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Under Ledelse af Lauge Koch

THE *COCCIDIA* OF THE EAST GREENLAND HARES

WITH A REVISION OF THE *COCCIDIA* OF HARES AND RABBITS

BY

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WITH 10 FIGURES AND 8 TABLES IN THE TEXT

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INTRODUCTION

The material treated in the present paper was collected during a wintering in East Greenland (Eskimonæs, 74°05′ N. lat.) in 1932—33, in which period I was a member of the Danish Three-Year Expedition to Christian X's Land under the leadership of Dr. LAUGE KOCH. I wish here to express my thanks to Professor AD. S. JENSEN and to the leader of the expedition, Dr. LAUGE KOCH, for their kind help and support. I likewise thank Professor M. CHRISTIANSEN for having placed his laboratory at my disposal during the work.

A total of twenty-two Arctic hares were examined, all of them derived from the near vicinity of Eskimonæs. The examination was principally made on the oocysts, which were concentrated from faeces by the usual flotation method by means of a saturated sodium chlorid solution. In addition the contents of the gall-bladder were examined. Altogether 760 oocysts were measured.

The host is *Lepus arcticus groenlandicus* RHOADS, a race distributed from Scoresby Sound on the east coast of Greenland around the north of Greenland and down the west coast as far as Disko Bay. The species originates from North America (DEGERBØL and BRÆSTRUP 1934—35).

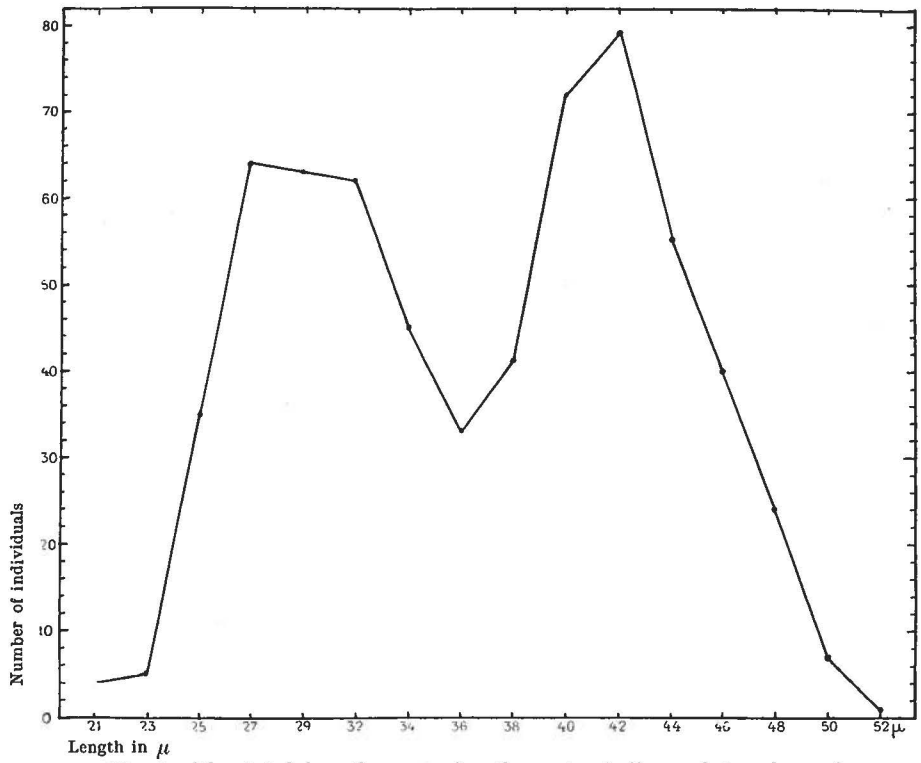


Fig. 1. The total length curve for the not wholly sculptured species.

DESCRIPTION OF THE SPECIES FOUND

All the parasites belong to the genus *Eimeria* SCHNEIDER (family *Eimeridae*), distinguished by their oocyst containing four spores with two sporozoites each.

It was noted at once that several species of *Coccidia* occurred. One of them was so remarkable in a morphological respect, notably by its dark colour and the peculiar sculpture distributed over the whole surface of the oocyst, that it was always recognisable even in an unsporulated condition. The other types caused somewhat greater difficulties.

In addition to the above-mentioned type there seemed to occur some big elongated, small elongated, and small more roundish ones, that is to say, altogether four types. This was confirmed by the later investigations.

In order to distinguish the latter three, not immediately recognisable forms the total length curve was first drawn (fig. 1)[1]).

[1]) It was necessary to distribute the values measured in groups of 2 μ. Each ocular line corresponded to about 2 μ, and values of 1 μ had accordingly to be estimated; in this way a deficit of these values arose. As the chance of an incor-

The curve shows at any rate two distinct peaks, that is to say, one indicating an especially large number of oocysts about 40—44 μ, and a

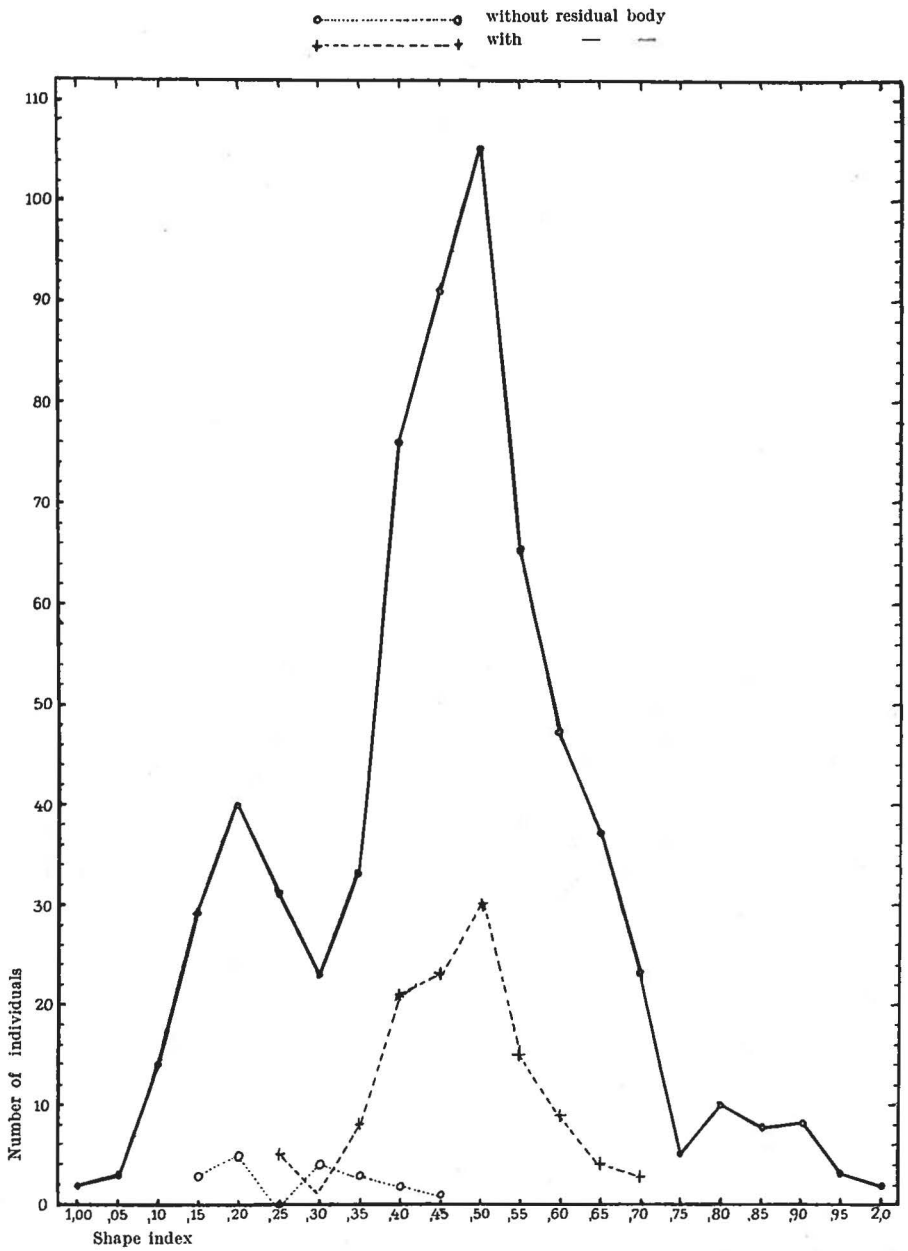


Fig. 2. Shape index curve for the not wholly sculptured species.

rect estimate was taken to be equally great in both directions, the deficit values were equally distributed, though in case of odd figures the greater part were grouped downwards (cf. the tables, the column Distribution).

