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Studies on gregarines (*Gregarinomorpha*) of arthropods in Poland

Studia nad gregarynami (*Gregarinomorpha*) stawonogów Polski

Contents

I. Introduction

The knowledge of protozoans, parasitic in arthropods in Poland, is very imperfect. Therefore special studies have been undertaken with the aim to get information on the fauna of entomophilic protozoans, and their possible use in the biological control of pest arthropods. Besides faunistic aspects these investigations also cover the study of the nature of infectious processes in the host organism caused by protozoans as well as the role of parasitic protozoans in the dynamic of host populations.

Results of studies on some of the microsporidians and flagellates were already published by the author (Lipa 1957 a,b, 1963, 1964 a,b, 1966 a,b). New species were described and many important information on their parasitism, phylogeny and occurrence in Poland was collected.

While continuing such studies an attempt has been made to analyse parasitism of gregarines, and the present paper is the first in the series devoted to gregarines of arthropods in Poland. Besides insect gregarines that of *Diplopoda* and *Chilopoda* were included into these studies. The knowledge of gregarines of related groups of arthropods will allow to discover the eventual ways of parasites' circulation and of their phylogeny. On the other hand, the learning of parasites of insects, spiders and millipedes, which in many cases are very serious pests, may establish a basis for biological control studies of pest arthropods.

Studies of gregarines are justified by many reasons. A great number of species described in the time, when the taxonomy of gregarines was not as good as it is now. Many species were therefore incompletely described, synonyms are not clear and the pathogenesis in unknown. Due to the wide range of the problem it was not possible to work out all questions completely. Nevertheless, this paper summarizes, up to date, the results of studies of gregarines in Poland, draws out the lines of further studies, and forms the basis for further research of this problem.

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II. Short evaluation of the knowledge of gregarines

Cavolini 1787 was probably the first who noticed the gregarines parasitic in animals but it was Dufour 1826 a, 1827 who described the first authentic case of gregarinosis of an arthropod. He also described the genus *Gregarina*, now the most numerous in the clase of *Gregarinomorpha*.

For many years gregarines were regarded as helminths. Their elongated bodies and ability to make associations of two or more individuals, confused zoologists who identified them as trematodes and cestodes. Many years had passed when studies of such investigators as Stein 1848, Lankester 1863, Schneider 1873, 1875 and others allowed to place *Gregarinomorpha* among *Sporozoa* of the kingdom *Protozoa*. Monographs published by Watson 1916 and Watson-Kamm 1922 have been the main publications on *Eugregarinaria* up to now. In recent years significant contributions to the

knowledge of *Eugregarinaria* were made by Filiponi 1954 a,b and Theodorides 1955, and on *Schizogregarinaria* by Weiser 1954 b. A general information on gregarines is given in many textbooks on protozoology, e.g. by Doflein and Reichenow 1953, Grassé 1953, Kudo 1954, Raabe 1964 and from the standpoint of invertebrate pathology by Steinhaus 1949, Weiser 1963, 1966 and Lipa 1967.

On the basis of morphology and the type of development Grassé 1953 divded *Gregarinomorpha* into three orders:

Order 1. *Archigregarina* Grassé — includes species with a very simple asexual development, only by schizogony. The members of this order parasitize *Enteropneusta* and *Annelida*.

Order 2. *Eugregarinaria* Leger — comprises species that develop exclusively by sexual way (sporogony) and parasitize various invertebrates, mainly arthropods.

Order 3. *Schizogregarinaria* Leger — comprises species that develop sexually and asexually. So far, they are known as parasites of insects.

A great majority of papers dealing with *Eugregarinaria* are concerned only with the morphological description of species observed in arthropods and do not cover the histopathological problems. Due to lack of such information, it was, therefore believed that the pathogenic effect of eugregarines is very low, as the damage of gut epithelium by the developing trophozoites could be compensated by regenerative processes.

However the investigations of some authors indicate that the pathogenicity of eugregarines is very complex. Among others it was Siedlecki 1901, 1911 who noticed pathological changes in the tissues as well as changes in the ratio of nucleus to cytoplasm during his study on *Lankesteria ascidiae* (Lankester) in *Tunicata;* Leger et Duboscq 1904 gave much attention to this problem, too.

Some authors e.g. Grassé 1953 examined the pathogenicity of gregarines from the standpoint of their intracellular and extracellular development, nucleoplasmatic reactions and influence of sexual cells. However, there is very little factual information illustrating the specific mechanisms and there are even contradictory data on the pathogenicity of eugregarines.

Sumner 1936 report that *Tenebrio molitor* L. infected with *Gregarina steini* Berndt developed better than insects free from the parasite. These data were not confirmed by Leonova 1937. On the other hand Foerster 1938 b and Weiser 1963 pointed out, that eugregarines parasitizing in the body cavity of arthropods cause atrophy of various organs and the death of larvae or adults.

Pathogenicity of *Schizogregarinaria* is generally recognized. These parasites develop intracellularly or intercellularly in internal organs and seriously damage large parts of the tissues of the hosts. This is mainly due to the asexual development (schizogony), as multiple and frequent divisions lead to a high increase in intensity of infection. The damage of tissues and the weakening of life processes lead to the death of the infected host.

The mechanism of pathogenicity of gregarines in arthropods has not been studied in detail. It is generally believed that the pathogenicity of gregarines depends on a mechanical destruction of tissues and organs of the host organism. In many cases the patency of gut is stopped by a huge number of gamonts of eugregarines developing in the gut of arthropods. There is no question that

such efects are very easy to notice but it is generally beleived there must be also other mechanisms of the influence of gregarines on their hosts. For example, the excretion of toxins and the harmful effect of metabolities of gregarines, on the cells lying close to the infected tissues or to parasites, cannot be excluded.

Summarizing the above, the character of parasitism of gregarines is not fully known and requires additional studies. In this paper there are given some information enlarging our knowledge on this subject.

III. History of studies of gregarines in Poland

The knowledge of gregarine fauna in Poland is very imperfect and research papers on this group are limited only to a few in number.

Characterizing chronologically the publications concerning gregarines, the article by Wrześniowski 1862 published in the Polish Universal Encyclopedia should be mentioned in the first place. In this article Wrześniowski gave the proper characteristic of the morphology of gregarines, their movements, forming of associations, and their development. However, his view on the systematic position of gregarines, like those of other zoologists of that time, was incorrect. Then the gregarines were considered to be either protozoans (*Protozoa*) or worms (*Vermes*). Wrześniowski thought that most probably gregarines were juvenile developmental stages of *Enteropneusta*. Wrześniowski did not develop his view widely but it may be thought that his opinion was based on the similarity in morphology between gregarines of the sub-order *Cephalina* and *Glossobalanus* spp. and of other members of *Enteropneusta*. The head of *Enteropneusta* would correspond to the epimerite or protomerite of gregarines and their body — to the deutomerite.

Minkiewicz 1867 published a paper on gregarines of man which in the light of our present knowledge of these protozoans must be considered as having no relation with gregarines. So far, there is no record of gregarines parasitizing vertebrates as they are exclusive parasites of invertebrates. Minkiewicz's mistake was caused by the similarity between the morphology of gregarines of the genus *Monocystis* and the eggs of lice (*Anoplura*). He merely joined Lindeman 1884, in this regard, and recognized in his article four gregarine species parasitizing man, that is: *Monocystis capitata* on hair and skin of man; *Monocystis hominis* in the spleen of man; *Monocystis sphaeriae* in the kidney and suprarenal glands; and *Monocystis stiedae* in the liver of the rabbit and in muscles of man. The bodies he considered to be "*Monocystis capitata*" were apparently eggs of *Pediculus humanus capitis* De Geer; "*Monocystis hominis*" apparently is *Diplospora belli* Wenyon (=*Isospora hominis* Rivolti); "*Monocytis stiedae*" is now known as *Eimeria stiedae* (Lindeman); "*Monocystis sphaeria*" is, so far, difficult to identify with present recognized species.

There are more encyclopedic articles on gregarines (Anonyms 1867, 1900) and recently these protozoans were extensively discussed by Lipa 1967.

In a group of research papers of Polish authors on gregarines of European countries we have to mention, first of all, papers by Siedlecki 1899, 1901, 1911 on *Lankesteria ascidiae* (Lankester) from *Ciona intestinalis* L. Lipa 1966 c worked on *Didymophyes minuta* (Ishii) from *Tribolium destructor* Uytt, in the Soviet Union. Lipa i Semjanov 1967 worked on gregarines of

Coccinellidae in the Soviet Union and Lipa and Steinhaus 1959, 1962 — on gregarines of *Coccinellidae* in the United States. Lipa and Martignoni 1968 described a new gregarine from *Phryganidia californica* Packard in the United States. Siedlecki 1901, 1904, 1911, Nussbaum 1903 and Dembowski 1913 worked on some cytological problems connected with gregarines.

Intensive faunistic studies of gregarines parasitizing insects and millipeds of the north-eastern part of Poland were done by Wellmer 1911, and of Silesia by Foerster 1938 a,b. Wellmer 1911 recorded 6 gregarine species and his paper was only faunistic as he had not studied the life cycle and pathogenicity of the recorded gregarines.

Papers by Foerster 1938 a,b are very valuable. In the first paper Foerster 1938 a listed 88 gregarine species recorded in Silesia, especially in the neighbourhood of Wrocław, including 29 new species. In his second paper Foerster 1938 b discussed general problems connected with parasitism of gregarines and factors that influence gregarine infections in insects. However, like in Wellmer's paper, Foerster 1938 a,b too, gave very scanty biometrical data and completely neglected histopathological problems.

IV. Materials and methods

Three groups of *Arthropoda* were included into these investigations: *Insecta, Diplopoda* and *Chilopoda*. Arthropods were collected from 1953 to 1966 in the following voivodeships and localities in Poland: Białystok — Białowieża (Hajnówka County); Lublin — Góra Puławska, Kurów, Puławy (Puławy County); Poznań — City of Poznań, Kórnik, Marcelin, Kobylniki, Rogalin (Poznań County); Chludowo, Sierniki (Oborniki County); Popowo Podleśne, Modliszewko (Gniezno County); Książ (Śrem County); Gola, Janówka, Laski, Marianka, Siemianice (Kępno County); Zielona Góra — Kałek, Ogardy (Strzelce Krajeńskie County). Localities in which collected arthropods apeared to be healthy are not mentioned.

The collected arthropods were dissected in a physiological solution, that slowed down the plasmolysis of gregarines, ensuring the time required for taking photographs, measuring and description.

Gregarines of the order *Eugregarinaria* were preserved in two ways: 1) they were placed in 50% ethanol or 5% formalin, or 2) mounted as permanent microscopic preparations. In such cases the arthropods were disected directly in Bouin's fluid or first in physiological solution and later they were transferred to fixing fluids. After 10—15 minutes of fixing the gregarines were washed several times in 50—70% ethanol, until picric acid was washed out. Then gregarines were transferred on microscopic slides smeared with egg albumin and, after attaching to the glass, were stained in 0.25% to 0.5% Giemsa's solution for 16—20 hours. Then staining was corrected by placing slides into 70% ethanol acidified by glacial acetic acid, dehydrated in alcohol, cleared in xylol and embedded into Euparal.

Histological studies were performed on microscopic preparations. Whole arthropod bodies, or only their intestines, were fixed in Bouin's or Duboscq-Brasil's fluids for 6 to 18 hours, washed in 70% ethanol, and routinely embedded into paraffin and then sectioned on the microtome. Microtome slides 6—10 μ

thin received in this way were stained in 0.25% Giemsa's solution or Heidenhain's hematoxylin.

In the case of some species of arthropods their populations were checked in various periods in order to estimate the infection level.

Abbreviations used in this paper:

LE — length of epimerite
LP — length of protomerite
LD — length of deutomerite
WP — width of protomerite
WD — width of deutomerite
TL — total length
LP:TL — ratio length protomerite to total length of gamont
WP:WD — ratio width protomerite to width of deutomerite
Prim. — primite
Sat. — satellite
Trophoz. — trophozoite

V. List of recorded and studied gregarines

During this study 46 gregarine species were recorded and studied. Among them 45 species belong to the eight families of the order *Eugregarinaria* and only one species to the order *Schizogregarinaria*.

Out of 46 recorded and studied species 26 appeared to be new species, including also a new family and a new genus. The list of studied species is as follows:

Eugregarinaria of *Diplopoda*

1. Family *Stenophoridae*
   1. *Stenophora caudata* sp. n. from *Chromatoiulus projectus* Koch
   2. *Stenophora juli* (Frantzius) from *Schizophyllum sabulosum* (L.)
   3. *Stenophora julimarginati* (Leidy) from *Schizophyllum sabulosum* (L.)
   4. *Stenophora nematoides* Leger et Duboscq from *Strongylosoma pallipes* (Oliver)
   5. *Stenophora orthomorphae* sp. n. from *Orthomorpha gracilis* (Koch)
   6. *Stenophora poznanensis* sp. n. from *Orthomorpha gracilis* (Koch)
   7. *Stenophora sarmatiuli* sp. n. from *Sarmatiulus vilnensis* (Jawłowski)
   8. *Stenophora schizophylli* sp. n. from *Schizophyllum sabulosum* (L.)
   9. *Stenophora strongylosomae* sp. n. from *Strongylosoma pallipes* (Oliver)
   10. *Stenophora uncigeri* sp. n. from *Unciger foetidus* Koch
2. Family *Gregarinidae*
   11. *Cnemidospora lutea* Schneider from *Glomeris connexa* Koch
3. Family *Dactylophoridae*
   12. *Echinomera leptoiuli* sp. n. from *Leptoiulus proximus* (Nemec)

Eugregarinaria of *Chilopoda*

4. Family *Actinocephalidae*
   13. *Actinocephalus dujardini* Schneider from *Lithobius forficatus* L.
5. Family *Dactylophoridae*
   14. *Echinomera hispida* (Schneider) from *Lithobius forficatus L.* and *L. calcaratus* Koch
   15. *Rhopalonia lithobii* sp. n. from *Lithobius calcaratus* Koch

Eugregarinaria of *Insecta*

6. Family *Gregarinidae*
   16. *Gamocystis tenax* Schneider from *Ectobius lapponicus* L.
   17. *Gregarina blattarum* Siebold from *Blatta orientalis* L. and *Periplaneta americana* L.
   18. *Gregarina chrysomelae* sp. n. from *Chrysomela polita* L.
   19. *Gregarina coccinellae* sp. n. from *Coccinella septempunctata* L. and *Hippodamia tredecimpunctata* (L.)
   20. *Gregarina cuneata* Stein from *Tenebrio molitor* L.
   21. *Gregarina harpali* sp. n. from *Harpalus aeneus* L.
   22. *Gregarina forficulae* sp. n. from *Forficula auricularia* L.
   23. *Gregarina hypophloei* sp. n. from *Hypophloeus unicolor* Pill.
   24. *Gregarina macrocephalia* sp. n. from *Aphodius depressus* Kug.
   25. *Gregarina minuta* Ishii from *Tribolium confusum* F.
   26. *Gregarina munieri* (Schneider) from *Chrysomela coerulans* Scriba
   27. *Gregarina ovata* Dufour from *Forficula auricularia* L.
   28. *Gregarina rostrata* Wellmer from *Lagria hirta* L.
   29. *Gregarina ruszkowskii* sp. n. from *Coccinella septempunctata* L. and *Coccinella quinquepunctata* L.
   30. *Gregarina steini* Berndt from *Tenebrio molitor* L.
   31. *Gregarina typographi* Fuchs from *Ips typographus* L.
   32. *Euspora fallax* Schneider from *Melolontha melolontha* L.
   33. *Leidyana ephestiae* Daviault from *Ephestia kühniella* Zell.
7. Family *Didymophyidae*
   34. *Didymophyes ontophagi* Foerster from *Ontophagus fracticornis* Preyssl.
   35. *Didymophyes paradoxa* Stein from *Geotrupes stercorarius* L., *G. stercorosus* Scriba, *G. vernalis* L.
8. Family *Actinocephalidae*
   36. *Bothriopsides histrio* (Schneider) from *Dytiscus marginalis* L. and *Hydrophilus* sp.
   37. *Coleorhynchus heros* (Schneider) from *Nepa cinerea* L.
   38. *Pyxinia frenzeli* Laveran et Mesnil from *Attagenus pellio* L.
   39. *Stictospora provincialis* Leger from *Amphimallon solstitialis* L.
9. Family *Acanthosporidae*
   40. *Ancyrophora balazyi* sp. n. from *Carabus coriaceus* L.
   41. *Ancyrophora philonthi* sp. n. from *Philonthus laevicollis* Boisd.
   42. *Ancyrophora stelliformis* (Schneider) from *Carabus violaceus* L. and *Pterostichus vulgaris* L.
10. Family *Stylocephalidae*
   43. *Stylocephalus carabi* sp. n. from *Carabus glabratus* L.
   44. *Stylocephalus oblongatus* (Hammerschmidt) from *Opatrum sabulosum* (L.)
11. Family *Iorellidae* nov. fam.
   45. *Iorella wegoreki* g.n. sp. n. from *Dytiscus marginalis* L.

Schizogregarinaria of *Insecta*

12. Family *Ophryocystidae*
   46. *Mattesia dispora* Naville from *Ephestia kühniella* Zell.

VI. Gregarines of *Diplopoda* and *Chilopoda*

During the study of *Gregarinomorpha* of the so called *Myriapoda* 11 gregarine species were found in 8 species of millipedes (*Diplopoda*) and 4 gregarine species in 3 species of centipedes (*Chilopoda*). Out of the total number of 15 recorded and studied gregarine species 9 appeared to be new species.

Eugregarinaria of millipedes (*Diplopoda*)

1. *Stenophora caudata* sp.n.

Host: *Chromatoiulus projectus* Koch.
Habitat: Intestine.
Locality: Białowieża 10.VII.1965.

Morphology: Gamonts solitary (Figs. 1 and 2). Maximum length 204 μ; maximum width 103 μ. Ratio LP:TL = 1 : 7.6—13.6; ratio WP:WD = 1 : 1.4—3.4 (Table 1).

Table 1

Measurements of living trophozoites and gamonts of *Stenophora caudata* sp.n. (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
15	101	28	96	116	1:7.7	1:3.4
13	136	15	50	149	1:11.4	1:3.3
18	169	33	88	187	1:10.4	1:2.6
15	189	35	103	204	1:13.6	1:3.1
15	98	25	35	113	1:7.6	1:1.4

Protomerite conical, wider than long. Septum seen. Constriction at septum absent. Ectoplasm clearly seen. Endocyte granular and not translucent.

Deutomerite widest in the middle and tapering into a narrow caudal end (Figs. 1 and 2). Endocyte brown or dark and granular. Caudal end with corrugated ectoplasm and homogenous endocyte. Nucleus 12—17 μ in diameter.

Cysts and spores were not seen.

Development and parasitism: The parasite was observed only in adults of *Chromatoiulus projectus* Koch.

Taxonomic position: The characteristic caudal end was not observed among members of the genus *Stenophora* and therefore I assume that it is a new species and propose the name *Stenophora caudata* sp.n. for it.

Distribution: Poland.

2. *Stenophora juli* (Frantzius)

Synonyms: *Sporadina juli* Frantzius, 1848; *Gregarina juli*: Diesing, 1851; *Stenocephalus juli*: Schneider, 1875; *Gregarina paradoxa*: Gabriel, 1880; *Stenophora juli*: Labbe, 1899; *Stenophora juli*: Leger et Duboscq, 1904; *Stenophora juli* (Frantzius) Labbe: Watson, 1916.
Host: *Schizophyllum sabulosum* (L.)

Habitat: Intestine.
Locality: Góra Puławska 26.VI.1963; Puławy 26.VI.1963; Mielno Koszalińskie 6.IX.1963; 29.VI.1964. Poznań 8.IV.1964, 10.IV.1964; Białowieża 11.VII.1964.

Morphology: Gamonts solitary and elongate (Fig. 3). Maximum length 480 μ; maximum width 67; Ratio LP : TL = 1 : 12—17; ratio WP : WD = = 1 : 1.6—2 (Table 2).

Table 2

Measurements of living trophozoites and gamonts of *Stenophora juli* (Frantzius) (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
9	150	13	21	159	1:17	1:2
9	105	18	33	114	1:12	1:2
27	425	30	50	449	1:17	1:1.6
27	437	32	67	464	1:17	1:2
30	450	30	50	480	1:16	1:1.6

Protomerite small, cylyndrical at the deutomerite and oval at the top (Fig. 4). Slightly longer than wide. Endocyte translucent.

Deutomerite very elongated, widest in one third of its lenght and tapering toward the end. Endocyte yellow and translucent. Nucleus oval 20 μ in diameter with one large karyosome located in the front part of deutomerite.

Cysts and spores: Cysts oval from 150 to 200 μ in diameter. Spores released by cyst rupture. Spores spindle-shaped 10 μ long.

Development and parasitism: The host becomes infected by swallowing the spores. Sporozoites that leave the spores penetrate the gut epithelium and develop into trophozoites. Fully grown gamonts are observed in the lumen of the gut. Gamonts in associations were not seen, but cysts were observed.

The pathogenicity of the parasite for its host depends on the intensity of infection, but the parasite was never observed in great number in this milliped.

Taxonomic position: Due to an incomplete description of this gregarine given by Frantzius 1848 this species *Stenophora juli* was described later several times by various authors under different generic and specific names. In this paper detailed measurements of this gregarine are given for the first time.

Schneider 1875 described this species as *Stenocephalus juli* Schneider and identified it with *Gregarina juli marginati* Leidy. Although there is some similarity in the proportions and shape of bodies of *Stenocephalus juli* and *G. juli marginati*, they differ in the color of the endocyte. Leidy 1853 emphasized that *G. juli marginati* is not translucent and Schneider 1875 described the endocyte of *Stenocephalus juli* as yellow or orange.

In the studied material I observed that *Stenophora* (=*Stenocephalus*) *juli* was always translucent and had the same shape of the protomerite, independent on the length of the deutomerite. This feature was emphasized by Schneider 1875 who stressed the fact that, in spite of the polymorphism of *S. juli*, the shape of protomerite was constant.

For the reasons explained above I propose the following definition of the *Stenophora juli* (Frantzius) Labbe: Sporonts solitary and elongated, rarely

ellipsoidal. Length variable, but most frequenty about 400 μ. Protomerite at the deutomerite cylindrical and narrowing toward the top. The septum and constriction well seen. Deutomerite elongated narrowing toward the end. Endocyte of protomerite and deutomerite is translucent and yellow. Cysts oval 150—200 μ in diameter. Spores spindle-shaped 10 μ long and released by simple rupture of cysts.

Distribution: France (Schneider 1875; Labbe 1899; Theodorides et Ormieres 1955) and Germany (Frantzius 1848; Diesing 1851); recorded for the first time in Poland.

3. *Stenophora julimarginati* (Leidy)

Synonyms: *Gregarina juli marginati* Leidy, 1853; *Stenophora larvata* (Leidy) Ellis, 1913 pro parte; *Stenophora juli* (Frantzius): Labbe, 1899 pro parte; *Stenocephalus juli*: Schneider, 1875 pro parte; *Stenophora julimarginati*: Leger et Duboscq, 1904; *Stenophora larvata* (Leidy) Ellis: Watson, 1916 pro parte.
Host: *Schizophyllum sabulosum* (L.)
Habitat: Intestine.
Locality: Puławy 26.VI.1963; Góra Puławska 26.VI.1963; Mielno Koszalińskie 7.IX.1963, 8.IX.1963, 24.VI.1964; Poznań 10.IV.1964, 15.IV.1964; Białowieża 12.VII.1964; Sierniki 16.VI.1965.

Morphology: Gamonts solitary and oval (Figs. 5 to 7). Maximum length 415 μ; maximum width 195 μ. Ratio LP:TL=1:8—15; ratio WP:WD=1:3—5 (Table 3).

Table 3

Measurements of living trophozoites and gamonts of *Stenophora julimarginati* (Leidy) (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
32	324	44	159	356	1:11	1:4
25	288	38	152	324	1:13	1:4
38	279	38	139	317	1:8	1:4
22	146	22	114	168	1:8	1:5
19	267	32	121	286	1:15	1:4
38	336	44	165	374	1:10	1:4
32	330	57	165	362	1:11	1:3
32	267	44	133	298	1:9	1:3
38	286	44	140	324	1:8	1:3
40	375	52	195	415	1:10	1:3

Protomerite small, conical, wider than long (frequently twice so). Septum apparent and slightly convex upward deutomerite. Endocyte dark. Deutomerite oval or elongated. Oval forms have a slightly pointed end of the deutomerite, on the other hand, elongated forms have deutomerites with round ends (Fig. 6). Nucleus 15 μ in diameter with one large karyosome located in the posterior part or in the middle of deutomerite rarely seen inside the dark endocyte. Endocyte strongly granular, very dense and, as a rule, not translucent; easily liable to plasmolysis.

Cysts and spores: Cysts oval about 210 μ in diameter. Spores not seen.

Development and paratitism: Development and type of parasitism similar to those of *Stenophora juli* (Frantzius). Gamonts show tendency to become oval during development. Oval gamonts about 120 μ in diameter but associations not seen.

Taxonomic position: There is great confusion about gregarines infecting *Schizophyllum sabulosum* and some questions were already discussed together with *Stenophora juli*. Leidy 1853 described *Gregarina juli marginati* later identified by Schneider 1875 with *Stenocephalus juli*, described from the same host. Labbe 1899 regarded *S. julimarginati* as a synonym of *S. juli* (Frantzius) but Ellis 1913 identified this species with *Stenophora larvata* (Leidy).

On the basis of my investigation I assume that *Stenophora julimarginati* (=*Gregarina juli marginati* Leidy) described by Leidy 1853 is a good species, parasitizing *Schizophyllum sabulosum*. The second species *Stenophora juli* (Frantzius) also parasitizes the same milliped but differs from the latter in many features.

Morphological differences between both species were discussed in the preceding pages, but for the purpose of clarity they will be repeated. The gamonts of *Stenophora juli* are long and elongated while gamonts of *S. julimarginati* are oval. Ratio LP:TL for *S. juli* is on an average about 1:16 and ratio WP:WD does not exceed 1:2.

On the other hand ratio LP:TL for *S. julimarginati* is, on an average 1:12 and WP:WD is, on an average, 1:5 and never falls lower than 1:3. These differences are especially clear when we compare the width of gamonts; maximum width of *S. juli* was 75 μ while that of *S. julimarginati* 195 μ.

The color and density of the endocyte are of special taxonomic value. The endocyte of *S. juli* is translucent and yellow while the endocyte of *S. julimarginati* is not translucent and is brown-dark. For this reason the recognitions of both species is justified, and according to the recommendation of the International Rules of Zoological Nomenclature to avoid names consisting of three words I propose the name *Stenophora julimarginati* (Leidy).

The proposition of Ellis 1913 to identify *S. julimarginati* as a synonym of *S. larvata* is not correct because of serious differences between these species. Gamonts of *S. larvata* are up to 800 μ long and 23 μ wide. The two other species *S. juli* and *S. julimarginati* are much shorter and several times wider.

The recognition of these three species will prevent and stop confusion observed in literature. Crawley 1903 was the first to notice that *S. juli* could not be identified with *S. julimarginati*. A similar view was expressed by Leger et Duboscq 1904.

Distribution: USA (Leidy 1853; Ellis 1913) and France (Schneider 1875; Leger et Duboscq 1904); recorded for the first time in Poland.

4. *Stenophora nematoides* Leger et Duboscq

Host: *Strongylosoma pallipes* (Oliver).
Habitat: Intestine.
Locality: Białowieża 19.VI.1962, 19.VII.1965.

Morphology: Sporonts solitary and very elongate (Figs. 8 and 9). Maximum length 474 μ; maximum width 59 μ. Ratio LP:TL = 1:9.8—29; ratio WP:WD = = 1:1.2—3.5 (Table 4).

Table 4

Measurements of living trophozoites and gamonts of *Stenophora nematoides* Leger et Duboscq (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
13	252	10	13	265	1:21	1:1.2
33	353	18	28	386	1:11.7	1:1.6
15	353	15	39	368	1:24.3	1:2.5
20	325	15	33	345	1:17	1:2.2
15	422	20	40	437	1:29	1:2
19	455	22	41	474	1:25	1:1.9
23	231	15	31	251	1:10.9	1:2.1
16	196	15	45	212	1:13.4	1:3.0
15	133	14	32	148	1:9.8	1:2.3
20	282	17	59	302	1:15.1	1:3.5

Protomerite wider than long frequently cylindrical (Fig. 10). Endocyte homogenous, rarely granular. Septum straight and clearly visible. Ectoplasm well seen. Deutomerite very elongate, frequently cylindrical. In the middle of its length there is a narrowing, and then, a cylindrical elongation. The endocyte of protomerite and deutomerite is brown or light green. Nucleus oval 12 μ in diameter with single karyosome. Ectoplasm of deutomerite slightly ribbed longitudinally.

Cysts and spores were not seen. In the paper by Leger et Duboscq 1903, there is no information, either.

Development and parasitism: Development and parasitism were not studied because of lack of material. In 1962 two examined specimens were infected and in 1965 two out of four examined were infected.

Taxonomic position: This species is identified as *Stenophora nematoides* Leger et Duboscq due to its protomerite, constriction in deutomerite and ratios of LP:TL and WP:WD.

Distribution: Known in Corsica as parasite of *Strongylosoma italicum* Latzel (Leger et Duboscq 1903); for the first time recorded in Poland.

5. *Stenophora orthomorphae* sp.n.

Host: *Orthomorpha gracilis* (Koch)
Habitat: Intestine.
Locality: Poznań 10.I.1963, 4.IV.1963, 26.VI.1963, 1.XII.1963, 28.VI.1965.

Morphology: Gamonts solitary. Young trophozoites and mature gamonts have the same shape and are elongate (Figs. 11—18). Maximum length 987 μ and maximum width 187 μ. Ratio LP:TL = 1:3—7.9; ratio WP:WD = 1:1.1—1.2 (Table 5).

Table 5

Measurements of living trophozoites and gamonts of *Stenophora orthomorphae* sp.n. (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
125	862	150	175	987	1:7.9	1:1.2
87	587	150	162	637	1:6.4	1:1.1
100	875	150	175	975	1:4.7	1:1.2
187	375	162	187	562	1:3	1:1.2

Protomerite triangular or heart-like upside down with well seen constriction at septum. Septum straight and clearly visible. Protomerite very active and frequently invaginated into deutomerite (Figs. 16—18). Endocyte of protomerite and of deutomerite translucent and yellow-green.

Deutomerite cylindrical with thick ectoplasm, frequently with constriction in the middle or close to septum (Fig. 15). End of the body straight or slightly oval. Endocyte translucent. Nucleus 6—8 μ in diameter located in the middle of deutomerite.

Cysts and spores: Cysts are oval 400 μ in diameter. Spores solitary 14 μ long.

Development and parasitism: The host becomes infected by swallowing the cysts with spores and the emerging sporozoites penetrate the gut epithelium. The development of trophozoites takes place inside the cells and later intercellularly. Gamogony takes place in the gut lumen. In heavy infection the extensive parts of the gut epithelium are destroyed by the trophozoites and gamonts of the parasite, and the life processes of the hosts are seriously slowed down causing the death of hosts.

Taxonomic position: Due to its morphological and developmental features this species is placed among the genus *Stenophora*. Ellis 1912 a described *Stenophora robusta* Ellis from *Orthomorpha gracilis* (Koch), and *Stenophora cockerellae* Ellis and *Stenophora elongata* Ellis from *Orthomorpha coarctata* (Saussere), all in the United States. The investigated *Stenophora* sp. differs from *S. robusta* in lack of invagination on the top of the protomerite, and the presence of constriction and well developed ectoplasm. From *S. cockerellae* it differs in lack of motile papillas on protomerite. From *S. elongata* it differs in the larger size of the body. I assume, therefore, it to be a new species and I propose the name *Stenophora orthomorphae* sp.n.

Distribution: Poland.

6. *Stenophora poznanensis* sp.n.

Host: *Orthomorpha gracilis* (Koch)
Habitat: Intestine.
Locality: Poznań 3.XII.1962, 12.I.1963, 17.IV.1963, 27.XII.1963, 3.XII.1963. 19.I.1965.

Morphology: Sporonts solitary, oval (Figs. 19—22). Maximum length 165 μ; maximum width 76 μ. Ratio LP:TL=1:4.6—7.9; ratio WP:WD=1:2.1—3.3 (Table 6).

Table 6

Measurments of living trophozoites and gamonts of *Stenophora poznanensis* sp.n. (in microns)

LP	LD	WP	WD	TL	WP:WD	WP:WD
18	90	16	45	108	1:6	1:2.7
16	91	18	37	107	1:6.5	1:2.1
18	82	18	45	100	1:5.6	1:2.5
18	64	19	34	82	1:4.6	1:2.7
17	95	17	45	112	1:6.6	1:2.6
21	105	18	60	126	1:6	1:3.3
22	142	27	76.5	165	1:7.3	1:2.8
25	136	24	75	162	1:6.3	1:3.1
19	72	16	48	91	1:4.7	1:2.9
13	93	16	48	106	1:7.9	1:2.9

The protomerite changes its shape in various developmental stages (Figs. 19—22). In gamont stages it is conical with slightly oval lateral walls at the septum; on its top there is a slight flattening. Endocyte very granular, and yellow-green (Fig. 22). Septum convex, upward to deutomerite and not well apparent. The protomerite of trophozoites is rather elongated and its length is equal to 1/3 of the total length of the gamont.

The deutomerite of trophozoites elipsoidal or oval with homogenous and translucent endocyte.

The deutomerite of gamonts is elongated or oval with a maximum width in the middle of its length. Ectoplasm is thick in which epicyte, sarcocyte and myocyte is well seen. Endocyte of trophozoites and of young gamonts is translucent (Fig. 21), but in mature gamonts it is granular and not translucent (Fig. 22). Nucleus 5 μ in diameter, with one karyosome, located in the anterior or posterior part of deutomerite.

Cysts and spores: Cysts are oval 60—100 μ in diameter with thick wall. Spores cylindrical 5 μ long.

Development and parasitism: Life cycle and parasitism similar to those of *Stenophora orthomorphae* sp.n. In weak infection the pathogenicity is low but when infection is very intesive the damage of gut epithelium is large.

Population of *Orthomorpha gracilis* was studied in the productive greenhouse in Poznań during four successive years. In spring the density of millipedes was always maximum and it varied from 200 to 500 per square meter. This huge number of millipeds formed a layer on the surface of the soil. In season, due to thermic soil sterilization performed by the owner, the population of *O. gracilis* was seriously reduced. Parallelly to changes in density of millipeds, changes in the level of gregarine infection occurred.

Taxonomic position: Due to its morphological and developmental features this species is placed among the genus *Stenophora*. It differs from *Stenophora orthomorphae* sp.n. in its protomerite and smaller size; from *Stenophora robusta* Ellis it differs in lack of invagination on the top of the protomerite; from *S. cockerellae* Ellis it differs in lack of motile papillas on the protomerite. I take

it, therefore, as a new species and propose for it the name *Stenophora poznanensis* sp.n. after the name of the town of Poznań.

Distribution: Poland.

Epizootic studies: While discussing epizootic problems the infection of *Orthomorpha gracilis* by *Stenophora orthomorphae* sp.n. and *S. poznanensis* sp.n. is discussed together, due to the similar type of parasitism of both species.

The first case of infection of *O. gracilis* was recorded in 1962; systematic observation of this species were undertaken in 1963. The results of observations are given in Table 7.

Table 7

Infection of *Orthomorpha gracilis* Koch with gregarines *Stenophora orthomorphae* sp.n. and *S. poznanensis* sp.n. checked at various periods

Date of observation	Number of specimens		
	examined	infected	healthy
1963			
January	69	34	35
April	68	21	47
July	7	1	6
August	7	0	7
November	21	7	14
December	42	12	30
1964			
January	6	0	6
February	5	0	5
March	21	0	21
April	19	5	14
May	33	1	32
June	14	0	14
September	12	0	12
December	20	0	20
1965			
January	37	16	21
Total number of examined specimens	381	97	284

The observation were accomplished in productive greenhouse in Poznań in which normal cultural treatments and chemical control of pests were performed. In summer of 1963 (July and August) due to chemical treatment the density of millipedes was significantly reduced and the level of gregarine infection also decreased. In winter, however, the host population and the infection level reached the previous figures.

In January of 1964 due to cultural treatments the density of *O. gracilis* decreased again and so did the infection by gregarines. This year, however, although the density of *O. gracilis* reached the average level in summer, the gregarine infection was very low.

Data presented in Table 7 show that such factors as cultural or chemical treatments that are unfavorable for *O. gracilis* reduce the number of millipeds infected by *Stenophora* spp. Only when density of millipeds is sufficiently high to ensure frequent contact, the parasite is easily distributed among its hosts.

7. *Stenophora sarmatiuli* sp.n.

Host: *Sarmatiulus vilnensis* (Jawłowski).
Habitat: Intestine.
Locality: Kórnik 27.IV.1962, 15.VI.1963.

Morphology: Gamonts solitary, uniform in size and shape (Figs. 23—24). Maximum length 171 μ; maximum width 111 μ. Ratio LP:TL — 1:4—7; ratio WP:WD = 1:2—4 (Table 8).

Table 8

Measurements of living trophozoites and gamonts of *Stenophora sarmatiuli* sp.n. (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
23	109	25	73	121	1:6	1:3
20	73	23	54	93	1:4	1:2
23	76	24	60	98	1:4	1:3
24	83	24	64	107	1:4	1:3
25	88	25	60	113	1:4	1:3
25	146	30	100	171	1:7	1:3
25	118	28	101	143	1:6	1:4
28	139	30	111	166	1:6	1:4
25	113	25	88	139	1:5	1:3
24	111	25	86	135	1:6	1:3

Protomerite conical with rounded top. Endocyte of protomerite lighter than that of deutomerite (Figs. 23 and 24).

Deutomerite oval or cylindrical with very dark endocyte. End of deutomerite flattened. Nucleus with two karyosomes rarely seen inside the dark endocyte located at the widest part of the deutomerite.

Cysts and spores: Cysts oval 80 to 150 μ in diameter (Fig. 25). Dehiscence by simple rupture. Spores oval 12 μ long.

Development and parasitism: Infection is caused by the swallowing of cysts and the emerging sporozoites penetrate the gut epithelium and develop intracellularly. The growing trophozoite ruptures the cell wall and falls out into the gut lumen. Maturing gamont becomes dark and its endocyte is granulated.

Fully mature gamonts are almost oval and their ectoplasm is seen as a light-colored outer layer. Associations are not apparent.

Like other members of the family *Stenophoridae*, the trophozoites of *Stenophora sarmatiuli* develop intra- or intercellularly in the gut epithelium. Frequently, instead of falling out into the gut lumen, the trophozoites puncture the intestine and fall out into the body cavity. The fate of such trophozoites is

unknown. The life cycle of gregarines may be only completed in the lumen of the gut as merely here cysts were observed. The penetration of gamonts to the body cavity causes, as a rule, the death of the host, as trough the opening produced by gamonts the microflora of the gut penetrates the hemocoel and causes septicemia.

Taxonomic position: The development and morphology of this gregarine indicate that it belongs to the family *Stenophoridae*, which parasitize millipedes (*Diplopoda*). There was no previous record of gregarine infection of *Sarmatiulus vilnensis*. From various *Julus* spp. and related species several gregarines were described but they differ from this species by their elongate body while the investigated species is oval or even round. I hold therefore, that it is a new species and propose the name *Stenophora sarmatiuli* sp.n. for it.

Distribution: Poland.

8. *Stenophora schizophylli* sp.n.

Host: *Schizophyllum sabulosum* (L.).
Habitat: Intestine.
Locality: Białowieża 19.VI.1963, 14.VII.1965.

Morphology: Gamonts solitary and very elongate (Figs. 26—29). Maximum length up to 242 μ; maximum width 70 μ. Ratio LP:TL = 1:6.2—8.7; ratio WP:WD = 1:1.7—2.5 (Table 9).

Table 9

Measurements of living trophozoites and gamonts of *Stenophora schizophylli* sp.n. (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
32	210	25	63	242	1:7.6	1:2.5
25	197	25	63	222	1:8.7	1:2.5
32	210	31	63	242	1:7.6	1:2.5
25	197	25	57	222	1:8.7	1:2.5
32	203	32	70	235	1:7.4	1:2.2
38	197	32	63	235	1:6.2	1:2.5
25	190	25	63	216	1:8.5	1:2.5
19	133	25	44	152	1:8	1:1.7
25	146	25	51	171	1:6.8	1:2
23	123	26	60	146	1:6.3	1:2.3

Protomerite of gamonts conical with slight constriction in the middle. On the top a slight flattening. Septum slightly convex upward to deutomerite. Ectoplasm 2 μ thick. Constriction at septum well seen (Fig. 29). Endocyte of protomerite is not translucent and granular.

Deutomerite of gamonts is elongate and uniformly wide along its whole length. Endocyte is slighty lighter in color close to septum, and dark in other parts of deutomerite. There is no distinct ectoplasmic layer. Nucleus is about 22 μ in diameter with one karyosome (Fig. 32). Delicate longitudinal ribs on deutomerite are frequently observed.

