ovoid	+	+
separata	*Rattus norvegicus*, *Rattus rattus* (?) *Rattus (Dephomys) defua*, *Rattus hawaiiensis*	10–19×10–17 In *R. defua:* 16–21×15–17 M 18×16 In *R. hawaiiensis:* 12–16×10–13 M 14×12	Ellipsoidal, ovoid, subspherical	1 layer, smooth, colorless to pale yellowish	−	+	−	In *R. defua:* 11×7, almost ellipsoidal In *R. hawaiiensis:* 9×5, almost ellipsoidal	+	+

TABLE 12 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
hasei	*Rattus rattus*	Spherical: 12–24, M 16 Others: 16–20×12–17	Ovoid, ellipsoidal, or spherical	1 layer, smooth	–	+	–	9×5		–
nochti	*Rattus rattus, Rattus norvegicus* (?)	15–24×12–22 M 17×14	Ovoid	1 layer (?), smooth	–	–	–			–
ratti	*Rattus rattus*	16–28×15–16 M 23×15	Cylindrical to ovoid	1 layer (?), smooth	–	+	–			+
praomysis	*Rattus (Praomys) tullbergi rostratus*	17–24×16–23 M 21×20	Subspherical to ellipsoidal	1 layer, 1μ thick, smooth to somewhat rough, pale yellowish to brownish	–	+	–	10–12×6–7 M 11×7 ellipsoidal to sl. ovoid	+	+
falciformis	*Mus musculus*	14–26×11–24	Broadly ovoid, subspherical, spherical	1 layer (?), smooth, colorless	–	±	–	10–12×6–8	+	+
hindlei	*Mus musculus*	22–27×18–21	Ovoid	Smooth	–	+	–	Ovoid		?
keilini	*Mus musculus*	24–32×18–21 M 29×19	Pointed at both ends	Smooth, yellowish	–	–	–	12×6		?
krijgsmanni	*Mus musculus*	18–23×13–16 M 22×15	Ellipsoidal, "oval"	Smooth, colorless or yellowish	–	+	–	Ovoid		?

musculi	*Mus musculus*	21–26	Spherical	Smooth, greenish	–	–	–	Broadly ovoid		?
schueffneri	*Mus musculus*	18–26×15–16	Cylindrical, with rounded ends	Smooth, colorless	–	–	–	Ovoid		?
hansonorum	*Mus musculus*	15–22×13–19 M 18×16	Subspherical	1 layer 0.8 μ thick, smooth, pale yellowish	–	+	–	9×7 ovoid, thick-walled	+	+
ferrisi	*Mus musculus*	17–20×14–16 M 18×15	Ellipsoidal to subspherical	1 layer 0.9 μ thick, smooth, colorless to very pale yellowish	–	+	–	10–11×5–6 elongate ovoid	+	∓
musculoidei	*Mus (Leggada) musculoides*	17–22×15–19 M 20×17	Subspherical to ellipsoidal	1 layer, 1 μ thick, smooth, pale yellowish to yellowish brown	–	+	–	10–12×7 M 10×7 lemon-shaped	∓	+
lophuromysis	*Lophuromys s. sikapusi*	19–23×13–15 M 21×14	Ellipsoidal to ovoid	1 layer, 0.8 μ thick, smooth, yellowish to brownish yellow	–	±	–	11×6–7 elongate ellipsoidal to sl. ovoid	+ tiny	–
sikapusii	*Lophuromys s. sikapusi*	20–23×15–18 M 21×17	Subspherical to ellipsoidal	1 layer, 1 μ thick, smooth, to sl. pitted, pale yellowish	–	+	–	10–12×7–8 football-shaped	–	+
liberiensis	*Lophuromys s. sikapusi*	20–27×14–20 M 21×17	Ellipsoidal	1 layer, 0.9 μ thick, smooth, pale yellowish	–	+	–	10×5 ellipsoidal	–	+

TABLE 12 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
harbelensis	*Lophuromys s. sikapusi*	32 · 23	Ovoid	2 layers, both yellowish-brown: inner ellipsoidal, 1.5 μ thick at 1 end decreasing to 0.9 μ at other end; outer 1 μ thick around ⅔ of oocyst, disappearing anteriorly	?	–	–	14×8 football-shaped	+	+
africana	*Lophuromys s. sikapusi*	14–21×11–16 M 17×14	Subspherical to ellipsoidal	1 layer, 0.9 μ thick, smooth, colorless to pale yellowish	–	+	–	8–11×6 M 10×6 ovoid	+ small	+
kruidenieri	*Lophuromys s. sikapusi*	27–31×19–21 M 29×19	Ellipsoidal, but narrowed and flattened at both ends, sometimes asymmetrical	1 layer, 1.3 μ thick, at sides, 0.6–0.7 μ at both ends, sl. to mod. rough, sometimes pitted, yellowish brown	–	+	–	15×8 elongate ovoid, rounded at 1 end, truncate at other	–	±
schoutedeni	*Cricetomys dissimilis*	14–15×11–13	Ovoid	1 layer (?), 0.5 μ thick, whitish	–	Fine powder	+	7×6	–	+

sp. Fantham, 1926	*Rattus (Mastomys) coucha*	16–21×15–16	Oval			
sp. Fantham, 1926	*Tatera lobengulae*	15–17×10–13		Thin-walled, frail		
Eimeria (?) sp. of Yakimoff, Gousseff, & Suz'ko, 1945 (syn., *E. halli* (?))	*Nesokia indica huttoni*	22–31×15–23 M 26×20	Ovoid	Colorless	—	Did not sporulate

TABLE 13

EIMERIA OF RODENT FAMILY MUSCARDINIDAE (MYOMORPHA; GLIROIDEA)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
gliris	*Glis glis*	14–23×12–17 M 21×16	Ovoid	Smooth, 2 layers each 1.25 μ thick, inner dark brown, outer yellowish	–	+	–	Ovoid: 6–10×4–8 M 9×7	–	+
myoxi	*Eliomys quercinus*	18×15	Ovoid	Relatively thin at micropylar end	+			7.5×6 ovoid		
dyromidis	*Dryomys nitedula*	16–30×13–24 Spherical 15–25	Ovoid, rarely spherical	Smooth, colorless, 1 layer 1 μ thick	–	±	–	Ovoid 7–14×6–9	–	+
nachit-schevanica	*Dryomys nitedula*	20–26×17–20 M 24×19	Ovoid	Smooth, colorless, 1 layer 1.3 μ thick	+ capped	–	–	Ovoid: 10–13×6–9 M 12×7	+	+

TABLE 14

EIMERIA OF RODENT FAMILY DIPODIDAE (MYOMORPHA; DIPODOIDEA)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
allactagae	*Allactaga major*, *Allactaga elator*	22–26 [a] M 24 [a] 22×18 [b]	Spherical [a] Ovoid [b]	1 layer, uniform, thick, smooth,[b] colorless [b]	–	+	– [b]	9×7 [b] oval [b]		–
lavieri	*Allactaga major*	17–18	Spherical	Yellowish orange	–	–	–	9×8 broadly oval (illustrated as ellipsoidal)		+
joyeuxi	*Allactaga major*	24–28×21 M 26×21	Subspherical	Yellow	–	–	+	14×11 broadly ovoid		–

[a] Spherical forms described by Iwanoff-Gobzem (1934) from the type host, *A. major*.
[b] Ovoid forms described by Svanbaev (1956) from *A. elator*.

TABLE 15

EIMERIA OF RODENT SUBFAMILY CAVIINAE (HYSTRICOMORPHA; CAVIOIDEA; CAVIIDAE)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
caviae	*Cavia porcellus, Cavia aperea*	13–26×12–23	Ovoid, ellipsoidal, subspherical	2 layers, smooth, often brownish	–	–	+	11–13×6–7		+

TABLE 16

EIMERIA OF RODENT SUBFAMILY DOLICHOTINAE (HYSTRICOMORPHA; CAVIOIDEA; CAVIIDAE)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
dolichotis	*Dolichotis p. patagonum*	16–27×14–22 M 21×18	Subspherical to ellipsoidal	1 layer, smooth, colorless	–	–	–	11×7	+	+

TABLE 17

EIMERIA OF RODENT FAMILY HYDROCHOERIDAE (HYSTRICOMORPHA; CAVIOIDEA)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
capibarae	*Hydrochoerus hydrochoerus*	25–33×20–28 M 30×26	Ovoid, ellipsoidal	2 μ thick, with fine radial striations, yellowish	–	–	–	14–15×8 ovoid	+	+
hydrochoeri	*Hydrochoerus hydrochoerus*	20–22×16–18	Ovoid	1 layer, 0.8 μ thick, smooth, colorless	–	–	–	10–11×6–7 ovoid	+	+

TABLE 18

EIMERIA OF RODENT SUBFAMILY CUNICULINAE (HYSTRICOMORPHA; CAVIOIDEA; DASYPROCTIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
E. (?) noelleri	*Cuniculus paca*	19 diam.	Spherical	No sporulated oocysts seen						

TABLE 19

EIMERIA OF RODENT SUBFAMILY DASYPROCTINAE (HYSTRICOMORPHA; CAVIOIDEA; DASYPROCTIDAE)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
paraensis	*Dasyprocta aguti*	33–40×30–35	Spherical or sl. ovoid	2 layers, 2 μ thick, brownish yellow: outer layer rough, punctate; inner radially striated	–	–	–	20×11 ovoid	+	+
cotiae	*Dasyprocta aguti*	28–29×18	Ovoid, ellipsoidal	1 layer, sl. striated, sometimes quite thick, v. sl. rough and pale brownish yellow, sometimes thinner, smooth, colorless	–	–	–	13×8–9 ovoid	+	+
aguti	*Dasyprocta aguti*	16–17	Spherical	Thin, smooth, colorless	–	–	–	10×6	+?	+

TABLE 20

EIMERIA OF RODENT FAMILY ECHIMYIDAE (HYSTRICOMORPHA; OCTODONTOIDEA)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
myopotami	*Myocastor coypus*	22–27×18–23 15–33×12–28 [a] 21–26×12–17 [b] M 23×14 [b]	Ovoid, sometimes ellipsoidal, subspherical, or spherical	Smooth, yellowish brown, 2 or 3 layers, outer one thin	–	–	–	9–12×6 [a] pointed at 1 end [a] Ovoid: 7–11×4–6 [b] M 9×5 [b]	+?	+
pellucida	*Myocastor coypus*	30–40×20–23 28–31×16–19 [a] 21–33×12–16 [c]	Ovoid or almost cylindroid, bean-shaped [c]	2 layers, smooth, pale lilac or colorless	+		– [c]	Piriform [c] 9×6 [c]		+ [c]
coypi	*Myocastor coypus*	21–26×12–16 M 23×15 12.5–17.5 diam. [a]	Ovoid Spherical [a]	1 layer, thick, transparent, presumably smooth (fragile [a])	–	+	–	9–12×5–7 M 11×6 ellipsoidal	–	+
seideli	*Myocastor coypus*	38–45 diam. or 45–48×38–42	Spherical or subspherical	3 layers 2–5 μ thick; outer layer thin whitish; middle light to dark brown, almost opaque, thick, v. rough; inner colorless, thin	–	–	–	26–29×13 piriform to ovoid	+	+

TABLE 20 (*Continued*)

Eimeria SPECIES	HOSTS	OOCYST CHARACTERS						SPOROCYST CHARACTERS		
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM	SIZE (Microns)	STIEDA BODY	RESIDUUM
nutriae	*Myocastor coypus*	19–23×15–18 M 20×16	Broadly ovoid or subspherical	Pitted, yellowish, 1 layer	–	+	–	Ovoid: 10–12×4–6 M 11×5	–	+
myocastori	*Myocastor coypus*	13–15×11–13 M 14×12	Broadly ovoid	Smooth, colorless, 2 layers, the outer thinner than the inner	+	–	–	Cigar-shaped 9–11×3–5 M 10×4	–	+

[a] According to Seidel (1956).
[b] According to Prasad (1960).
[c] According to Pellérdy (1960).

TABLE 21

EIMERIA OF RODENT FAMILY BATHYERGIDAE (HYSTRICOMORPHA; BATHYERGOIDEA)

Eimeria Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
heterocephali	*Heterocephalus glaber*		Ovoid		−					+

TABLE 22

ISOSPORA OF RODENTS

Isospora Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
citelli	*Spermophilus variegatus*	22–23×21–22	Subspherical	2 layers, smooth, v. pale tan, outer 1 μ thick, inner 0.4 μ thick	–	+	–	15×10 broadly lemon-shaped	+	+
freundi	*Cricetus cricetus*	Spherical: 13–24 M 20 Subspherical: 20–27×17–24	Spherical, subspherical	Smooth	–	–	–	14×8–9	–	–
teres	*Lagurus lagurus*	24–36	Spherical		–	+	–	16–21×8–13		–
laguri	*Lagurus lagurus*	24–32×16–22	Ovoid	Thick	–	–	+	16–21×8–13		–
laguri (?)	*Spermophilus maximus*	18–29×18–24 M 23.5×21	Ellipsoidal, subspherical, spherical	Smooth, 1.5–2.0 μ thick, greenish, yellow-green, or brown	–	–	+	8–13×7–11 M 10×6.4 [*sic*] ellipsoidal, spherical		
laguri	*Meriones tamariscinus*	21–30×20–26 M 27×20 [*sic*]	Ellipsoidal, subspherical	Smooth, 1.5–1.9 μ thick, yellow-green	–	–	+	12–14×7–10 M 13×9 ellipsoidal, ovoid		–

mcdowelli	*Microtus pennsylvanicus*	9–11×8–10 M 10×9	Subspherical	1 layer	–	–	–	6–8×4–5 M 7×5 ellipsoidal		+
batabatica	*Arvicola terrestris*	20–24×19–21 M 23×21	Subspherical or ovoid	Smooth, colorless, 1 layer, 1 μ thick	–	–	–	Ovoid: 9–14×6–9 M 13×8	+	+
ordubadica	*Meriones persicus*	18–20×14–18 M 20×17	Ovoid, subspherical	Smooth, colorless, 1 layer	–	–	–	Ovoid: 10–12×8–10 M 12×10	–	+
uralicae	*Apodemus sylvaticus*	26.4×22.5	Ovoid	Smooth, greenish, 1.6 μ thick, 1 layer (?)	–	+	–	13.8×9.1 ovoid	–	–
ratti	*Rattus norvegicus*	22–24×20–21	Subspherical	1 layer, smooth, pale tan to tan, 1 μ thick	–	+	–	16×11 asymmetrically broadly ovoid	+	+

TABLE 23

DORISIELLA OF RODENTS

Dorisiella Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
arizonensis	*Neotoma lepida*	21–28×21–22 M 22×21	Spherical to subspherical	2 layers: outer smooth, 1 μ thick, colorless; inner 0.5 μ thick, pale tan	–	+	–	11–13×9–10 M 13×9 lemon-shaped, thin-walled	+	+

TABLE 24

WENYONELLA OF RODENTS

Wenyonella Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
hoarei	*Sciurus* sp.	14–18.5	Spherical		–	–	–	10×8 ovoid	+	+
uelensis	*Funisciurus anerythrus*	26–30×19–20	Ovoid to ellipsoidal	Thick	–	–	+ disappears later	11×8 ellipsoidal	–	+
parva	*Tamiscus emini*	15×13	Subspherical	2 layers, thick	–	–	–	8×5 ellipsoidal	–	–

TABLE 25

CARYOSPORA OF RODENTS

Caryospora Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
microti	*Microtus pennsylvanicus*	9–11×8–10 M 10×9	Spherical to subspherical	1 layer	–	–	–	7–9×6–7 M 7×6.5 spherical to subspherical	–	+

TABLE 26

TYZZERIA OF RODENTS

Tyzzeria SPECIES	HOSTS	OOCYST CHARACTERS					
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM
peromysci	*Peromyscus maniculatus*	11–14×9–11 M 13×10	Ellipsoidal	1 layer, smooth, v. pale yellowish, 0.6 μ thick	−	+	−
peromysci	*Peromyscus leucopus*	14–17×11–12 M 15×11	Ellipsoidal	1 layer, smooth, v. pale yellowish, 0.6 μ thick	−	+	+

TABLE 27

CRYPTOSPORIDIUM OF RODENTS

Cryptosporidium SPECIES	HOSTS	OOCYST CHARACTERS					
		SIZE (Microns)	SHAPE	WALL	MICROPYLE	POLAR GRANULE	RESIDUUM
muris	*Mus musculus*	7×5	Ovoid, ellipsoidal, or spherical, with knoblike attachment organ	1 layer, smooth	−		+
parvum	*Mus musculus*	4–5×3	Ovoid or spherical, with knoblike attachment organ	1 layer, smooth	−		+

TABLE 28

KLOSSIA OF RODENTS

Klossia Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
perplexens	*Peromyscus maniculatus*	42–53×35–44 M 48×40	Ellipsoidal	2 layers: outer colorless, transparent, smooth, 2 μ thick; inner pale brown, 0.5 μ thick	–	–	+	13–14 M 13.3 spherical	–	+

TABLE 29

KLOSSIELLA OF RODENTS

Klossiella Species	Hosts	Oocyst Characters						Sporocyst Characters		
		Size (Microns)	Shape	Wall	Micropyle	Polar Granule	Residuum	Size (Microns)	Stieda Body	Residuum
muris	*Mus musculus*	Up to 40 μ diameter (probably no	Irregular	true oocyst exists)			+	16×13 subspherical to spherical	–	+
cobayae	*Cavia porcellus, Cavia aperea*	30–40 (probably no true oocyst exists)	Irregular				+			
sp. (Hartmann and Schilling, 1917)	*Jaculus jaculus*	Not described								

TABLE 30

NAMED SPECIES OF *EIMERIA* IN RODENTS

Rodent Family	No. Rodent Genera[a]	No. Rodent Species[a]	No. *Eimeria* Species Described	Rodent Genera from Which *Eimeria* Has Been Described		Rodent Species from Which *Eimeria* Has Been Described	
				No.	Per Cent	No.	Per Cent
Bathyergidae	5	53	1	1	20	1	2
Echimyidae	28	152	6	1	4	1	1
Dinomyidae	1	1	0	0		0	
Erethizontidae	4	29	0	0		0	
Dasyproctidae	2	29	4	2	100	2	7
Hystricidae	4	28	0	0		0	
Cuniculidae	1	2	0	0		0	
Chinchillidae	3	7	0	0		0	
Caviidae	5	22	2	2	40	3	14
Hydrochoeridae	1	2	2	1	100	1	50
Aplodontiidae	1	1	0	0		0	
Sciuridae	44	386	39	10	23	26	7
Castoridae	1	4	1	1	100	1	25
Heteromyidae	5	103	6	3	60	7	7
Geomyidae	9	96	2	2	22	2	2
Anomaluridae	4	9	0	0		0	
Pedetidae	1	2	0	0		0	
Ctenodactylidae	4	8	0	0		0	
Dipodidae	15	50	3	1	7	2	4
Muscardinidae	9	54	4	3	33	3	6
Lophiomyidae	1	1	0	0		0	
Spalacidae	1	8	0	0		0	
Rhizomyidae	2	8	0	0		0	
Muridae	186	1633	106	25	13	46	3
(Subf. Murinae)	(71)	(608)	(37)	(9)	(13)	(15)	(2)
(Subf. Rhynchomyinae)	(1)	(1)	0	0		0	
(Subf. Hydromyinae)	(7)	(8)	0	0		0	
(Subf. Dendromyinae)	(5)	(52)	0	0		0	
(Subf. Deomyinae)	(1)	(1)	0	0		0	
(Subf. Otomyinae)	(2)	(28)	0	0		0	
(Subf. Cricetinae)	(54)	(499)	(25)	(8)	(15)	(15)	(3)
(Subf. Gymnuromyinae)	(1)	(1)	0	0		0	
(Subf. Tachyoryctinae)	(2)	(16)	(1)	(1)	(50)	(1)	(6)
(Subf. Gerbillinae)	(12)	(145)	(28)	(1)	(8)	(6)	(4)
(Subf. Myospalacinae)	(1)	(13)	0	0		0	
(Subf. Microtinae)	(29)	(261)	(15)	(6)	(21)	(9)	(3)
Total	337	2688	176	52	15	95	4

[a] Based on a count of genera and species listed by Ellerman, J. R. 1940–1941. The families and genera of living rodents. London, Brit. Mus. (Nat. Hist.). 2 vol., xxvi + 689, xii + 690 pp.

TABLE 31

MORPHOLOGICAL CHARACTERISTICS OF OOCYSTS OF *EIMERIA* SPECIES FROM DIFFERENT RODENT FAMILIES

Rodent Family	Numbers of *Eimeria* Species With or Without Designated Characters									
	Micropyle		Polar Granule		Oocyst Residuum		Stieda Body		Sporocyst Residuum	
	+	−	+	−	+	−	+	−	+	−
Sciuridae	15	27	17	16	12	26	19	11	30	4
Geomyidae	1	1	0	2	0	2	1	1	2	0
Heteromyidae	0	6	3	3	4	2	5	1	6	0
Castoridae	0	1	1	0	1	0	0	1	0	0
Muridae	12	92	63	33	41	64	42	32	89	12
Cricetinae	(2)	(24)	(18)	(7)	(17)	(11)	(18)	(5)	(24)	(1)
Microtinae	(4)	(11)	(6)	(6)	(5)	(9)	(5)	(5)	(13)	(2)
Gerbillinae	(3)	(24)	(17)	(10)	(14)	(14)	(6)	(17)	(24)	(4)
Murinae	(3)	(32)	(22)	(10)	(4)	(30)	(13)	(5)	(27)	(5)
Tachyoryctinae	(0)	(1)			(1)	(0)			(1)	(0)
Muscardinidae	2	2	2	1	0	3	1	2	3	0
Dipodidae	0	3	1	2	1	2			1	2
Caviidae	0	2	0	2	1	1	1	0	2	0
Hydrochoeridae	0	2	0	2	0	2	2	0	2	0
Dasyproctidae	0	3	0	3	0	3	2	0	3	0
Echimyidae	2	4	2	3	0	6	2	3	6	0
Bathyergidae	0	1							1	0
Total	32	144	89	67	60	111	75	51	148	18
Per cent of total for each character	18	82	57	43	35	65	60	40	89	11

TABLE 32

SUMMARY OF CROSS-INFECTION EXPERIMENTS WITH *EIMERIA* IN RODENTS

Eimeria SPECIES	DONOR HOST	RECEPTOR HOST	RESULT	REFERENCE
sciurorum	*Sciurus vulgaris*	*Rattus norvegicus*	—	Galli-Valerio, 1922
mira	*Sciurus vulgaris*	*Spermophilus citellus*	—	Pellérdy, 1954
		Glis glis	—	
moelleri	*Sciurus carolinensis*	European domestic squirrel (*Sciurus vulgaris* ?)	+	Möller, 1923
cynomysis	*Cynomys ludovicianus*	Domestic cat	—	Andrews, 1927
citelli	*Spermophilus tridecemlineatus*	*Rattus norvegicus*	—	Kartchner and Becker, 1930
		Mus musculus	—	
petauristae	*Petaurista inornatus*	Indian rabbit	—	Ray and Singh, 1950
mohavensis	*Dipodomys panamintinus mohavensis*	*Dipodomys panamintinus leucogenys*	+	Doran, 1951, 1953
		Dipodomys p. panamintinus	+	
		Dipodomys p. caudatus	+	
		Dipodomys m. merriami	+	
		Dipodomys brevinasus	+	
		Dipodomys heermanni morroensis	+	
		Dipodomys h. tularensis	+	
		Dipodomys h. swarthi	+	
		Dipodomys d. deserti	+	
		Dipodomys a. agilis	+	
		Perognathus longimembris	—	
		Perognathus formosus mohavensis	—	
		Peromyscus boylii	—	
		Peromyscus maniculatus	—	
		Peromyscus californicus	—	
		Peromyscus truei	—	
		Onychomys torridus	—	
		Neotoma lepida	—	
		Spermophilus leucurus	—	
		Mus musculus	—	
		Rattus norvegicus	—	
leucopi	*Peromyscus leucopus*	*Peromyscus nuttalli*	—	Von Zellen, 1961
tachyoryctis	*Tachyoryctes ruandae*	*Rattus norvegicus*	—	van den Berghe and Chardome, 1956
		Mus musculus	—	
apionodes	*Apodemus flavicollis*	*Mus musculus*	—	Pellérdy, 1954
		Microtus arvalis	—	
		Clethrionomys glareolus	—	
		Cricetus cricetus	—	

TABLE 32 (*Continued*)

Eimeria SPECIES	DONOR HOST	RECEPTOR HOST	RESULT	REFERENCE
apodemi	*Apodemus flavicollis*	*Mus musculus*	—	Pellérdy, 1954
		Microtus arvalis	—	
		Clethrionomys glareolus	—	
		Cricetus cricetus	—	
rugosa	*Apodemus flavicollis*	*Mus musculus*	—	Pellérdy, 1954
		Microtus arvalis	—	
		Clethrionomys glareolus	—	
		Cricetus cricetus	—	
hungaryensis	*Apodemus flavicollis*	*Mus musculus*	—	Pellérdy, 1954
		Microtus arvalis	—	
		Clethrionomys glareolus	—	
		Cricetus cricetus	—	
vinckei	*Thamnomys s. surdaster*	*Rattus norvegicus*	—	Rodhain, 1954
		Mus musculus	—	
nieschulzi	*Rattus rattus*	*Rattus norvegicus*	+	Dieben, 1924
	Rattus norvegicus	*Rattus rattus*	+	Dieben, 1924
		Mus musculus	—	
		Cavia porcellus	—	
		Oryctolagus cuniculus	—	
	Rattus norvegicus	*Mus musculus*	—	Pérard, 1926
		Oryctolagus cuniculus	—	
falciformis	*Mus musculus*	*Rattus norvegicus*	—	Nöller, 1920
		Canis familiaris	—	
	Mus musculus	*Rattus norvegicus*	—	Pérard, 1926
oryzomysi	*Oryzomys* sp.	*Mus musculus*	—	Carini, 1935
phyllotis	*Phyllotis a. amicus* (?)	*Mus musculus*	—	Gonzales-Mugaburu, 1942
		Rattus norvegicus	—	
weissi	*Phyllotis a. amicus* (?)	*Mus musculus*	—	Gonzales-Mugaburu, 1946
		Cavia porcellus	—	
dolichotis	*Dolichotis patagonum*	*Cavia porcellus*	—	Zwart and Strik, 1961

PLATES

Plate 1

Figs. 1–4. *Eimeria sciurorum* Galli-Valerio, 1922. Oocysts from *Sciurus vulgaris* (from Yakimoff, Sokoloff, and Rastegaieff, 1931). × 1300.

Figs. 5 and 6. *Eimeria serbica* Pop-Cenitch and Bordjochki, 1957. Oocysts from *Sciurus vulgaris* (?) (from Pop-Cenitch and Bordjochki, 1957). × 1300.

Figs. 7 and 8. *Eimeria neosciuri* Prasad, 1960. Oocysts from *Sciurus carolinensis* (from Prasad, 1960). × 1700.

Fig. 9. *Eimeria neosciuri* Prasad, 1960. Oocyst from *Sciurus vulgaris* (from Ryšavý, 1954). × 1700.

Figs. 10–14. *Eimeria neosciuri* Prasad, 1960 from *Sciurus carolinensis* (from Prasad, 1960). × 900.

10. Young schizont in intestinal cell.
11. Schizont containing 13 nuclei in intestinal cell.
12. Schizont containing merozoites in intestinal cell.
13, 14. Developing macrogametes in intestinal cells.