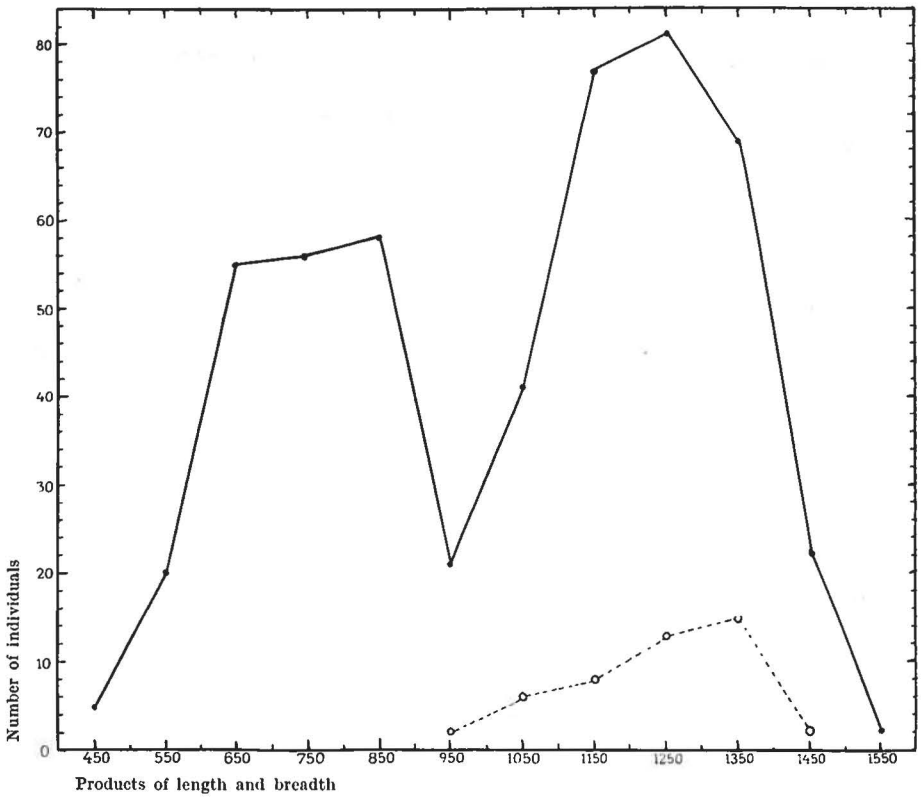


Fig. 3. Product curve for the oblong, not wholly sculptured forms. The broken line indicates the forms which are sculptured on the foremost half.

broader peak about 26—33 μ; the latter fact might indicate that we are here concerned with more than one type. The existence of a particularly large type is thus rendered probable.

In order to establish the possible existence of a delimited roundish type, the total shape index curve was drawn (fig. 2). It shows a markedly two-peaked course. Accordingly there exists a roundish type, with a mean shape index of about 1.20 and (as will be seen from the large number of individuals) oblong types with a mean shape index curve of 1.45—1.55.

In order to make a further distinction it will be necessary to consider morphological characters also. In this connection it was of special interest that the roundish forms seemed to lack a residual body in the oocyst, while such a body was mostly present in the oblong ones. Fig. 2 shows the curve (broken line) for the absence and presence of residual bodies, and conditions will be seen to correspond to those expected. By starting from the curves it was possible to identify the roundish forms (Table 1).

Table 1. Length and breadth of type A, the round oocysts without residual body.

The whole figures indicate the number of individuals. The figures in parentheses are shape indices.

Length	Breadth											Total	Distribution
	17	18	19	20	21	22	23	24	25	26	27		
21	..	1 (1.17)	..	..	..	..	..	..	..	..	..	1	2
22	..	..	1 (1.16)	..	..	..	..	..	..	..	..	1	..
23	..	..	1 (1.21)	..	..	..	..	..	..	..	..	1	2
24	..	..	..	..	2 (1.14)	..	..	..	..	..	..	2	..
25	..	1 (1.39)	1 (1.32)	..	2 (1.19)	2 (1.14)	2 (1.08)	2 (1.04)	2 (1.00)	..	..	14	25
26	..	..	..	1 (1.30)	1 (1.23)	5 (1.18)	10 (1.13)	2 (1.09)	..	..	..	19	..
27	..	..	1 (1.42)	1 (1.35)	..	..	14 (1.18)	4 (1.13)	7 (1.08)	..	..	27	40
28	..	..	..	..	1 (1.33)	..	3 (1.23)	2 (1.17)	2 (1.12)	..	..	8	..
29	..	..	..	..	1 (1.38)	2 (1.32)	5 (1.26)	4 (1.21)	6 (1.16)	..	1 (1.07)	19	24
30.5	..	..	..	..	..	..	..	..	1 (1.24)	..	..	1	..
32	..	..	..	..	1 (1.52)	1 (1.45)	..	1 (1.33)	..	..	1 (1.19)	4	5
33	..	..	..	..	..	..	1 (1.43)	..	..	..	..	1	..
Total	..	2	4	2	8	10	37	15	18	..	2	98	98
Distrib.	1	..	6	..	14	..	50	..	25	..	2	98	..

An analysis was next made of the oblong forms with residual bodies. For the purpose of illustrating the conditions, a curve was drawn on the basis of the product of length and breadth (fig. 3). It shows two maxima. If these conditions are combined with the morphological characters, it can especially be pointed out that the small forms have a small residual body, while the large ones have a large residual body (see figs. 5 and 6, a and b). By means of these characters the two oblong types were separated (Tables 2 and 3). The sculptured form is tabulated in Table 4.

Table 2. Type B. Small oblong oocysts with a small residual body.

Length	Breadth											Total	Distribution
	17	18	19	20	21	22	23	24	25	26	27		
23	..	..	..	..	..	..	..	..	..	..	..	..	1
24	..	..	1 (1.26)	..	..	..	..	..	..	..	..	1	..
25	..	..	1 (1.32)	..	..	..	..	..	..	..	..	1	4
26	1 (1.53)	1 (1.44)	1 (1.37)	..	3 (1.23)	..	..	..	..	..	..	6	..
27	..	1 (1.50)	7 (1.42)	2 (1.35)	.. ..	1 (1.22)	1 (1.18)	..	..	..	..	12	21
28	..	..	2 (1.47)	..	2 (1.33)	4 (1.27)	4 (1.22)	..	..	..	..	12	..
29	..	..	1 (1.53)	4 (1.15)	4 (1.38)	4 (1.32)	7 (1.26)	2 (1.21)	..	..	..	22	39
30.5	..	..	1 (1.61)	..	11 (1.45)	..	6 (1.33)	2 (1.27)	2 (1.24)	..	..	22	..
32	..	..	1 (1.68)	2 (1.60)	10 (1.52)	6 (1.45)	7 (1.39)	3 (1.33)	4 (1.28)	..	..	33	51
33	..	..	..	..	2 (1.57)	2 (1.50)	4 (1.43)	3 (1.38)	2 (1.32)	..	..	13	..
34	..	..	1 (1.79)	..	5 (1.61)	5 (1.55)	10 (1.48)	5 (1.42)	5 (1.36)	2 (1.31)	..	33	44
35	..	..	..	..	1 (1.67)	..	5 (1.52)	1 (1.46)	1 (1.40)	1 (1.35)	1 (1.30)	10	..
36	..	..	1 (1.89)	..	2 (1.71)	2 (1.64)	7 (1.57)	3 (1.50)	4 (1.44)	..	..	19	28
37	..	..	2 (1.95)	1 (1.85)	..	2 (1.68)	2 (1.61)	..	..	..	1 (1.37)	8	..
38	..	..	..	..	..	..	2 (1.65)	..	2 (1.52)	..	..	4	11
39	..	..	..	..	..	1 (1.71)	2 (1.62)	1 (1.63)	1 (1.56)	..	..	5	..
40	..	..	..	..	1 (1.90)	..	..	..	1 (1.60)	..	..	2	5
41	..	..	..	..	..	..	..	1 (1.71)	..	..	..	1	..
Total	1	2	19	9	41	27	57	21	22	3	2	204	204
Distrib.	2	..	25	..	59	..	81	..	34	..	3	204	..

Table 3. Type C, large oblong oocysts with a large residual body.

The whole figures outside the parentheses indicate the total number of individuals. The whole figures in parentheses indicate the number of the variety mentioned later which is especially distinguished by its fine sculpture on the front part. The decimal fractions in parentheses as usual indicate the shape index.

Length	Breadth										Total	Distribution
	23	24	25	26	27	28	29	30.5	32	33		
34	..	1 (1.42)	..	..	..	..	..	..	..	..	1	1
35	..	..	..	..	..	..	..	..	..	..	..	..
36	..	..	1 (1) (1.44)	1 (1.38)	..	..	..	..	..	..	2	3
37	..	..	..	1 (1.42)	..	..	1 (1.28)	..	..	..	2	..
38	..	..	1 (1.52)	6 (1) (1.46)	11 (1) (1.41)	1 (1.36)	..	..	..	..	19	26
39	..	..	2 (1.56)	..	3 (1) (1.44)	6 1,39	1 (1.34)	..	..	..	12	..
40	..	..	5 (1.60)	8 (1.54)	13 (2) (1.48)	15 (1.39)	6 (2) (1.38)	1 (1.31)	1 (1.24)	..	49	69
41	..	..	3 (1) (1.64)	3 (2) (1.58)	4 (1.52)	10 (1) (1.46)	7 (1.41)	1 (1.34)	..	..	28	..
42	1 (1) (1.83)	..	..	..	17 (2) (1.56)	15 (1.50)	20 (3) (1.45)	1 (1.38)	1 (1.31)	..	55	79
43	..	..	1 (1) (1.72)	1 (1.65)	1 (1.60)	8 (1) (1.53)	7 (2) (1.48)	..	..	1 (1.31)	19	..
44	..	..	1 (1.76)	1 (1.69)	8 (1) (1.63)	6 (2) (1.57)	22 (5) (1.52)	2 (2) (1.44)	..	..	40	56
45	..	1 (1.88)	2 (1.80)	..	..	2 (1) (1.60)	7 (4) (1.55)	2 (1.48)	..	..	14	..
46	..	1 (1.92)	1 (1.84)	..	4 (1) (1.70)	3 (1.64)	18 (3) (1.59)	2 (1.51)	1 (1.44)	..	30	40
47	..	..	2 (1.88)	..	..	..	3 (1.62)	..	..	..	5	..
48	..	..	1 (1.92)	1 (1.85)	3 (1) (1.79)	4 (1.71)	11 (2) (1.67)	1 (1.57)	..	..	21	24
49	..	..	..	..	1 (1.81)	..	1 (1.69)	..	..	..	2	..
50	..	..	..	..	2 (1.85)	2 (1.78)	2 (1.72)	..	..	..	6	7
51	..	..	..	..	..	..	..	..	..	..	..	..
52	..	..	..	..	..	..	..	..	..	..	..	1
53	..	..	..	..	..	..	1 (1.83)	..	..	..	1	..
Total	1	3	20	22	67	72	107	10	3	1	306	306
Distrib.	3	..	32	..	114	..	148	..	9	..	306	..