Cysts and spores were not seen.

Development and parasitism: The host becomes infected by swallowing the cysts. Sporozoites that penetrate the gut epithelium change into trophozoites which are seen as dark bodies on histological sections (Fig. 30). The mature trophozoites leave the intercellular cavities and this process causes a very extensive damage of the gut (Fig. 30). Mature gamonts are located very close to the epithelium and frequently attached by their epimerites (Fig. 31). It is well seen on histological preparations that gamonts cause serious damage of epithelial cells (Fig. 32). Therefore it may believed that the parasite plays an important role in the reduction of the density of its host.

Taxonomic position: *Schizophyllum sabulosum* is known as host for *Stenophora juli* and *S. julimarginati*. However, these two species differ from the investigated species in their shape and size of the body (see descriptions of both species). Furthermore, this species differs from those two in its high pathogenic effect. I consider it, therefore, as a new species and propose the name *Stenophora schizophylli* sp.n. for it.

Distribution: Poland.

9. *Stenophora strongylosomae* sp.n.

Host: *Strongylosoma pallipes* (Oliver).
Habitat: Intestine.
Locality: Białowieża 19.VI.1963, 16.VII.1965.

Morphology: Gamonts solitary, elongate (Figs. 33—35). Maximum length 191 μ; maximum width 103 μ. Ratio LP:TL = 1:5.9—9.7; ratio WP:WD = = 1:2—3.7 (Table 10).

Table 10

Measurements of living trophozoites and gamonts of *Stenophora strongylosomae* sp.n. (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
21	104	16	58	125	1:5.9	1:3.6
24	167	26	103	191	1:7.9	1:3.9
22	121	20	72	143	1:6.5	1:3.6
23	139	25	91	162	1:7.0	1:3.6
16	139	25	91	155	1:9.7	1:3.6
25	132	23	54	157	1:6.3	1:2.3
15	97	23	55	112	1:7.5	1:2.4
30	132	23	85	162	1:5.4	1:3.7
12	85	22	75	97	1:7.8	1:3.5
18	111	25	50	129	1:7.2	1:2

Protomerite conical with slightly rounded top (Fig. 35), wider than long. Endocyte granular and not translucent. Septum slightly convex upward to deutomerite.

Deutomerite elongate (Figs. 33—36). Widest in the middle part or at the septum. Endocyte dark and granular. Nucleus about 7.5 μ in the posterior part of deutomerite. Some deutomerites are malformed (Fig. 36).

Cysts and spores were not seen.

Development and parasitism: Life cycle and pathogenicity were not studied. The parasite was observed in mixed infection with *Stenophora nematoides* Leger et Duboscq. Two examined specimens were infected.

Taxonomic position: The investigated species differs from *S. nematoides* in its shorter protomerite and wider deutomerite. Ratio values LP:TL of *S. nematoides* is 1:10—29 and ratio WP:WD is 1:1.2—3.5 (on an average 1:2.2). On the other hand ratio LP:TL of *Stenophora* sp. is 1:5.9—9.1 and ratio WP:WD = 1:2—3.7 (on an average 1:3.2).

Endocyte of *S. nematoides* is homogenous and more or less translucent while that of *Stenophora* sp. is dense and granular. Due to this differences I consider this gregarine to be a new species and propose the name *Stenophora strongylosomae* sp.n. for it.

Distribution: Poland.

10. *Stenophora uncigeri* sp.n.

Host: *Unciger foetidus* Koch.
Habitat: Intestine.
Locality: Siemianice 18.VII.1963.

Morphology: Gamonts solitary, elipsoidal (Figs. 37 and 38). Maximum length 111 μ; maximum width 56 μ. Ratio LP: TL = 1:4—5; ratio WP:WD = 1:1.2—1.7 (Table 11).

Table 11

Measurememnts of living trophozoites and gamonts of *Stenophora uncigeri* sp.n. (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
14	52	20	34	67	1:4	1:1.2
13	50	20	35	63	1:5	1:1.7
18	79	32	56	97	1:5	1:1.7
21	90	29	34	111	1:5	1:1.2

Protomerite wider than long, flattened at the top (Figs. 37 and 38). Endocyte light colored and poorly granulated.

Deutomerite elipsoidal. Endocyte granular, yellow. Nucleus hardly seen in the posterior part of the deutomerite. Anterior end of deutomerite flattened while the posterior end rounded.

Cysts and spores: Cysts oval about 100 μ in diameter (Fig. 39).

Development and parasitism: Life cycle and parasitism of this species was not studied, for only one out of three examined specimens was infected. Four gregarines were observed in that specimen.

Taxonomic position: On the basis of morphology this species is placed among the genus *Stenophora*. This is the first record of gregarinosis in *Unciger*

foetidus and the parasite involved differs in its protomerite structure from other gregarine species known from millipedes. I consider, therefore it is a new species and propose the name *Stenophora uncigeri* sp.n. for it.

Distribution: Poland.

11. *Cnemidospora lutea* Schneider

Host: *Glomeris connexa* Koch.
Habitat: Intestine.
Locality: Białowieża 14.VII.1964, 10.VII.1965.

Morphology: Gamonts solitary, elongate (Fig. 40). Maximum length 425 μ; maximum width 100 μ. Ratio LP:TL = 1:11—27; ratio WP:WD = 1:2—3 (Table 12).

Table 12

Measurements of living trophozoites and gamonts of *Cnemidospora lutea* Schneider (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
27	312	35	97	339	1:12	1:2
25	300	32	100	325	1:13	1:3
10	155	27	72	175	1:15	1:3
19	343	32	51	362	1:19	1:2
20	212	29	92	232	1:11	1:3
19	406	32	57	425	1:22	1:2
22	287	32	95	310	1:13	1:3
13	330	25	57	343	1:27	1:2
22	260	30	80	282	1:12	1:3
16	375	25	51	391	1:24	1:2

Protomerite variable: in young gamonts elongate (Fig. 41), while in older gamonts oval (Fig. 42). Endocyte granular and dark. Septum well seen.

Deutomerite cylindrically elongate, sometimes with slight constriction in the middle and slightly bent. Ectoplasm with longitudinal ribs. Endocyte of gamonts brown or dark. Nucleus rarely seen, located in the posterior part of the deutomerite. Endocyte of trophozoites lighter than that of gamonts. Nucleus 22 μ in diameter with a few karyosomes, and located in the anterior part of the body.

Cysts and spores: Cysts oval 155 μ in diameter. Spores elipsoidal 7 μ long. Dehiscence by simple rupture. Schneider 1882 did not observe cysts.

Development and parasitism: The hosts become infected by swallowing the cysts. Sporozoites penetrate the gut epithelium and are transformed into trophozoites. When cells are broken throphozoites develop further intercellularly. The transformation of trophozoites into gamonts takes place either in the gut epithelium or in the gut lumen. The association of gamonts may also take place in the gut epithelium or in the gut lumen.

Cysts are released from the body of the infected host after its death. The number of parasites in the gut of the host is frequently very high and exceeds

50 gregarines (Fig. 43). Trophozoites and gamonts damage large parts of the gut epithelium and cells show great hypertrophy of nuclei and their cytoplasm contains large numbers of vacuoles (Fig. 44).

In the studied population 70% of examined specimens were infected by the parasite.

Taxonomic position: Schneider 1882 described *Cnemidospora lutea* parasitizing the gut of *Glomeris* sp. Due to special features of the protomerite, divided into two parts, Schneider created a new genus. The investigated species from *Glomeris connexa* has in general the protomerite typical for genus *Cnemidospora,* although some differences are noticed. Other features like the endocyte, ratio values of LP:TL and WP:WD are almost identical. Therefore the gregarine observed in *Glomeris connexa* is identified as *Cnemidospora lutea* Schneider.

Distribution: France (Schneider 1882); for the first time recorded in Poland.

12. *Echinomera leptoiuli* sp.n.

Host: *Leptoiulus proximus* (Nemec).
Habitat: Intestine.
Locality: Siemianice 18.VII.1963.

Morphology: Gamonts solitary, oval (Fig. 45). Maximum length 206 μ; maximum width 99 μ. Ratio LP:TL = 1:15—19; WP:WD = 1:3—4 (Table 13).

Table 13

Measurements of living trophozoites and gamonts of *Echinomera leptoiuli* sp.n. (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
9	128	25	81	137	1:15	1:3
9	100	25	93	169	1:18	1:4
11	196	31	99	206	1:19	1:3

Epimerite in form of a few short processes. Protomerite flat, several times wider than long. Endocyte translucent. Septum straight.

Deutomerite bottle-like. Endocyte granular and greenish, especially dense in its central part. Nucleus invisible. End of deutomerite oval.

Cysts and spores: Cysts oval 120 μ in diameter. Spores cylindrical 6 μ long.

Development and parasitism: Development and parasitism similar to those of *Echinomera hispida* (Schneider). Trophozoites damage the gut epithelium and the gamonts develop in the gut lumen (Fig. 46).

Taxonomic position: Structure of protomerite and other morphological features indicate that this species belongs to the genus *Echinomera.* This is the first record of gregarinosis caused by a member of the genus *Echinomera* in *Diplopoda.* The investigated species differs from other members of the genus *Echinomera* in its shape, endocyte and size. I assume therefore it is a new species and I propose the name *Echinomera leptoiuli* sp.n. for it.

Distribution: Poland.

Eugregarinaria of centipedes (*Chilopoda*)

13. *Actinocephalus dujardini* Schneider

Host: *Lithobius forficatus* L.
Habitat: Intestine.
Locality: Janówka 7.VI.1963.

Morphology: Gamonts solitary and elongate (Fig. 47). Maximum length 305 μ; maximum width 115 μ. Ratio LP:TL = 1:4—5; ratio WP:WD = 1:1 (Table 14).

Table 14

Measurements of living trophozoites and gamonts of *Actinocephalus dujardini* Schneider (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
70	203	92	108	273	1:4	1:1
74	231	100	115	305	1:4	1:1
60	201	85	98	261	1:5	1:1

Epimerite pear-like with 15 to 22 short rigid spines directed backward. Protomerite large, wider than long. Deutomerite two to four times longer than protomerite. The maximum width of deutomerite is at septum, and then the deutomerite tapers into a sharp end (Fig. 47). Endocyte granular and very dark. Nucleus 20 μ in diameter with 4 karyosomes.

Cysts and spores were not seen.

Development and parasitism: Life cycle of *A. dujardini* was not studied as only one specimen was infected with this parasite. Schneider 1875 gave a series of drawings of cyst-formation but did not discuss this problem in the text. There is no information on its parasitism, either. Crawley 1903 frequently observed this gregarine in *L. forficatus* in USA.

Distribution: France (Schneider 1875); USSR (Wellmer 1911) and USA (Crawley 1903); recorded for the first time in Poland.

14. *Echinomera hispida* (Schneider)

Synonyms: *Echinocephalus hispida* Schneider, 1875; *Echinomera hispida* (Schneider) Labbe, 1899.
Host: *Lithobius forficatus* L., *Lithobius calcaratus* Koch.
Habitat: Intestine.
Locality: Siemianice—Janówka 5.VI.1963; Poznań 15.VI.1963, 18.VI.1964; Góra Puławska 24.VI.1963.

Morphology: Gamonts solitary, elipsoidal or oval (Figs. 48-50). Maximum length of observed gamonts 317 μ; maximum width 254 μ. Ratio LP:TL = = 1:6—13; ratio WP:WD = 1:2—4 (Table 15).

Epimerite with short processes. Protomerite short and flat, lying on wide deutomerite like a cap. Protomerite two to five times wider than long. Endocyte dark, lighter in color than that of deutomerite.

Deutomerite oval or elipsoidal, width and length almost equal. Endocyte dark. Nucleus located in the middle of deutomerite and seen as a light-colored spot in the dark endocyte (Fig. 50).

Cysts and spores: Cysts oval up to 527 μ in diameter. Dehiscence by simple rupture. Spores cylindrical in chains.

Table 15

Measurements of living trophozoites and gamonts of *Echinomera hispida* (Schneider) (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
19	198	93	186	217	1:12	1:2
19	161	80	167	180	1:10	1:2
24	217	87	198	242	1:10	1:2
25	285	112	248	310	1:13	1:2
25	292	57	203	317	1:12	1:3
31	156	70	165	190	1:6	1:2
37	273	57	254	310	1:8	1:4
25	273	63	241	298	1:12	1:4
25	292	59	133	317	1:12	1:2
20	151	50	108	171	1:8	1:2

Development and parasitism: The host becomes infected by swallowing the cysts or spores. Sporozoites penetrate the gut epithelium and are transformed into trophozoites which for a long time develop intercellularly and are later attached to the epithelium with their epimerites.

In the gut lumen of the host various developmental stages may be observed. Young gamonts are light in color and as maturation progresses their endocyte becomes granular and dark. Protomerite conical in young stages (Fig. 48) gradually shortens and flattens (Fig. 50).

Pathogenicity of the gregarine depends on the intensity of infection. In strong infection the life processes of the host are weakened and this cause its death. The intensity of infection is frequently very high and up to 80 gamonts were observed in the gut lumen. In such hosts serious damage of epithelial cells is observed (Fig 51).

In some cases simultaneous bacterial septicemia and gregarinosis were observed. Infected centipedes were sluggish and when put on their back they could not return to their normal position. Their fat bodies were pink in color. At microscopic investigation, bacteria were found in their body cavities morphologically similar to intestinal bacteria. It may be supposed that these bacteria penetrate the body cavity from gut through openings done by growing trophozoites.

The infection level in centipede populations was as follows: in Poznań 30% (40 examined specimens), Siemianice 15% (13 examined specimens), Puławy 8% (25 examined specimens).

Taxonomic position: Schneider 1875 did not give measurements of *Echinomera hispida* and it was, therefore, difficult to identify this species in studies carried out by several authors. In spite of the difficulties *E. hispida* was

recorded in *Lithobius forficatus* L., and *L. coloradensis* (Cock.) (Crawley 1903, Ellis 1913, Watson 1916).

Ellis 1913 gave the following measurements: length 180 μ and width 80 μ. Watson 1916 gave measurements of three gamonts: length 270 to 320 μ, and width 120 μ.

The life cycle of this species was worked out by Schellack 1907.

Distribution: Recorded previously from Poland as parasite of *Lithobius forficatus* (L.) by Wellmer 1911. Known from France (Schneider 1875), Germany (Schellack 1907), USA (Crawley 1903; Ellis 1913). For the first time recorded from *Lithobius calcaratus* Koch.

15. *Rhopalonia lithobii* sp.n.

Host: *Lithobius calcaratus* Koch.
Habitat: Intestine.
Locality: Siemianice 17.VII.1963.

Morphology: Gamonts solitary and not divided into protomerite and deutomerite (Fig. 52). Front end flattened. Endocyte granular. Length from 120 to 160 μ; width from 30 to 60 μ. Nucleus 15 μ in diameter, has one karyosome, and is located in the center of deutomerite.

Development and parasitism: Life cycle and parasitism of this species was not studied as only one specimen was infected.

Taxonomic position: Lack of protomerite in the gamont stage indicates that this species belongs to the genus *Rhopalonia*. So far, two species of this genus are known, that is *Rhopalonia geophili* Léger from *Himantarium gabrielis* L. and *Stigmatogaster gracilis* Mein., and *Rhopalonia stellata* Léger from *Himantarium gabrielis* L.

R. geophili differs from the investigated species in its larger size and several karyosomes in the nucleus. *R. stellata* has similar length, but other features of that species are unknown. Both species have never been recorded from *Lithobius* spp. Due to morphological differences and host specificity I assume *Rhopalonia* sp. from *Lithobius calcaratus* is a new species and I propose for it the name *Rhopalonia lithobii* sp.n.

Distribution: Poland.

VII. Gregarines of *Insecta*

During the studies on *Gregarinomorpha* of insects 31 species were recorded 30 of which belong to the order *Eugregarinaria* and 1 to the order *Schizogregarinaria*. Out of 30 studied eugregarine species 11 of them appeared to be new species.

Eugregarinaria of insects

16. *Gamocystis tenax* Schneider

Host: *Ectobius lapponicus* L.
Habitat: Intestine.
Locality: Puławy 11.V.1962.

Morphology: Gamonts in associations (Fig. 53). Body elipsoidal, almost oval. Protomerite in associated gamonts invisible. Maximum length of observed gamonts 400 μ; maximum width 317 μ (Table 16).

Table 16

Measurements of living trophozoites and gamonts of *Gamocystis tenax* Schneider (in microns)

	TL	WD
Prim.	362	317
Sat.	400	317
Prim.	349	241
Sat.	368	190

Primite, as a rule, larger than satellite. Endocyte granular and very dense.

Cysts and spores: Cysts oval up to 362 μ in diameter with several spore ducts. Spores cylindrical.

Development and parasitism: Development of the parasite and their pathogenicity were not studied. Out of six examined specimens three were infected. Intensity of parasitism was low and up to 8 associations were observed in the infected host.

Taxonomic position: While describing this species Schneider 1875 characterized it as forming associations by attachment of protomerite to protomerite. In my investigations I did not observe any such association and, in general, it is impossible to state it, as gamonts are not divided into protomerite and deutomerite. All features of the investigated species allow to identify it as *Gamocystis tenax* Schneider.

Distribution: France (Schneider 1875) and USSR (Wellmer 1911); for the first time recorded from Poland.

17. *Gregarina blattarum* Siebold

Synonyms: *Gregarina blattarum* Siebold, 1839; *Gregarina blattae orientalis*: Leidy, 1853; *Clepsidrina blattarum*: Schneider, 1875.
Host: *Blatta orientalis* L., *Periplaneta americana* L.
Habitat: Intestine.
Locality: Puławy 11.XI.1963; Poznań 7.II.1965.

Morphology: Gamonts in associations (Fig. 58). Maximum length of observed gamonts 819 μ; maximum width 635 μ. Ratio LP:TL = 1:3.6—10.9; ratio WP:WD = 1:1.1—2.6 (Table 17).

Protomerite cylindrical in young trophozoites (Fig. 54) while in gamonts oval. Endocyte light and translucent in young gamonts (Fig. 55 and 56). With the maturation of trophozoites their endocyte blackens and becomes opaque (Figs. 55-57). Septum and constriction well seen (Fig. 57). Deutomerites of young trophozoites are more elongate while in gamonts they are rounded or oval. Nucleus about 76 μ in diameter has 6 to 8 karyosomes; and is well seen as a white spot in dark endocyte (Fig. 57).

Table 17

Measurements of living trophozoites and gamonts of *Gregarina blattarum* Siebold (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Prim.	140	638	267	514	778	1:6.6	1:1.9
Sat.	95	635	279	470	730	1:7.7	1:1.7
Prim.	171	730	298	635	802	1:5.3	1:2.1
Sat.	76	527	305	596	775	1:10.1	1:1.8
Prim.	95	495	159	241	591	1:6.2	1:1.5
Sat.	70	527	146	210	597	1:8.2	1:1.4
Prim.	63	508	114	248	572	1:9.0	1:2.1
Sat.	44	444	108	121	489	1:10.9	1:1.1
Prim.	51	222	95	133	273	1:5.4	1:1.4
Sat.	38	146	44	114	184	1:4.8	1:2.6
Prim.	63	292	114	178	355	1:5.6	1:1.6
Sat.	44	317	82	108	362	1:8.1	1:1.3
Prim.	108	489	165	305	597	1:5.5	1:1.8
Sat.	70	464	140	165	533	1:7.6	1:1.2
Prim.	89	469	140	254	559	1:6.4	1:1.8
Sat.	63	450	140	197	514	1:8.1	1:1.4
Prim.	81	394	76	102	444	1:8.8	1:1.2
Sat.	25	165	25	38	190	1:7.5	1:1.5
Prim.	107	273	140	222	381	1:3.6	1:1.6
Sat.	51	317	89	114	368	1:7.2	1:1.3
Trophoz.	197	622	317	483	819	1:4.2	1:1.5
Trophoz.	178	540	241	432	718	1:4.0	1:1.8

Cysts and spores: Cysts oval up to 577 μ in diameter with 8—10 spore ducts (Figs. 59-60). Spores cylindrical.

Development and parasitism: This species was the object of many studies and its life cycle is excellently known (Sprague 1941). Therefore this problem is ommitted here.

The infection level in various populations of *Blatta orientalis* was rather high: in Poznań 15% (44 examined insects), in Puławy 32% (61 examined insects).

The intensity of infection is very high. The gut of many insects is frequently fully filled with gregarines. Therefore it may be concluded that the parasite is harmful for its host, although no external symptoms of infection were observed.

Taxonomic position: This species is one of the best known gregarines due to the wide distribution of its hosts. Siebold 1839 gave the first description of this species. Stein 1848 described cysts and spores. A general review of literature on this species was geven by Sprague 1941 in his excellent paper on the chromosome cycle of *Gregarina blattarum*.

Size of gamonts of *G. blattarum* collected in Poland is somewhat larger than

given in literature. Watson 1916 gave the maximum length about 500 μ, while in my material the maximum length was 819 μ. There are also higher ratio values LP:TL and WP:WD, which according to Watson 1916 are 1:3 and 1:1.1 respectively.

These differences in the size of gamonts are due to normal variability and the investigated gregarine is identified as *Gregarina blattarum* Siebold.

Distribution: Cosmopolitan parasite (Wellmer 1911; Watson 1916; Sprague 1941), from Poland recorded previously by Foerster (1938 a).

18. *Gregarina chrysomelae* sp.n.

Host: *Chrysomela polita* L.
Habitat: Gastric caeca.
Locality: Białowieża 11.VII.1965.

Morphology: Gamonts in associations consisting of two or three individuals (Figs. 65 and 66). Maximum length of observed gamonts 177 μ; maximum width 63 μ. Ratio LP:TL = 1:3.2—5; ratio WP:WD = 1:1.1—2.3 (Table 18).

Table 18

Measurements of living trophozoites and gamonts of *Gregarina chrysomelae* sp.n. (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
25	101	20	28	126	1:5	1:1.3
23	76	25	48	99	1:4.3	1:1.9
38	139	30	33	177	1:4.1	1:1.1
25	68	30	40	93	1:4.2	1:1.2
30	108	27	33	138	1:4.5	1:1.7
25	88	30	50	114	1:4.5	1:1.7
20	63	30	40	83	1:4.1	1:1.3
20	45	33	40	65	1:3.2	1:1.2
25	101	25	58	126	1:5.0	1:2.3
18	63	33	60	81	1:4.7	1:1.8
25	62	35	62	87	1:3.5	1:1.7
15	50	40	62	65	1:4.3	1:1.5

Protomerite large and semicircular (Fig. 61). Septum and constriction well seen. Endocyte granular, brown and translucent.

Deutomerite elipsoidal or oval (Figs. 61, 62 and 65). Endocyte granular and dark (Figs. 61—65). Nucleus with one karyosome (Fig. 61).

Cysts and spores: Cysts about 50 μ in diameter with 5—6 sporoducts. Spores not seen.

Development and parasitism: The parasite develops in the gastric caeca (Figs. 63-64). When the insect is dissected and its gut examined under the microscope, gamonts and trophozoites are seen as dark spots against the translucent gut (Fig. 64). Inside the gastric caeca gregarines occur singly, in pairs or in groups of three (Figs. 65 and 66). The size of parasitized caeca is significantly increased as compared with the healthy caeca (Fig. 186).

Taxonomic position: The structures of protomerite and cysts indicate that this gregarine belongs to the genus *Gregarina*. In some of the examined speci-

mens of *Chrysomela polita* another species *Gregarina munieri* (Schneider) was observed. Both species differ in the size and type of endocyte. Furthermore, *G. munieri* lives in the gut lumen while *Gregarina* sp. in the gastric caeca. Therefore I assume the gregarine living in the gastric caeca is a new species and propose the name *Gregarina chrysomelae* sp.n. for it.

Distribution: Poland.

19. *Gregarina coccinellae* sp.n.

Synonyms: *Gregarina barbarara* Watson sensu Foerster, 1938 a.
Host: *Coccinella septempunctata* L., *Hippodamia tredecimpunctata* L.
Habitat: Intestine.
Locality: Poznań 16.VIII.1962; Ogardy 9.VIII.1963; Mielno Koszalińskie 24.VI.1964, 25.VI.1964; Białowieża 11.VII.1964.

Morphology: Gamonts in associations of two individuals, elongate (Fig. 67). Maximum length of observed gamonts 179 μ; maximum width 112 μ. Ratio LP:TL = 1:4.8—11.6; ratio WP:WD = 1:1—3.5 (Table 19).

Table 19

Measurements of living trophozoites and gamonts of *Gregarina coccinellae* sp.n. (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Trophoz.	22	122	57	107	144	1:6.4	1:1.9
Trophoz.	17	125	60	75	142	1:8.1	1:1.2
Trophoz.	12	132	62	62	144	1:11.6	1:1
Prim.	19	102	48	85	121	1:6.4	1:1.1
Sat.	10	100	52	52	110	1:10.6	1:1
Prim.	21	81	21	73	102	1:4.8	1:3.5
Sat.	14	104	50	62	118	1:8.1	1:1.2
Prim.	23	131	38	89	133	1:5.8	1:2.4
Sat.	14	139	58	83	154	1:6	1:1.4
Prim.	21	100	35	71	121	1:5.8	1:2
Sat.	14	100	50	71	115	1:7.9	1:1.4
Prim.	25	106	35	73	131	1:5.2	1:2
Sat.	17	112	50	71	129	1:7.7	1:1
Prim.	27	127	52	112	140	1:5	1:2.1
Sat.	17	150	65	97	157	1:9.8	1:1.3
Prim.	25	137	50	105	162	1:6.5	1:2
Sat.	22	157	62	100	179	1:8.1	1:1.6
Prim.	27	132	52	100	160	1:6	1:2
Sat.	15	110	50	87	125	1:8.2	1:1.7

Trophozoites with large epimerite (Fig. 68) that becomes reduced as maturation of trophozoites progresses. Gamonts in associations.

Primite: Protomerite semicircular, wider than long (Fig. 67). Endocyte granular and opaque. Septum and constriction well seen. Deutomerite oval or elongate. Nucleus seen as white spot in dark endocyte. Ectoplasm not distinct.

Satellite: Protomerite flattened, few times wider than long (Fig. 67). Endocyte granular and darker than that of primite. Septum well seen while constriction not as clear as in primite. Deutomerite elongate. Nucleus has three karyosomes and is seen as white spot in dark endocyte (Fig. 69).

Cysts and spores: Cysts oval up to 115 μ in diameter (Fig. 70). Spores spindle-shaped 7 μ wide and 12 μ long, and occuring in chains (Fig. 71).

Development and parasitism: The host becomes infected by swallowing cysts or spores and sporozoites penetrate the gut epithelium. Trophozoites are attached to the epithelium with their epimerites while the rest of their body is in the gut lumen. Associating of gamonts and cyst-formation in this species is typical for eugregarines.

Intensity of parasitism is very strong and in many infected specimens up to 80 gregarines in the gut were observed (Fig. 69). Infection level in some populations of hosts of this parasite was as follows: Mielno Koszalińskie 30% (12 examined adults of *Coccinella septempunctata*), Poznań 21% (8 adults of *C. septempunctata*), Białowieża 100% (two adults of *Hippodamia tredecimpunctata* L.).

Taxonomic position: Morphology of gamonts and structure of cysts indicate that this species belongs to the genus *Gregarina*. From *Coccinellidae* three gregarine species described by Watson 1915, 1916 are known: *Gregarina barbarara* from *Coccinella* sp., *Gregarina katherina* from *C. novemnotata* and *Gregarina fragilis* from *Coccinella* sp.

The investigated species differs from all three species by its dimensions and ratio of WP:WD. Endocyte of *Gregarina* sp. is granular and dark (Fig. 67), while the species described by Watson 1915 have a translucent endocyte and require to be stained with Lugol's fluid in order to observe them.

The comparison of the investigated species of *Gregarina* with preparations of gregarines described by Watson indicated that this *Gregarina* sp. is a new species. I propose, therefore the name *Gregarina coccinellae* sp.n. for it. It differs from *Gregarina ruszkowskii* sp.n. by associating only in pairs and by larger dimensions.

Gregarine recorded by Foerster 1938 a as *Gregarina barbarara* Watson I consider to be a synonym of *Gregarina coccinellae* sp.n.

Detailed revision of gregarines parasitizing *Coccinellidae* will be given by the author elsewhere.

Distribution: Poland; recorded in USSR (Lipa i Semjanov 1967).

20. *Gregarina cuneata* Stein

Synonyms: *Clepsidrina polymorpha* Hammerschmidt, 1838; *Gregarina cuneata* Stein, 1848; *Gregarina polymorpha*: Lankester, 1863; *Clepsidrina polymorpha* var. *cuneata*: Schneider, 1875; *Gregarina polymorpha* var. *cuneata*: Labbe, 1899; *Gregarina xylopini* Crawley 1903; *Clepsidrina cuneata*: Pfeiffer, 1910.
Host: *Tenebrio molitor* L.
Habitat: Intestine.
Locality: Poznań 1.IX.1965 (permanent laboratory culture).

Morphology: Gamonts in associations, elongate (Fig. 72). Maximum length of observed gamonts 419 μ; maximum width 108 μ. Ratio LP:TL = 1:9—10; ratio WP:WD = 1:1.3—1.9 (Table 20).

Primite: Protomerite semicircular, longer than wide (Fig. 73). Septum and constriction well seen. Endocyte granular. Ectoplasm seen as light-colored outer layer. Deutomerite elongate and widest at the septum. Nucleus in the anterior

Table 20

Measurements of living trophozoites and gamonts of *Gregarina cuneata* Stein (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Prim.	38	330	57	76	368	1:9.7	1:1.3
Sat.	38	317	51	70	356	1:9.3	1:1.3
Prim.	32	254	38	57	286	1:9	1:1.6
Sat.	32	314	44	70	343	1:10	1:1.5
Trophoz.	44	374	54	108	419	1:9.5	1:1.9

part of deutomerite. Endocyte dark, not translucent and strongly granular (Fig. 72), but the ectoplasm is light in color. End of deutomerite flattened (Fig. 74).

Satellite: Protomerite rhomboidal (Fig. 74). Septum well seen while the constriction is not as clear as in primite. Endocyte is granular and dark (Fig. 74). Ectoplasm seen as ligth colored outer layer.

Cysts and spores: Cysts oval up to 600 μ in diameter (Fig. 77).

Development and parasitism: The life cycle of this gregarine was extensively studied by several authors and these problems are ommitted here.

The intensity of infection is very strong and up to 200 gregarines were observed in the host. Trophozoites that develop in the gut epithelium cause damage of large regions of the epithelial cells (Figs. 75, 76 and 191). In the studied laboratory culture of *Tenebrio molitor* 60% of insects were infected.

Distribution: Cosmopolitan species; previously recorded from Poland by Foerster 1938 a.

21. *Gregarina forficulae* sp.n.

Host: *Forficula auricularia* L.
Habitat: Intestine.
Locality: Poznań 30.VIII.1961.

Morphology: Gamonts in associations, elongate (Figs. 78 and 79). Maximum length of observed gamonts 172 μ; maximum width 70 μ. Ratio LP:TL = 1:4.1—6.6; ratio WP:WD = 1:1.2—2.1 (Table 21).

Protomerite oval. Endocyte light in color. Septum and constriction well seen. Deutomerite cylindrically elongate. Nucleus 12 μ in diameter has three karyosomes. Ectoplasm seen as light-colored outer layer. Endocyte homogenous. Deutomerite of the satellite slightly narrowing toward the posterior end.

Cysts and spores: Cysts up to 197 μ in diameter. Spores were not seen.

Development and parasitism: Only one adult was infected by seven associations. Development not studied.

Taxonomic position: The investigated gregarine belongs to the genus *Gregarina* but differs in many respects from *Gregarina ovata* Dufour known from *Forficula auricularia*. Gamonts of *G. ovata* have dark and not translucent endocyte, and are twice larger than *Gregarina* sp. (Figs. 78 and 79). The ratio LP:TL is also different. Cysts of *G. ovata* are 400 to 600 μ in diameter while cysts of *Gregarina* sp. are up to 200 μ diameter. For the reasons explained above

Table 21

Measurements of living trophozoites and gamonts of *Gregarina forficulae* sp.n. (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Prim.	20	113	48	58	133	1:6.6	1:1.2
Sat.	28	96	49	53	124	1:4.4	1:1.2
Prim.	35	111	55	60	146	1:4.1	1:1.2
Sat.	33	106	48	58	139	1:4.2	1:1.2
Prim.	35	111	50	60	146	1:4.1	1:2.1
Sat.	28	93	31	58	121	1:4.3	1:1.7
Prim.	38	113	45	55	151	1:4.2	1:1.2
Sat.	28	103	30	50	131	1:4.7	1:1.6
Prim.	22	73	51	66	95	1:4.3	1:1.3
Sat.	32	140	51	70	172	1:5.4	1:1.3

I assume that the investigated gregarine is a new species and propose the name *Gregarina forficulae* sp.n. for it.

Distribution: Poland.

22. *Gregarina harpali* sp.n.

Host: *Harpalus aeneus* Fabr.
Habitat: Intestine.
Locality: Kobylniki 23.IX.1964.

Morphology: Gamonts in associations, elongate (Fig. 80). Maximum length of observed gamonts 273 μ; maximum width 68 μ. Ratio LP:TL = 1:4—5.4; ratio WP:WD = 1:1—1.4 (Table 22).

Table 22

Measurements of living trophozoites and gamonts of *Gregarina harpali* sp.n. (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Prim.	63	189	50	68	252	1:4	1:1.4
Sat.	43	191	60	63	234	1:5.4	1:1
Trophoz.	50	224	53	60	273	1:5.3	1:1.1

Protomerite oval. Endocyte homogenous and translucent. Septum and constriction well seen. Deutomerite cylindrically elongated. Endocyte homogenous and translucent. Nucleus 30 μ in diameter, has one karyosome, and is located in the middle of deutomerite (Fig. 80).

Cysts and spores unknown.

Parasitism: In one host insect only one association and single gamonts were observed.

Taxonomic position: The morphology of gamonts indicates that the investigated species belongs to the genus *Gregarina*. C r a w l e y 1903 described *Gregarina parva* (=*Gigaductus parvus* Crawley) from *Harpalus caliginosus* Fab. and *H. pennsylvanicus* Dej. in USA. Gamonts of *H. parva* are twice smaller than those of *Gregarina* sp. from *Harpalus aeneus* and their deutomerites are oval while of this species they are elongate. Due to these differences I assume that the investigated gregarine is a new species and propose the name *Gregarina harpali* sp.n. for it.

Distribution: Poland.

23. *Gregarina hypophloei* sp.n.

Host: *Hypophloeus unicolor* Pill.
Habitat: Intestine.
Locality: Rogalin 15.I.1965.

Morphology: Gamonts in associations of two or more individuals, elongate (Figs. 81 and 82). Maximum length of observed gamonts 143 μ; maximum width 50 μ. Ratio LP:TL = 1:3—8.2; ratio WP:WD = 1:1.5—2.1. (Table 23).

Table 23

Measurements of living trophozoites and gamonts of *Gregarina hypophloei* sp.n. (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Prim.	20	123	28	43	143	1:7.2	1:1.5
Sat. I	20	116	28	50	136	1:6.8	1:1.8
Sat. II	20	98	26	46	118	1:5.8	1:1.6
Sat. III	13	25	15	33	38	1:3	1:2.1
Prim.	18	65	25	43	83	1:4.7	1:1.8
Sat.	10	35	23	38	45	1:4.5	1:1.6
Trophoz.	15	109	24	40	124	1:8.2	1:1.7

Protomerite oval, wider than long. Endocyte homogenous and translucent. Septum and constriction well seen. Deutomerite cylindrically elongate and slightly narrowing toward the end (Figs. 81 and 82). Endocyte granular and dark. Nucleus 7 to 10 μ in diameter, located in the anterior end or in the middle part of deutomerite.

Cysts and spores were not seen.

Development and parasitism: The life cycle of the parasite was not studied as only one insect was infected. Twelve gregarines were observed in the examined beetle.

Taxonomic position: The morphology of gamonts indicates that this species belongs to the genus *Gregarina*. The type of associotion of gamonts in this gregarine is very characteristic and not observed in any gregarine from related host insects. Also other features like size and shape of protomerite and of deutomerite do not correspond with characteristic of other gregarines. Therefore I consider that the gregarine found in *Hypophloeus unicolor* Pill.

has never been previously recorded and described. Accordingly, I assume it is a new species and propose the name *Gregarina hypophloei* sp.n. for it.

Distribution: Poland.

24. *Gregarina macrocephalia* sp.n.

Host: *Aphodius depressus* Kug.
Habitat: Intestine and gastric caeca.
Locality: Chludowo 16.VI.1965.

Morphology: Gamonts solitary, oval (Fig. 83). Maximum length of observed gamonts 177 μ; maximum width 76 μ. Ratio LP:TL = 1:2.5—4.2; ratio WP:WD = = 1:1—1.5 (Table 24).

Table 24

Measurements of living trophozoites and gamonts of *Gregarina macrocephalia* sp.n. (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
57	102	58	70	159	1:2.8	1:1.2
57	92	51	76	149	1:2.6	1:1.5
44	102	38	63	146	1:3.3	1:1.5
57	92	63	70	149	1:2.6	1:1.1
63	114	57	76	177	1:2.8	1:1.3
63	102	63	70	165	1:2.6	1:1.1
57	102	57	70	159	1:2.8	1:1.2
63	95	63	63	158	1:2.5	1:1
32	102	51	70	134	1:4.2	1:1.2
44	89	69	70	133	1:3	1:1

Protomerite oval and large; its length almost equals half the length of deutomerite (Figs. 83 and 84). Endocyte granular and dark. Constriction deep and equals one third or one fourth of the width of deutomerite. Septum not clearly seen.

Deutomerite cylindrically elongate, with round end. Endocyte granular, darker in the anterior part of deutomerite. Nucleus not seen, located in the dark endocyte.

Cysts and spores were not seen.

Development and parasitism: The gregarine develops in the gut lumen and inside the gastric caeca (Fig. 84 and 85). When the host intestine is examined under the microscope the gregarines are seen as dark spots against the translucent intestine (Fig. 85). Associations were not observed in gut lumen and in gastric caeca either.

Taxonomic position: In a number of *Aphodius* species were described gregarines of the genus *Didymophyes* and *Gamocystis* (Marshall 1893; Foerster 1938 a; Cordua 1953). They differ, however, from the investigated species by the formation of associations, protomerite structure and their dimensions. Due to the epimerite structure this gregarine should be placed to the genus *Gregarina*, and this is the first record of infection by *Gregarina*

species in beetles of the genus *Aphodius*. Due to differences explained above I assume that the investigated gregarine is a new species and propose the name *Gregarina macrocephalia* sp.n. for it.

Distribution: Poland.

25. *Gregarina minuta* Ishii

Host: *Tribolium confusum* Duv.
Habitat: Intestine.
Locality: Poznań 12.VI.1962, 30.VI.1965.

Morphology: Gamonts in associations, elongate (Figs. 86 and 88). Maximum length of observed gamonts 165 μ; maximum width 50 μ. Ratio LP:TL = = 1:5—16; ratio WP:WD = 1:1.7—2.7 (Table 25).

Table 25

Measurements of living trophozoites and gamonts of *Gregarina minuta* Ishii (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Prim.	15	62	15	27	77	1:5.1	1:1.8
Sat.	7	62	17	30	69	1:9.3	1:1.7
Prim.	10	93	18	30	103	1:10	1:1.7
Sat.	8	78	15	30	86	1:11.3	1:2.0
Prim.	10	101	13	30	111	1:11	1:2.4
Sat.	10	91	18	33	101	1:10	1:1.8
Prim.	10	40	10	20	50	1:5	1:2
Sat.	8	48	13	25	56	1:7.3	1:2
Trophoz.	15	150	22	50	165	1:11	1:2.2
Trophoz.	17	125	17	47	142	1:8.1	1:2.7
Trophoz.	10	76	13	23	86	1:8.5	1:1.8
Trophoz.	8	113	20	40	121	1:16	1:2
Trophoz.	10	116	18	38	126	1:12.5	1:2.1

Primite: Protomerite oval with flattened posterior end, wider than long. Septum and constriction well seen. Endocyte dense and not translucent. Deutomerite cylindrically elongate with oval end. Endocyte granular and dark. Nucleus has one karyosome and is seen as a white spot in the dark endocyte.

Satellite: Protomerite twice wider than long. Deutomerite elongate. Nucleus located in the anterior end of deutomerite. Endocyte granular and dark.

Cysts and spores: Cysts oval up to 160 μ in diameter (Fig. 87). Spores were not seen.

Parasitism: In the studied laboratory culture 25% of insects were infected. The parasite frequently occurred together with *Adelina tribolii* (Bhatia) (Fig. 196). Infection by both protozoans is always lethal for host insects.

Taxonomic position: Ishii 1914 described *Gregarina minuta* Ishii from *Tribolium castaneum* F. (=*T. ferrugineum* F.) which was later divided by Watson 1916 into two species: *Gregarina minuta* Ishii and *Didymophyes*

minuta (Ishii) Watson. Watson based her view on the large variation of dimensions in Ishii's paper and on the fact that in some satellites there were no protomerites. Watson's view is correct and verified by my recent investigations carried out in the Soviet Union where I found that *Tribolium destructor* Uytt. is parasitized by *Didymophyes minuta* (Ishii) (Lipa 1966 c).