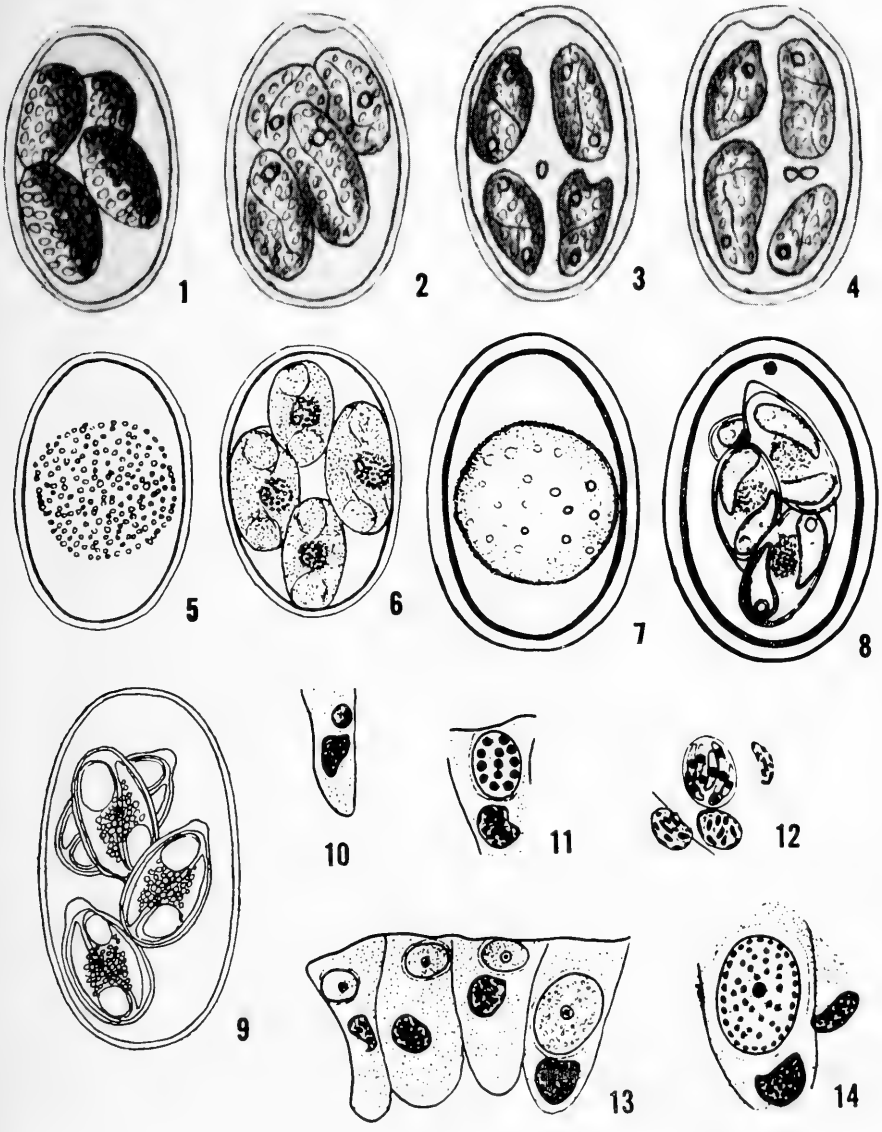
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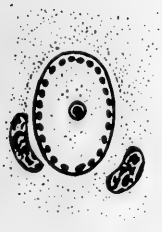
Plate 2

Figs. 15 and 16. *Eimeria neosciuri* Prasad, 1960 from *Sciurus carolinensis* (from Prasad, 1960). × 900.

15. Mature macrogamete showing plastic granules.
16. Mature microgametocyte containing microgametes.

Figs. 17–24. *Eimeria ascotensis* n. sp. from *Sciurus carolinensis* (from Webster, 1960). × 2600.

17. Undifferentiated young stages in intestinal cells.
18. Schizont containing merozoites.
19. Endogenous oocyst.
20. Microgametocyte containing microgametes.
21. Mature macrogamete.
22. Unsporulated oocyst.
23. Developing oocyst.
24. Sporulated oocyst.



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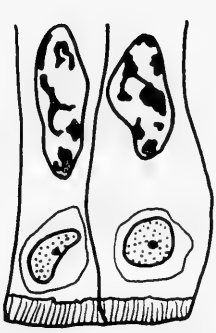

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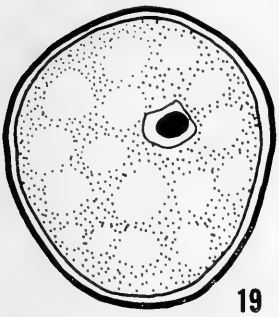

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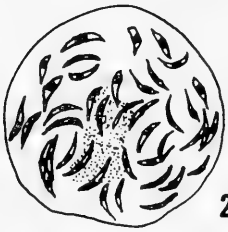

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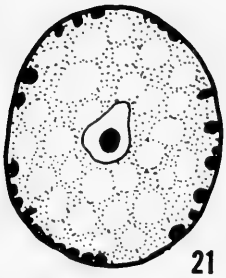

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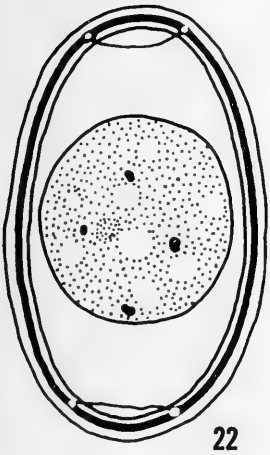

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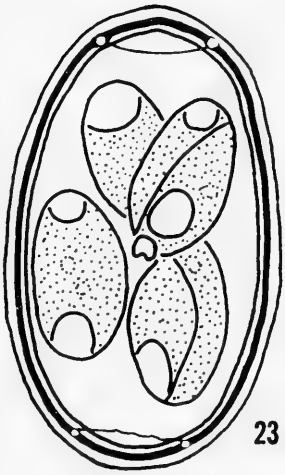

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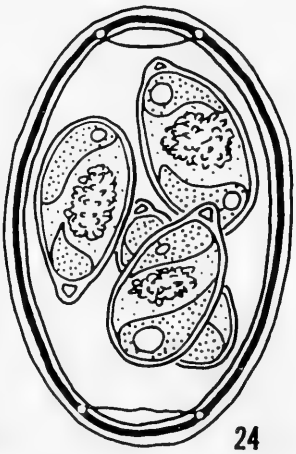

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Plate 3

Figs. 25–27. *Eimeria kniplingi* n. sp. Oocysts from *Sciurus niger rufiventer* (from Knipling and Becker, 1935). × 2200.

Fig. 28. *Eimeria sp.* Bond and Bovee, 1957. Oocyst from *Sciurus carolinensis* (from Bond and Bovee, 1957). × 1400.

Fig. 29. *Eimeria tamiasciuri* Levine, Ivens, and Kruidenier, 1957. Oocyst from *Tamiasciurus hudsonicus* (from Levine, Ivens, and Kruidenier, 1957). × 2650.

Fig. 30. *Eimeria toddi* Dorney, 1962. Oocyst from *Tamiasciurus hudsonicus* (from Dorney, 1962). × 1200.

Figs. 31–35. *Eimeria garnhami* McMillan, 1958 from *Xerus erythropus* (from McMillan, 1958).

31. Mature schizont with merozoites. × 600.
32. Nearly mature microgametocyte. × 1800.
33. Nearly mature macrogamete. × 1700.
34. Intracellular zygote. No measurements.
35. Undifferentiated oocyst from fresh feces. × 1900.

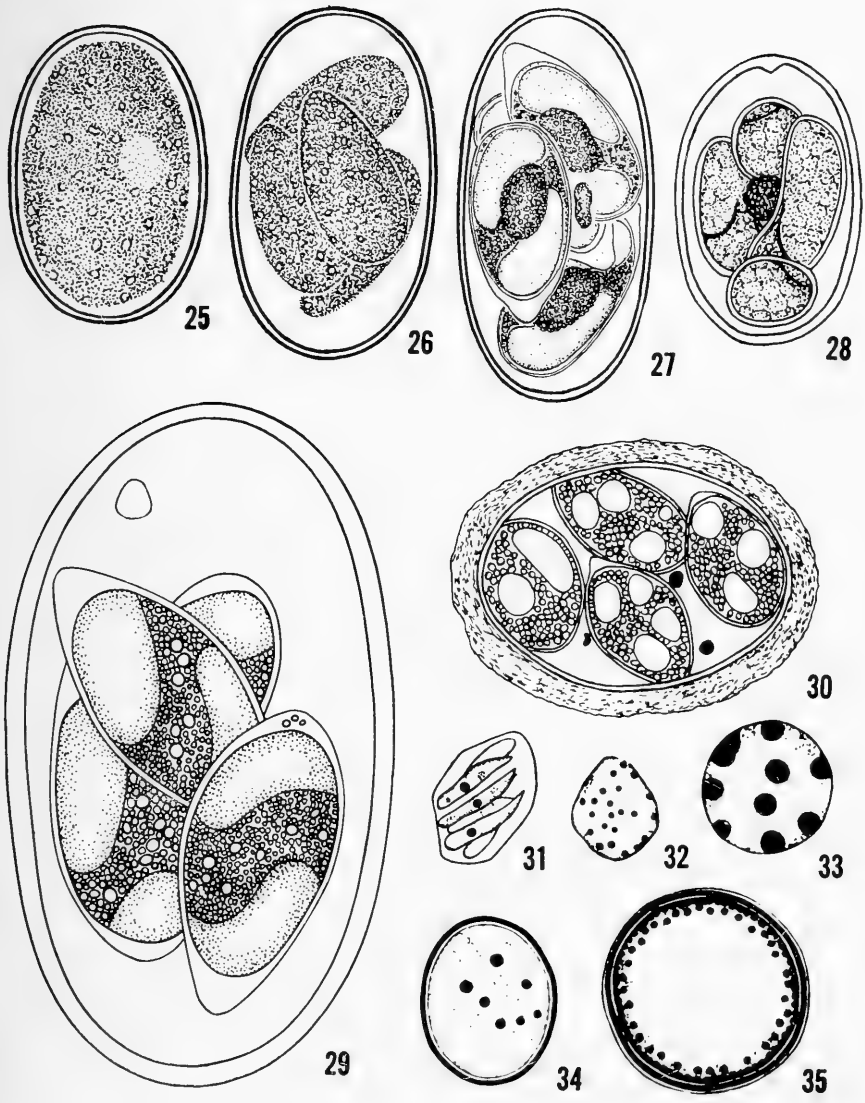
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Plate 4

Figs. 36 and 37. *Eimeria garnhami* McMillan, 1958 from *Xerus erythropus* (from McMillan, 1958). × 1800.

36. Undifferentiated oocyst 90 days old.

37. Sporulated oocyst.

Figs. 38 and 39. *Eimeria monacis* Fish, 1930. Oocysts from *Marmota monax* (from Fish, 1930). × 2000.

Fig. 40. *Eimeria cynomysis* Andrews, 1928. Oocyst from *Cynomys ludovicianus* (from Andrews, 1928). × 1500.

Figs. 41–44. *Eimeria citelli* Kartchner and Becker, 1930 from *Spermophilus tridecemlineatus* (from Kartchner and Becker, 1930). × 2040.

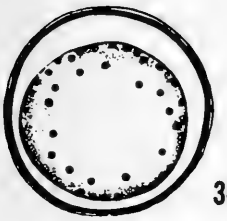
41. Unsegmented oocyst from fresh feces.

42. Oocyst with sporocyst prior to formation of sporozoites but showing refractile bodies.

43. Sporulated oocyst.

44. Section of an infected cecal wall showing gametes and gametocytes within cells of glands.

Fig. 45. *Eimeria glaucomydis* Roudabush, 1937. Oocyst from *Glaucomys volans* (from Roudabush, 1937). × 1900.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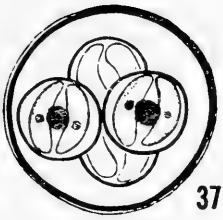
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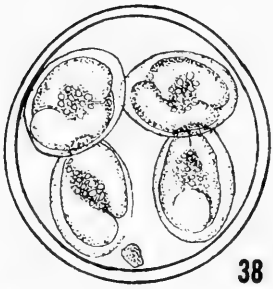
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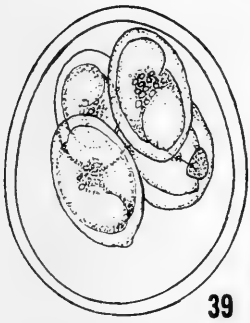
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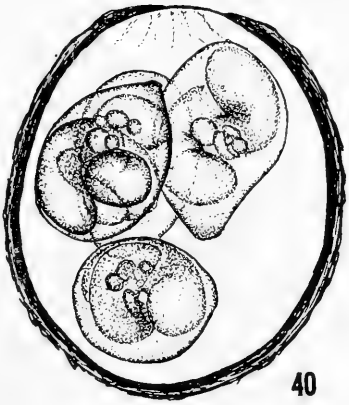
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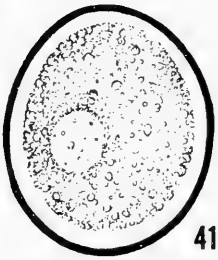
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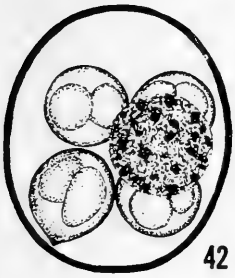
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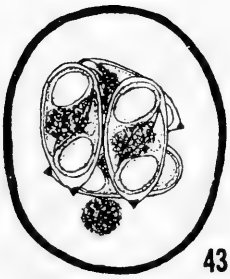
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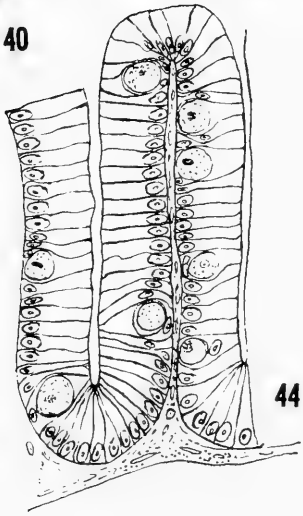
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Plate 5

Figs. 46–48. *Eimeria citelli* Kartchner and Becker, 1930 from *Spermophilus pygmaeus* (from Sassuchin and Rauschenbach, 1932). × 1800.

46. Unsporulated oocyst.
47. Oocyst showing incomplete sporulation.
48. Sporulated oocyst.

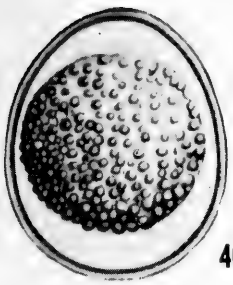
Fig. 49. *Eimeria bilamellata* Henry, 1932. Oocyst from *Spermophilus franklinii* (from Hall and Knipling, 1935). × 2000.

Fig. 50. *Eimeria volgensis* Sassuchin and Rauschenbach, 1932. Oocyst from *Spermophilus pygmaeus* (from Sassuchin and Rauschenbach, 1932). × 1800.

Fig. 51. *Eimeria franklinii* Hall and Knipling, 1935. Oocyst from *Spermophilus franklinii* (from Hall and Knipling, 1935). × 2000.

Figs. 52. and 53. *Eimeria hoffmeisteri* Levine, Ivens, and Kruidenier, 1958. Oocysts from *Spermophilus spilosoma*.

52. From Levine, Ivens, and Kruidenier, 1958. × 2600.
53. From Ivens, Kruidenier, and Levine, 1959. × 2600.



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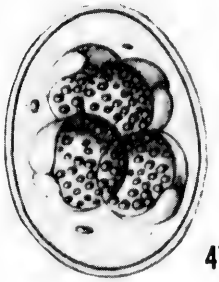

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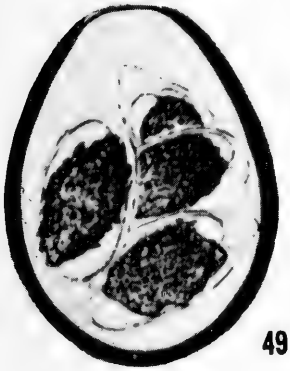

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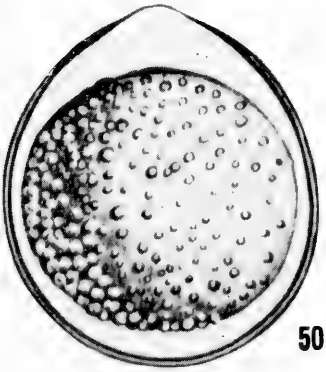

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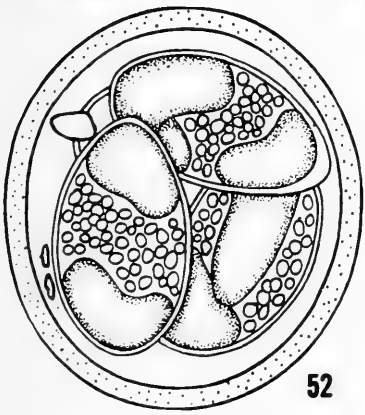

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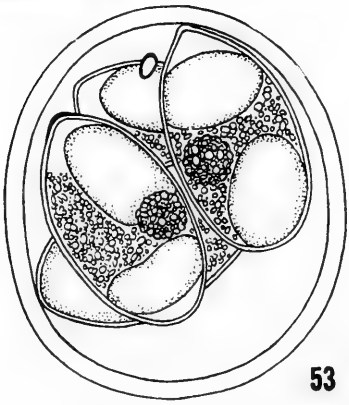

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PLATE 6

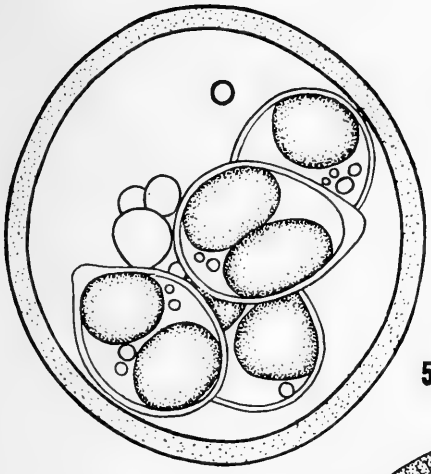
FIG. 54. *Eimeria callospermophili* Henry, 1932. Oocyst from *Spermophilus spilosoma* (from Levine, Ivens, and Kruidenier, 1958). × 2600.

FIG. 55. *Eimeria vilasi* Dorney, 1962. Oocyst from *Tamias striatus* (from Dorney, 1962). × 2600.

FIG. 56. *Eimeria wisconsinensis* Dorney, 1962. Oocyst from *Tamias striatus* (from Dorney, 1962). × 1200.

FIG. 57. *Eimeria parasciurorum* Bond and Bovee, 1957. Oocyst from *Glaucomys volans* (from Roudabush, 1937). × 1600.

FIG. 58. *Eimeria lateralis* Levine, Ivens, and Kruidenier, 1957. Oocyst from *Spermophilus lateralis* (from Levine, Ivens, and Kruidenier, 1957). × 2650.



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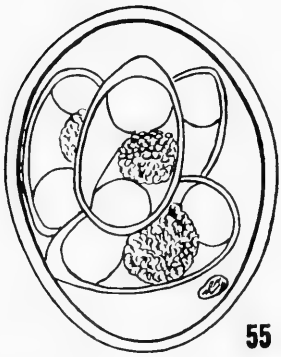

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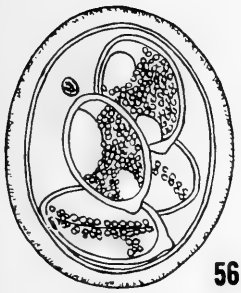

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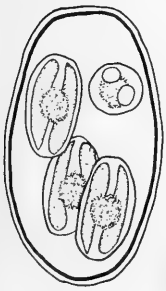

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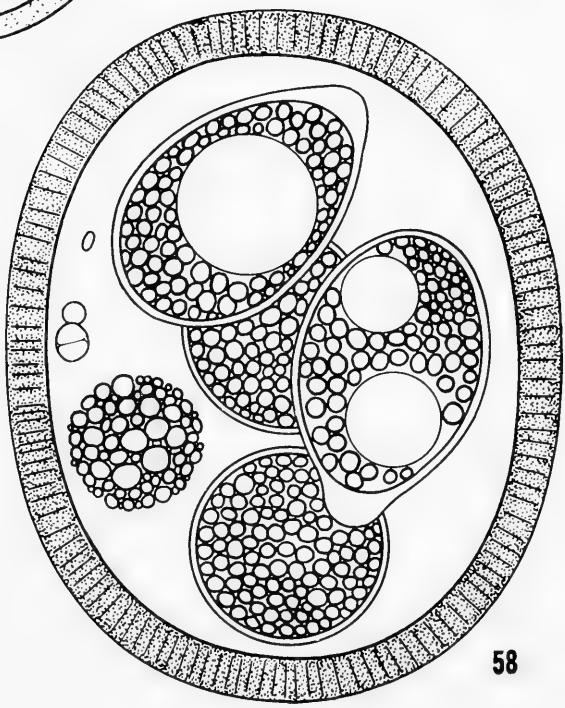

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Plate 7

Fig. 59. *Eimeria eutamiae* Levine, Ivens, and Kruidenier, 1957. Oocyst from *Eutamias dorsalis* (from Levine, Ivens, and Kruidenier, 1957). × 2650.

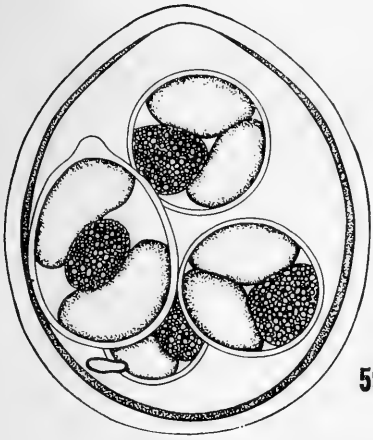
Fig. 60. *Eimeria geomydis* Skidmore, 1929. Oocyst from *Geomys bursarius* (from Skidmore, 1929). × 2100.

Figs. 61–65. *Eimeria parasciurorum* Bond and Bovee, 1958 from *Glaucomys volans* (from Bond and Bovee, 1958). × 1300.

61. Unsporulated oocyst.
62. Unsporulated oocyst prior to segmentation.
63. Oocyst with sporoblasts and polar body which quickly disintegrates.
64. Oocyst showing immature sporocysts with developing sporozoites.
65. Completely sporulated oocyst.

Figs. 66–69. *Eimeria petauristae* Ray and Singh, 1950 from *Petaurista petaurista* (from Ray and Singh, 1950). × 1100.

66. Sporulated oocyst with outer covering ruptured.
67. Sporocyst liberated from the oocyst.
68. Sporozoite coming out of narrow end of sporocyst.
69. Liberated sporozoite.



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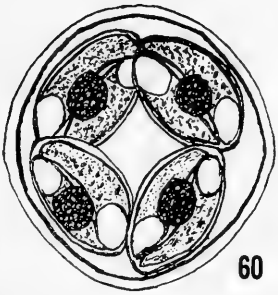

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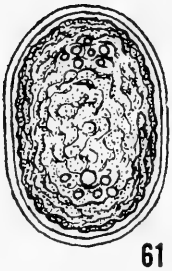

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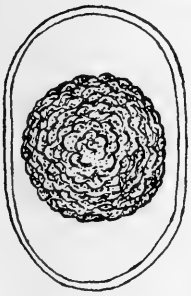

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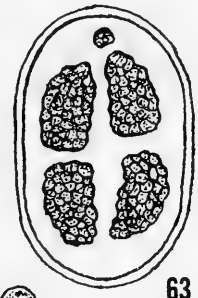

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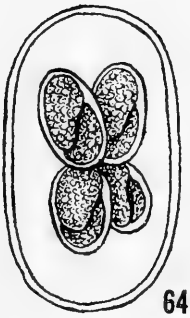

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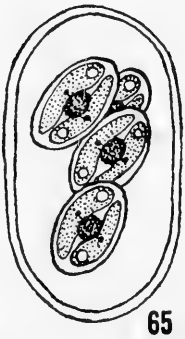

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Plate 8

Fig. 70. *Eimeria thomomysis* Levine, Ivens, and Kruidenier, 1957. Oocyst from *Thomomys bottae* (from Levine, Ivens, and Kruidenier, 1957). × 2650.

Fig. 71. *Eimeria perognathi* Levine, Ivens, and Kruidenier, 1957. Oocyst from *Perognathus intermedius* (from Levine, Ivens, and Kruidenier, 1957). × 2650.

Figs. 72 and 73. *Eimeria mohavensis* Doran and Jahn, 1949 from *Dipodomys mohavensis* (from Doran and Jahn, 1952). × 1700.

72. Immature oocyst showing two polar bodies.

73. Completely sporulated oocyst.

Figs. 74–77. *Eimeria mohavensis* Doran and Jahn, 1949 from *Dipodomys p. mohavensis* and *D. merriami* (from Doran, 1953).

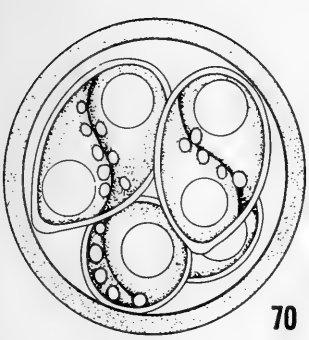
74. Mature macrogamete. × 2500.

75. Microgametocyte. × 2300.

76. Merozoite packet (small type). × 3200.

77. Merozoite packet (large type). × 3200.

Fig. 78. *Eimeria penicillati* Ivens, Kruidenier, and Levine, 1959. Oocyst from *Perognathus penicillatus* (from Ivens, Kruidenier, and Levine, 1959). × 2600.



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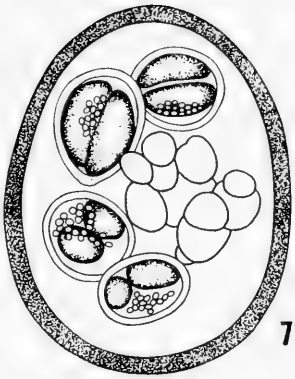

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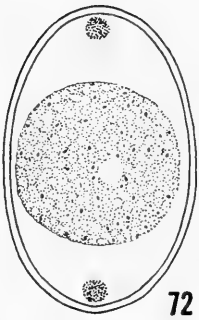

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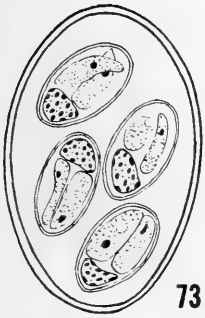

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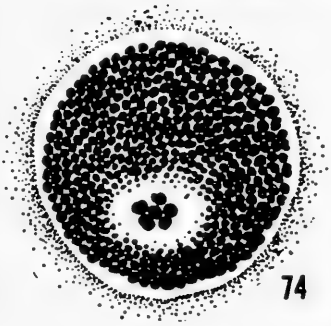

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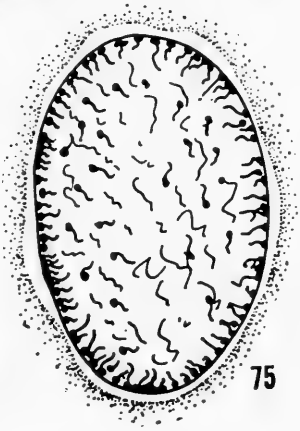

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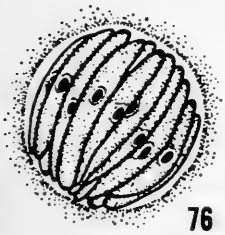

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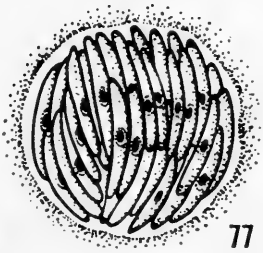

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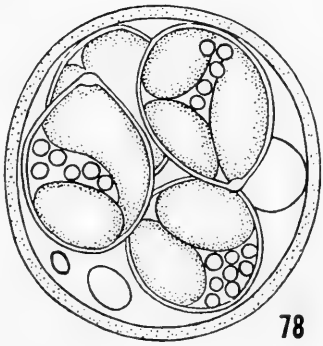

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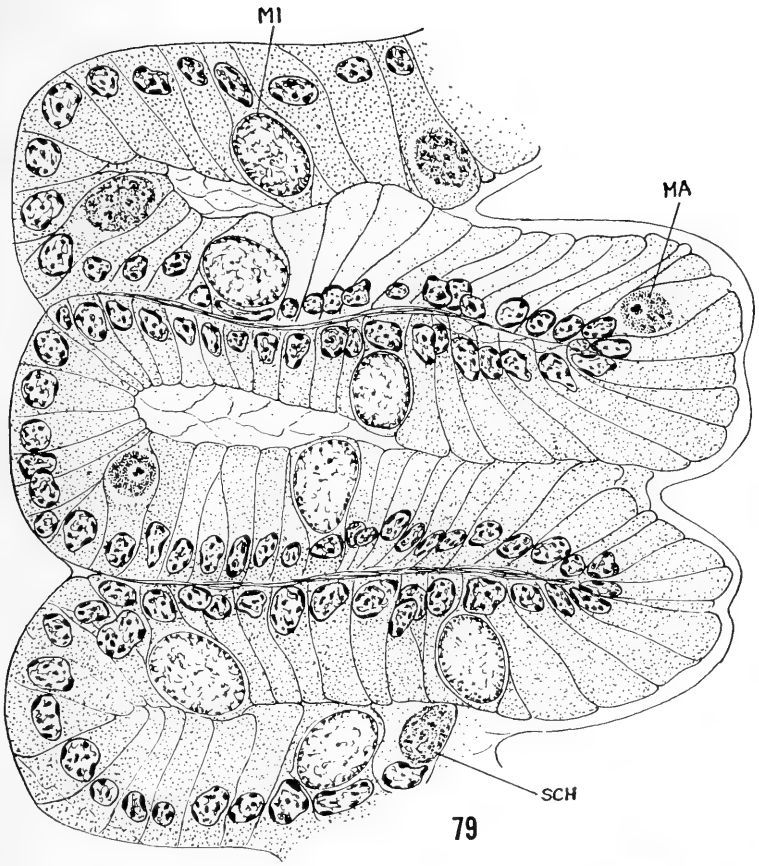
Plate 9

Figs. 79 and 80. *Eimeria mohavensis* Doran and Jahn, 1949 from *Dipodomys p. mohavensis* (from Doran and Jahn, 1952).