Table 4. Type D, dark, wholly sculptured oocysts.

Length	Breadth										Total	Distribution
	23	24	25	26	27	28	29	30.5	32	33		
32	..	..	..	..	1 (1.19)	..	..	..	..	..	1	1
33	..	..	..	..	..	..	..	..	..	..	..	..
34	..	..	..	..	2 (1.26)	6 (1.21)	4 (1.17)	..	..	..	12	17
35	..	..	..	..	3 (1.30)	2 (1.25)	5 (1.21)	..	..	..	10	..
36	1 (1.57)	..	..	..	4 (1.33)	13 (1.29)	37 (1.24)	2 (1.15)	1 (1.14)	..	58	72
37	..	..	..	..	1 (1.37)	1 (1.32)	14 (1.28)	1 (1.21)	..	..	17	..
38	..	..	..	..	..	2 (1.36)	23 (1.31)	3 (1.25)	2 (1.18)	..	30	43
39	..	1 (1.63)	..	..	..	1 (1.39)	5 (1.34)	..	1 (1.21)	1 (1.18)	9 9	.. ..
40	..	..	..	..	..	1 (1.43)	6 (1.38)	3 (1.31)	2 (1.24)	..	12	17
41	..	..	..	..	..	..	1 (1.41)	..	..	..	1	..
42	..	..	..	..	..	..	2 (1.45)	..	..	..	2	2
Total	1	1	..	..	11	26	97	9	6	1	152	152
Distrib.	2	..	0	..	24	..	115	..	11	..	152	..

Of common features there is special reason to point out that all the *Coccidia* are associated with the intestinal canal. I never succeeded in ascertaining oocysts in the gall bladder, while, on the other hand, type A and type C were directly observed in the duodenum. The characteristics found for the four species of *Coccidia* are enumerated below.

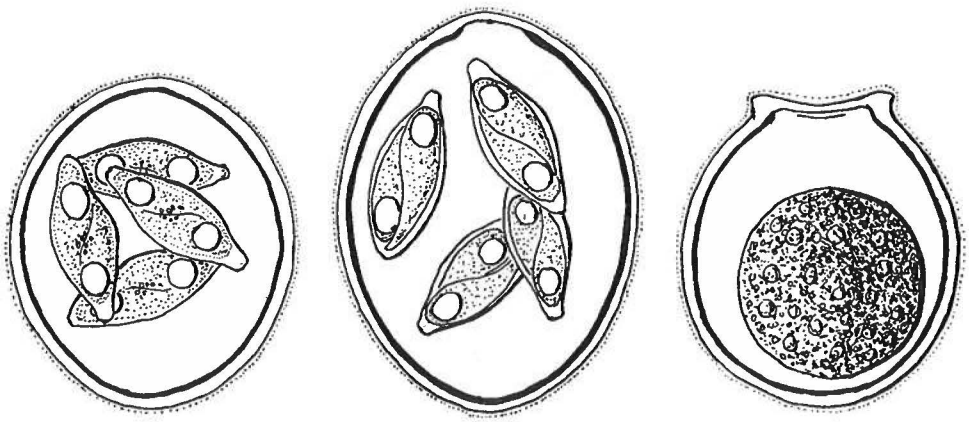
Type A. Fig. 4, a, b, and c.

Oocyst roundish, ranging from almost globular to broadly ellipsoidal, colourless, without sculpture. Micropyle absent or, if present, broad, more or less indistinct, sometimes surrounded by a thickened margin. Sporulates without residual bodies with four short fusiform spores (c. 13—16 μ × 6—7 μ), with a peg-shaped micropyle and an only slightly developed or no residual body. Thickness of wall of oocyst about 1 μ. Mean length 26.98 $\mu \pm 0.20\,\mu$[1]) varying from 21 μ to 32 μ.

$$\sigma = \pm 1.97\,\mu; \quad \text{v (variation coefficient}^2\text{)} = 7.30$$

[1]) This is the mean error of the mean value (M).

[2]) $v = \frac{100\sigma}{M}$.

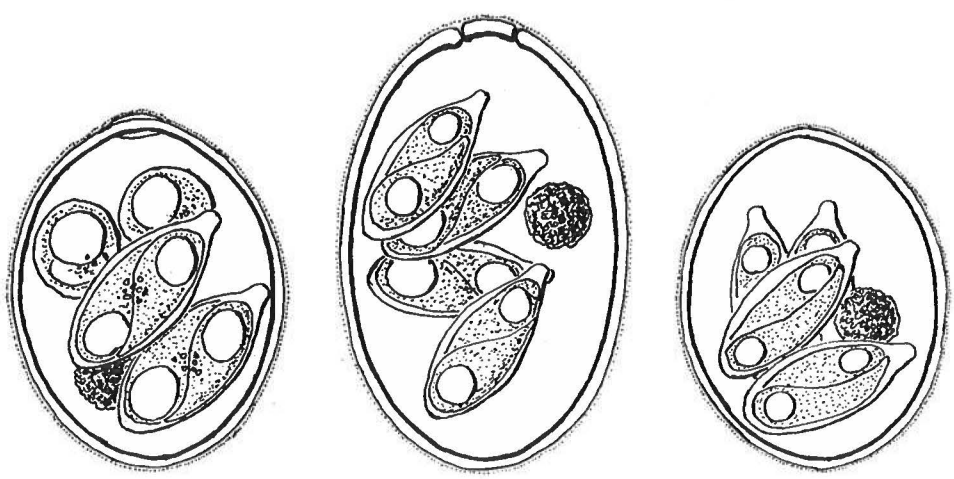


a. $27\mu \times 23\mu$ ($14\mu \times 6\mu$)[1])

b. $33\mu \times 25\mu$ ($15\mu \times 6\mu$)

c. $25\mu \times 24\mu$

Fig. 4. Oocysts of type A = *Eimeria exigua var. septentrionalis* YAKIMOFF etc. 1936.



a. $29\mu \times 23\mu$ ($17\mu \times 8\mu$)

b. $36\mu \times 24\mu$ ($16\mu \times 7\mu$)

c. $28\mu \times 22\mu$ ($15\mu \times 7\mu$)

Fig. 5. Oocysts of type B = *Eimeria perforans var. groenlandica nov.*

[1]) The numbers in parentheses indicate the size of the spores.

Average breadth 23.00 $\mu \pm 0.18\,\mu$, varying from 17 μ to 27 μ

$\sigma = \pm 1.81\,\mu$; v = 7.87. Mean shape index 1.17.

Type A inhabits the duodenum.

The species was found in 41 per cent of the hares examined.

Type B. Fig. 5, a, b, and c.

Oocyst broadly ellipsoidal, colourless, not sculptured. Mostly with (though also without, all transitions) a narrow, most frequently plug-shaped micropyle. Sporulates with a small residual body (4—7 μ). The four spores shaped like a short spindle (13—19 $\mu \times$ 7—8 μ), without or with a slightly developed residual body. Peg-shaped micropyle. Thickness of wall of oocyst about 1 μ. Mean value of length 32.55 $\mu \pm 0.22\,\mu$, varying from 23 μ to 40 μ,

$\sigma = \pm 3.11\,\mu$; v = 9.55.

Mean value of breadth 22.26 $\mu \pm 0.13\,\mu$, varying from 17 μ to 27 μ.

$\sigma = \pm 1.96\,\mu$; v = 8.81. Mean shape index 1.46.

Type B inhabits the intestinal canal (not more precisely localised).

The species was found in 50 per cent of the hares investigated.

Type C. Fig. 6, a and b.

a) Oocyst broadly ellipsoidal, faintly yellowish, with no sculpture. Mostly with a distinct, plug-shaped micropyle. Sporulates with a big residual body (7—12 μ). The four spores oblong-fusiform (17—22 $\mu \times$ 7—8 μ), with indistinct peg-shaped micropyle. A slightly developed or no residual body. Thickness of wall of oocyst about 1 μ.

Mean length 42.71 $\mu \pm 0.18\,\mu$, varying from 34 μ to 52 μ.

$\sigma = \pm 3.12\,\mu$; v = 7.31.

Mean breadth 25.84 $\mu \pm 0.09\,\mu$, varying from 23 μ to 32 μ.

$\sigma = \pm 1.51\,\mu$; v = 5.84. Mean shape index 1.65.