Among gregarines observed in *Tribolium confusum* there was a variation in size from 50 to 165 μ. Small and large gamonts formed associations. Some satellites had no distinct protomerite due to temporarily contracted body. Because its features this species is identified as *Gregarina minuta* Ishii.

Distribution: Japan (Ishii 1914); USSR (Wellmer 1911); Canada (Laird 1959); and France (Theodorides 1955 e); for the first time recorded in Poland.

26. *Gregarina munieri* (Schneider)

Synonyms: *Clepsidrina munieri* Schneider, 1875; *Gregarina munieri*: Labbe, 1899; *Gregarina diabotrica* Watson-Kamm, 1918: Theodorides, 1954.
Host: *Chrysomela coerulans* Scriba.
Habitat: Intestine.
Locality: Białowieża 10.VII.1965.

Morphology: Gamonts in associations, elongate (Fig. 89). Maximum length of observed gamonts 492 μ; maximum width 240 μ. Ratio LP:TL = 1:4.4—6.9; ratio WP:WD = 1:1.4—2.1 (Table 26).

Table 26

Measurements of living trophozoites and gamonts of *Gregarina munieri* (Schneider) (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Prim.	66	348	84	180	414	1:6.3	1:2.1
Sat.	60	336	108	204	396	1:6.6	1:1.9
Prim.	84	288	108	168	372	1:4.4	1:1.5
Sat.	72	288	108	180	360	1:5	1:1.6
Prim.	78	300	114	180	378	1:4.8	1:1.5
Sat.	72	288	114	204	360	1:5	1:1.4
Prim.	66	384	108	198	450	1:6.9	1:1.8
Sat.	72	300	114	192	372	1:5.2	1:1.7
Prim.	84	408	132	240	492	1:5.9	1:1.8
Sat.	66	276	120	228	342	1:5.2	1:1.9

Primite: Protomerite longer than wide, rarely oval. Septum and constriction well seen. Endocyte slightly granular, yellow or light brown. Deutomerite elipsoidal with dark endocyte (Fig. 89).

Satellite: Protomerite wider than long and more flattened than that of primite. Septum and constriction clearly visible. Nucleus located in the anterior end of protomerite. Deutomerite elipsoidal and darker than that of primite being brown (Fig. 89).

Cysts and spores were not seen. Schneider 1875 and Watson 1916 described cyst as oval with 3—6 short spore ducts. Barrel shaped spores occur in chains.

Parasitism: The parasite occurs in great number in the lumen of the host, and by the damage of the epithelial cells disturbs feeding and causes death of the host.

Taxonomic position: Schneider 1875 described *Gregarina munieri* Schneider from *Timarcha tenebricosa* (F.), which was also reported from *Chrysomela violacea* Goeze and *C. haemoptera* L. Dimensions of these gregarines were not given in the original description; Watson 1916 gave only ratios LP:TL = 1:6—7 and ratio WP:WD = 1:7, probably estimated by examining the drawings in Schneider's paper. However, the unusual value of ratio WP:WD given by Watson is aparently due to the typographic error.

Due to the similarity between the investigated species and features of *G. munieri* the gregarine recorded in *Chrysomela coerulans* is identified as *Gregarina munieri* (Schneider).

Watson-Kamm 1918 described *Gregarina diabotrica* that was accepted by Theodorides 1954 as a synonym of *G. munieri*.

Distribution: France (Schneider 1875), USA (Watson-Kamm 1918) and Marocco (Theodorides 1955 c); previously recorded in Poland by Foerster 1938 a.

27. *Gregarina ovata* Dufour

Synonyms: *Gregarina ovata* Dufour, 1826; *Clepsidrina conoidea* Hammerschmidt, 1838; *Clepsidrina ovata*: Schneider 1873.
Host: *Forficula auricularia* L.
Habitat: Intestine.
Locality: Poznań 7.VIII.1961, 30.IX.1961; Marcelin 29.IX.1961; Siemianice 27.XI.1962; 18.VII.1963.

Morphology: Gamonts in associations, oval or elongate (Fig. 90). Maximum length of observed gamonts 593 μ; maximum width 346 μ. Ratio LP:TL = = 1:5—12.2; ratio WP:WD = 1:1.5—2.5. Although it is one of widely distributed gregarines its dimensions have been unknown and are given in this paper for the first time (Table 27).

Protomerite oval in primite, and flattened in satellite (Figs. 90 and 92). Endocyte dark. Septum and constriction well seen. Deutomerite oval (Fig. 91), with dark endocyte. Nucleus 30 μ in diameter with few karyosomes.

Cysts and spores: Cysts oval from 400 to 600 μ in diameter. Spores cylindrical 16 by 7.5 μ.

Development and parasitism: Life cycle of the parasite was studied by Paehler 1904 and Schnitzler 1905. The intensity of infection is high as 40—50 gregarines are observed in one host. Data on the infection level in populations of *Forficula auricularia* are given in Table 28.

Distribution: Cosmopolitan parasite; previously recorded in Poland by Siebold 1837, Wellmer 1911 and Foerster 1938 a.

28. *Gregarina rostrata* Welmer

Host: *Lagria hirta* L.
Habitat: Intestine.
Locality: Białowieża 12.VII.1964, 10—11.VII.1965.

Table 27

Measurements of living trophozoites and gamonts of *Gregarina ovata* Dufour (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Prim.	82	418	109	255	500	1:6.1	1:2.3
Sat.	55	455	146	255	510	1:9.3	1:1.7
Prim.	91	455	127	309	546	1:6	1:2.4
Sat.	55	473	146	291	528	1:9.6	1:2
Prim.	91	437	146	291	546	1:6	1:2
Sat.	55	510	164	300	565	1:10	1:1.8
Prim.	91	364	127	237	455	1:5	1:1.9
Sat.	55	400	164	346	455	1:8.3	1:2.1
Prim.	82	500	127	328	582	1:7.1	1:2.5
Sat.	55	528	146	309	582	1:10.6	1:2.1
Prim.	66	435	115	230	501	1:7.6	1:2
Sat.	37	385	139	221	422	1:11.4	1:1.5
Prim.	79	514	131	285	593	1:7.4	1:2.1
Sat.	44	484	171	279	528	1:11.4	1:1.5
Prim.	66	328	90	221	394	1:6	1:2.4
Sat.	33	369	131	238	402	1:12.2	1:1.8
Prim.	74	336	115	221	410	1:5.5	1:1.9
Sat.	33	336	115	246	369	1:11	1:2.1
Prim.	33	303	107	172	336	1:10.2	1:1.6
Sat.	33	353	115	246	385	1:11.7	1:1.2

Morphology: Gamonts in associations, oval or elongate (Figs. 93—95). Maximum length of obserwed gamonts 230 μ; maximum width 135 μ. Ratio LP:TL = 1:5.4—11.8; ratio WP:WD = 1:1.3—4.1 (Table 29).

Morphology and dimensions of primites and satellites similar, in some cases, however, primite is larger than satellite (Fig. 94).

Primite: Protomerite longer than wide and with dark endocyte. Septum and constriction well seen. Deutomerite cylindrically elongate. Endocyte dark and with granules about 2.5 μ in diameter. Nucleus seen as white spot in dark endocyte (Fig. 94).

Satellite: Protomerite wider than long. Septum and constriction clearly visible. Deutomerite cylindrical and elongate. Ectoplasm with longitudinal ribs. Endocyte dark with granules 2.5 μ in diameter. Nucleus rarely seen as a white spot in dark endocyte.

Associated gamonts have similar dimensions. In the case of one association the primite was 205 μ long while the satellite only 101 μ.

Nucleus in large gamonts 22.5 μ in diameter and in small gamonts 7.7 μ. Endocyte of young gamonts and of trophozoites is light in color, while in mature gamonts dark.

Cysts and spores: Cysts oval up to 300 μ in diameter (Fig. 96).

Development and parasitism: The life cycle of the investigated species is typical for the development of *Eugregarinaria*. The trophozoites destroy large numbers of epithelial cells (Figs. 97 and 98). Gamonts that occur in a great number in the gut of the host lie close to the epithelium and slow down the processes of regeneration.

Table 28

Infection of *Forficula auricularia* L. by *Gregarina ovata* Dufour in various localities

Locality and date	Number of insects	
	examined	infected
Poznań		
7.VII.1961	7	2
12.VIII.1962	1	0
31.VIII.1962	2	0
24.VII.1964	1	0
1.IX.1964	2	2
Marcelin		
29.IX.1961	33	14
Siemianice		
27.XI.1962	3	2
18.VII.1963	10	7
Gola		
28.XI.1962	4	1
Wronki		
7.VII. 1962	1	0

Taxonomic position: Wellmer 1911 described *Gregarina rostrata* Wellmer from *Lagria hirta* L. He observed that trophozoites have a long epimerite considered by him as specific feature; it was expressed in the specific name of this species.

In trophozoites and gamonts of the investigated species I have not observed the epimerite of that type as described by Wellmer. On the other hand, the shape of protomerite and deutomerite and other features of both species are very similar. Dimensions of the investigated species are slightly larger than of *G. rostrata* given by Wellmer. It should be emphasized that Wellmer 1911 did not give exact dimensions of *G. rostrata* and mentioned the maximum length only.

On the basis of features and drawings given in Wellmer's paper and comparing them with features of the investigated species I assume that the species found in *Lagria hirta* should be identified as *Gregarina rostrata* Wellmer.

The definition of *Gregarina rostrata* Wellmer in the light of my investigations is as follows: Protomerite oval or semicircular. Lack of epimerite in gamonts living in the gut lumen. Deutomerite elipsoidal, the maximum width in the middle. Endocyte of protomerite and of deutomerite is dark and not

Table 29

Measurements of living trophozoites and gamonts of *Gregarina rostrata* Wellmer (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Prim.	22	155	40	85	177	1:7.8	1:2.1
Sat.	17	120	45	70	137	1:7.8	1:1.5
Prim.	27	147	25	85	174	1:6.3	1:3.4
Sat.	20	162	47	85	182	1:9.1	1:2.1
Prim.	25	137	20	82	162	1:6.5	1:4.1
Sat.	17	130	42	80	147	1:8.4	1:2.1
Prim.	15	162	47	117	177	1:11.8	1:2.4
Sat.	12	127	37	80	140	1:11.1	1:2.1
Prim.	37	190	50	135	227	1:6.1	1:2.7
Sat.	17	220	75	167	237	1:13.5	1:2.2
Prim.	94	475	125	327	569	1:6.1	1:2.6
Sat.	43	550	187	419	593	1:13.6	1:2.2
Prim.	30	132	45	77	162	1:5.4	1:1.7
Sat.	20	137	47	65	157	1:7.8	1:1.3
Prim.	25	197	52	112	222	1:8.9	1:2.1
Sat.	25	202	45	100	227	1:9.1	1:2.2
Prim.	25	185	52	115	210	1:8.4	1:2.1
Sat.	20	187	42	97	207	1:10.3	1:2.1
Prim.	20	92	35	67	112	1:5.6	1:1.9
Sat.	20	110	32	65	130	1:6.5	1:2

translucent. Maximum length 230 μ; maximum width 135 μ. Ratio LP:TL = = 1:5.4—11.8; ratio WP:WD = 1:1.1—4.1.

Distribution: USSR (Wellmer 1911); previously recorded in Poland by Wellmer 1911.

29. *Gregarina ruszkowskii* sp.n.

Synonyms: *Gregarina katherina* Watson sensu Foerster, 1938 a.
Host: *Coccinella septempunctata* L., *Coccinella quinquepunctata* L.
Habitat: Intestine.
Locality: Poznań 16.VIII.1962, 18.VIII.1962, 5.IV.1963; Ogardy 9.VIII.1963; Kórnik 12.VI.1963; Kałek 4.V.1964; Mielno Koszalińskie 24.VI.1964.

Morphology: Gamonts in multiple associations, oval (Figs. 99 and 100). Maximum length of observed gamonts 92 μ; maximum width 83 μ. Ratio LP:TL = 1:3—8.6; ratio WP:WD = 1:1—2.3 (Table 30).

Epimerite as a small oval wart, 3.5 to 6 μ long. Protomerite semicircular, twice to four times wider than long. Endocyte slightly granular and translucent. Septum well seen, but constriction is not distinct.

Deutomerite oval (Fig. 100). Ectoplasm indistinct. Endocyte slightly granular and translucent. Nucleus with three karyosomes.

Table 30

Measurements of living trophozoites and gamonts of *Gregarina ruszkowskii* sp.n. (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:LD
Prim.	13	71	33	68	84	1:6.5	1:2
Sat. I	13	78	40	76	91	1:7	1:1.9
Sat. II	13	71	35	65	84	1:6.5	1:1.9
Prim.	13	78	35	81	91	1:7	1:2.3
Sat. I	15	73	38	76	88	1:5.9	1:2
Sat. II	10	76	43	83	86	1:8.6	1:1.9
Sat. III	10	76	40	78	86	1:8.6	1:1.9
Prim.	15	63	25	30	78	1:5.1	1:1.2
Sat.	15	55	30	35	70	1:4.6	1:1.2
Prim.	15	63	23	33	78	1:5.1	1:1.5
Sat.	13	63	33	43	76	1:6	1:1.3
Prim.	17	48	25	46	65	1:3	1:1.8
Sat.	10	48	21	37	58	1:5	1:1.3
Prim.	19	48	29	46	67	1:3.5	1:1
Sat.	10	63	27	39	71	1:6.8	1:1.4
Prim.	17	66	31	46	83	1:5	1:1.5
Sat.	12	71	31	46	83	1:6.7	1:1.5
Prim.	18	65	25	43	83	1:4.7	1:1.7
Sat.	10	58	25	35	68	1:6.8	1:1.4
Prim.	18	70	27	45	88	1:3	1:1.3
Sat.	15	77	32	42	92	1:6.1	1:1.3
Prim.	10	63	30	58	73	1:7.2	1:1.9
Sat.	13	58	25	53	70	1:5.6	1:2.1

Cysts and spores: Cysts 100 μ in diameter with 6 spore ducts. Spores were not seen.

Parasitism: The intensity of infection is low as only up to 15 gregarines were observed in one host. The infection level in populations of the host insects is as follows: Mielno Koszalińskie 24.VI.1962 — 100% (15 examined adults of *C. quinquepunctata*); Niechorze 24.IX.1964 — 0% (42 examined adults of *C. septempunctata*); Poznań 18.VIII.1962 — 13% (24 examined adults of *C. septempunctata);* Kałek 28.IV.1964 — 12% (8 examined adults of *C. quinquepunctata).*

Taxonomic position: Watson 1915 described three gregarine species parasitizing *Coccinellidae: Gregarina barbarara* from *Coccinella* sp. with gamonts 145 μ long; *Gregarina katherina* from *Coccinella novemnotata* Herbst with gamonts 72 μ long; and *Gregarina fragilis* from *Coccinella* sp. with gamonts 111 μ long.

Foerster 1938 a claimed that while studying gregarines of insect of the region of Silesia he recorded *Gregarina katherina* in *Coccinella septempunctata* L. and *C. quatuordecimpustulata* L., and *Gregarina barbarara* in *Tytaspis*

sedecimpuctata L. and *Exochomus quadripustulatus* L. He did not give, however, data as to their features and dimensions.

The investigated species cannot be identified with any species described by Watson 1915. All these species are very translucent and practically could be observed only after staining them with Lugol's fluid. In Figs. 111 and 112 one can see that the investigated gregarine is easily observed under the microscope.

Dimensions of gamonts of *G. katherina* are similar to gamonts of *Gregarina* sp., but other features differ these two species. The nucleus of *Gregarina* sp. has three karyosomes while that of *G. katherina* only one. Gamonts of *Gregarina* sp. form multiple associations (up to 5 gamonts in the association), a feature that was never observed in *G. katherina*.

In my collection I have slides with gregarines observed by Watson 1915, and none can be compared with the investigated species. I assume, therefore, this gregarine is a new species and propose the name *Gregarina ruszkowskii* sp.n. for it. The specific name is given in honour of the late Professor Jan Ruszkowski, eminent Polish entomologist.

For reasons explained above I assume that Foerster 1938 a did not observe *Gregarina katherina*, but the species being described in this paper. All species described by Watson 1915 are limited only to the Nearctic in their distribution.

Distribution: This species was apparently recorded in Poland by Foerster 1938 a; known from USSR (Lipa i Semjanov 1967).

30. *Gregarina steini* Berndt

Host: *Tenebrio molitor* L.
Habitat: Intestine.
Locality: Poznań 3.VI.1965 (laboratory culture).

Morphology: Gamonts in asociations, elongate (Fig. 101 and 102). Maximum length of observed gamonts 171 μ; maximum width 43 μ. Ratio LP:TL = = 1:3—8.4; ratio WP:WD = 1:1.1—2 (Table 31).

Protomerite semicircular. Endocyte granular, light-colored and translucent. Septum and constriction well seen. Deutomerite cylindrically elongate, frequently narrowing towards the end (Fig. 101). Endocyte granular and yellow. Nucleus 12 μ in diameter with one karyosome. Protomerite of satellite shorter than of primite. Other features of the primite like those of the satellite.

Cysts and spores: Spores oval up to 155 μ in diameter. Spores invisible.

Parasitism: The infection of host insects was very intensive and in one case about 300 gregarines were observed in the gut of the host insect. The epithelial cells are seriously damaged by the parasite (Fig. 103). Infected insects have a smaller size and are less active than healthy ones.

Taxonomic position: *Gregarina steini* was described by Berndt 1902 and according to Watson 1916 it was a doubtful species. The investigated gregarine was identified as *Gregarina steini* due to its dimensions and morphological features.

Other species known from *Tenebrio molitor* have larger gamonts: *Gregarina cuneata* Stein — 300 by 170 μ; *Gregarina polymorpha* (Hammerschmidt) — 350 by 100 μ.

Distribution: Germany (Berndt 1902); previously recorded from Poland by Foerster 1938 a. Apparently, this is a cosmopolitan species.

Table 31

Measurements of living trophozoites and gamonts of *Gregarina steini* Berndt (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Prim.	20	96	25	33	116	1:5.2	1:1.3
Sat.	20	88	23	28	108	1:5.3	1:1.2
Prim.	25	93	25	33	118	1:4.7	1:1.3
Sat.	18	65	23	28	83	1:4.6	1:1.2
Prim.	25	86	23	28	110	1:4.4	1:1.2
Sat.	18	70	23	28	88	1:5	1:1.2
Prim.	25	86	20	30	111	1:4.4	1:1.5
Sat.	20	78	18	28	98	1:4.9	1:1.6
Prim.	25	141	30	38	166	1:6.6	1:1.2
Sat.	15	60	18	20	75	1:3	1:1.1
Prim.	25	139	28	30	164	1:6.5	1:1.1
Sat.	20	151	20	43	171	1:8.4	1:2
Prim.	20	126	25	30	146	1:7.2	1:1.2
Sat.	23	101	20	30	123	1:5.4	1:1.5

31. *Gregarina typographi* Fuchs

Host: *Ips typographus* L.
Habitat: Intestine.
Locality: Białowieża 11.VII.1963; Laski 3.VIII.1963.

Morphology: Gamonts in associations, oval or elongate (Fig. 106). Maximum length of observed gamonts 118 μ; maximum width 55 μ. Ratio LP:TL = = 1:2.2—5; ratio WP:WD = 1:1.1—2 (Table 32).

Protomerite of trophozoites almost as long as deutomerite (Fig. 104). Septum and constriction well seen. Endocyte of protomerite and of deutomerite is poorly

Table 32

Measurements of living trophozoites and gamonts of *Gregarina typographi* Fuchs (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
25	63	30	38	88	1:3.5	1:1.2
28	76	43	43	103	1:3.7	1:1
28	50	45	53	78	1:2.8	1:1.1
33	86	28	55	118	1:3.6	1:2
30	59	47	45	90	1:2.9	1:1
27	61	41	41	88	1:3.2	1:1
18	72	31	41	90	1:5	1:1.3
27	73	57	63	100	1:3.7	1:1.1
47	59	68	77	106	1:2.2	1:1.1
23	64	44	47	87	1:4	1:1.8

granular and translucent (Fig. 104). As maturation progresses the deutomerite becomes elongate, but in some associated gamonts the deutomerite is oval (Figs. 105 and 106).

Endocyte of gamonts dark but septum always clearly seen (Fig. 106). Morphological features of the primite the same as those of the satellite. Nucleus 15 μ diameter.

Cysts and spores were not seen.

Parasitism: In Białowieża National Park the population of *Ips typographus* was infected in 60% (42 examined insects).

Distribution: Germany (Fuchs 1915); Czechoslovakia (Weiser 1954 d); from Poland already recorded by Bałazy 1966 who based his studies on this material.

32. *Euspora fallax* Schneider

Host: *Melolontha melolontha* L.
Habitat: Intestine.
Locality: Poznań 8.X.1961.

Morphology: In the examined grubs only cysts were observed (Fig. 107). Schneider 1875 mentioned that gamonts of *Euspora fallax* are in associations but the dimensions of gamonts were not given; the ratio LP:TL = 1:6 and the ratio WP:WD = 1:2.5 (Watson 1916). Protomerite oval. Septum and constriction clearly seen. Deutomerite elipsoidal and maximum width in the middle. Nucleus with one karyosome. Endocyte of protomerite and of deutomerite dense and dark.

Parasitism: Out of 9 examined grubs of *M. melolontha* two were infected by *Euspora fallax*.

Cysts and spores: Cysts oval from 254 to 317 μ in diameter without spore ducts. Dehiscence by simple rupture. Spores prismatic.

Distribution: France in *Amphimallon* sp. (Schneider 1875); USSR (Wellmer 1911); for the first time recorded in Poland.

33. *Leidyana ephestiae* Daviault

Host: *Ephestia kühniella* Zell.
Habitat: Intestine.
Locality: Poznań 4.VII.1964 (laboratory culture).

Morphology: Gamonts solitary, elongate (Fig. 112). Maximum length of observed gamonts 353 μ; maximum width 176 μ. Ratio LP:TL = 4.6—8.1; ratio WP:WD = 1:1.3—3.6 (Table 33).

Epimerite oval, frequently larger than protomerite (Figs. 108 and 109). Protomerite of trophozoites elipsoidal. Endocyte granular and translucent. Septum and constriction well seen. Deutomerite oval with maximum width in the middle. Nucleus large with one karyosome.

Protomerite of gamonts conical (Fig. 112). Endocyte granular and not translucent. Septum and constriction clearly visible. Ectoplasm seen as light outer layer, more distinct in the posterior end of deutomerite. Deutomerite cylindrically elongate, tapering toward the end. Nucleus 25 μ in diameter, has one karyosome, and is seen as a white spot in dark endocyte (Fig. 125). The bodies of trophozoites and of gamonts are frequently contracted and bent (Fig. 111).

Table 33

Measurements of living trophozoites and gamonts of *Leidyana ephestiae* Daviault (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
44	258	63	88	302	1:7	1:1.4
76	277	59	88	353	1:4.6	1:1.5
38	246	57	76	284	1:7.4	1:1.3
38	246	57	76	284	1:7.4	1:1.3
38	258	60	101	296	1:7.8	1:1.7
38	208	58	107	246	1:6.5	1:1.8
38	246	58	101	284	1:7.4	1:1.7
38	227	54	88	265	1:7	1:1.6
44	265	38	139	309	1:8.1	1:3.6
38	246	58	176	284	1:7.4	1:3.0

Cysts and spores: Cysts oval 175 μ in diameter (Fig. 110). Dehiscence by simple rupture. Spores barrel-shaped 7 μ long.

Development and parasitism: The host becomes infected by swallowing the cysts or spores. Sporozoites penetrate into epithelium and the trophozoites that develop here cause extensive damage of the epithelial cells and gut wall (Fig. 114, 187, 188). Young trophozoites have epimerites (Figs. 108 and 109), and when maturation progresses they loose epimerites and their bodies become elongate. The mature gamonts are greatly elongate and have dark endocytes (Fig. 112). They live in the gut lumen (Fig. 113) or adhered to the epithelium (Figs. 114, 187, 188). On histological sections of the body of infected insects, gregarines stain well showing a distinct nucleus (Fig. 187).

Pathological changes in the gut depend on intensity of infection. In many cases more than 130 gregarines were observed in the guts of insects. The pathogenic effect of the parasite on its host is caused by extensive damage of the gut epithelium and by stopping the patency of the gut lumen because of a great number of gamonts (Fig. 188).

Infection level in populations of *Ephestia kühniella* is high and in the studied laboratory culture 65% of insects were infected. Parasites were observed only in larvae while the moths were healthy.

Distribution: France (Daviault 1929); for the first time recorded in Poland. This is aparently a cosmopolitan species.

34. *Didymophyes ontophagi* Foerster

Host: *Ontophagus fracticornis* Preyssl.
Habit: Gastric caeca.
Locality: Popowo Podleśne 11.X.1963.

Morphology: Gamonts in associations, oval (Figs. 115-117). Maximum length of observed gamonts 147 μ; maximum width 140 μ. Ratio LP:TL = 1:2.5—3; ratio WP:WD = 1:1.7—3 (Table 34).

Protomerite oval, wider than long. Endocyte granular at the septum and homogenous at the top. Septum and constriction well seen. Deutomerite wider

Table 34

Measurements of living trophozoites and gamonts of *Didymophes ontophagi* Foerster (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
45	88	58	14	133	1:3	1:2.4
41	78	60	125	119	1:2.9	1:2
38	80	49	140	118	1:3.1	1:3
57	90	75	130	147	1:2.5	1:1.7
42	85	63	134	127	1:3	1:2.1

than long, frequently flattened vertically. Endocyte strongly granular at the septum while in the posterior part it is more homogenous.

In the studied material only one association and single gamonts were observed. Foerster 1938 a observed associations in which the satellite had no protomerite.

Cysts and spores: Cysts oval without spore ducts. Dehiscence by simple rupture. Foerster 1938 a did not observed cysts.

Development and parasitism: The parasite develops in gastric caeca (Figs. 115-118). Infected caeca are hyperthrophied (Fig. 116). Normal caeca are up to 200 μ long and 90 μ wide. Infected caeca are up to 273 μ long and 150 μ wide. The infected caeca differ from normal ones and appear as spots when the gut is examined under the microscope (Fig. 118).

Gregarines transferred from gastric caeca into water show signs of quick plasmolysis, due to a difference in osmotic pressure, and their body wall ruptures.

Taxonomic position: The investigated gregarine is identified as *Didymophyes ontophagi* Foerster described from *Ontophagus fracticornis* Preyssl. (Foerster 1938 a). According to Foerster 1938 a the maximum length of *D. ontophagi* was 193 μ and maximum width 217 μ. Cordua 1953 described from *O. fracticornis* gregarine *Didymophyes longa* Cordua with gamonts 400 μ long and 80 μ wide. Various gregarines are known from other *Didymophyes* spp., but they differ from *D. ontophagi* by their features.

Distribution: Previously recorded from Poland by Foerster 1938 a known from Germany (Cordua 1953).

35. *Didymophyes paradoxa* Stein

Synonyms: *Didymophyes paradoxa* Stein, 1848; *Gregarina paradoxa*: Lankester, 1863, *Didymophyes rara* Leger, 1892.
Host: *Geotrupes stercorarius* L., *Geotrupes stercorosus* Scriba, *Geotrupes vernalis* L.
Habitat: Intestine.
Locality: Gola 18.VII.1962, 20.VII.1962; Białowieża 11.VII.1964.

Morphology: Gamonts in associations, elongate (Fig. 119). Maximum length of observed gamonts: primite — 273 μ, and of satellite — 400 μ; maximum width of primite — 176 μ and of satellite — 145 μ. Ratio LP:TL = 1:3—5.1; ratio WP:WD = 1:1.1—1.7 (Table 35).

Primite. Protomerite much wider than long. Endocyte granular and not translucent. Septum and constriction well seen. Deutomerite cylindrically

Table 35
Measurements of living trophozoites and gamonts of *Didymophyes paradoxa* Stein (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
Prim.	53	220	150	167	273	1:5.1	1:1.1
Sat.		396		132	396	—	—
Prim.	70	198	141	176	268	1:3.8	1:1.2
Sat.		369		145	369	—	—
Prim.	70	150	141	163	220	1:3	1:1.2
Sat.		400		132	400	—	—
Prim.	53	176	135	163	229	1:4.3	1:1.2
Sat.		400		145	400	—	—
Prim.	57	194	123	132	251	1:4.3	1:1.7
Sat.		396		118	396	—	—
Prim.	53	172	132	150	224	1:4.2	1:1.1
Sat.		387		132	387	—	—

elongate. Endocyte very dark, especially in the middle of deutomerite (Fig. 119). Nucleus invisible in dark endocyte.

Satellite. Protomerite not seen. Anterior end of satellite convex upward to deutomerite of the primite. Endocyte of satellite more granular than that of primite (Fig. 119).

Cysts and spores: Cysts oval up to 250 μ by 170 μ (Fig. 120). Dehiscence by simple rupture.

Development and parasitism: The parasite develops in the gut of the host. In one host up to 15 gregarines were observed. Infection of *Geotrupes* spp. is different in various biotopes. *Geotrupes vernalis* L. was infected in 1962 in Gola in 14% (24 examined insects); *Geotrupes stercorosus* Scriba in Białowieża in 1964 in 13% (23 examined insects).

Adults of *Geotrupes* spp. are frequently simultaneously infected by *Didymophyes paradoxa* and a microsporidian *Plistophora* sp. (Fig. 195).

Taxonomic position: The investigated species is identified as *Didymophyes paradoxa* Stein described by Stein 1848 from *Geotrupes* sp. and *Geotrupes stercorarius* L. The dimensions of this species were not given in the original description. Foerster 1938 a mentioned that the total length of the association of *D. paradoxa* is 350 μ, while in my material the length of association was great as 669 μ. Cordua 1953 also observed such large associations.

Distribution: Germany (Stein 1848, Cordua 1953) France (Labbe 1899); USRR (Wellmer 1911); recorded previously from Poland by Foerster 1938 a as parasite of *Geotrupes vernalis* L.

36. *Bothriopsides histrio* (Schneider)

Synonyms: *Bothriopsis histrio* Schneider, 1875; *Bothriopsides histrio* (Schneider) Foerster, 1938; *Bothriopsides terpsichorella* (Ellis) sensu Foerster, 1938; *Bothriopsides acilli* Baudoin, 1961.
Host: *Dytiscus marginalis* L., *Hydrophilus* sp.
Locality: Poznań 6.VI.1965; Białowieża 11.VII.1965.

Morphology: Gamonts solitary, elongate (Figs. 123-125). Maximum length of observed gamonts 828 μ; maximum width 154 μ. Ratio LP:TL = 1:3.5—4.4; ratio WP:WD = 1:1—1.1 (Table 36).

Table 36

Measurements of living trophozoites and gamonts of *Bothriopsides histrio* (Schneider) (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
228	600	168	154	828	1:3.6	1:1.1
101	350	107	107	451	1:4.4	1:1
220	550	130	150	770	1:3.5	1:1.1
184	570	125	147	754	1:4.1	1:1.1

Epimerite seen as short or long processes (Fig. 122). Protomerite very long, frequently with maximum width at the top, and has the form of a flower pot (Figs. 121—125). Endocyte of protomerite homogenous, poorly granulated.

Deutomerite long, tapering toward the end. Septum strongly convex upward to protomerite (Figs. 124-125). Endocyte granular and not translucent along its total length. Nucleus oval, seen as a white spot in dark endocyte.

Cysts and spores were not seen.

Parasitism: The parasite inhabits the gut of adults and larvae of species of the family *Dytyscidae*. Only few parasites were observed in each examined insect thus indicating that apparently this gregarine is not strongly pathogenic.

Taxonomic position: Schneider 1875 described the genus *Bothriopsis* and the species *B. histrio* with a characteristic long protomerite and the septum convex upward to the protomerite. Foerster 1938 a corrected the generic name to *Bothriopsides* as Strand 1926 pointed out that the name *Bothriopsis* had been previously used in the classification of *Reptilia*.

Schneider 1875 emphasized the high polymorphism of *B. histrio* and described two forms, marginata and typical, which do not differ significantly from one another. In fact, I observed a high polymorphism of the protomerite of *B. histrio* which changes its shape, length and width in a few seconds. In spite of this polymorphism the specific and generic features, that is, long protomerite and septum convex upward to protomerite is always clearly seen (Figs. 123-125).

Gamonts of *B. histrio* show a great variation in size. Schneider 1875 did not mention the dimensions in the original description of this species. Watson 1916 reported that gamonts were up to 425 μ long. In my material gamonts of *B. histrio* were from 451 μ to 828 μ long.

High polymorphism and variation in size caused serious taxonomic difficulties concerning the *Bothriopsides histrio*. For example Baudoin 1961 assumed that the gregarine found by him in *Acilius sulcatus* L. is a new species and described it as *Bothriopsides acilli*, that differs from *B. histrio* by the structure of protomerite. However, when we take into consideration the fact that the protomerite of *B. histrio* is highly polymorphic, sligth differences in the structure of the protomerite have no taxonomic value and I assume, therefore, that *Bothriopsides acilli* Baudoin is a synonym of *Bothriopsides histrio*. In fact,

Schneider 1875 and Foerster 1938 a listed *Acilius sulcatus* L. as a host of *B. histrio.*

I recognize also *Bothriopsides terpsichorella* (Ellis) sensu Foerster 1938 a as a synonym of *B. histrio,* too. The species *B. terpsichorella* is known as a parasite of *Hydrophilus* sp. only in USA and Foerster 1938 a incorrectly recorded it from the region of Silesia. As a matter of fact, Foerster 1938 a had not explained the reasons why the gregarine observed by him in *Ilybius ater* Deg. was identified as *B. terpsichorella.* There is no doubt that such incorrect identification was caused by the scanty description of *B. histrio* which misled Foerster in his identification of the gregarine from *Ilybius ater.* It was mentioned above that Watson 1916 gave 425 μ as the maximum length of *B. histrio* and 720 μ as the average length of *B. terpsichorella.* In the studied material gamonts of *B. histrio* were up to 828 μ long. Therefore I assume that the recognition of *Bothriopsides terpsichorella* (Ellis) sensu Foerster, 1938 as a synonym of *Bothriopsides histrio* is justified.

Apparently due to the same reasons Crawley 1903 incorrectly identified the gregarine found in larvae of *Dytyscidae* as *Bothriopsides histrio.* Crawley 1903 probably observed *Bothriopsides terpsichorella* (Ellis, 1913). Therefore I propose to recognize the name *Bothriopsides histrio* (Schneider) sensu Crawley, 1903 as a synonym of *Bothriopsides terpsichorella* (Ellis).

Distribution: France (Schneider 1875, Desportes 1963); USRR (Wellmer 1911), Belgium (Baudoin 1961); previously recorded from Poland by Foerster 1938 a.

37. *Coleorhynchus heros* (Schneider)

Synonyms: *Coleophora heros* Schneider, 1885; *Coleorhynchus heros* (Schneider) Labbe, 1899.
Host: *Nepa cinerea* L.
Habitat: Intestine.
Locality: Białowieża 12.VII.1964.

Morphology: Gamonts solitary, oval (Fig. 126). Dimensions of a single gamont: length of protomerite — 50 μ, length of deutomerite 237 μ, width of protomerite — 125 μ, width of deutomerite — 300 μ, total length of gamont — 287 μ. Ratio LP:TL = 1:5.7; ratio WP:WD = 1:2.5. Schneider 1875 mentioned that gamonts are 2 to 3 milimeters long.

Protomerite twice wider than long. Endocyte translucent. Deutomerite oval with dark endocyte. Nucleus has single karyosome and is seen as a light spot in dark endocyte.

Cysts and spores were not seen.

Parasitism: One gamont was observed in the gut of the adult insect.

Distribution: France (Schneider 1885, Poisson 1939); USRR (Wellmer 1911); Czechoslovakia (Stein 1848); USA (Ellis 1913); Germany (Grell 1939); previously recorded from Poland by Foerster 1938 a and Lipa 1966 a.

38. *Pyxinia frenzeli* Laveran et Mesnil

Host: *Attagenus pellio* L.
Habitat: Intestine.
Locality: Kurów 2.IV.1960; 10.VIII.1963.

Morphology: Gamonts solitary, oval (Fig. 127). Maximum length of observed gamonts 110 μ; maximum width 27 μ. Ratio LP:TL = 1:3.5—5.5; ratio WP:WD = = 1:1—1.3 (Table 37).

Table 37

Measurements of living trophozoites and gamonts of *Pyxinia frenzeli* Laveran et Mesnil (in microns)

LE	LP	LD	WP	WD	TL	LP:TL	WP:WD
—	22	75	22	27	97	1:4.4	1:1.2
4	9	25	12	15	34	1:3.7	1:1.2
7	25	73	30	30	98	1:3.9	1:1
10	15	54	17	22	69	1:4.6	1:1.3
5	8	20	15	18	28	1:3.5	1:1.2
5	15	38	17	17	53	1:3.6	1:1
12	20	90	15	18	110	1:5.5	1:1.2

Epimerite cylindrical and elongate with light endocyte. Protomerite generally oval, sometimes cylindrical with grayish-green endocyte. Deutomerite elipsoidal or oval with homogenous endocyte (poorly granular), dark gray and not translucent. Nucleus oval with single and large karyosome.

Cysts and spores: Cysts round, up to 140 μ in diameter, without spore ducts. Dehiscence by simple rupture. Spores cylindrical.

Parasitism: Out of eight examined insects in 1960 two were infected, and in 1963 three out of ten. Intensity of infection was low, as up to 10 gregarines were observed in the host only.

Distribution: France (Laveran et Mesnil 1900); for the first time recorded in Poland.

39. *Stictospora provincialis* Leger

Synonyms: *Actinocephalus stelliformis* var. *c* Schneider, 1875; *Stictospora provinciclis* Leger, 1893.
Host: *Amphimallon solstitialis* L.
Habitat: Intestine.
Locality: Modliszewko 11.X.1963, 16.I.1964, 24.III.1964; Książ 29.X.1963.

Morphology: Gamonts solitary, elongate (Fig. 129). Maximum length of observed gamonts 1712 μ; maximum width 397 μ. Ratio LP:TL = 1:7.1—11.4; ratio WP:WD = 1:1.1— 4.7 (Table 38).

Protomerite semicircular, slightly wider than long. Endocyte granular and dark. Septum and constriction well seem. Deutomerite elongate and tapering toward the end. Nucleus 44—51 μ in diameter, has three karyosomes, and is located in various parts of deutomerite (Fig. 130).

Cysts and spores were not seen.

Development and parasitism: The host becomes infected by swallowing the cysts or spores. The sporozoites penetrate the epithelium of the gut and are transformed here into trophozoites. These fall out into lumen of the gut and change into gamonts (Fig. 128). In few cases gamonts were observed in the body

cavity. Apparently these gamonts instead of falling out into the gut lumen penetrate the gut wall into the body cavity. In fact, in some cases, associations were even observed in the epithelium (Fig. 189) what is unusual for this species. It would indicate that some deviations from a typical development might take place.

Table 38

Measurements of living trophozoites and gamonts of *Stictospora provincialis* Leger (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
112	925	125	200	1037	1:9.2	1:1.6
150	1562	212	312	1712	1:11.4	1:4.7
125	1375	175	250	1500	1:12	1:4
125	1062	150	225	1187	1:9.5	1:1.5
146	901	146	152	1047	1:7.1	1:1
166	1318	218	268	1484	1:8.9	1:1.3
166	1331	307	358	1497	1:9	1:1.1
179	1344	294	371	1523	1:7.9	1:1.2
205	1395	282	397	1600	1:7.8	1:1.4
141	1050	205	307	1190	1:8	1:1.4

The intensity of infection of host insects was very high and from several to 276 gregarines were observed in the gut of insects.

The pathological effect of the parasite on its host is quite evident when histological slides are examined. The trophozoites and gamonts damage epithelial cells mainly mechanically. They rupture the cells and make cavities in the epithelium. There are, however, evidences that the parasites damage the cells by physiological means. This is proved by a quite different staining of cells that are close to gamonts and trophozoites of the parasite. Such cells are deeply stained with Giemsa's solution while normal cells are much lighter. These show that close contact of the parasite is harmful for cells and their cytoplasm is basophilic (Figs. 130 and 190).

The infection level in a population of *Amphimallon solstitialis* in Mielno of Gniezno county was 26% (178 examined insects). Larvae of *Melolontha melolontha* L. and *Phyllopertha horticola* L. collected in the same biotope were healthy.

Taxonomic position: Morphological features of the investigated species indicate that it belongs to the genus *Stictospora*. Leger 1893 described *Stictospora provincialis* parasitizing *Melolontha* sp., and *Rhizotrogus* sp. (=*Amphimallon* sp.). The investigated species differs in some features from *Stictospora provincialis* e.g. in my material the ratio WP:WD = goes up to 1:12 while according to Watson 1916 it is only 1:6 These differences, however, are due to the fact that the previous information on some features of *S. provincialis* has been limited. The data collected on the investigated gregarine of *Amphimallon solstitialis* allow to identify it as *Stictospora provincialis* Leger.

