

NEW SPECIES OF EIMERIA (PROTOZOA: EIMERIIDAE) FROM MEXICAN RODENTS

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MATERIALS AND METHODS

During the summer of 1956 the University of Illinois Natural History Museum and Graduate College sponsored a collecting expedition to Mexico. The three mammalogists who were members of the expedition, William Z. Lidicker, Jr., Wayne H. Davis and John R. Winkelmann, collected fecal samples from 23 rodents of various species, placed them in 2.5% potassium bichromate solution, and brought them back to Urbana for examination. Each sample was mixed thoroughly, placed in a thin layer in a Petri dish for a week to sporulate, and stored in a refrigerator. The samples were examined microscopically after sugar flotation, using a Leitz Ortholux microscope with apochromatic objectives.

The present paper describes five new species of *Eimeria* and re-describes *E. callospermophili* Henry, 1932, from a new host.

The skins and skulls of the host animals are preserved in the University of Illinois Natural History Museum. The numbers given with the host designations below are those of the host animals in the museum.

We should like to express our appreciation to Messrs. Lidicker, Davis, and Winkelmann and to Dr. Donald F. Hoffmeister, director of

the museum, for collecting the specimens and identifying the hosts.

RESULTS

Eimeria callospermophili

Henry, 1932

Description: Oocysts (Figs. 1, 2) spherical to subspherical. Oocyst wall colorless to pale yellowish, slightly rough and pitted, composed of single layer about 1.1 microns thick. Micropyle absent. Fifty-three sporulated oocysts measured 15 to 27 by 14 to 25 microns, with mean of 20.1 by 19.0; length-width ratios ranged from 1.0 to 1.1, with mean of 1.06. Sporulated oocysts contained four lemon-shaped sporocysts measuring about nine by seven microns; Stieda body present. Oocyst refractile granule present. Oocyst residuum composed of several large, homogeneous bodies. Sporocyst residuum absent or composed of one to 15 or more round granules. Sporozoites often at ends of sporocysts, but may lie lengthwise in them.

Some oocysts were seen (Fig. 2) which contained only two sporocysts, each with two sporozoites, and thus resembled *Cyclospora*. However, 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 sporocysts, or with one, two, three or four imperfectly developed sporocysts. It was concluded that the *Cyclospora*-like forms were actually abnormal *E. callospermophili*.

Host: Citellus spilosoma spilosoma (U. Ill. Mus. No. 12,468) (spotted ground squirrel).

Location: Intestinal contents.

Locality: Host trapped by Mr. Winkelmann on July 7, 1956, seven miles north of Rincon de Romos, Aguascalientes, Mexico.

Remarks: Of the ten species of *Eimeria* which have been described from ground squirrels of the genus *Citellus*, the present form most closely resembles *E. callospermophili* Henry, 1932, which was described from *C. lateralis* (syn., *Callospermophilus chrysodeirus*) in California. However, while the oocyst wall of the present form is composed of a single layer, that of *E. callospermophili* was said to be "probably" composed of two layers, although they could not be separated.

Henry (1932) stated that the oocysts of *E. callospermophili* were subspherical and gave their dimensions as 16.0 to 22.4 by 16.0 to 22.4 microns, with a mean of 19.2 by 16.0. There is obviously an error in the figures for width, but whether it is the range or the mean which is wrong cannot be determined. The sporocysts of *E. callospermophili* measure 10.2 by 8.5 microns, while those of our form are 9 by 7. Furthermore, Henry's description makes no mention of the Stieda body or 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 *E. callospermophili* from the original host species, these differences do not appear to warrant the creation of a new species for the form from *C. spilosoma*.