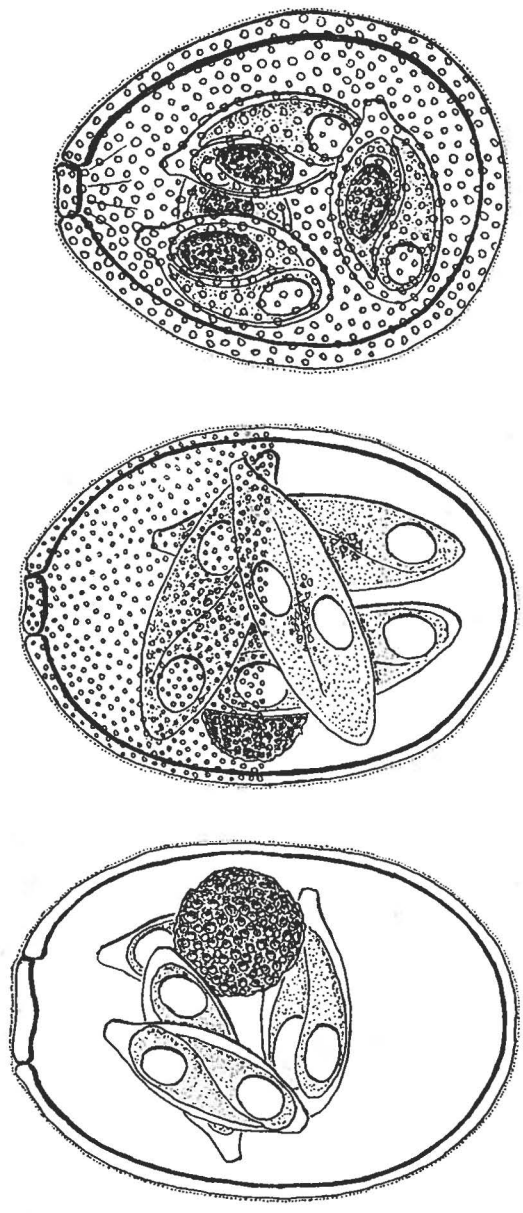
The species was found in 50 per cent of the hares examined.

b) A type of oocyst with a similar variation in size occurred, too (see the curve Fig. 3 and Table 3), differing only by the front part of the cyst being finely sculptured (some few transitional stages with indistinct sculpture.) the spores elongated-fusiform (22—28 $\mu \times$ 7—8 μ). This form was only found once singly (only a few cysts were found), otherwise always in company with the main form.

(a) was found in 50 per cent of the hares examined.

(b) - - - 27 - - - - - -

Both forms inhabit the duodenum.



a. $42\mu \times 29\mu$ $(19\mu \times 7\mu)$

b. $40\mu \times 29\mu$ $(26\mu \times 8\mu)$

c. $36\mu \times 29\mu$ $(17\mu \times 9\mu)$

Fig. 6 a. Oocyst of type C a = *Eimeria magna var. robertsoni nov. f. typ.* b. Oocyst of type C b = *Eimeria magna var. robertsoni forma semisculpta nov.* c. Oocyst of type D = *Eimeria sculpta* sp. nov.

Type D. Fig. 6 c.

Oocyst broadly pear-shaped, dark-brown, with a well-developed sculpture throughout the surface. Distinct narrow plug-shaped micropyle. Sporules without residual bodies. The four spores thick-fusiform (M = 17.1 μ × 9.5 μ (15—19 μ × 9—10 μ)) with distinct peg-shaped micropyle. Large, sharply delimited ellipsoidal residual body in the spore. Thickness of wall of oocyst about 2 μ.

Mean length 36.84 μ ± 0.15 μ, varying from 32 μ to 42 μ.

$\sigma = \pm 1.80\ \mu$; v = 4.89.

Mean breadth 28.75 μ ± 0.09 μ, varying from 23 μ to 32 μ.

$\sigma = \pm 1.15$; v = 4.00. Mean shape index 1.28.

Type D inhabits the intestinal canal; not more precisely localised. The species was found in 64 per cent of the hares examined.

Fig. 7 will give a clear illustration of the sizes of the four types. The curves indicate the variations in length.

Discussion of the Literature.

The information given in the available literature on *Coccidia* in hares proves to be very scanty, and moreover the *Coccidia* of hares and rabbits have, as a rule, been identified without further comments.

The *Coccidia* of rabbits must be said to be fairly well known, and hence it will be most convenient to ascertain what *Coccidia*-species have been described from rabbits. According to the latest investigations (KESSEL and JANKIEWICZ 1931 and YAKIMOFF 1934) six species are known, viz. *Eimeria stiedae* LINDEMANN 1865, *E. perforans* LEUCKART 1879, *E. magna* PÉRARD 1925, *E. media* KESSEL 1929, *E. irresidua* KESSEL and JANKIEWICZ 1931, and *E. exigua* YAKIMOFF 1934.

Before this result was reached, controversy had run high since the middle of the last century, when the *Coccidia* of the rabbits were first described. Among others BECKER (1934) and UDINZEFF (1936) have summarised the varying views.

Not till 1925 did PÉRARD, through his exact experiments, establish some stability, separating three distinct species, viz. *Eimeria stiedae*, which inhabits the bile ducts only and has no residual body in the oocyst; *E. magna* and *E. perforans*, which both live in the small intestine, and both have a residual body in the oocyst; however, *E. magna* is the larger and coloured form, while *E. perforans* is smaller and colourless. PÉRARD does not seem to have had before him any of the recently described species, whereas this was the case with WAWORUNTU in 1924. He dis-

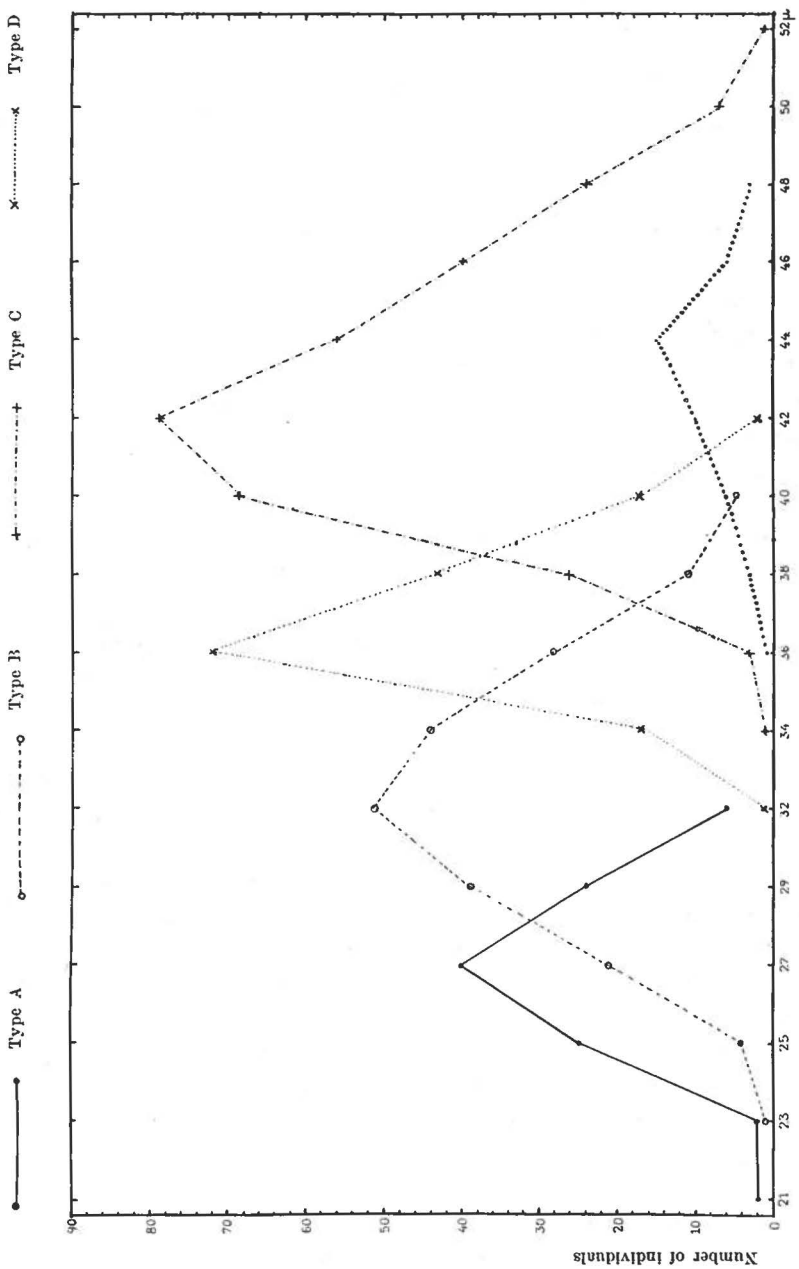


Fig. 7. Length curves for the four types.

tinguishes clearly between four types of oocysts. He causes some confusion as regards the life cycle of the *Coccidia;* but his four oocysts can be distinctly identified, even though he does not himself identify all of them correctly. Further HEGNER & CHU, 1930, p. 459 (The Philippine Islands), CORREA 1931 (South America), and CHANG 1935, p. 155 (China) mention various *Coccidia*-species from laboratory rabbits (see Table 5). CORREA alone records definitely *E. stiedae*, it being found in the liver, while those recorded by the other authors were found in fæces without liver *Coccidia* being ascertained at the same time. Possibly CORREA, in addition to *E. stiedae* and *E. perforans*, had before him other species also (the sizes given for the oocysts found in the intestinal canal would seem to indicate this); but the question cannot be decided, because he had no opportunity to examine sporulated oocysts.

It is no doubt a concurrent cause of the previous confusion that some of the earlier observers had before them several different species and regarded them as one species. Another circumstance which likewise renders it difficult to estimate the earlier (and many of the recent) observations, is that the size is always very vaguely indicated, only the average size and possibly the extreme sizes being stated, often without information about the number of individuals on which the measurements were based, and always without indication of the distribution of the variants. Only KESSEL and JANKIEWICZ (1931) supply material useful in this respect for the rabbit-*Coccidia*, giving curves for the variation of length and breadth. Otherwise statistics of the variation of the material are only available as regards the *Coccidia* of other animals (e. g. ANDREWS 1928 (skunk, prairie-dogs) and JONES 1932 (poultry)) from American quarters.

It will now be in place to discuss in more detail YAKIMOFF's paper on *Eimeria exigua* (1934), and to treat at the same time UDINZEFF's statements about the same species (1936).

YAKIMOFF's main result is that there exists a very small *Coccidia* species whose oocyst is colourless, and which does not develop a residual body. This is quite correct. But he arrives at the peculiar result that it occurs in two forms, a spherical and an oval form, and he computes the average value for each of them. In his Tables I, IV, and V he gives lengths and breadths for a fairly large material measured. In Table V, a type is tabulated which he regards as *perforans*, probably because it has a residual body in the oocyst. He does not state it expressly, but it seems actually (as appears, for instance, when the length-curves are drawn) to differ numerically from the two types he thought it possible to distinguish in Table I (globular) and Table IV (oval).