Distribution: France (Leger 1893); USSR (Wellmer 1911); Germany (Foerster 1938 a); previously recorded from Poland by Foerster 1938 a.

40. *Ancyrophora balazyi* sp.n.

Host: *Carabus coriaceus* L., larvae of *Carabidae*.
Habitat: Intestine.
Locality: Białowieża 10.VII.1965; Poznań 11.VIII.1965.

Morphology: Gamonts solitary, elongate (Figs. 136 and 137). Maximum length of observed gamonts 438 μ; maximum width 203 μ. Ratio LP:TL = = 1:2.2—5; ratio WP:WD = 1:1.1—1.9 (Table 39).

Table 39

Measurements of living trophozoites and gamonts of *Ancyrophora balazyi* sp.n. (in microns)

LE	LP	LD	WP	WD	TL	LP:TL	WP:WD
25	55	141	86	96	196	1:3.6	1:1.1
20	68	111	71	76	179	1:2.6	1:1.1
20	55	154	83	101	209	1:3.8	1:1.2
20	87	107	60	87	195	1:2.2	1:1.9
15	27	97	30	45	125	1:4.5	1:1.5
17	37	140	35	45	177	1:5	1:1.3
—	50	136	58	76	187	1:3.7	1:1.3
—	114	254	114	133	368	1:3.2	1:1.2
—	121	317	184	203	438	1:3.6	1:1.2
—	58	159	76	88	217	1:3.7	1:1.1

Epimerite oval with finger-like processes directed forward or on sides, and being 25 μ long (Fig. 131).

Trophozoites elongate (Figs. 132-134). Protomerite rhomboidal, longer than wide. Septum and constriction seen. Endocyte dark but frequently lighter at septum than in other parts.

Protomerite of gamonts conical and slightly flattened, wider than long (Fig. 136). In the place from which epimerite was broken up there is a sign of tattered ectoplasm (Fig. 137). Endocyte dark and strongly granulated. Constriction slight and septum poorly seen in gamonts.

Deutomerite widest at the septum and then tapering to one third of its maximum width (Fig. 136). Endocyte dark, granulated and not translucent. Nucleus seen as white spot in dark endocyte in young trophozoites only (Fig. 134), while in gamonts not seen. Nucleus has a few karyosomes, most frequently five. Ectoplasm seen as light outer layer around the body. Deutomerite of trophozoites cylindrical (Fig. 133) while of gamonts tapering (Fig. 136).

Cyst and spores: Cysts oval up to 444 μ in diameter (Fig. 135). Dehiscence by simple rupture. Spores spindle-shaped 12 by 7 μ.

Parasitism: Intensity of infection is variable and 1 to 20 gregarines were observed in a host insect.

Taxonomic position: The structure of the epimerite and other morphological features indicate that the investigated species belongs to the genus *Ancyrophora*. This species differs from *Ancyrophora gracilis* and *Ancyrophora stelliformis* by its dimensions and the structure of trophozoites, as well as by the ratio LP:TL. I assume, therefore, that the gregarine recorded from *Carabus coriaceus*

is a new species and propose the name *Ancyrophora balazyi* sp.n. for it. The specific name of this species is in honour of my friend Dr Stanisław Bałazy from Wielkopolski National Park.

Distribution: Poland.

41. *Ancyrophora philonthi* sp.n.

Host: *Philonthus laevicollis* Boisd.
Habitat: Intestine.
Locality: Białowieża 19.VI.1963.

Morphology: Gamonts solitary, elongate (Figs. 138 and 139). Maximum length of observed gamonts 273 μ; maximum width 149 μ. Ratio LP:TL = 1:2.7—4; ratio WP:WD = 1:1.2—1.7 (Table 40).

Table 40

Measurments of living trophozoites and gamonts of *Ancyrophora philonthi* sp.n. (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
47	142	72	123	189	1:4	1:1.7
65	115	62	101	180	1:2.7	1:1.6
80	193	122	149	273	1:3.4	1:1.2

Protomerite large, about one third as long as the total length of gamont, oval or slightly elongate. Septum well seen on its periphery, in the middle part indistinct. Ectoplasm seen as distinct light-colored outer layer. Endocyte granular and dark.

Deutomerite elongate, frequently tapering toward the end (Figs. 138 and 139). Ectoplasm as light-colored outer layer around the deutomerite. Endocyte dark and dense. Nucleus not seen.

Cysts and spores: Cysts up to 480 μ in diameter without spore ducts. Spores were not seen.

Parasitism: Out of three examined insects only one beetle was infected with six gregarines.

Taxonomic position: The structures of the epimerite, cysts and other features of this species indicate that it belongs to the genus *Ancyrophora*. It differs from other species of the same genus by the morphology of gamonts and different dimensions. I consider, therefore, that the investigated gregarine is a new species and propose the name *Ancyrophora philonthi* sp.n. for it.

Distribution: Poland.

42. *Ancyrophora stelliformis* (Schneider)

Synonyms: *Actinocephalus stelliformis* Schneider, 1875; *Ancyrophora gracilis* (Schneider): Wellmer 1911.
Host: *Carabus violaceus* L., *Pterostichus vulgaris* L.
Habitat: Intestine.
Locality: Marianka—Siemianice 20.VII.1963.

Morphology: Gamonts solitary, elongate (Figs. 140—143). Maximum length of observed gamonts 449 μ; maximum width 106 μ. Ratio LP:TL = 1:5.3—6.6; ratio WP:WD = 1:1—1.9 (Table 41).

Protomerite oval in trophozoites, wider than long. Septum and constriction well seen. Endocyte of young trophozoites translucent (Fig. 140-T) while in older ones it is dark (Fig. 140-G).

Protomerite of gamonts oval or conical (Figs. 140-143). Endocyte dark and granular. Deutomerite elongate with maximum width at the septum and tapering toward the end (Figs. 140-143). Endocyte granular and not translucent. The nucleus has 3 karyosomes and is located in the widest part of deutomerite.

Table 41

Measurements of living trophozoites and gamonts of *Ancyrophora stelliformis* (Schneider) (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
66	330	88	101	396	1:6	1:1
64	317	70	92	381	1:5.9	1:1.3
66	282	79	106	348	1:5.2	1:1.3
66	224	48	84	390	1:5.9	1:1.8
70	378	101	101	449	1:6.3	1:1
66	375	97	88	431	1:6.5	1:1.1
66	326	70	88	392	1:5.3	1:1.9
70	370	92	97	440	1:6.2	1:1
66	356	70	92	422	1:6.4	1:1
66	374	101	106	440	1:6.6	1:1

Cysts and spores: Cysts 550 μ in diameter (Fig. 144). Dehiscence by simple rupture. Spores spindle-shaped 8 μ long.

Parasitism: The intensity of infection is high and more than 50 gregarines were observed in a host insect (Fig. 143).

Distribution: France (Schneider 1875; Pfeiffer 1893), USSR (Wellmer, 1911); previously recorded from Poland by Wellmer 1911 and Foerster 1938 a.

43. *Stylocephalus carabi* sp.n.

Host: *Carabus glabratus* Payk.
Habitat: Intestine.
Locality: Białowieża 9—10.VII.1965.

Morphology: Gamonts solitary and very elongate (Figs. 148 and 149). Maximum length of observed gamonts 1440 μ; maximum width 92 μ. Ratio LP:TL = = 1:4.6—6; ratio WP:WD = 1:1—1.6 (Table 42).

Epimerite of variable shape. Protomerite oval, longer than wide. Endocyte dark. Septum and constriction well seen. Top of the protomerite convex (Figs. 146 and 147).

Deutomerite very elongate and tapering to a sharp point, the maximum width at the septum. Endocyte very dark. Nucleus 35 μ in diameter, located in anterior part of deutomerite.

Cysts and spores: Cysts up to 300 μ in diameter (Fig. 150). Spores were not seen.

Development and parasitism: Trophozoites develop at first in the epithelium and later in the gut lumen. Young trophozoites are small, their protomerite is wide and short (Fig. 145), and their endocyte is dark. Their body is frequently bent and the body contracted due to the contraction of myonems (Fig. 145). Older trophozoites are 400 to 600 μ long. Their protomerite is elongate and

Table 42
Measurements of living trophozoites and gamonts of *Stylocephalus carabi* sp.n. (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
72	360	60	60	432	1:6	1:1
144	516	84	136	660	1:4.6	1:1.6
55	205	47	62	260	1:4.7	1:1.3
67	275	72	75	342	1:5	1:1
37	190	45	55	227	1:6	1:1.2
264	1056	85	86	1320	1:5	1:1
207	873	72	72	1080	1:5	1:1
240	1200	90	92	1440	1:6	1:1

consists of two parts (Figs. 146 and 147): the first — is convex, and the other is wider, both with dark endocyte. Mature gamonts are up 1440 μ long (Figs. 148 and 149). Their deutomerite is almost always bent.

Intensity of infection is very high and 50 to 60 gregarines were observed in a host insect.

Taxonomic position: Due to features of the epimerite this gregarine is identified as belonging to the genus *Stylocephalus* and is considered to be a new species. Accordingly the name *Stylocephalus carabi* sp.n. is proposed for it.

Distribution: Poland.

44. *Stylocephalus oblongatus* (Hammerschmidt)

Synonyms: *Rhizinia oblongata* Hammerschmidt, 1838; *Sporadina oblongata* (Hamm.) Frantzius, 1848; *Gregarina oblongata* (Hamm.) Diesing, 1851; *Stylorhynchus oblongatus* (Hamm.) Schneider, 1875; *Stylocephalus oblongatus* (Hamm.) Watson, 1916.
Host: *Opatrum sabulosum* (L.)
Habitat: Intestine.
Locality: Poznań 10.IV.1961; 13.VI.1962, 2.VII.1963, 10.VII.1962, 20.V.1964, 26.VI.1965; Góra Puławska 11.V.1962.

Morphology: Gamonts solitary, very elongate (Figs. 154 and 157). Maximum length of observed gamonts 1448 μ; maximum width 174 μ. Ratio LP:TL = = 1:7—20; ratio WP:WD = 1:1.7—2.5 (Table 43).

Trophozoites bottle-shaped with a stilleto-like epimerite (Fig. 151). Their endocyte is poorly granular and translucent.

Protomerite of gamonts oval and slightly flattened, in general as wide as long (Fig. 152). A mark left by the epimerite that fell away is frequently seen on the top of protomerite (Fig. 155). Endocyte poorly granular and ectoplasm is seen as light-colored, thin outer layer (Fig. 155). Septum and constriction well seen.

Deutomerite elongate with maximum width close to septum and tapering to one third of its maximum width at the end. Endocyte dark and not translucent, less granular at the posterior end than in other parts. The nucleus has few karyosomes, and is seen as a white spot in dark endocyte (Fig. 154).

Dead gamonts were observed in which the endocyte was preserved only in the protomerite and the ectoplasm was longitudinally ribbed (Fig. 153).

Table 43

Measurements of living trophozoites and gamonts of *Stylocephalus oblongatus* (Hammerschmidt) (in microns)

LP	LD	WP	WD	TL	LP:TL	WP:WD
49	549	49	107	598	1:12.1	1:2.1
49	484	49	107	533	1:10.8	1:2.1
49	681	49	123	730	1:14.8	1:2.5
159	948	71	139	1107	1:7	1:2
68	648	76	171	716	1:15	1:2.3
57	910	57	148	967	1:16.7	1:2.4
49	672	57	148	721	1:14.6	1:2.5
57	664	57	131	721	1:14.6	1:2.3
57	774	63	111	831	1:14.5	1:1.7
73	1375	81	174	1448	1:20	1:2

Cysts and spores: Cysts oval up to 394 μ in diameter (Figs. 156 and 157). Dehiscence by simple rupture. Spores in chains.

Development and parasitism: The host becomes infected by swallowing the cysts or spores. Sporozoites penetrate the epithelium and are transformed into trophozoites with stilleto-like epimerites (Fig. 151). Gamonts live in the gut lumen. Associations were not observed. In young cysts two associating gamonts may be seen (Fig. 156).

The pathogenicity of the parasite is most significant in the period of intracellular and intercellular development. Epithelial cells are destroyed and they take stain abnormally.

Intensity of infection is high and frequently up to 50 gregarines are observed in a host insect.

During some years the changes in infection level of *Opatrum sabulosum* by *Stylocephalus oblongatus* were studied in the Marcelin Forest in Poznań (Table 44). Results obtained in 1961 showed great differences in the infection level checked during short intervals.

Taxonomic position: Due to morphological features and the structure of the epimerite the gregarine found in *Opatrum sabulosum* is identified as *Stylocephalus oblongatus* (Hammerschmidt) described by Hammerschmidt 1838 from the same insect. Watson 1916 gave the maximum length 3000 μ and the ratio LP:TL = 1:6—8 for this gregarine.

This gregarine parasitizes *Asida grisea* (F.) and *Olocrates gibbus* F. (Watson 1916).

Distribution: France (Schneider 1875); Germany (Hamerschmidt 1838); USSR (Wellmer 1911); Israel (Theodorides 1955c); for the first time recorded in Poland.

Table 44

Infection of *Opatrum sabulosum* (L) in various years in Poznań

Date	Number of insects		Per cent of infection
	examined	infected	
1961			
10.IV	10	5	50%
2-5.VIII.	54	16	29%
14.VIII.	25	22	88%
1962			
15.IV.	1	1	
13.VI.	2	1	
10.VIII.	4	0	
1963			
5.VI.	2	0	
16.VI.	5	1	
1964			
20-21.V.	30	12	40%

Iorellidae familia nova

Iorella genus novum

The gregarine found in *Dytiscus marginalis* L. differs so significantly in its morphological features and the type of associations from other species that it was considered to be necessary to establish a new family and a new genus.

Definition of the *Iorellidae* fam. nova, and *Iorella* gen. nov: Gamonts in associations attach protomerite to protomerite. Epimerite globular. Protomerite regularly cylindrical with special morphological adaptations securing a good attachment in association. Septum straight. Deutomerite elongate and tapering toward the end. Nucleus elongate or kidney-like. Cysts and spores were not seen. Type species *Iorella wegoreki* sp.n. The new family *Iorellidae* and the new genus *Iorella* is named after the name of the Institute of Plant Protection (the Polish initials of the Institute are IOR).

45. *Iorella wegoreki* g.n., sp. n.

Synonyms: *Bothriopsides histrio* (Schneider) pro parte sensu Baudoin, 1961; *Legeria agilis* (Schneider) pro parte sensu Baudoin, 1961; *Bothriopsides graphoderi* Baudoin, 1961 pro parte.
Host: *Dytiscus marginalis* L.
Habitat: Intestine.
Locality: Poznań 6.VI.1964.

Morphology: Gamonts in associations, elongate (Figs. 165 and 169). Associations formed by attachment of protomerite to protomerite. Maximum length of observed gamonts 1220 μ; maximum width 150 μ. Ratio LP:TL = 1:8.3—12.5; ratio WP:WD = 1:1.3—1.7 (Table 45).

Table 45

Measurements of living trophozoites and gamonts of *Iorella wegoreki* g.n., sp.n. (in microns)

	LP	LD	WP	WD	TL	LP:TL	WP:WD
	97	1123	78	117	1220	1:12.5	1:1.5
Prim.	94	689	78	139	783	1:8.4	1:1.7
Sat.	94	688	97	131	783	1:8.3	1:1.3
Prim.	94	702	78	128	796	1:8.5	1:1.6
Sat.	94	717	94	150	811	1:8.7	1:1.5

Epimerite globular (Figs. 158 and 161). Protomerite of young trophozoites wider than long (Figs. 159, 162—164). Although the protomerite may be contracted it always preserve its characteristic shape (Figs. 162 and 164). Endocyte granular and not translucent. Septum and constriction well seen. Protomerite of mature gamonts regularly cylindrical and longer than wide (Figs. 168 and 169).

Deutomerite very elongate. Maximum width at the septum and then tapering toward the end. Ectoplasm seen as 2—3 μ thin light-colored outer layer (Fig. 164). Endocyte granular and dark. Nucleus kidney-like or elongate and has 5 karyosomes (Fig. 164).

The protomerite and the deutomerite show great ability for conctraction due to well developed myonems (Fig. 166). The associations also show an inclination for bowing (Fig. 168), but special adaptations of protomerites secure a good attachment (Figs. 165 and 169).

Cysts and spores were not seen.

Development and parasitism: Young trophozoites develop in the epithelium of the gut and later are transformed into gamonts in the gut lumen.

The intensity of infection is high and up to 50 gregarines were observed in a host insect. In result of such strong infection the gut is damaged.

Discusion of the new genus *Iorella* nov. gen.: In nowadays gregarines of arthropods known the associations are formed in such a way that the protomerite of the satellite is attached to the deutomerite of the primite. In the investigated species the association is formed by the attachment of protomerite to protomerite. In our investigations carried on during many years, I have never observed such a type of associations. I consider, therefore, that such a type of associations can be recognized as a feature of the genus and the family. Associations formed in this manner are not casual but they are permanent and even the bowing of the association cannot break the associated gamonts (Fig. 168).

Some authors reported an association in which gamonts were attached with their protomerites to one another. Huxley 1910 reported it in the genus *Ganymedes* described by him which comprises gregarines with a body not divided into a distinct protomerite and deutomerite.

Due to differences between the *Ganymedes* genus and the investigated gregarine, they cannot be placed into one genus or even family. Desportes 1963 reported front association (protomerite to protomerite) at *Hoplorhynchus oligacanthus* (von Siebold) Schneider from dragonflies *Boyeria irenae* and *Onychogomphus uncatus*. As this feature was never observed in *H. oligacanthus* by other authors it is quite probable that Desportes observed the gregarine belonging to the genus *Iorella* n.g.

While studying the gregarines of *Dytyscidae*, Baudoin 1961 observed associations typical for the genus *Iorella* but he recognized them incorrectly as gamonts of *Bothriopsides histrio* (Schneider). None of the authors (Schneider 1875; Foerster 1938 a) studying *Bothriopsides histrio* reported such a type of associations. In my investigations on *B. histrio* I found that the structure of protomerite (see Figs. 124-125) of *B. histrio* makes such attachments impossible. Furthermore, it seems well proved by photographs that *Bothriopsides histrio* and *Iorella wegoreki* sp.n. are distinct and separate species. This is supported by the differences in the structure of their protomerites and nuclei. The nucleus of gamonts of *Bothriopsides* is oval while in the genus *Iorella* it is kidney-like or elongate. In Fig. 7 of Baudoin's (1961) paper we can see that gamonts attached to one another by their protomerites have nuclei of the *Iorella* type.

Furthermore, while comparing the development of *Legeria agilis*, described in the original paper by Schneider 1875, and the one described in Baudoin's (1961) paper, with the development of *Iorella wegoreki* sp.n., it may be seen that some stages recognized by Baudoin as developmental stages of *Legeria agilis* are in fact stages in the life cycle of *Iorella*. Baudoin 1961 claims that *Legeria agilis* form associations by means of protomerite to protomerite (Baudoin 1961; Fig. 46) but this has never been observed by other authors in the genus *Legeria*. I assume also that some stages recognized in the development of *Bothriopsides graphoderi* Baudoin (Baudoin 1961) should be regarded as forms of *Iorella wegoreki* because they are identical with them.

From the above we can see that Baudoin 1961 was the first to notice a member of the genus *Iorella*, but the forms in its development were recognized by him as stages in the life cycle of *Bothriopsides* spp. and *Legeria agilis*. Additional studies are necessary to explain whether the species observed by Baudoin 1961 is identical with *Iorella wegoreki* sp.n. described here or whether it is a new species. Some differences in the structure of the protomerite in Baudoin's material might probably suggest that the species observed by him is different from *Iorella wegoreki* sp.n.

Summarizing the above it seems justified to establish a new genus *Iorella* defined on page 152 and, belonging to a new family *Iorellidae*.

The specific name of *Iorella wegoreki* sp.n. is given in honour of Professor Władysław Węgorek, Director of the Institute of Plant Protection.

Distribution: Poland; probably observed by Baudoin 1961 in Belgium as parasite of *Dytiscus marginalis* L. and *Graphoderes cinereus* L.

Schizogregarinaria of insects

46. *Mattesia dispora* Naville

Synonyms: *Mattesia dispora* Naville, 1930; *Coelogregarina ephestiae* Ghelelovitch, 1948 sensu Weiser, 1954 non Ghelelovitch, 1948.
Host: *Ephestia kühniella* Zell.
Habitat: Fat body.
Locality: Poznań 18.II.1961 (permanent laboratory culture).

Ephestia kühniella Zell. is known as host of three gregarines: from *Eugregarinaria* for *Leidyana ephestiae* Daviault (Daviault 1929) and from family *Schizogregarinaria* for *Mattesia dispora* Naville (Naville 1930) and *Coelogregarina ephestiae* Ghelelovitch (Ghelelovitch 1948).

The species described by Naville 1930 — *Mattesia dispora* — was studied by many authors (Mattes 1927; Musgrave and Mackinnon 1938; Finlyason 1953; Weiser 1953, 1954 a,c).

Weiser 1954 a,c identified *Mattesia dispora* with *Coelogregarina ephestiae* and recognized it as one species. However, Canning 1964 showed differences in the development of spores in the genus *Mattesia* and *Coelogregarina* and for this reason she supported the former view that these two genera existed, and were separate.

Contradictory views on the status of schizogregarines of *Ephestia kühniella* were the main reason in undertaking the study on this gregarines.

Infection: The host becomes infected by swallowing the spores from which, under the influence of digestive fluids, the sporozoites emerge. The sporozoites appear as spindle-shaped forms 12 to 20 μ long and 1.5 to 2.0 μ wide (Figs. 170-172). Their nucleus is stained red with Giemsa's solution and the cytoplasm deep blue.

Sporozoites are very active. They penetrate the fat body cells or hemocytes (Figs. 170 and 172) and are transformed into other stages. The cells infected by sporozoites show characteristic changes (Fig. 170). Their cytoplasm is strongly vacuolized and this ends in the disintegration of cells.

While discussing the mechanism of infection we can distinguish the primary infection, that is the penetration of sporozoites emerging from the swallowed spores, and the secondary infection (autoinfection) by sporozoites emerging from the spores that have already developed in the tissues of the infected insect. In fact, empty spores left by sporozoites are frequently observed in smeared preparations (Fig. 179).

Micronuclear schizogony (first schizogony): Sporozoites that penetrate cells continue their development and are transformed into plasmodial bodies with small nuclei; these stages are called micronuclear schizonts (Fig. 173). Through their divisions several micronuclear merozoites are produced. These are spindle-shaped bodies from 5 to 8 μ long and 2 μ wide (Fig. 173).

Micronuclear schizonts are very active and they migrate through the body of the host infecting various parts of the fat tissue.

Macronuclear schizogony (second schizogony): Micronuclear merozoites are transformed into macronuclear schizonts (Figs. 173 and 174). Their size as well as the diameter of their nuclei are larger than those of micronuclear schizonts. The maximum size of macronuclear schizonts was 20 μ.

Through division of macronuclear schizonts, macronuclear merozoites are produced (Fig. 175) which, in turn, are transformed into gametocytes.

Gametogony: Gametocytes (gamonts) link in pairs (Fig. 176). Cases of one-spore gamogony were not observed what, according to Weiser 1954 a,c, would be the reason for identifying both genera: *Mattesia* and *Coelogregarina*. The results of our study clearly support Canning's 1964 view that in the gamogony of the genus *Mattesia* two spores are always produced.

Nuclei of gamonts become divided in such a way that 6 gametes are produced but only four take part in further development. These four gametes link in pairs and in each gametocytes two zygotes are produced. These produce the wall around themselves and turn into spores. Spores are seen in pairs in the host tissue (Figs. 173 and 184).

The spores: Spores are lemon-like in shape (Figs. 179, 181 and 182), from 13 to 14 μ long and 7 μ wide. On smeared stained preparations eight sporozoites are seen inside the spores (Fig. 179). In fresh preparations of the body of infected larvae spores are seen in large clusters (Fig. 180) floating in the hemolymph.

Histopathology: There are striking pathological changes in the tissues of infected insects. The fat body cells are strongly vacuolized and become degenerated (Figs. 170 and 173). At the final stage of infection there is practically no healthy cell and the whole body is filled with a huge number of spores of *Mattesia dispora* (Fig. 183).

In the organism of infected insects distinct defensive mechanisms against parasites are observed. They appear mostly as formations of cysts by phagocytes around the infected parts or cells of fat body (Figs. 177 and 178). Inside such cyst spores and other developmental stages of the parasite are captured and become gradually destroyed.

Taxonomic position: As two spores are produced in the development of the investigated schizogregarine it is identified as *Mattesia dispora* Naville. As indicated by Ghelelovitch 1948 and Canning 1964, shown in this paper, the type of sporogony of *Mattesia dispora* is quite different from that of *Coelogregarina ephestiae*. Accordingly, the genera *Coelogregarina* and *Mattesia* should be preserved.

Distribution: Cosmopolitan species; for the first time recorded in Poland.

VIII. Remarks on pathogenesis and invasiveness of studied gregarines

Histopathological effect of gregarines on arthropods

The pathogenicity of *Eugregarinaria* for their host is not generally accepted. As they live in the gut lumen many authors assume that they are rather harmless commensals. On the other hand, *Schizogregarinaria* are recognized as lethal parasites. Such an opinion, in general, is correct, but in more careful histopathological investigations we can see a great similarity in the mechanism of pathogenic effects of members belonging to both groups of gregarines on their hosts.

We have paid much attention to the problem of pathological changes in the tissues of arthropods, as this problem has never been studied broadly, and only very limited information is available in literature.

Results of studies of many authors e.g. Weiser 1953, 1954 a and Canning 1964, and the results of my studies, clearly indicate that

Schizogregarinaria are strongly pathogenic and their invasion always causes the death of the host. This is due to a progressing destruction of the fat body of the host.

When histological sections of the body of *Ephestia kuhniella* Zell. infected with *Mattesia dispora* Naville are examined (Figs. 173, 183 and 184) one can see that the fat body is strongly vacuolized. Due to progressive degeneration of cells the fat body diminishes and finally it is completely destroyed.. The dying insect appears on histological preparations like a sac with fluid that contains spores of *Mattesia dispora* and such tissues as hypodermis, muscles and intestines are undamaged by the parasite (Fig. 183).

Although some authors (e.g. Laveran et Mesnil 1900; Watson-Kamm 1920) paid some attention to the pathogenicity of *Eugregarinaria* their statements were not supported by photographs and therefore were not generally accepted. The data collected during our studies strongly indicate that definite and extensive pathological changes in the tissues and organism of their hosts are associated with the development and parasitism of eugregarines.

All eugregarines studied by us parasitized in the gut of their hosts. However, from the standpoint of location these gregarines may be divided into groups inhabiting: 1. the intestine lumen, and 2. gastric caeca of the intestine.

To the group of gregarines living in the gastric caeca belong, among others, *Gregarina chrysomelae* sp.n. (Figs. 63, 64 and 186), *Gregarina macrocephalia* sp.n. (Figs. 84 and 85), and *Didymophyes ontophagi* Foerster (Figs. 115-118). The presence of trophozoites or gamonts in the gastric caeca causes their great hypertrophy. In many cases this ends in the rupture of the wall of the gastric caecum. The bacteria that penetrate such openings cause septicemia and death of the arthropods. The number of such cases is great, as in many hosts almost all gastric caeca are parasitized e.g. in *Aphodius depressus* (Fig. 85).

In the case of eugregarines parasitizing in the lumen of the intestine the greatest pathological changes are observed in the period of intracellular and intercellular development of trophozoites. The damage of epithelium by trophozoites is mechanical and physiological. A good example of such pathological changes is given in our study of the damage of the epithelium of *Lagria hirta* L. by *Gregarina rostrata* Wellmer (Figs. 97, 98 and 185). The trophozoites are seen as dark stained bodies and are surrounded by cavities, being an evidence of pinocytosis. Such damage is even more striking in the epithelium of *Ephestia kühniella* Zell., infected with *Leidyana ephestiae* Daviault (Figs. 187 and 188). The trophozoites of *L. ephestiae* cause an extensive and almost complete destruction of the epithelial cells (Fig. 188).

Various pathological changes can be observed in the epithelium of the gut of *Amphimallon solstitialis* L. infected with *Stictospora provincialis* Leger (Figs. 128, 130, 189 and 190). This damage is especially well seen in Fig. 189 where two gamonts caused a large cavity in the epithelium. The epithelial layer separating the gamonts from the body cavity is so thin that it is quite probable it will break later and the parasites will fall into the body cavity.

Clear pathological changes in the epithelial cells located close to trophozoites and gamonts are discussed on page 156 and are well seen in Figs. 128 and 190. This part of epithelium, to which the gamonts adhere, is three times

thinner than in other parts (Fig. 128). Furthermore, a degeneration of nuclei and strong basophilic reactions are observed in such cells (Figs. 130 and 190).

There is a great damage of the gut of *Tenebrio molitor* L. by gamonts and trophozoites of *Gregarina cuneata* Stein (Fig. 191). The trophozoites developing in great numbers in the gut destroy the epithelium in which characteristic cavities are seen (Fig. 191).

The comparison of histopathology of eugregarine (Figs. 185, 191) and schizogregarine infections (Figs. 173 and 184) clearly indicates that the mechanism of pathogenicity of schizogregarines and of eugregarines developing intercellularly and intracellularly is very similar. However, due to the fact that schizogregarines destroy the fat body and eugregarines the gut epithelium, the former are much more important as lethal parasites of insects, than the others.

Eugregarines infecting *Diplopoda* and *Chilopoda* cause the same pathological changes in their bodies as described in insects. In Fig. 30 we see the destruction of gut epithelium of *Schizophyllum sabulosum* (L.) by *Stenophora schizophylli* sp.n. similar to that caused by *Leidyana ephestiae* in *Ephestia kühniella*. In Figs. 51 and 193 we can see trophozoites and gamonts of *Echinomera hispida* (Schneider) surrounded by cavities in the gut epithelium of *Lithobius forficatus* L. These data and photographs, together with what was written about individual species in the taxonomic part of this paper, clearly indicate, that the mechanism of gregarine infection in insects and in *Diplopoda* and *Chilopoda* is the same.

This great similarity in the type of damage of host tissue observed in various classes of arthropoda is due to the same mechanism of food assimilation by gregarines. It is pinocytosis, that is absorption of fluids through the whole surface of the body. This explains the presence of cavities surrounding trophozoites in various hosts well illustrated in Figs. 185 and 191—193.

Similar pathological pictures were recently reported by Harry 1965 in *Schistocerca gregaria* Forks. infected with *Gregarina garnhami* Canning.

The information given above increases our knowledge of the pathological processes caused by gregarines in arthropods and indicates that these processes are similar in case of eugregarines and schizogregarines developing in *Insecta*, *Diplopoda* and *Chilopoda*.

Mixed protozoan infections

Simultaneous infections of one host by two or more protozoan species are frequently observed during our studies. Such cases were observed in *Tenebrio molitor* L. infected with *Gregarina cuneata* Stein and *G. steini* Berndt (Fig. 72); in *Coccinella septempunctata* L. infected with *Gregarina coccinellae* sp.n. and *G. ruszkowskii* sp.n.; in *Forficula auricularia* L. infected with *Gregarina ovata* Dufour and *G. forficulae* sp.n. (Figs. 78 and 79), and in many other species of arthropods.

The above concerns the infections caused by members of the family of *Eugregarinaria*. Much more interesting are the cases when a host is infected by protozoans belonging to different orders. Such cases were frequently observed in the course of our studies.

In some colonies of *Ephestia kühniella* Zell. in 60% of examined insects the simultaneous infections with *Leidyana ephestiae* Daviault and *Mattesia dispora* Naville were observed (Fig. 194).

In populations of *Geotrupes* spp. in Białowieża and Gola from 15 to 30% of insects were simultaneously infected with eugregarine *Didymophyes paradoxa* Stein and a microsporidian *Plistophora* sp. (Fig. 195).

Tribolium confusum Duval was frequently infected with eugregarine *Gregarina minuta* Ishii and a coccidian *Adelina tribolii* Bhatia (Fig. 196).

The mechanism of simultaneous infection with two or more parasites and the course of such infection are not well known and they are one of the main gaps in the invertebrate pathology (V a g o 1959). The problem of interrelations between various pathogens in one insect host is of main interest for invertebrate pathology (L i p a 1966 a) and is broadly considered in our current investigations.

Host specificity of studied gregarines

The known parasitological rule formulated by F a h r e n h o l z 1913 indicates that when a parasite or related species of parasites infest various hosts then we can conclude about the phylogeny and phylogenic relationships between host species and their parasites. Accordingly, the host specificity of parasites is very important in studying the evolution of their hosts.

Out of several categories of host specificity only some may be applied in the studies of gregarines. These specifities are: ecological, physiological, intraspecific, and topical.

The host specificity of gregarines was discussed by F o e r s t e r 1938 b, T h e o d o r i d e s 1955 and S t a m m e r 1957. To avoid unnecessary repetition the general discussion will be limited to minimum.

As there are no experimental studies on host specificity among gregarines we conducted a few tests using gregarines of stored product pests as material:

Leidyana ephestiae Daviault from *Ephestia kühniella* Zell.

Mattesia dispora Naville from *Ephestia kühniella* Zell.

Gregarina minuta Ishii from *Tribolium confusum* Duv.

Gregarina steini Berndt from *Tenebrio molitor* L.

Gregarina cuneata Stein from *Tenebrio molitor* L.

In the course of some years mixed laboratory cultures of the above mentioned insects have been established by placing 10 to 30 insects of two or three species together. These specimens were taken from cultures heavily infected with parasites. When the gut contents and tissues of *Tenebrio molitor* and *Tribolium confusum* were examined under the microscope, spores of schizogregarine *Mattesia dispora* were observed in the gut, but no developmental stages and infection occurred. Negative results were also obtained at cross infections with eugregarines. This problem is still the object of our studies and thorough results of cross-infectivity tests will be published elsewhere.

The cases of narrow host specificity of gregarines are quite numerous. This is apperently caused by the fact that not all host species are suitable for the development of gregarines. L e g e r et D u b o s c q 1913 observed, that sporozoites of *Porospora* sp., which naturally parasitize the *Mollusca* and *Crustacea*, become degenerated in the organism of an accidental host.

There are, however, many examples showing that one gregarine infects two or more hosts. We have observed such cases during our work. For example *Gregarina coccinellae* sp.n. parasitize *Coccinella septempunctata* L.

and *Hippodamia tredecimpunctata* L., and *Didymophyes paradoxa* Stein parasitizes in three species of *Geotrupes*.

Foerster 1938 b discussing the problem of host specificity among gregarines stated that out of 245 gregarine species known in the year 1938, 158 species were recorded from one host, 44 species from two hosts, and 43 from more than two hosts. Stammer 1957 reported that among eugregarines parasitizing *Oligocheta* and *Arthropoda* 25% of species infect two or more hosts and 7% of species infect hosts belonging to various families or orders. On the other hand, Semans 1941, while analyzing the parasitism of gregarines of *Orthoptera*, stated that there are evidences of host specificity on the level of families and sub-families. The problems of host specificity concerning gregarines of *Coleoptera* were broadly discussed by Theodorides 1955 a.

Summarizing the above we must consider that among gregarines there are species with narrow and broad host-specificity. There is no doubt that many examples of broad host specificity are its exceptional cases or are due to incomplete knowledge of facts which would make them clear and understandable.

Many cases of the so called broad host-specificity may simply result from an incorrect identification of the gregarine species, which in many cases are incompletely described. Therefore, redescriptions of incompletely described gregarines and a careful analysis of their host specificity are necessary. These problems are of great value for the general parasitology and are the object of our broad studies.

IX. Remarks on epizootics of gregarine infections

Way of life of arthropods and occurrence of gregarines

In a well known paper, Dogel 1962 gave an analysis of the relationship between the fauna of parasites and the type of food of hosts. It is a pleasant task to find such interrelations on a large material concerning various groups of hosts and of parasites, and the conclusions drawn by Dogel are convincing. Similar relationships may be also found in a more uniform group e.g. in gregarines.

In fact, when we analyze lists of hosts and their gregarines in papers of Wellmer 1911, Semans 1941, Theodorides 1955 a and of others, as well as in this paper, we can see that not all arthropods are infected by gregarines. Some authors discussed this problem and special attention was given to these questions in Foerster's 1938 b paper.

Environment of the arthropod's life and gregarine infections

When data reported in this paper and in papers of other authors are analyzed some relationships between the way of life of arthropods and their infection by gregarines are clearly evident. First of all, there is a surprisingly high infection of *Diplopoda* and *Chilopoda*, and practically only *Geophilus* spp. was free of infection. Wellmer 1911 also observed that out of four studied myriapods three species were found to be hosts of gregarines and only *Geophilus* sp. was free of infection.

The number of *Diplopoda* and *Chilopoda*, studied by Wellmer 1911 and in the course of this investigotion, is not very large, but, at any rate, it

indicates that gregarines are very frequently observed among millipedes and centipedes. This is due to the fact that these arthropods live in the soil or leaf litter. In such environment cysts of gregarines can easily survive and be swallowed by healthy individuals. The spread of parasites and the infection of hosts are favored by the great density of these arthropods e.g. larvae and adults of *Orthomorpha gracilis* Koch frequently cover the soil in greenhouses with a thick layer.

The same conclusions may be drawn when analyzing the occurrence of gregarines among insects. A frequent and high infection level is striking among coprophages. The following species infected with gregarines were studied from this group of insects: *Aphodius depressus* Kug., *Ontophagus fracticornis* Preyssl., *Geotrupes stercorarius* L., *G. vernalis* L., *G. stercorosus* Scriba. Excrements of animals, especially of larger mammals, are inhabited by a number of insects, which develop in them in great density. Under such favorable conditions gregarines are easily transmitted from diseased to healthy individuals and the infection level is very high.

Another group of arthropods frequently infected by gregarines are soil insects e.g. *Scarabaeidae*. In the investigated population of *Amphimallon solstitialis* L. the maximum infection level was 26% (142 examined insects).

Foerster 1938 b, Semans 1941 and others give more information on the relations between the environment of arthropods' life and the infection with gregarines. Semans 1941 observed that orthopterans inhabiting environments with rich vegetation were more frequently infected than those inhabiting other biotopes.

Foerster 1938 b stressed, that the more frequent and higher infection of insects inhabiting humid environments is due to the fact that under such circumstances the cysts of parasites have better conditions for maturation than in sunny places. In fact, aquatic arthropods e.g. *Gammaridae* and *Trichoptera* are frequently infected with gregarines.

Especially high and frequent cases of gregarine infections are observed among insects feeding on stored food products. We studied the following insects from this group: *Ephestia kühniella* Zell., *Tribolium confusum* Duv. and *Tenebrio molitor* L. An analysis of literature also gives evidences that this group of insects is very frequently infected by a variety of protozoans, and that the level of infection is very high. This is due to a high density of insects and individuals of various generations living together, and to good conditions for maturation of cysts and spores.

However, there are known species and groups of arthropods which though living under favorable conditions are not infected with gregarines. Many authors noticed this phenomenon, and it was discussed by Foerster 1938 b.

During our investigations we have examined a number of species of bark beetles (*Scolytidae*) and ants (*Formicidae*). The bark beetles live in humid environment and several generations live parallelly. It would seem, therefore, that they should be frequently infected with gregarines. However, in spite of our extensive examinations, we have only found *Ips typographus* L. infected with eugregarine *Gregarina typographi* Fuchs. The examined individuals of other species were always healthy. Gregarines were not found among ants we studied during our investigation. The same refers to honey bees (*Apis mellifera* L.). There are also known insects belonging to the group

of stored product pests which have not been recorded as hosts for gregarines and other protozoans e.g. grain weevils (*Calandra* spp.) and bean and pea weevils (*Bruchidae*).

However, when all data available for gregarines of insects are analyzed, we can easily see that most facts indicate a close relationship between the life environment of arthropods and their infection with gregarines. We can suppose, therefore, that these deviations are caused by insufficient knowledge and apparently further researches will fill these gaps. Our studies of a gregarine infection of larvae of a lepidopteran *Phryganidia californica* Packard may serve as an example of necessary revision of our older views (Lipa and Martignoni 1968).

According to Schneider 1875 and Foerster 1938 b we cannot expect gregarine infections among insects feeding on leaves as well as in larvae of *Lepidoptera*. The finding of gregarines, therefore, in larvae of *P. californica* which feed on leaves of the Californian oak in the dry Californian climate is of great interest. It means that cysts can survive the radiation of the sun. In fact, the wall of the cyst is very thick and protects the spores against destruction well.

In many cases, the occurrence of gregarines or their absence in some insects, if this does not fit the general rule, must be considered as a result of several factors e.g. kind of food, phylogeny, pH of gut, etc.

Food of arthropods and gregarine infections

Schneider 1875 stated that among insects feeding on leaves and pollen of plants gregarines should not be expected. This was partially corrected by Foerster 1938 b who explained it as a result of destruction of cysts on parts of plants exposed to sun radiation. This eliminates the parasite from the environment and such insects are rarely or not at all infected.