Eimeria hoffmeisteri new species

Description: Oocysts (Fig. 4) subspherical. Oocyst wall colorless to pale yellowish, smooth, composed of single layer about 1.0 micron thick. Micropyle absent. Seven sporulated oocysts measured 15 to 20 by 13 to 18 microns, with mean of 17.7 by 16.1 microns; length-width ratios ranged from 1.0 to 1.2 with mean of 1.10. Sporulated oocysts contain 4 elongate ovoid sporocysts about 11.5 by 6.0 microns; Stieda body absent or inconspicuous. Oocyst refractile granule present. Oocyst residuum absent or composed of few homogeneous bodies. Sporocyst residuum composed of large amount of finely granular material. Sporozoites either at the ends of the sporocysts or lying somewhat longitudinally.

Host: Citellus spilosoma spilosoma (U. Ill. Mus. No. 12,468) (spotted ground squirrel)

Location: Intestinal contents.

Locality: Host trapped by Mr. Winkelmann on July 7, 1956, seven miles north of Rincon de Romos, Aguascalientes, Mexico. *E. callospermophili* was found in same animal.

Remarks: Ten species of *Eimeria* have been described from ground squirrels of the genus *Citellus*. *E. citelli* Kartchner and Becker, 1930, was described from *C. tridecemlineatus* in Iowa and has since been reported from *C. pygmaeus* in the U.S.S.R. and from *C. citellus* in Hungary (see Pellérdy and Babos (1953) for references). *E. beecheyi* Henry, 1932, was described from *C. beecheyi* in California. *E. bitamellata* Henry, 1932, was described from *C. lateralis* in California and has since been reported from *C. citellus* in Hungary by Pellérdy and Babos (1953). *E. callospermophili* Henry, 1932, was described from *C. lateralis* in California and is reported from *C. spilosoma* from Mexi-

co in the present paper. *E. volgensis* Sassuchin and Rauschenbach, 1932, was described from *C. pygmaeus* in the U.S.S.R. *E. beckeri* Yakimoff and Sokoloff, 1935, was described from *C. pygmaeus* in the U.S.S.R. *E. franklinii* Hall and Knipling, 1935, and *E. eubeckeri* Hall and Knipling, 1935, were described from *C. franklinii* in Iowa. *E. ussuriensis* Yakimoff and Sprinholtz-Schmidt, 1939, was described from *C. (Spermophilus) eversmanni* in Siberia. *E. lateralis* Levine, Ivens and Kruidenier, 1957, was described from *C. lateralis* in Arizona.

E. hoffmeisteri differs from *E. lateralis*, *E. bilamellata*, *E. collospermophili*, and *E. eubeckeri* in having a smooth rather than a rough oocyst wall. It differs from *E. bilamellata*, *E. eubeckeri*, and *E. volgensis* in lacking a micropyle. It differs from *E. beckeri*, *E. becheysi*, *E. bilamellata*, *E. citelli*, *E. eubeckeri*, and *E. ussuriensis* in having an oocyst refractile granule. It differs from *E. franklinii*, *E. lateralis*, *E. citelli*, and *E. eubeckeri* in not having a prominent Stieda body. It differs from *E. becheysi* in having a sporocyst residuum. It most closely resembles *E. franklinii*, but differs from it in being subspherical rather than elongate as well as in the Stieda body character.

Eimeria dipodomysis new species

Description: Oocysts (Fig. 7) ellipsoidal. Oocyst wall yellowish brown, rough, of two layers—outer one 3.5 microns thick at sides and 3.0 at ends, and inner one 0.7 microns thick. Micropyle absent. Seventeen sporulated oocysts measured 47 to 61 by 38 to 42 microns, with mean of 54.1 by 40.2 microns; length-width ratios ranged from 1.2 to 1.5, with mean of 1.35. Sporulated oocysts contained 4 ovoid sporocysts measuring about 16 by 11 microns. Stieda

body shaped like a somewhat conical dome, i.e., excavated in the center. No oocyst refractile granule could be distinguished. Oocyst residuum large, composed of a mass of homogeneous granules. In some oocysts these granules were few, large and loosely aggregated, while in others they were small and numerous, forming a compact mass. Sporozoites embedded in a large amount of sporocyst residual material.