From my experiences of type A, and from the whole way in which YAKIMOFF deals with the question, I feel convinced that *E. exigua*, like

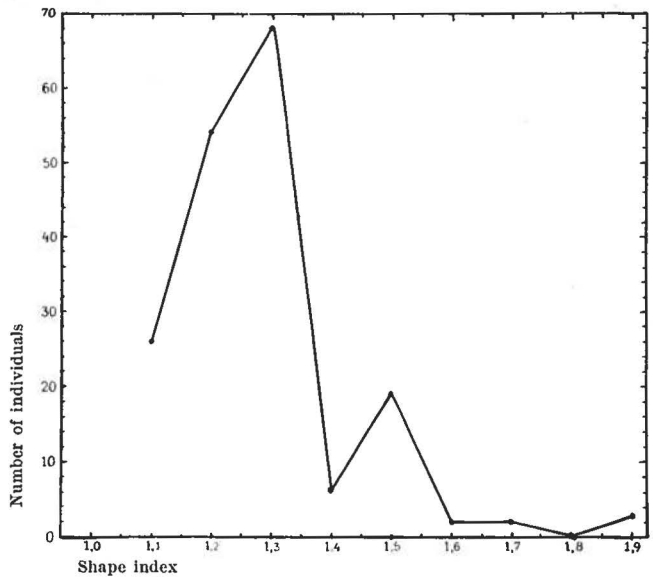


Fig. 8a. Shape index curve for "the oval type" of *Eimeria exigua*, after YAKIMOFF's Table IV (1934).

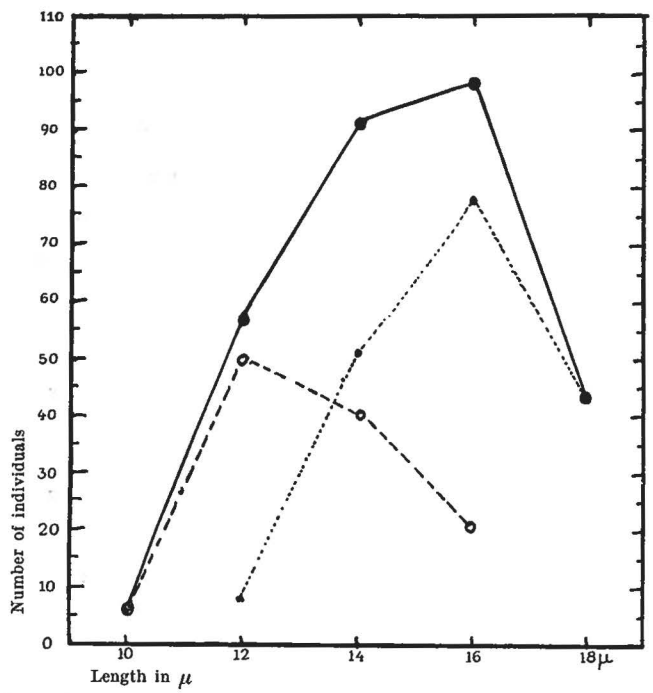


Fig. 8b. Length curve for *Eimeria exigua* after Tables I and IV of YAKIMOFF (1934). The broken curve left is "the spherical", the right "the oval" type. The continuous curve is the combined length curve.

Type A, is a species whose breadth is more variable in relation to its length than is the case in the other species. And I should think that the peculiar numerical relations given in his tables are due to a quite casual treatment of the material. Several things indicate that this is actually the case. He says himself (p. 21) that the spherical forms were less numerous than the oval ones, and further that the oval ones might be subspherical and on the whole vary considerably in shape. If we draw the shape index curve for his type II (Table IV) (fig. 8 a), it would seem that something is, as it were, lacking at the end nearest shape index 1.00, i. e. the spherical form. By combining the length values, a handsome curve likewise results (fig. 8 b). UDINZEFF 1936 presents a material apparantly measured more at random, and thus he seems to a less extent to have made a selection (which is not permissible if an average size is to be of any value). Of *E. exigua* he found 26 spherical and 89 oval specimens, or about three and a half oval ones for each spherical specimen. He states the average shape index for the oval ones as 1.33. If we reckon three and a half oval ones to one round one, we may arrive at a more correct combined shape index, viz. $\frac{1.33 \times 3.5 + 1.00}{4.5} = 1.25$, and thus approach the shape index (1.21) that may be computed for the small spherical *Coccidia*-species which was found by KESSEL and YANKIEWICZ (p. 318), and which was identified with *E. exigua* by YAKIMOFF. YAKIMOFF's most frequent shape index in his "oval type" ranges about 1.25 (fig. 8 a).

UDINZEFF's work (p. 74) contains a very unfortunate passage. He says about *E. exigua*, "Beim Sporulieren zeigen die Oozysten kleine Restkörper". I suppose, however, we may take it for granted that it should be "keine", since UDINZEFF has worked in YAKIMOFF's laboratory and accordingly must be assumed to know the species.

In this connection I may further point out that it is hardly permissible, as done by YAKIMOFF (1934, p. 20), to identify some spherical oocysts which PÉRARD (1924, p. 967) states that he has found in some adult rabbits. PÉRARD says himself that in infection experiments it was possible to make them change into the normal *perforans* type; accordingly they must have had residual bodies. Of course, PÉRARD may have made an experimental error; but I think it wisest to leave it to the future to determine the importance of PÉRARD's spherical oocysts, and not indiscriminately identify them already now with *E. exigua*.

The new *Coccidium* described by BRUCE 1919 (possibly comprising two species, since the variation in size is very great and only the largest oocysts are coloured) has not, unfortunately, been figured. At the present it is therefore impossible to decide which species he had before him.

HENRY (1932, p. 282), from a jack rabbit (*Lepus californicus*), records the four species which were found in California in the domestic rabbit by KESSEL & JANCKIEWICZ (1931).

In an editorial note (p. 186) to YAKIMOFF's paper 1936, C. PEREIRA mentions two papers by PINTO (1925 and 1933) in which *E. stiedae*, *E. magna*, and *E. perforans* are mentioned from the domestic rabbit. In the paper from 1933 PINTO, without stating his grounds, considers *E. media* = *E. perforans*, and E. *irresidua* = *E. stiedae*.

The information supplied by recent authors about the six species of rabbit-*Coccidia* will be tabulated below. The figure for *E. exigua* were found, in the case of YAKIMOFF, by adding his "oval" and "spherical" types and dividing by two. As regards UDINZEFF the procedure described above was used (Table 5).

It is fairly easy to survey the literature which treats especially the *Coccidia* in hares. Up to 1923 it was taken for granted that the *Coccidia* of rabbits and hares were identical. In 1923 NIESCHULZ described from Holland a new species, *Eimeria leporis*, which it seemed impossible to transfer to rabbits, and which was not to be found, either, in wild rabbits from the same regions. It is a parasite living in the small intestine, whose oocysts are formed in whitish nodules. NIESCHULZ further says that he has found "*Eimeria stiedae*", however, without stating anything about the presence of *Coccidia* in the liver nor anything about the appearance of the oocysts except their dimensions. Thus for the present it is impossible to say which species he had before him. Finally, he had once observed oocysts of "*E. perforans*", or "*perforans*"-like oocysts. In 1925 SCHIKARSKI in material from all parts of Germany found *Eimeria leporis* (whitish nodules in the small intestine!), and further, like NIESCHULZ, "*E. stiedae*", but not "*E. perforans*". SCHIKARSKI actually in one case (out of 19) ascertained liver coccidiosis, that is to say, probably *E. stiedae*. But in addition he had evidently other species before him.

YAKIMOFF, POLUEKTOFF, and RASTEGAÏEFF (1931) mention three species of *Coccidia* in excrements of two hares from Kasakstan (Kustanaï). The first one, which lacked a residual body, they identified with *E. stiedae*. However, as long as no liver coccidiosis has been ascertained at the same time, no safe identification can be made. Nos. 2 and 3, on the other hand, have no doubt been correctly determined as *Eimeria magna* and *E. leporis*.

BOUGHTON (1932, p. 535) found at any rate two *Eimeria* species in Western Canada in the American hare *Lepus americanus*. He identified them provisionally with *E. stiedae* and *E. perforans*, without, however, stating any facts in support of this identification. In the first place we are concerned with ellipsoidal or ovoid yellowish oocysts, often with a flattening of the micropyle; their size was 36—52 $\mu \times$ 24—27 μ. In the

Table 5. Tabular view of the most important characters of the

	Author	Shape	Colour	Micropyle
Eimeria stiedae. In the liver. No residual body.	WAWORUNTU 1924 Form 4	long-oval to cylinder-shaped	colourless in bile-duct, elsewhere light-yellow	not flattened, not sharply delimited
	PÉRARD 1924—1925	ovoid, slightly different poles	colourless to orange-yellow	absent or distinct, broad
	HEGNER & CHU[1]) 1930	oblong ovoid	—	broad, distinct
	CORREA 1931	oblong-ovoid	sometimes colourless, mostly orange-yellow	broad
	GOUSSEFF[1]) 1931	—	—	—
	KESSEL & JANKIEWICZ 1931	oblong-ovoid	colourless to reddish in bile-duct, reddish-orange in intestinal canal	broad, not sharply delimited
	YAKIMOFF[1]) 1933	—	—	—
	CHANG[1]) 1935	oblong-ovoid	—	broad, distinct
	UDINZEFF[1]) 1936	—	—	—
Eimeria perforans. In the small intestine. Small residual body.	WAWORUNTU 1924 Form 2	cylinder-shaped at times somewhat ovoid	colourless	no micropyle
	PÉRARD 1924—1925	cylinder- to egg-shaped	colourless	indistinct or absent
	HEGNER & CHU 1930	ellipsoidal	—	indistinct or absent
	CORREA 1931	ellipsoidal	colourless	indistinct
	GOUSSEFF 1931	—	—	—
	KESSEL & JANKIEWICZ 1931	cylinder-shaped to ellipsoidal	colourless	indistinct or absent

[1]) No demonstration of liver *Coccidia* is available.

species of *Coccidia* in rabbits described in the literature so far.

Length of oocyst	Breadth of oocyst	Shape index	Length of spore	Breadth of spore
32 μ—42 μ M. 36.9 μ	18 μ—22 μ M. 19.8 μ	M. 1.89	14.4 μ	8.3 μ
33 μ—43 μ M. 37.5 μ	18 μ—30 μ M. 21.5 μ	M. 1.74	18 μ	10 μ
M. 35 μ	M. 23 μ	M. 1.52	—	—
M. 36 μ	M. 23 μ	M. 1.56	—	—
23.7 μ—43.2 μ M. 31.4 μ	15.1 μ—28.0 μ M. 19.2 μ	1.10 μ—2.44 μ M. 1.82 μ	6.4 μ—17.2 μ M. 9.0 μ	4.2 μ—8.6 μ M. 6.0 μ
31 μ—42 μ M. 36.9 μ	17 μ—25 μ M. 19.9 μ	M. 1.85	16.7 μ	8.4 μ
24.19 μ—41.26 μ M. 34.7 μ	15.4 μ—30.9 μ M. 21.9 μ	1.31—2.06 M. 1.59	—	—
M. 37.5 μ	M. 22.5 μ	M. 1.67	—	—
31 μ—42 μ M. 32.8 μ	17 μ—26 μ M. 20.0 μ	1.25—2.17 M. 1.69	—	—
15 μ—30 μ M. 23.5 μ	11 μ—18 μ M. 14.6 μ	M. 1.61	7.9 μ	4.6 μ
23 μ—32 μ M. 25.5 μ	12 μ—20 μ M. 15.5 μ	M. 1.65	8 μ—12 μ	5 μ
M. 24 μ	M. 16 μ	M. 1.25	—	—
M. 26.4 μ	M. 16.5 μ	M. 1.60	—	—
15.1 μ—34.5 μ M. 19.9 μ	8.6 μ—23.7 μ M. 12.9 μ	1.06—2.04 M. 1.64	5.1 μ—8.6 μ M. 5.6	3.4 μ—6.4 μ M. 3.8
15 μ—29 μ M. 22.7 μ	11 μ—17 μ M. 14.2 μ	M. 1.59	8.8 μ	4.7 μ

Table 5

	Author	Shape	Colour	Micropyle
Eimeria perforans. In the small intestine. Small residual body.	YAKIMOFF 1934	oval	colourless	absent
	CHANG 1935	ellipsoidal	—	indistinct or absent
	UDINZEFF 1936	—	—	—
Eimeria magna. In the small intestine. Large residual body.	WAWORUNTU 1924 Form 1	ovoid-pitcher-shaped	greenish-yellowish	flattened, distinctly delimited w. thickening
	PÉRARD 1924—1925	ovoid	yellow-orange or brown	absent or mostly broad and distinct
	GOUSSEFF 1931	—	—	—
	KESSEL & JANKIEVIGZ 1931	broadly-oval	flesh-colured to brownish-yellow	distinctly delimited, surrounded by thickening
	YAKIMOFF 1933	—	—	—
	UDINZEFF 1936	—	—	—
Eimeria media In the intestinal canal. Small residual body.	WAWORUNTU 1924 Form 3	ovoid	light-yellow	not flattened, visible as a dark streak
	HEGNER & CHU 1930 Type 3 figs. 1,2 & 3	oblong-ovoid	—	narrow, distinct
	KESSEL & JANKIEWICZ 1931	oblong-ovoid	light-reddish to dark-orange-reddish	projecting, not sharply delimited
	CHANG 1935 *Eimeria* sp. p. 155, fig. 8	oblong-ovoid	—	narrow, distinct
	UDINZEFF 1936	—	—	—

(continued).

Length of oocyst	Breadth of oocyst	Shape index	Length of spore	Breadth of spore
16 μ—24 μ M. 20.8 μ	12 μ—16 μ M. 14.4 μ	1.15—1.92 M. 1.52	—	—
M. 22.5 μ	M. 15 μ	M. 1.50	—	—
20 μ—28.8 μ M. 23.3 μ	11 μ—17 μ M. 13.9 μ	1.18—2.63 M. 1.69	—	—
28 μ—44 μ M. 37.4 μ	21 μ—30 μ M. 25.5 μ	M. 1.47	16.2 μ	8.8 μ
M. 35 μ	M. 24 μ	M. 1.46	11 μ—15 μ	5.9 μ—8 μ
23.7 μ—38.8 μ M. 31.6 μ	12.9 μ—28.0 μ M. 18.8 μ	1.20—2.44 M. 1.69	6.4 μ—15.1 μ M. 9.0 μ	4.3 μ—8.1 μ M. 5.6 μ
31 μ—40 μ M. 35.5 μ	22 μ—26 μ M. 24.1 μ	M. 1.47	15.8 μ	8.4 μ
22.5 μ—39.6 μ M. 33.8 μ	16.2 μ—28.9 μ M. 22.3 μ	1.09—2.00 M. 1.52	—	—
31 μ—42 μ M. 33.8 μ	21 μ—26 μ M. 22.6 μ	1.22—2.00 M. 1.49	—	—
25 μ—32 μ M. 29.7 μ	16 μ—20 μ M. 16.4 μ	M. 1.75	11.6 μ	6.0 μ
M. 31 μ	M. 19 μ	M. 1.63	—	—
27 μ—36 μ M. 31.2 μ	15 μ—22 μ M. 18.5 μ	M. 1.69	12.1 μ	5.6 μ
M. 34.9 μ	M. 20.4 μ	M. 1.71	—	—
27 μ—31.5 μ M. 29.5 μ	14.8 μ—22.4 μ M. 17.8 μ	1.20—2.04 M. 1.64	—	—

Table 5

	Author	Shape	Colour	Micropyle
Eimeria irresidua. In the small intestine. No residual body.	KESSEL & JANKIEWICZ 1931	broadly-oval	light- to dark-yellowish	concave, narrow, sharply delimited
	UDINZEFF 1936	—	—	—
Eimeria exigua. In the intestinal canal. No residual body.	KESSEL & JANKIEWICZ 1931	broadly-oval to spherical	colourless	indistinct
	YAKIMOFF 1934	cylindric-oval to spherical	colourless	absent
	UDINZEFF 1936	oval to spherical	—	—

second place, small elliptical colourless occysts occurred without flattened micropyle ends and of a constant size of $15\,\mu \times 11\,\mu$. The infection percentage was about 80 (p. 540) in a material comprising 420 hares.

In 1933 a work by ROBERTSON, dealing with *Coccidia* from two English hares, appeared. This author thinks it possible to distinguish between five types. Unfortunately, however, his work cannot be said to have brought clarity. And the confusion is not diminished by the fact that as regards a single point, viz. the characters of *E. stiedae*, he has totally misunderstood the literature.

In my opinion it will be wise to eliminate entirely his Type II, all the more so since he is inclined himself to consider the oocysts classed by him under that type as deformed individuals of his Type IV.

Of the remaining four types, two (Nos. I and V) are clearly defined. He identifies No. I with *E. stiedae*. This is absolutely incorrect, since the oocyst contains a large residual body. But it shows considerable points of resemblance to *Eimeria magna*. The asymmetric shape, it is true, to which ROBERTSON attaches such great importance, bears no resemblance to that species. But ROBERTSON's figures indicate that to some extent he had deformed cysts before him, possibly because the hares, as he says, were very seriously attacked by coccidiosis, so that the cysts (provided he found them in the excrements and not in the intestines) may have been discharged more rapidly than normally. Personally I have observed, in a case of a deadly coccidiosis in the Greenlandic hare, that the occysts in the small intestine had an asymmetric, slender shape,

(continued).

Length of oocyst	Breadth of oocyst	Shape index	Length of spore	Breadth of spore
31 μ—43 μ M. 38.3 μ	22 μ—27 μ M. 25.6 μ	M. 1.50	20.5 μ	9.3 μ
31 μ—42.5 μ M. 38.2 μ	21 μ—25.6 μ M. 24.6 μ	1.35—2.00 M. 1.56	—	—
M. 16.4 μ	M. 13.5 μ	M. 1.21	—	—
10 μ—18 μ M. 14.5 μ	9 μ—16 μ 12.75 μ	1.00—1.89 M. 1.175	—	—
8.4 μ—17.0 μ M. 15.6 μ	8.4 μ—16.3 μ M. 13.7 μ	1.00—1.89 M. 1.17	—	—

which changed to the normal shape during its passage through the intestines. Hence I think that no great importance should be attached to the shape. Otherwise the appearance of ROBERTSON's Type I agrees with *E. magna*, though the average size is larger, 42 $\mu \times$ 25 μ. Further, no residual body is found in the spore, while a residual body is distinctly developed in the typical *E. magna*. I propose that ROBERTSON's Type I should be termed *Eimeria magna var. robertsoni var. nov.*

No. V he regards, and no doubt justly, as *E. perforans*. Both size and appearance render this determination extremely probable. In the material which he terms Types III and IV several forms are no doubt concealed.

Type III, which he identifies with *E. leporis*, according to his own view comprises three size groups, for which he even states the average size; however, without mentioning how he separated them. He says in the text that a residual body is always present in the oocyst, but he figures (p. 145, fig. 11) an oocyst without such a body. If we draw the shape index curve and the length curve, they will show a course which supports the supposition that there are several types (fig. 9), and accordingly it may be assumed that a type with no residual body has been added.

As regards Type IV conditions are no less confused. He says in the text that sometimes and rarely a residual body is present in the oocyst, and that it is mostly absent. He figures two types of oocysts (figs. 15 and 16); but in the text to the figures (p. 148) he says that a residual

body is present in the oocyst, that is to say, always. It is somewhat doubtful how this should be understood.

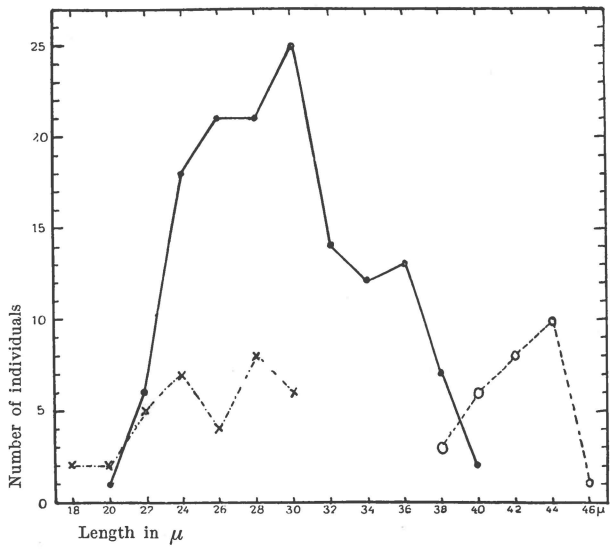


Fig. 9a. Length curves for ROBERTSON's Types I, III, and V (ROBERTSON 1933).

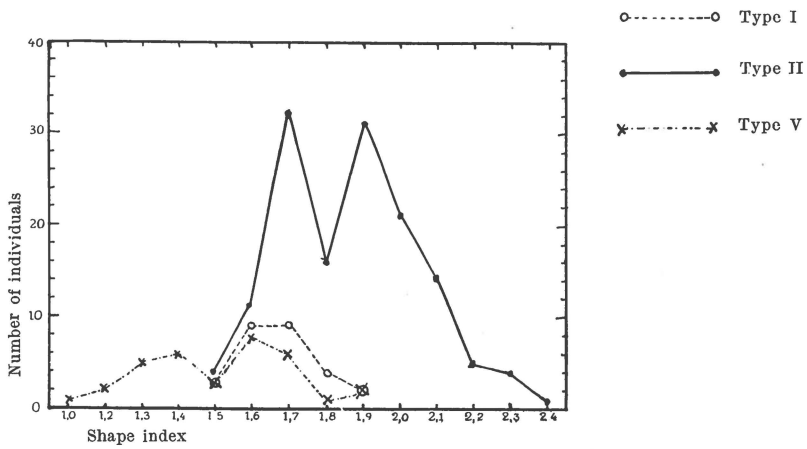


Fig. 9b. Shape index curves for Types I, III, and V (ROBERTSON 1933).

BECKER (1934, p. 88), without mentioning these peculiar conditions, is of opinion that Type IV is identical with *Eimeria magna* (ROBERTSON himself makes no identification), and cites, without comments or criticism, ROBERTSON's identification of Type I with *E. stiedae.*

It can hardly be doubted that ROBERTSON in his Type III among others had before him *E. leporis.* But as regards Type IV I consider it most correct to make no attempts at an identification until the various

points on which there is confusion have been cleared up in more detail. By way of illustration and documentation, length and shape index curves for ROBERTSON's Types I, III, and V (fig. 9) are given.

FEUERSTEIN (1935) found "*E. stiedae*", but no transformation of the liver, whereas in the small intestine he observed "weissliche, herdförmigen Gebilde" with oocysts, i. e. *E. leporis*.

Finally, *Coccidia* in hares are mentioned (1936) by SCHOENAER's (France) and YAKIMOFF, MATSCHOULSKY, and SPARTANSKY (northern

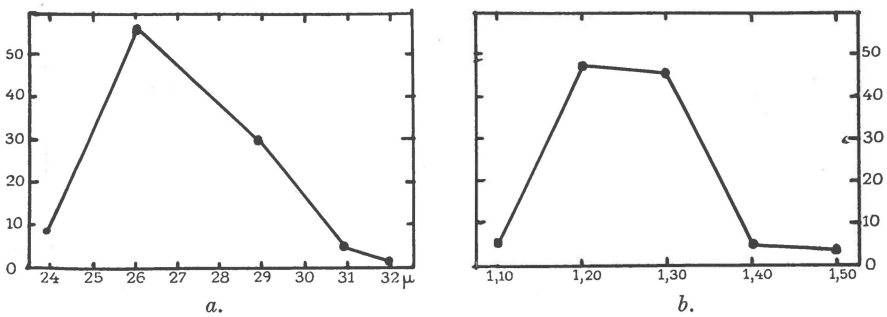


Fig. 10. Length curve (a) and shape index curve (b) for *E. septentrionalis* YAKIMOFF, MATSCHOULSKY and SPARTANSKY 1936 (after table).

Russia, from *Lepus timidus*, a species more closely related to *Lepus arcticus* than *Lepus europæus*) (See Table 6). The *E. septentrionalis* described by YAKIMOFF etc. shows complete agreement with my type A, besides, morphologically, by an almost entirely identical course of the length and shape index curves (as they may be drawn from YAKIMOFF, MATSCHOULSKY, and SPARTANSKY's table) (fig. 10).

The main points of our knowledge so far of *Coccidia* in hares, as delimited above, are tabulated in Table 6.

Identification of the Greenlandic *Coccidia* Species.

In general *Coccidia* are closely associated with certain species, numerous futile attempts having been made at infecting mice, rats, guinea pigs, rabbits, etc. with the *Coccidia* of specifically different hosts (see BECKER 1934, pp. 8—9). Only if the hosts are very closely related, will an infection be successful. Thus in 1931 BECKER infected *Sylvilagus floridanus mearnsi* ("cotton-tail rabbit") with *Eimeria magna* from *Lepus cuniculus* ("Belgian hare"?). This is all the more noticeable since *Sylvilagus* is generally regarded as more distantly related to *Lepus cuniculus* than the common European hare, *Lepus europæus*. NIESCHULZ in

Table 6. The *Coccidia* species

	Author	Shape	Colour	Micropyle
Eimeria leporis. In the small intestine. Medium-sized residual body in the oocyst	NIESCHULZ 1923	elongated egg-shaped to cylinder- or bean-shaped	colourless	no micropyle
	SCIKARSKI 1925	same as above	colourless	no micropyle
	YAKIMOFF, etc. 1931	cylinder- or bean-shaped	colourless	indistinct or absent
	ROBERTSON[1]) 1933 Type III partim.	oblong-ovoid to bean-shaped	colourless	absent
	SCHOENAERS 1936	oblong-ovid to cylinder-shaped	colourless	indistinct or absent
Eimeria magna. Large residual body.	YAKIMOFF, etc. 1931	oviform	—	delimited, rather broad
Eimeria perforans Small residual body.	ROBERTSON 1933 Type V	oval	—	indistinct to distinct narrowly plug-shaped
ROBERTSON's Type I. Large residual body = *E. magna var. robertsoni* nov.	ROBERTSON 1933 Type I	ovoid, often asymmetrical, front part narrow	—	distinctly delimited, narrow, projecting
Eimeria stiedae (?) Liver. Residual body in oocyst lacking.	YAKIMOFF, etc. 1931[2])	oval	—	broad
	RAUTMANN 1915 RÄBIGER 1915 SCHIKARSKI 1925	Liver coccidiosis has been ascertained in some		
	SCHOENAERS 1936[2])	ovoid	orange-yellow	distinct
Eimeria septentrionalis. No residual body in the oocyst	YAKIMOFF, etc. 1936	short ellipsoidal	colourless	broad, distinct

[1]) This Type is not a pure *E. leporis* (see the text).
[2]) No demonstration of liver *Coccidia* is available, so there exists no proof that it is *E. stiedae.*

hitherto described from hares.

Length of oocyst	Breadth of oocyst	Shape index	Length of spore	Breadth of spore
26 μ—38 μ M. 32 μ	13 μ—20 μ M. 16 μ	M. 1.96	12.5 μ	6.5 μ
24 μ—38 μ	11 μ—20 μ	—	—	—
25.2 μ—34.2 μ M. 30 μ	14 μ—18 μ M. 15.6 μ	1.56—2.38 M. 1.93	—	—
21 μ—39.5 μ M. 29.48	11 μ—19.5 μ M. 15.68	M. 1.89	—	—
c. 30 μ	c. 15 μ	c. 2	c. 10 μ	c. 5 μ
M. 34.2 μ	M. 21.6 μ	M. 1.58	—	—
18 μ—29.5μ M. 25.3 μ	12.5 μ—19.5 μ M. 16.5 μ	M. 1.53	10 μ—14 μ (mostly 12.5 μ)	—
38 μ—45 μ M. 42.1 μ	21 μ—30 μ M. 25.1 μ	M. 1.68	15 μ—18 μ	7 μ—9 μ
31.9 μ—36 μ M. 35.2 μ	21.8 μ—27 μ M. 24.1 μ	1.33—1.67 M. 1.46	—	—

few cases, and the presence of *E. stiedae* thus rendered probable.

c. 35 μ	c. 22 μ	c. 1.59	—	—
24 μ—32 μ M. 27 μ	20 μ—22 μ M. 21.6 μ	M. 1.25	12 μ—14 μ	6 μ—8 μ

Table 7, in which DA FONSECA's description of two *Eimeria*

	Author	Shape	Colour	Micropyle
Eimeria pintoensis	DA FONSECA 1932	slightly oval	yellowish-green	slightly marked
Eimeria paulistina	DA FONSECA 1933	oblong-ellipsoidal	deep greenish	broad, distinct, flattened

1923 did not succeed in infecting rabbits with *Eimeria leporis*, and in 1933 DA FONSECA tried in vain to transfer *Eimeria pintoensis* and *Eimeria paulistina* to rabbits.

As long as no infection experiments have been made, it is therefore impossible to say that the identy of all the hare-*Coccidia* described has been definitely established; however, *Eimeria leporis* has been safely established, although it has not yet been entirely delimited morphologically. On the basis of the oocysts *Eimeria magna* and *Eimeria perforans* have been demonstrated with great probability, and the identity of *Eimeria stiedae* has likewise been rendered probable by the demonstration of liver coccidiosis.

In order to clear up also the *Coccidia* of the Greenland hare by infection experiments I brought home living *Coccidia* cysts. However, the experiments proved impracticable, as it proved impossible to secure rabbits which were not spontaneously infected with *Coccidia*. Thus we are under the necessity of using only the morphological characters of the oocysts and must be content with the degree of probability which may be attained in this way.

Of the species described so far there are, as stated above, eight among which to choose. Of these, *Eimeria stiedae*, as a liver *Coccidium*, must be excluded. Nor can it possibly be *Eimeria leporis*. Only a very few of my forms are as slender in shape as *E. leporis* (about 1.9 as against 1.6), nor do any of them exhibit the characteristic bean-shape which always appears in *E. leporis* stocks, and I have never observed the characteristic nodules in the intestinal canal. *Eimeria irresidua* is out of the question. It is only Types A and D that lack a residual body, but both of them are entirely different from that species. Finally it cannot possibly be the *Eimeria* species from *Sylvilagus*.

Of the remaining four species of rabbit *Coccidia*, Type A bears a great resemblance to *Eimeria exigua*, Type B to *E. perforans*, and Type C to *E. magna*. *E. media* differs from Type B by being coloured, by always having a broad protruding micropyle, and by its constant egg-shape, while Type B is often rather cylinder-shaped, and from Type C by its small residual body.

species from *Sylvilagus minensis* in Brazil is tabulated.

Length of oocyst	Breadth of oocyst	Shape index	Length of spore	Breadth of spore
21.5 μ—25,5 μ M. 23.5 μ	M. 15.5 μ	M. 1.52	12 μ—14 μ	5 μ—7 μ
40 μ—43 μ	M. 23,5 μ	c. 1.77	M. 15.5 μ	M. 17.5 μ

Type A resembles *E. exigua* by its rounded shape (see p. 18) and its lack of a residual body; but it agrees entirely with the form described in 1936 by YAKIMOFF etc. under the name *Eimeria septentrionalis* (see above p. 29). Type B agrees with *Eimeria perforans*, as it shows the same ovoid to cylindrical shape, mostly with an indistinct micropyle; is colourless; and has a small residual body. Type C exhibits the following characters which it has in common with *Eimeria magna:* the oocyst is mostly coloured and with a distinct micropyle; big residual body. But it has not the thickened edge around the micropyle which was regarded by KESSEL and YANKIEWICZ as a characteristic feature and which was figured by WAWORUNTU. But it should be noted that PÉRARD did not indicate such a thickening, so too much importance should not be attached to it. A sculpture of the kind found on Type C, b is not mentioned in the literature; but such a sculpture, or more correctly, an indication of it is figured by REICHENOW (1921, pl.) or DOFLEIN-REICHENOW (1929, p. 939). However, Type C corresponds entirely, in size and by the residual body in the spore being but slightly developed, to *E. magna var. robertsoni nov. var.* (see p. 27).

A common feature of all the three types as compared with the aforementioned species of rabbit *Coccidia*, is a peculiar difference in size, all of them being larger, and (as will appear from KESSEL and YANKIEWIC's curves and those given above (fig. 8b) for *E. exigua*) even much larger, while they show about the same mutual relations. If for instance we consider the average length, we shall find

Eimeria exigua, about 14 μ—16 μ; Type A about 27 μ.
Eimeria perforans, about 23—25 μ; Type B about 32 μ.
Eimeria magna, about 33—37 μ; *E. m. var. robertsoni nov. var.* c. 42 μ Type C, about 43 μ.

On the basis of the considerations set forth above I feel justified in making a specific identification along the aforementioned lines, but must at the same time regard the forms found as special varieties. As moreover Type D (i. a. owing to the lack of a residual body in connection

with the sculpture distributed all over the oocyst) is no doubt a new species, the conclusion will be as follows:

Type A — *Eimeria exigua* YAKIMOFF 1934 *var. septentrionalis* YAKIMOFF 1936.
Type B — *Eimeria perforans* LEUCKART 1879 *var. groenlandica nov. var.*
Type Ca — *Eimeria magna* PÉRARD 1925 *var. robertsoni nov. var.*
Type Cb — *Eimeria magna* PÉRARD 1925 *var. robertsoni nov. var. forma semisculpta* n. f.
Type D — *Eimeria sculpta* nov. sp.

Table 8. Survey of the distribution of the *Coccidia* species in the individual host individuals.

+ = present; ++ fairly numerous to numerous.

Hare No.	Date	Type A = *E. exigua var. septentrionalis*	Type B = *E. perforans var. groenlandica* nov.	Type C = *E. magna var. robertsoni* nov.		Type D = *E. sculpta* sp. nov.
				a = *forma typica*	b = *forma semisculpta*	
12	11.— 9.—32	..	..	..	..	+
13	3.—10.—32	+ +	+	+	+	+
14	4.—10.—32	..	+ +	..	..	+
18	5.—10.—32	..	..	..	..	+
23	10.—10.—32	..	..	..	..	+ +
24	17.—10.—32	+	..	+	+	+ +
25	17.—10.—32	..	..	..	..	..
26	17.—10.—32	..	..	..	+	..
28	9.—11.—32	..	..	+ +	..	..
30	9.—11.—32	+	+	..	..	+ +
31	9.—11.—32	..	..	+ +	+	..
32	3.—12.—32	+ +	..	+ +	+	..
33	11.— 1.—33	+	+	+	+	+
34	11.— 1.—33	+	..	..	..	..
35	18.— 1.—33	+	..	+	..	+
36	5.— 2.—33	..	+	..	..	..
37	6.— 2.—33	..	..	..	..	+
38	26.— 2.—33	..	+	+	..	..
39	27.— 2.—33	..	+	..	+	+
40	27.— 3.—33	..	+	+	..	+ +
41	3.— 4.—33	+	+	+	..	..
42	3.— 4.—33	+ +	+	+	..	+ +

Biological Remarks.

As will be seen from the above table, the infection percentage was very high, viz. about 95. The distribution of the species was as follows:

Infected with	*E. exigua var. septentrionalis*	about	41	per cent	(9)
— —	*E. perforans var. groenlandica* ...	—	50	—	(11)
— —	*E. magna var. robertsoni f. typ.* ..	—	50	—	(11)
— —	*E. magna var. robertsoni f. semisculpta*	—	27	—	(6)
— —	*E. sculpta*	—	64	—	(14)
— —	*E. exigua var. septentrionalis* alone	—	5	—	(1)
— —	*E. perforans var. groenlandica* alone	—	5	—	(1)
— —	*E. magna var. robertsoni f. typ.* alone	—	5	—	(1)
— —	*E. p. var. groenlandica* and *E. sculpta* alone.....	—	5	—	(1)
— —	*E. p. var. groenlandica* and *E. m. var. robertsoni* alone.....	—	5	—	(1)
— —	All species and forms	—	9	—	(2)
— —	Four forms (i. e. except *E. p. var. gr.* and *E. m. var. robertsoni f. semisc.*)	—	9	—	(2)
— —	Three forms	—	27	—	(6)

In the hares which were shot no signs of disease were observed. But that the *Coccidia* in these regions, too, will be able to cause diseases under special circumstances was seen in a hare which was kept in captivity and was fed with sporulated oocysts (*E. magna var. robertsoni*). It died in the course of about a week. It was much emaciated, with suggestions of diarrhoea. Notably the hindmost part of the small intestine was sanguinary, with bloody lumps of slime. The urinary bladder was enormously swollen.

The infection seems to be distributed equally over the whole year (it is hardly reduced in the summer!), whether this is because the coccidiosis appears in a chronical form or it is due to constant fresh infections. The latter possibility is no doubt great, as the hare excrements lay very close together everywhere and in many places had excellent conditions for development owing to the moisture of the ground. If it is a case of constant fresh infections, which seems the most probable from many experiments on other animals where the possibility of fresh in-

fections was excluded, the oocysts must be very resistant to the influence of cold, for they are often exposed to temperatures below 40° C. below zero.

Summary.

1) Our knowledge so far of the *Coccidia* species in rabbits and hares is gathered in Tables 5 and 6.

2) Four *Coccidia* species found by examination of 22 specimens of *Lepus arcticus groenlandicus* RHOADS (Eskimonæs, East Greenland) are described (on the basis of the oocysts). Three of them, viz. *Eimeria exigua* YAKIMOFF 1934 *var. septentrionalis* YAKIMOFF 1936 (Fig. 4 a & b, Table 1), *Eimeria perforans* LEUCKART 1879 *var. groenlandica* nov. (Fig. 5 a, b, c, Table 2), and *Eimeria magna* PÉRARD 1925 *var. robertsoni* nov. (Fig. 6 a and b, Table 3), deviate from the main species especially by their considerable size, while *Eimeria sculpta* sp. nov. (Fig. 6 c, Table 4) is especially distinguished by its whole surface being sculptured.

3) It is shown that the infection percentage in the hare population examined was about 95. The infection was equally distributed over the whole year (Table 8), presumably as a consequence of constant new infections. The *Coccidia* did not produce pathologic symptoms in the period during which the investigation was made. The oocysts may be able to withstand very low temperatures (less than 40° C. below zero).

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