79. Section through cecum. MA-Macrogamete; MI-Microgametocyte; SCH-Schizont.

80. Diagram of intestinal tract showing locations of schizogony. SI-Small Intestine; CA-Cecum.



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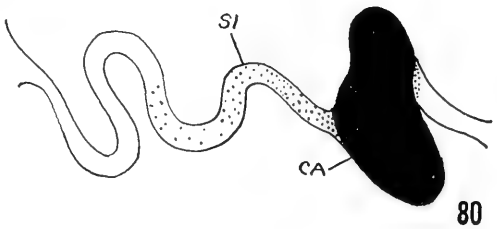

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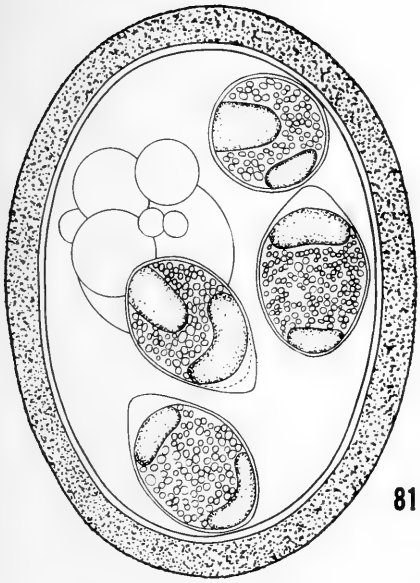
PLATE 10

FIG. 81. *Eimeria dipodomysis* Levine, Ivens, and Kruidenier, 1958. Oocyst from *Dipodomys phillipsi* (from Levine, Ivens, and Kruidenier, 1958). × 1400.

FIG. 82. *Eimeria couesii* Kruidenier, Levine, and Ivens, 1960. Oocyst from *Oryzomys couesi* (from Kruidenier, Levine, and Ivens, 1960). × 2650.

FIG. 83. *Eimeria liomysis* Levine, Ivens, and Kruidenier, 1958. Oocyst from *Liomys pictus* (from Levine, Ivens, and Kruidenier, 1959). × 2600.

FIG. 84. *Eimeria picti* Levine, Ivens, and Kruidenier, 1958. Oocyst from *Liomys pictus* (from Levine, Ivens, and Kruidenier, 1958). × 2600.



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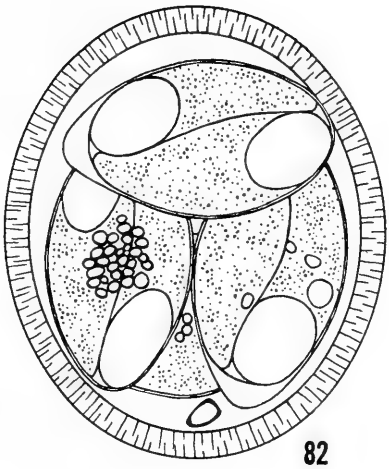

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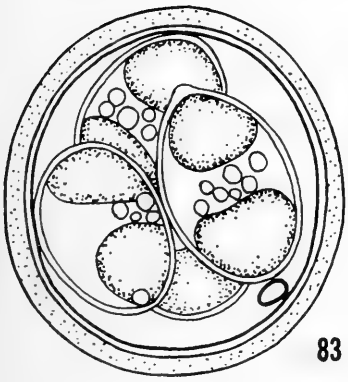

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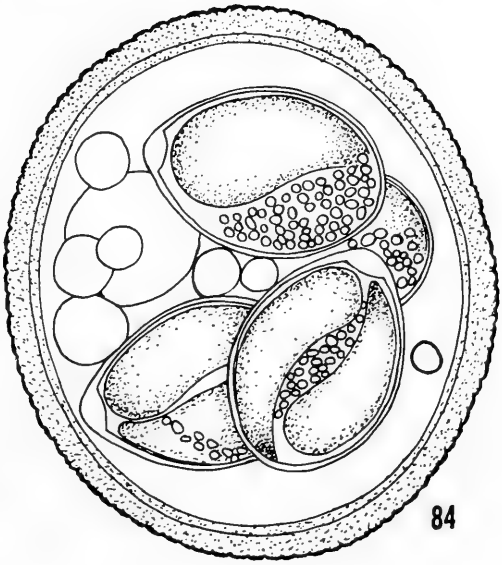

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Plate 11

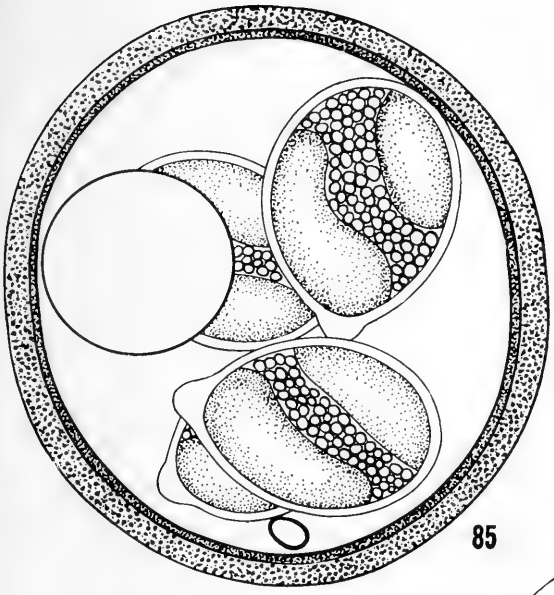
Fig. 85. *Eimeria peromysci* Levine, Ivens, and Kruidenier, 1957. Oocyst from *Peromyscus truei* (from Levine, Ivens, and Kruidenier, 1957). × 2650.

Fig. 86. *Eimeria langebarteli* Ivens, Kruidenier, and Levine, 1959. Oocyst from *Peromyscus boylii* (from Ivens, Kruidenier, and Levine, 1959). × 2650.

Figs. 87 and 88. *Eimeria arizonensis* Levine, Ivens, and Kruidenier, 1957 (from Levine and Ivens, 1960.) × 2600.

87. Oocyst from *Peromyscus leucopus.*

88. Oocyst from *Peromyscus maniculatus.*



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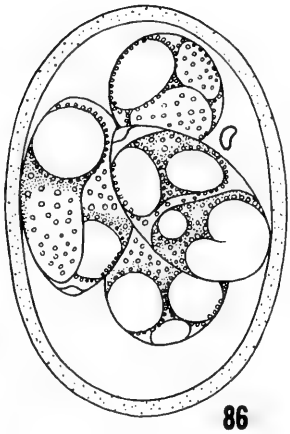

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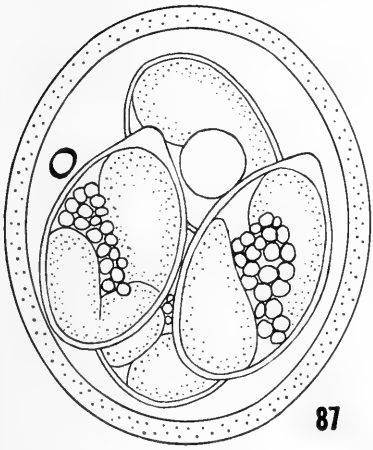

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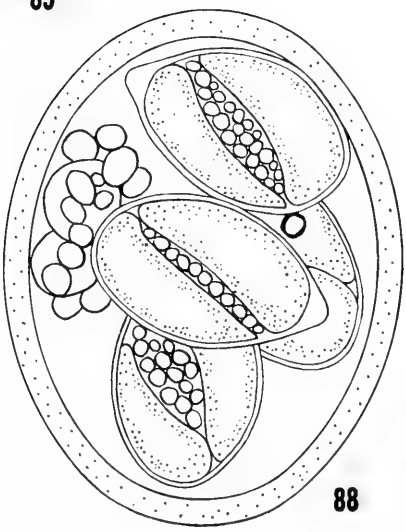


88

Plate 13

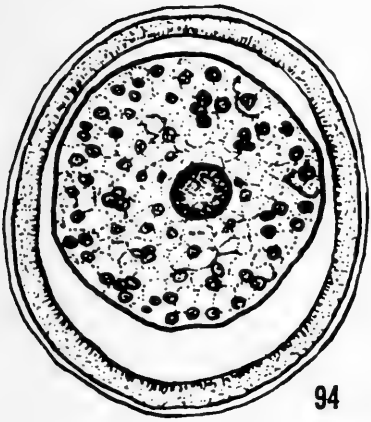
Figs. 94–97. *Eimeria leucopi* von Zellen, 1961 from *Peromyscus leucopus* (from von Zellen, 1961). × 2650.

94. Newly discharged cyst after protoplasmic withdrawal.

95. Clear area subsequent to nuclear disappearance.

96. Buckelbildung or ball stage. Refractile globules associated with mound formation.

97. Buckelbildung or ball stage. Formation of four mounds.



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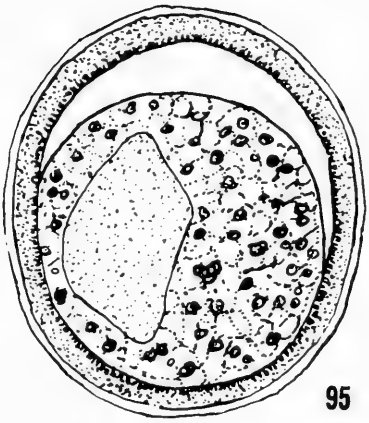

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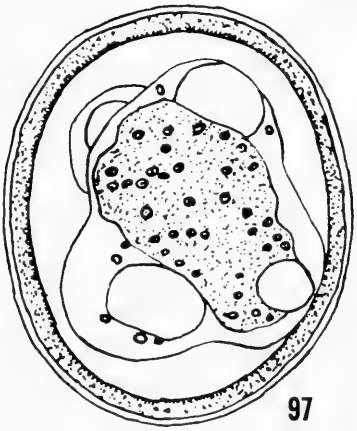
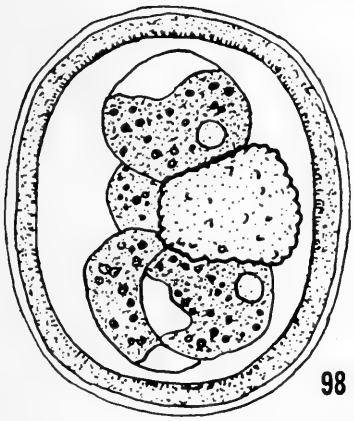


97

Plate 14

Figs. 98–101. *Eimeria leucopi* von Zellen, 1961 from *Peromyscus leucopus* (from von Zellen, 1961). × 2650.

98. Sporoblasts, with clear polar caps, separate from granular residuum.
99. Pyramid stage. Two days, fourteen hours.
100. Late pyramid stage. Two hours after Fig. 99.
101. Sporoblast elongation. Globular material retained within sporoblasts.



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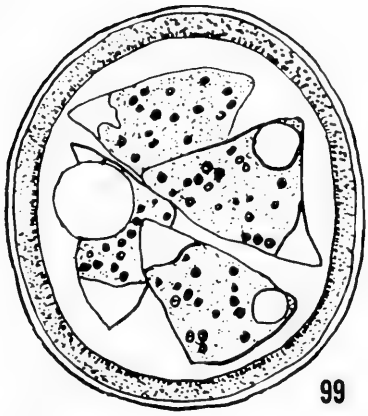

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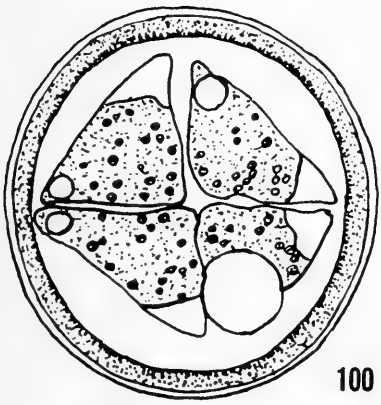

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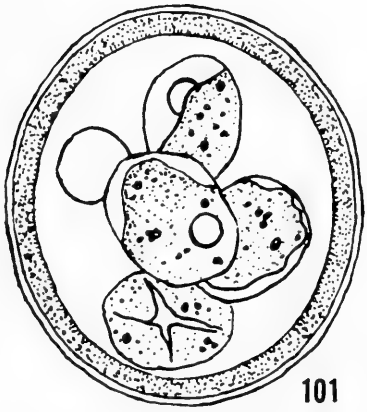


101

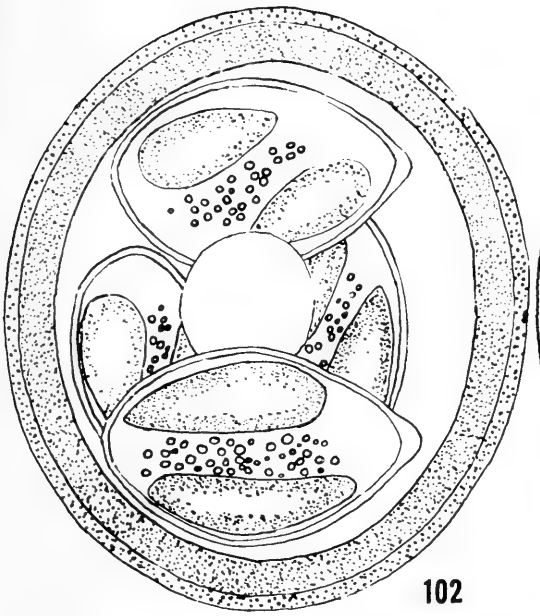
PLATE 15

FIG. 102. *Eimeria leucopi* von Zellen, 1961. Completely sporulated oocyst from *Peromyscus leucopus* (from von Zellen, 1961). × 3800.

FIG. 103. *Eimeria baiomysis* Levine, Ivens, and Kruidenier, 1958. Oocyst from *Baiomys taylori* (from Levine, Ivens, and Kruidenier, 1958). × 2600.

FIG. 104. *Eimeria onychomysis* Levine, Ivens, and Kruidenier, 1957. Oocyst from *Onychomys leucogaster* (from Levine, Ivens, and Kruidenier, 1957). × 2650.

FIG. 105. *Eimeria albigulae* Levine, Ivens, and Kruidenier, 1957. Oocyst from *Neotoma albigula* (from Levine, Ivens, and Kruidenier, 1957). × 2650.



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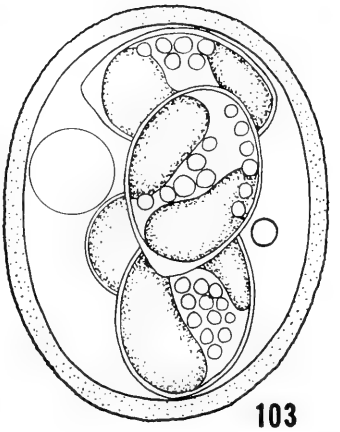

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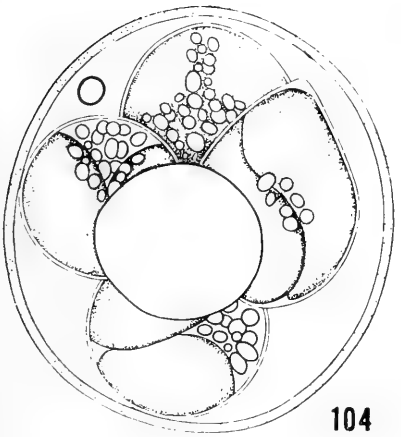

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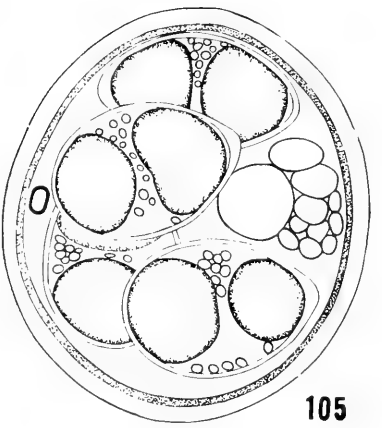

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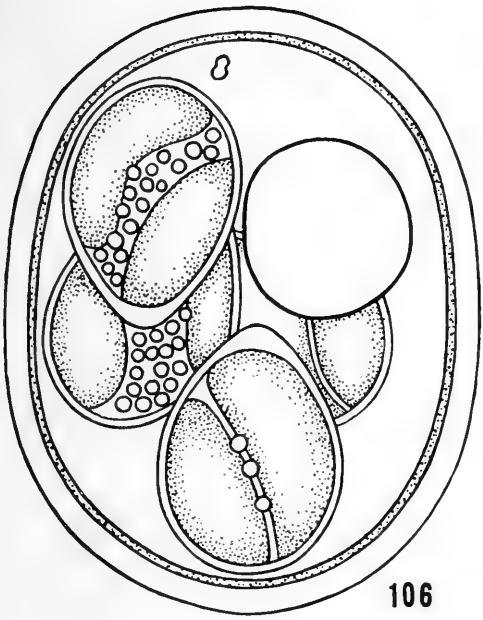
Plate 16

Fig. 106. *Eimeria davisi* Ivens, Kruidenier, and Levine, 1959. Oocyst from *Neotoma albigula* (from Ivens, Kruidenier, and Levine, 1959). × 2600.

Fig. 107. *Eimeria migratoria* Musaev and Veĭsov, 1961. Oocyst from *Cricetulus migratorius* (from Musaev and Veĭsov, 1961). × 2000.

Fig. 108. *Eimeria cricetuli* Musaev and Veĭsov, 1961. Oocyst from *Cricetulus migratorius* (from Musaev and Veĭsov, 1961). × 2000.

Figs. 109 and 110. *Eimeria jardimlinica* Musaev and Veĭsov, 1961. Oocysts from *Cricetulus migratorius* (from Musaev and Veĭsov, 1961). × 2000.



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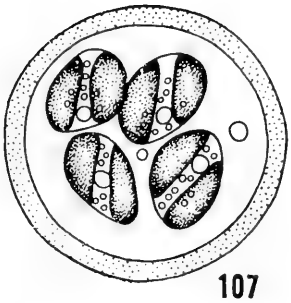

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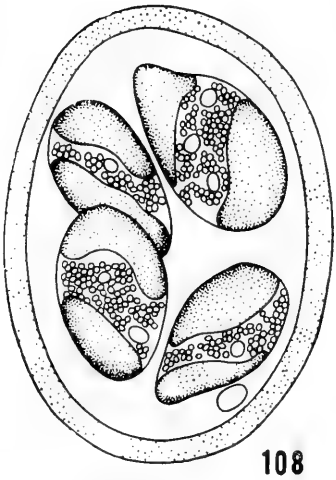

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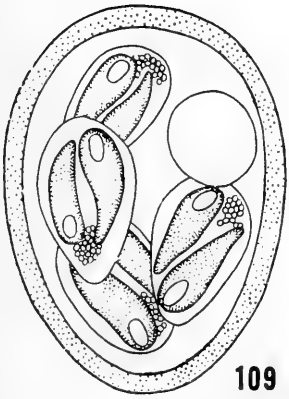

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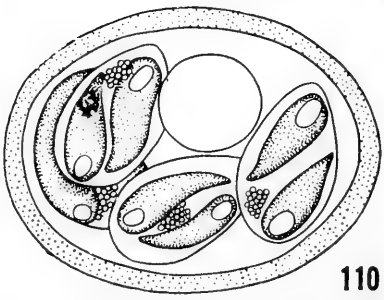

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Plate 17

Figs. 111 and 112. *Eimeria immodulata* Musaev and Veĭsov, 1961. Oocysts from *Cricetulus migratorius* (from Musaev and Veĭsov, 1961). × 2000.

Fig. 113. *Eimeria arusica* Musaev and Veĭsov, 1961. Oocyst from *Cricetulus migratorius* (from Musaev and Veĭsov, 1961). × 2000.

Fig. 114. *Eimeria microtina* Musaev and Veĭsov, 1959. Oocyst from *Microtus socialis* (from Musaev and Veĭsov, 1959). × 2000.

Figs. 115 and 116. *Eimeria wenrichi* Saxe, Levine, and Ivens, 1960. Oocysts from *Microtus pennsylvanicus* (from Saxe, Levine, and Ivens, 1960). × 2580.

Figs. 117 and 118. *Eimeria bohemica* Ryšavý, 1957 from *Arvicola terrestris* (from Ryšavý, 1957). × 1800.

117. Unsporulated oocyst.

118. Sporulated oocyst.

Fig. 119. *Eimeria batabatensis* n. sp. Oocyst from *Arvicola terrestris* (from Musaev and Veĭsov, 1960). × 2000.

Fig. 120. *Eimeria dicrostonicis* Levine, 1952. Oocyst from *Dicrostonyx groenlandicus richardsoni* (from Levine, 1952). × 2300.

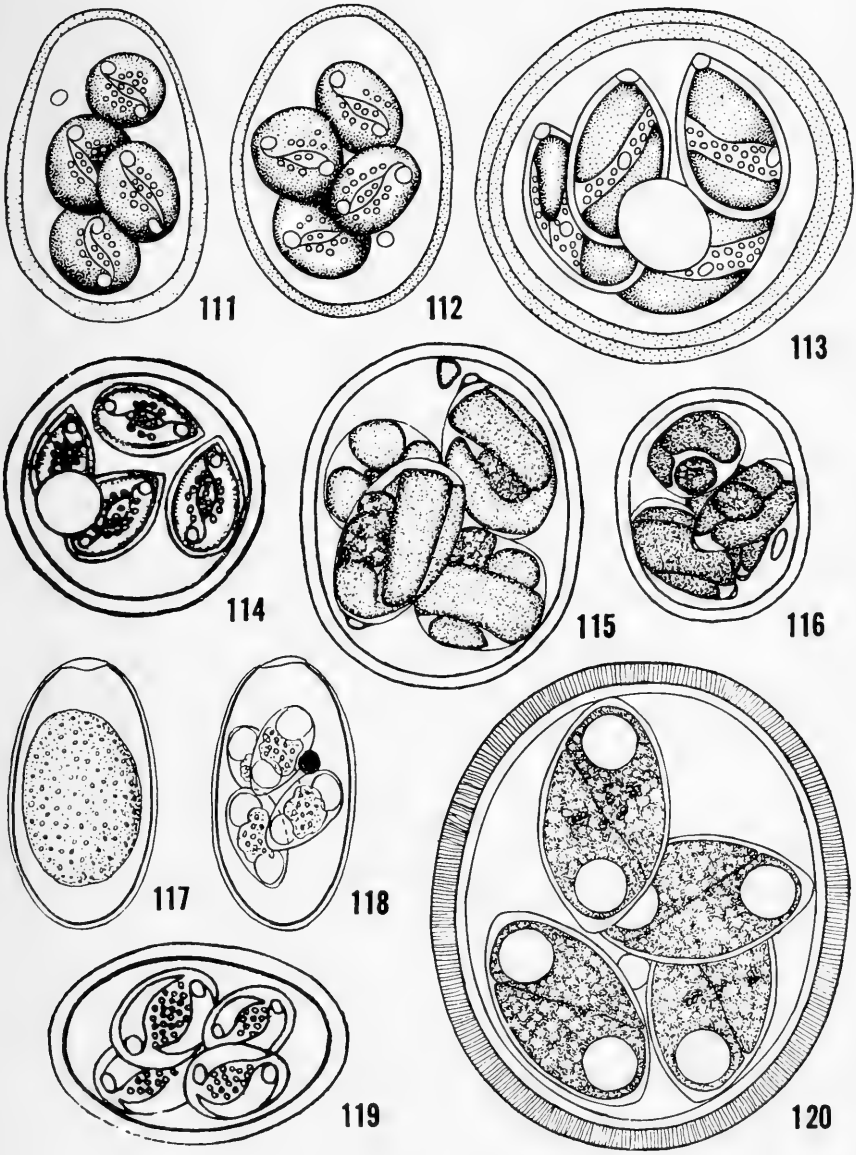
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Plate 18

Fig. 121. *Eimeria terrestris* Musaev and Veĭsov, 1960. Oocyst from *Arvicola terrestris* (from Musaev and Veĭsov, 1960). × 2000.

Fig. 122. *Eimeria talischaensis* Musaev and Veĭsov, 1960. Oocyst from *Arvicola terrestris* (from Musaev and Veĭsov, 1960). × 1600.

Figs. 123–125. *Eimeria rysavyi* n. sp. from *Clethrionomys glareolus*.

123. Oocyst (from Ryšavý, 1957). × 1600.

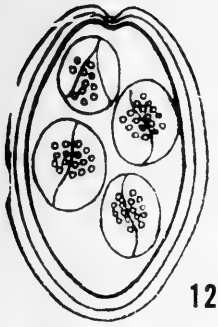
124, 125. Oocysts (from Černa, 1962). × 1440.

Fig. 126. *Eimeria noraschenica* Musaev and Veĭsov, 1960. Oocyst from *Meriones persicus* (from Musaev and Veĭsov, 1960). × 1700.

Figs. 127 and 128. *Eimeria disaensis* Musaev and Veĭsov, 1960. Oocysts from *Meriones persicus* (from Musaev and Veĭsov, 1960). × 1400.

Figs. 129 and 130. *Eimeria lerikaensis* Musaev and Veĭsov, 1960. Oocysts from *Meriones persicus* (from Musaev and Veĭsov, 1960). × 1800.

Fig. 131. *Eimeria salasuzica* Musaev and Veĭsov, 1960. Oocyst from *Meriones persicus* (from Musaev and Veĭsov, 1960). × 2100.