When lists of insects having gregarines are checked one can easily see that flying insects e.g. adults of *Lepidoptera*, parasitic *Hymenoptera, Diptera, Odonata* and others were not recorded till now as hosts for gregarines. This is apparently due to the specific type of feeding, which does not favor gregarine infections. These insects feed on leaves and pollen or suck the blood of animals, that is use food rarely contaminated by infective stages of gregarines.

We known, however, a few cases of gregarine infections among insects feeding on pollen e.g. *Coccinellidae;* with blood — *Culicidae*, and among predaceous insects — *Carabidae*. In case of *Carabidae* the occurrence of gregarines is related to their life habit. They live on the surface of soil in which cysts easily survive.

In some *Culicidae* the occurrence of gregarines in adult insects is due to the transference of these parasites from larval forms to adult insects.

Among *Coccinellidae*, according to Foerster 1938 b, gregarines occur only in beetles and are not recorded in larval forms. In fact, in our research we observed gregarines only in adults, while larvae were free of infection. Gregarines were also noted only in adults of *Chrysomela polita* L. and *Lagria hirta* L.

While looking for relationships between food and occurrence of gregarines special attention should be given to the problem of changes in food of larval and adult forms of arthropods. In centipedes and millipedes larvae feed on

the same food as adults and therefore one can expect that there is no difference between the gregarine fauna of larvae and adults. In fact, data collected during our investigations indicate that there is no difference in the gregarine species infecting larvae and adults of *Chilopoda* and *Diplopoda*.

A similar phenomenon is observed in hemimatobolic insects e.g. *Blatta orientalis* L. and *Ectobius lapponicus* L. as their larvae feed on the same food as adults. Larvae and adults of these species are infected with the same gregarines and at the same level.

In holometabolic insects the influence of food on gregarine infections is clearly seen. Among studied insects we can distinguish groups in which larvae and adults live in the same environment and consume the same food e.g. *Carabus* spp., *Tenebrio* spp., *Geotrupes* spp., *Tribolium* spp. The gregarine fauna of larvae and adults of this group of insects is also identical.

However this phenomenon can be different in insects that after the metamorphosis change the environment they inhabited as larvae, as with the change of environment a change of food and a reaction of gut contents is frequently connected. These changes can have a various range and a different influence on the gregarine fauna of such insects:

1. changes are neutral for gregarines and therefore the fauna of gregarines and their number is not affected;
2. changes which affect the gregarine fauna e.g. larvae of *Agrion* spp. are infected with *Actinocephalus sieboldi* (Kölliker) while the adults with *Menospora polyacantha* Leger (F o e r s t e r 1938 b);
3. changes are so significant that gregarine fauna of larvae is eliminated and is not transmitted to adults e.g. *Melolontha melolontha* L.;
4. due to changes, there are favorable conditions for gregarines and therefore, although larvae are free from infection, adults become infected e.g. *Lagria hirta* L. and *Coccinellidae*.

Our knowledge of these questions is very fragmentary and studies are conducted to get more information on these problems.

Analogically, lack or excess of food may influence the occurrence of gregarines in arthropods, just as the kind of food does. S e m a n s 1941 noticed, that well fed *Acrididae* were more frequently infected with gregarines than those suffering hunger. This is perhaps due to physiological changes or, what is more probable, insects consuming more food had greater chances to become infected with gregarines. L e o n o v a 1937 found that starvation of larvae and beetles of *Tribolium confusum* Duv. eliminated *Gregarina polymorpha* Stein from their guts.

In literature there is little information on the relationship between the occurrence of gregarines and the reaction (pH) of their gut. S e m a n s 1941 explained that the lack of gregarines in *Tettigoniidae* is due to the acid reaction of their gut (pH = 5.6), but *Acrididae* which have pH = 6.0 are very frequently infected with gregarines.

G ö h r e 1943 found that that location of various gregarine species in the gut of *Tenebrio molitor* depended on pH; *Gregarina cuneata* Stein is located in pars cardiaca where pH is from 4.4 to 5.8; *G. polymorpha* (Hammerschmidt) inhabits the ventriculous part where pH is from 6.3 to 7.5; and *G. steini* Berndt parasitizes the part where Malpighian tubules have their exits and where pH is from 5.5 to 8.2.

Metamorphosis of arthropods and gregarine infections

Changes in the fauna of gregarines or in their life cycle connected with the metamorphosis of arthropods were partially discussed in the preceding chapter while discussing changes in the environment of the lives of larvae and adults.

The growth and development connected with the changes of larval stages of myriapods and of insects with hemimetabolic development e.g. *Blatta* spp. do not cause changes in gregarine fauna. On the other hand, such changes are noticeable in insects with holometabolic development.

Fedotova-Vinogradova 1924 found close relationship between the development of gregarine *Diplocystis phryganeae* F.—V. and the development of its host *Phryganea grandis* L. When the host insect underwent metamorphosis gamonts of the gregarine associated and formed cysts. In adult insects, therefore, only cysts were observed.

In the course of our studies such a phenomenon has not been observed. Though dissecting a great number of pupae of *Ephestia kühniella* Zell. we have not observed that gamonts of *Leidyana ephestiae* Daviault would incyst in mass. The ratio of cysts and gamonts was the same in larvae as in pupae.

Geographical distribution of studied gregarines

The distribution of gregarines is a problem that was given very little attention and consequently the data are fragmentary and incomplete.

It is a known rule in parasitology, that the distribution of a parasite coincides with the distribution of its host in general. We know many cases, however, that the parasite occurs in a lesser area than its host. On the other hand, there are cases that thanks to parasitizing two or more hosts the parasite is distributed much wider than each of its hosts.

Several examples of this kind can be met among gregarines. The *Gregarina blattarum* Siebold studied by us occurs everywhere, where their host *Blatta* spp., *Blatella* spp. and *Periplaneta* spp. distributed. Eugregarine *Leidyana ephestiae* Daviault and schizogregarine *Mattesia dispora* Naville were noted in all regions of the world where their host *Ephestia kühniella* Zell. occurs. In general, therefore, it may be stated, that gregarines parasitizing synanthropic arthropods are cosmopolitan just as their hosts are. This statement can be extended to other species, too. For example I observed *Gregarina coccinellae* sp.n. in *Coccinella septempunctata* L. in Poland and in USSR (Lipa i Semjanov 1967), probably the same gregarine was observed by Iperti 1964 in Italy and France.

Stenophora nematoides Leger at Duboscq is the member of group of gregarines which are widely distributed as they parasitize two hosts. This gregarine parasitizes *Strongylosoma pallipes* (Oliver) in Poland while in France (Corsica) *Strongylosoma italicum* Latzel. *Didymophyes minuta* (Ishii) described from *Tribolium confusum* Duv. in Japan was observed in *Tribolium destructor* Uytt. in USSR (Lipa 1966 c).

Studies on the distribution of gregarines has a great theoretic significance, as it allows to find important information on the way of their circulation in

nature and on their hosts. These problems connected with gregarines still need extensive studies. Results of such investigations on gregarines of *Coccinellidae* of Palaearctic and Nearctic are now being prepared by the author.

X. List of gregarines recorded in Poland with their hosts[1]

List of fully identified gregarines

1. *Acanthospora polymorpha* Leger
   Copelatus ruficollis Schall.
2. *Actinocephalus acutispora* Leger
   Silpha sp.
3. *Actinocephalus digitatus* Schneider
   Carabus cancellatus Illig
   Carabus clathratus L.
   Carabus glabratus Payk.
   Carabus nemoralis Mull.
   Pterostichus vulgaris L.
4. *Actinocephalus dujurdini* Schneider
   Lithobius forficatus L.
5. *Actinocephalus dytiscorum* (Frantzius)
   Acilius sulcatus L.
6. *Actinocephalus echinatus* Wellmer
   Harpalus rufipes Dft.
   Platynus assimilis Payk.
   Pterostichus diligens Strm.
   Pterostichus gracilis Dej.
   Pterostichus niger Schall.
   Pterostichus vulgaris L.
7. *Actinocephalus notiophili* Foerster
   Notiophilus biguttatus F.
8. *Actinocephalus parvus* Wellmer
   Cerathopyllidae
9. *Actinocephalus permagnus* Wellmer
   Carabus coriaceus L.
10. *Actinocephalus sieboldii* (Kölliker)
    Agrion puella (L.)
11. *Actinocephalus tipulae* Leger
    Tipula sp.
12. *Ancyrophora balazyi* sp. n.
    Carabus coriaceus L.
13. *Ancyrophora gracilis* Leger
    Abax ater Villers
    Carabus arvensis Hbst.
    Carabus cancellatus Illig
    Carabus glabratus Payk
    Carabus intricatus L.
    Carabus nemoralis Mull.
    Carabus nitens L.
    Carabus ulrichi Germ.
    Pterostichus niger Schall.
    Pterostichus vulgaris L.
    Silpha sp.
14. *Ancyrophora philonthi* sp. n.
    Philonthus laevicollis Boisd.
15. *Ancyrophora stelliformis* Schneider
    Carabus violaceus L.
    Philonthus carbonarius Gyll.
    Pterostichus vulgaris L.
    Staphylinus erthropterus L.
16. *Ancyrophora uleiotae* Foerster
    Rhizophagus nitidulus Fabr.
    Uleiota platata L.
17. *Ancyrophora uncinata* Leger
    Noterus clavicornis Feg.
    Rhanthus exoletus Foerster
18. *Asterophora elegans* Leger.
    Limnophilus flavicornis Fbr.
    Limnophilus griseus L.
    Limnophilus rhombicus L.
    Limnophilus sparsus Curt.
    Stenophylax sp.
19. *Beloides firmus* (Leger)
    Dermestes atomarius Er.
    Dermestes lardarius L.
20. *Bothriopsides claviformis* (Pinto)
    Hyphydrus ovatus L.
21. *Bothriopsides histrio* (Schneider)
    Acilius sulcatus L.
    Agabus sp.
    Colymbetes fuscus L.
    Colymbetes paykulli Er.
    Dytiscus dimidiatus Bergst.
    Dytiscus marginalis L.
    Dytiscus sp.

[1] This list is based on personal investigations of the author and on papers by Wellmer 1911 and Foerster 1938 a, b.

Graphoderes bilineatus Hoppe
Graphoderes zonatus Deg.
Ilybius ater Deg.
Ilybius fenestratus F.
Nartus grapei Gyll.
Rhanthus exoletus For.
Rhanthus notatus F.
Rhanthus pulverosus Steph.

22. *Cnemidospora lutea* Schneider
Glomeris connexa Koch

23. *Coleorhynchus heros* (Schneider)
Nepa cinerea L.

24. *Didymophyes aphodii* Foerster
Aphodius prodromus Brahm.
Aphodius rufus Moll.
Aphodius scrutator Hrbst.
Aphodius sp.
Ontophagus fracticornis Preyssl.
Ontophagus nuchicornis L.

25. *Didymophyes hydrobiina* Foerster
Enochrus frontalis Er.
Hydrobius fuscipes L.

26. *Didymophyes leuckartii* Marshall
Aphodius distinctus Müll.
Aphodius sp.

27. *Didymophyes ontophagi* Foerster
Ontophagus fracticornis Preyssl.

28. *Didymophyes paradoxa* Stein
Geotrupes stercorarius (L.)
Geotrupes stercorosus Scriba
Geotrupes vernalis L.

29. *Didymophyes rotunda* Foerster
Onthophagus ovatus L.

30. *Echinomera hispida* (Schneider)
Lithobius forficatus L.

31. *Echinomera leptoiuli* sp. n.
Leptoiulus proximus (Nemec)

32. *Euspora falax* Schneider
Melolontha melolontha L.
Melolontha sp.

33. *Gamocystis tenax* Schneider
Ectobius lapponicus L.
Ectobius lividus Fbr.

34. *Gigaductus exiguus* Wellmer
Pterostichus niger Schall.

35. *Gregarina acridiorum* Leger
Acrydium bipunctatum L.
Calliptamus italicus L.
Decticus verrucivorus L.
Metrioptera grisea Fbr.
Oedopodida coerulescens L.
Stenobothrus biguttulus L.
Stenobothrus haemorrhoidalis Charp.
Stenobothrus lineatus Panz.
Stenobothrus nigromaculatus H.—S.
Stenobothrus pullus Phill.

36. *Gregarina alphitophagi* Foerster
Alphitophagus bifasciatus Say

37. *Gregarina amarae* Frantzius
Amara familiaris Dft.
Harpalus rufipes Dej.
Harpalus rufitarsis Dft.

38. *Gregarina anthici* Kamm.
Formicomus pedestris Rossi

39. *Gregarina atomariae* Foerster
Atomaria sp.

40. *Gregarina blattarum* Siebold
Blatta orientalis L.
Periplaneta americana L.

41. *Gregarina byrrhina* Foerster
Byrrchus pilula Illig.
Simplocaria semistriata Fabr.

42. *Gregarina cestiforme* Foerster
Rhagio sp.

43. *Gregarina cetoniae Foerster*
Cetonia sp.
Osmoderma eremita Scopoli

44. *Gregarina chrysomelae* sp. n.
Chrysomela polita L.

45. *Gregarina cis* Foerster
Cis boleti Scop.
Cis micans Fabr.

46. *Gregarina clavata* Kolliker
Ephemera vulgata L.
Cleon sp.

47. *Gregarina coccinellae* sp. n.
Coccinellae septempuctata L.
Exochomus quadripustulatus L.
Hippodamia tredecimpunctata L.
Tytthaspis sedecimpunctata L.

48. *Gregarina coelomica* Foerster
Pyrochroa coccinea L.

49. *Gregarina cuneata* Stein
Alphitobius ovatus Hrbst.
Tenebrio molitor L.

50. *Gregarina cylindrica* Foerster
Cucujidae
Ditoma crenata Fabr.

51. *Gregarina endomychi* Foerster
Endomychus coccineus L.
52. *Gregarina exiguus* (Wellmer)
Amara similata Gyll.
Pterostichus vulgaris L.
53. *Gregarina forficulae* sp. n.
Forficula auricularia L.
54. *Gregarina harpali* sp. n.
Harpalus aeneus L.
55. *Gregarina ipidiae* Foerster
Ipidia quadrimaculata Queens.
56. *Gregarina hypophloei* sp. n.
Hypophloeus unicolor Pill.
57. *Gregarina laemophloei* Foerster
Laemophloeus ferrugineus Steph.
58. *Gregarina latifolia* Braune
Niptus hololeucus Falderm.
59. *Gregarina laucornetensis* (Schneider)
Dryops auriculatus Geoffr.
60. *Gregarina longa* (Leger)
Tipulidae
61. *Gregarina lonirostris* (Leger)
Thanasimus formicarius L.
62. *Gregarina macrocephala* (Schneider)
Liogryllus campestris L.
63. *Gregarina macrocephalia* sp. n.
Aphodius depressus Kug.
64. *Gregarina malachiidarum* Foerster
Anthocomus coccineus Schall.
Axinotarsus pulicarius Fbr.
Axinotarsus ruficollis Oliv.
Malachius bipustulatus L.
65. *Gregarina minuta* Ishii
Tribolium confusum Duv.
66. *Gregarina munieri* (Schneider)
Chrysomela cerealis L.
Chrysomela coerulans Scriba
Chrysomela graminis L.
Chrysomela polita L.
Chrysomela styphylea L.
Chrysomela violacea Mull.
Galeruca tanaceti L.
Galeruca rustica Schall.
67. *Gregarina mystacidarum* Frantzius
Limnophilus flavicornis Fbr.
Limnophilus (ignarus Hag.?)
68. *Gregarina nemurae* Foerster
Leuctra sp.
Nemura sp.
69. *Gregarina omalina* Foerster
Cucujidae
Ditoma crenata Fabr.
Heperothops dissimilis Grav.
Omalium rivulare Payk.
70. *Gregarina ovata* Dufour
Forficula auricularia L.
71. *Gregarina plegaderi* Foerster
Plegaderus saucius Er.
72. *Gregarina polyaulia* Wellmer
Amara aulica Panz.
Amara familiaris Dftsch.
Amara similata Gyll.
Dromius longiceps Dej.
Harpalus affinis Schrank
Harpalus aeneus F.
Harpalus ruficornis F.
73. *Gregarina ptini* Foerster
Ptinus fur L.
Ptinus latro Fbr.
Ptinus (pilosus Müll.?)
74. *Gregarina polymorpha* (Hammerschmidt)
Tenebrio molitor L.
75. *Gregarina rostrata* Wellmer
Lagria hirta L.
76. *Gregarina ruszkowskii* sp. n.
Coccinella septempunctata L.
Coccinella quinquepunctata L.
Coccinella quattuordecimpunctata L.
77. *Gregarina similis* Foerster
Amphigerontia bifasciata (Latr.)
Anthicus gracilis Panz.
Notoxus monocerus L.
Soronia grisea L.
Soronia punctatissima Illig.
Telmapthophilus caricis Oliv.
78. *Gregarina soroniae* Foerster
Soronia grisea L.
Soronia punctatissima Illig.
79. *Gregarina steini* Berndt
Tenebrio molitor L.
80. *Gregarina typographi* Fuchs
Ips typographus L.
81. *Gregarina vulgata* L.
Ephemera vulgata L.
82. *Gregarina wellmeri* Zwetkow
Allacma fusca L.

Tetrodontophora bielanensis Waga

83. *Haylospora psocorum* (Siebold)
Graphopsocus cruciatus (L.)
Mesopsocus unipunctatus Müll.
Lachesilla quercus (Klbe.)
Psocus quadripunctatus Fabr.

84. *Hoplorhynchus oligacanthus* (Siebold)
Calopteryx splendens (Harris)

85. *Iorella wegoreki* sp. n.
Dytiscus marginalis L.

86. *Legeria agilis* (Schneider)
Ilybius fenestratus F.
Ilybius subaeneus Er.

87. *Leidyana ephestiae* Daviault
Ephestia kühniella Zell.

88. *Leidyana gryllorum* (Cuenot)
Liogryllus campestris L.

89. *Mattesia dispora* Naville
Ephestia kühniella Zell.

90. *Menospora polyacantha* Leger
Agrion puella (L.)
Agrion pulchellum (Vanderlind)
Enallgma cyathigerum (Charp.)
Erythroma najas (Hansem.)
Lestes sponsa Hansem.
Lestes sp.
Platychemis pennipes (Pallas)
Sympecma fusca (Vanderlind).

91. *Monocystis legeri* Blanchard
Pterostichus niger Schall.

92. *Pileocephalus heerii* (Köll.)
Leptocerus aterrimus Steph.

93. *Pyxinia anobii* Vincent
Stegobium paniceum L.

94. *Pyxinia frenzeli* Laveran et Mesnil
Attagenus pellio L.

95. *Pyxinia möbuszi* Leger et Duboscq
Attagenus pellio L.

96. *Pyxinia rubecula* Hamm.
Dermestes vulpinus Fbr.

97. *Rhopalonia lithobii* sp. n.
Lithobius calcaratus Koch

98. *Sciadospora phalangi* (Leger)
Opilio grossipes Herbst.

99. *Sphaerocystis hydrophili* Foerster
Hydrophilus caraboidaes L.

100. *Steinina diaperis* Foerster
Diaperis boleti L.

101. *Steinina ovalis* (Stein)
Tenebrio molitor L.

102. *Stenophora caudata* sp. n.
Chromatoiulus projectus Koch

103. *Stenophora juli* (Frantzius)
Schizophyllum sabulosum (L.)

104. *Stenophora julimarginati* (Leidy)
Schizophyllum sabulosum (L.)

105. *Stenophora nematoides* Leger et Duboscq
Strongylosoma pallipes (Oliver)

106. *Stenophora orthomorphae* sp. n.
Orthomorpha gracilis (Koch)

107. *Stenophora poznanensis* sp. n.
Orthomorpha gracilis (Koch)

108. *Stenophora sarmatiuli* sp. n.
Sarmatiulus vilnensis (Jawłowski)

109. *Stenophora schizophylli* sp. n.
Schizophyllum sabulosum (L.)

110. *Stenophora strongylosomae* sp. n.
Strongylosoma pallipes (Oliver)

111. *Stenophora uncigeri* sp. n.
Unciger foetidus Koch

112. *Stictospora provincialis* Leger
Amphimallon solstitialis L.
Melolontha sp.

113. *Stylocephalus brevirostris* (Kölliker)
Hydrous aterrimus L.

114. *Stylocephalus carabi* sp. n.
Carabus glabratus L.

115. *Stylocephalus eledonae* Foerster
Eledona agaricola Hrbst.
Mycetophagus piceus Fabr.
Penthaphyllus testaceus Hellw.

116. *Stylocephalus oblongatus* (Hammerschmidt)
Opatrum sabulosum L.

117. *Stylocystis ensifera* (Ellis)
Oxytelus tetracarinatus Block

118. *Stylorhynchus longicollis* Stein
Blaps mortisaga L.

119. *Taeniocystis parva* Foerster
Forcipomyia sp.

List of gregarines identified only to genus

Actinocephalus sp.
Cordulea aenea (L.)
Gomphus vulgatissimus (L.)
Sialis sp.
Didymophyes sp.
Sphaeridium scaraboides L.
Gregarina spp.
Agathidium seminulum L.
Agathidium sp.
Cerylon ferrugineum Steph.
Cerylon histeroides Fbr.
Cleon sp.
Corixa sp.
Dacne bipustulata Thunbg.
Dolichopodidae
Limnobiidae
Mycetaea hirta Mrsh.
Mycetophagus quadripustulatus L.
Niptus holoecus Fald.
Phaedon cochleariae F.
Phyllobius piri L.
Platystethus arenarius Geoffr.
Plegaderus saucius
Rhopaldonthus fronticornis Panz.
Telmatophilus caricis Oliv.
Triplax aenea Schall.

List of arthropods in which gregarines were recorded but were not identified even to genus

Anthicus gracilis Panz.
Cercyon convexiusculus Steph.
Cychrus rostratus L.
Notoxus monocerus L.
Sialis sp.
Tritoma bipustulata Fbr.
Ula sp.

XI. Summary and conclusions

During these studies 46 gregarine species were recorded from 2 species of *Chilopoda*, 8 species of *Diplopoda* and 34 species of *Insecta*. Out of this number 20 gregarines appeared to be new species; besides 1 new genus and 1 new family have been described. 26 species were new for Poland and several new hosts for previously described gregarines were discovered. A total number of recorded gregarines in Poland reaches 119 species.

Gregarines are parasites of arthropods commonly occuring in Poland and infect them in a high percentage. Among infected arthropods there are important agricultural and forest pests, beneficial insects and indifferential species.

Schizogregarines are the most pathogenic parasites as they parasitize intracellularly. However, the histopathological picture of infected tissues by eugregarines is very similar to that caused by schizogregarines. Eugregarines, therefore, can be regarded as important factors of the mortality of their hosts.

On the basis of results of these studies it may be concluded that the pathogenicity of eugregarines depends on: 1. mechanic damage of gut epithelium; 2. physiologic influence, through excretion of metabolites and through toxins in the process of pinocytosis and intracellular or intercellular development of trophozoites in the gut epithelium; 3. the slowing down of the absorption of food and stopping the movement of food in the gut due to the filling of the gut lumen with gregarines; 4. making the port of entry for other microorganisms.

Bacterial septicemia were frequently observed among *Chilopoda, Diplopoda* and *Insecta* heavily infected with gregarines. It indicates that bacteria enter the body cavity of arthropods through openings made by sporozoites or trophozoites of gregarines in the gut epithelium.

Mixed infections that is simultaneous infections of arthropods with two or more parasitic protozoans were frequently observed during these studied. This indicates that special studies of this problem are very urgent in order to explain the type of interrelationships existing between protozoans involved in mixed infections and the kind of joint effect on their hosts.

There is a distinct relationship, with some exceptions, between the way of life of arthropods and their infection with gregarines. Among arthropods living in soil, the leaf litter, stored flour products or among coprophages, the infection with gregarines is extremely frequent and high; the same concerns aquatic insects. Such environments secure better survival of the cysts and a better spread of parasites in the population of their hosts. Flying and parasitic insects are very rarely infected with gregarines. It is very interesting to find that social insects like ants, are not known as hosts for gregarines, and bees and bark beetles are very rarely infected with gregarines.

The influence of metamorphosis on parasitism of gregarines requires special studies. Among *Diplopoda, Chilopoda* and *Insecta-hemimetabola,* the fauna of gregarines of larval and adult stages is the same. In the case of *Insecta-holometabola* inhabiting as larvae and adults the same environment (e.g. stored food products) the gregarine fauna is also the same. On the other hand, the fauna of gregarines of adult insects, that leave the environment inhabited during the larval development, shows significant changes. In the case of *Leidyana ephestiae* Daviault it was not found that pupation of *Ephestia kühniella* Zell. caused associating and incystation of gamonts.

While analyzing the geographic distribution of gregarines three groups may be distinguished: 1. cosmopolitan species e.g. *Leidyana ephestiae* Daviault and *Gregarina blattarum* Siebold that occur everywhere where their hosts occur; 2. gregarines with wide distribution thanks to parasitizing two or more host arthropods, occupying different regions e.g. *Stenophora nematoides* Leger et Duboscq; 3. gregarines noted locally although their hosts are widely distributed.

STRESZCZENIE

Badano 46 gatunków gregaryn pasożytujących w 2 gatunkach *Chilopoda,* 8 gatunkach *Diplopoda* i 34 gatunkach *Insecta.* W tej liczbie opisano 20 gatunków nowych, oraz 1 nowy rodzaj i nową rodzinę. Stwierdzono 26 gatunków nowych dla Polski oraz uzupełniono listy żywicieli dla znanych uprzednio gregaryn. Łącznie zanotowano w Polsce 119 gatunków gregaryn.

Gregaryny są pospolicie występującymi pasożytami stawonogów w Polsce i zarażają je w znacznym procencie. Wśród zarażanych stawonogów są ważne szkodniki rolnicze i leśne, owady pożyteczne i gatunki obojętne.

Schizogregaryny, jako pasożyty wewnątrzkomórkowe, odznaczają się największą chorobotwórczością. Jednakże histopatologiczny obraz tkanek przy inwazjach gregaryn właściwych (*Eugregarinaria*) jest bardzo zbliżony. Z tego względu należy uznać również eugregaryny za ważny czynnik śmiertelności w populacjach ich żywicieli.

Na podstawie uzyskanych wyników stwierdzono, że chorobotwórczość eugregaryn polega na: 1. mechanicznym uszkodzeniu nabłonka jelita; 2. fizjologicznym wpływie, poprzez wydzielanie metabolitów i toksyn w procesie pinocytozy, w okresie życia trofozoitów w nabłonku jelita, wskazują na to obszerne jamy w tkankach żywiciela wokół pasożyta; 3. utrudnianiu przyswajania pokarmu oraz jego przesuwania się w jelicie wskutek wypełniania światła przewodu pokarmowego; 4. tworzeniu wrót infekcji dla innych grup mikroorganizmów.

Septicemie bakteryjne były bardzo często obserwowane u krocionogów, pareczników i owadów silnie zarażonych przez gregaryny. Wskazuje to na przenikanie bakterii do jamy ciała stawonogów przez otwory powstałe w wyniku uszkadzania nabłonka przez sporozoity lub trofozoity gregaryn.

Mieszane inwazje czyli jednoczesne zarażanie żywicieli przez dwa lub więcej pasożytnicze pierwotniaki było często obserwowanym zjawiskiem. Wskazuje to na potrzebę podjęcia badań celem wyjaśnienia jakiego rodzaju jest wzajemne oddziaływanie pierwotniaków na swoich żywicieli przy łącznym zarażeniu.

Istnieje wyraźna, choć nie pozbawiona wyjątków, zależność między sposobem życia stawonogów a zarażaniem ich przez gregaryny. Wśród stawonogów żyjących w glebie, ściółce, produktach mącznych lub u koprofagów zarażenie przez gregaryny jest wyjątkowo częste i wysokie. Podobnie jest także u owadów wodnych. Tego rodzaju środowiska zapewniają bowiem lepsze przeżywanie cyst oraz kontaktowanie się zarażonych żywicieli ze zdrowymi stawonogami. Natomiast owady pasożytnicze oraz latające są rzadkimi żywicielami gregaryn. Jest interesujące, że żyjące w dużym zagęszczeniu mrówki nie są zarażone przez gregaryny, a wśród kornikόw gregarynozy są bardzo rzadkie i notowane tylko u *Ips typographus*.

Wpływ metamorfozy na zarażenie przez gregaryny wymaga dokładnych badań. U *Chilopoda*, *Diplopoda* i *Insecta-hemimetabola*, parazytofauna larw i postaci dorosłych jest jednakowa. Również u owadów z zupełnym przeobrażeniem, w przypadku zamieszkiwania tych samych środowisk przez larwy i owady dorosłe, skład ich parazytofauny jest jednakowy. Natomiast u stawonogów, które jako imagines opuszczają środowisko zamieszkiwane w okresie rozwoju larwalnego, skład gregaryn ulega zmianie. W przypadku *Leidyana ephestiae* Daviault nie stwierdzono aby przepoczwarczenie się gąsienic jej żywiciela mklika mącznego (*Ephestia kühniella* Zell.) pociągało za sobą incystowanie się gamontów.

Na podstawie danych o geograficznym rozprzestrzenieniu można wyróżnić trzy grupy gregaryn: 1. gatunki kosmopolityczne np. m. in. *Leidyana ephestiae* Daviault i *Gregarina blattarum* Siebold występują wszędzie tam, gdzie występują ich żywiciele; 2. gatunki o szerokim zasięgu dzięki temu, że zarażają dwu lub więcej żywicieli, których zasięgi nie zachodzą na siebie np. m. in. *Stenophora nematoides* Leger et Duboscq; 3. gatunki notowane lokalnie chociaż ich żywiciele są gatunkami szeroko rozprzestrzenionymi.

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EXPLANATION OF PLATES I—XLIII

Figs. 1—2. *Stenophora caudata* sp. n. from *Chromatoiulus projectus* Koch
1—2: Gamonts (×300)
Figs. 3—4. *Stenophora juli* (Frantzius) from *Schizophyllum sabulosum* (L.)
3: Gamont (×300)
4: Protomerite and part of deutomerite (×300)
Figs. 5—7. *Stenophora julimarginati* (Leidy) from *Schizophyllum sabulosum* (L.)
5: Trophozoite (×160)
6—7: Gamonts (×400 and ×200)
Figs. 8—10. *Stenophora nematoides* L. et D. from *Strongylosoma pallipes* (Oliver)
8—9: Gamonts (×120)
10: Part ef epimerite (E), protomerite (P) and part of deutomerite (D) (×300)
Figs. 11—18. *Stenophora orthomorphae* sp. n. from *Orthomorpha gracilis* (Koch)
11—15: Subsequent stages in the maturation of trophozoites (×300)
16—18: Gamonts; notice high motility of deutomerite and solid shape of protomerite (×300)
Figs. 19—22. *Stenophora poznanensis* sp. n. from *Orthomorpha gracilis* (Koch)
19—20: Oval trophozoites (×200)
21—22: Gamonts (×200)
Figs. 23—25: *Stenophora sarmatiuli* sp. n. from *Sarmatiulus vilnensis* (Jawłowski)
23—24: Gamonts (×200 and ×60 respectively)
25: Cyst (×150)
Figs. 26—32. *Stenophora schizophylli* sp. n. from *Schizophyllum sabulosum* (L)
26—27: Trophozoites (×200)
28: Gamont (×200)
29: Protomerite and part of deutomerite (×600)
30—32: Gut of the host damaged by the parasite: J — epithelium of the intestine, T — trophozoites, G — gamonts, N — nucleus of the gamont with single karyosome (×300 to ×600)
Figs. 33—36. *Stenophora strongylosomae* sp. n. from *Strongylosoma pallipes* (Oliver)
33—35: Gamonts (×200)
36: Mal-formed gamont (×230)
Figs. 37—39. *Stenophora uncigeri* sp. n. from *Unciger foetidus* Koch
37—38: Gamonts (×200)
39: Cyst (×80)
Figs. 40—44. *Cnemidospora lutea* Schneider from *Glomeris connexa* Koch
40: Gamonts (×80)
41: Epimerite (E), protomerite (P) and part of deutomerite (D) (×250)
42: Typical protomerite and part od deutomerite (×250)
43: Group of normal and mal-formed gamonts (×80)
44: Gut of the host damaged by the parasite (×20)
Figs. 45—46. *Echinomeria leptoiuli* sp. n. from *Leptoiulus proximus* (Nemec)
45: Gamont (×200)
46: Gamont at the gut epithelium (×100)
Fig. 47. *Actinocephalus dujardini* Schneider from *Lithobius forficatus* L.
47: Gamont (×200)
Figs. 48—51. *Echinomera hispida* (Schneider) from *Lithobius forficatus* (L.)
48—49: Gamonts (×200)
50: Gamont with visible nucleus (×200)
51: Trophozoite of the parasite in the gut wall of the host (×150)
Fig. 52. *Rhopalonia lithobii* sp. n. from *Lithobius calcaratus* Koch
52: Gamonts (×250)
Fig. 53. *Gamocystis tenax* Schneider from *Ectobius lapponicus* L.
53: Association of gamonts (×200)
Figs. 54—60. *Gregarina blattarum* Siebold from *Blatta orientalis* L.
54—56: Trophozoites (×300)
57: Mature gamont with visible nucleus (×200)
58: Gamonts in association (×200)
59: Young cyst with signs of fusion of two gamonts (×100)
60: Mature cyst (×100)

Figs. 61—66. *Gregarina chrysomelae* sp. n. from *Chrysomela polita* L.
61: Young gamont with visible nucleus (×300)
62: Mature gamont (×200)
63: Gamont in the gastric caecum of the gut of host (×100)
64: Gut of the host heavily infected with gregarines seen as dark spots (×40)
65: Gamonts seen in the gut of the host (×100)
66: Three gamonts in association (×100)
Figs. 67—71. *Gregarina cocinellae* sp. n. from *Coccinella septempunctata* L.
67 and 69: Gamonts in associations (×200 and ×100 respectively)
68: Gamont (×300)
70: Cyst with signs of fusion of two gamonts (×100)
71: Chain of spores (×900)
Figs. 72—77. *Gregarina cuneata* Stein from *Tenebrio molitor* L.
72: Gamonts of *G. cuneata* (GC) and *G. steini* Berndt (GS) in associations (×80)
73: Protomerite and deutomerite of the primite (×320)
74: Deutomerite (D) of the primite and protomerite (P) and deutomerite (D) of the satellite (×320)
75: Trophozoites (T) and gamonts (G) in the gut of the host (×50)
76: Cross section through the gut of *T. molitor* with visible gamonts and trophozoites (×50)
77: Cyst at the gut epithelium of the host (×300)
Figs. 78—79. *Gregarina forficulae* sp. n. from *Forficula auricularia* L.
78—79. Gamont of *G. forficulae* (GF) and *G. ovata* Dufour (GO) in associations (×40 and ×80 respectively)
Fig. 80. *Gregarina harpali* sp. n. from *Harpalus aeneus* L.
80: Gamont with visible nucleus (×160)
Figs. 81—82. *Gregarina hypophloei* sp. n. from *Hypophloeus unicolor* Pill.
81: Four and two gamonts in associations (×120)
82: Gamont (×200)
Figs. 83—85. *Gregarina macrocephalia* sp. n. from *Aphodius depressus* Kug.
83: Gamonts (×120)
84: Gamont in gastric caecum (×120)
85: Gut of the host heavily infected with the parasite seen as dark spots (×40)
Figs. 86—88. *Gregarina minuta* (Ishii) from *Tribolium confusum* Duv.
86: Gamonts in association (×100)
87: Cyst and gamonts (×100)
88: Gamonts in association (×100)
Figs. 89. *Gregarina munieri* (Schneider) from *Chrysomela coerulans* Scriba
89: Gamonts in associations (×80 and ×200)
Figs. 90—92. *Gregarina ovata* Dufour from *Forficula auricularia* L.
90: Gamonts in association (×50)
91: Satellite from the broken association; P — protomerite, D — deutomerite (×150)
92: Primite (PR) and satellite (SA) from broken association (×150)
Figs. 93—98. *Gregarina rostrata* Wellmer from *Lagria hirta* L.
93—95: Gamonts in associations (×120)
96: Cyst (×100)
97—98: Gamonts (G) and trophozoites (T) in the gut of the host (×200)
Figs. 99—100. *Gregarina ruszkowskii* sp. n. from *Coccinella quinquepunctata* L.
99—100: Gamonts in multiple associations (×150 and ×300 respectively)
Figs. 101—103. *Gregarina steini* Berndt from *Tenebrio molitor* L.
101—102: Gamonts in association (×150)
103: Trophozoites in the gut wall of the host (×200)
Figs. 104—106. *Gregarina typographi* Fuchs from *Ips typographus* L.
104—105: Gamonts (G) and trophozoites (T) (×100)
106: Gamonts in association (×200)
Figs. 107. *Euspora fallax* Schneider from *Melolontha melolontha* L.
107: Cyst (×100)
Figs. 108—114. *Leidyana ephestiae* Daviault from *Ephestia kühniella* Zell.
108—109: Trophozoites: E — epimerite, P — protomerite, D — deutomerite (×200)
110: Cyst (×100)

111—113: Gamonts: In Fig. 113 nuclei are seen in gamonts as white spots (×40 to ×120)
114: Gamonts in the gut lumen of the host (×120)

Figs. 115—118. *Didymophyes ontophagi* Foerster from *Ontophagus fracticornis* Preyssl.
115—117: Gamonts in gastric caeca (×120)
118: Gut of the host infected with gregarines seen as dark spots (×80)

Figs. 119—120. *Didymophyes paradoxa* Stein from *Geotrupes stercorosus* Scriba
119: Gamonts in association (×200)
120: Cyst (×300)

Figs. 121—125. *Bothriopsides histrio* (Schneider) from *Dytiscus marginalis* L.
121—122: Trophozoites: E — epimerite, P — protomerite, D — deutomerite (×50 and ×120 respectively)
123—125: Gamonts (×120 to ×450)

Fig. 126. *Coleorhynchus heros* (Schneider) from *Nepa cinerea* L.
126: Trophozoite at the gut wall (×160)

Fig. 127. *Pyxinia frenzeli* L. et M. from *Attagenus pellio* L.
127: Gamont (×200)

Figs. 128—130. *Stictospora provincialis* Leger from *Amphimallon solstitialis* L.
128: Cross section through the gut of the host infected with the parasite: I — wall of the intestine, G — gamonts, FB — fat body, MT — Malpighian tubules (×50)
129: Gamonts (×40)
130: Gamont at the wall of the gut with visible nucleus with karyosomes (×200)

Figs. 131—137. *Ancyrophora balazyi* sp. n. from *Carabus coriaceus* L.
131—134: Trophozoites; E — epimerite, P — protomerite, D — deutomerite (×120). In Fig. 134 nuclei are seen.
135: Cyst (×20)
136—137: Gamonts; E — part of epimerite, P — protomerite, D — deutomerite (×200)

Figs. 138—139. *Ancyrophora philonthi* sp. n. from *Philonthus laevicollis* Boisd.
138—139: Gamonts (×150)

Figs. 140—144. *Ancyrophora stelliformis* Schneider from *Pterostichus vulgaris* L.
140: Gamonts (G) and trophozoites (T) (×150)
141—143: Gamonts (×80 to ×150)
144: Cyst (×120)

Figs. 145—150. *Stylocephalus carabi* sp. n. from *Carabus glabratus* L.
145—146: Gamonts (×100)
147: Protomerite (P) and part of deutomerite (D) (×200)
148—149 Gamonts (G) and trophozoites (T) (×80)
150: Cyst (×12)

Figs. 151—157. *Stylocephalus oblongatus* (Hammerschmidt) from *Opatrum sabulosum* (L.)
151: Trophozoite; E — epimerite, P — protomerite, D — deutomerite (×100)
152: Protomerite and part of deutomerite of gamont (×160)
153: Dead trophozoite (×160)
154: Gamont with nucleus seen as white spot (×160)
155: Protomerite with sign of broken epimerite and part of deutomerite (×250)
156: Cyst (×40)
157: Cyst and gamonts (×40)

Figs. 158—169. *Iorella wegoreki* sp. n. from *Dytiscus marginalis* L.
158 and 161: Trophozoites; E — epimerite; P — protomerite, D — deutomerite (×40 and ×120 respectively)
159, 160, 162, 163, 164, 166, 167: Gamonts: N — kidney shaped nucleus (all ×150 except Fig. 159 that is ×40)
165: Gamonts in association (×20)
166: Trophozoite with contracted body (×150)
167: Gamonts from broken association (×40)
168: Gamonts in bent association (×20)
169: Attachment of protomerite to protomerite; notice special morphological features ensuring good attachment (×150)

Figs. 170—183. *Mattesia dispora* Naville from *Ephestia kühniella* Zell.
170: Fat body cell destroyed by sporozoites (S) and macrogametes (MaG); H — hemocytes (×1000)
171: Sporozoites in the smeared tissue of dead host (×1000)
172: Sporozoite inside the hemocyte (×1000)
173: Fat body destroyed by developmental stages of the parasite: SP — spores, Mi — micronuclear schizont, Ma — macronuclear schizont, GM — gametocytes, V — vacuoles (×800)
174: Macronuclear schizont (×1000)
175: Macronuclear merozoites (×1000)
176: Gametocytes (GM) in the fat body (×1000)
177: Spores and sporozoites captured inside the cyst formed by hemocytes of the host as evidence of phagocytic reaction (×600)
178: Degenerated gametocytes captured by group of hemocytes (×1000)
179: Normal spores (Sn) and empty spores (Se) in the smeared tissue of the dead host (×1200)
180: Group of spores floating in the hemolymph at Malpighian tubules (×250)
181: Spores as seen under phase contrast (×1000)
182—183: Fat body of the host larvae destroyed by the spores of parasite seen as dark spindle shaped bodies; C — cuticule of the larvae (×800 and ×200 respectively)

Fig. 184. Pathological changes in the fat body of *Ephestia kühniella* Zell. infected with *Mattesia dispora* Naville; SP — pair of spores on gametocyst, GM — gametocytes, C — cuticule, V — vacuoles (×800)

Figs. 185. Epithelium of the gut of *Lagria hirta* L. destroyed by trophozoites of *Gregarina rostrata* Wellmer; notice cavities surrounding each trophozoite that are evidences of pinocytosis (×400)

Fig. 186. Hypethrophied gut caeca of *Chrysomela polita* L. infected with *Gregarina chrysomelae* sp., G — gamonts of the parasite (×150)

Figs. 187—188. Epithelium of the gut of *Ephestia kühniella* Zell. destroyed by gamonts and trophozoites of *Leidyana ephestiae* Daviault: G — gamonts, T — trophozoites, M — muscles, FB — fat body, C — cuticule (×400 and ×50 respectively)

Figs. 189—190. Gut epithelium of *Amphimallon solstitialis* L. damaged by gamonts of *Stictospora provincialis* Leger; FB — fat body, MT — Malpighian tubules, F — food in the gut lumen (×800)

Fig. 191. Gut epithelium of *Tenebrio molitor* L. damaged by gamonts and trophozoites of *Gregarina cuneata* Stein; notice the cavities surrounding each trophozoites as evidence of pinocytosis (×200)

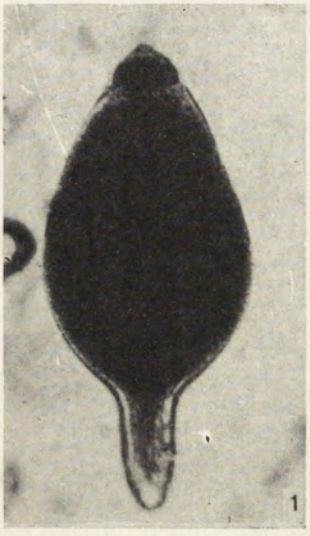
Fig. 192. Cavity surrounding trophozoite of *Gregarina steini* Berndt inside the gut epithelium of *Tenebrio molitor* L. (×200)

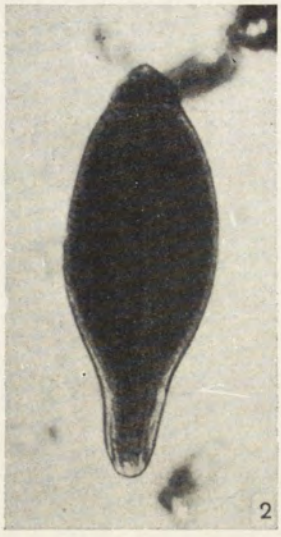
Fig. 193. Cavity surrounding the trophozoite of *Echinomera hispida* (Schneider) inside the gut epithelium of *Lithobius forficatus* L. (×200)

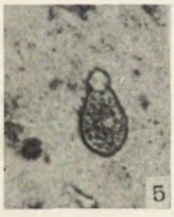
Fig. 194. Mixed infection of *Ephestia kühniella* Zell. with gamonts of *Leidyana ephestiae* Daviault and spores of *Mattesia dispora* Naville (×160)

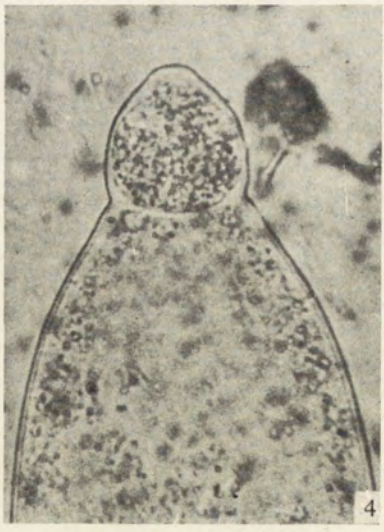
Fig. 195. Mixed infection of *Geotrupes stercorosus* Scriba with gamonts of *Didymophyes paradoxa* Stein and spores of a microsporidian of the genus *Plistophora* (×160)

Fig. 196. Mixed infection of *Tribolium confusum* Duval with gamonts of *Gregarina minuta* Ishii and oocysts of coccidian *Adelina tribolii* Bhatia (×160).