Host: *Dipodomys ornatus* (U. Ill. Mus. No. 12,369) (ornate kangaroo rat.)

Location: Intestinal contents.

Locality: Host trapped by Mr. Winkelmann on July 6, 1956, 16 miles south of Aguascalientes, Aguascalientes, Mexico. Another *D. ornatus* from the same locality and a third from Lagos de Morenos, Jalisco, were negative.

Remarks: Four other species of *Eimeria* have been described from rodents of the family Heteromyidae. *E. mohavensis* Doran and Jahn, 1949, was described from *Dipodomys panamintinus* in California by Doran and Jahn (1952), and *E. perognathi* Levine, Ivens and Kruidenier, 1957, was described from *Perognathus intermedius* in Arizona. *E. liomysis* and *E. picti* are described below from *Liomys pictus* and *L. irroratus*. *E. dipodomysis* averages more than twice as long or wide as any of these and has a much heavier, rougher, darker wall. The only rodent *Eimeria* which resemble it at all are *E. botelhoi* Carini, 1932, from the squirrel, *Sciurus (Guerlinguetus) ingrami*, in Brazil, *E. petauristae* Ray and Singh, 1950, from the Himalayan flying squirrel, *Petaurista inornatus*, in India, and *E. mira* Pellérdy, 1954, from the common squirrel, *Sciurus vulgaris*, in Europe. However, all of these have a micropyle and only