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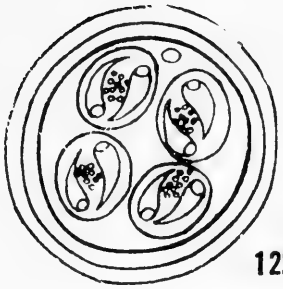

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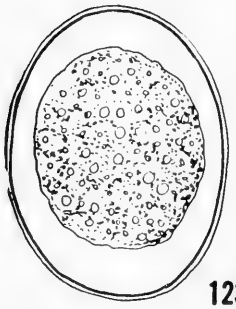

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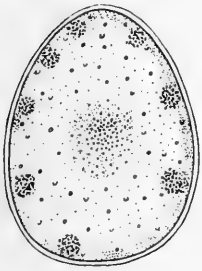

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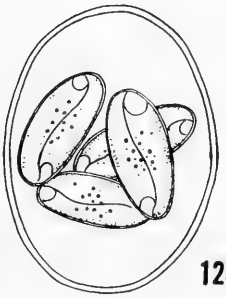

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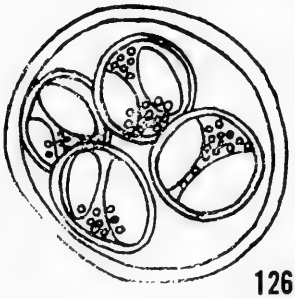

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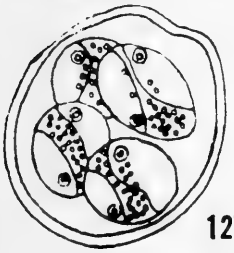

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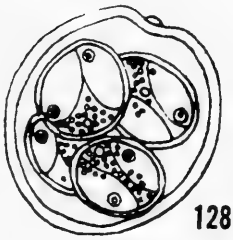

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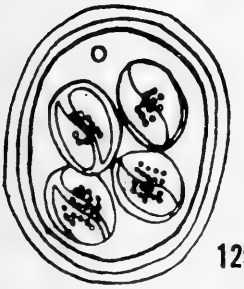

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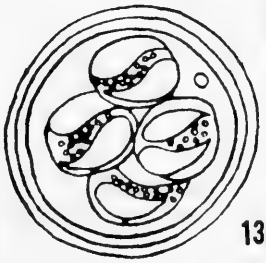

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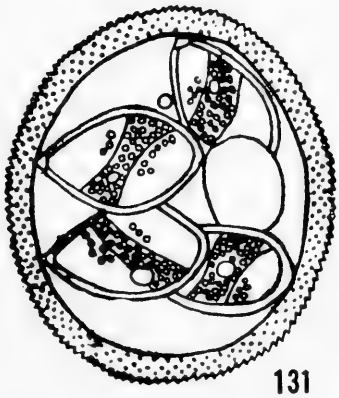

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Plate 19

Fig. 132. *Eimeria cernae* n. sp. Oocyst from *Clethrionomys glareolus* (from Černa, 1962). × 2900.

Fig. 133. *Eimeria schachtachtiana* Musaev and Veĭsov, 1960. Oocyst from *Meriones shawi* (from Musaev and Veĭsov, 1960). × 2000.

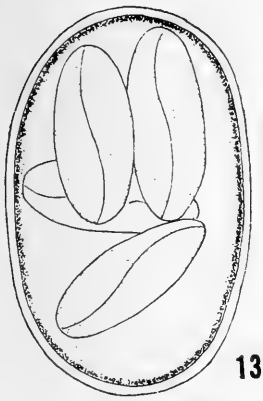
Fig. 134. *Eimeria nehramaensis* Musaev and Veĭsov, 1960. Oocyst from *Meriones shawi* (from Musaev and Veĭsov, 1960). × 2100.

Fig. 135. *Eimeria dzhahriana* Musaev and Veĭsov, 1960. Oocyst from *Meriones shawi* (from Musaev and Veĭsov, 1960). × 2000.

Fig. 136. *Eimeria araxena* Musaev and Veĭsov, 1960. Oocyst from *Meriones shawi* (from Musaev and Veĭsov, 1960). × 2800.

Fig. 137. *Eimeria astrachanbazarica* Musaev and Veĭsov, 1960. Oocyst from *Meriones shawi* (from Musaev and Veĭsov, 1960). × 2500.

Fig. 138. *Eimeria zulfiaensis* Veĭsov, 1961. Oocyst from *Meriones vinogradovi* (from Veĭsov, 1961). × 1700.



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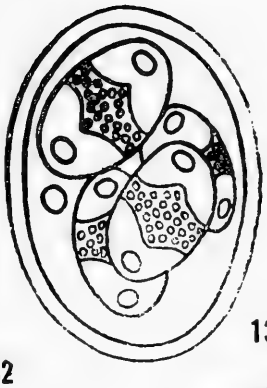

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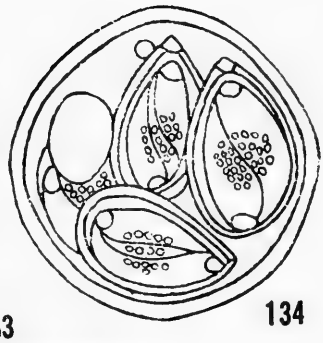

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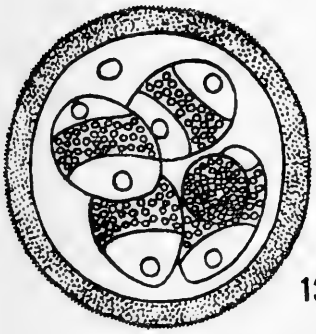

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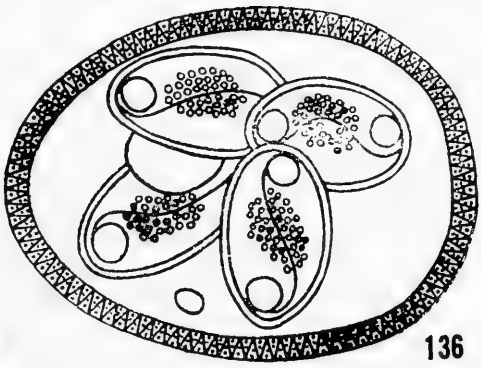

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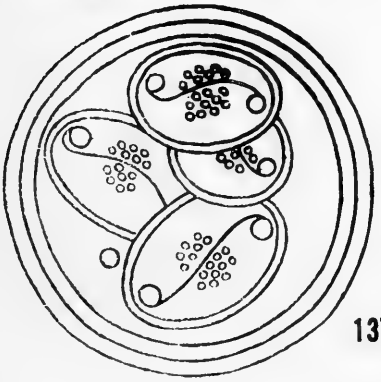

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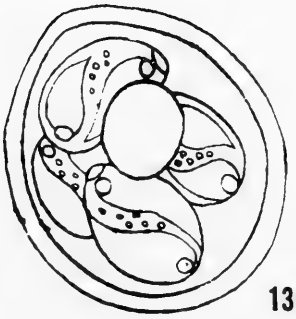

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Plate 20

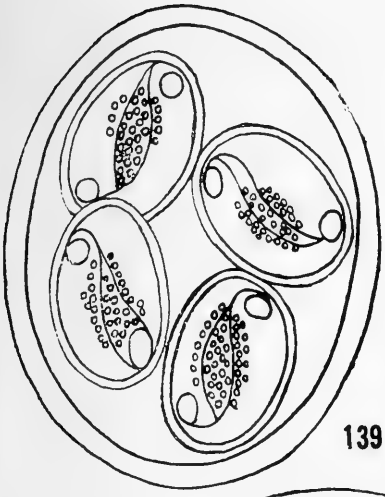
Fig. 139. *Eimeria vinogradovi* Veĭsov, 1961. Oocyst from *Meriones vinogradovi* (from Veĭsov, 1961). × 2900.

Fig. 140. *Eimeria jurschuaensis* Veĭsov, 1961. Oocyst from *Meriones vinogradovi* (from Veĭsov, 1961). × 2300.

Fig. 141. *Eimeria sadaraktica* Veĭsov, 1961. Oocyst from *Meriones vinogradovi* (from Veĭsov, 1961). × 1800.

Fig. 142. *Eimeria bistratum* Veĭsov, 1961. Oocyst from *Meriones vinogradovi* (from Veĭsov, 1961). × 2600.

Fig. 143. *Eimeria arabiana* Veĭsov, 1961. Oocyst from *Meriones vinogradovi* (from Veĭsov, 1961). × 2700.



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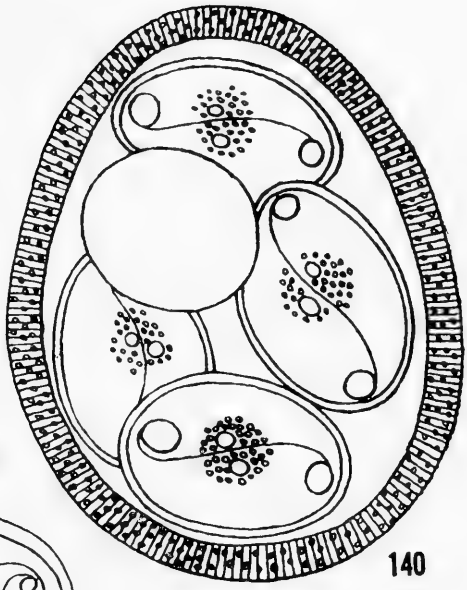

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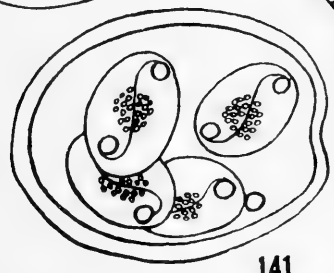

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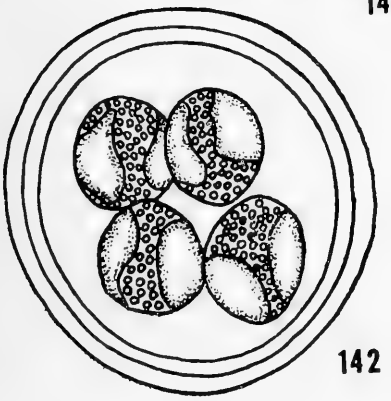

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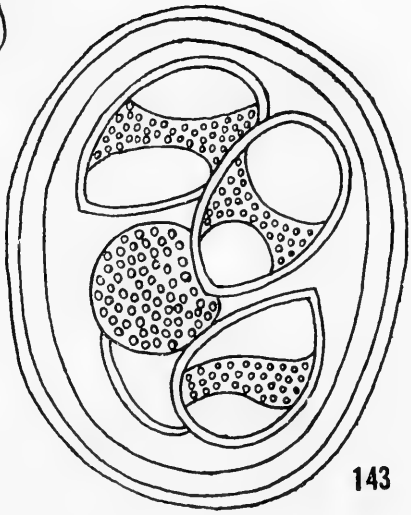


143

Plate 21

Fig. 144. *Eimeria tasakendica* Veĭsov, 1961. Oocyst from *Meriones vinogradovi* (from Veĭsov, 1961). × 2800.

Fig. 145. *Eimeria musajevi* Veĭsov, 1961. Oocyst from *Meriones vinogradovi* (from Veĭsov, 1961). × 2300.

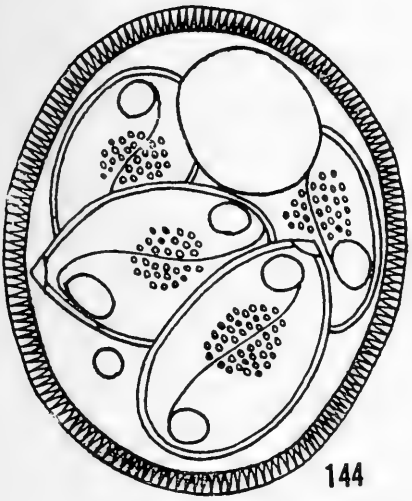
Fig. 146. *Eimeria erythrourica* Musaev and Alieva, 1961. Oocyst from *Meriones libycus* (from Musaev and Alieva, 1961). × 2000.

Fig. 147. *Eimeria schamchorica* Musaev and Alieva, 1961. Oocyst from *Meriones libycus* (from Musaev and Alieva, 1961). × 1600.

Fig. 148. *Eimeria achburunica* Musaev and Alieva, 1961. Oocyst from *Meriones libycus* (from Musaev and Alieva, 1961). × 1500.

Fig. 149. *Eimeria sumgaitica* Musaev and Alieva, 1961. Oocyst from *Meriones libycus* (from Musaev and Alieva, 1961). × 2000.

Fig. 150. *Eimeria martunica* Musaev and Alieva, 1961. Oocyst from *Meriones libycus* (from Musaev and Alieva, 1961). × 1700.



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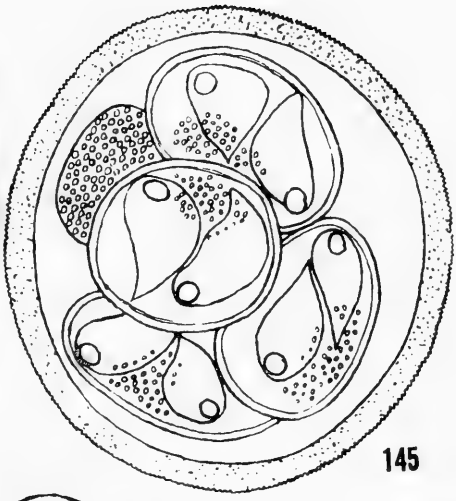

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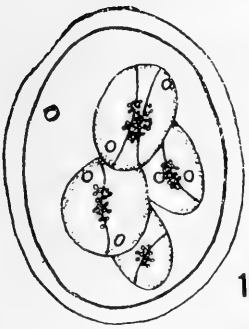

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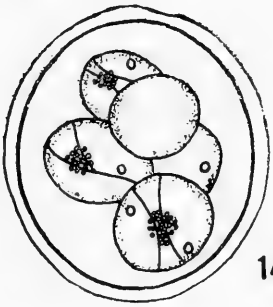

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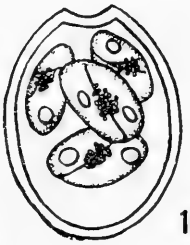

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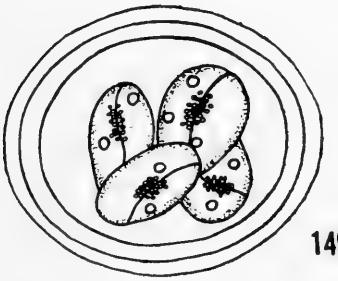

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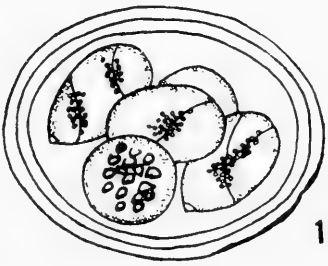

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Plate 22

Fig. 151. *Eimeria apionodes* Pellérdy, 1954. Oocyst from *Apodemus flavicollis* (from Pellérdy, 1954). × 2100.

Figs. 152 and 153. *Eimeria apodemi* Pellérdy, 1954.

152. Oocyst from *Apodemus flavicollis* (from Pellérdy, 1954). × 2100.

153. Oocyst from *A. flavicollis* and *A. sylvaticus* (from Černa, 1962). × 1500.

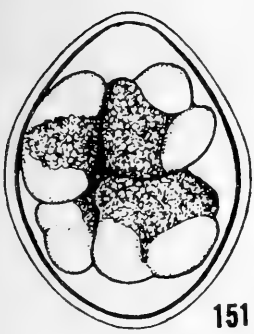
Fig. 154. *Eimeria poljanskii* Veĭsov, 1961 emend. Oocyst from *Meriones vinogradovi* (from Veĭsov, 1961). × 1900.

Figs. 155 and 156. *Eimeria hungaryensis* n. sp.

155. Oocyst from *Apodemus flavicollis* (from Pellérdy, 1954). × 2000.

156. Oocyst from *Apodemus sylvaticus* (from Černa, 1962). × 2200.

Fig. 157. *Eimeria tachyoryctis* van den Berghe and Chardome, 1956. Oocyst from *Tachyoryctes ruandae* (from van den Berghe and Chardome, 1956). × 3000.



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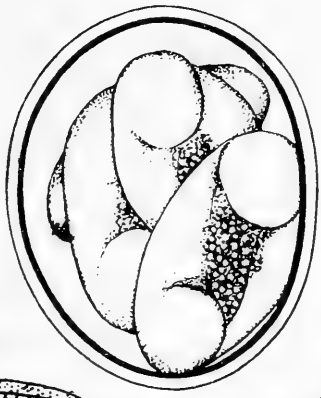

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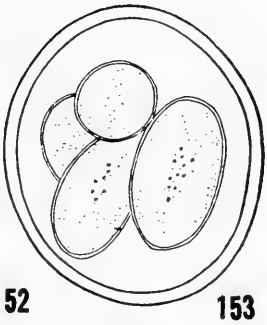

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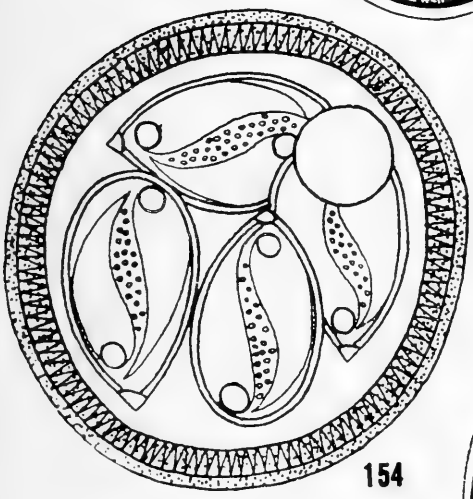

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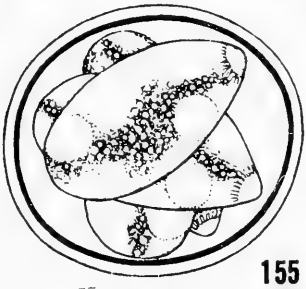

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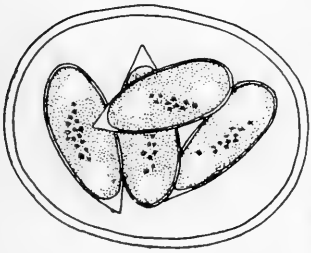

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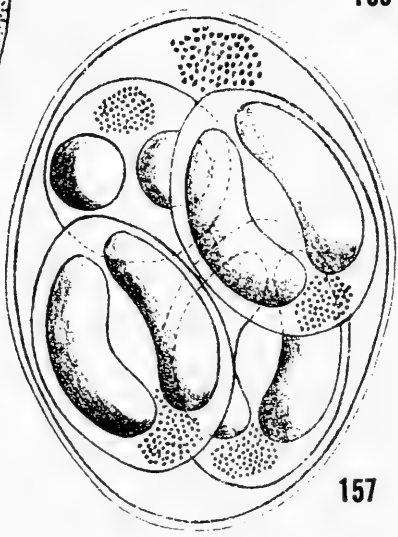

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Plate 23

Fig. 158. *Eimeria rugosa* Pellérdy, 1954. Oocyst from *Apodemus flavicollis* (from Pellérdy, 1954). × 2100.

Fig. 159. *Eimeria svanbaevi* n. sp. Oocyst from *Apodemus sylvaticus* (from Ryšavý, 1954). × 1400.

Figs. 160 and 161. *Eimeria* sp. (Ryšavý, 1954) syn. *Eimeria keilini* Yakimoff and Gousseff of Ryšavý, 1954 and of Černa, 1962.

160. Oocyst from *Apodemus sylvaticus* (from Ryšavý, 1954). × 1500.

161. Oocyst from *Apodemus flavicollis* (from Černa, 1962). × 1500.

Fig. 162. *Eimeria dasymysis* Levine, Bray, Ivens, and Gunders, 1959. Oocyst from *Dasymys incomptus rufulus* (from Levine, Bray, Ivens, and Gunders, 1959). × 2600.

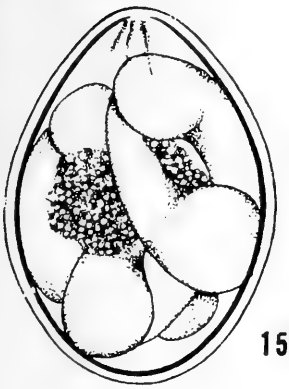
Fig. 163. *Eimeria lemniscomysis* Levine, Bray, Ivens, and Gunders, 1959. Oocyst from *Lemniscomys striatus striatus* (from Levine, Bray, Ivens, and Gunders, 1959). × 2600.

Fig. 164. *Eimeria putevelata* Bray, 1958. Oocyst from *Lemniscomys striatus striatus* (from Bray, 1958). × 1600.

Figs. 165 and 166. *Eimeria miyairii* Ohira, 1912.

165. Oocyst from *Rattus norvegicus* (from Becker, 1934). × 1200.

166. Oocyst from *Rattus norvegicus* and *R. rattus* (?) (from Matubayasi, 1938). × 1200.



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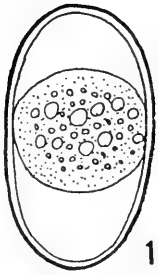

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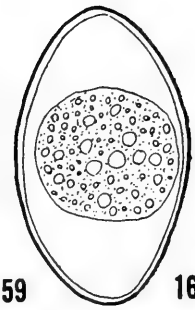

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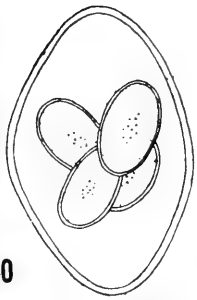

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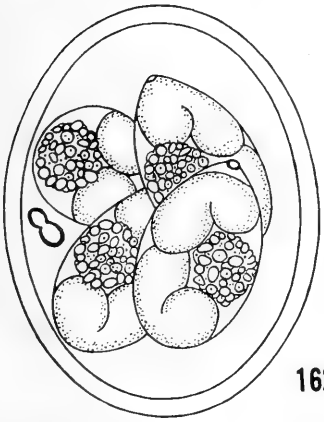

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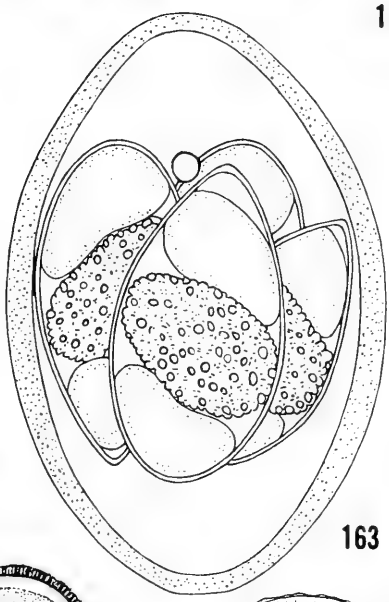

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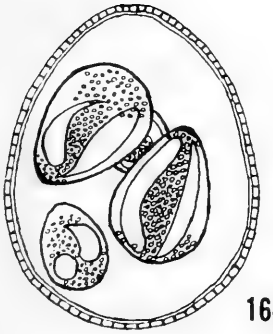

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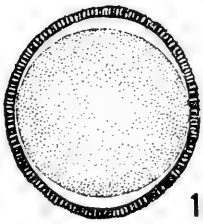

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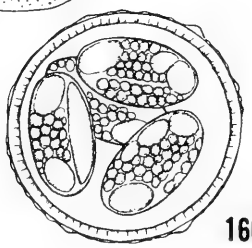

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Plate 24

Figs. 167–181. *Eimeria miyairii* Ohira, 1912.

167. Oocysts from *Rattus norvegicus* (from Pinto, 1928). × 4000.

168–181. From *Rattus norvegicus* (from Roudabush, 1937).

168. Sporozoite. × 2300.

169. Sporozoite in host cell. × 2300.

170. Group of first-generation merozoites. × 1500.

171. First-generation merozoite. × 1800.

172. Schizont (probably second-generation).

173. Group of second-generation merozoites. × 1900.

174. Second-generation merozoite. × 2500.

175. Group of third-generation merozoites. × 1400.

176. Third-generation merozoite. × 2300.

177. Microgametocyte (surface view).

178. Microgamete. × 3000.

179. Double infection with young macrogametes shown below epithelium.

180. Macrogamete.

181. Figure copied by Roudabush from Ohira (1912) showing typical macrogamete.

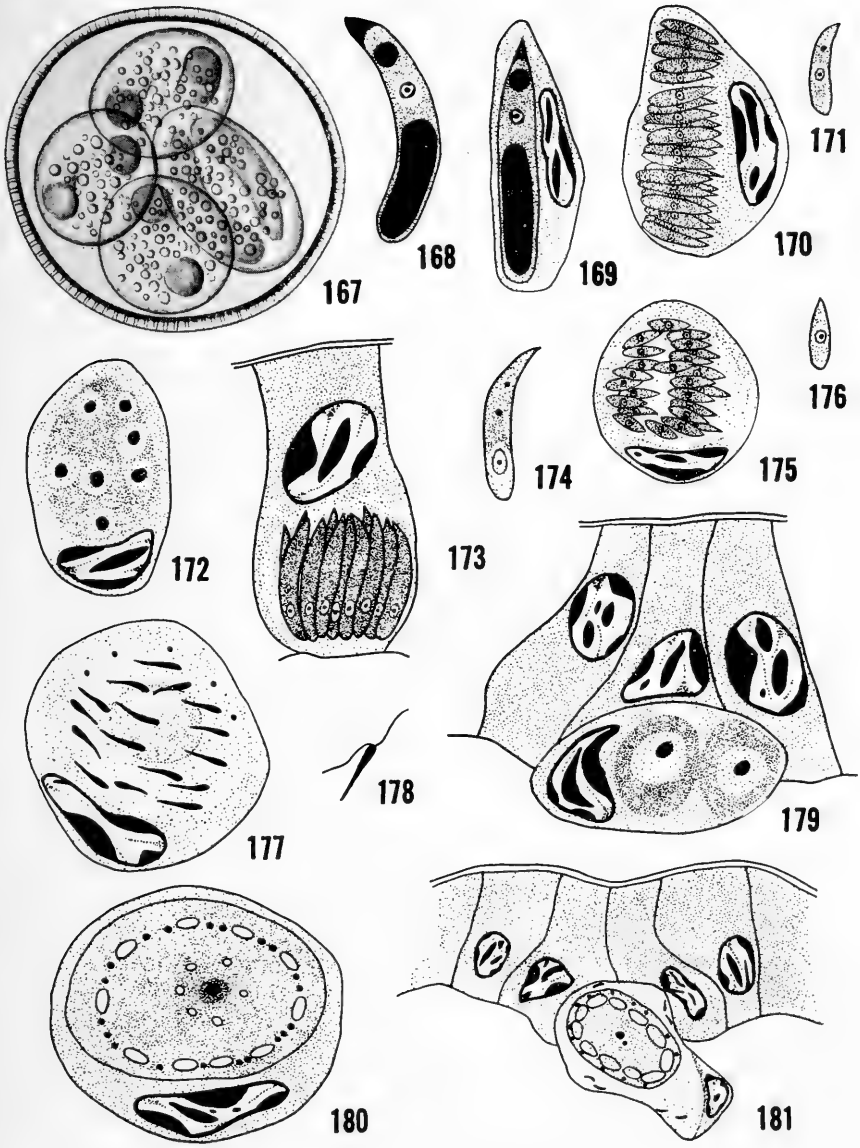
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Plate 25

Figs. 182–187. *Eimeria nieschulzi* Dieben, 1924.

182. Oocyst from *Rattus norvegicus* (from Pérard, 1926). × 2000.

183, 184. Oocysts from *R. norvegicus* and *R. rattus* (?) (from Matubayasi, 1938). × 1400.

185. Oocyst from *R. norvegicus* (from Becker, 1934). × 1100.

186. Oocyst from *R. norvegicus* (from Becker, Hall, and Hager, 1932). × 2200.

187. Oocyst from *R. norvegicus* (original). × 2600.

Figs. 188–193. *Eimeria separata* Becker and Hall, 1931.

188. Oocyst from *Rattus norvegicus* (from Becker, Hall, and Hager, 1932). × 1800.

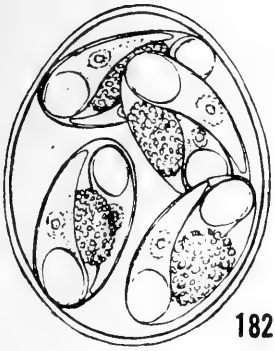
189. Oocyst from *R. norvegicus* (from Ryšavý, 1954). × 2400.