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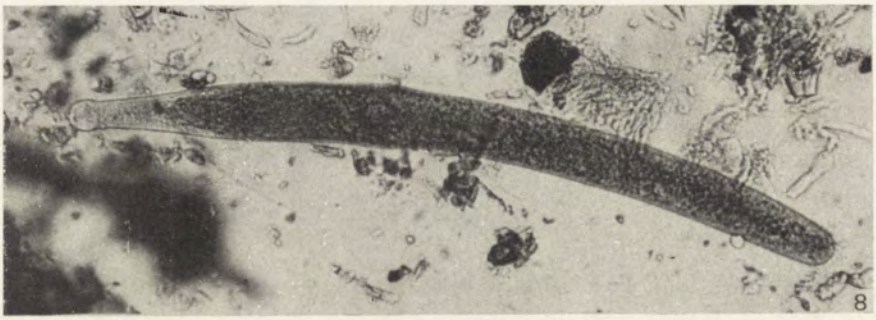
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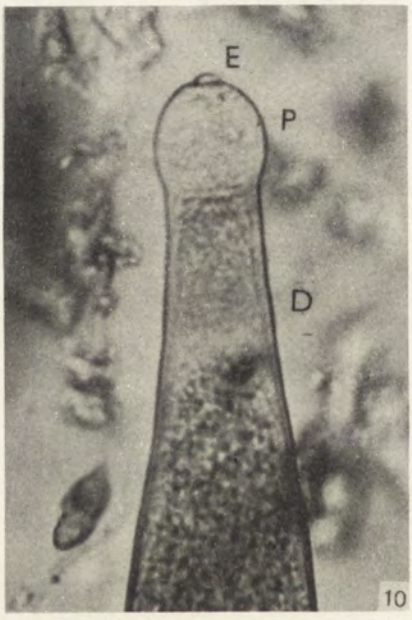

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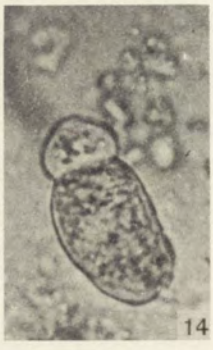
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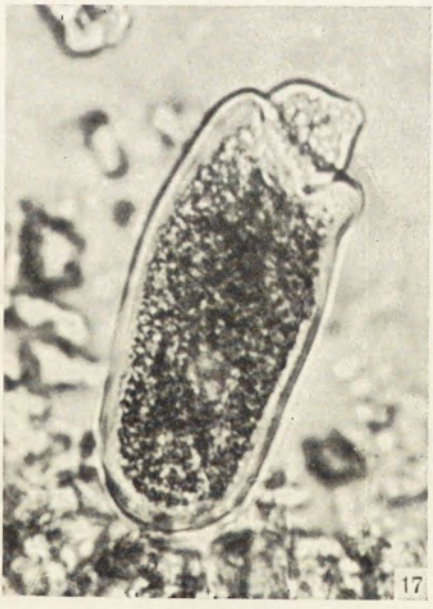

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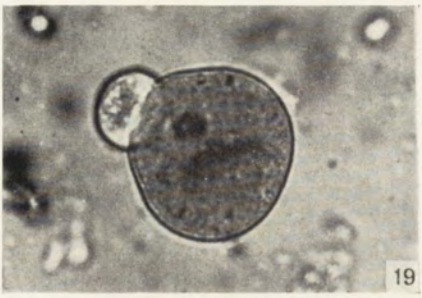
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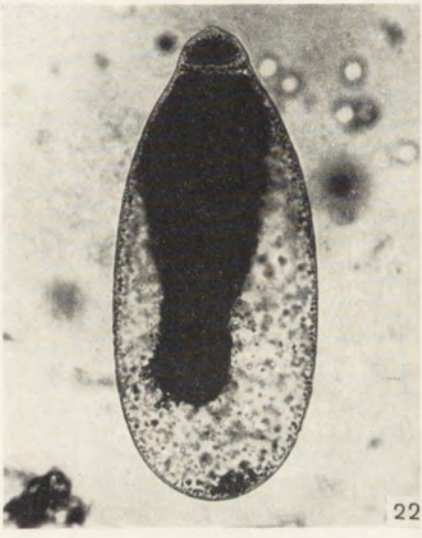
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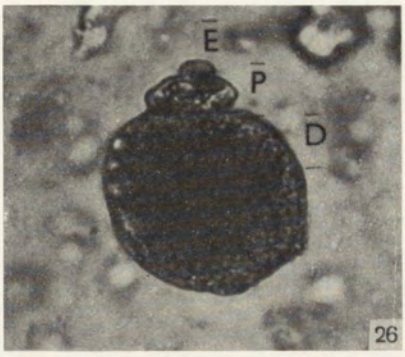

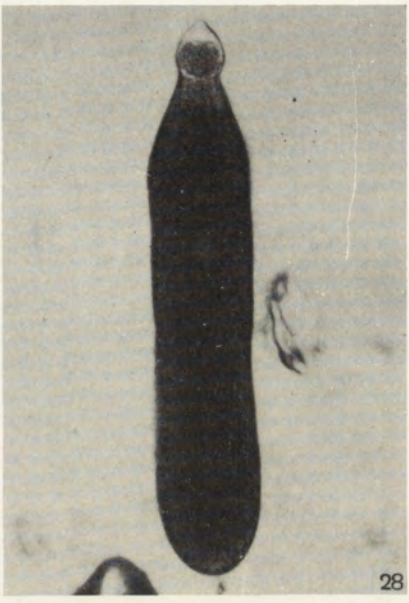

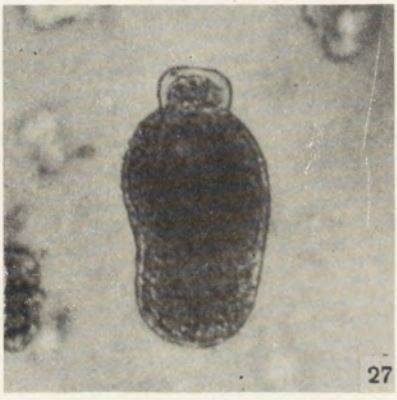

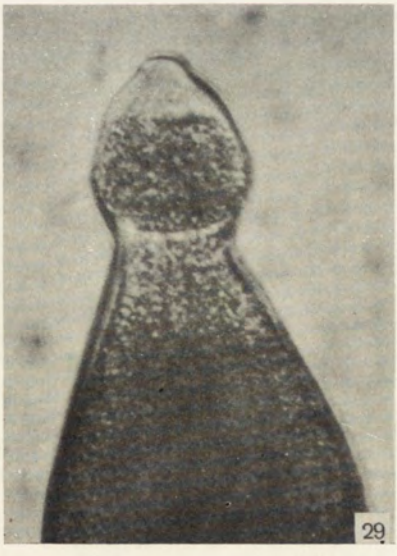

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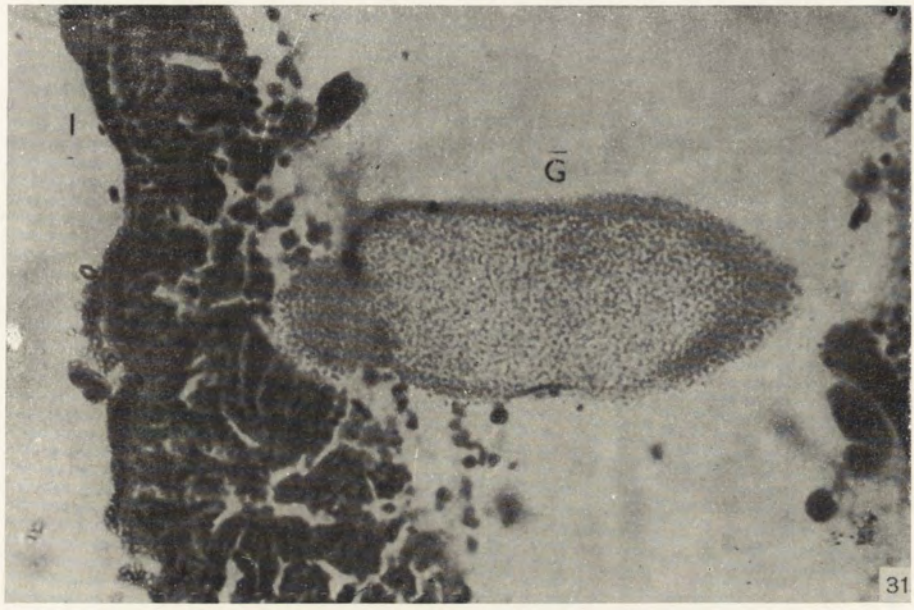

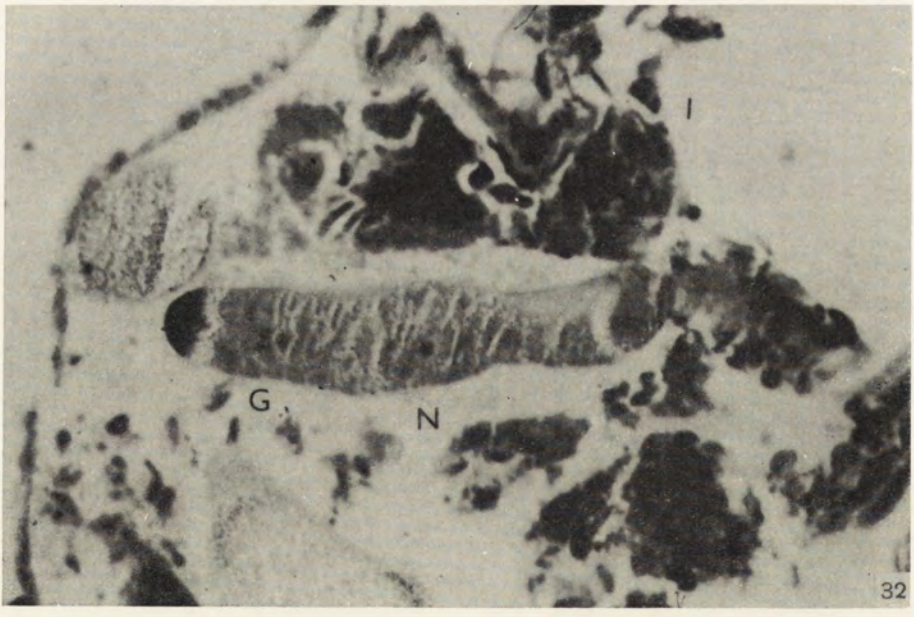

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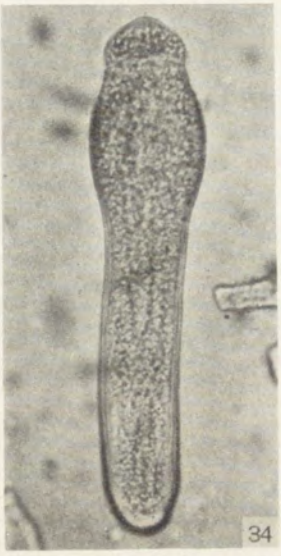

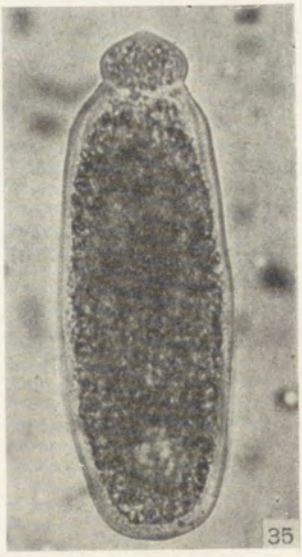

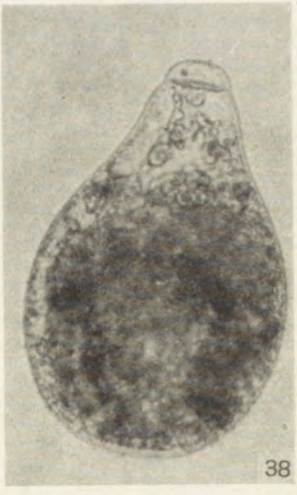

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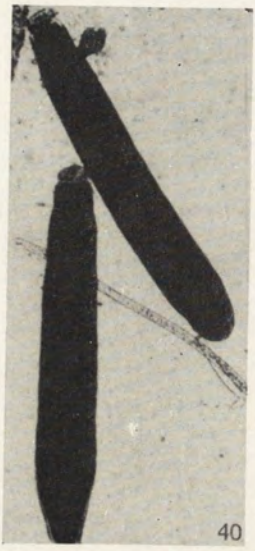
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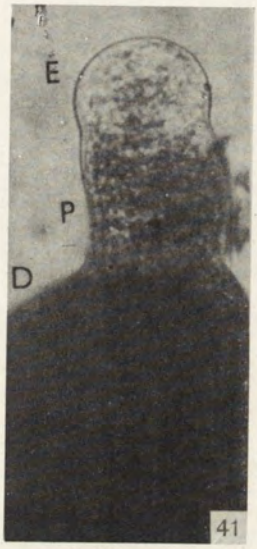

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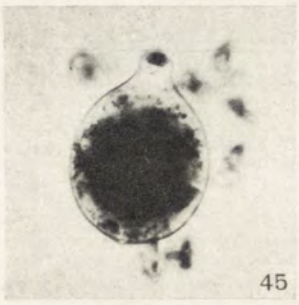

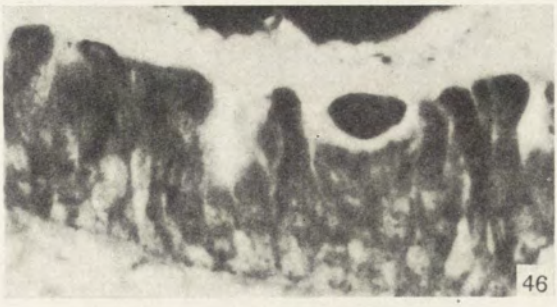

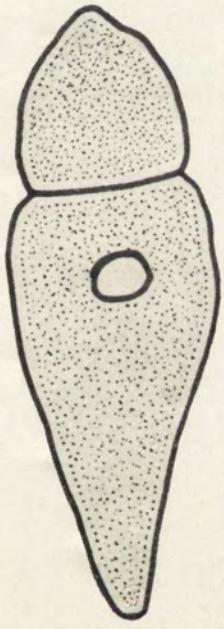

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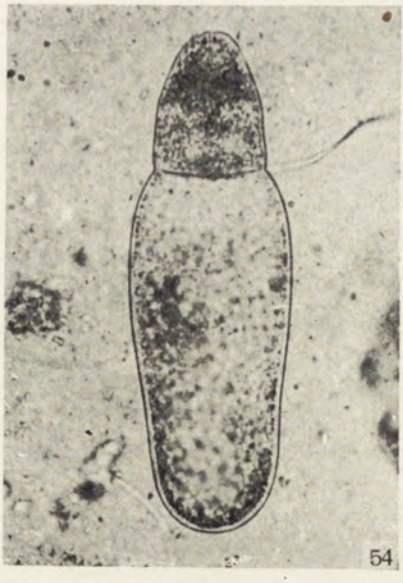
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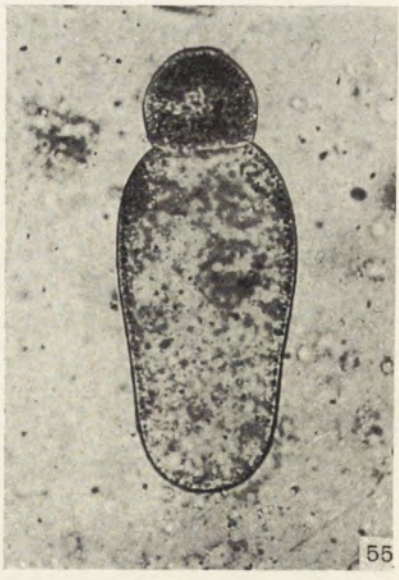
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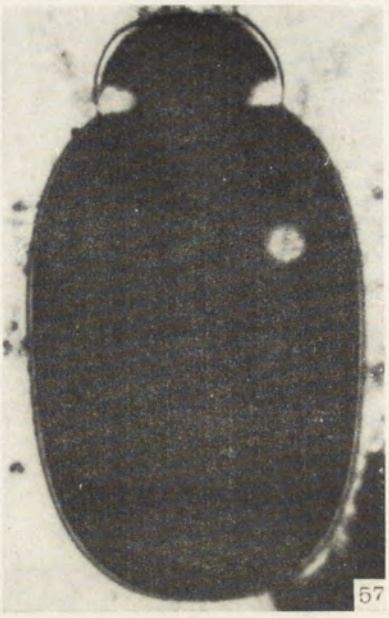

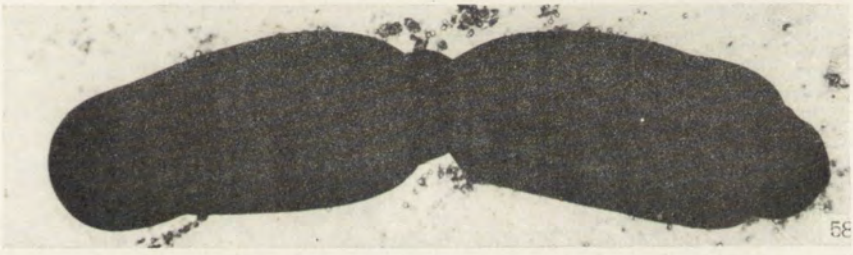

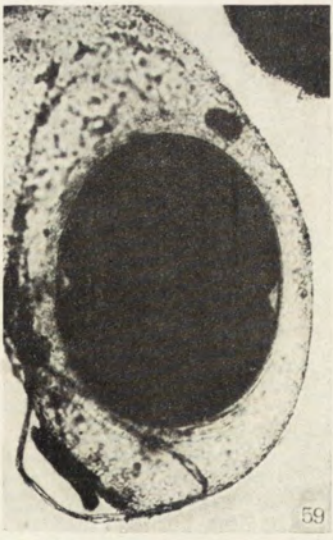

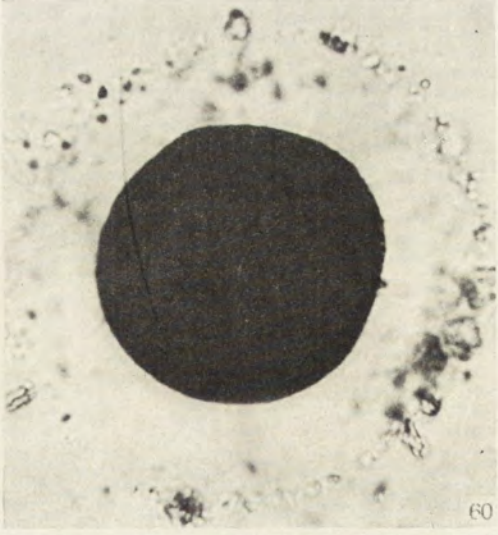

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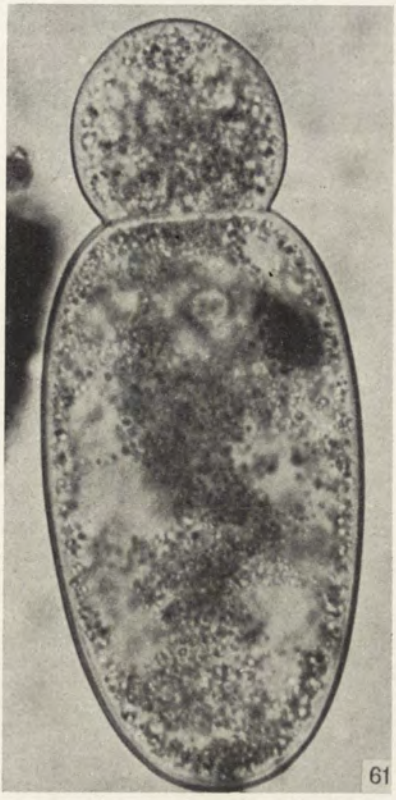

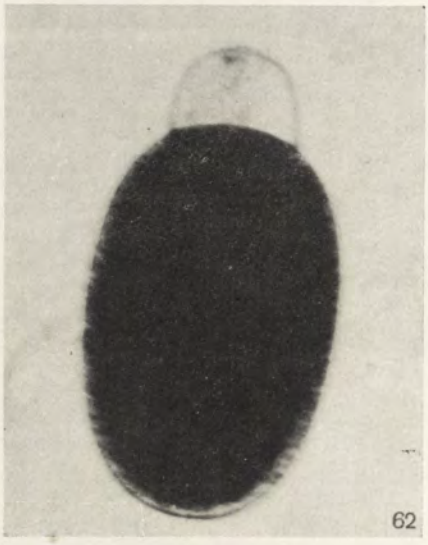

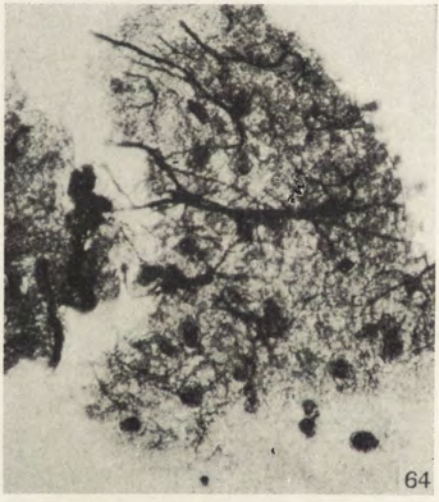

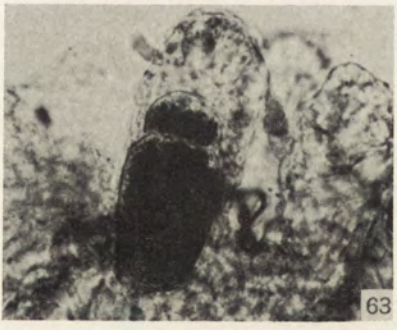

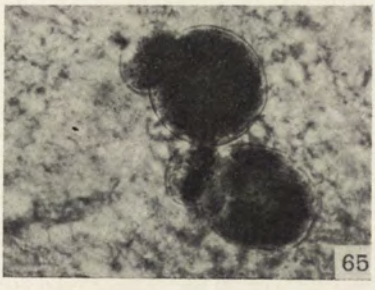

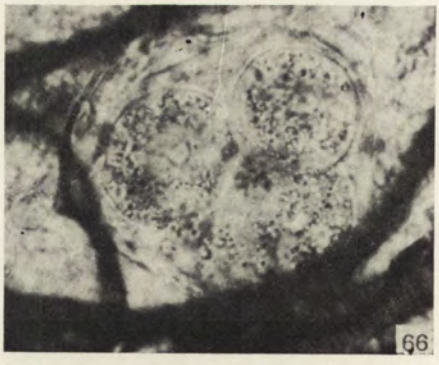

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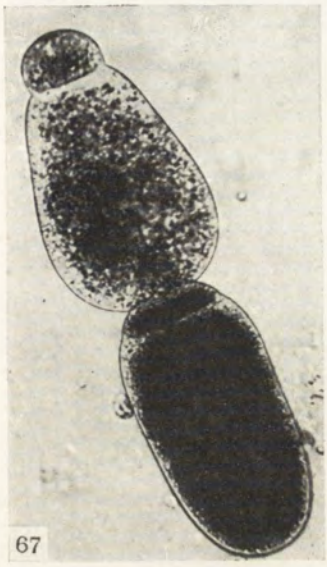

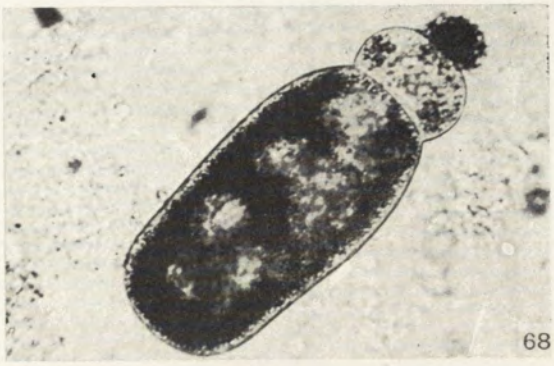

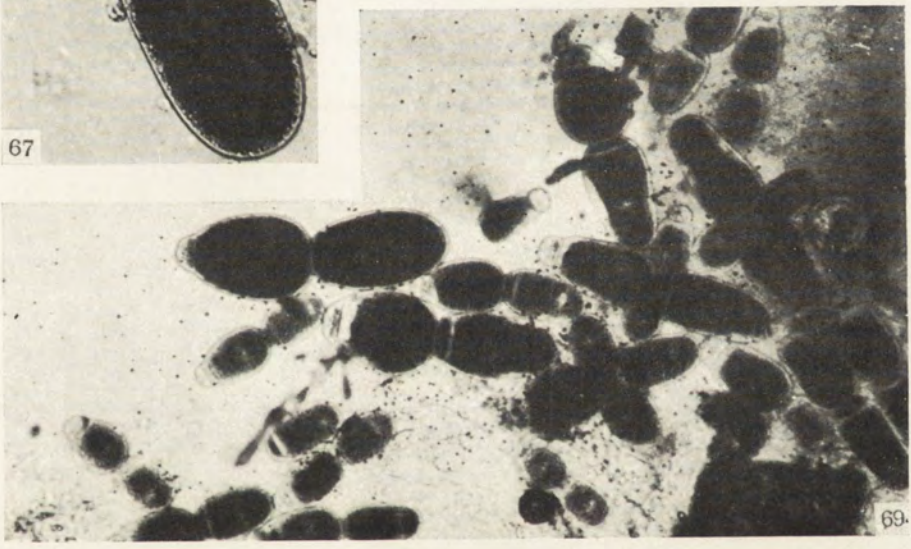

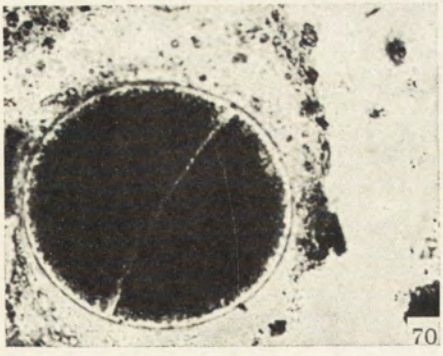

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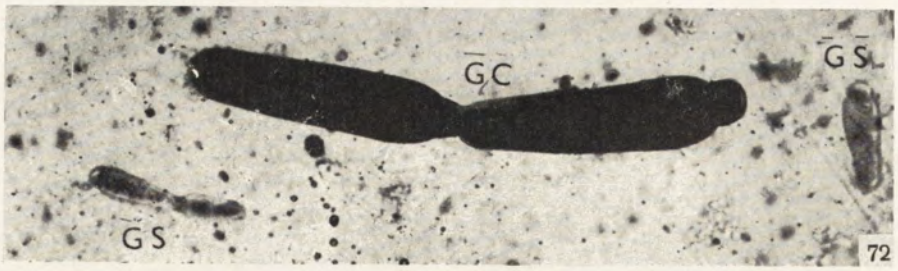

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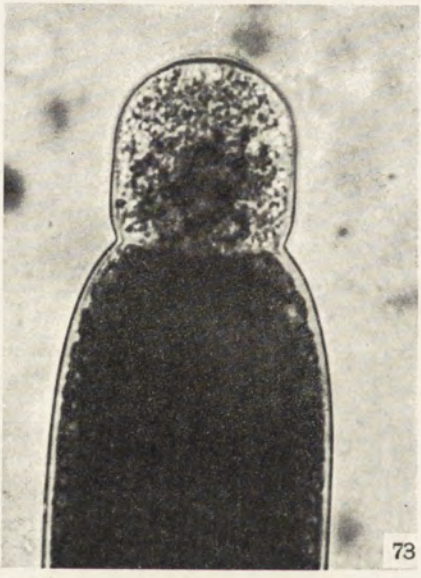
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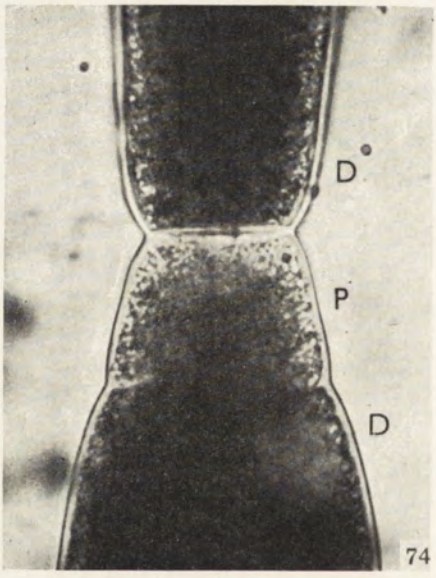

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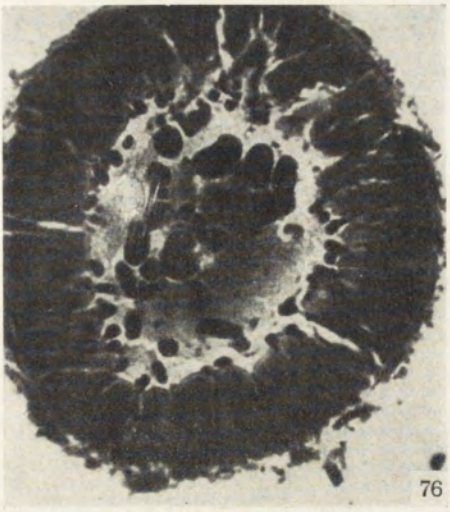
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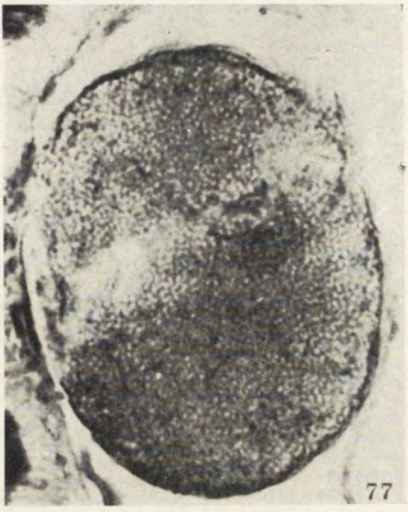
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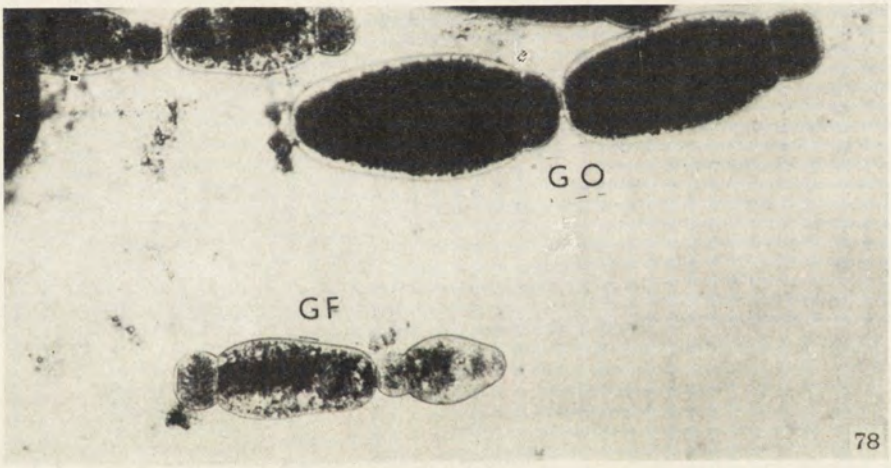

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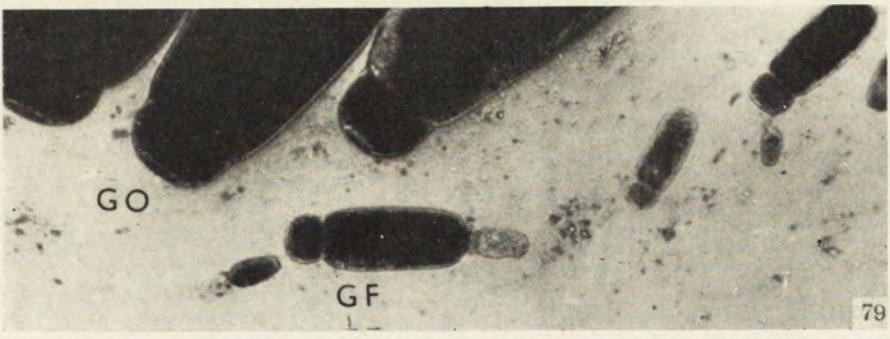

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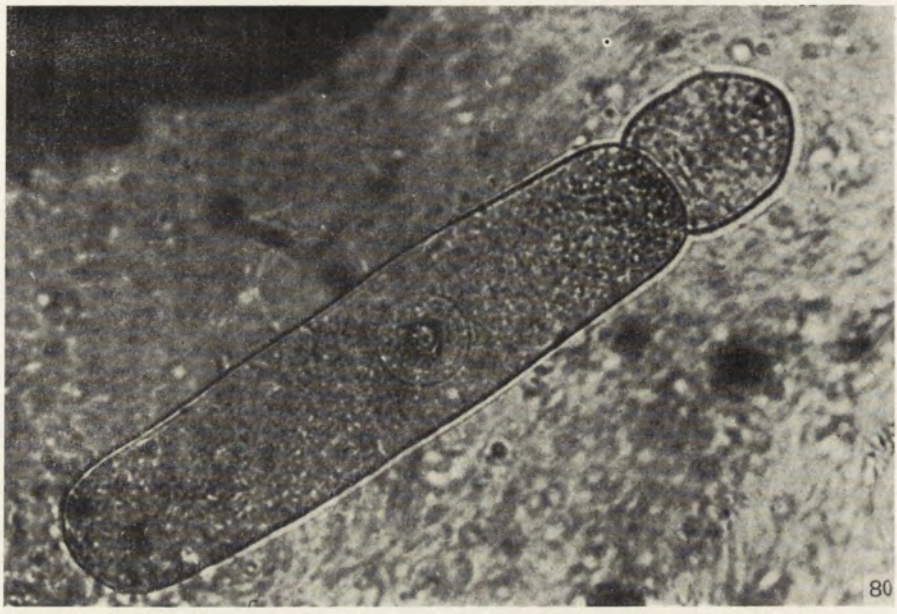

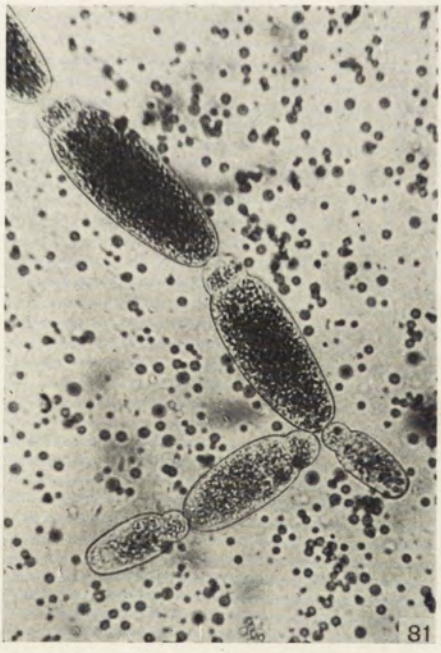

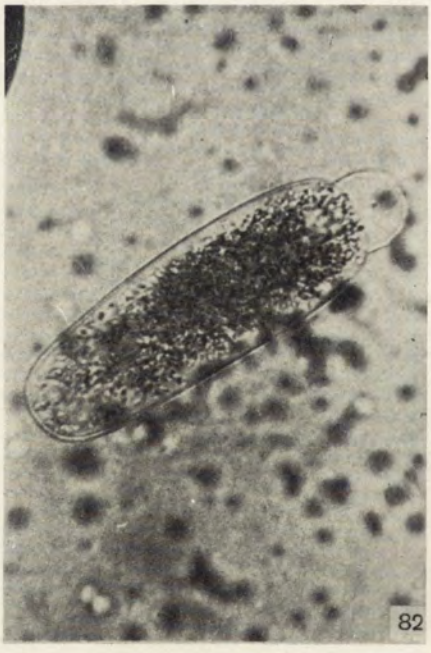

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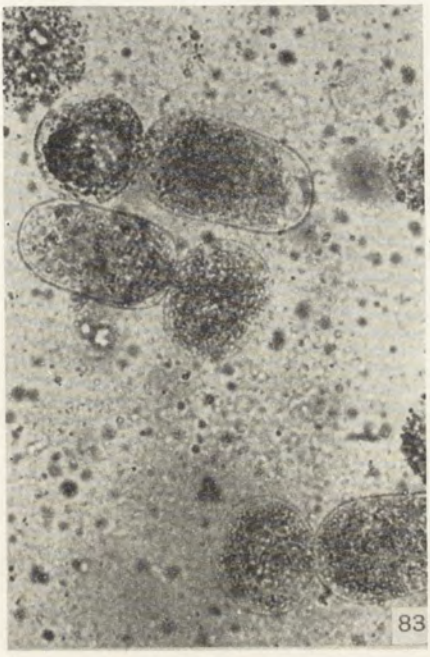