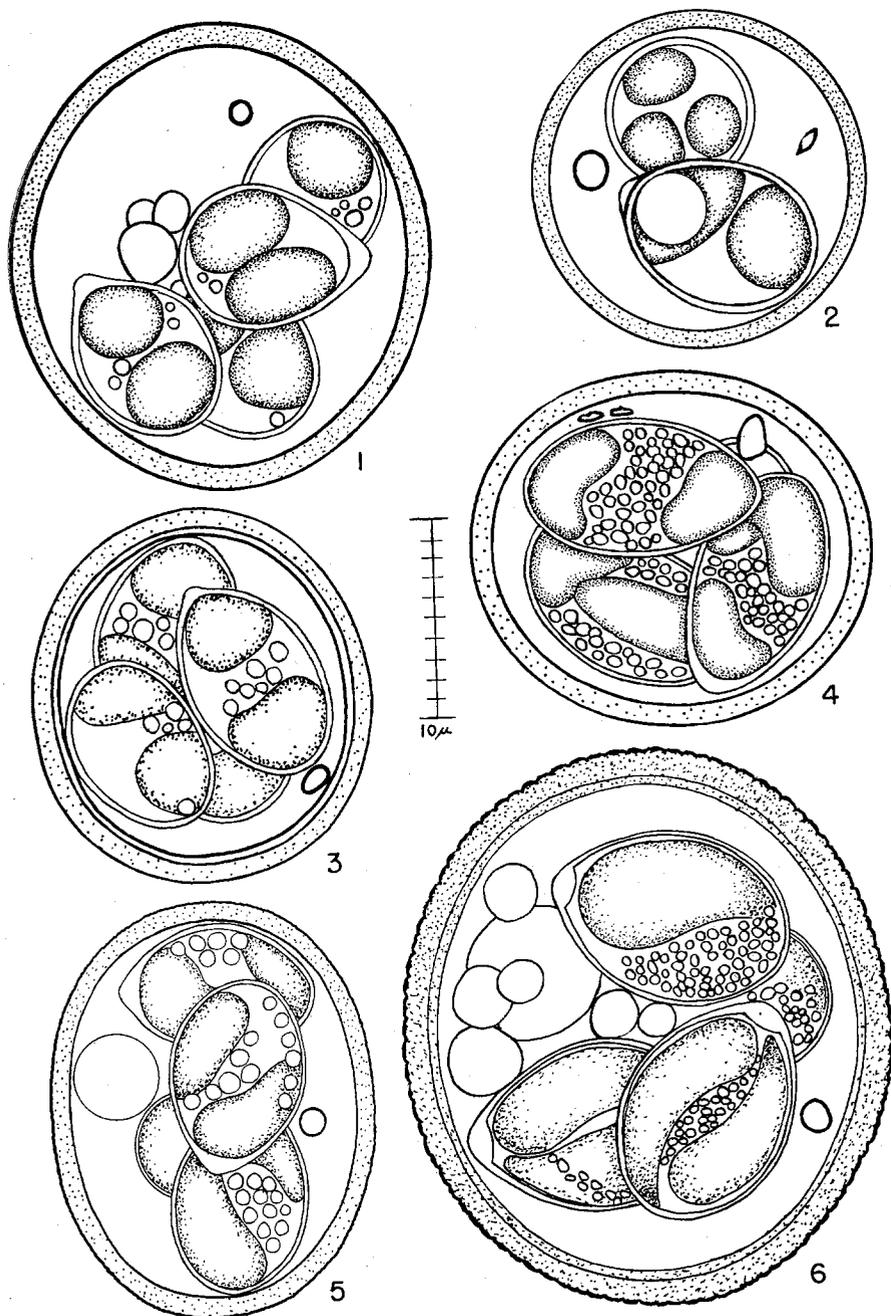


FIG. 1.—*Eimeria callospermophili* Henry, 1932, from *Citellus s. spilosoma*, x 2600. FIG. 2.—Abnormal *E. callospermophili* containing two sporocysts; from *C. s. spilosoma*, x 2600. FIG. 3.—*Eimeria liomysis* n. sp. from *Liomys pictus*, x 2600. FIG. 4.—*Eimeria hoffmeisteri* n. sp. from *Citellus s. spilosoma*, x 2600. FIG. 5.—*Eimeria baiomysis* n. sp. from *Baiomys taylori*, x 2600. FIG. 6.—*Eimeria picti* n. sp. from *Liomys pictus*, x 1400.

E. petauristae approaches *E. dipodomysis* in size.

Eimeria liomysis new species

Description: Oocysts (Fig. 3) subspherical to ellipsoidal. Oocyst wall of two layers—outer one 0.9 microns thick, pale yellow, slightly rough and pitted, and inner one 0.3 microns thick and practically colorless. Micropyle absent. Seventy-five sporulated oocysts from two specimens of the type host measured 15 to 24 by 14 to 21 microns, with mean of 19.5 by 17.7; length-width ratios ranged from 1.0 to 1.3, with mean of 1.10. Forty-four sporulated oocysts from a *Liomys irroratus* measured 15 to 23 by 14 to 20 microns, with mean of 18.2 by 17.2; length-width ratios ranged from 1.0 to 1.1, with mean of 1.06. Sporulated oocysts contained 4 almost ellipsoidal to ovoid sporocysts about 10 by 7 microns, with small Stieda body. Oocyst refractile granule present. Oocyst residuum absent. Sporozoites usually at the ends of the sporocysts, with some relatively large residual granules between them.

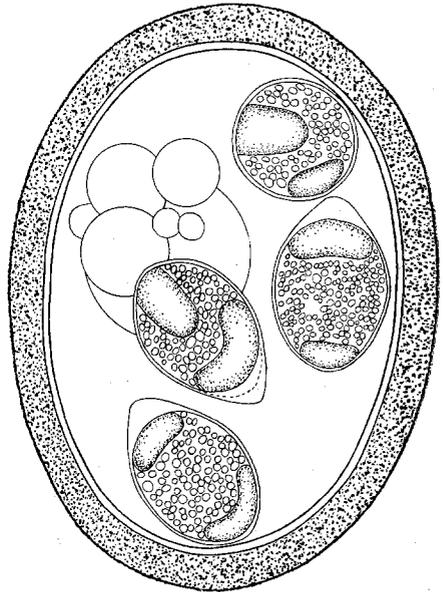
Type Host: *Liomys pictus* (U. Ill. Mus. Nos. 12,690 and 12,692) (painted spiny pocket mouse).

Other Host: *Liomys irroratus* (U. Ill. Mus. No. 12,713) (Mexican spiny pocket mouse).

Location: Intestinal contents.

Locality: *L. pictus* trapped by Mr. W. Z. Lidicker, Jr., on July 26, 1956, 11 miles northeast (by road) of Copala, Sinaloa, Mexico. *L. irroratus* trapped by Mr. Lidicker on July 14, 1956, 11 miles southeast (by road) of Guadalajara, Jalisco, Mexico.

Remarks: Four other species of *Eimeria* had been described from rodents of the family Heteromyidae (see remarks under *E. dipodomysis* above). *E. liomysis* differs from *E. mohavensis*, *E. perognathi* and *E. dipodomysis* in being more nearly spherical and in having an oocyst refractile granule. It differs from *E. mohavensis* in having a small



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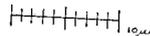


FIG. 7.—*Eimeria dipodomysis* n. sp. from *Dipodomys ornatus*, x 2600.

Stieda body and from *E. perognathi* in lacking an oocyst residuum and in having much larger sporocysts. It is much smaller than *E. dipodomysis* and differs further from it in lacking an oocyst residuum and in having smaller sporocysts and a less noticeable Stieda body. It differs from *E. picti* in being smaller and in lacking an oocyst residuum.

Eimeria picti new species

Description: Oocysts (Fig. 6) subspherical to ellipsoidal. Oocyst wall of two layers—outer one brownish yellow, 1.3 microns thick, rough and pitted, and inner one brownish yellow and 0.4 microns thick. When outer wall is broken, inner wall usually remains intact. Micropyle absent. Fifty-three sporulated oocysts measured 22 to 32 by 19 to 28 microns, with mean of 25.8 by 22.5:

length-width ratios ranged from 1.0 to 1.2, with mean of 1.15. Sporulated oocysts contained 4 broadly lemon-shaped sporocysts measuring 11 to 12 by 8 to 9 microns; Stieda body present. One or two oocyst refractile granules present. Oocyst residuum usually composed of a number of large, clear irregular granules, but sometimes was a single large, granular mass. Sporocyst residual material composed of a few to many granules. Sporozoites lie longitudinally, head to tail, in the sporocyst.

Host: *Liomys pictus* (U. Ill. Mus. No. 12,692) (painted spiny pocket mouse).

Location: Intestinal contents.

Locality: Host trapped by Mr. W. Z. Lidicker, Jr., on July 26, 1956, 11 miles northeast (by road) of Copala, Sinaloa, Mexico. The same animal was infected with *E. liomysis*.

Remarks: Four other species of *Eimeria* have so far been described from rodents of the family Heteromyidae (see remarks under *E. dipodomysis* above). *E. picti* differs from all but *E. liomysis* in having an oocyst refractile granule. It is much smaller than *E. dipodomysis* and has a much thinner wall. It differs from *E. mohavensis* in having an oocyst residuum and sporocyst Stieda body. It differs from *E. perognathi* in shape and in having a two-layered oocyst wall. It is larger than *E. liomysis* and differs further from it in having an oocyst residuum.

Eimeria baiomysis new species

Description: Oocysts (Fig. 5) ellipsoidal. Oocyst wall yellowish, quite rough and pitted, of single layer 1.6 microns thick. Micropyle absent. Twenty-five sporulated oocysts measured 20 to 25 by 13 to 21 microns, with mean of 22.9 by 19.3; length-width ratios ranged from 1.0 to 1.3 with mean of 1.19. Sporulated oocysts contained 4 ovoid sporocysts

about 11.0 to 11.5 by 7 to 8 microns; Stieda body present. Oocyst refractile granule present. Oocyst residuum a homogeneous body. Sporocyst residual material composed of coarse granules. Sporozoites lie lengthwise in sporocysts.

Host: *Baiomys taylori* (U. Ill. Mus. No. 13,026) (pigmy mouse).

Location: Intestinal contents.

Locality: Host trapped by Mr. W. Z. Lidicker, Jr., on July 5, 1956, eight miles east of Queretero, Queretero, Mexico. Two other *B. taylori* collected in the same locality were uninfected.

Remarks: Eleven species of *Eimeria* have been described from rodents of the subfamily Cricetinae. One of these, *E. criceti* Pellérdy, 1956, was described briefly by Nöller (1920) from the wild European hamster, *Cricetus cricetus* (tribe Cricetini), under the name *E. falci-formis* var. *criceti*. *E. baiomysis* is much larger and also differs from it in having an oocyst residuum.

The other ten species were described from rodents of the tribe Hesperomyini to which *Baiomys* belongs. They are: *E. neotomae* Henry, 1932, from *Neotoma fuscipes* in California; *E. residua* Henry, 1932, from *N. fuscipes* in California; *E. oryzomysi* Carini, 1937, from *Oryzomys* sp. in Brazil; *E. phyllotis* Gonzales-Mugaburu, 1942, from *Phyllotis amicus* in Peru; *E. operculata* Levine, Ivens and Kruidenier, 1957, from *Neotoma stephensi* in Arizona; *E. albigulae* Levine, Ivens and Kruidenier, 1957, from *N. albigula* in Arizona; *E. onychomysis* Levine, Ivens and Kruidenier, 1957, from *Onychomys leucogaster* in Arizona; *E. peromysci* Levine, Ivens and Kruidenier, 1957, and *E. arizonensis* Levine, Ivens and Kruidenier,

1957, from *Peromyscus truei* in Arizona; and *E. eremici* Levine, Ivens and Kruidenier, 1957, from *P. eremicus* in Arizona.

E. baiomysis differs from *E. oryzomysi*, *E. phyllotis*, and *E. operculata* in having an oocyst refractile granule. It differs from *E. neotomae*, *E. phyllotis*, and *E. operculata* in having an oocyst residuum. It differs from *E. operculata* in having a sporocyst residuum and in not having an oocyst operculum. It differs from *E. neotomae*, *E. oryzomysis*, *E. operculata*, *E. arizonensis*, and *E. eremici* in having a rough, pitted wall. Its wall differs from that of *E. albigulae* in being composed of a single layer rather than of two, of which the outer layer is colorless and the inner one pale brownish. In addition, its sporozoites lie lengthwise in the sporocysts, while those of *E. albigulae* are polar. It differs from *E. onychomysis* in having an oocyst wall three times as thick. It is much smaller than *E. peromysci* and also differs from it in having an oocyst wall composed of a single layer rather than of two and in having much smaller sporocysts. It differs from *E. residua* in having a yellowish wall composed of a single layer rather than a brown one composed of two layers and in being more elongate. This latter difference is emphasized by a comparison of Henry's photomicrograph of *E. residua* with our own photomicrographs of *E. baiomysis*. In addition, the oocysts of *E. baiomysis* are somewhat smaller and the sporocysts somewhat larger than those of *E. residua*. These species resemble each other quite closely, but the relatively small differences

enumerated above combined with the difference in host genus justify the establishment of a new species for the form from *Baiomys*.

SUMMARY

In a survey of 23 rodents of 12 species from Mexico, the following species of *Eimeria* were found and described: *E. callospermophili* Henry, 1932, and *E. hoffmeisteri* n. sp. from the spotted ground squirrel, *Citellus s. spilosoma*; *E. dipodomysi* n. sp. from the ornate kangaroo rat, *Dipodomys ornatus*; *E. liomysis* n. sp. from the painted spiny pocket mouse, *Liomys pictus*, and the Mexican spiny pocket mouse, *L. irroratus*; *E. picti* n. sp. from *L. pictus*; and *E. baiomysis* n. sp. from the pigmy mouse, *Baiomys taylori*. This raises to 34 the number of species of North American rodents from which *Eimeria* has been described, and to 55 the number of species of *Eimeria* occurring in them.

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