190. Oocyst from *R. norvegicus* (from Becker, 1934). × 1100.

191. Oocyst from *R. norvegicus* (original). × 2600.

192. Oocyst from *R. hawaiiensis* (original). × 2600.

193. Oocyst from *Rattus* (*Dephomys*) *defua* (from Levine, Bray, Ivens, and Gunders, 1959). × 2600.



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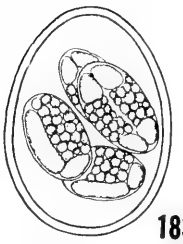

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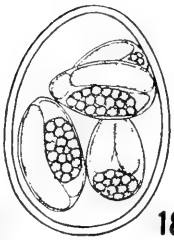

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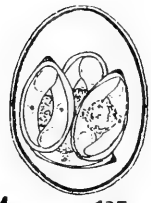

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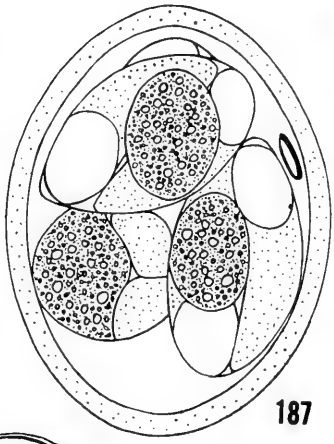

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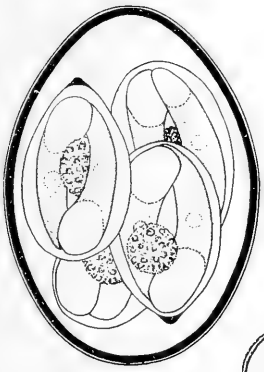

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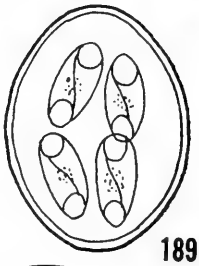

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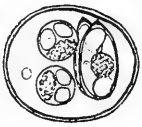

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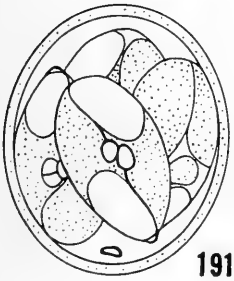

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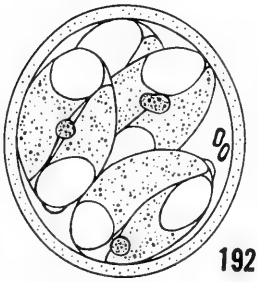

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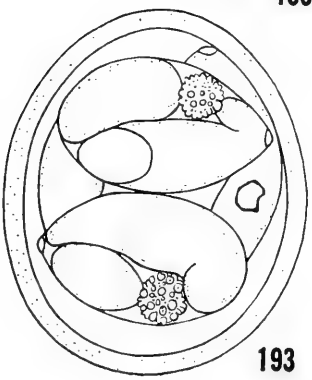

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Plate 26

Figs. 194–208. *Eimeria nieschulzi* Dieben, 1924 from *Rattus norvegicus* (from Roudabush, 1937).

194. Sporozoite. × 2400.
195. Sporozoite with divided posterior globule. × 2400.
196. Cross section of first-generation merozoites in cell; note refractile globule.
197. Group of first-generation merozoites. × 1900.
198. First-generation merozoite. × 2300.
199. Group of second-generation merozoites. × 1900.
200. Second-generation merozoite. × 2600.
201. Group of third-generation merozoites. × 2100.
202. Third-generation merozoite. × 2100.
203. Group of fourth-generation merozoites. × 1800.
204. Fourth-generation merozoite. × 2500.
205. Developing microgametocyte.
206. Microgametocyte (surface view).
207. Mature macrogamete.
208. Microgamete. × 1800.

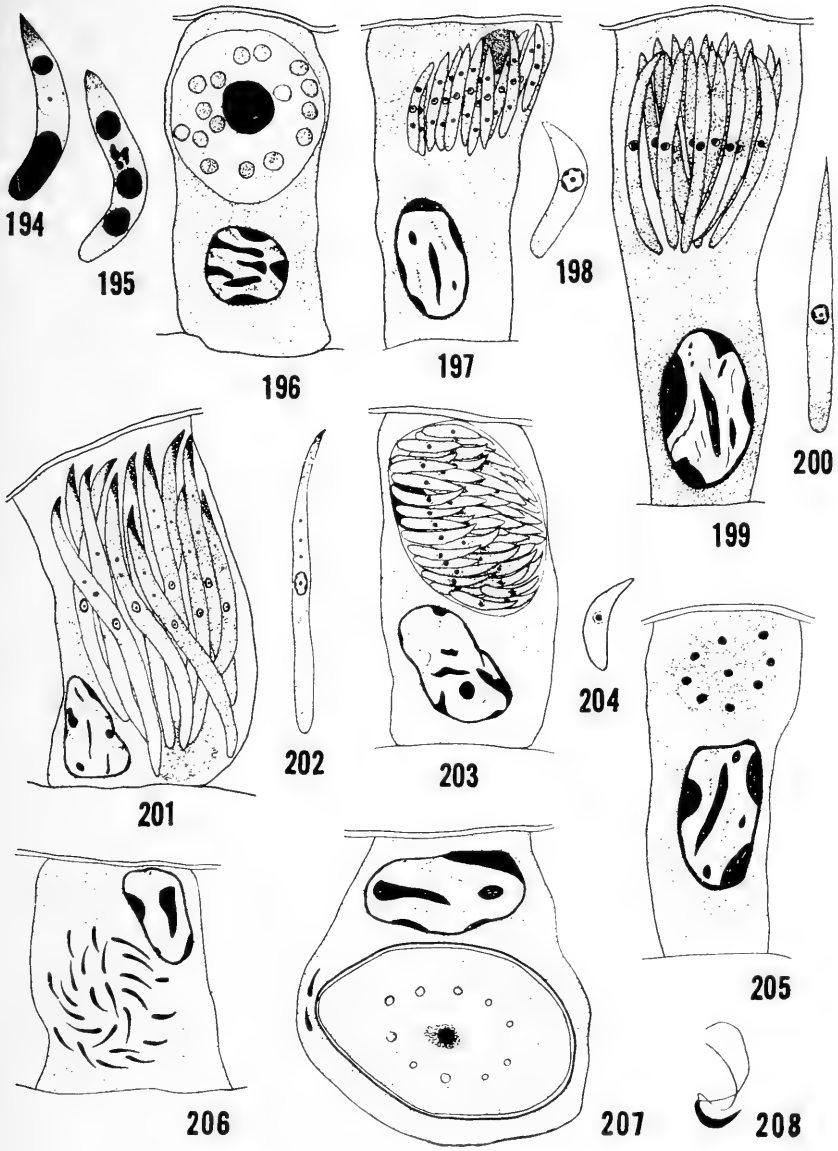
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Plate 27

Figs. 209–214. *Eimeria nieschulzi* Dieben, 1924 from *Rattus norvegicus* (from Roudabush, 1937). Development of the oocyst wall. Plastic granules shown as white bodies with a solid outline. Haematoxylinophilic granules shown as large black dots.

209. Early development showing migration of granules.

210. Plastic granules have almost reached the periphery. Second group remains close to the nucleus.

211. Plastic granules have reached the edge and have begun to flatten out. Haematoxylinophilic granules have begun to elongate.

212. Outer wall formed from plastic granules. Inner wall forming from haematoxylinophilic granules.

213. Inner wall almost fully formed.

214. Mature oocyst inner wall shrunken away from outer wall. Second set of plastic granules shown in cytoplasm.

Figs. 215–227. *Eimeria separata* Becker and Hall, 1931 from *Rattus norvegicus* (from Roudabush, 1937).

215. Sporozoite. × 2400.

216. Sporozoite after rounding up.

217. Early first-generation merozoites.

218. Group of first-generation merozoites. × 1600.

219. First-generation merozoite. × 2300.

220. Early second-generation schizont (double infection).

221. Group of second-generation merozoites. × 1700.

222. Second-generation merozoite. × 2500.

223. Group of third-generation merozoites. × 1900.

224. Third-generation merozoite. × 2300.

225. Microgametocyte (surface view).

226. Almost mature macrogamete.

227. Microgamete. × 2400.

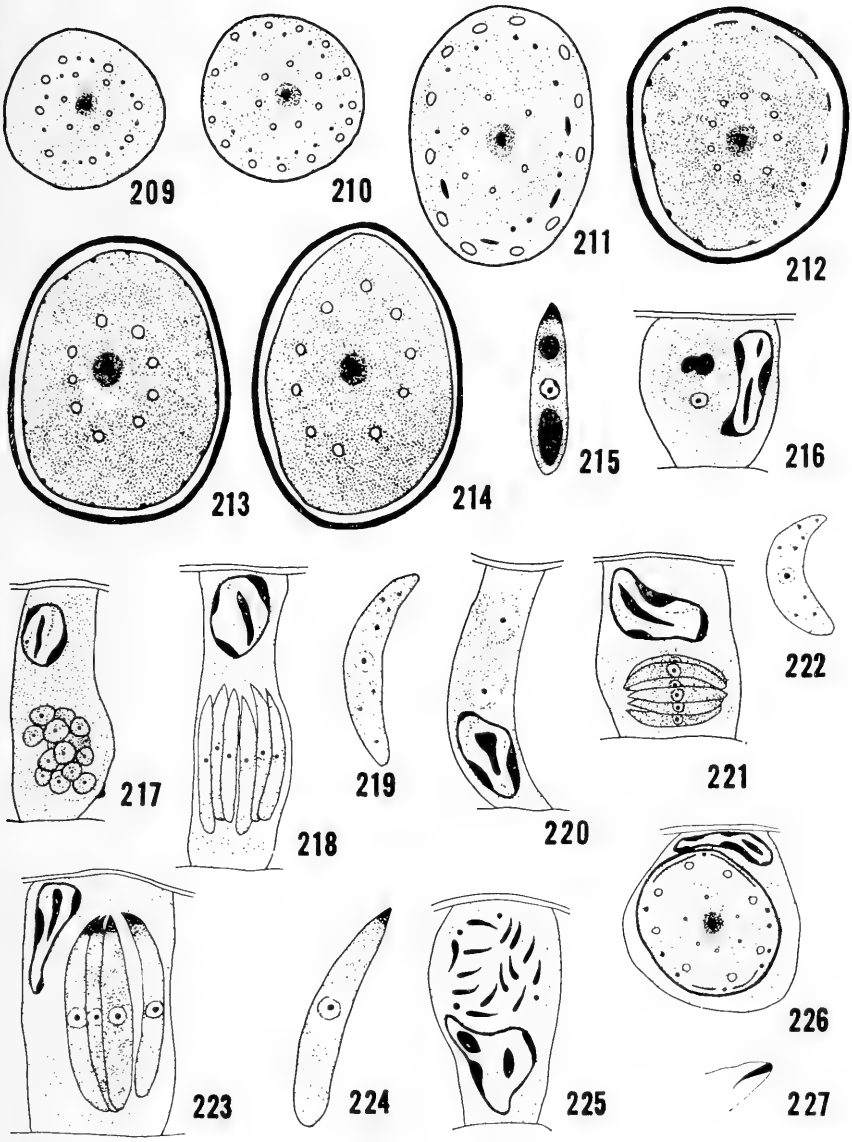
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Plate 28

Fig. 228. *Eimeria praomysis* Levine, Bray, Ivens, and Gunders, 1959. Oocyst from *Rattus* (*Praomys*) *tullbergi rostratus* (from Levine, Bray, Ivens, and Gunders, 1959). × 2600.

Figs. 229–240. *Eimeria falciformis* (Eimer, 1870) Schneider, 1875 from *Mus musculus*.

229. Sporulated oocyst (original). × 2700.

230, 231. Sporulated oocyst and sporozoites, respectively (from Reichenow, 1953).

232–239. From Wenyon (1926). × 2400.

232, 233, 234, 235. Bundles of merozoites.

236 and 237. Sections through bundles of merozoites.

238. Microgametocyte.

239. Macrogamete.

240. Sporulated oocyst (from Černa, 1962). × 2500.

Fig. 241. *Eimeria hansonorum* n. sp. Oocyst from *Mus musculus* (original). × 2600.

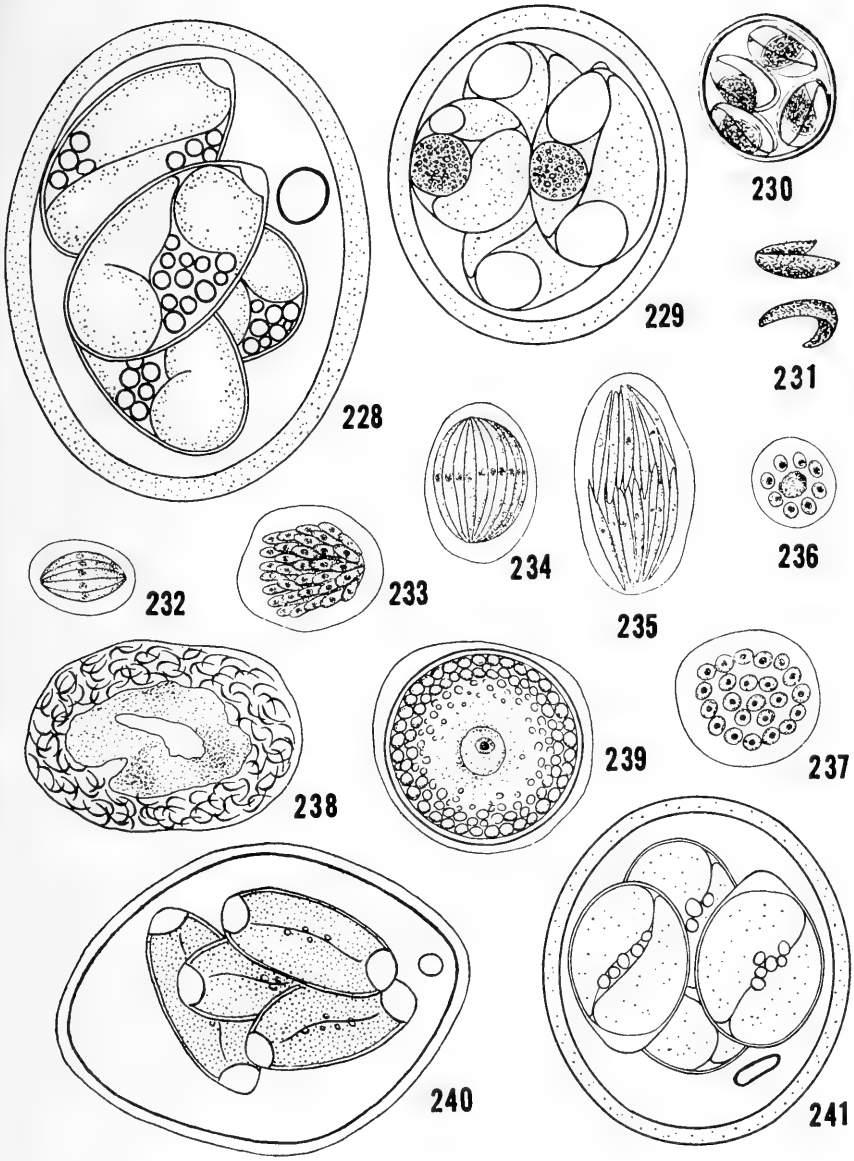
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Plate 29

Fig. 242. *Eimeria ferrisi* n. sp. Oocyst from *Mus musculus* (original). × 2600.

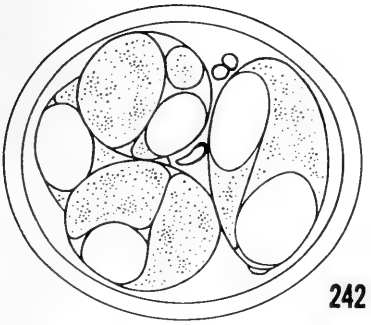
Fig. 243. *Eimeria musculoidei* Levine, Bray, Ivens, and Gunders, 1959. Oocyst from *Mus (Leggada) musculoides* (from Levine, Bray, Ivens, and Gunders, 1959). × 2600.

Fig. 244. *Eimeria lophuromysis* Levine, Bray, Ivens, and Gunders, 1959. Oocyst from *Lophuromys s. sikapusi* (from Levine, Bray, Ivens, and Gunders, 1959). × 2600.

Fig. 245. *Eimeria sikapusii* Levine, Bray, Ivens, and Gunders, 1959. Oocyst from *Lophuromys s. sikapusi* (from Levine, Bray, Ivens, and Gunders, 1959). × 2600.

Fig. 246. *Eimeria liberiensis* Levine, Bray, Ivens, and Gunders, 1959. Oocyst from *Lophuromys s. sikapusi* (from Levine, Bray, Ivens, and Gunders, 1959). × 2600.

Fig. 247. *Eimeria africana* Levine, Bray, Ivens, and Gunders, 1959. Oocyst from *Lophuromys s. sikapusi* (from Levine, Bray, Ivens, and Gunders, 1959). × 2600.



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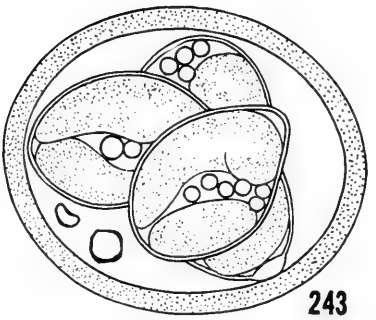

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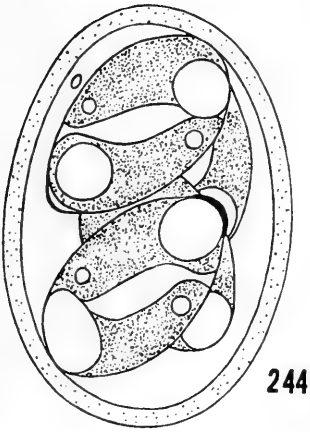

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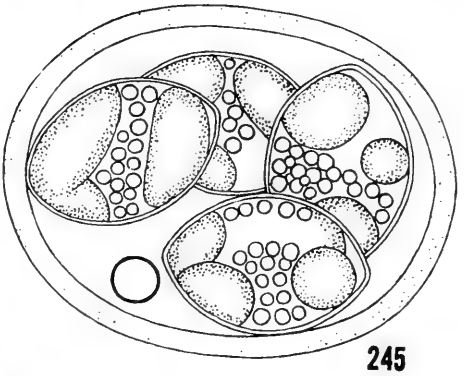

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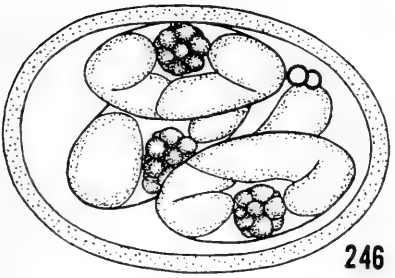

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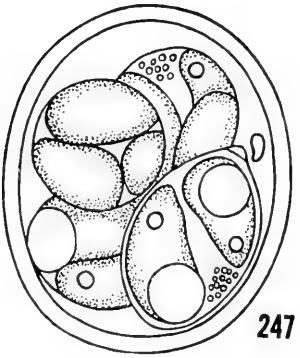

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Plate 30

Fig. 248. *Eimeria harbelensis* Levine, Bray, Ivens, and Gunders, 1959. Oocyst from *Lophuromys s. sikapusi* (from Levine, Bray, Ivens, and Gunders, 1959). × 2600.

Fig. 249. *Eimeria schoutedeni* van den Berghe and Chardome, 1957. Oocyst from *Cricetomys dissimilis* (from van den Berghe and Chardome, 1957). × 3500.

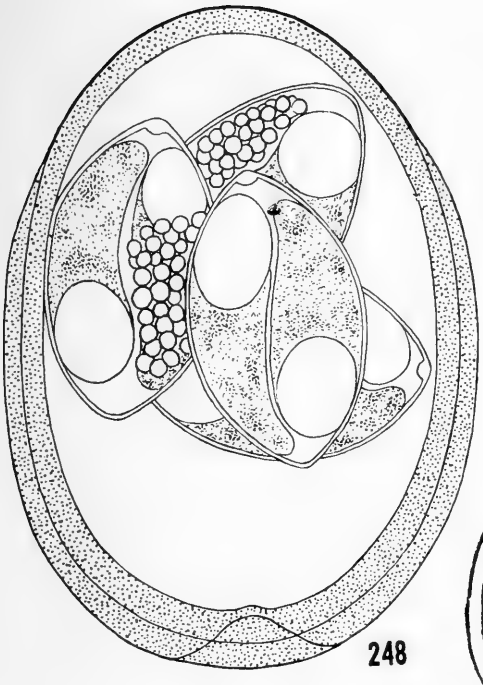
Fig. 250. *Eimeria dyromidis* Zolotarev, 1935. Oocyst from *Dryomys nitedula* (from Musaev and Veĭsov, 1959). × 2700.

Fig. 251. *Eimeria nachitschevanica* Musaev and Veĭsov, 1959. Oocyst from *Dryomys nitedula* (from Musaev and Veĭsov, 1959). × 2600.

Figs. 252 and 253. *Eimeria dolichotis* Morini, Boero, and Rodriguez, 1955 from *Dolichotis patagonum patagonum* (from Morini, Boero, and Rodriguez, 1955).

252. Sporulated oocyst. × 1700.

253. Sporocyst. × 3000.



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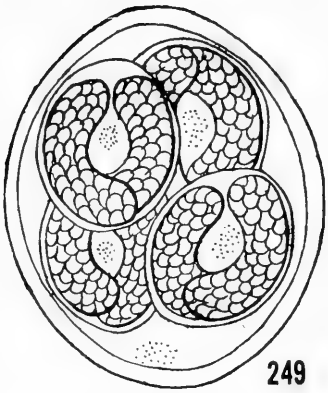

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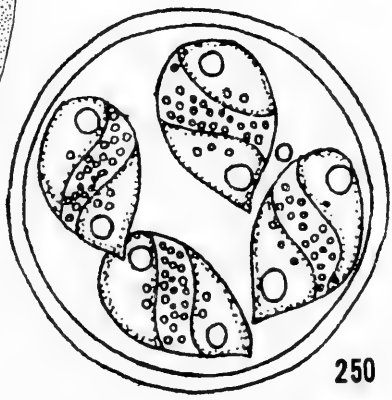

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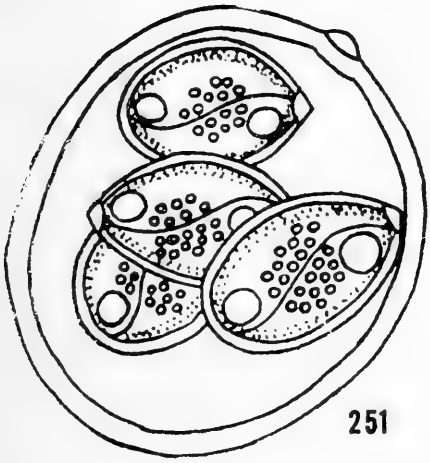

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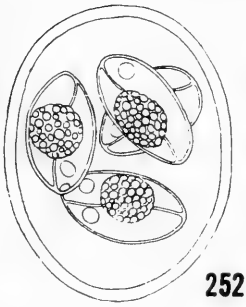

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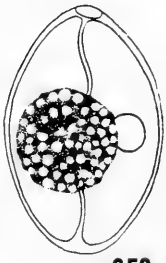

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Plate 31

Fig. 254. *Eimeria caviae* Sheather, 1924. Oocyst from *Cavia porcellus* (from Ryšavý, 1954). × 1500.

Fig. 255. *Eimeria myopotami* Yakimoff, 1933. Oocyst from *Myocastor coypus* (from Prasad, 1960). × 1300.

Figs. 256 and 257. *Eimeria nutriae* Prasad, 1960. Oocysts from *Myocastor coypus* (from Prasad, 1960). × 1300.

Fig. 258. *Eimeria myocastori* Prasad, 1960. Oocyst from *Myocastor coypus* (from Prasad, 1960). × 1600.

Fig. 259. *Eimeria kruidenieri* Levine, Bray, Ivens, and Gunders, 1959. Oocyst from *Lophuromys s. sikapusi* (from Levine, Bray, Ivens, and Gunders, 1959). × 2600.

Fig. 260. *Klossia perplexens* Levine, Ivens, and Kruidenier, 1955. Oocyst from *Peromyscus maniculatus* (from Levine, Ivens, and Kruidenier, 1955). × 1700.

Fig. 261. *Isospora mcdowelli* Saxe, Levine, and Ivens, 1960. Oocyst from *Microtus pennsylvanicus* (from Saxe, Levine, and Ivens, 1960). × 2600.

Fig. 262. *Isospora batabatica* Musaev and Veĭsov, 1960. Oocyst from *Arvicola terrestris* (from Musaev and Veĭsov, 1960). × 2100.

Fig. 263. *Caryospora microti* Saxe, Levine, and Ivens, 1960. Oocyst from *Microtus pennsylvanicus* (from Saxe, Levine, and Ivens, 1960). × 2600.

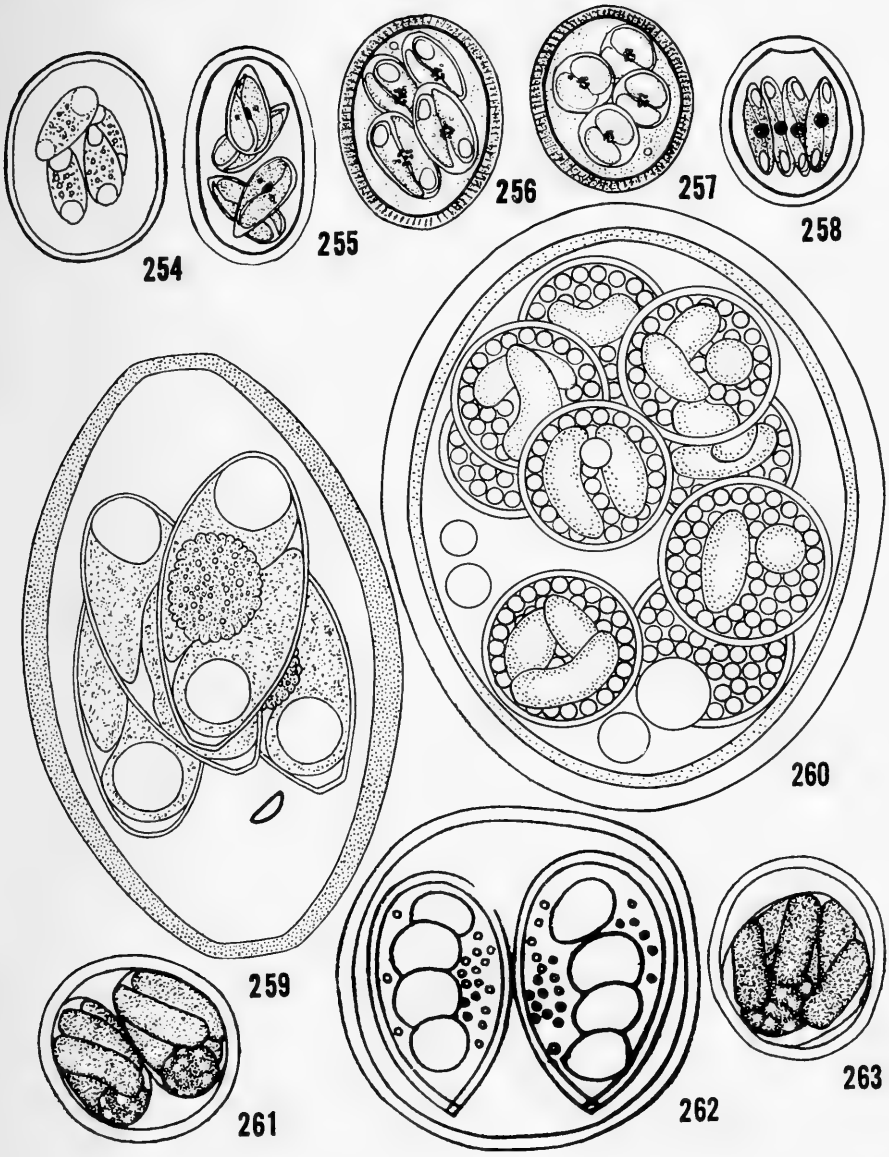
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Plate 32

Fig. 264. *Caryospora microti* Saxe, Levine, and Ivens, 1960. Oocyst from *Microtus pennsylvanicus* (from Saxe, Levine, and Ivens, 1960). × 2600.

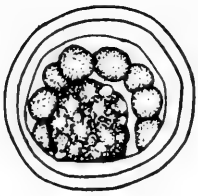
Fig. 265. *Tyzzeria peromysci* Levine and Ivens, 1960. Oocyst from *Peromyscus maniculatus* (from Levine and Ivens, 1960). × 2600.

Fig. 266. *Isospora citelli* Levine, Ivens, and Kruidenier, 1957. Oocyst from *Spermophilus variegatus* (from Levine, Ivens, and Kruidenier, 1957). × 2600.

Fig. 267. *Isospora ratti* n. sp. Oocyst from *Rattus norvegicus* (original). × 2600.

Fig. 268. *Dorisiella arizonensis* Levine, Ivens, and Kruidenier, 1955. Oocyst from *Neotoma lepida* (from Levine, Ivens, and Kruidenier, 1955). × 3400.

Fig. 269. *Isospora ordubadica* Musaev and Veĭsov, 1960. Oocyst from *Meriones persicus* (from Musaev and Veĭsov, 1960). × 2000.



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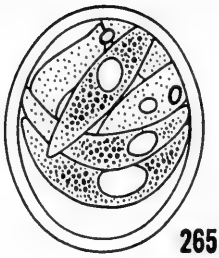

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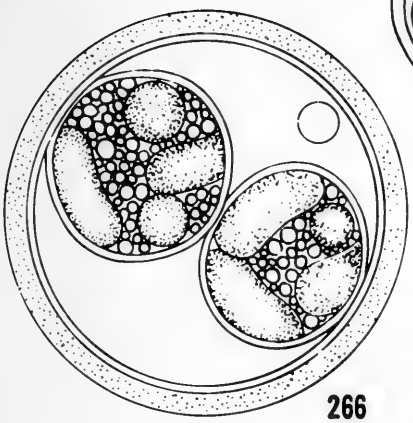

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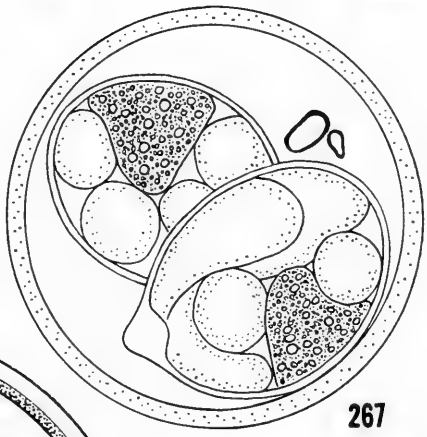

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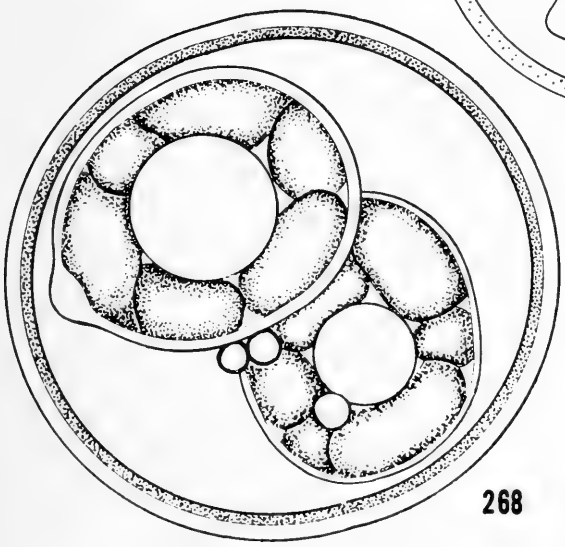

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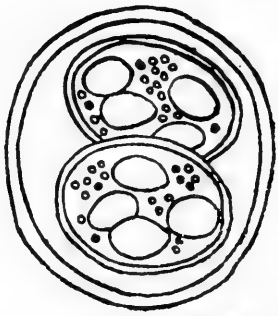

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Plate 33

Figs. 270 and 271. *Eimeria sciurorum* Galli-Valerio, 1922.

270. Oocyst from "Eichhornchen" (from Yakimoff and Gousseff, 1935). × 1700.

271. Oocyst from *Sciurus vulgaris* (from Pellérdy, 1954). × 2000.

Fig. 272. *Eimeria mira* Pellérdy, 1954. Oocyst from *Sciurus vulgaris* (from Pellérdy, 1954). × 1900.

Figs. 273–275. *Eimeria andrewsi* Yakimoff and Gousseff, 1935.

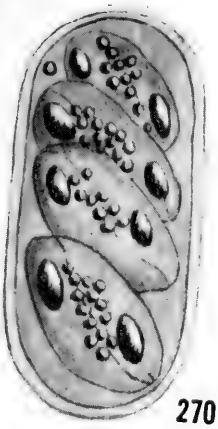
273, 274. Oocysts from "Eichhornchen" (from Yakimoff and Gousseff, 1935). × 2200.

275. Oocyst from *Sciurus vulgaris* (from Pellérdy, 1954). × 2000.

Fig. 276. *Eimeria silvana* Pellérdy, 1954. Oocyst from *Sciurus vulgaris* (from Pellérdy, 1954). × 1900.

Fig. 277. *Eimeria beecheyi* Henry, 1932. Oocyst from *Spermophilus beecheyi* (from Henry, 1932). × 2000.

Fig. 278. *Eimeria monacis* Fish, 1930. Oocyst from *Marmota monax* (from Crouch and Becker, 1931). × 1900.



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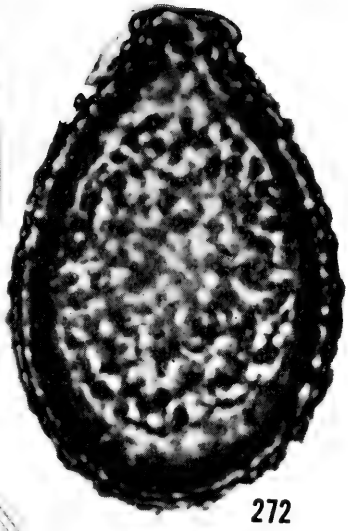

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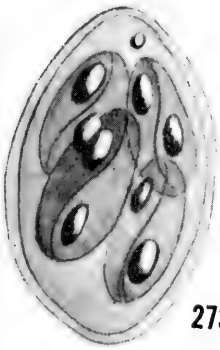

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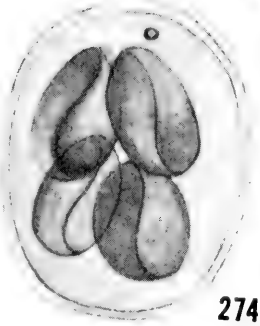

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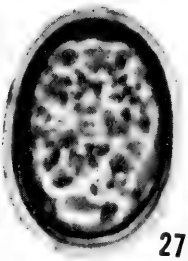

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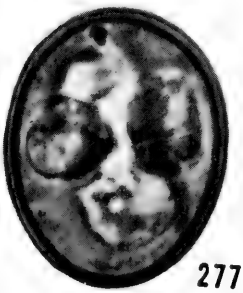

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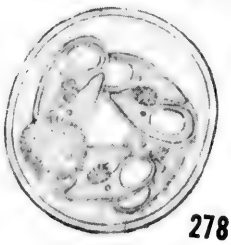

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PLATE 34

FIG. 279. *Eimeria os* Crouch and Becker, 1931. Oocyst from *Marmota monax* (from Crouch and Becker, 1931). × 1900.

FIG. 280. *Eimeria perforoides* Crouch and Becker, 1931. Oocyst from *Marmota monax* (from Crouch and Becker, 1931). × 1900.

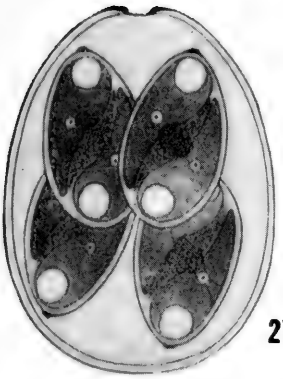
FIGS. 281 AND 282. *Eimeria callospermophili* Henry, 1932 from *Spermophilus lateralis* (from Henry, 1932). × 1800.

281. Unsporulated oocyst showing large polar granule and roughened wall.

282. Sporulated oocyst showing residual body above two sporocysts; other sporocysts not in focus.

FIGS. 283 AND 284. *Eimeria volgensis* Sassuchin and Rauschenbach, 1932. Oocysts from *Spermophilus pygmaeus* (from Zolotarev, 1938). × 1500.

FIGS. 285 AND 286. *Eimeria bilamellata* Henry, 1932. Oocysts from *Spermophilus lateralis* (from Henry, 1932). × 1800.



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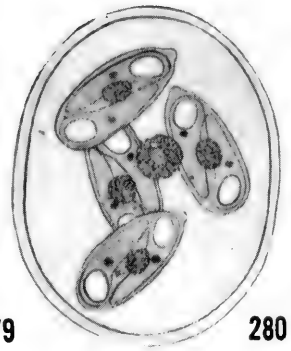

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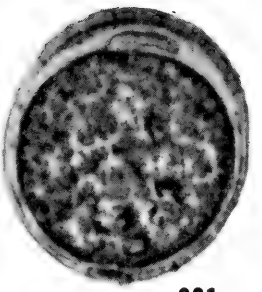

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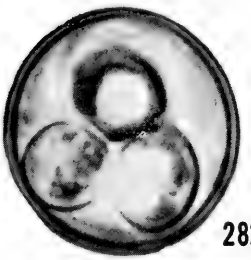

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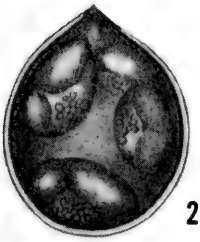

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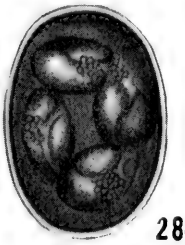

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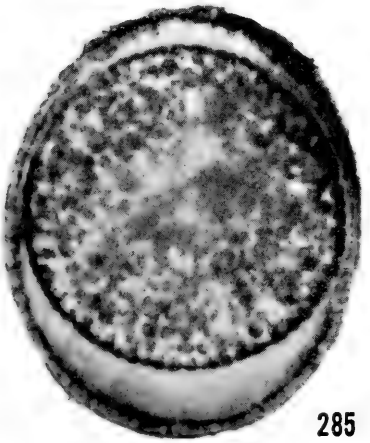

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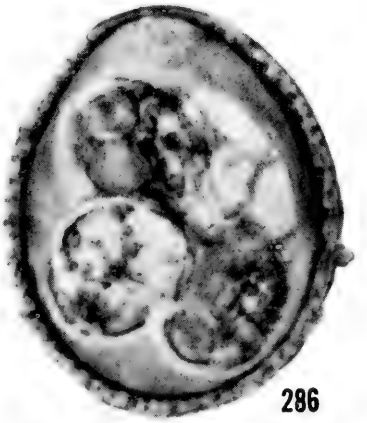

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Plate 35

Fig. 287. *Eimeria bilamellata* Henry, 1932. Oocyst from *Spermophilus lateralis* (from Henry, 1932). × 1800. The outer, roughened wall is split in half and lies above and below the oocyst. The inner wall is smooth and transparent.

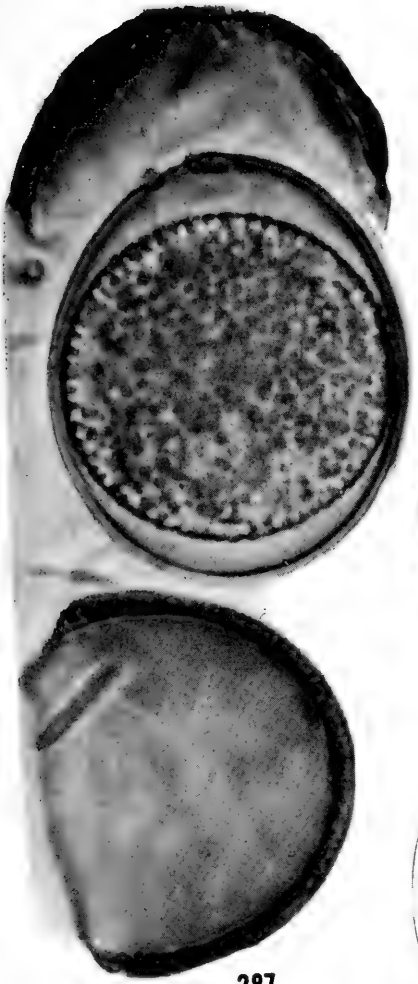
Fig. 288. *Eimeria residua* Henry, 1932. Oocyst from *Neotoma fuscipes* (from Henry, 1932). × 1800.

Figs. 289 and 290. *Eimeria ondatrazibethicae* Martin, 1930 emend. from *Ondatra zibethica* (from Martin, 1930).

289. Sporulated oocyst. × 1700.

290. Sporocyst. × 1800.

Fig. 291. *Eimeria citelli* Kartchner and Becker, 1930. Oocyst from *Spermophilus pygmaeus* (from Yakimoff and Sokoloff, 1934). × 3600.



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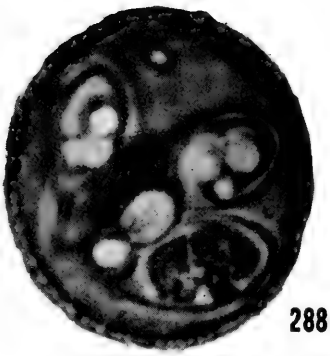

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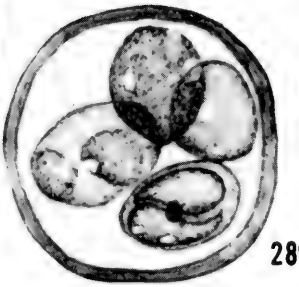

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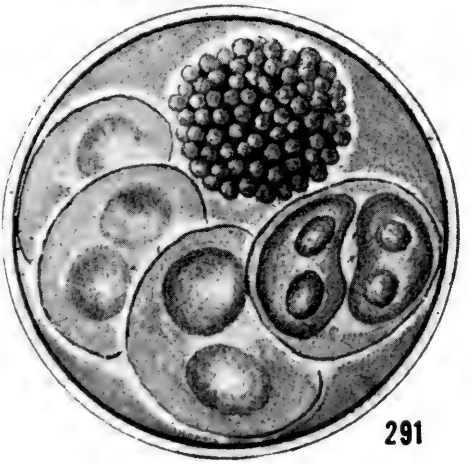

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Plate 36

Fig. 292. *Eimeria beckeri* Yakimoff and Sokoloff, 1935. Oocyst from *Spermophilus pygmaeus* (from Yakimoff and Sokoloff, 1935). × 3600.

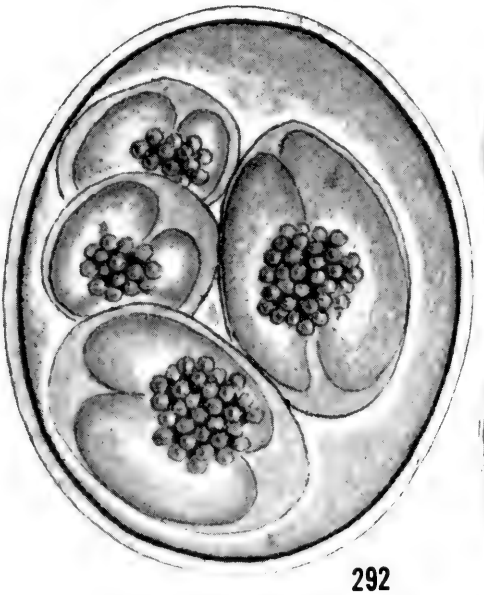
Fig. 293. *Eimeria ellobii* Svanbaev, 1956. Oocyst from *Ellobius talpinus* (from Svanbaev, 1956). × 900.

Fig. 294. *Eimeria markovi* Svanbaev, 1956. Oocyst from *Meriones tamariscinus* (from Svanbaev, 1956). × 900.

Figs. 295–297. *Eimeria oryzomysi* Carini, 1937, from *Oryzomys* sp. (from Carini, 1937).

295 and 296. Sporulated oocysts. × 1300.

297. Villus, showing endogenous stages.



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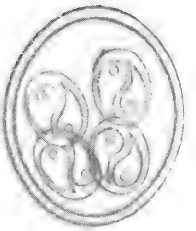

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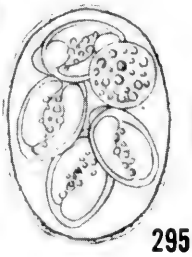

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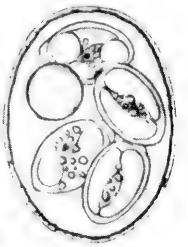

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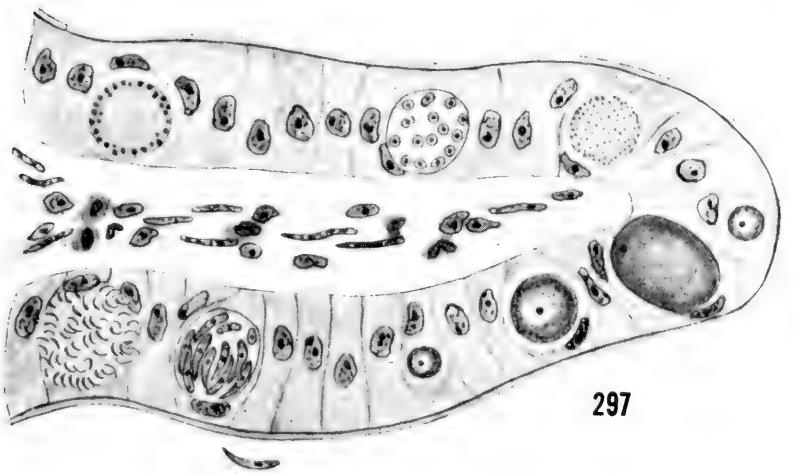

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Plate 37

Fig. 298. *Eimeria hindlei* Yakimoff and Gousseff, 1938. Oocyst from *Mus musculus* (from Yakimoff and Gousseff, 1938). × 2200.

Fig. 299. *Eimeria musculi* Yakimoff and Gousseff, 1938. Oocyst from *Mus musculus* (from Yakimoff and Gousseff, 1938). × 1700.

Fig. 300. *Eimeria vinckei* Rodhain, 1954. Oocyst from *Thamnomys surdaster surdaster* (from Rodhain, 1954). × 1300.

Fig. 301. *Eimeria arvicanthis* van den Berghe and Chardome, 1956. Oocyst from *Arvicanthis abyssinicus rubescens* (from van den Berghe and Chardome, 1956). × 2800.

Figs. 302–312. *Eimeria miyairii* Ohira, 1912 from *Rattus norvegicus* and *Rattus rattus* (?) (from Matubayasi, 1938). × 3900.

302–304. Schizogony.

305. Merozoites.

306–308. Microgametogony.

309–312. Macrogametogony.

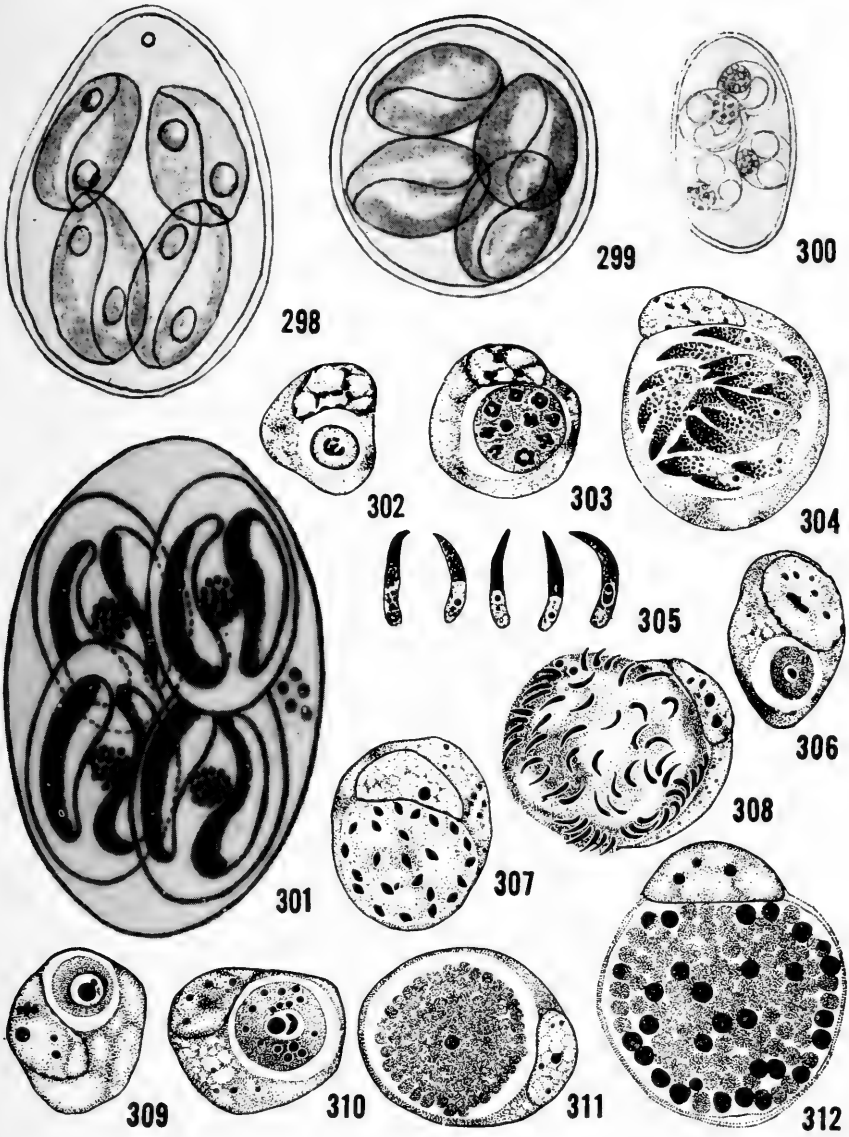
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PLATE 38

FIGS. 313–325. *Eimeria nieschulzi* Dieben, 1924 from *Rattus norvegicus* and *Rattus rattus* (?) (from Matubayasi, 1938). × 3900.

313–316. First type of schizogony.

317–319. Second type of schizogony.

320. Merozoites of both types.

321–323. Macrogametogony.

324 and 325. Microgametocytes.

FIGS. 326–332. *Eimeria separata* Becker and Hall, 1931 from *Rattus norvegicus* and *Rattus rattus* (?) (from Matubayasi, 1938). × 3900.

326–328. Schizogony.

329. Merozoites.

330 and 331. Macrogametogony.

332. Mature microgametocyte.

FIGS. 333 AND 334. *Eimeria hasei* Yakimoff and Gousseff, 1936. Oocyst from *Rattus rattus* (from Yakimoff and Gousseff, 1936). × 1800.

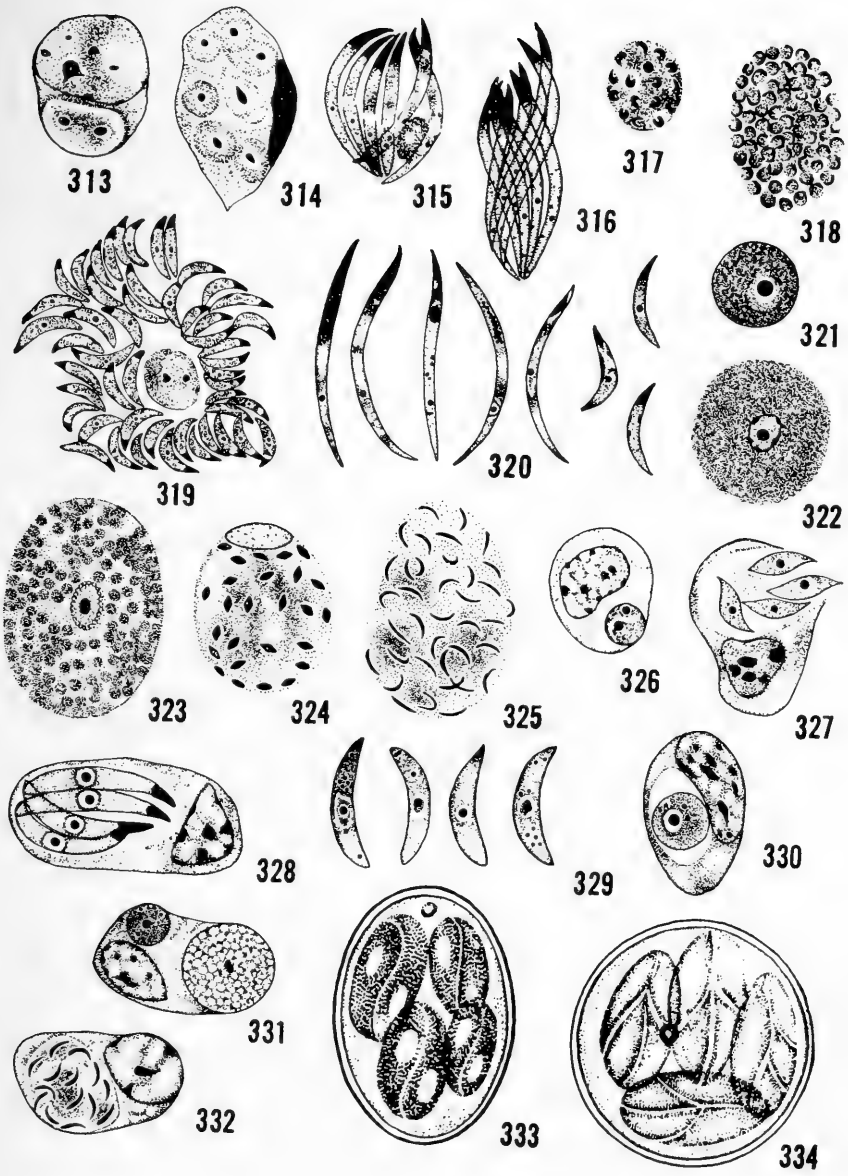
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Plate 39

Fig. 335. *Eimeria nochti* Yakimoff and Gousseff, 1936. Oocyst from *Rattus rattus* (from Yakimoff and Gousseff, 1936). × 2100.

Fig. 336. *Eimeria ratti* Yakimoff and Gousseff, 1936. Oocyst from *Rattus rattus* (from Yakimoff and Gousseff, 1936). × 1500.

Figs. 337–339. *Eimeria falciformis* (Eimer, 1870) Schneider, 1875 from *Mus musculus*.

337, 338. Oocysts (from Wenyon, 1926). × 1500.

339. Oocyst (from Clarke, 1895). × 900.

Fig. 340. *Eimeria aguti* Carini, 1935. Oocyst from *Dasyprocta aguti* (from Carini, 1935). × 1200.

Fig. 341. *Eimeria gliris* Musaev and Veĭsov, 1961. Oocyst from *Glis glis* (from Musaev and Veĭsov, 1961). × 2000.

Fig. 342. *Eimeria capibarae* Carini, 1937. Oocyst from *Hydrochoerus hydrochoerus* (from Carini, 1937). × 1700.

Fig. 343. *Eimeria hydrochoeri* Carini, 1937. Oocyst from *Hydrochoerus hydrochoerus* (from Carini, 1937). × 1700.

Fig. 344. *Eimeria cotiae* Carini, 1935. Oocyst from *Dasyprocta aguti* (from Carini, 1935). × 1100.

Fig. 345. *Eimeria paraensis* Carini, 1935. Oocyst from *Dasyprocta aguti* (from Carini, 1935). × 1100.


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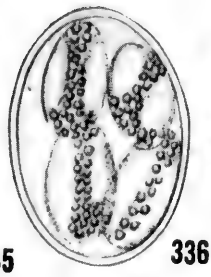
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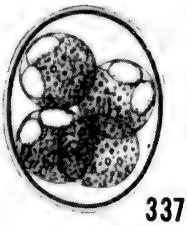
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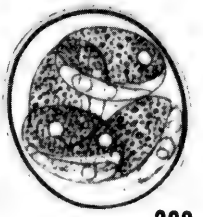
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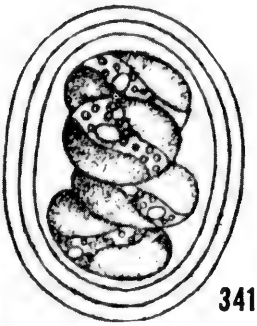
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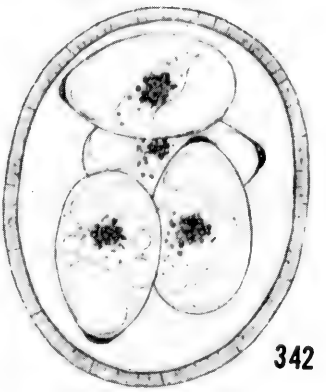
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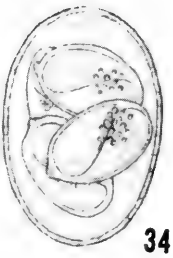
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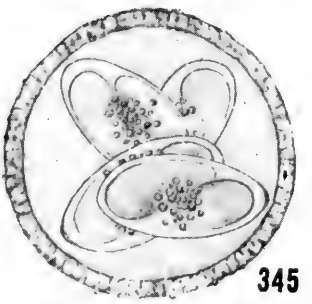
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Plate 40

Fig. 346. *Eimeria schueffneri* Yakimoff and Gousseff, 1938. Oocyst from *Mus musculus* (from Yakimoff and Gousseff, 1938). × 2500.

Fig. 347. *Eimeria keilini* Yakimoff and Gousseff, 1938. Oocyst from *Mus musculus* (from Yakimoff and Gousseff, 1938). × 1800.

Fig. 348. *Eimeria lavieri* Yakimoff and Gousseff, 1936. Oocyst from *Allactaga major* (from Yakimoff and Gousseff, 1936). × 2700.

Fig. 349. *Eimeria joyeuxi* Yakimoff and Gousseff, 1936. Oocyst from *Allactaga major* (from Yakimoff and Gousseff, 1936). × 1900.

Figs. 350–357. *Eimeria caviae* Sheather, 1924 from *Cavia porcellus.*

350, 351. Sporulating and sporulated oocysts respectively (from Sheather, 1924). × 1000.

352–357. Schizogony (from Lapage, 1940).

352. First division of the nucleus of the schizont. Karyosome appears to be dividing into two unequal portions. × 2250.

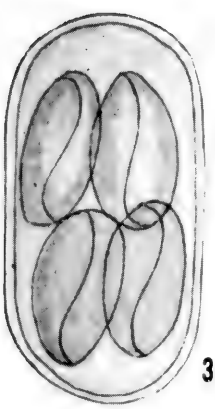
353. Young schizont showing two karyosomes, formed by first division of nucleus, beginning to elongate for second division. × 2250.

354. Young schizont with three nuclei showing that division of the nuclei is not synchronous. Two of the nuclei show only the karyosomes and the halo of karyolymph, the extrakaryosomatic areas of these nuclei having been decolorized by differentiation of the iron hematoxylin. The extrakaryosomatic area of the third nucleus still retains some of its stain. × 2250.

355. Young schizont showing simulation of division of its nucleus. × 2250.

356. Schizont with three nuclei in the resting phase. × 2250.

357. Schizont with nuclei showing amitotic divisions. × 2250.



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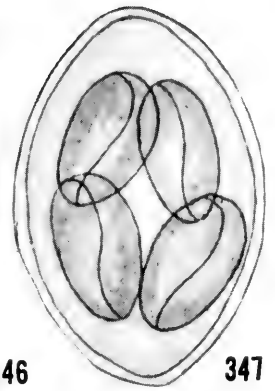

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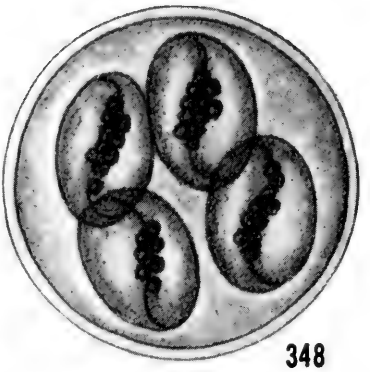

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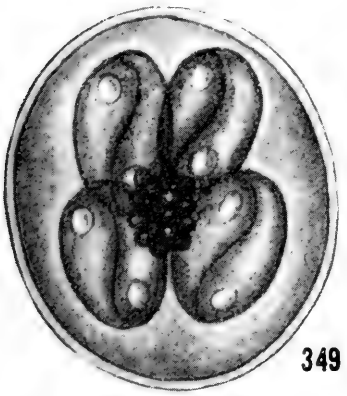

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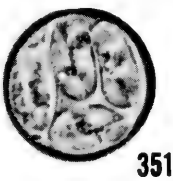

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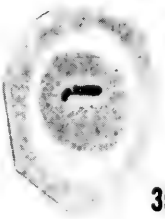

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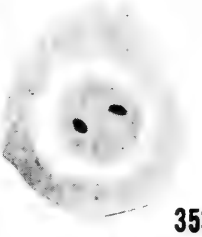

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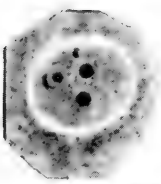

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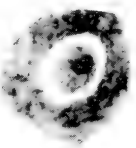

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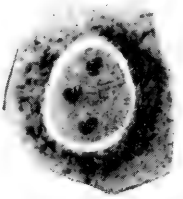

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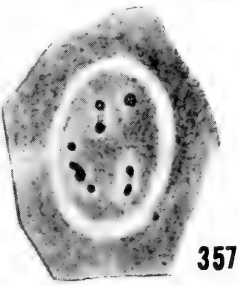

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Plate 41

Figs. 358–371. *Eimeria caviae* Sheather, 1924 from *Cavia porcellus* (from Lapage, 1940).

358. Schizont or microgametocyte. The two are indistinguishable until more nuclei are present. × 1500.

359. A bundle of merozoites. Residual body absent. Nuclei in typical resting phase. × 2250.

360, 361. A bundle of merozoites. Residual body present in each. Nuclei overstained so that typical structure is obscured. × 1500.

362. Microgametocyte. × 1500.

363. Microgametocyte at stage where nuclei stain lightly. × 1500.

364. Microgametocyte showing chromatin massing along one border of the nucleus before each nucleus forms the body of a microgamete. × 1500.

365. Young microgametes being formed on surface of microgametocyte. × 1500.

366. Mature microgametes on surface of microgametocyte. × 1500.

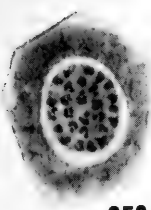
367. Young macrogamete with nucleus in typical resting phase and a cluster of small, spherical granules. × 1500.

368. An almost mature macrogamete with a single nucleus in resting phase and its cytoplasm full of granules. × 1500.

369. A young oocyst with its outer wall only, formed from the outermost row of granules; the inner ones, which stain yellow with azan, are left. × 1500.

370. An oocyst with both its walls. A few of the granules which stain yellow with azan and form the inner wall remain in the cytoplasm. The nucleus appears flattened and distorted. × 1500.

371. Mature oocyst with its walls and nucleus in typical resting phase. × 1500.



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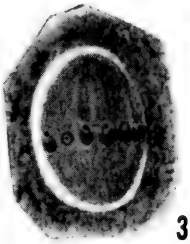

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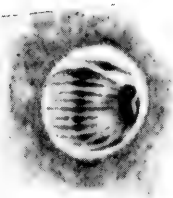

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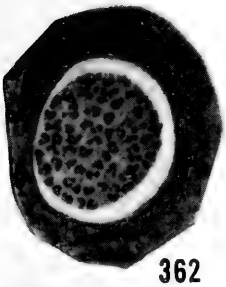

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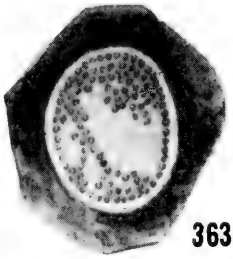

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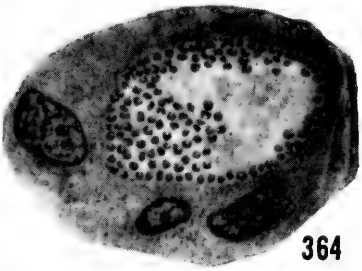

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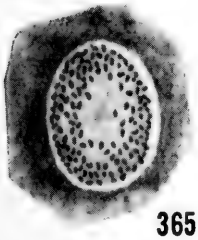

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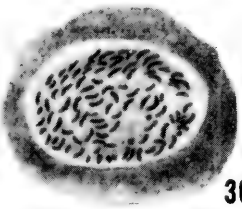

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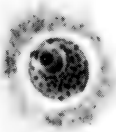

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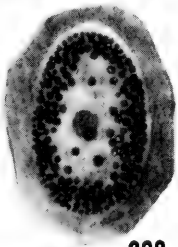

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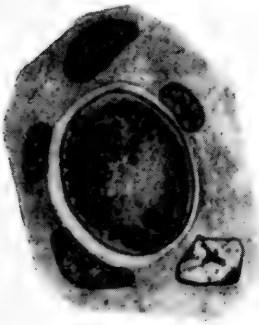

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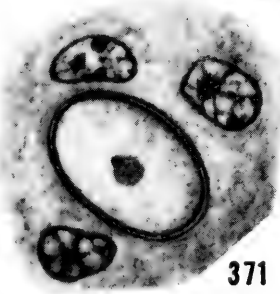

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Plate 42

Figs. 372–374. *Eimeria seideli* Pellérdy, 1957 from *Myocastor coypus* (from Seidel, 1954).

372. Immature sporocyst. × 2300.

373. Mature sporocyst. × 2300.

374. Sporulated oocyst. × 1200.

Fig. 375. *Isospora freundi* Yakimoff and Gousseff, 1935. Oocyst from *Cricetus cricetus* (from Yakimoff and Gousseff, 1935). × 1600.

Fig. 376. *Eimeria krijgsmanni* Yakimoff and Gousseff, 1938. Oocyst from *Mus musculus* (from Yakimoff and Gousseff, 1938). × 2200.

Fig. 377. *Wenyonella uelensis* van den Berghe, 1938. Oocyst from *Funisciurus anerythrus* (from van den Berghe, 1938). × 1900.

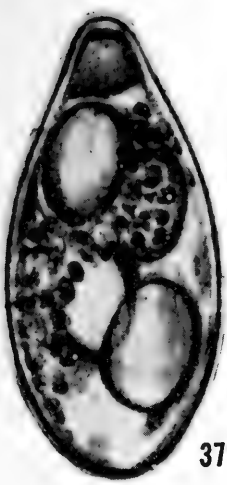
Fig. 378. *Wenyonella parva* van den Berghe, 1938. Oocyst from *Tamiscus emini* (from van den Berghe, 1938). × 1900.

Fig. 379. *Isospora uralicae* Svanbaev, 1956. Oocyst from *Apodemus sylvaticus* (from Svanbaev, 1956). × 900.

Figs. 380–382. *Wenyonella hoarei* Ray and Das Gupta, 1935 from *Sciurus* sp. (from Ray and Das Gupta, 1935).

380, 381. Sporulated oocysts. × 1400.

382. Mature sporocyst. × 2100.



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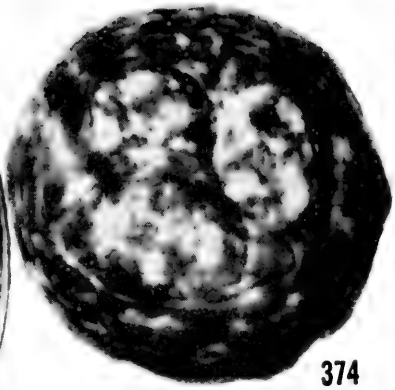

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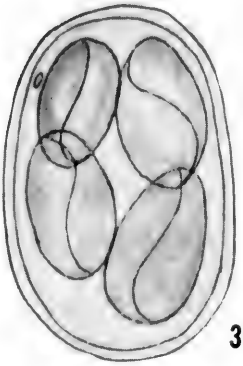

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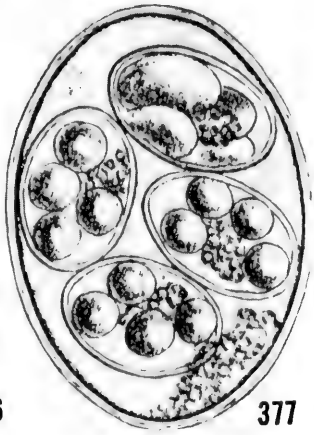

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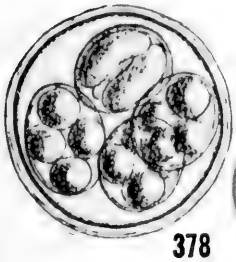

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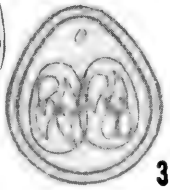

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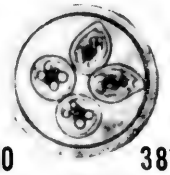

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Plate 43

Figs. 383–403. *Cryptosporidium muris* Tyzzer, 1907 from *Mus musculus* (from Tyzzer, 1910).

383. A minute organism which has become attached to the surface of the epithelium. It has a delicate limiting membrane and an organ of attachment. The cytoplasm stains intensely blue and contains a large vacuole, probably of lipoid material.

384. A similar organism of somewhat larger size. A delicate protoplasmic process extends from the organ of attachment.

385. In this organism there are two masses of chromatin which are apparently about to divide into four.

386. The four masses of chromatin are somewhat irregular and each is surrounded by a mass of cytoplasm which bulges slightly from the surface of the organism.

387. The chromatin is now situated within eight fingerlike processes which project from the surface away from the organ of attachment.

388. Mature schizont about which there is no apparent limiting membrane. The eight merozoites remain in a compact mass with a small amount of residual material.

389. Free merozoites showing variation in size.

390. A minute organism with a relatively large amount of chromatin probably destined to become a microgametocyte.

391. Microgametocyte with two masses of chromatin.

392. A later stage of nuclear division.

393. Microgametocyte in which 8 masses of chromatin are in the process of dividing into 16.

394. Mature microgametocyte showing the characteristic grouping of the microgametes over the surface of the residual material away from the organ of attachment.

395. Mature microgametocyte on the surface of which there are 15 microgametes.

396. Small macrogamete showing nucleus and a small mass of red staining granules.

397. Macrogamete showing the outline of the iodophilic granules, which are practically unstained.

398. Group of macrogametes, one of which has a delicate process extending from the organ of attachment. All have the red-staining granules and some contain vacuoles and hyaline globules.

399. Three oocysts with immature sporozoites and a residuum. The red-staining material has become fused into a homogeneous globule within the residual mass.

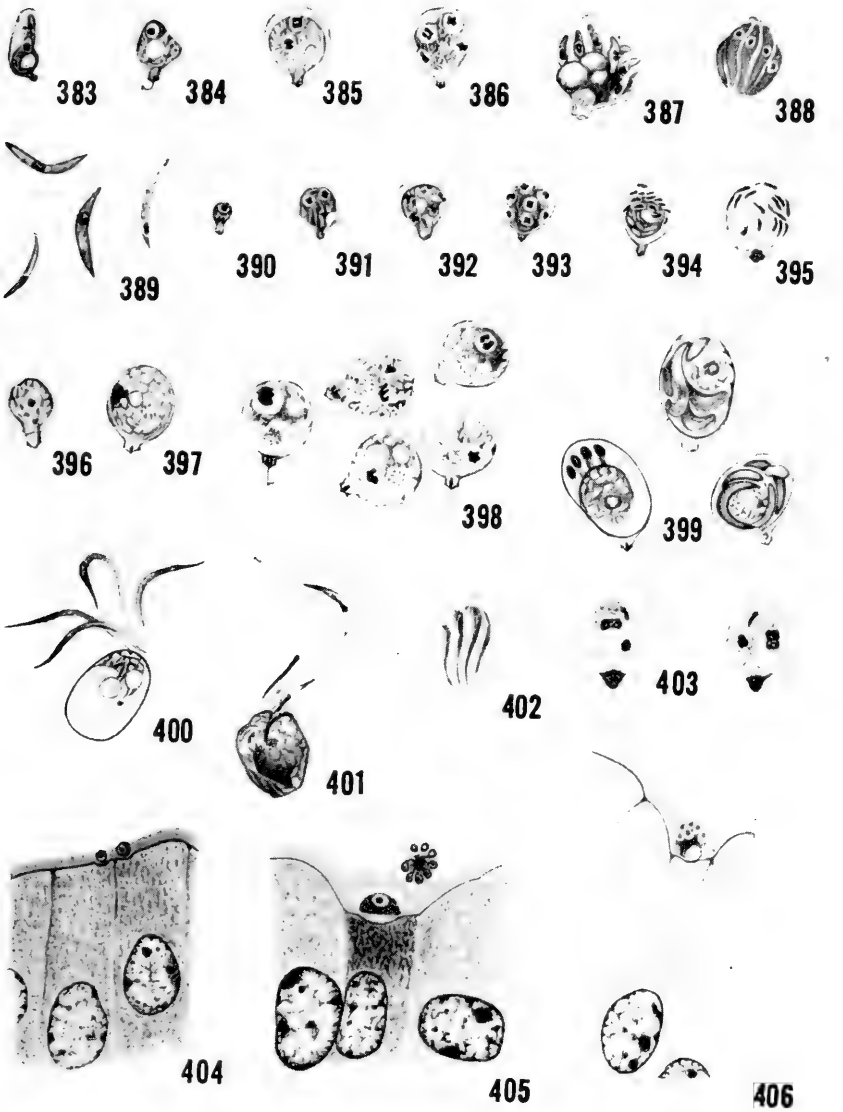
400. Oocyst from which the mature sporozoites have escaped.

401. Oocyst from which the sporozoites are escaping. The rod-shaped nucleus is apparent near the sharper end of the sporozoites.

402. Mature oocyst showing the characteristic arrangement of the sporozoites, which are bent over the centrally situated residuum and are spirally twisted.

403. Two macrogametes showing male and female pronuclei.

Figs. 404–406. *Cryptosporidium parvum* Tyzzer, 1912 from *Mus musculus* (from Tyzzer, 1912). × 1800.



404. Two minute organisms situated in the striated border of the epithelium of a villus.

405. Large organism with a single nucleus, probably a schizont, attached to the surface of an epithelial cell. Above this is a schizont showing 8 merozoites in optical cross section arranged around a centrally situated residuum.

406. Schizont with nuclei arranged at the surface away from pole of attachment.

Plate 44

Figs. 407–422. *Cryptosporidium parvum* Tyzzer, 1912 from *Mus musculus* (from Tyzzer, 1912). × 1800.

407. Free merozoites, some of which are grouped about a mass of residual material. To the left certain organisms which have become attached are still elongate.

408. From left to right a schizont with two nuclei, two macrogametes which appear somewhat vacuolated owing to the dissolving out of the iodophilic granules; to the right of these, an uninucleated organism.

409. Macrogamete with a minute deeply stained rod or granule near its surface and between this and the nucleus a clear space, an appearance suggesting a stage of fertilization.

410. Mature oocyst containing four long sporozoites.

411. Immature microgametocyte.

412. Mature microgametocyte.

413, 414. Merozoites showing change in shape and structure attending their attachment to the surface of the epithelium.

415–422. Forms illustrating schizogony. The schizonts in some instances appear larger than they actually are on account of flattening. Fig. 417 shows arrangement of chromatin masses in pairs during nuclear division. Fig. 418 shows the granular structure of the chromatin, and it as well as Fig. 420 shows a delicate limiting membrane. Fig. 422 shows more or less immature merozoites.

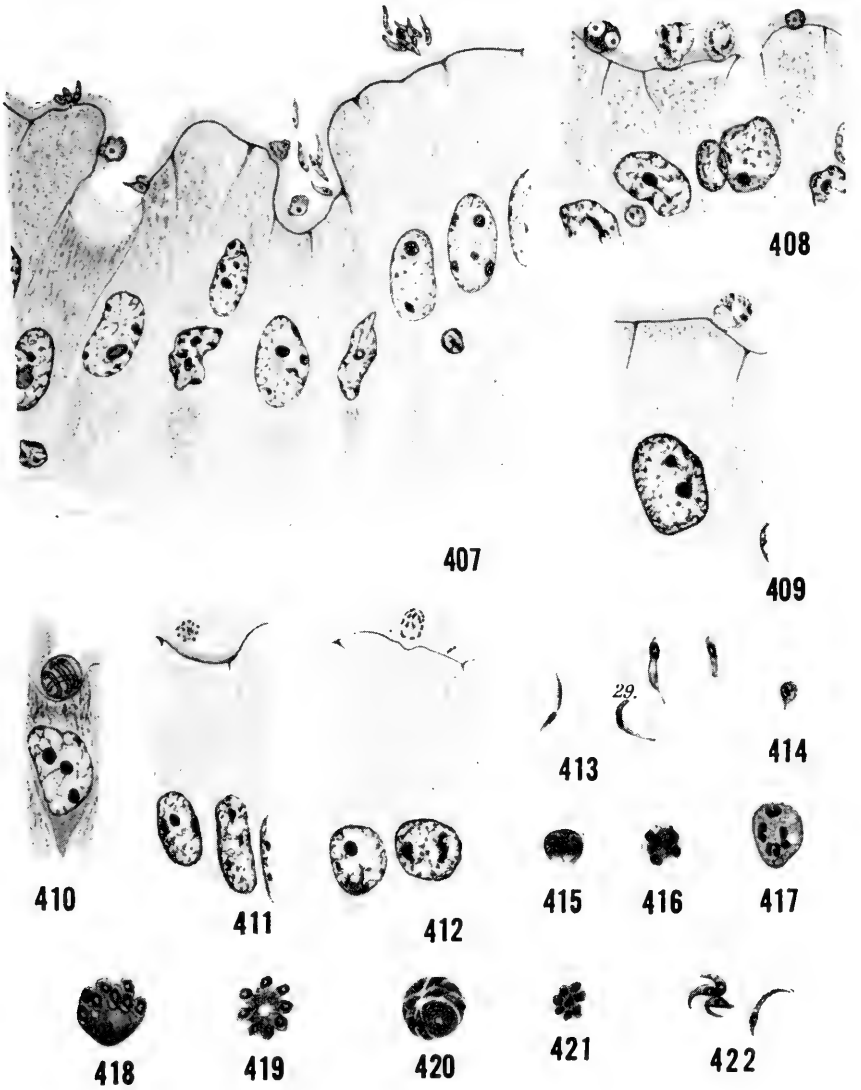

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Plate 45

Figs. 423–429. *Klossiella muris* Smith and Johnson, 1902 from *Mus musculus* (from Smith and Johnson, 1902).

423. Infected cell from a fresh kidney. It contains a sporont within a large vacuole. The spherical refractile bodies in the sporont are plastin granules. × 850.

424. Double infection. The nucleus has already divided and become distributed near the periphery. × 737.

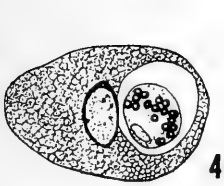
425. Mother sporoblast, showing nuclei near periphery, containing one to four karyosomes and a mass of granular chromatin. × 1435.

426. Longitudinal section of portion of a convoluted tubule with three infected cells almost occluding its lumen. The two cells to the right show the attachment of the infected cell to the basement membrane by a narrow, densely granular peduncle. The increase in size of the infected cells is clearly seen. × 870.

427. Mother sporoblast, with daughter sporoblasts beginning to form. × 1475.

428. A stage a little later than the preceding. The daughter sporoblasts, each with its nucleus at its distal end, appear to bud out from a large central mass. × 1590.

429. Daughter sporoblasts nearly complete, still attached by a narrow peduncle to the central mass. × 1590.



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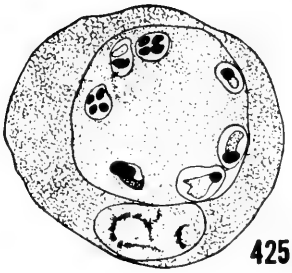

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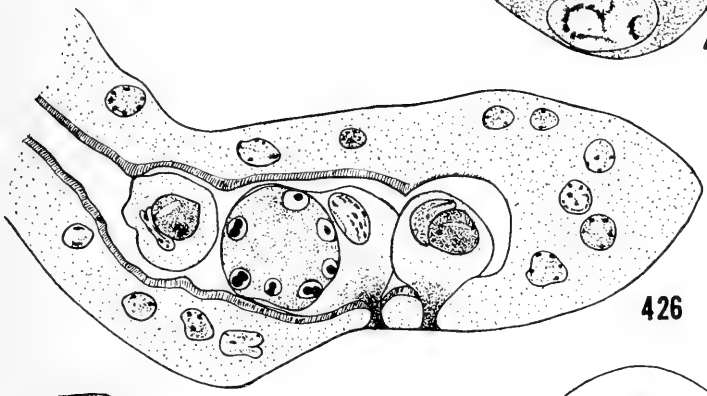

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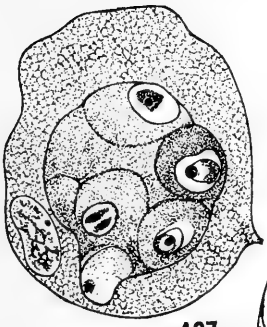

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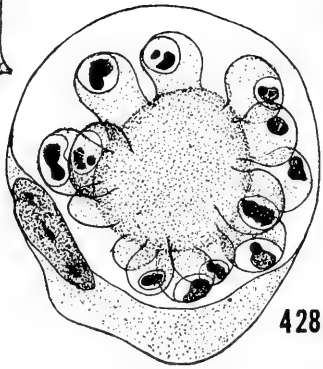

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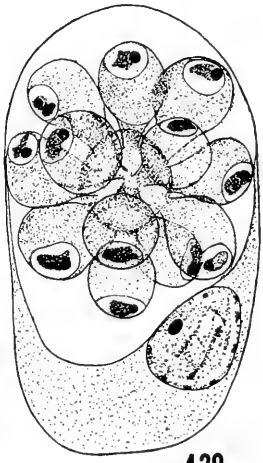

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PLATE 46

FIGS. 430–437. *Klossiella muris* Smith and Johnson, 1902 from *Mus musculus* (from Smith and Johnson, 1902).

430. Transverse section of convoluted tubule, with very large flask-shaped cell, containing *Klossiella* in the daughter sporoblast stage. The infected cell nearly fills the lumen. It still retains its attachment to the basement membrane by a narrow peduncle. × 870.

431. Infected cell from fresh kidney in salt solution. It contains 14 sporoblasts, in which the small plastin granules are conspicuous. The cell is more or less flattened by pressure of the cover glass. × 850.

432. Small brood of sporoblasts, showing division and distribution of nuclei preparatory to formation of sporozoites. × 870.

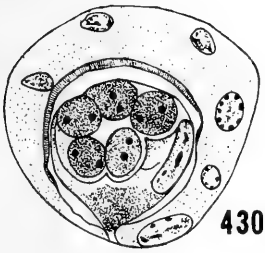
433. Brood of sporocysts still within cell membrane of the completely atrophied host cell. Six sporocysts contain sporozoites; four are solidly stained and opaque. × 870.

434. Sporocyst from fresh kidney showing sporozoites still attached to residuum. × 850.

435. More advanced sporocyst in transverse optical section. The nucleus appears in four sporozoites. × 850.

436. Section of glomerulus showing parasite *in situ* in visceral layer of Bowman's capsule. × 485.

437. Falciform bodies, oldest stage of glomerular parasite observed. × 1590.



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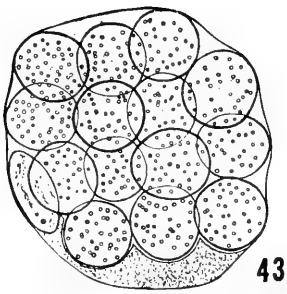

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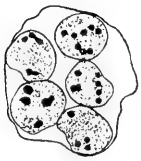

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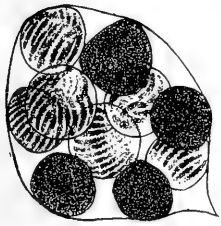

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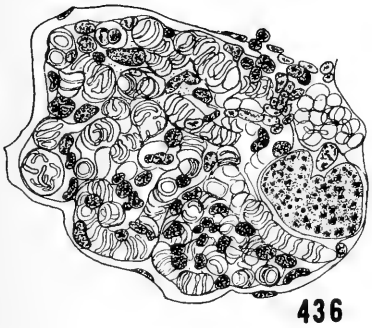

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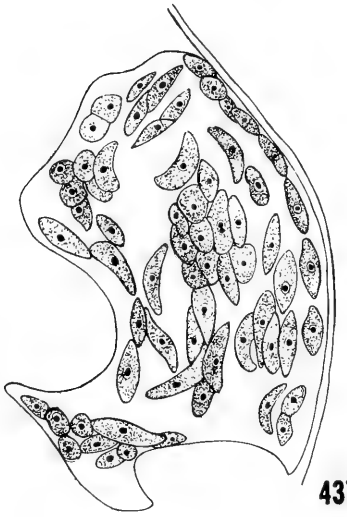


437

Plate 47

Figs. 438–443. *Eimeria nieschulzi* Dieben, 1924 from *Rattus norvegicus* (from Dieben, 1924). × 2300.

438. Unsporulated oocyst. After about half an hour the protoplasm of the new oocyst has contracted into a globule, the sporont.

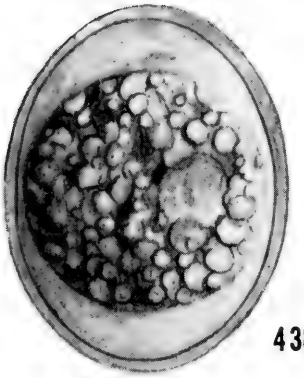
439. Possible chromosome conjugation after fertilization. After a little more than one day, a clear line appears in the sporont; it extends lengthwise through the whole sporont.

440. Possible reduction division. Very often a little body appears to leave the sporont.

441. Sporont becomes irregular, and bright granules appear at four corners. The sporont then becomes rectangular.

442. "Buckel" or "stringed" stage.

443. Four daughter globules formed by deepening of the grooves.



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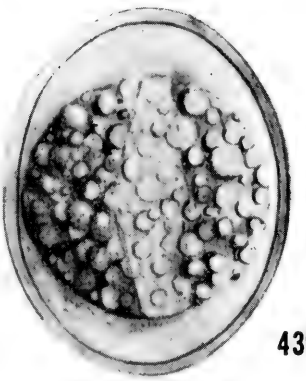

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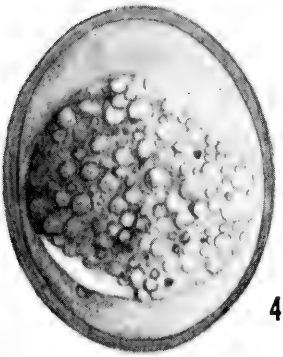

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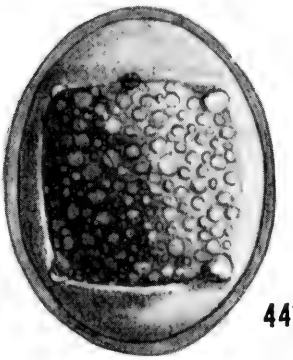

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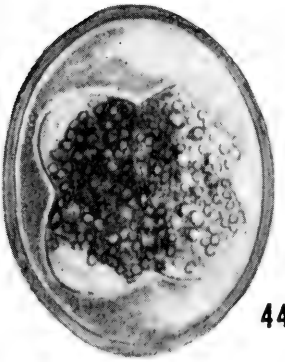

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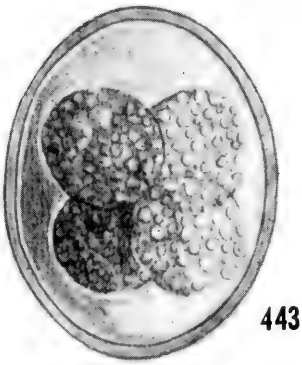
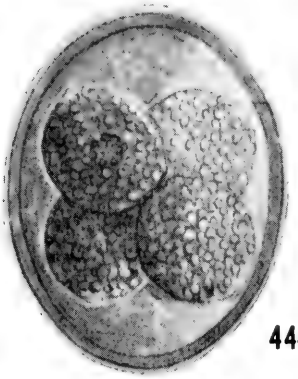


443

Plate 48

Figs. 444–449. *Eimeria nieschulzi* Dieben, 1924 from *Rattus norvegicus* (from Dieben, 1924). × 2300.

444. "Pseudopyramid" stage of sporont.
445. Pyramid stage.
446. Four rounded sporoblasts formed.
447. Sporoblasts become oval and sporozoites begin to form.
448, 449. Completely sporulated oocysts.



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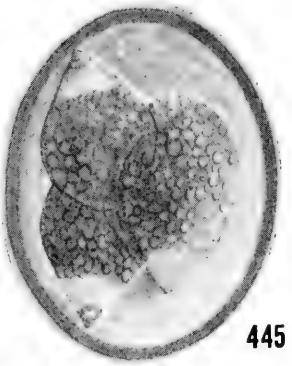

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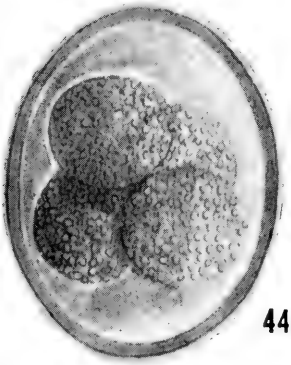

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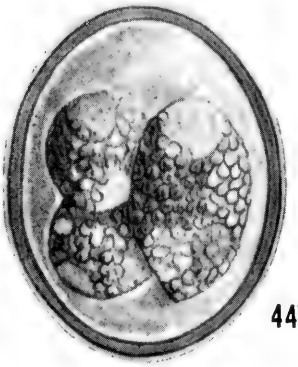

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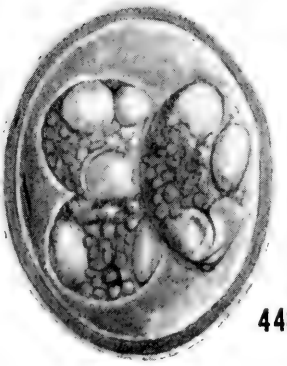

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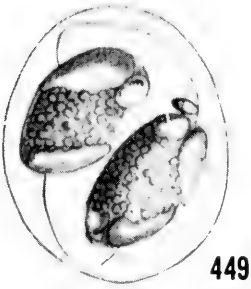

449

ADDENDUM

Since the manuscript for this monograph was submitted for publication, several additional species of rodent coccidia have been described.

Svanbaev (1963) described four species of *Eimeria* and one of *Isospora* from the marmot *Marmota marmota menzbieri* (syn., *M. menzbieri*) in Kazakhstan, USSR. Under the name *Eimeria monacis* Fish, 1930, he described a species with ovoid, short ovoid, or spherical oocysts measuring 16–28 × 13–24 μ, with a mean of 23.5 × 19 μ; with a smooth, yellow-green, double-contoured wall 0.8–1.8 μ thick; without a micropyle but with an oocyst polar granule and oocyst residuum; with spherical or ovoid sporocysts measuring 6–10.5 × 7.0–7.2 μ [*sic*], with a mean of 8.5 × 6.5 μ [*sic*], without a sporocyst residuum but with a refractile globule in the sporozoites. This species is neither *E. monacis* nor any other species of *Eimeria* previously described from *Marmota*. We are therefore naming it *Eimeria tyanshanensis* n. sp., since the hosts came from western Tyan-Shan.

Under the name *Eimeria os* Crouch and Becker, 1931, Svanbaev (1963) described a species with spherical, short ovoid, or ovoid oocysts measuring 18–25 × 16–23 μ, with a mean of 22 × 20 μ; with a smooth, double-contoured, greenish or yellow-green wall 0.9–1.8 μ thick; without a micropyle or oocyst polar granule but with an oocyst residuum; with ovoid sporocysts measuring 7–10 × 5–8 μ, with a mean of 8 × 7 μ and with a sporocyst residuum. This species is not *E. os*, but appears to be *E. monacis*.

Under the name *Eimeria menzbieri* Svanbaev, 1963, he described a species with ovoid or short ovoid oocysts measuring 18–28 × 13–24 μ,

with a mean of 24 × 21 μ; with a smooth, double-contoured, yellow-brown or yellow-orange wall 1.2–2.1 μ thick (illustrated as composed of two layers); with a micropyle but without an oocyst polar granule or oocyst residuum; with ovoid or short ovoid sporocysts measuring 8–11 × 6–8 μ, with a mean of 9 × 7 μ, with a Stieda body, sporocyst residuum, and refractile globules in the sporozoites. This species is probably valid, since it appears to be different from any other species of *Eimeria* from *Marmota* even though it has some resemblance to *E. os.*

Under the name *Eimeria* sp., Svanbaev (1963) described a species with ovoid to short ovoid oocysts measuring 79–89 × 63–68 μ, with a mean of 84 × 66 μ; with a yellow-brown, tri-contoured wall 5–6 μ thick of which the outer layer was rough and the inner layer radially striated; without a micropyle, oocyst polar granule, or oocyst residuum; with ovoid, short ovoid, or spherical sporocysts measuring 24–30 × 21–27 μ, with a mean of 27 × 24 μ. These oocysts did not sporulate completely. This form differs from any species of *Eimeria* described from *Marmota,* but, since it did not sporulate completely, it is best left unnamed.

Under the name *Isospora* sp., Svanbaev (1963) described a species with short ovoid to spherical oocysts measuring 20–22 × 19–20 μ, with a mean of 21 × 20 μ; with a smooth, greenish, double-contoured wall 1 μ thick; without a micropyle or oocyst residuum but with an oocyst polar granule; with ovoid sporocysts measuring 14–15 × 7–8 μ, with a mean of 14 × 7 μ. These oocysts did not sporulate completely. This form resembles *I. citelli* Levine, Ivens, and Kruidenier, 1957, but, since it did not sporulate completely, it is best left unnamed.

Vetterling (1964) described three species of *Eimeria* from the prairie dog *Cynomys l. ludovicianus* from Colorado. The first was an emended description of *E. cynomysis* Andrews, 1928. This species has subspherical to ovoid oocysts measuring 30–37 × 25–31 μ, with a mean of 32.5 × 29 μ and with length-width ratios of 1.05–1.31, with a mean of 1.15; with a smooth, yellow-green wall 1.4 μ thick composed of two layers, with a micropyle 5 μ wide, but without oocyst polar granule or oocyst residuum; with lemon-shaped sporocysts measuring 18 × 12 μ, with a Stieda body and sporocyst residuum, without sporozoite globules.

Eimeria ludoviciani Vetterling, 1964 has subspherical to ellipsoidal oocysts measuring 16–26 × 13–21 μ, with a mean of 21 × 18 μ and length-width ratios of 1.07–1.42, with a mean of 1.21; with a smooth, colorless wall 0.9 μ thick composed of two layers; without a micropyle but with oocyst polar granule and oocyst residuum; with lemon-shaped sporocysts measuring 9 × 7 μ, with a Stieda body and sporocyst residuum but without sporozoite globules.

Eimeria larimerensis Vetterling, 1964 has spherical to ellipsoidal

oocysts measuring 31–40 × 26–37 μ, with a mean of 36.5 × 32 μ and length-width ratios of 1.00–1.33, with a mean of 1.15; with a mammillated wall composed of two layers, of which the outer is brown, granular, and 1.7 μ thick and the inner thin and colorless; without a micropyle or oocyst residuum but with an oocyst polar granule; with lemon-shaped sporocysts measuring 18 × 12 μ, with a Stieda body and sporocyst residuum.

Levine and Ivens (1963) described *Eimeria siniffi* Levine and Ivens, 1963 from the deermouse *Peromyscus maniculatus*. It has oocysts with straight sides and rounded ends measuring 26–31 × 17–19 μ, with a mean of 28 × 18 μ; with a smooth, colorless to pale yellowish wall composed of a single layer 1.2 μ thick; with an operculated micropyle, with an oocyst polar granule, and without an oocyst residuum but with a trace of cobwebby material; with elongate ovoid sporocysts measuring 13–15 × 6–7 μ, with a mean of 14 × 7 μ, without a Stieda body but with a sporocyst residuum.

Prasad (1960) described three new species of *Eimeria* and one of *Isospora* from different hosts. *Eimeria egypti* Prasad, 1960 from *Meriones s. shawi* has ovoid oocysts measuring 27–29 × 15–17 μ, with a mean of 28 × 16 μ; with a smooth, light brown wall composed of two layers of which the outer is thicker than the inner; with a micropyle 4 μ wide and an oocyst residuum, but probably without an oocyst polar granule; with piriform sporocysts measuring 7–9 × 4–5 μ, with a Stieda body, sporocyst residuum, and sporozoite globules.

Eimeria sylvatica Prasad, 1960 from *Apodemus sylvaticus* has ovoid or spherical oocysts measuring 16–21 × 10–17 μ, with a mean of 18.5 × 14 μ (with the spherical oocysts having a mean of 14 μ); with a smooth, pale yellow wall composed of three layers, of which the inner is very thin and the middle one rather thicker; without a micropyle or oocyst residuum but with an oocyst polar granule; with ovoid sporocysts measuring 11–13 × 5–7 μ, with a sporocyst residuum and probably without a Stieda body.

Eimeria cricetomysi Prasad, 1960 from *Cricetomys gambianus* has ovoid or ellipsoidal oocysts measuring 18–21 × 15–17 μ, with a mean of 19 × 16 μ; with a smooth, yellow wall composed of two layers of which the outer is thicker than the inner; without a micropyle or oocyst residuum but with an oocyst polar granule; with ovoid sporocysts measuring 11–13 × 6–8 μ, with a Stieda body, sporocyst residuum, and sporozoite globules.

Isospora egypti Prasad, 1960 from *Meriones s. shawi* has subspherical oocysts measuring 20–22 × 16–20 μ, with a mean of 21 × 18 μ; with a smooth, light brown wall composed of two layers of which the outer is thicker than the inner; without micropyle, oocyst polar granule, or oocyst

residuum; with ovoid sporocysts measuring 10–12 × 6–8 μ, with a small Stieda body, with a sporocyst residuum, and with sporozoite globules.

Musaev and Veĭsov (1962) described three new species of *Eimeria* from the golden hamster *Mesocricetus auratus* (syn., *Cricetus auratus*) from Transcaucasia. *Eimeria aurata* Musaev and Veĭsov, 1962 has spherical, colorless oocysts measuring 10–18 μ, with a mean of 16 μ; with a smooth, yellow wall composed of a single layer 1 μ thick; without a micropyle or oocyst residuum but with an oocyst polar granule; with spherical or ovoid sporocysts, the former measuring 6–8 × 4–6 μ, with a mean of 6 × 4 μ, and the latter 4–6 μ, with a mean of 4 μ, without a Stieda body or sporozoite globules but with a sporocyst residuum.

Eimeria amburdariana Musaev and Veĭsov, 1962 has spherical, colorless oocysts 18–24 μ in diameter, with a mean of 21 μ; with a smooth wall composed of a single layer 1.5 μ thick; without a micropyle but with oocyst polar granule and residuum; with ovoid sporocysts measuring 8–12 × 6–9 μ, with a mean of 11 × 8 μ, without a Stieda body but with a sporocyst residuum.

Eimeria razgovica Musaev and Veĭsov, 1962 has ovoid oocysts measuring 16–22 × 14–18 μ, with a mean of 21 × 17 μ; with a smooth wall composed of two layers each 1 μ thick, the inner layer dark brown and the outer bright yellow; without a micropyle or oocyst residuum but with an oocyst polar granule; with ovoid sporocysts measuring 6–8 × 4–6 μ, with a mean of 7 × 5 μ, without a Stieda body but with a sporocyst residuum and with sporozoite globules.

Veĭsov (1962) described four new species of *Eimeria* from the vole *Microtus majori* in Azerbaĭdzhan. *Eimeria majorici* Veĭsov, 1962 has ovoid or ellipsoidal colorless oocysts measuring 16–28 × 12–24 μ, with a mean of 23 × 17 μ; with a smooth wall composed of one layer 1.5–2.0 μ thick; without micropyle, oocyst polar granule, or oocyst residuum; with piriform or ovoid sporocysts measuring 6–12 × 4–8 μ, with a mean of 9 × 7 μ, with a Stieda body, sporocyst residuum, and sporozoite globules.

Eimeria abuschevi Veĭsov, 1962 has ovoid, colorless oocysts measuring 22–31 × 16–27 μ, with a mean of 29 × 25 μ; with a smooth wall composed of a single layer 2 μ thick; without micropyle or oocyst polar granule but with an oocyst residuum; with piriform or ovoid sporocysts 8–13 × 4–9 μ, with a mean of 11 × 7 μ, with a Stieda body and sporocyst residuum but without sporozoite globules.

Eimeria correptionis Veĭsov, 1962 has ellipsoidal or ovoid oocysts measuring 18–26 × 14–20 μ, with a mean of 21 × 17 μ; with a smooth, yellowish wall composed of a single layer 1.5 μ thick; with a micropyle but without oocyst polar granule or oocyst residuum; with ovoid or piriform sporocysts measuring 6–11 × 4–7 μ, with a mean of 9 × 5 μ,

apparently without a Stieda body, with a sporocyst residuum, and without sporozoite globules.

Eimeria bicrustae Veĭsov, 1962 has ovoid or ellipsoidal oocysts measuring 16–28 × 12–22 μ, with a mean of 21 × 15 μ; with a smooth wall composed of two layers each 1 μ thick, the inner one dark brownish and the outer one yellowish; without micropyle, oocyst polar granule, or oocyst residuum; with ovoid or piriform sporocysts measuring 6–10 × 4–6 μ, with a mean of 9 × 5 μ, with a Stieda body, sporocyst residuum, and sporozoite globules.

Veĭsov (1963) described eight new species of *Eimeria* plus a ninth form to which he gave a new name from the vole *Microtus arvalis* in Azerbaĭdzhan. He gave the new name to a form of *Eimeria* with ovoid, ellipsoidal, or spherical oocysts measuring 12–24 × 8–18 μ, with a mean of 20 × 16 μ; with a smooth, colorless to yellowish wall composed of a single layer 1.5 μ thick; without a micropyle, oocyst polar granule, or oocyst residuum; with ovoid, piriform, or rarely spherical sporocysts measuring 6–10 × 4–8 μ, with a mean of 9 × 7 μ (and the spherical ones 4–10 μ in diameter, with a mean of 6 μ), with a Stieda body, sporocyst residuum, and sporozoite globules. He called it *Eimeria arvalis* (Iwanoff-Gobzem, 1935) nom. nov. Iwanoff-Gobzem (1935) had described it and had thought that it was the same as *E. arvicolae,* which Galli-Valerio (1905) had described from *Microtus nivalis.* Veĭsov (1963) said that the species of *Eimeria* in *M. arvalis* are different from those in *M. nivalis,* so that the present form must have a different name from *E. arvicolae.* He therefore called it *E. arvalis.* However, the name *E. arvalis* is not available since, as used by Iwanoff-Gobzem (1934), it was a *lapsus calami* for *E. arvicolae.* Futhermore, Veĭsov's (1963) description of this form does not differ from his own (1962) description of *E. majorici* from *M. majori* (to which he did not refer in his later paper). Hence, we consider *E. arvalis* of Veĭsov, 1963 to be a synonym of *E. majorici* Veĭsov, 1962.

Eimeria derenica Veĭsov, 1963 has ovoid or ellipsoidal, colorless oocysts measuring 20–38 × 14–30 μ, with a mean of 29 × 21 μ; with a smooth wall composed of a single layer 2–3 μ thick; without a micropyle or oocyst residuum but with an oocyst polar granule; with ovoid or ellipsoidal sporocysts measuring 8–16 × 4–12 μ, with a mean of 12.5 × 9 μ, without a Stieda body but with sporocyst residuum and sporozoite globules.

Eimeria gomurchaica Veĭsov, 1963 has ovoid or ellipsoidal, colorless oocysts measuring 20–34 × 18–30 μ, with a mean of 28.5 × 24 μ; with a smooth wall composed of a single layer 2–3 μ thick; without a micropyle or oocyst polar granule but with an oocyst residuum; with ovoid or piriform sporocysts measuring 8–16 × 6–12 μ, with a mean of 12.5 × 9 μ, with a Stieda body, sporocyst residuum, and sporozoite globules.

Eimeria zuvandica Veĭsov, 1963 has ovoid, rarely ellipsoidal, colorless oocysts measuring 16–26 × 12–22 μ, with a mean of 22 × 16.5 μ; with a smooth wall composed of a single layer 1.0–1.5 μ thick; with a micropyle and oocyst polar granule but without an oocyst residuum; with ovoid sporocysts measuring 6–10 × 4–8 μ, with a mean of 9 × 7 μ, without a Stieda body but with a sporocyst residuum and sporozoite globules

Eimeria iradiensis Veĭsov, 1963 has ovoid, colorless oocysts measuring 20–32 × 16–24 μ, with a mean of 25 × 20.5 μ; with a rough, granulated, dark yellow wall composed of a single layer 2 μ thick; without a micropyle, oocyst polar granule, or oocyst residuum; with ovoid sporocysts measuring 8–12 × 4–8 μ, with a mean of 11 × 7 μ, with a Stieda body and sporocyst residuum but without sporozoite globules.

Eimeria monocrustae Veĭsov, 1963 has ovoid or subspherical oocysts measuring 22–32 × 18–28 μ, with a mean of 27 × 24 μ; with a rough, yellowish brown wall composed of a single layer 2.5 μ thick; without a micropyle or oocyst polar granule but with an oocyst residuum; with ovoid sporocysts measuring 8–16 × 6–10 μ, with a mean of 12 × 8 μ, with a Stieda body, sporocyst residuum, and sporozoite globules.

Eimeria iwanoffi Veĭsov, 1963 has ovoid or ellipsoidal oocysts measuring 12–30 × 8–26 μ, with a mean of 21.5 × 17.5 μ; with a smooth wall composed of two layers each 1.25 μ thick, the outer yellow-brown and the inner colorless; without a micropyle or oocyst residuum but with an oocyst polar granule; with ovoid or spherical sporocysts, the former measuring 6–14 × 4–10 μ, with a mean of 10 × 7 μ, and the latter measuring 4–8 μ, with a mean of 6 μ, without a Stieda body or sporozoite but with a sporocyst residuum.

Eimeria primbelica Vesĭov, 1963 has ovoid oocysts measuring 20–40 × 16–34 μ, with a mean of 24 × 23 μ; with a smooth wall 2–3 μ thick composed of two layers, the outer yellowish brown and the inner colorless; without a micropyle but with an oocyst polar granule and oocyst residuum; with ovoid sporocysts measuring 6–18 × 4–12 μ, with a mean of 11 × 8 μ, without a Stieda body but with sporocyst residuum and sporozoite globules.

Eimeria kolanica Veĭsov, 1963 has ovoid oocysts measuring 16–26 × 14–22 μ, with a mean of 21 × 19 μ; with a wall composed of two layers each 1 μ thick, the outer dark brown and the inner colorless; with a micropyle but without oocyst polar granule or oocyst residuum; with spherical sporocysts 6–10 μ in diameter, with a mean of 8 μ, without a Stieda body or sporozoite globules but with a sporocyst residuum.

Musaev, Veĭsov, and Alieva (1963) described five new species of *Eimeria* from the social vole *Microtus socialis* in Azerbaĭdzhan. *Eimeria chudatica* Musaev, Veĭsov, and Alieva, 1963 has ovoid or ellipsoidal, colorless

oocysts measuring 10–23 × 8–21 μ, with a mean of 21 × 17 μ; with a smooth wall composed of a single layer 1.0–1.5 μ thick; without a micropyle or oocyst residuum but with an oocyst polar granule; with ovoid or rarely spherical sporocysts, the former measuring 6–11 × 4–9 μ, with a mean of 9 × 5 μ, and the latter measuring 4–9 μ, with a mean of 7 μ, without a Stieda body but with a sporocyst residuum and sporozoite globules. This species is probably valid, although in most respects it resembles *E. derenica* Veĭsov, 1963 from *M. arvalis*.

Eimeria cusarica Musaev, Veĭsov, and Alieva, 1963 has ovoid, colorless oocysts measuring 24–31 × 16–28 μ, with a mean of 29 × 23 μ; with a smooth wall composed of a single layer 2.0–2.5 μ thick; without a micropyle or oocyst residuum but with an oocyst polar granule; with ovoid sporocysts measuring 8–13 × 6–11 μ, with a mean of 11 × 9 μ, with a Stieda body and sporocyst residuum but without sporozoite globules. This species is probably valid, although it resembles *E. wenrichi* Saxe, Levine, and Ivens, 1960, differing essentially only in size.

Eimeria cubinica Musaev, Veĭsov, and Alieva, 1963 has ovoid to ellipsoidal, colorless oocysts measuring 14–24 × 10–18 μ, with a mean of 21 × 15 μ; with a smooth wall composed of a single layer 1.5–2.0 μ thick; with a micropyle but without oocyst polar granule or oocyst residuum; with ovoid or piriform sporocysts measuring 6–11 × 4–9 μ, with a mean of 9 × 5 μ, with a Stieda body, sporocyst residuum, and sporozoite globules.

Eimeria hadrutica Musaev, Veĭsov, and Alieva, 1963 has ovoid or ellipsoidal oocysts measuring 16–32 × 14–24 μ, with a mean of 21 × 17 μ; with a smooth wall composed of two layers each 1.0–1.5 μ thick, the outer one yellowish brown and the inner one colorless; without a micropyle, oocyst polar granule, or oocyst residuum; with ovoid, rarely spherical sporocysts, the former measuring 6–14 × 4–12 μ, with a mean of 9 × 7 μ, and the latter measuring 6–9 μ, with a mean of 7 μ, without a Stieda body but with a sporocyst residuum and sporozoite globules.

Eimeria micropiliana Musaev, Veĭsov, and Alieva, 1963 has ovoid or subspherical oocysts measuring 20–25 × 16–21 μ, with a mean of 23 × 19 μ; with a smooth wall composed of two layers, the outer one dark yellow and 1.5 μ thick, the inner one colorless and 1.0 μ thick; with a micropyle but without oocyst polar granule or oocyst residuum; with ovoid sporocysts measuring 6–11 × 4–7 μ, with a mean of 10 × 5.5 μ, without a Stieda body or sporozoite globules but with a sporocyst residuum.

The above new species bring to 225 the number of named species of coccidia reported from rodents. Of these, 204 are *Eimeria,* 10 *Isospora,* 3 *Wenyonella,* 2 each *Cryptosporidium* and *Klossiella,* and 1 each *Dorisiella, Caryospora, Tyzzeria,* and *Klossia.*

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