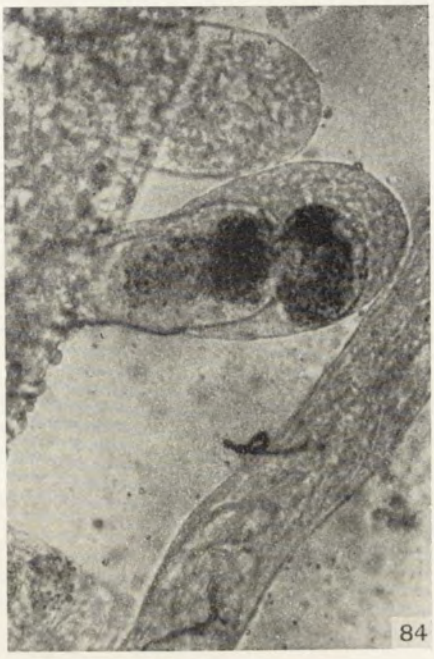

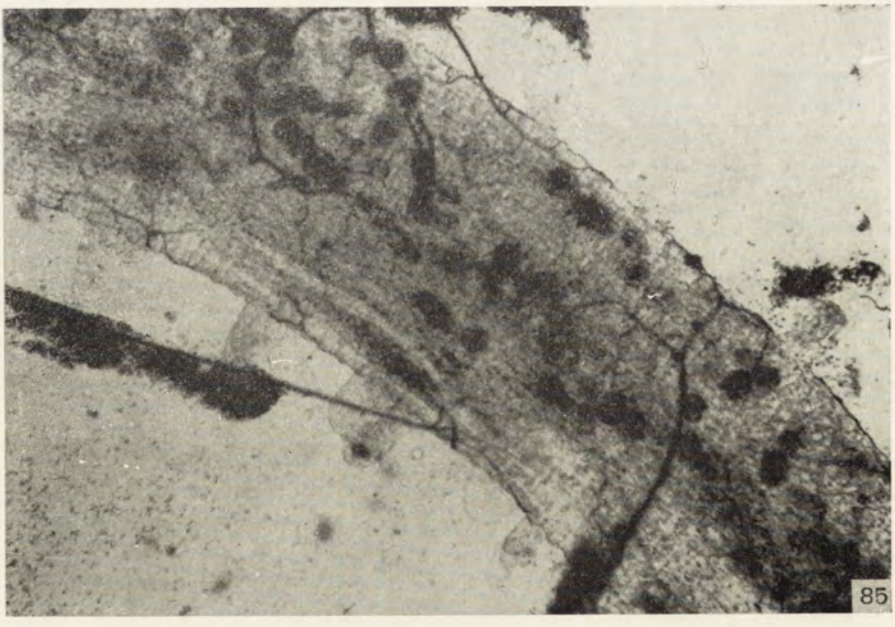

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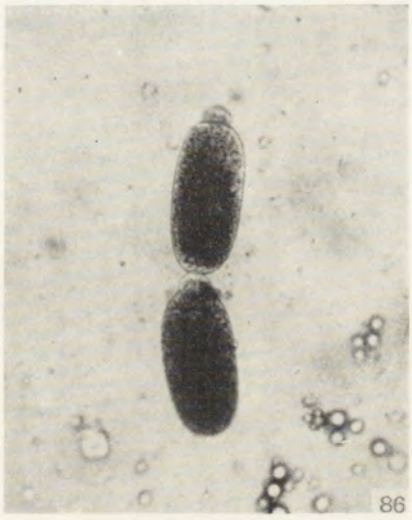

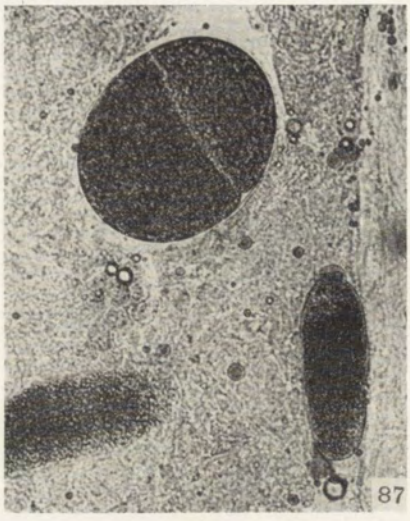

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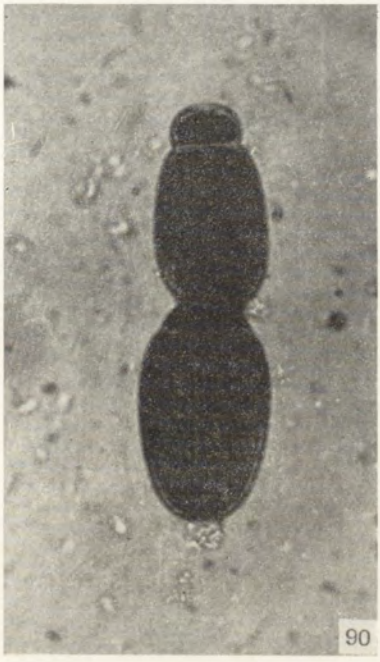

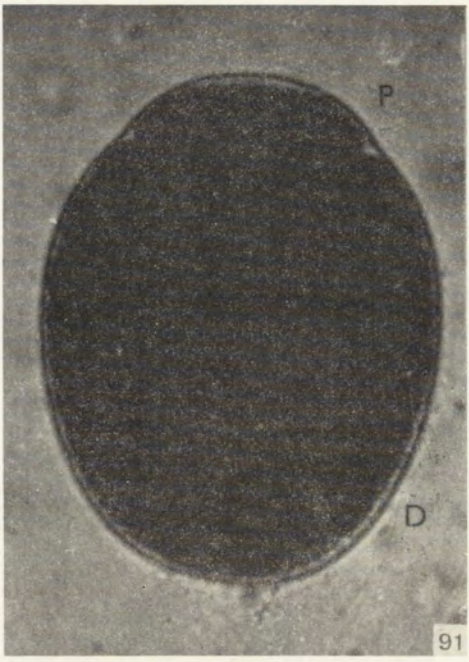

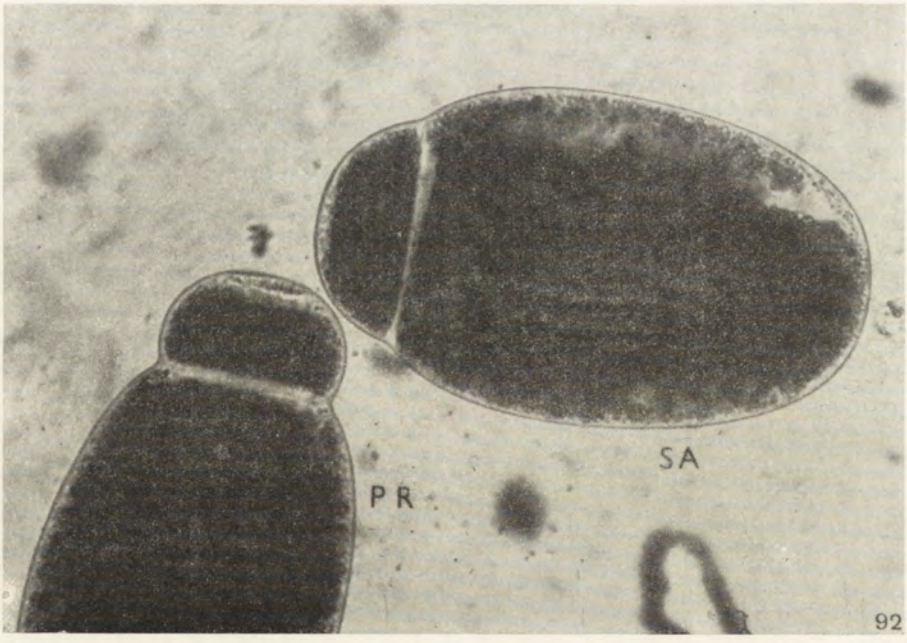

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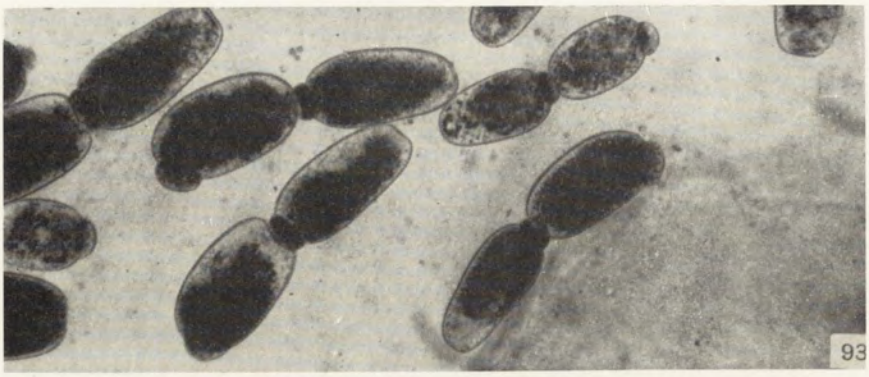

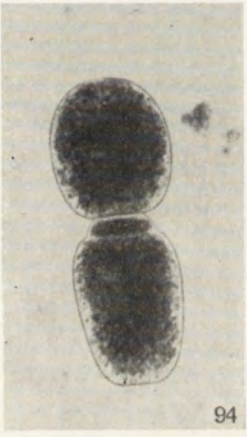

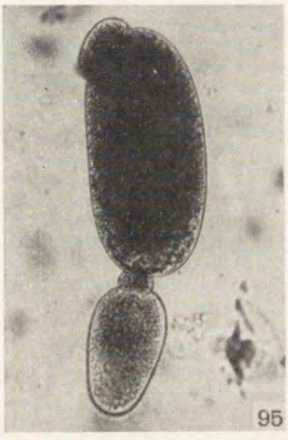

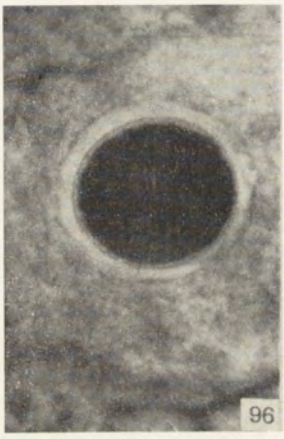

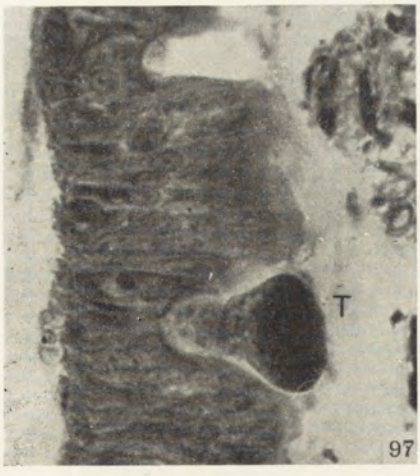

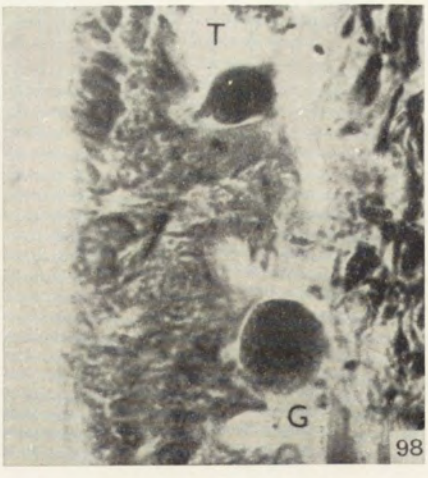

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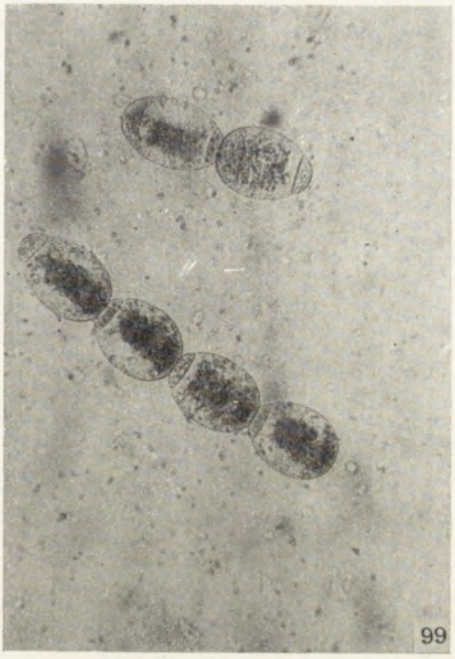

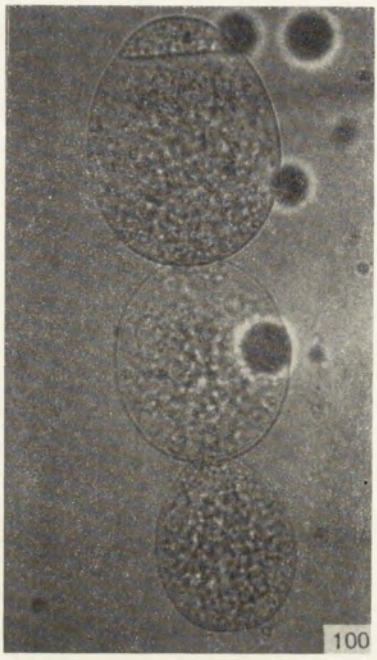

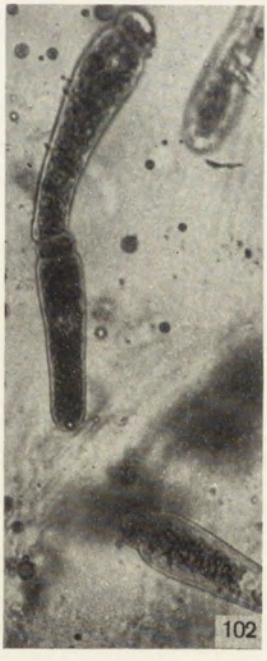

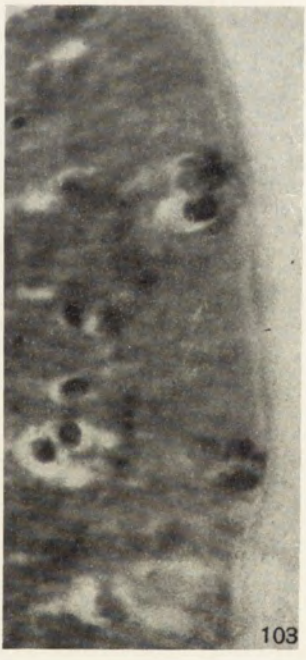

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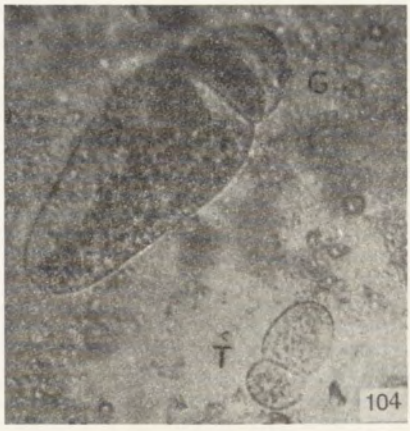

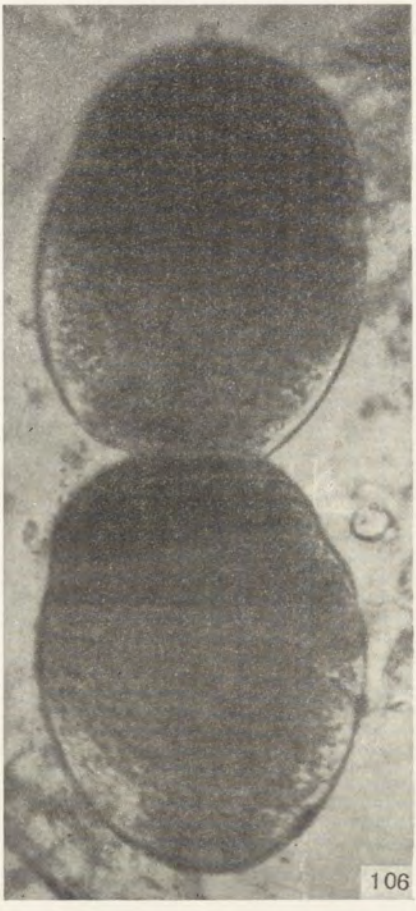

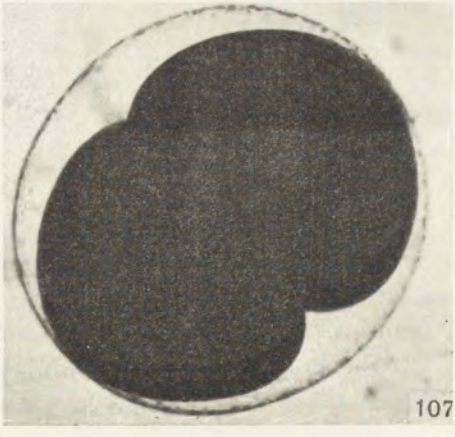

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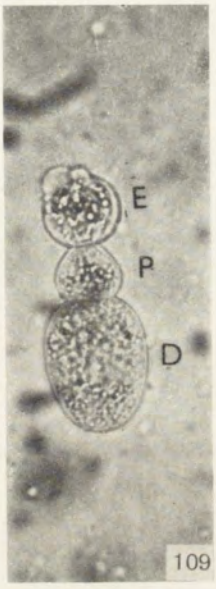

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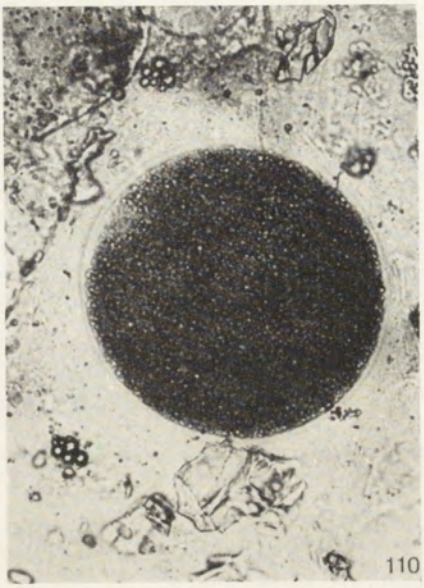
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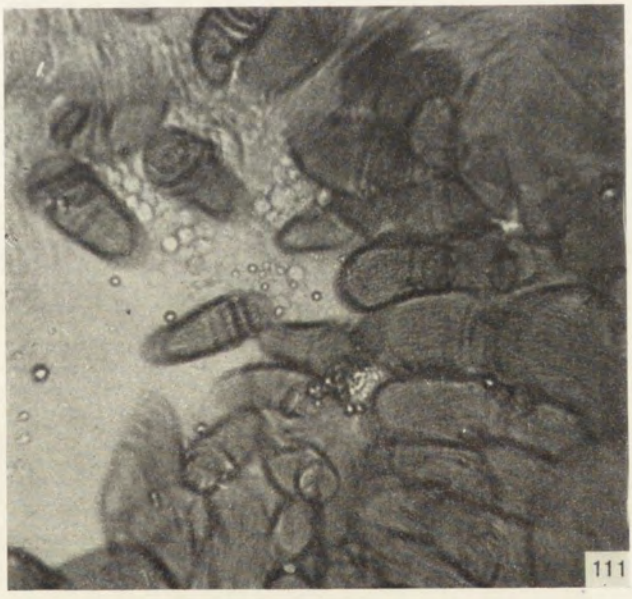
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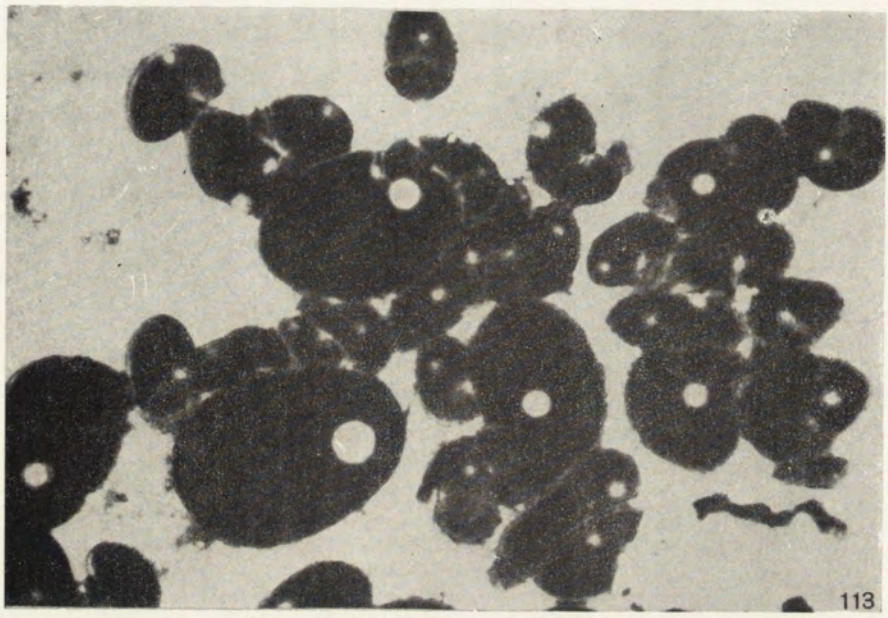

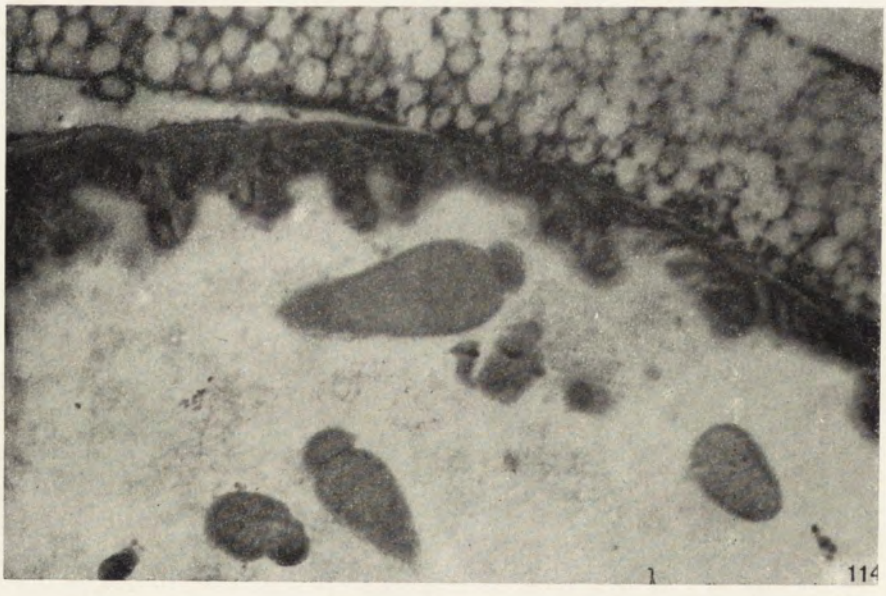

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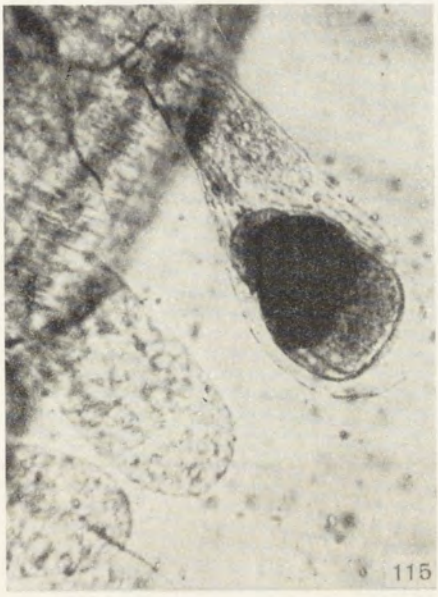
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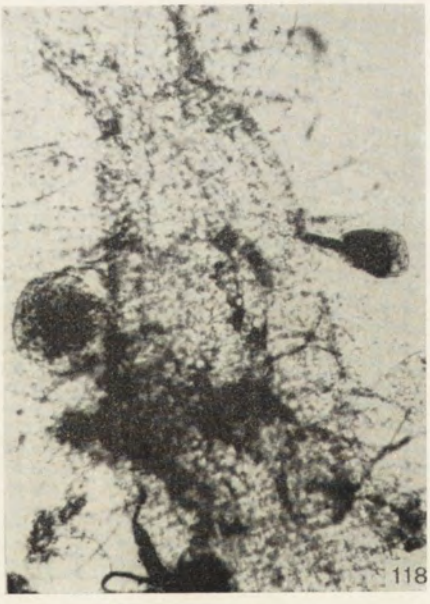
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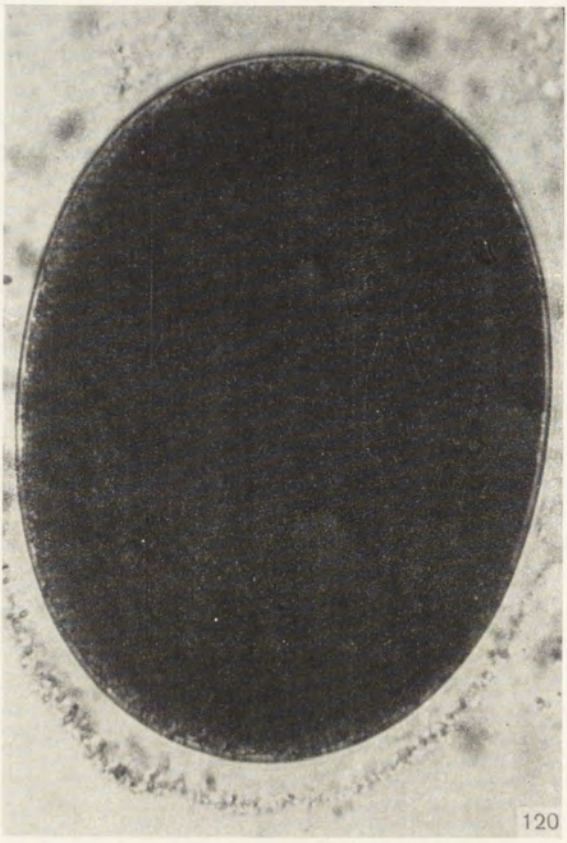

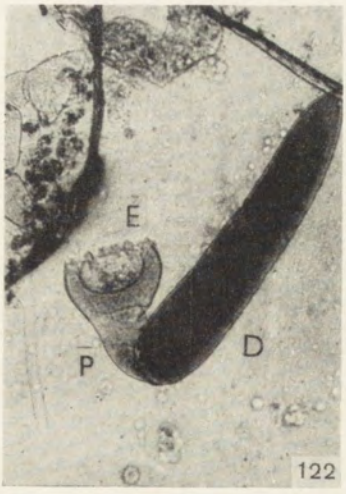

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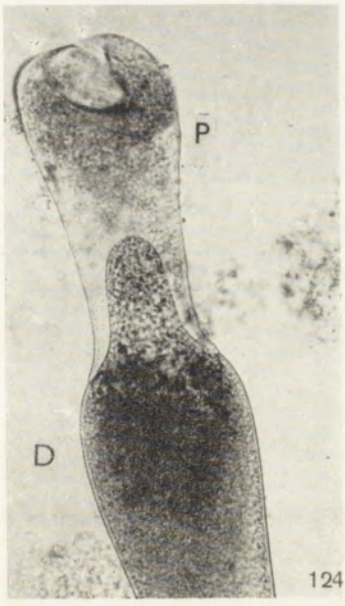

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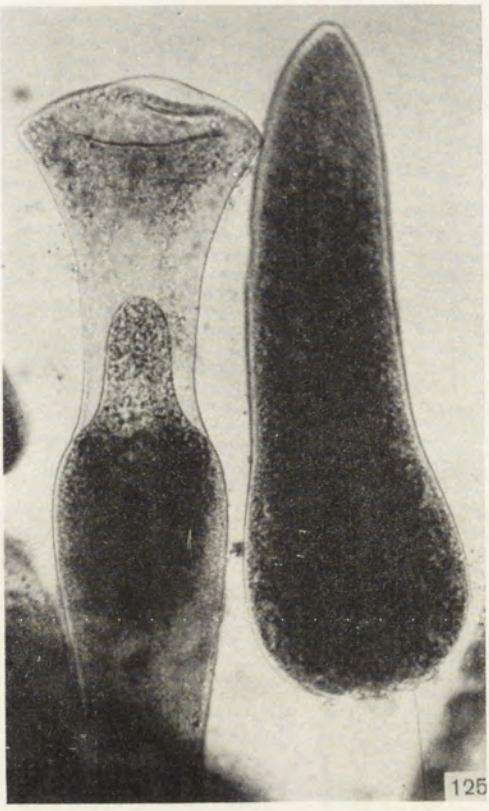
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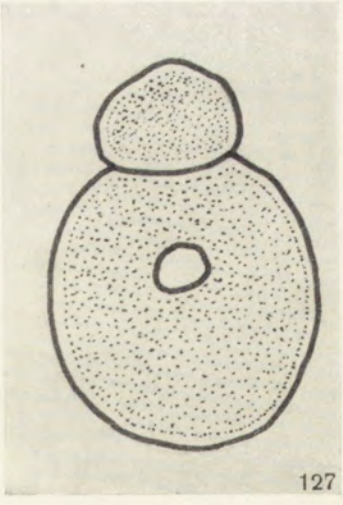
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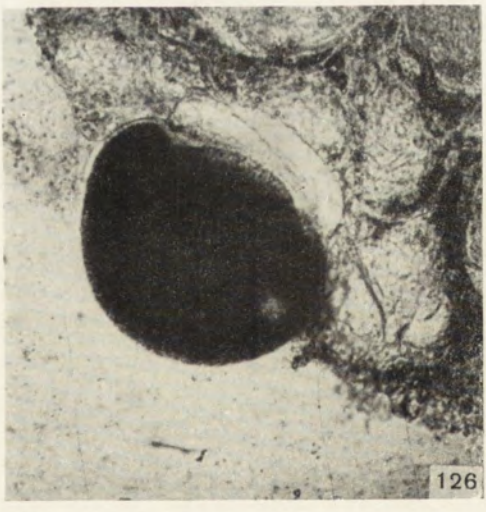
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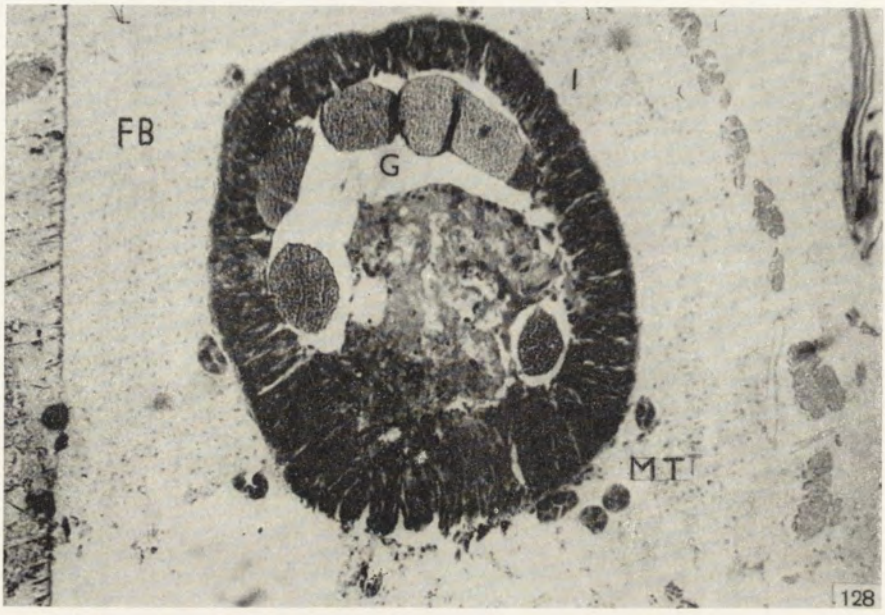

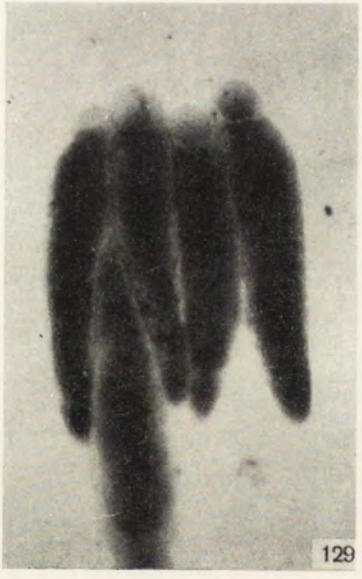

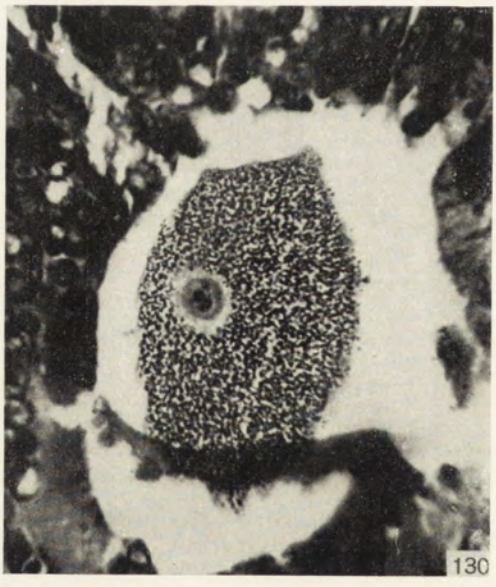

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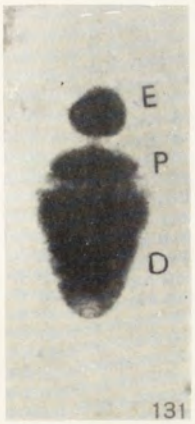

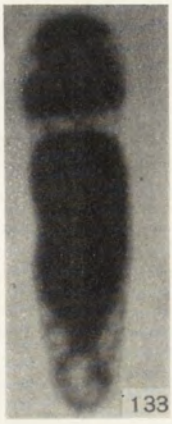

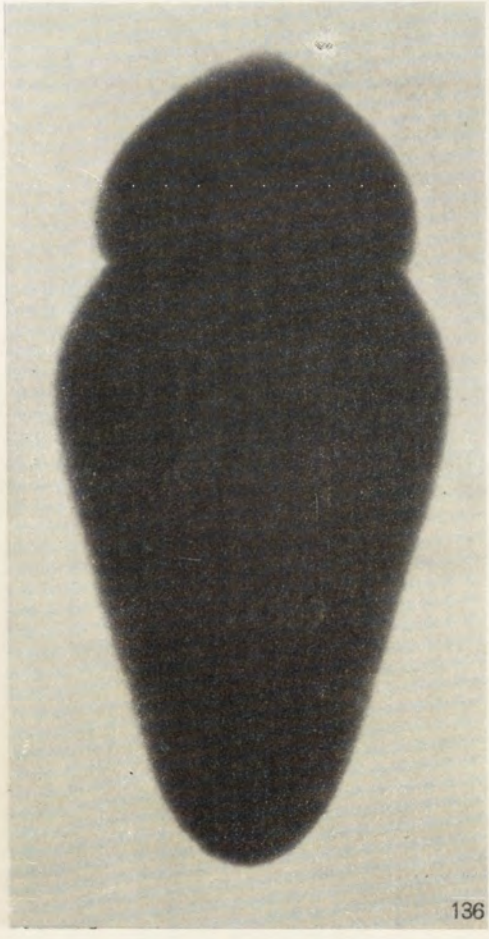

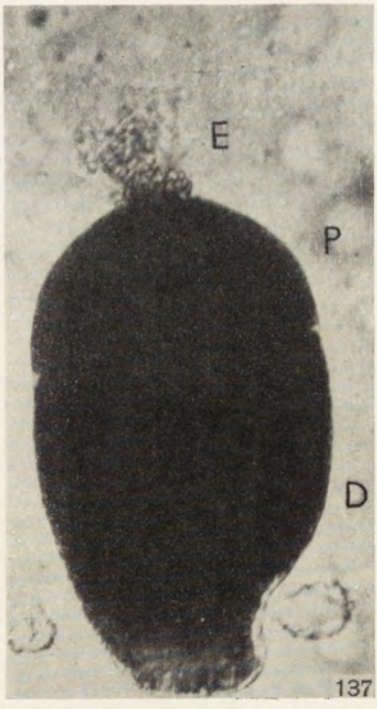

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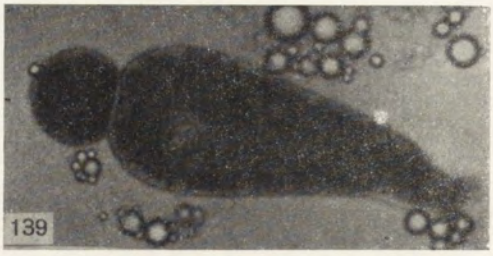

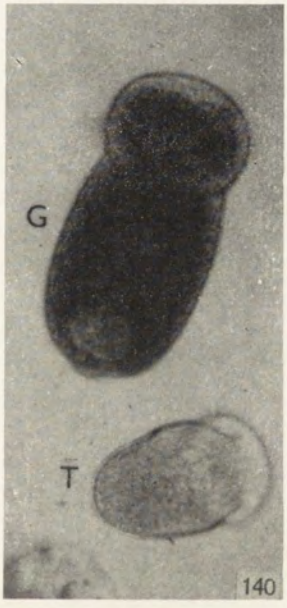

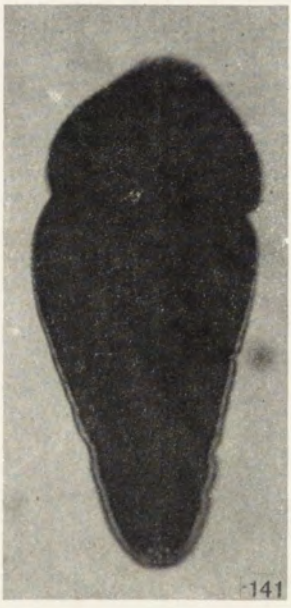

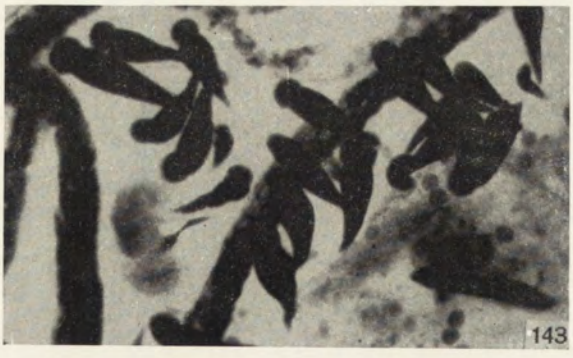

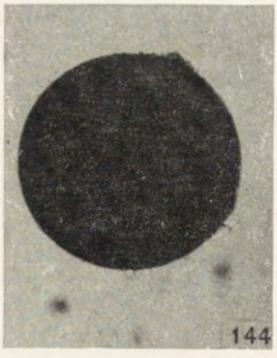

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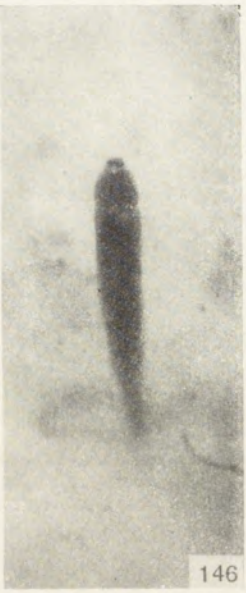

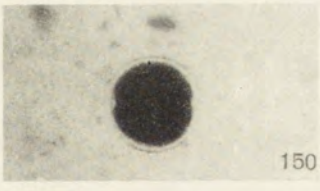

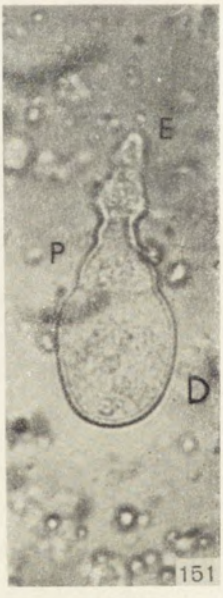

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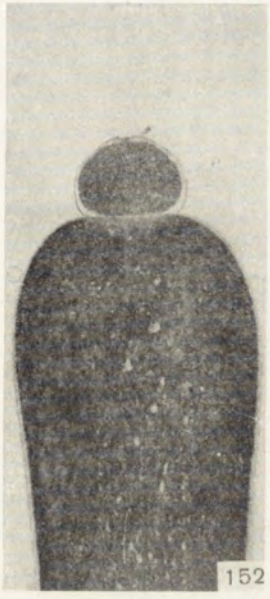

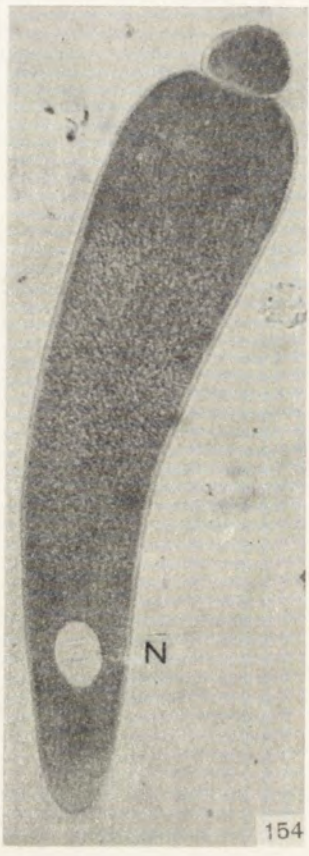

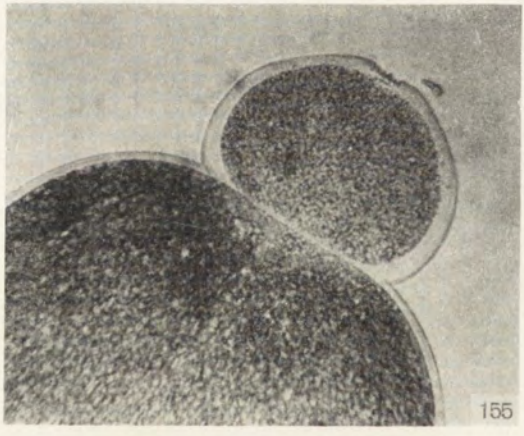

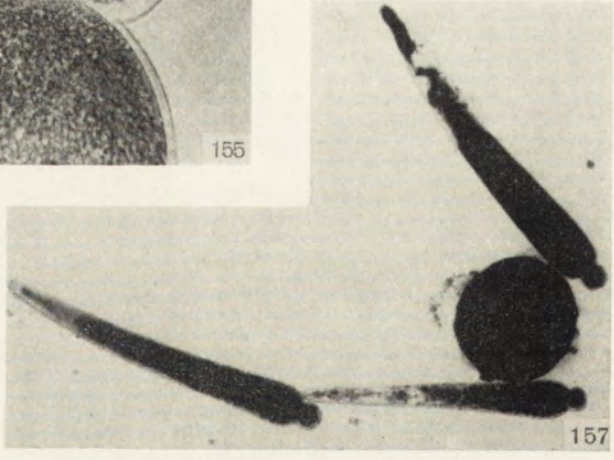

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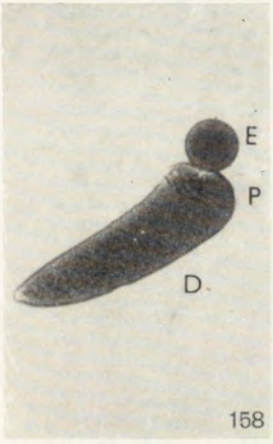

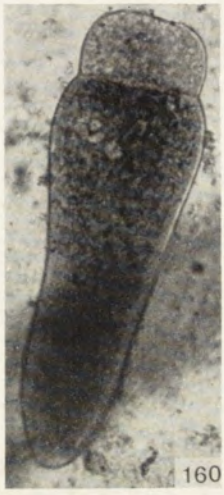

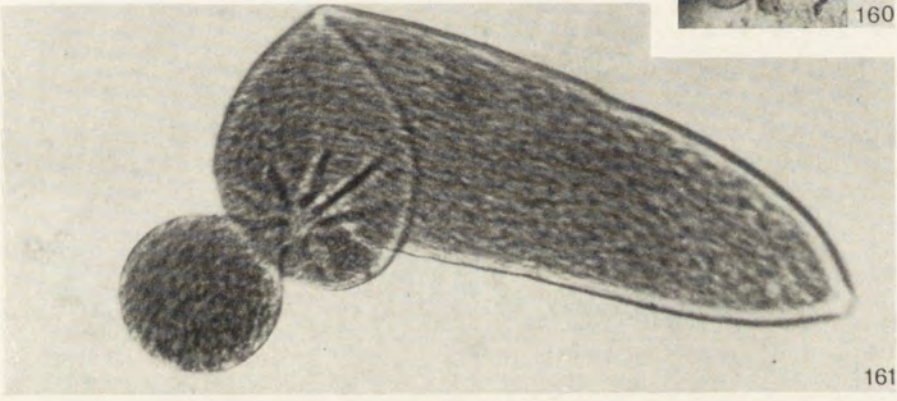

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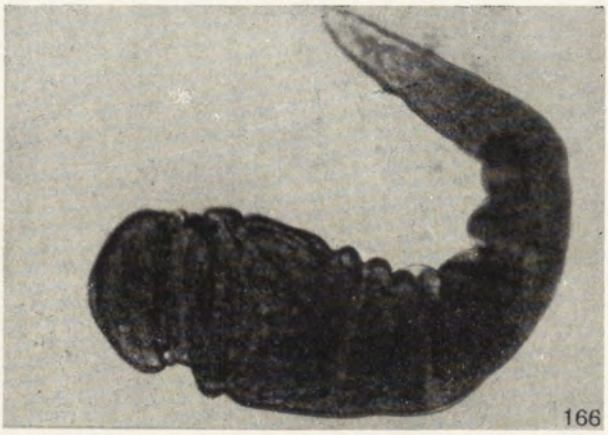

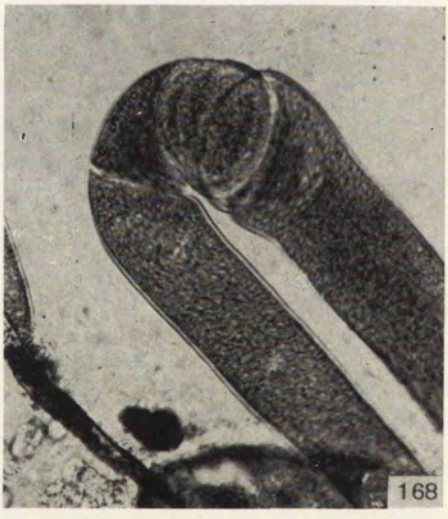

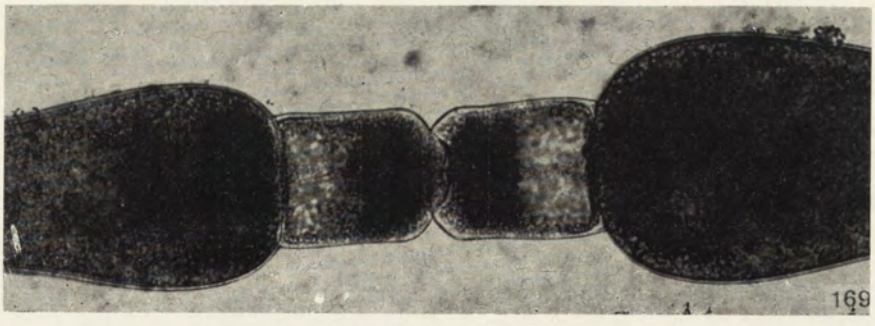

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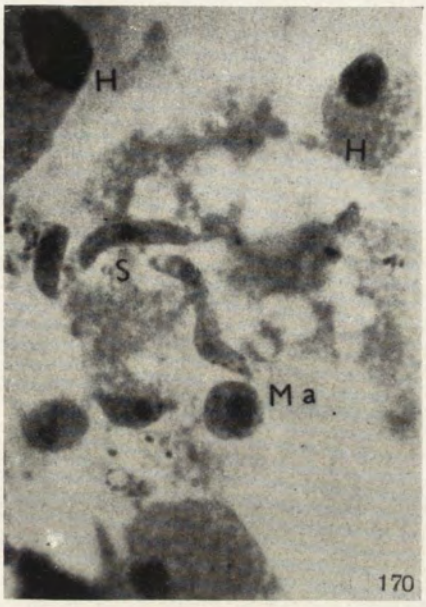

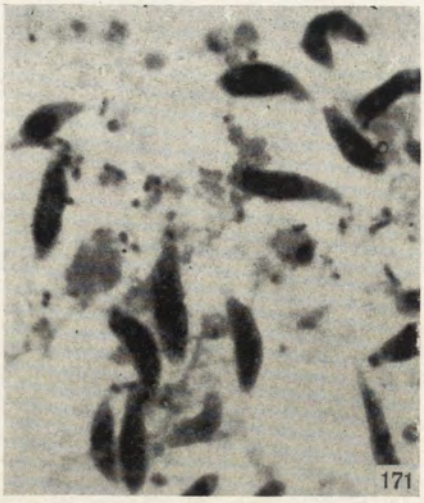

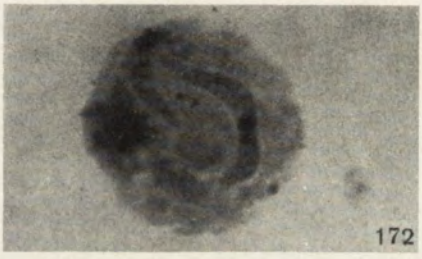

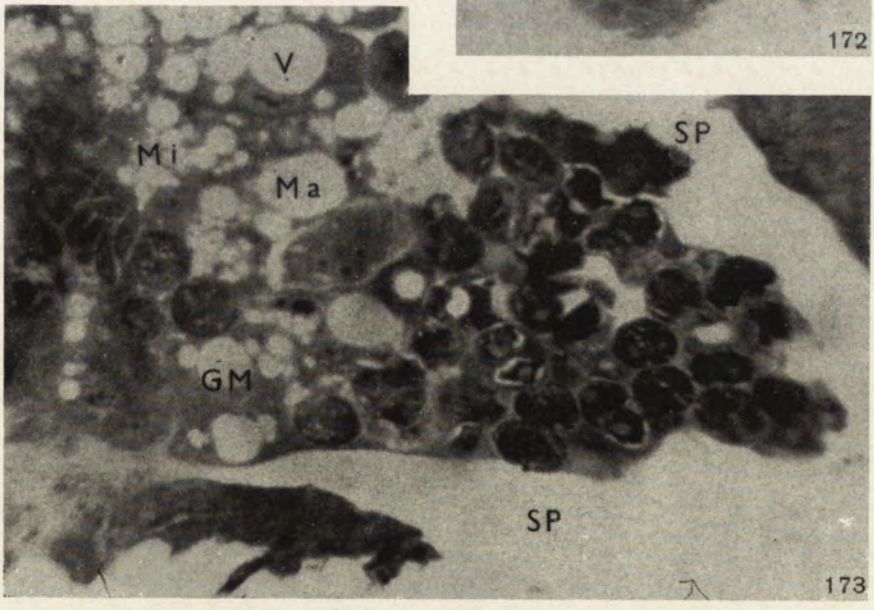

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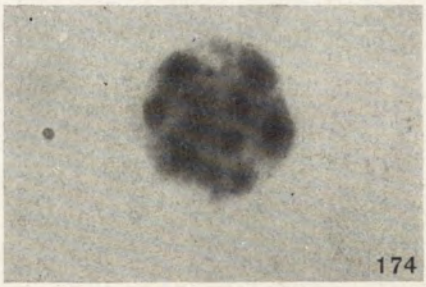

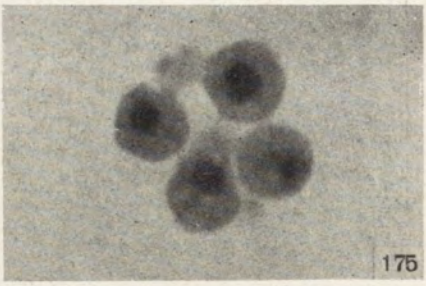

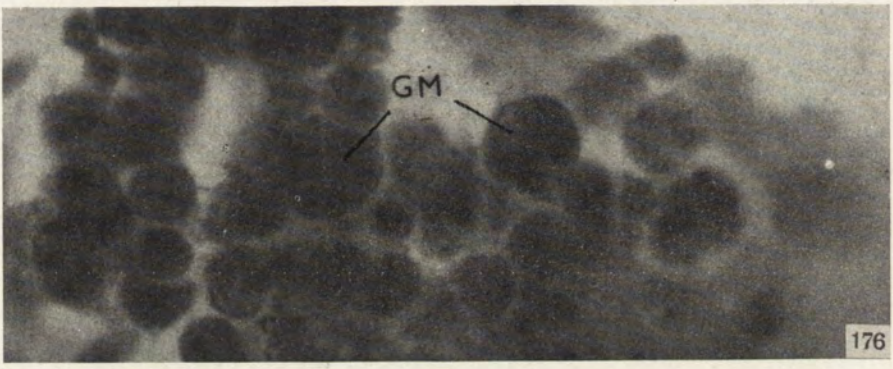

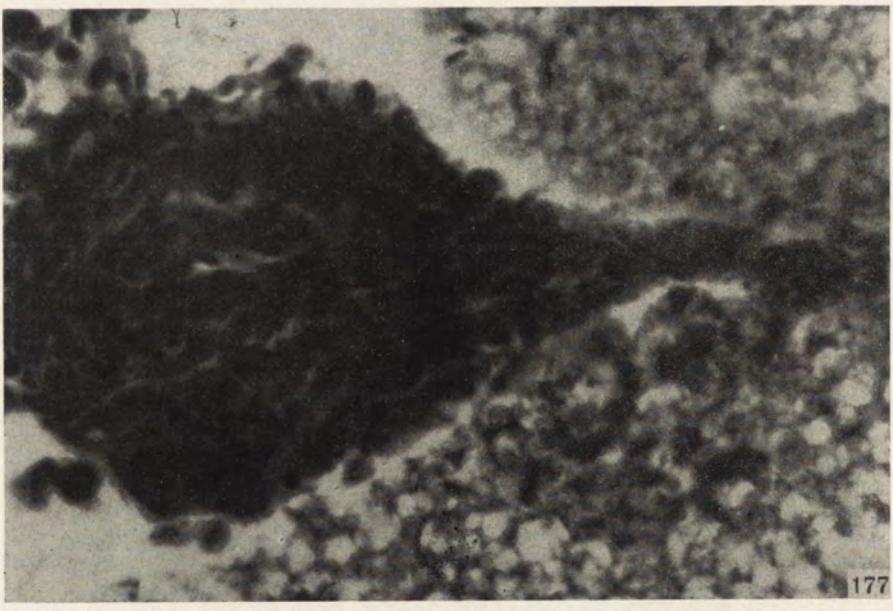

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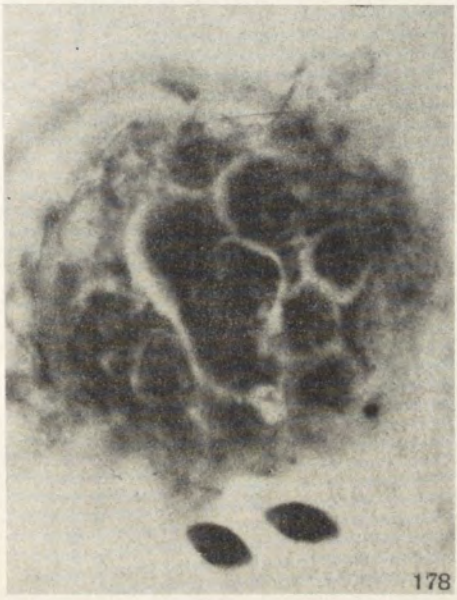
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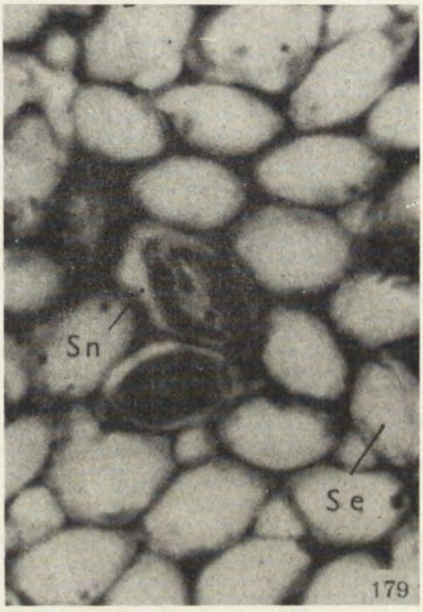

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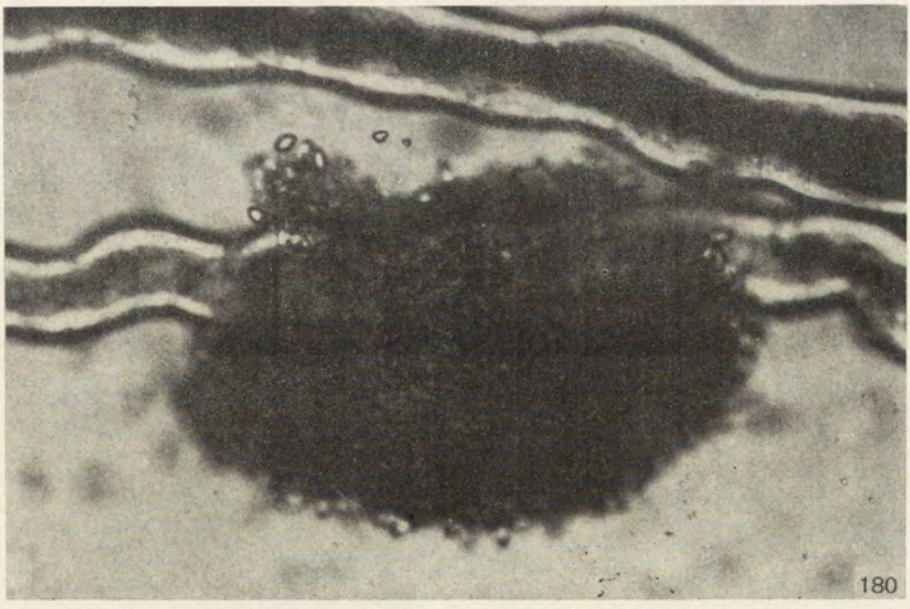
180

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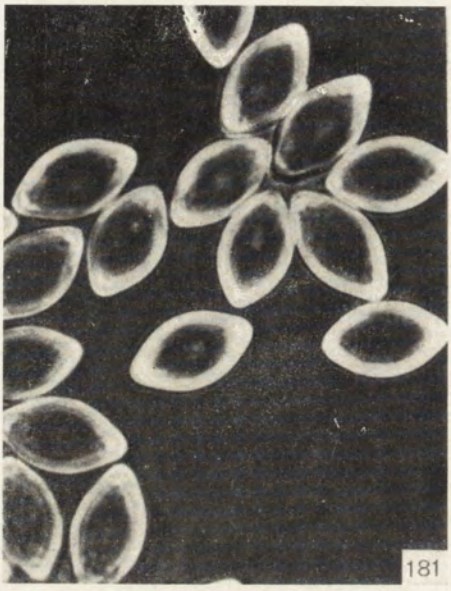

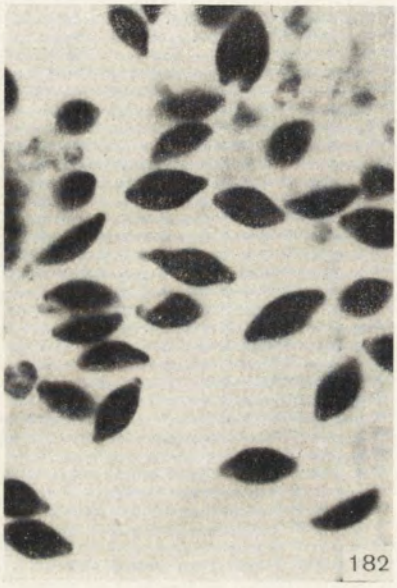

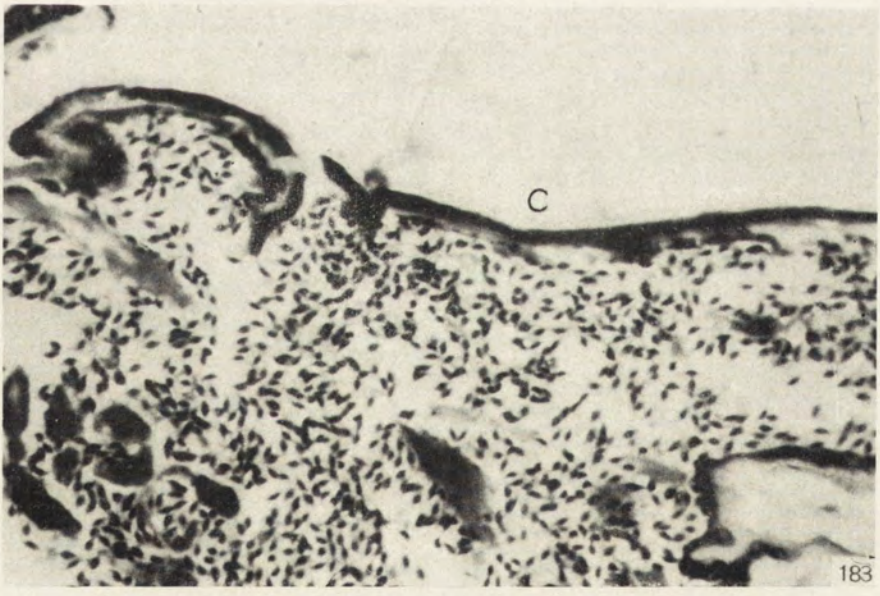

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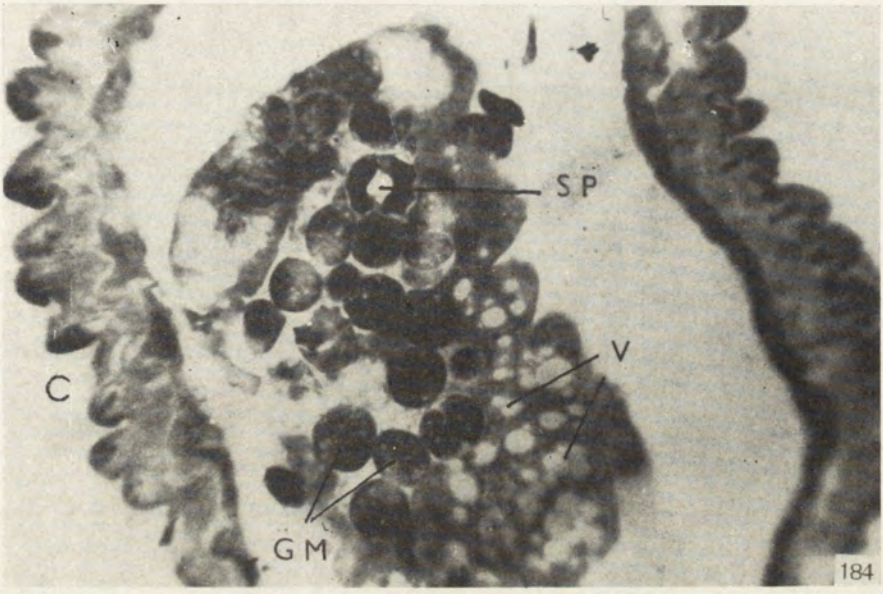
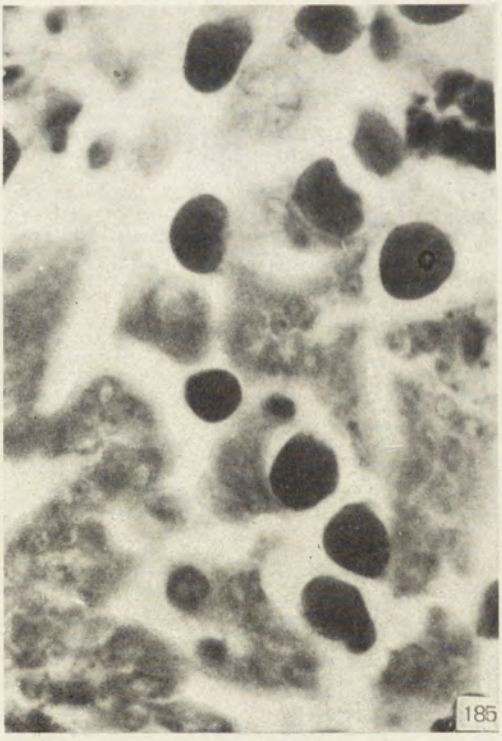
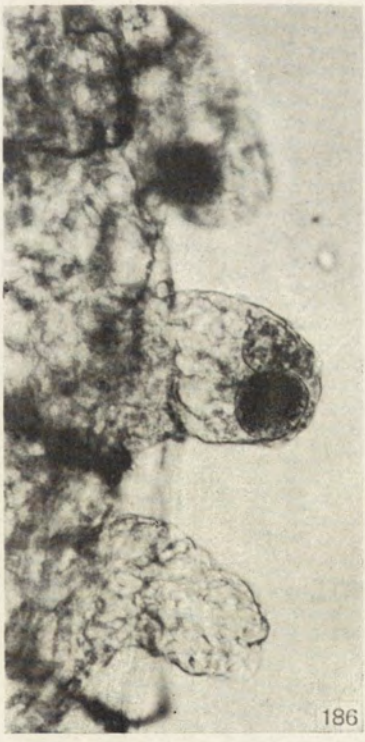
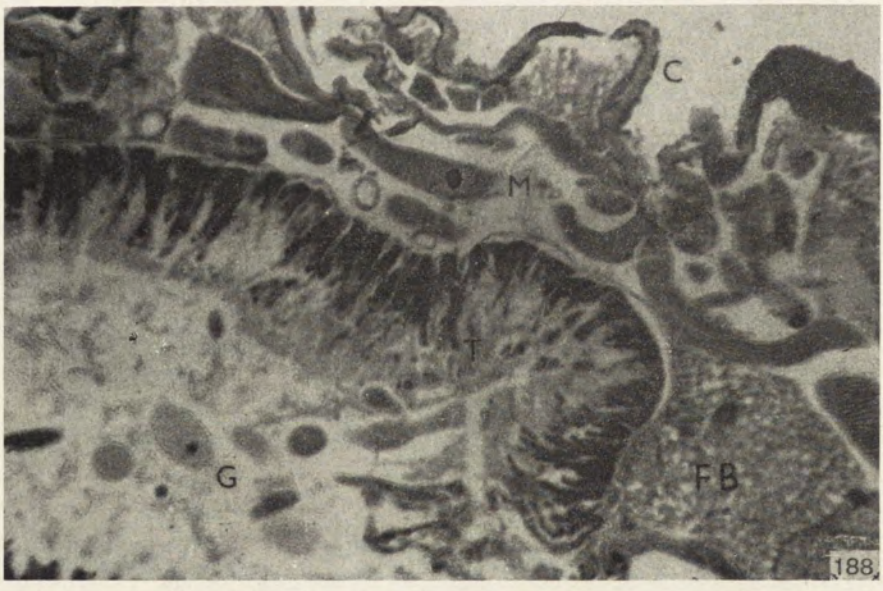






J. J. Lipa auctor phot.



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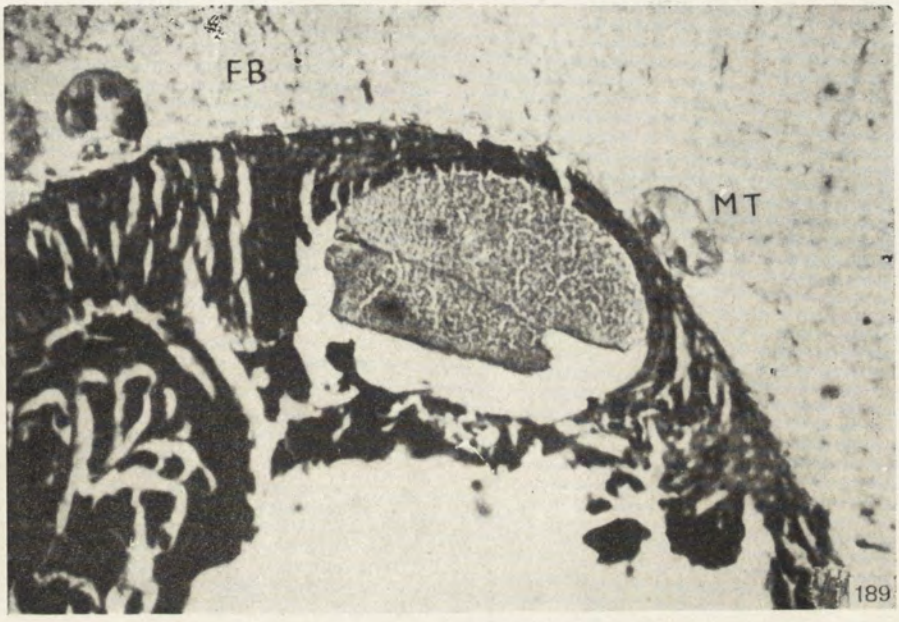

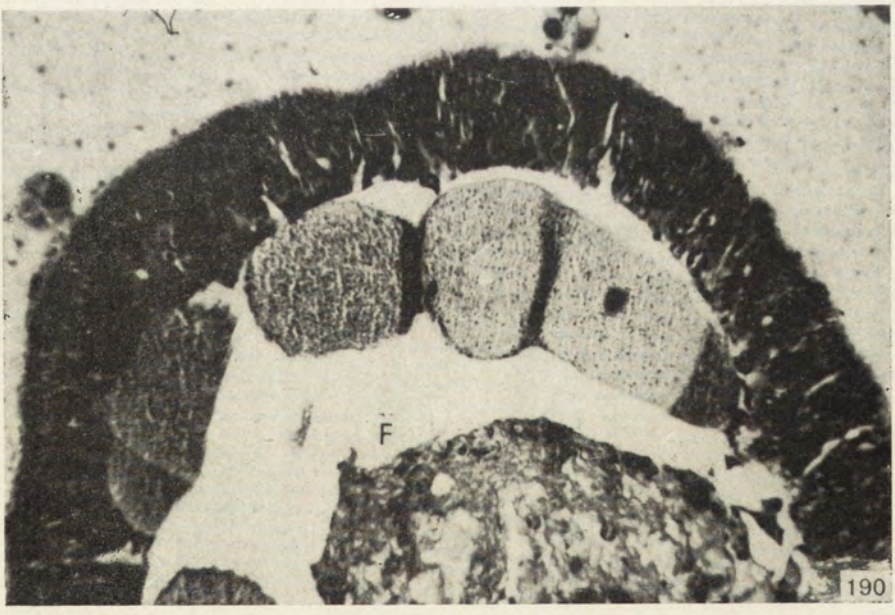

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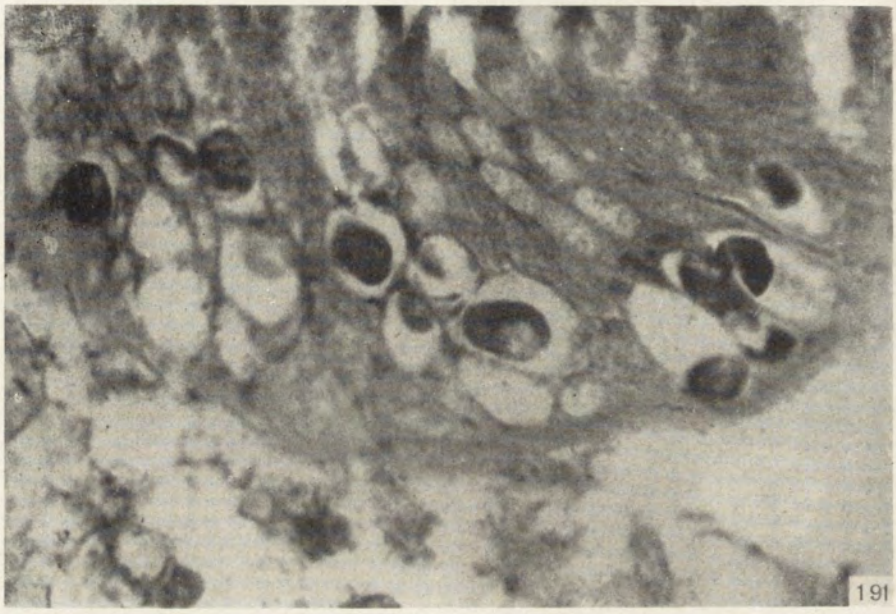
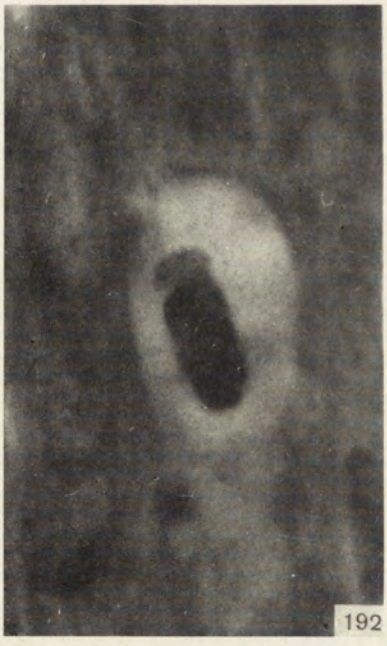
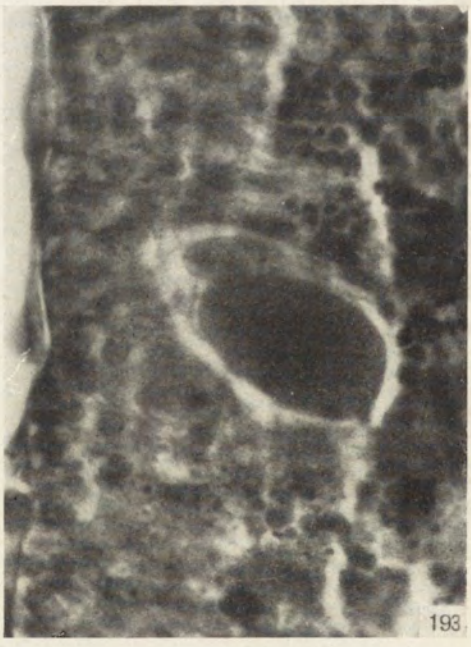
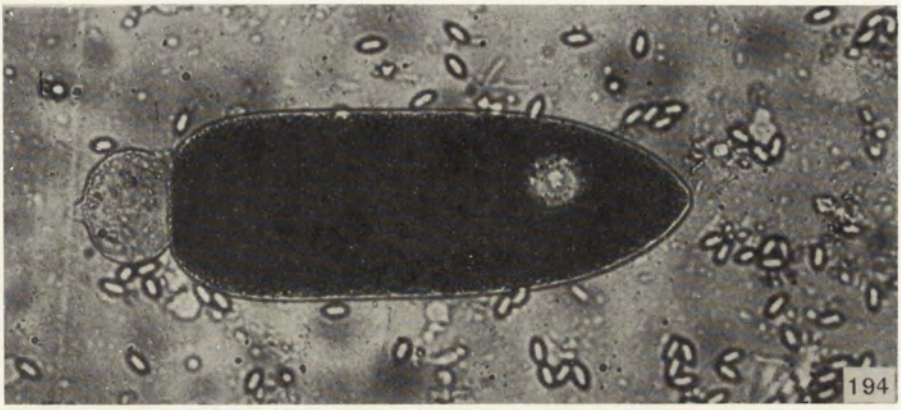






J. J. Lipa auctor phot.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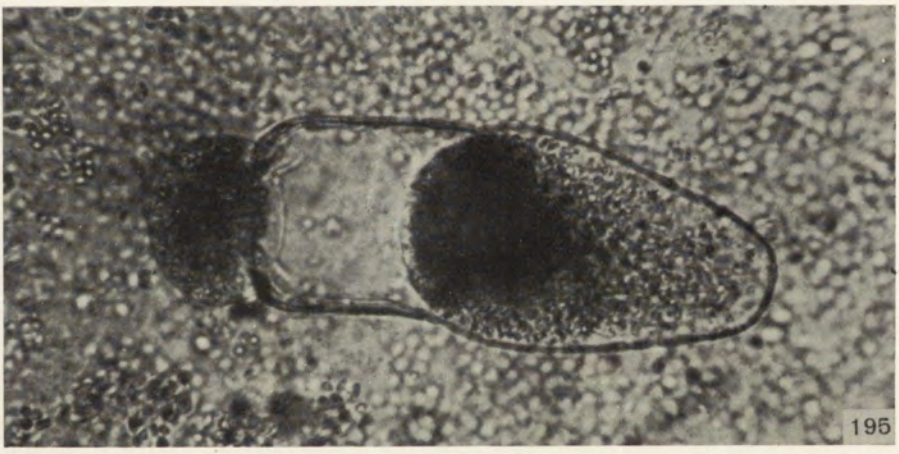
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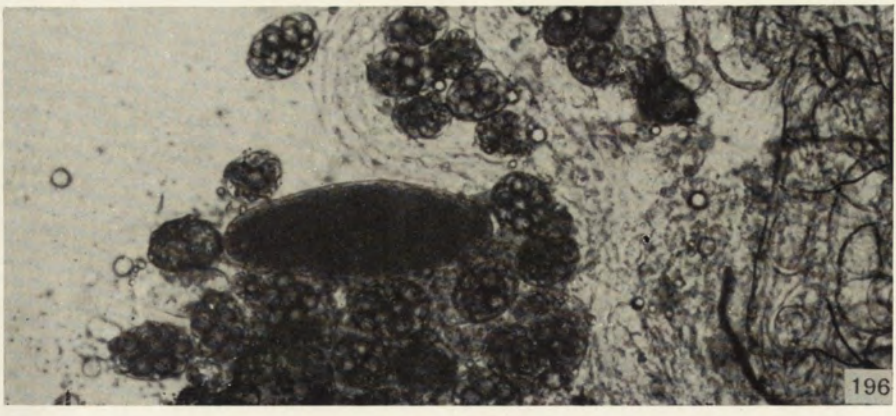
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Fasciculi praeparati:

W. Michajłow: *Euglenoidina (Flagellata)* — parasites of *Cyclopidae (Copepoda)* [*Euglenoidina (Flagellata)* — pasożyty *Cyclopidae (Copepoda)*] — A. Czapik: La morphologie de *Uronema elegans* Maupas et de *Uronema parva* sp. n. [Morfologia *Uronema elegans* Maupas i *Uronema parva* sp. n.] — M. Wolska: Study on the family *Blepharocorythidae* Hsiung. IV. *Pararaabena dentata* gen. n., sp n. from the intestine of Indian elephant [Badania nad rodziną *Blepharocorythidae* Hsiung. IV. *Pararaabena dentata* gen. n., sp. n. z jelita słonia indyjskiego] — Г. А. Штейн: Паразитические инфузории *(Peritricha, Urceolariidae)* рыб бассейна Амура [Parasitic ciliates *(Peritricha, Urceolariidae)* of fishes of the Amur basin] — T. Brown: A reconsideration of the nomenclature and taxonomy of *Aspidisca costata* (Dujardin, 1842), (Ciliata) [Neue Erwägungen über die Nomenklatur und Taxonomie von *Aspidisca costata* (Dujardin, 1842), (Ciliata)] — J. Lipa: *Herpetomonas chatoni* (Paillot) comb. nov., a flagellate parasite of adult moth of *Agrostis segetum* Schiff. *(Lepidoptera: Noctuidae)* [*Hepertomonas chatoni* (Paillot) comb. nov., wiciowiec pasożytujący w motylu *Agrostis segetum* Schiff. *(Lepidoptera: Noctuidae)*] — J. Lipa: Observation on gregarines of *Gammaridae (Crustacea)* in the Baikal Lake [Obserwacje nad gregarynami kiełży *(Gammaridae: Crustacea)* jeziora Bajkał] — J. Lipa: *Nosema lepturae* sp. n., a new microsporidian parasite of *Leptura rubra* L. *(Coleoptera: Cerambycidae)* [*Nosema lepturae* sp. n., nowy gatunek mikrosporidia pasożytujący w *Leptura rubra* L. *(Coleoptera: Cerambycidae)*] — I.I. Skoblo and D. V. Ossipov: The autogamy during conjugation in *Paramecium caudatum* Ehrb. I. Study on the nuclear reorganisation in the course of the first three stages of synkaryon division [Автогамия при канъюгации *Paramecium caudatum* Ehrb. I. Изучение ядерной реорганизации для стадии III деления синкариона] — A. Grębecki and E. Mikołajczyk: Ciliary reversal and re-normalization in *Paramecium caudatum* immobilized by Ni ions [Rewersja rzęskowa i powrót do normy u *Paramecium caudatum* unieruchomionego przez jony Ni] — J. Rostkowska and W. Moskwa: The influence of magnetic field on susceplibility for toxic compounds in *Spirostomum ambiguum* Ehrb. [Wpływ pola magnetycznego na wrażliwość *Spirostomum ambiguum* Ehrb. na związki toksyczne] — M. Doroszewski: Responses to shake of water in course of regeneration in *Dileptus cygnus* [Reakcje *Dileptus cygnus* na wstrząs wody w przebiegu regeneracji]

Cena zł 40.—

Fasciculus: