Watson

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STUDIES ON GREGARINES

Including Descriptions of Seventeen New Species and a Synopsis of the Eugregarine Records from the Myriapoda, Coleoptera and Orthoptera of the World

BY

MINNIE ELIZABETH WATSON

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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Minnie Elizabeth Watson

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BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

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Henry B. Ward
In Charge of Major Work

Henry B. Ward
Head of Department

Recommendation concurred in:

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INTRODUCTION

This paper is the natural outcome of an intensive and extensive study of Gregarines found parasitic in various Orthoptera, Coleoptera and Myriapoda during the past three years.

The work was done chiefly in the Zoological Research Laboratory in the University of Illinois, under the supervision of Professor H. B. Ward. I am deeply indebted to Professor Ward for his direction and kindly suggestions throughout the work. One of the species was found and studied at the Biological Laboratory of the Brooklyn Institute, at Cold Spring Harbor, New York, and I wish to thank Dr. C. B. Davenport for the opportunity of carrying on investigation at the Station. I wish also to thank Professor F. D. Barker, Professor H. B. Baker, and Mr. Elmer Shafer for kindly sending me material from which parasites were obtained.

The gregarines were studied with reference to their biology, including habitats, relation to the host, seasonal distribution, and character of movement, and in order to determine the modes of reproduction. They were also studied from a systematic point of view and seventeen new species are here described. A further object in view was the recording in

concise form of the facts concerning all the polycystid gregarines which literature records from the Orthoptera, Coleoptera and Myriapoda of the world; and a list was made of all the polycystids known, with their hosts so that species will not be recorded as new which have hitherto been discovered and that new species will not be given names already used.

Technique

The method used in studying the live parasites was as follows:The anterior and posterior ends of the host are clipped off as closely as possible and the alimentary tract is drawn out intact and then slit lengthwise with fine scissors and placed flat on a slide. The masses of food and parasites are teased out carefully to form a layer as thin and nearly transparent as possible.

I find distilled water and normal salt solution the best media for observation of the live material. A minimum amount of water is used and a cover slip placed above to prevent rapid evaporation and the presence of irregular reflecting surfaces. The animals are then in an unnatural medium and will disintegrate sooner or later, so sketches must be drawn for measurement as soon as possible after removal, a minimum amount of light and a medium microscopic power (3 ocular and 3 or 5 Leitz objective) serving for general purposes. When the parasites are nearly transparent (e.g. those in the Coccinelli-

dae) a drop of iodine-iodide solution renders them visible; safranin in water, filtered, serves to bring out in vivo the nucleus and sometimes the longitudinal striations.

Although the parasites are best studied alive, some stained preparations are valuable. In order to preserve parasites in toto for future study, the intestine is slit longitudinally and teased apart gradually to loosen the food masses and the parasites. The whole is then dropped into the fixing solution and agitated gently, when the free parasites drop to the bottom of the dish. The best fixing agent is corrosive-acetic washed with 50% alcohol and iodine and with 70% and iodine, and kept in 70% alcohol until needed. Picro-formol (Bouin) was used in some instances with good results. For staining the totos, two methods were used. The slide was smeared with a very small amount of egg albumen and the animals dropped upon it from a capillary pipette. The slide was then placed horizontally in a dish of 95% alcohol for about two minutes to coagulate the albumen and then carried down the alcohols to a water solution of Ehrlich's hematoxylin or to an alcoholic solution of borax-carmine and counterstained with picric acid. The alcohols and stains should be placed in flat dishes and the slide kept horizontal and gradually immersed and withdrawn from each solution to insure against loss of the parasite from the slide. Many grades of alcohol should be used and the parasite

kept in each alcohol for fifteen minutes.

If the material is abundant, the parasites may be stained en masse in a small dish but there is always considerable loss in the transfer of stains, etc.

The study of toto mounts should be supplemented as far as possible with sections. In the instance of the small species not visible to the eye, sections afford the only means of study outside of live material. The whole alimentary canal is fixed intact and sectioned. Sections are best cut thin, from two to five micra, and the stain used with best results is Ehrlich's hematoxylin counter stained with erythrosin or eosin or used alone. They reveal either the character of the organ of attachment of the young parasites to the host cells or the fact that their development is intercellular, the position of the sporonts with relation to the cell walls, and various points in structure of the adults. They also disclose the position inside or outside of the alimentary tract or its appendages. If the parasite is able to bore through the walls of the intestine into the coelom, this is often depicted in a series of sections; if the pyloric caeca are seats of infection the fact is revealed in the same manner.

Previous Work

In 1903 Minchin adequately summarized the history of gregarines from the time of Redi, who in 1708 recorded the first

account of what was possibly a gregarine, through Dufour, who gave the first authentic account of the genus which he called Gregarina in 1828, up to 1903. Other histories of the previous work done were given by Lankester (1863), Bütschli (1882) and Léger (1892).

Since 1903, work on gregarines has been largely systematic, and many new species, a dozen new genera and a very few new families have been named. The suborder Schizogregarinae (Minchin) has received considerable attention from such workers as Léger and Duboscq, Fantham, Siedlecki, Dogeil, and Brasil, and new species have been described by them from Crustacea, tracheate Arthropoda and Holothuria. Some new species have been described among the Eugregarinae abroad since 1903 and in the United States Crawley, Hall and Ellis have contributed data concerning many new species, all parasitic in tracheate Arthropoda.

Lühe (1903) and Sokolow (1911 and 1912) have written on Physiology, Morphology and Reproduction of gregarines in general.

A List of the Special Terms Which Are Applied to Gregarine Morphology

ASSOCIATION· The group formed by the attachment of two or more sporonts.

BIASSOCIATIVE. The adjective referring to an association formed by two sporonts attached by unlike ends.

CEPHALINE Gregarine. One which possesses an epimerite at some stage in its life-history.

CEPHALONT. A term applied to the young cephaline gregarine with an epimerite, whether it is attached to the host cell or free in the lumen. Synonymous with trophozoite.

CYST. The structureless membrane secreted by the associated sporonts at the beginning of reproduction.

DEUTOMERITE. The portion of a sporont which is preceded by the septum.

ECTOPLASM. The outer zone of the body comprising the epicyte, sarcocyte and myocyte.

ENDOPLASM. The granular protoplasm found within the ectoplasm.

EPICYTE. The thin fragile external layer of the ectoplasm.

EPIMERITE. The temporary or rarely permanent structure at the anterior end of the protomerite by which the young parasite is attached to the host cell. It is derived from the epicyte.

ISOGAMETES. The gametes which are morphologically identical. Present in most gregarines.

KARYOSOME. A chromatic mass surrounded by plastin and contained within the nucleus. The young individuals possess a single karyosome which buds off others as the animals increase in size.

LONGITUDINAL Striations. The very delicate ridges which form the outside of the epicyte.

MYOCYTE. An hypothetical ectoplasmic layer consisting of the myonemes.

MYONEMES. The network of contractile fibrillae embedded in the periphery of the endocyte and running around the animal in a crosswise direction. They produce movement of the body.

OCTOZOIC Spore. A spore containing eight sporozoites.

POLYCYSTID. A term applied to gregarines which possess a septum which divides the endocyte into regions. Infrequently several septa are present.

PRIMITE. The first individual in an association of two or more sporonts.

PROTOMERITE. The portion of a sporont which precedes the septum.

PSEUDOCYST. The residual protoplasm after the spores are separated off, which acquires a membranous wall which swells until the true cyst-wall is burst and allows the extrusion of the ripe spores.

SARCOCYTE. A middle layer of the ectoplasm.

SATELLITE. Any sporont in an association which is attached behind the primite. Generally there is but one, but sometimes several are attached in a cluster to the posterior end of the primite or arranged linearly one behind the other.

SEPTUM. The thin layer of sarcocyte which separates the two portions of the sporont, the protomerite and the deutomerite.

SPORE. The body into which the zygote develops after the acquisition of a resistant outer covering.

SPORE Duct. A long tubular outgrowth from the cyst through which the spores are extruded when ripe.

SPOROCYST. The covering or coverings of the spore.

SPORONT. An adult gregarine living free in a cavity and deprived of its epimerite.

SPOROZOITE. One of the eight more or less small falciform bodies which is released when the spore walls are absorbed.

TROPHOZOITE. The young parasite which is living either entirely intercellular or attached to an epithelial cell of the host by an epimerite. Synonymous with cephalont.

ZYGOTE. The body formed by the copulation of two gametes.

Part One

BIOLOGY

A: THE HOSTS INFECTED

Only the Invertebrates are parasitised with any of the various sorts of gregarines. These Sporozoa have been reported from the following phyla: Coelenterata, Echinodermata, Plathelmonthes, Coelhelminthes (the Archianellida, Gephyrea, Hirudinea, and the Polychaete and Oligochaete Annelida), Arthropoda (the Crystacea, Onycophora, Myriapoda, Hexapoda and Arachnida), Mollusca and Chordata (the Enteropneusta and Tunicata). Thus far the only animals below the vertebrates from which gregarines have not been reported are the phyla Rotifera, Porifera and the Protozoa and the sub-phylum Leptocardii.

Partial List of Animals Examined for Parasites

MYRIAPODA	No. examined	No. parasitised
Scutigera	10	0
Scolopendra sp.	5	0
Scolopocryptops sexspinosus	10	2
Lithobius sp.	6	..
Geophilus sp.	15	0
Euryurus erythropygus	2	2
Callipus lactarius	24	20
Parajulus impressus	30	25
Polydesmus virginiensis	6	0
Spirobolus marginatus	6	0
HEMIPTERA		
Reduvius sp.	10	0
Many unideitified		0
DIPTERA		
Musca domestica	10	0
Unidentified larvae	50	0

NEUROPTERA		
Damsel fly larvae	15	0
Dragon fly larvae	30	0
LEPIDOPTERA		
Many unideitified larvae		0
MOLLUSCA		
Venus mercenaria	10	0
Mactra solidissima	5	0
Mya arenaria	10	0
Mytilus edulis	5	0
Modiola sp.	5	0
Pecten irradiens	10	0
Ostrea virginica	15	0
CRUSTACEA		
Porcellio sp.	8	0
Oniscus asellus	30	0
Talorchestic longicornis	500	200
Orchestia agilis	50	2
Orchestia palustris	10	0
Balanus eberneus	5	0
Balanus balanoides	50	0
Panopeus sayii	10	0
Eupagurus bernhardi	25	0
Gelasimus pugilator	50	40
Gelasimus pugnax	20	20
Cancer irroratus	4	0
Platyonichus sp.	4	0
Libinia dubia	)	
Libinia emarginata	)50	40
ANNELIDA		
Nereis sp.	5	5
Amphitrite sp.	6	2
Enchytraeus albidis	12	5
Heliodrilus caliginosus	6	6
Allobophora foetida	4	4
Lumbricus terrestris	3	3
Cerebratulus lacteus	4	0
COLEOPTERA		
Carabidae	25	3
Galuita janus	30	0
Melanotus fissilis	7	0
Hydrophilus triangulis	3	0
Pterostichus stygicus	10	4

Dytiscidae	25	0
Gyrinidae	15	0
Dinetus assimilis	5	0
Agabus semivittatus	4	0
Tenebrionidae	15	7
Passalus cornutus	24	0
Elateridae	7	4
Coccinella sp.	10	3
Coccinellidae	30	0
Amara angustata	5	5
Coptotomus interrogatus	7	5
ORTHOPTERA		
Ceuthophilus stygius	15	8
Forficula auricularia	15	0
Ishnoptera pennsylvanica	10	4
Gryllus abbreviatus	200	150
Gryllus pennsylvanicus	100	80
Melanoplus femur-rubrum	300	200
Melanoplus differentialis	50	10
Melanoplus acrididum	5	5
Melanoplus bivitattus	10	6
Schistocerca americana	2	1
Dissosteria carolina	10	8
Encoptolophus sordidis	25	15
Arphia sulphurea	5	5
Hesperotettix praetensis	10	8

This list is incomplete for many animals were examined and no record kept when no parasites were present. The numbers given above represent approximate estimates.

Localities Represented

The hosts from which the parasites described herein were found chiefly in and around Urbana, Illinois. Some were taken in New Jersey and on Long Island, N.Y., and material was received from Haverford, Pa., Colorado Springs, Colo. and Lincoln, Neb. which afforded new data on distribution of several species.

Seat of Infection

The most frequently observed location of the sporonts in the hosts is the mid-intestine. The parasites are not found in the oesophagus or crop and in the rectum only when the infection is exceptionally heavy. The cysts are often recovered from the mid-intestine but usually from the rectum. They can be easily procured from the moistened feces of those species in which they are large enough and opaque enough to be distinguished. I have been able to procure them thus only from the Acrididae.

Cross-sections of the host intestine reveal the fact that the sporonts lie close to the epithelium and not scattered through the food masses. In the Myriapoda they lie deeply seated between the lobes of the intestine where they are not easily dislodged. Thus the parasites are in position to absorb the richly laden digestive liquids just before the latter reach the villi. The parasites thus placed are not in danger of being swept along to the exterior by the peristaltic movements in the intestine.

Sporonts and trophozoites are also found in the pyloric caeca of the Acrididae. In the Myriapoda the sporonts are able to bore through the walls of the intestine and are found, though rarely, in the coelom.

The Stenophoridae are intercellular and the trophozoites are embedded in the intestinal cells while the Gregarinidae

are not, one end of the trophozoite only being projected into the epithelial cell.

Seasonal Variation Within the Host

Evidence on seasonal variation was confined to the Acrididae and the Gryllidae and extended over a period of two years. Locusts were collected at Urbana from early spring until June 20 and were very generally parasitised but the number of parasites per host was small, averaging from one to ten. The nymphs of the Acrididae which hatch in the early spring were not infected in APril but when examined in June showed a slight infection.

In the fall, observations were again made at Urbana and disclosed considerably greater parasitism than in the spring. Nearly every locust examined was heavily infected, fifty parasites being an approximate minimum.

The same increase in the fall is true of the Cricket parasites. About fifty adults were examined at Urbana in June and it was found that only five or six were infected, and then with very few parasites. In the fall, practically every cricket examined revealed heavy infection.

Crickets were examined frequently throughout July and August at the Biological Laboratory at Cold Spring Harbor, New York. The parasitism here steadily increased from sparse to heavy inside of two months. Conditions here were, however,

particularly favorable for the rapid increase. The crickets were collected on the Sand Spit, a long narrow peninsula separating the Inner and Outer Harbors and they were taken from under the flotsam and jetsam brought to the inside of the spit by the incoming tide. Here there are no waves to change appreciably the upper limite of the tidal zone and the crickets are undisturned. The cricket population is large because of the influx of organic debris. Thus the insects/are confined to a restricted habitat and as cysts are produced and the spores scattered the animals are reinfected over and over again.

A number of crickets were taken in August from debris along the shores of Northport Harbor and from Huntington Beach, Long Island and all were uninfected. Both these localities are part of the exposed shore of Long Island Sound. A number were also taken inland at Arlington, New Jersey and were also uninfected. Practically every cricket examined in the later summer at Cold Spring Harbor and at Oyster Bay (four miles away) was infected. The only explanation which can be offered by the writer for these phenomena is that the spores, having once become established in restricted areas, have no way of becoming scattered broadcast but reproduce themselves in enormous numbers in these restricted localities.

Relation of Parasite to Host-Tissue

The relation of the parasite to the tissues of the host is a subject still under discussion. It is a field in which very little actual investigation has been undertaken and one which offers many interesting problems in biological chemistry.

In the growing stages, the Eugregarine is either completely intracellular without an epimerite, or possesses an epimerite by which it is attached to the epithelial cells of the host intestine. The Acephalinae (including Monocystis) and some of the Cephalinae, e.g. the Stenophoridae and the genus Frenzelina of the Gregarinidae, are intracellular; most of the cephaline Eugregarines are, however, not intracellular but possess epimerites which alone penetrate the host-cell.

Thus there are two modes of infection. When the parasite is completely intracellular, the sporozoite penetrates the free end of the cell, works its way inward by ameboid movement (Léger and Duboscq 1909) and comes to lie in the proximity of the nucleus. The parasite at once begins to affect the nucleus, causing the breaking up and rearrangement of the chromatin into small more or less spherical bodies, which reacts differently to the stain than do the normal nuclei. The cytoplasm also is affected chemically for it stains less deeply than the normal cell cytoplasm.

Siedlecki (1901) thinks these results are due to a substance secreted by the parasite. Using Monocystis ascidiae as his material, he noted that the parasitised cell is at first greatly enlarged. The parasite within the enlarged cell then increases enormously in size so that the host cell and its contents may be ten or more times the size of the normal epithelial cell; the parasite finally breaks out, for its rate of growth exceeds that of the epithelial cell, and the cell shrinks and finally disappears, the adjoining cells gradually filling in the space left. The author says the chemical substance secreted by the parasite at first stimulates growth in the epithelial cell and later retards it, killing the cell, the parasite escaping when dissolution has set in. The normal excretions must be emptied into the cytoplasm of the host-cell and may provoque changes therein but that the cell is killed is a question. There is no other source of food for the parasite than that by the absorption from the cell which surrounds it and it appears to the writer that the shrinking of the cell is due at least in part to the gradual withdrawal from it of its liquid content and the absorption of the latter by the contiguous parasite. How else the intracellular parasite grows is not easily explainable. If the host-cell is killed by toxins which are the excretory products of the parasite, the dead protoplasm is gradually used up as food for the growing organism. An animal is generally poisoned by its own excretory products;

the gregarine would seem to be an exception unless we suppose that the host-cell remains alive and that it throws off the parasite's excretions along with its own waste products.

Those parasites which are not intracellular possess epimerites by which they are attached to the free end of the epithelium of the host, the rest of the parasite lying in the lumen of the intestine.

Five questions may be asked in this case: (1) Does the epimerite absorb food from the parasitised epithelial cell? (2) Does the epimerite absorb from the latter all the food that the gregarine receives? (3) Does the epicyte of the gregarine body absorb all the food from the lumen of the intestine and the epimerite act only as a holdfast organ? (4) Is a toxic substance secreted and given out into the parasitised cell through the epimerite of the parasite? (5) Is a toxic substance given out through the walls of the parasite body into the lumen of the intestine, which is absorbed by the parts of the epithelial cells nearest the surface?

Laveran and Mesnil (1900) state that, in Pyxinia frenzeli, the cell to which the parasite is attached at first greatly hypertrophies, then atrophies and disappears completely about the time the cephalont is ready to discard the epimerite and live free in the intestine. The hypertrophy, they say, is due to an increase in the liquid content of the cell only, with a de-

crease in the density of its cytoplasm and nucleus. They do not attempt to give an explanation of the cause of the phenomenon.

Léger and Duboscq (1902) think this hypertrophy is only apparent and not real, for the penetration of the sporozoite into the cell irritates it so that the cell contracts in length at the same time increasing in width, the latter phenomenon giving rise to the idea that there is hypertrophy. They think the parasite absorbs the cell content through the epimerite and that constant and steady increase in the withdrawal of the cell sap accounts for the apparent atrophy.

Pyxinia mobüszi possesses a long tongue-like epimerite which extends through the penetrated cell longitudinally to the mesothelial layer of the intestine. The penetrated cell seems to be uninjured by this epimerite and the authors think the animal absorbs blood from the capillaries in the mesothelium by means of the epimerite.

The Dactylophoridae, e.g. Nina nobilis, have epimerites with many long radices which Léger and Duboscq (1902:458) state penetrate at many places several adjoining cells and probably function as an apparatus for nutrition. Many species, Beloides, Pyxinia, etc., have a long central style in the epimerite which punctures the cytoplasmic vacuoles and absorbs the cell sap directly.

Siedlecki (1901:98) says the long filaments from the

epimerite of Nina nobilis penetrate into the epithelial layers between the cells and do not puncture the cells themselves, as Léger and Duboscq think.

Minchin (1912) says that the cytoplasm of the cell is absorbed by the parasite which I infer to mean used as food, and that "when the cytozoic phase is past and the host cell exhausted, the parasite drops off, shedding its epimerite."

The present writer agrees with Léger and Duboscq and with Minchin that there is absorption through the epimerite. When a free cephalont is stained, its epimerite is seen to contain considerable endoplasm and not to be an ectoplasmic structure merely, filled with sap. Moreover, stained sections of parasitised epithelium reveal the presence of attached cephalonts which are transparent or nearly so and do not absorb the stain. Living material often contains large numbers of free cephalonts which contain no or but very little protoplasm. These facts lead to the theory that the epicyte is not yet in physiological condition to absorb fluids from the intestine but that all such absorption takes place through the epimerite. Whether or not the epimerite possesses an epicyte of different structural character from that of the rest of the body is not known. It does, however, possess a very delicate, fragile, highly permeable layer susceptible to slight changes in osmotic pressure. The suggestion may be made that because the chemical constituency of the fluids in the lumen

of the intestine and in the epithelial cells is obviously dissimilar, the parasite may or may not be able to absorb either of these fluids through the epicyte; and if they are absorbed may not be nourished by one of the ingested fluids. The fact that the epimerite often contains protoplasm while the rest of the cephalont is still transparent or nearly so and that the cephalont remains nearlytransparent as long as the epimerite persists leads to the theory that whereas at first all the absorption takes place through the epimerite, as the cephalont develops there occurs a gradual change in food from the predigested cell-sap to the juices free in the intestinal tract as well as a transfer in its mode of absorbing these substances from the epimerite to the general epicyte of the body. The general epicyte of the body may be physiologically different when the cephalont is very young and when it is nearly ready to discard the epimerite.

The third question: Does the epicyte of the gregarine body absorb all the food from the lumen of the intestine and the epimerite only act as a holdfast? has been answered in the negative above. There may come a time when maturity approaches and the epimerite is at the point of being discarded when the question may be answered in the affirmative; during the greater part of the cephalont life, however, the epicyte is probably ineffective in absorbing nourishment.

Is a toxic substance given out into the parasitised cell through the epimerite of the parasite? Siedlecki (1901:100)

says the presence of the parasite within the cell (Monocystis ascidiae) incites hypertrophy, then atrophy and that these phenomena are due to the chemical action of the parasite. In another species, however, Nina nobilis, which possesses numerous long protoplasmic filaments which penetrate deeply into the epithelium of the intestine, the author says of these threads

> "Tous ces changements provoques dans l'epithelium sont de nature purement mechanique."

They have observed changes in form and of displacement of the cells but regard these as unallied to the hypertrophy and atrophy which is induced by chemical excitation.

Siedlecki finds in one instance a chemical effect excited by the presence of the parasite in or attached to a cell; in another species purely a mechanical effect; while Léger and Suboscq, as mentioned, believe the apparent hypertrophy due to mechanical irritation of the parasite upon the cell rather than to any toxin secreted by the parasite. Yet illustrations given by Léger and Duboscq to illustrate mechanical effect indicate a different staining reaction in the case of many of the parasitised cells and a rearrangement of the chromatin in the nucleus unlike that in normal cells.

The last question is stated as follows: Is a toxic substance given out through the epicyte of the parasite into the lumen which is absorbed by the parts of the epithelium nearest the surface? It is often the case that the free end of the cell is

shrivelled first. This end is nearest the hypothetical center of influence of the toxin which would be given out through the body of the parasite exposed in the lumen. It is also the end which is penetrated by the epimerite and the part naturally used as food first. The fact that the whole cell often reacts differently to the stain and not the outer end only and that the deep-seated nucleus is affected by the very small parasite indicate the untenability of this theory as a cause of cellular reaction to the parasite.

A theory for the shrivelling of the parasitised cell may be derived from the facts of liquid pressure. The cell-wall is normally under some pressure from within, due to turgor. When the cell is punctured by the sporozoite, some of the cell-sap might ooze out. Most of the liquid content of the cell is, however, contained in vacuoles and not liable to be affected by the puncture. The viscid cytoplasm of the cell would probably be unable to find exit through the small opening. The puncture is as small as is the penetrating sporozoite and closed by the same. The parasite grows rapidly, enlarging the opening only as fast as the parasite grows. I have in no instance seen a section wherein the cell-wall was torn by the growing animal, and in every instance the two fitted tightly together so as to form seemingly one layer at the nect of the epimerite. Thus the theory of loss of cell-contents by the oozing out through the puncture made is untenable.

B. MOVEMENT IN GREGARINES

Movement in Gregarines has probably been observed as long as the animals themselves. Dufour (1837:11) said

> "Leurs mouvemens sont fort obscurs et leur locomobilité est d'une lenteur extrême; cepandant je les ai constatés."

Siebold (1837:408) doubted that Gregarines were animals for he saw no movements. Kölliker (1848:32-3) described movement of the gliding type as

> "Eine langsam vorwärtsschreitende Bewegung ohne sichbare Contractionen der Leibeshülle".

He also noted the bending movement and described it as follows:

> "Bewegungen nach dieser oder jener Richtung durch mehr oder minder energische, auf verschiedene Weisen sich combinirende Zusammenschnurungen der Leibeshülle."

Kölliker did not attempt to explain the cause of these movements but he answered the question raised by Siebold "Are the Gregarines animals?" by describing the violent contractions seen in many of his new species, movements which only animals possess.

Leidy (1849:232) "detected movements of an animal character" and discovered the longitudinal striations of the epicyte which he thought were mucsular in function.

Van Beneden (1872) discovered the network of transverse fibrillae which Schneider (1875:505-6) called the myocyte. Contractility of the elements in this myocyte has since then been assigned as the basis for the bending movements of Gregarines.

The first explanation for the gliding movement was offered by Schewiakoff (1894) who supposed a gelatinous secretion from the posterior end of the body formed a stalk and that as the animal secreted new additions to this stalk it pushed itself forward by that amount.

Porter (1897) probably without knowledge of Schewiakoff's theory, proposed the following hypothesis:

> "It (locomotion) is a 'very slow movement of translation in a straight line' without any apparent contraction of the walls of the body. It is probably caused by a very slight undulatory motion of the under surface of the animal."

Crawley (1902:420; 1903a:57), unaware of porter's hypothesis, came to the same conclusion that an undulatory movement on the under side of the body is the basis for locomotion, and disagreed with Schewiakoff's explanation.

My observations on movement in Gregarines have been chiefly confined to the species Leidyiana solitaria, of the family Gregarinidae because of its activity and the readiness with which material is obtained.

In the normal intestinal juices of the host when the intestine is first opened, practically none of the animals are in motion; they lie rather in inert masses from which the name Gregarine is derived. Since the juices rapidly evaporate and cannot be secured from other animals in sufficient abundance to observe normal movement over a considerable portion of time,

artificial media must be used, the most common being distilled water. This causes the animals to disintegrate after periods varying from fifteen minutes to three or four hours, depending on the age of the parasites and their ability to adapt themselves to a change in external pressure. The young fragile animals disintegrate rapidly; the oldest often resist the change in external pressure for several hours. When an epimerite is present on a free individual, it is quickly ruptured in a water medium.

Egg-albumen is not a satisfactory medium in which to observe motion, for the parasite has great difficulty in ploughing its way through the thick substance. Rupture of the walls is prevented by its use because of a similarity in density between the body and the medium.

Various acids in 0.5% solution were used and their effects on motion noted, among the acids being hydrochloric, nitric, acetic, sulphuric, and tannic. All of them killed the animals very quickly and caused the protoplasm to collect in masses; the epicyte was also often ruptured. Chloroform and sulphuric ether in 0.5% solutions produced no apparent structural changes but the parasites were quickly anaesthetised.

Normal salt solution acts as a stimulant on motion and in it the parasites remain alive and active longer than in water. It is therefore the best medium in which to observe motion. Sea water has practically the same effect as normal saline.

Movement of locomotion consists of a uniform gliding progression with no apparent localized motion of the body. It is best seen in animals from a freshly opened host intestine mounted on a slide and supplied with an abundance of light. The parasites are negatively heliotropic and consequently attempt to avoid the light rays by moving rapidly from the tissues toward the periphery of the cover slip and down the sides until they encounter masses of debris under which they try to hide.

The rate of progression has been measured in several instances. It averaged 0.8 micron per sec. in Leidyiana solitaria. The same individual is able to increase or decrease its rate of motion through a considerable range. A sample set of successive rates, measured at intervals of 15 sec., reads as follows: 0.7 μ per sec., 1.8; 4; 5.6; 2.8; 2.6; 1.5; 0.8; and 0.0. An accompanying diagram illustrates progression combined with bending movement and the distances covered in successive intervals, Fig. 233. In the Stenophoridae, motion of progression is slower, an average reading .007 per sec. for two species, one of which was five times the length of the other and of correspondingly greater volume.

Just how the progressive movement is effected is a matter much discussed. Schewiakoff (1894) makes the statement that it is caused by the secretion of a hollow gelatinous "stalk" formed of cintiguous threads at the posterior end of the

body which pushes the animal forward. He says that the gregarine is able to move only until its store of secretion is exhausted and cannot go on until it has accumulated the materials from which to secrete a new addition to the "stalk."

Upon cutting off most of the light from the field, there can be seen many fine threads leading from the posterior end of the gregarine back to a mass of debris from which it is apparently trying to extricate itself. A slight motion of the microscope or of the table beneath will cause the threads to tremble; but moving the cover-slip a trifle does not rupture them. I have often observed the animal swinging about in an arc at the end of this fastened thread or strand of threads without breaking it. This was noted in twenty-five instances in a single field and was repeated by the parasites until their walls were ruptured and the protoplasm oozed out.

After a mount has been made for some time and the gregarines have become scattered about in the debris, many animals can often be seen headed away from inert masses, moving a short distance forward and then being jerked quickly back as if by some invisible spring. Rarely is an animal able to free ifself. When it does so, the release is sudden and the distance traversed often as surprisingly great as the time it takes is short. The release may be comparedto the cutting of a tense cord. Generally, however, the parasite is not able to effect its release and keeps

on trying until the walls are ruptured or death ensues from some other cause.

I have never observed backward gliding movement. The only backward motion seen was the sudden jerking mentioned above. This phenomenon may possibly be accounted for in the following manner: The animal exerts considerable effort to move forward against the backward pull of the threads and debris behind it. Its body becomes stretched out long and narrow by the contraction of the myonemes. These myoneme fibrillae suddenly relax and the body becomes shorter and normal in shape. As the tension on the caudal threads is thus released, the body is drawn backward with a sudden jerk. The motion is thus passive and simply reaction and not actively incited motion in a backward direction.

It is not to be denied, then, that under some circumstances there are formed gelatinous threads which seem to fuse and form a thick thread or strand from the posterior end of the body, but they are obviously an hindrance rather than an incentive to progression. My theory concerning the reason why there is such a group of threads present will be discussed later.

Granted here that such a group is present, it obviously comes from the animal itself and is carried to the posterior end of the body by the longitudinal ridges which gregarines possess (See fig. 243 for illustration of these longitudinal ridges). The animal in a mass of debris tries to liberate itself. In this motion there is secreted a lubricating substance which in a medium

other than the normal digestive juices adheres to the debris. In endeavoring to get free, a great deal of energy is expended and considerable lubrication secreted and so the thread is formed from which the animal is unable to extricate itself. Each added trial only causes more secretion to be poured forth and makes the snare the more secure. The body becomes drawn out long and slender indicating the strain which the animal undergoes. (Fig. 236).

I have made the hypothesis that normally there is a secretion from the body which reaches the posterior end of the body. When a parasite is moving through a medium in which there is fine scattered debris, it picks up much of it. After a considerable accumulation has taken place, one of two things may happen. The end-masses may drop off by their own weight, the force exerted by the strand of threads being less than that exerted either by the progressing animal or by the dead weight behind. If the strand withstands the stress exerted by the moving animal but the dead weight exerts greater force than the combination of the other two, the strand and the animal, the parasite is caught and eventually dies.

The presence of the caudal threads can often be demonstrated with carmine. In a freshly made mount, the carmine does not seem to adhere and I have never been able to demonstrate the presence of threads in a freshly opened intestine. The medium must then be other than the normal digestive juices. It thus

seems possible that no strands are present in the normal condition but that they harden only after being for some time in an unnatural medium. Instead of hardening and condensing in the host, the constituents of the secretion are probably dissolved in the digestive juices as fast as formed.

As for the reason for the presence of the semi-gelatinous secretion from the body, I accept the hypothesis which Porter states, that movement is probably caused by a very light undulatory motion of the under surface of the animal. Just as Limax moves forward by slight ventral, and dorsally imperceptible, muscular movements in a vertical direction on an underlying surface the friction of which is caused by the secretion of a sticky mucous, the gregarine moves forward by imperceptible vertical movements in the myonemes on that side of the body which happens to be vertical at the time, friction being produced with the under surface by the exudation of mucous from the body. That there is a secretion from the whole body and not only from the posterior region is demonstrated by carmine which adheres in fine particles to all parts of the animal.

It was shown by Schewiakoff that there are tiny pores between the longitudinal ridges. These probably serve as exits for the secretion. The longitudinal ridges carry it backward and away after it has served its usefulness in effecting motion. The secretion is in the form of threads simply because it is

constricted into narrow lines by passing backward between the tiny ridges. The threads are not necessarily continuous but may be often broken.

Thus I am of the opinion that the secretion at the posterior end of the body does not produce motion, but that it is a waste product by the time it has reached this end; it is likewise effective as shown above in inhibiting motion in an unnatural medium as well as of producing it.

Besides the simple progressive movement, a twisting or bending movement is commonly observed. The body bends or twists often with little or no change of position.

This bending motioninvolves chiefly the anterior half of the deutomerite. The protomerite is turned from side to side like the head of a higher animal while the parasite is progressing from place to place. The protomerite, of itself, appears, however, to be incapable of movement and not the slightest change in form has been noticed. The region of greatest capacity for motion is the anterior end of the deutomerite. The endocyte of this region flows out into small pockets made in the elastic epicyte and as a group of two or three small outpushings is made on one side, close together, the protomerite falls to the opposte side. An outpushing of several small pockets just below the bent-over protomerite tends to straighten it; if half a dozen or more are formed in a circle around the anterior end of the

deutomerite, the protomerite will sink into the central depression and often be obscured from sight.

The parasite is able to move through a place much narrower than the width of the body by the contraction and expansion of the epicyte, as in the instance of an amoeba.

Bending movement when the animal is out of its normal habitat may be due to external stimuli such as the endeavor to avoid light and the water medium. When in the normal habitat, the animal does not need to move about in search of food; there is no light to avoid; and the chief function of the bending movement when the parasite is in the intestine is probably the formation of cysts. The animals rotate about an imaginary axis coming closer and closer together by bending more and more, and finally forming a perfect sphere. (See figs. 234, 235 and 238). The formation of cysts by the use of normal saline occurred in twenty-five minutes. The salt solution was removed as soon as the cyst was completely formed and the cyst wasked with distilled water. It developed to completion with the exudation of ripe spores. Cysts have, however, developed in but little longer time in distilled water.

Summary

1. Normal salt solution is the best artificial medium in which to study motion.

2. Locomotion is effected by means of a progressive gliding movement with no apparent localized motion of the body.

3. Progression takes place at the average rate of 0.8 μ per sec. in Leidyiana solitaria.

4. In artificial media, there are formed gelatinous threads from the posterior end of the deutomerite.

5. These threads may be seen with a high power and a minimum amount of light and in a mount which has been made for some time.

6. They do not occur in a freshly made mount.

7. The threads may be demonstrated with carmine granules in solution.

8. The animal probably moves by imperceptible vertical movements of the myonemes of the side which is ventral at the time, and upon a surface whose friction is caused by an exudation of slime from the body of the parasite.

9. This slime (mucous) is secreted by the body and runs out through pores between the longitudinal ridges in the epicyte.

10. The mucous runs backward along the longitudinal ridges to the posterior end and is discharged as a waste product in the form of broken threads or strands.

11. The anterior half of the deutomerite is the region chiefly involved in bending movement.

12. The protomerite is incapable of independent bending movement.

13. The normal object of contortion is the formation of cysts.

Part Two

MORPHOLOGY OF GREGARINES

A: MORPHOLOGY OF THE SPORONTS

The structural characteristics of the Gregarines have been described by many writers, including Delage and Herouard (1896), Bütschli (1882), Minchin (1903 and 1912), Doflein (1911), and others. For this reason, I have not attempted to describe the general morphology of the group but rather facts of form and structure that I have observed in the two families which have been under observation, viz. the Stenophoridae and the Gregarinidae.

a) The Stenophoridae

All of the species of this family are solitary. In all gregarines which reproduce sexually, the union of two sporonts is necessary but in the Stenophoridae this intimate association lasts only while the cyst is being made and not, as in some families, during the greater part of the sporont-life. The cyst is probably formed quickly and this union very brief; no sporonts were seen in the process of cyst-formation.

One characteristic of almost all the described Stenophoridae is the great length of the deutomerite as compared with the protomerite. The ratio is seldom less than 10:1 and often as high as 30:1.

The protomerite is not constant in shape; it is, however, generally more or less conical, rounded at the apex, either as a simple cone (Fig. 7) or constricted or dilated slightly half-

way from apex to base (Figs. 14, 16, etc.); there is generally, but not always a small papilla at the anterior end (Fig. 24). The epimerite, which is superimposed upon the protomerite of the cephalont, contains some endoplasm which is continuous with that of the protomerite through the narrow neck connecting epimerite and protomerite. At the apex of the protomerite of the sporont, i.e. an individual which has lost its epimerite, the epicyte is very thin and the endocyte reaches nearly to the top. When the epicyte of the sporont upon the slide is ruptured, this rupture takes place at the apex and is accompanied by an extrusion of protoplasm at this point; the endocyte breaks first at its weakest place, and in this family the apex of the protomerite is the weakest place. The thinness of the ectoplasm at the apex gives rise to the idea that there is a pore here.[1] I am of the opinion that there is no pore present but that the epimerite severs its connection with the trophozoite by gradual constriction at its short neck and drops off as a ball. The apex of the protomerite closes over completely, leaving a trace of the narrow channel in the epicyte by which the endoplasm of the two parts was in connection. That there is an opening to the exterior at this point in the sporont seems doubtful for I have never seen the extrusion of endoplasm in a freshly taken sporont to which a slight pressure was applied; it occurred only when the animal had been kept on a slide in a

1. As stated by Ellis (1912c) in the Diplopoda.

normal saline or water medium, and then only after from fifteen minutes to an hour or until the decrease in the density of the outside medium had had time to affect the parasite.

Not all protomerites of the Stenophoridae are conical in shape. In Stenophora Brolemanni Leger and Duboscq (Fig. 13) the protomerite is shaped like a flattened cork fitting into the neck of a bottle, the deutomerite surrounding it in a thin layer nearly to the apex; in Stenophora spiroboli Crawley, it is almost hemispherical in shape (Fig.70).

In the sporonts of the Stenophoridae I have seen, the deutomerite is long and slender. Leger and Duboscq record dimorphism in several species, Stenophora silene (Figs. 22 and 23), S. chordeume (Figs. 24 and 25), S. varians (Figs. 16 and 17), etc., wherein the sporonts are both elongate and subglobular in shape. The writer has not observed an authentic and unquestionable case of dimorphism. The long, slender sporonts are, however, able to contract so as to be of quite a different shape from the normal. Immature specimens of several species are subglobular and stain more deeply than the sporonts but no mature subglobular specimens have been seen.

There is generally a constriction at the septum which distinctly differentiates protomerite and deutomerite; this is lacking in Stenophora spiroboli Crawley (Fig. 70) and in S. robusta Ellis (Fig. 26) and only slightly developed in S. poly-

desmivirginiensis Leidy. The widest part of thedeutomerite is generally the anterior third; sometimes the deutomerite is a cylinder more or less equal in width throughout. A combination of the two shapes is seen in Stenophora diplocorpa (Fig. 21), in which the deutomerite gradually broadens and then contracts in the anterior half, being conspicuously constricted at the middle, and cylindrical posterior to the constriction. The deutomerite terminates in a broadly rounded, truncated, or conical extremity.

The protomerite and deutomerite differ greatly in endoplasmic content, and therefore in color and consistency. The protomerite is always the less dense, being often nearly or quite transparent; the granular content is sparse and the large irregular granules often clustered near the septum, the r est of the space being filled with a colorless fluid. Staining reactions of the two parts differ also. The deutomerite contains fairly homogeneous endoplasm always densest at the center of mass, which is generally in the anterior third of the body. In the posterior part of the attenuated forms, there is often so little endoplasm that the animal is transparent in the last fifth to third of its body. The deutomerite is generally gray or black in its denser regions and a lighter gray in regions of lesser density.

The nucleus may be either s pherical or ellipsoidal in the sporonts, and varies considerably in relative size in different species. It generally contains one karyosome in mature

sporonts of this family, sometimes more than one, but never many, and the karyosomes stain deeply, often revealing the presence of one or two very small centrioles within.

Longitudinal striations in the epicyte seem to be characteristic of the family, and myonemes have been observed in a great many instances. (See fig. 243 for these structures in Leidyiana solitaria, one of the Gregarinidae). It is probable that both types of structures are invariably present in motile gregarines and form the material foundation for prevailing ideas as to the cause of motion.

The epimerite seems to be an inconstant factor. Sometimes is is well-developed and even retained in specimens free in the lumen of the intestine (Stenophora nematoides (Fig. 15), S. diplocorpa and S. lactaria). Generally, however, workers who have not sectioned the intestines of hosts have failed to find any trace of an epimerite. This is possible from the fact that development is intracellular and not extracellular as in the Gregarinidae, in which family the epimerite alone penetrates the cell. The whole trophozoite lies embedded and is able to obtain nourishment by osmosis, just as it does when it becomes a sporont, taking food in the former instance from the cell originally penetrated and those surrounding it rather than from the lumen. Often intracellular parasites never possess epimerites (Léger and Duboscq, 1904, Pl. XIV, figs. 1, 3, and 4); and yet in the same section

there may be smaller specimens which show the epimerite. The presence or absence is undoubtedly due to age of the parasite. The reason for the presence of an epimerite at all is not evident; unless it is an ancestral vestige, for it disappears while the animal is still living an intracellular existence.

The larger embedded trophozoites are found in various positions in the host cells, generally however, headed away from the lumen, i.e. with their protomerites contiguous with the mesothelial lining of the intestine. Infrequently one is met with which has the protomerite turned toward the lumen (Leger and Duboscq, ibid, fig. 5) or turned in some other direction (Leger and Duboscq, ibid, fig. 6). Individuals of Stenophora lactaria have frequently been found boring their way, protomerite first, through the mesothelial walls of the intestine into the coelom, and in sections of the host, some specimens have actually been found in the coelom, lying close to the coelom-wall of the intestine. During the boring process, the muscular tissue in the wake of the parasite is destroyed, leaving the surrounding tissue shredded and contorted.

The adult parasites seem to prefer lying loose between lobes or clusters of intestinal cells, rather than to living in the open lumen. The interstices of the lobes are very frequently occupied by large adult gregarines.

The sporozoite is spindle-shaped and swells in the lumen. It penetrates the free end of a cell between the cilia and

undergoes development within the cell. The first trophozoic stage I have seen is the small, completely formed body without a protomerite lying embedded with its epimerite at the distal end of the cell, next to the mesothelial layer. It undergoes considerable growth here with the consequence that the cell is destroyed and the parasite comes to lie in a self-formed cyst between two cells, often affecting parts of these contiguous cells and causing the cells for some distance around to be greatly compressed. Then the epimerite disappears and the protomerite develops and becomes more or less flattened against the basement layer of the cell. The trophozoites emerge into the lumen through the space left by the originally destroyed cell. The nucleus of the trophozoite of Stenophora lactaria is spherical; it begins however to acquire its ellipsoidal form while still in the intercellular stage.

b) The Gregarinidae

The parasites of this family become associative while they are quite immature and long before they are ready to form cysts. The shape of the sporonts remains fairly constant whether they are young or fully mature. The sporonts of the genus Gregarina are always more or less obese, and very frequently doliform. The protomerite is much larger in comparison to the size of the body than in the Stenophoridae. In length it varies from one-half to one-eighth the total length of the body. It is frequently hemispherical, and as often cylindrical rounded in front, but is

never more than twice as high as wide; it is rarely conical. There is sometimes a slight indentation at the apex.

The epicyte is fairly thick over the entire body but thicker at the anterior end and at the septum than elsewhere.

The deutomerite is nearly always wider than the protomerite. It is fairly regular in shape throughout the family, being generally widest in the middle portion or slightly anterior thereto and gradually tapering both anteriorly and posteriorly. The posterior end is always rounded; it is never sharply acute.

The endoplasmic contents of the protomerite and deutomerite differ more in density than in character of the granules. The protomerite contains homogeneous granules about the same size and consistency as those of the deutomerite but fewer in number, rendering this portion always less dense.

Myonemes are difficult to detect in the Gregarinidae, even with an oil immersion objective when the animals are alive. They can be seen in longitudinal sections of adults as large, deeply staining dots, seemingly larger protoplasmic granules, situated at the edge of the endoplasm. (Fig. 232). Cross-sections naturally do not reveal their presence. In total mounts and with an intravitam stain, they can be seen as a delicate network of fibrillae extending around the animal horizontally. (Fig. 243).

Longitudinal striations in the epicyte are rendered visible by simply crushing the animal on the slide and liberating the dense endocyte. They are very delicate parallel striations

visible with the oil immersion lens and situated on the outside of the epicyte. They may be seen in both protomerite and deutomerite and traced continuously from one end of the animal to the other. (Fig. 243). They do not converge at the anterior and posterior ends, being rather continuous over the ends as at other portions of thé body. The writer has never seen between the striations the pores which Schewiakoff says serve for the extrusion of mucous.

The nucleus in the genus Gregarina is always spherical. In the trophozoites and in immature sporonts, there is often but one large karyosome and never more than five or six. As size of the animal increases, the karyosomes increase in number and decrease in size, and are scattered irregularly throughout the nucleus. In mature sporonts they are often arranged in a twisted chaplet and are always too numerous to count. One of the reasons why maturity of the cyst and its dehiscence occurs in so short a time in the Gregarinidae (two days) may be that the nucleus of the mature sporonts has already broken up into numerous small elements before cyst-formation has taken place and only needs to lose its wall while in the cyst for these particles to surround themselves with a portion of the sporont endoplasm and become gametes. In the Stenophoridae, the nucleus of a mature sporont contains but one large karyosome which, after cyst-formation has taken place, must break up into constituent elements.

The epimerite of all the Gregarinidae in which it has

been observed is a large globular slightly stalked or sessile structure which is often retained after its usefulness is over and the trophozoite is liberated in the lumen. (Figs. 224-7). There is a little endoplasm present in the nearly transparent epimerite which can be demonstrated with an intravitam stain.

B: THE LIFE HISTORY OF A TYPICAL CEPHALINE GREGARINE

The life history may be outlined briefly as follows: Sporozoite trophozoite sporont gamete zygote sporont sporozoite. The sporozoite is a very minute falciform body liberated from the spore by the action of the digestive juices of the host which has swallowed it.[1] This small body possesses no means of locomotion other than the extrusion of protoplasm. It lodges among the cilia of the intestinal epithelium and bores its way into the cell by ameboid movement. (Leger and Duboscq, 1909). Penetration is probably effected by the excretion of a toxin which lowers the resistance of the cell wall. It either merely punctures the wall and projects a small portion of its body into the cell, as in most Gregarinidae, or completely embeds itself in the cell mass, deriving its nourishment from the cell sap, as in the Steno-

1. There is some evidence to substantiate the theory that autoinfection occurs and accounts for the enormous number of parasites which is often present ina host. See last page of chapter on Cysts.

phoridae. As soon as the sporozoite begins to absorb nourishment and to grow, it becomes a trophozoite. A combination of factors determines when the trophozoite shall be liberated into the lumen. The destruction of epithelial cells and the growth of the parasite go hand inh hand and when the cells no longer supply sufficient nourishment or when the activity of the parasite causes it to release its hold, the trophozoite is liberated into the intestine or coelom and thenceforth absorbs nourishment from the fluids of that cavity.

After the cell has been destroyed and the parasite liberated, the epimerite is no longer useful and drops off. With the loss of the epimerite and the change in habitat, the animal becomes a sporont. At some stage in sporont life, generally an early one, a member of the genus Gregarina attaches to one end of the body another sporont, the two forming an association. In general in which the sporonts are solitary, attachment of two sporonts takes place just previous to cyst-formation. Upon reaching a certain size or density or because of some unknown internal factor, the two sporonts rotate about a common axis and form a sphere. This spherical mass acquires a relatively thick gelatinous covering, the cyst, and leaves the body of the host with the feces. If it remains in a moist place for 48 hours, development proceeds as follows: The sporont nucleus breaks up into a myriad of small chromidial bodies, each small body acquiring a small amount of the residual protoplasm of the sporont. These nucleated

particles are gametes. The gametes of the two sporonts are allowed to mingle by the breaking down of the separation walls, when they fuse two by two and form zygotes. The zygote acquires a tough, resistant transparent covering and the concent breaks up into eight parts, each with a portion of the zygote-nucleus. The resulting body is an octozoic spore. The spores are liberated from the cyst through sporeducts which are formed from the residual protoplasm of the cyst. They are scattered over the grass and ground by the wind and rain and are eaten by a new or by the same host along with its food. Parasitism is thus accidental. The spores upon reaching the alimentary canal of the host are acted upon by the digestive juices and the spore wall absorbed. Upon the removal of this wall, the eight sporozoites are set free and the life-history is repeated.

C: THE QUESTION OF SPORONT MATURITY

The question may be raised in connection with the development of the sporonts and cysts: Can one detect a sporont which is fully mature and ready for cyst-formation? After many months of observation upon a number of species of several genera, I have come to the conclusion that full maturity can be detected and the imminent cyst-formation predicted. In a genus like Gregarina, in which the association of sporonts is a characteristic feature, the fact that specimens are in associations of two does not indicate that the sporonts are mature for associations are

often formed early in sporont life, while the animals are very small and obviously immature. In fact many sporonts are seen in association which are much smaller than some cephalonts of the same species free in the intestine. So the fact that sporonts are linked together in twos is not an indication that maturity has been reached.

Density of the animals is often a criterion of maturity but not one upon which to depend. Cephalonts are transparent or nearly so; the small sporonts are but slightly opaque and opacity increases steadily with age, the oldest in many species being very dense and practically black in transmitted light. If, however, a host is starved a few days before being opened, the parasites are likewise starved and all become more or less transparent.

Size increases with age and only the large individuals in any case may be expected soon to form cysts.

While no one of these three characteristics can be used as a test for maturity of the sporonts, an association of large sporonts in which the individuals are well filled with protoplasmic granules and hence opaque, indicates without doubt that the sporont is mature.

Movement of such an association is no longer active motion of translation; the sporonts have become sluggish and tend to revolve. When the revolution becomes fairly well established, it takes a spiral form and gives place to rotation. The animals finally become a compact spherical mass with a cyst wall which has

been secreted during rotation.

The sporonts are now in position to reproduce themselves.

D: THE CYSTS

Observations on cyst-formation and development, like those on Movement, have been confined chiefly to one species. In the family Stenophoridae, I have not been able to procure the dehiscence of any cysts; in the Gregarinidae observed, however, it was an easy matter to procure cysts and watch their development. Cysts were taken from moistened fecal masses or from the intestine by means of a needle and placed on slides. Bits of broken glass were used to raise the cover slip, and distilled water added. The cell was sealed with vaseline and placed in a petri dish well vaselened. along the edges.

a) Cysts of the Stenophoridae

observed were spherical or slightly ellipsoidal. They are generally found in the posterior part of the intestine and were not seen until fully developed and rotation had ceased. It is not difficult to determine in most cases that two individuals were involved in making a cyst. The line of separation is often indicated in the cyst and there is often a slight difference in density of the two conjugants. In one instance one sporont was nearly black and the other pale tan, This fact was not noted until after the cyst had been in the damp chamber half an hour. In all

cases observed the cysts became lighter in color after being in the damp chamber a few hours. In freshly opened intestines, cysts do not show a clear hyaline layer but after being out the extrusion of water causes the inner mass to shrivel and the epicyst to swell so that the whole diameter is greater than at first. Although cysts were kept in the damp chamber nine days, no spores developed. Whenever still intact, the cysts were crushed at the end of that time but there was no apparent differentiation of the protoplasm and none was revealed by staining. Most of the cysts, however, shrivelled and disintegrated.

b) Cyst-formation in the Gregarinidae
(Leidyiana solitaria n.sp.)

This species is in its normal sporont stage non-associative. The young sporonts which have but recently lost their epimerites are nearly transparent but as age increases density increases and is due to the absorption of food. The oldest sporonts are very dense and practically black in the deutomerite so that the nucleus is not visible when they are alive. The body in the young sporonts is long and rather slender, but it widens appreciably in the older ones. The middle-aged animals are very active in their movements but the older individuals become very sluggish and tend to lie motionless in masses (See fig. 230).

In dense, sluggish individuals one may expect cyst-formation to take place. The sporont retains its power to bend and twist after it has apparently ceased to use its progressive

powers. Sluggish individuals in rotation set in motion currents in the surrounding medium and slowly attract into this ever-widening circle of influence particles of debris or nearby gregarines. If debris is drawn into the whirlpool, it is not retained, but slips to the outside again. Another gregarine is, however, attracted and held, probably because of the mucous on its exterior, and caused to rotate with the first one. If two gregarines are attracted, the force exerted by the first is too weak to hold both and one is invariably liberated. A sporont is apparently unable to make a cyst alone. A single sporont has been seen to rotate forthree hours without succeeding in attracting another and then to straighten out suddenly and move to another part of the field.

When such an association is formed, the sporonts are not attached by particular parts of the body, as are associations of the genus Gregarina, but are held together in a haphazard fashion by secretions only. In rotation, the sporonts come closer and closer together laterally, slipping by a few sudden jerks until one does not project beyond the other, the protomerites bend around so as to meet the posterior ends of the deutomerites (Figs. 234, 5, 8), the deutomerites projecting and contracting so as to leave no unfilled interstices until the result is a compact sphere. In one such process, there was formed in the middle of one side of each deutomerite a tiny cupped indentation and the two cups fitted together to form a perfect sphere. This sphere became smaller and smaller as the cyst developed and finally disappeared in the gen-

eral breaking down of the inclosed sporont walls. (Figs. 235, 8).

The mass continues its slow rotation for hours. After a compact mass has been formed, one can still distinguish the nuclei and the protomerite and deutomerite of each sporont, the former by the pale tan color. (Figs. 239, 40). This demarkation is lost and soon after the faintly visible lighter nuclear areas disappear. The straight line which separates the two sporonts (their lateral walls) remains visible for twenty-four hours after the cyst has begun to form. It disappears finally and the cyst-mass becomes perfectly homogeneous throughout (Fig. 241).

All the time that the mass is revolving, there is being exuded from the two bodies the sticky gelatinous and transparent secretion. This exude follows after the animals as very slender spiral threads and forms a spirally arranged layer constantly increasing in width as rotation continues. When rotation ceases there is formed around the cyst-mass an appreciable layer of this gelatinous matter arranged as very fine concentric threads.

Motion of the mass was watched in one instance to completion. My notes opposite the time of each successive complete rotation read as follows: "Brings another gregarine into the vortex; the two rotate together; shove a third gregarine out of the way; protrudes out a protomerite as if feeling the way; retracts same; the two slip and slide until form a perfect sphere; central spherical area left between the two sporonts; gelatinous layer form-

ing around the rotating sphere; the outer layer wider and distinct." The time for the first complete rotation of the solitary individual was one and one-fourth minutes. Approximately this rate is retained during fifteen rotations. The rotations become slower as the mass more and more nearly approximates a sphere. two and one-third min; four min.; five min. are recorded for successive rotations. At the end of forty-five minutes, the cyst was complete but still slowly rotating at the rate of one rotation in from four to five minutes. When next observed, two hours later, motion had ceased and there was present a gelatinous layer one-third the radius of the cyst in thickness.

Fully-formed cysts which are still in the process of rotation are frequently taken from the host and they continue to rotate a half hour or more after removal.

c) Cyst Development and Dehiscence

When the mass has finished rotating, it is a beautifully homogeneous opaque gray spherule surrounded by a thick transparent cyst-wall fifty micra in width, or half the radius of the inner mass. The mass begins to disintegrate in twelve or fifteen hours, the protoplasm becoming arranged in many dense areas (Fig. 242). The diameter of the inner mass decreases and that of the transparent cyst-wall increases by the exudation of water from the inner regions. In twenty-four hours the protoplasm within the cyst-wall has begun to shrink from the periphery. Five hours later (29 hrs.) the spore-ducts are clearly indicated (Fig. 245), by

dense accumulations of protoplasm around the periphery of orange colored disc on the cyst surface. From three or four to a dozen of these discs are delineated. The orange color is due to an accumulation of orange-colored oil which dissolves and loses its color in ether. Soudan III stains it red. The oil can be pressed out from the cyst in large globules. The origin of this oil in the cyst is of course the endoplasm of the sporonts. The protomierte is tan in color and probably contains considerable oil; the deutomerite may contain as much or more but the color is obscured by the great number of protoplasmic granules which renders the whole very opaque.

After 35 hrs. the ducts leading from the periphery to the center of the cyst-mass appear and r esemble spokes of a wheel. In a few hours more the spore-ducts begin to project from the surface of the sphere, the center depressed. (Figs. 247, 8). By this time the individual spores are visible within the mass (Fig. 246). At the end of from 42-60 hours, the spores are liberated. (Fig. 249). Although from one to a dozen spore-ducts begin to grow outward,not more than one has been seen to complete itself. This is accounted for probably by the fact that pressure is exerted on most of the incipient ducts by the slide and cover-slip, and growth to completion inhibited. One duct is often directed horizontally between the two surfaces and it always is this lateral duct which develops and through which spores are extruded. When there has been considerable debris in the vicinity of the developing cysts,

the ducts are often coiled and twisted about the cyst itself. I have never been able to incite spore-exudation without the use of a cover slip for even in a carefully sealed damp chamber there is enough volume within the chamber itself to cause sufficient evaporation to take place to dry up the unprotected cyst.

The duct which is formed is very long, 25 mm. or eight times the radius of the cyst. (Fig. 249). The ducts grow inward from the periphery, where they first appear, to the region of the residual mass of protoplasm. Then they grow outward from the peripheral region until they acquire the enormous length attained in a few species. The growth outward seems to be from the region of the periphery, the older portion pushed ahead. The tip of the long duct is orange-colored as is the disc from which growth began, showing that the oil globules are pushed along with the first outgrowths of the tube. There does not seem to be an eversion of the duct here, as in Gregarina rigida and other species (Lankester, 1903:183).

The spores emerge in chains which soon break up into small segments. The spores (Fig. 255) are barrel-shaped and truncate at the ends. They possess an epispore and endospore easily discernible when a stain is used on the slide. They are slightly cupped at the ends. I think there is a corona of very delicate spines or cilia at each end which serves to hold the spores together in chains and to furnish a means of locomotion for the isolated spores. That spores do move from place to place is easily

determined by watching a few chains of freshly liberated spores on a slide. (Care should be taken that the slide is undisturbed and yet not allowed to evaporate.) In a few hours no two spores will be left attached but they will lie in small clusters or scattered over a whole field.

Sometimes spore-ducts do not develop and the cyst has superficially undergone but little differentiation, yet upon crushing the walls after a day or so, or when the spore-ducts should have been formed, perfectly formed spores emerge, to all appearances and staining reactions identical with those loberated in the normal way. Of course nothing is known of their potency as compared with those extruded in the normal manner.

The concents of the spores vary greatly. If the cyst is broken before the spore-ducts have had a chance to form, and apparently before the spores are ripe, they will be found to contain many small clustered or isolated chromosomes which stain deeply. All the spores from a given cyst are in approximately the same stage of development. Another broken cyst will yield spores with fewer chromosomes, from ten to fifteen, for instance. A cyst brought to completion yielded spores each of the many examined containing eight large chromosomes. These spores were watched for a day and at the end of that time delicate partitions were seen between each two of which was contained one large chromidial body. These partitions represented lines of separation between the eight

sporozoites which were being developed (Fig. 255). I was unable to procure or else to find any liberated sporozoites by any of the following methods: 1) Some spores were left on the slide in a water medium; 2) others were placed in normal sodium chloride solution; 3) the intestinal juice of a freshly killed cricket was run under a third cover slip on which were a few spores; and 4) spores were placed on a small mass of fresh intestinal epithelium. In the last two instances putrefaction was soon set up in the non-sterile tissues. Using spores of another gregarine from a crab, (parasite still unnamed) I sterilized some of the colorless blood from the heart of the crab by boiling it in a test tube and used the liquid as a medium but without inciting the spores to develop.

Cysts were crushed at various developmental stages and stained. The spores were found to be well developed before the spore-ducts are formed, so the early stages of development are the sources of greatest change.

Immediately after the protoplasm of the cyst becomes collected in masses, small clear papillae begin to appear on the periphery of each mottled mass. (Fig. 244). This layer of papillae being formed, another is seen beneath, until the three or four outer layers of the cyst show these papillae, the inner mass being residual non-metamorphosed protoplasm.

The papillae soon become constricted off to form tiny globular bodies, each of which contains a deeply-staining particle

inside. These globular bodies are the gametes (Fig. 251). Upon crushing and staining a cyst in the gamete stage, I have repeatedly been unable to find the least evidence of a difference in shape or size or in staining reaction between the gametes from opposite poles of the cyst, ile. from each of the two constituent sporonts. The gametes are isogameges. That there is, however, a difference between them is shown by the attraction of certain gametes for others. Before the partition wall between the two sporonts is absorbed, the gametes of each side do not attract others from the same side of the partition. But when the partition wall has disappeared and the cyst is examined, it is seen to contain very many 'double' gametes, i.e. gemates in pairs. (Fig. 252). If taken early enough, the gametes are seen to be barely contiguous at one point. The next stage observed is that in which each retains its identity but is flattened on the side of attachment to the other (Fig. 253). Then the identity of each becomes lost and the r esult is a body twice the size of the original gamete, with a nuclear content made up of the fusion of that of the two gametes. This larger body, which in staining reaction is identical with that of the gametes, is the zygote. In a cyst of twenty-four hours, no spore-ducts had begun to appear but the cyst was full of zygotes.

The zygotes when fully formed are ellipsoidal in shape, contain many small deeply-staining bodies, and possess a rather thin wall (Fig. 254). They develop gradually into spores. The

outline becomes more spore-like by the gradual flattening of the ends and the decrease in the number of chromidia while the outer wall increases in thickness. In a cyst of about thirty hours, the zygotes have attained the shape of the ripe spores but the content is still that characteristic of the zygote.

From the thirtieth hour on, the chromidia rearrange themselves and decrease in number by fusion, and the perfection of the mechanism for the expelling of the ripe spores proceeds.

It is probable that the cyst can develop and spores be expelled while within the intestine, possibly resulting in the re-infection of the host and accounting for the enourmous numbers of parasites found in some hosts. I have seen cysts dense and opaque, cysts pearly gray and mottled, cysts with orange-colored discs, the incipient spore-ducts, and even cysts with spore-ducts well developed and nine in number, all within the body of a freshly caughtcricket. The same advanced stages of the cysts of another species have been found in the bodies of freshly opened locusts and also in certain Crustacea.

Part Three

SYNOPSIS OF THE EUGREGARINE RECORDS OF THE MYRIAPODA, COLEOPTERA AND ORTHOPTERA OF THE WORLD

Introduction

The synopses and list of species which follow were made in order to obtain the essential features of all the known species of eugregarines parasitic in three groups of animals so that in placing on record some twenty species which I had found during the last year there would be no danger of redescribing a species under a new name or of describing a new species under a name already used. It is hoped that the synopses will be useful in future researches on the gregarines of these groups wherever library facilities are limited.

Species have been included from the whole world and not from the United States only for many species of protozoa are notably cosmopolitan and not by any means restricted to one portion of the globe. The study of gregarines is as yet scarcely begun in the United States and very few species have been found both in the Old World and in the New, but workers in the United States must be on the outlook for Old World species and should not describe forms new to this country as actually new species without considering the parasites of other regions of the world.

Every effort has been made to include in these synopses all the species mentioned in the literature Sources of information are as follows: Dufour (1837), Kölliker (1848), Stein (1848),

Frantzius (1848), Diesing (1851), Lankester (1863), Minchin (1903), Labbé (1899), Sokolow (1911), Ellis (1913c), Zoologischer Anzeiger indices from 1848 to 1895, the Concilium Bibliographicum from 1895 to date, and current periodicaly, Archiv für Protistenkunde, Archives de Parasitologie, etc., for the past and the present calendar years. These references have to a great extent acted as checks on each other although the original sources have not infrequently revealed other species not elsewhere mentioned. Many of the older species which are recorded in the synopses do not appear in Labbé's Sporozoa.

Labbé repeatedly regards as synonyms species which occurred in the same host genus or in allied genera without regard to whether or not the species of parasites were identical. In most instances the species are not the same although the same species or genus of host is involved, and unlike parasites have been separated. For example, Phialoides ornata Léger and Gregarina brevirostra Kölliker were regarded as synonymous because they infest the same host. In some instances Labbé regarded as synonyms species which actually belong together, for example, Actinocephalus lucanus Stein and Stephanophora radiosa Léger, which are identical, the species now being known as Actinocephalus conicus (Dufour) Stein.

The law of priority has been adhered to strictly and many parasites known by later assigned names have been referred

to names given to them many years before, e.g. Actinocephalus conicus which was known for long as Actinocephalus lucanus. Labbe in most instances calls such species by the later assigned names in his treatise.

In the descriptions of species, well-developed sporonts have been taken as the standard except where such have not been described, these rare instances being noted in the synopses. Shape of the cephalonts is often quite unlike that of the sporonts and thus of no systematic value in diagnosis. Whenever the epimerite is mentioned in the literature, it is described in this paper; when it is not mentioned in the literature, as is often the case, the generic determination of the author is based on other characters. The sporonts are often polymorphic and the synopsis records are based on expanded, quiescent and, as far as known, normal specimens except where the polymorphism is marked. In these instances such facts are noted.

In the description of each new species, I have given measurements of several sporonts. In most published descriptions the length and width of one sporont only are stated, generally of the largest one observed and the ratios of various parts are based on this one parasite.

As the discovery of new species proceeds, I am of the opinion that many will be very similar to others already described and not easily differentiated from them unless a wide range of [illegible] . . . , [illegible]

[illegible] which [illegible] the [illegible] as [illegible]. In

no most instances [illegible]

to this treatise.

In the descriptions of species, well-developed [illegible]

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often the case, [illegible]

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In the description of each new species, I have given [illegible]

[illegible] of several specimens. In most [illegible] descriptions the

length and width of each [illegible]

the largest [illegible]

[illegible] this [illegible].

As the discovery of new species proceeds, I [illegible]

[illegible]

[illegible]

measurements and ratios is taken from parasites in different hosts and selections made therefrom for use in a table. This applies in particular to the genus Gregarina, where differences between species appear to be limited. One observer might find the maximum length to be a and the ratio of two parts 1:2. Another worker on the same species might find his largest specimen to be 2a long and the ratio of parts 1:3 and describe the species as different from the former. A table showing lengths and ratios selected from measurements of many parasites in the same host and from as many hosts and under as varying conditions as possible (habitat, season, etc.), thus eliminating the danger of duplication of species.

I have differentiated new species in the same genus by the following characteristics: size, both maximum and average; ratio of length protomerite to total length; ratio of width protomerite to width deutomerite; general shape of the body; shape of the protomerite; shape of the deutomerite; character of the interlocking device; size and shape of the nucleus; color and character of the protoplasm; and the size and shape of the cysts and their method of dehiscence.

It is true of many species that the family or generic determination or both are uncertain because important diagnostic features such as the epimerite and spores are often lacking. The correct family can sometimes be determined when only one of these

factors is present. In some instances the correct genus can be ascribed even though important data are lacking, e.g. the genus Gregarina, by its biassociative factor and the host involved. If there is any doubt about the position of a given animal, the parasite is placed at the end of the particular genus to which it probably belongs.

In describing the associative gregarines, generally only specific measurements of the primite are given for the proportions of the satellite differ considerably within the same species as it happens to be more or less flattened while those of the primite remain fairly constant. The shape given for the posterior end of the deutomerite is that of the satellite, where the deutomerite is free at its posterior end; in the primite it is altered by contiguity with the protomerite of the primite.

The species of gregarines indigeneous to each of the three groups are arranged in families, and under each family the genera are placed in alphabetical order. In each genus the species are arranged in chronological order, the oldest first, the latest additions last. New species not hitherto found are described in detail in the groups to which their hosts belong.

In as many instances as possible, the names of the hosts have been checked and corrected to accord with the best

authorities. This has often, however, been impossible and the names had to be left as in the original citation. Especially is this true of the older species of parasites, many of which have not been found since the original discovery seventy-five years ago or more.

The names of the Myriapod hosts have been corrected those abroad in accordance with Latzel (1884) and those endemic to the United States with Bollman (1893). Coleopteran literature seems not to be in condition to warrant the finding of synonyms for many of the early-described species. For instance, the name by which a beetle is known today will be recorded, but not the name by which it was known some fifty years ago and by which it was called when the parasites infesting it were described. When names have been corrected to accord with present-day knowledge, the older name is placed in parenthesis after the now-accepted name.

The spelling of the name of the diplopod _Julus_ as given by Linnaeus (1766) has been used throughout wherever the word appears, whether in the name of the host or in the name of a species of parasite where the name is used as a prefix. The _Iulus_ of some authors is, then, disregarded in the nomenclature of the species.

A Brief Synopsis of the Families and Genera of the Tribe Cephalina (Delage) of the Suborder Eugregarinae (Léger)

This synopsis is based on the classifications of Minchin (1903 and 1912) and Poche (1913).

Subphylum Sporozoa Leuckart 1879:241.
Class 1. Telosporidia Schaudinn. Sporulation ends the life of the individual.
Order 1. Gregarinida Bütschli 1882:503. Reproduction by spore-formation only or by both spore-formation and budding.
Suborder 1. Schizogregarinae Léger.
2. Eugregarinae Léger. Reproduction limited to spore-formation. Spores octozoic.
Tribe 1. Acephalinae Kölliker (Monocystoidae Poche).
2. Cephalinae Delage 1896:269. Eugregarinae with an epimerite at some stage in the life-history. Body usually divided by septum into protomerite and deutomerite. Spores with two coats. Mainly parasitic in the gut of arthropods.
Family 1. Didymophyidae Léger 1892:105. In associations of two or three. No septa in satellites.
Genus 1. Didymophyes Stein 1848:186. Characters of the family. Epimerite a small pointed papilla, cyst dehiscence by simple rupture. Spores ellipsoidal.
Family 2. Gregarinidae Labbé 1899:9. Associative or solitary, satellite with septum. Epimerite symmetrical, simple. Cysts with or without spore-ducts.
Genus 2. Gregarina Dufour 1828:366. Biassociative. Epimerite small, globular or cylindrical. Spores doliform to cylindrical. Cysts dehisce by sporeducts.
Genus 3. Hirmocystis Labbé 1899:12. Associations of from two to twelve or more. Epimerite a small cylindrical papilla. Cysts dehisce by simple rupture. Spores ovoidal.
Genus 4. Hyalospora Schneider 1875:583. Biassociative. Epimerite a simple globular knob. Cysts dehisce by simple rupture. Spores ellipsoidal. Endoplasm yellow-orange.
Genus 5. Cnemidospora Schneider 1882:446. Solitary. Epimerite not known. Anterior half of proto-

merite gray, posterior half yellow-green. Dehiscence of cysts by simple rupture. Spores ellipsoidal.

Genus 6. Euspora Schneider 1875:582. Biassociative. Epimerite not known. Cysts dehisce by simple rupture. Spores prismatic.

Genus 7. Sphaerocystis Léger 1892:115. Protomerite only in young stages. Solitary, subspherical. Dehiscence by simple rupture. SPores ovoidal.

Genus 8. Camocystis Schneider 1875:587. Protomerite only in young stages. Associative. Sporulation partial, with sporeducts. Spores cylindrical.

Genus 9. Frenzelina Léger & Duboscq 1907:773-4. (Cephaloidophora Mawrodiadi 1908:101-33). Biassociative. Epimerite not known. Cysts dehisce by simple rupture. Spores ovoidal, with dark equatorial line. Intercellular development.

Genus 10. Uradiophora Mercier 1912:198. Bi- or triassociative. EPimerite simple style, forked at end. Cysts dehisce by simple rupture. Spores doliform.

Genus 11. Leidyiana Watson 1915. Solitary. Epimerite a simple globular sessile knob. Dehiscence by spore-ducts. Spores doliform.

Family 3. Dactylophoridae Léger 1892:165. Epimerite complex. Sporonts solitary. Cysts dehisce with lateral pseudocyst or by simple rupture. Spores elongate, cylindrical or ellipsoidal.

Genus 12. Dactylophorus Balbiani 1889:41. Protomerite dilated laterally with peripheral digitiform processes. Sporonts solitary. Spores in chains obliquely.

Genus 13. Nina Grebnecki 1873:? Protomerite formed of two long narrow horizontal lobes fused and upturned spirally at one end. Periphery set with teeth from which project long slender filaments. Spores in chains obliquely.

Genus 14. Trichorhynchus Schneider. 1882:438. EPimerite a very long slender neck with dilation at end. Cysts with papillae and indentations on surface. Lateral pseudocyst for dehiscence. Spores cylindrical or ellipsoidal, not in chains.

Genus 15. Echinomera Labbé 1899:16. Epimerite an eccentric cone with eight or more short digitiform processes from sides. Dehiscence by simple rupture. Spores cylindrical, in chains.

Genus 16. Rhopalonia Léger 1893:1285. No protomerite in sporonts. Epimerite a subspherical cushion with ten or more short thick digitiform processes. Pseudocyst. Spores cylindrical.

Genus 17. Acutispora Crawley 1903:632. Epimerite not seen. Pseudocyst. Spores biconical, thick blunt endosporic rod at each end.

Genus 18. Metamera Duke 1910: 261-86. Epimerite subconical, apex eccentric, surrounded by numerous branched digitiform appendages. Dehiscence by simple rupture. Spores biconical.

Family Actinocephalidae Léger 1892:166. Sporonts solitary. Epimerites varied. Cysts dehisce by simple rupture. Spores irregular, biconical or cylindro-biconical.

Genus 19. Actinocephalus Stein 1848:196. Epimerite small, sessile or on a short neck, with 8 or 10 short sharp spines or simple bifurcate digitiform processes. Spores biconical.

Genus 20. Geneiorhynchus Schneider 1875:594. Epimerite a tuft of short bristles set at the apex of a long slender neck. Spores cylindro-biconical.

Genus 21. Pyxinia Hammerschmidt 1838:357. Epimerite a flat crenulate crateriform disc from center of which rises a short or long style. Spores biconical.

Genus 22. Beloides Labbé 1899:27. Epimerite a spiny globule with a long apical style set on a short stout neck. Spores biconical.

Genus 23. Phialoides Labbé 1899:24. Epimerite a broad cushion with peripheral row of teeth and a thickened collar placed on a long slender neck. Spores biconical.

Genus 24. Legeria Labbé 1899:24. Epimerite not known. Protomerite dilated and massive. Septum convex upward. Spores cylindro-conical.

Genus 25. Coleorhynchus Labbé 1899:23. Epimerite not known. Protomerite a round shallow disc depressed in center. Septum convex upward. Spores biconical.

Genus 26. Bothriopsis Schneider 1875:596. Epimerite an ovoidal structure with 6 or more long slender filaments. Protomerite very large, septum convex upward. Spores biconical.

Genus 27. Asterophora Léger 1892:129. Epimerite a thick horizontal disc with a milled border and a stout style projecting from center. Spores cylindrobiconical.

Genus 28. Schneideria Léger 1892:153. (Rhabdocystis Boldt 1910:289-93). Epimerite like that of Asterophora. Style shorter. No protomerite in sporonts. Spores biconical.

Genus 29. Stictospora Léger 1893:129-31. Epimerite spherical, centrally depressed, armed with a dozen backwardly directed mucrones set on a short neck. Spores biconical, slightly curved.

Genus 30. Stylocystis Leger 1899:526-33. Epimerite a recurved sharply pointed cone. Spores biconical.

Genus 31. Steinina Léger & Duboscq 1904:352-5. Epimerite a short mobile digitiform process changing into a flattened button. Spores biconical.

Genus 32. Taeniocystis Léger 1906:307-29. Epimerite a small sphere set with 6 or 8 recurved hooks. Deutomerite divided by septa into numerous linear segments. Spores biconical.

Genus 33. Discorhynchus Labbé 1899:20. (Syn. Sycia Leger 1892:52. Epimerite a large globular structure with a thick collar around base. Short stalk. Spores biconical, slightly curved.

Genus 34. Amphoroides Labbé 1899:20. Epimerite a globular sessile papilla. Protomerite cup-shaped. Spores curved.

Genus 35. Pileocephalus Schneider 1875:591. Epimerite a lance-shaped or simple cone. Spores biconical.

Genus 36. Anthorhynchus Labbé 1899:19. Epimerite a large fluted flattened button. Spores ovoidal, pointed.

Genus 37. Sciadophora Labbé 1899:18. Epimerite large, compressed laterally, peripherally crenulate. Protomerite bears numerous backwardly directed mucrones. Spores biconical.

Genus 38. Hoplorhynchus Carus 1863:570. Epimerite a flat button with 8 to 10 digitiform processes carried on a long collar. Spores biconical.

Genus 39. Amphorocephalus Ellis 1913a:462-3. Epimerite dilated in middle, terminating in concave peripherally fluted disc at anterioe end. Spores not known. Protomerite constricted across middle.

Family 5. Acanthosporidae Léger 1892:167. Sporonts solitary, epimerite simple or appendicular. Dehiscence by simple rupture. Spores with equatorial and polar spines.

Genus 40. Acanthospora Léger 1892:145. Epimerite a simple conical papilla. Spores biconical or ovoidal with row of equatorial spines and a tuft of four spines at each pole.

Genus 41. Corycella Léger 1892:144. Epimerite globular with 8 large recurved hooks. Spores biconical, 4 spines at each pole.

Genus 42. Ancyrophora Léger 1892:146. Epimerite a globule with 8 or 10 backwardly directed digitiform processes. Spores biconical with equatorial and polar spines.

Genus 43. Cometoides Labbé 1899:29. Epimerite a spherical button with long slender filaments. Spores cylindro-biconical, with polar and two rows of equatorial spines.

Family 6. Menosporidae Léger 1892:168. Sporonts solitary, epimerite a large cup bordered with hooks and placed on a long slender collar. Cysts dehisce by simple rupture. Spores crescentic, smooth.

Genus 44. Menospora Léger 1892:168. Characters of the family.

Family 7. Stylocephalidae Ellis 1912:25. Sporonts solitary, epimerites varied. Nucleus ovoidal. Dehiscence by pseudocyst. Spores irregularly shaped, brown or black, extruded in chains.

Genus 45. Stylocephalus Ellis 1912:25. Epimerite a dilated papilla at end of a long slender neck. Cyst covered with small papillae and indentations. Spores hat-shaped.

Genus 46. Spaerorhynchus Labbé 1899:32. Epimerite a small sphere or ellipsoid at end of a long slender neck.

Genus 47. Lophocephalus Labbé 1899:31. Epimerite a large sessile flattened crateriform disc, the periphery crenulate and set at base with numerous short upwardly directed digitiform processes. Spores hat-shaped, black.

Genus 48. Cystocephalus Schneider 1886:99. Epimerite a large lance-shaped papilla set on a short stout cylindrical collar. Spores irregularly shaped.

Genus 49. Oocephalus Schneider 1886:101. Epimerite a spherical button upon a short conical neck. Spores not known.

Family 8. Stenophoridae Léger & Duboscq 1904:361. Development intercellular. Sporonts solitary. Epimerite absent or a simple structure. Cysts dehisce by simple rupture. Spores ovoidal with equatorial line. Not extruded in chains.

Genus 50. Stenophora Labbé 1899:15. Characters of family. Confined to Diplopoda.

Genera of Uncertain positions

Genus 51. Ulivina Mingazzini 1891:235. ?

Genus 52. Nematoides Mingazzini 1891:233. Dicystid, no septum in sporonts. Epimerite forked, situated on a long collar.

Genus 53. Ganymedes Huxley 1910:155-75. Associative, epimerite not known. Complete fusion of two individuals into one cytoplasmic mass. Cup at posterior end to aid in attachment. Spores unknown. Liver of crustaceans.

Genus 54. Agrippina Strickland 1912:108. Sporonts solitary, epimerite a circular disc armed with digitiform processes on periphery, short neck. Spores ellipsoidal.

List of the Polycystid Gregarines in the Diplopoda

The parasites are arranged in chronological order, under each genus

Page	Name of parasite	Name of host
	Stenophora larvata (Leidy) Ellis	Spirobolus spinigerus Wood
75-78	Stenophora polydesmivirginiensis (Leidy) Watson	Fontaria virginiensis (Druru)
79-81	Stenophora julipusilli (Leidy) Crawley	Julus and Parajulus
81-83	Stenophora juli (Frantzius) Schneider	Julus sabulosus (L.) Julus boleti C. Koch
84-88	Stenophora dauphinia Watson	Julus mediterràneus Latzel Julus boleti C. Koch Julus fallax Meinert
88-91	Stenophora spiroboli (Crawley) Ellis	Spirobolus sp.
91-92	Stenophora fontaria (Crawley) Watson	Polydesmus sp. Fontaria sp.
92-94	Stenophora brölemanni Léger & Duboscq	Blaniulus hirsutus Bröl. Brachydesmus superus Latzel Brachyiulus pusillus lusitanus Verh.
94-95	Stenophora nematoides Léger & Duboscq	Strongylosoma italicum Latz.
96-96	Stenophora varians Léger & Duboscq	Schizophyllum corsicum Bröl.
97-99	Stenophora producta Léger & Duboscq	Julus varius Fabricus
99-100	Stenophora aculeata Léger & Duboscq	Craspedosoma rawlinsii simile Verh.
100-1	Stenophora polyxeni Léger & Duboscq	Polyxenus lagurus (L) Lat.
101	Stenophora silene Léger & Duboscq	Lysiopetalum foetidissum Savi
102-4	Stenophora chordeume Léger & Duboscq	Chordeuma silvestre C.Koch
104-7	Stenophora corsica Léger & Duboscq	Craspedosoma légeri Bröl.
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Stenophora cockerellae Ellis 108	Parajulus sp.
Stenophora elongata Ellis 109	Orthomorpha coarctata (Sauss.)
Stenophora robusta Ellis 107-8	Parajulus venustus Wood Orthomorpha gracilis (C.Koch) Orthomorpha sp.
Stenophora impressa Watson 109-12	Parajulus impressus (Say)
Stenophora diplocorpa Watson 117-19	Euryurus erythropygus (Brandt)
Stenophora lactaria Watson 112-7	Callipus lactarius (Say)
Cnemidospora lutea Schneider 119-21	Glomeris sp.
Amphoroides polydesmi (Léger) Labbé 121-3	Polydesmus complanatus (L.) Polydesmus dispar Silvestri
Amphoroides calverti (Crawley) Watson 123-4	Callipus lactarius (Say)

Stenophora larvata (Leidy) Ellis
Fig. 1.

1849	Gregarina larvata	Leidy	1849:232
1851	Gregarina larvata	Diesing	1851:553
1853	Gregarina juli marginati	Leidy	1853:237
1863	Gregarina juli	Lankester	1863:94
1875	Stenocephalus juli	Schneider	1875:584-5
1899	Stenophora juli	Labbé	1899:15
1903	Stenophora juli	Crawley	1903a:51
1904	Stenophora iulimarginati	Léger & Duboscq	1904:362
1913	Stenophora larvata	Ellis	1913b:286

Stenophora: Sporonts solitary, elongate. Max. length 800μ, max. width 23μ. Ratio length prot:total length :: 1:20; width prot:width deut :: 1:2. Protomerite small, subglobular, slightly flattened top and bottom, a flat circulat papilla at apex with an apparent pore in center. A conspicuous constriction at septum. Deutomerite elongate-cylindrical, tapering gradually from center to an acute but bluntly pointed cone. Endocyte of protomerite clear, granular; of deutomerite dense and opaque. Nucleus small, spherical.

Taken at Philadelphia, Pa.

Host: Spirobolus spinigerus Wood. (Julus marginatus Say).

Habitat: Intestine.

This species was observed by Leidy in 1849 and was the first gregarine that he observed. His general statement regarding the parasite is quoted here nearly in full because of its quaintness.

"Gregarina is probably the larva condition of some more perfect animal, but in the 116 individuals of Julus which I

have examined, I have not been able to detect any form which could be derivable from it. Creplin doubts its animality. - - - - I detected movements of an animal character, and this led me to seek for muscular structure, which resulted in the discovery of the longitudinal lines of the inferior cell. These escaped the observation of Siebold - - -. In the state in which Gregarina is found, it would probably hold a rank between the Trematoda and Trichina, the lowest of the Nematoidea."

To Leidy, then, must be attributed the discovery of the longitudinal striations in the epicyte and it is interesting to note that he discovered them during his first observations on the Gregarines.

Leidy renamed the species four years later from the host in which it was found.

Lankester (1863:94), in a classification of the gregarines, grouped three of Leidy's forms---G. larvata, G. juli marginati and G. juli pusilli--together with Gregarina juli Frantz. under the name of the latter, apparently because they were all parasites of and the only known parasites of the same diplopod.

Schneider (1875:585) disregarding the rule of priority united Gregarina juli marginati and a species which he discovered under the name Stenocephalus juli (Leidy). His remarks are as follows:

"Cette espèce est commune et me paraît etre identique à celle décrite par Leidy sous le nom de Gregarina juli marginati. Dans ce cas, elle serait probablement répandue chez les différentes espèces du genre Julus, puisqui'on la connaîtrait déjà chez trois d'entre elles. - - - L'espèce est légèrment polymorphe; elle est tantôt très-allongee et relativement étroite, tantôt remarquablement massive; mais son protomérite demeure toujours identique à lui-même et suffit amplement au diagnostic."

Leidy gave no measurements of his species and Schneider based the identity of the two forms on the similarity of Leidy's figures with his material. It is true that the general shapes of the two are very similar but the protomerites differ slightly and the color differs markedly. Leidy's species is white; Schneider's yellow to yellow-orange. Because of these dissimilarities, the two forms should be separated.

Labbé (1899:15) changed the name of the genus Stenocephalus of Schneider to Stenophora.

Crawley (1903b:634) did not consider the two species identical. His words are as follows:

"There is a good deal of confusion regarding the gregarines occurring in the Diplopod family Julidae. These gregarines all bear a certain amount of resemblance to one another, and it has been usual to relegate all of them to the species Stenophora juli Frantz. Leger & Duboscq (1903) have recently shown that such a procedure is not warranted for the fauna of Corsica and the case is certainly the same for that of the eastern U.S. The Julidae of this reason are infected with certainly two and possibly three species of Stenophora, while the classic S. juli apparently does not occur."

Léger and Duboscq (1904:361-2) take up the same discussion in their history of the Stenophoridae, and their words are:

"Leidy fit connaître une Grégarine assez particulière, parasite de l'intestin de Iulus marginatus Say. Il l'appela d'abord (1851) Grégarina larvata, puis changea son nom en celui de Grégarina iuli marginati dans un travail postérieur (1853) où il décrit une autre Grégarine, G. iuli pusilli, parasite d'un petit iule--qui n'est pas Iulus pusillus Leach.
Ray Lankester (1863) réunit les deux Gregarines de Leidy au Stenophora iuli de Frantzius, et cette synonymie fut admise par tous les auteurs qui suivirent.
Schneider (1875) le premier, décrivit avec précision la Grégarine parasite des Iulus sabulosus et Iulus terrestris. Il nota l'absence d'épimérite, la striation de l'épicyte très

marquée sur les 2 segments, la coloration jaune ou orangée de l'entocyte et le caractère des spores. Ces particularités lui firent créer le genre Stenocephalus pour cette Grégarine qu'il identifia à la Gregarine décrite par Leidy dans Spirobolus marginatus Say. Il l'appela Stenocephalus iuli Leidy, nonobstant les règles de la nomenclature.

Stenocephalus iuli devint ainsi la seule Grégarine des Iules et Gabriel (1880) y rapporta de lui-même sa Grégarina paradoxa.

Dans les Sporozoa du Tierreich (1899) Labbé consacra les habitudes prises en ne reconnaissant pour Gregarine parasite des Iules que le Stenophora iuli. Il se contenda de remplacer le nom générique de Schneider par celui de Stenophora, le nom de Stenopcehalus ayant ete attribue antérieurment a un genre d'Hemipteres.

Howard Crawley (1903a) etudiant les Grégarines des Iules et Paraiulus des Etats-Unis, rapporta les diverses espèces de Leidy au Stenophora iuli, tout en créant une nouvelle espèce pour un Stenophora d'un Spirobolus. Mais, dans un travail sur la faune de Corse (1903a) nous avons montré que les Stenophora étaient representés par plusieurs espéces reconnaissables à la seule vue du céphalin. Notre facon de voir est adoptée par Crawley dans un second travail (1903b) et il restaure le Stenophora iulipusilli Leidy en soutenant que le classique Stenophora iuli n'existe pas en Amerique.

Les espèces américanes de Stenophora se trouvent ainsi bien séparées du Stenophora iuli (Frantzius) Schneider. Nous (1903b) en avons détaché également un certain nombre de Stenophora des Diplopodes de Corse ou de Provence."

Stenophora larvata has not been found since Leidy's discovery of the species and its validity must be questioned until his work is substantiated by rediscovery of this parasite.

Stenophora polydesmivirginiensis (Leidy) Watson
Figs. 2, 3 and 4.

1853	Gregarina polydesmi virginiensis	Leidy	1853:238
1863	Gregarina Polydesmi	Lankester	1863:94
1899	Amphoroides polydesmi	Labbé	1899:20
1903	Gregarina polydesmivirginiensis	Crawley	1903a:45-46
1913	Amphoroides polydesmivirginiensis	Ellis	1913c:274
1915	Stenophora polydesmivirginiensis	Watson	

Stenophora: Sporonts solitary, elongate. Length 400-900μ[1]; width of deutomerite through widest part 25-60μ. Ratio--length prot:total length :: 1:15 to 1:17; width prot:width deut :: 1:1.5 to 1:2 in normally extended individuals. Protomerite subglobular to elongate, length twice the width. Slight constriction, if any, at septum. Protomerite as wide or wider than deutomerite at the septum. Deutomerite cylindrical, well rounded at posterior end. Endocyte transluscent. Nucleus visible in vivo, ellipsoidal, one spherical karyosome.

Cyst and spores unknown.

Taken at Philadelphia and Wyncote, Pa. and Raleigh, N.C.

Host: Fontaria virginiensis (Drury) (Polydesmus virginiensis).

Habitat: Intestine.

This species was described first by Leidy (1853:238).

Leger (1892)132) described a species, Amphorella polydesmi, from the intestine of Polydesmus complanatus (L.). He created for the species a new genus, characterized by the presence of a short circular cup-like protomerite.

1. Crawley (1903:46) gives 400μ as a maximum while Leidy gives 900μ.

Labbé (1899:20) united the A. polydesmi of Leger and G. polydesmivirginiensis of Leidy as one species and because Amphorella was invalid, called the genus Amphoroides and the species Amphoroides polydesmi (Léger).

But the protomerite of G. polydesmivirginiensis does not coincide in shape with that of the genus Amphoroides, for it is subglobose and bears no indication of a cup-like depression which is characteristic of the latter genus; therefore it must be placed elsewhere. The three following factors coincide with those of the genus Stenophora, viz: a) subglobose protomerite b) relative length of protomerite as compared with total length c) solitary sporonts. The spores and the epimerite still remain undiscovered and until they are found the generic determination is, of course, not absolute.

Crawley (1903a:45-6) called the species G. polydesmivirginiensis (Leidy), but in a later paper (1903b:640) he included it in a group of doubtful forms, all of which, however, he placed in the genus Gregarina.

Ellis (1913c:274) erroneously attributes to Crawley the assignment of the species name Amphoroides polydesmivirginiensis. It is Ellis, himself, (1913c:274) who names the species Amphoroides polydesmivirginiensis (Leidy). He offers no explanation therefor.

For reasons given above, the species is now removed

from the genus Amphoroides and placed in the genus Stenophora, the name now standing Stenophora polydesmivirginiensis (Leidy).

This is a well defined species, having been found and drawn by Crawley in 1903 and taken from the host in which it was originally found. The writer has examined a half dozen specimens of this diplopod taken at Urbana, Illinois without finding an instance of infection.

Stenophora julipusilli (Leidy) Crawley
Fig. 6.

1853	Gregarina juli pusilli	Leidy	1853:238
1863	Gregarina juli	Lankester	1863:94
1899	Gregarina julipusilli	Labbé	1899:35
1903	Stenophora juli	Crawley	1903a:51
1904	Stenophora iulipusilli	Léger & Duboscq	1904:362

Stenophora: Sporonts solitary, elongate, rather stout. Max. length 400μ, max. width not given. Ratio--length prot:total length :: 1:9 in adults; ratio width prot:width deut :: 1:1.5. Shape protomerite conical with a rather sharp apex, widest below median portion, papilla with an apparent pore at anterior end, deep constriction at septum. Slightly broader than high. Deutomerite irregularly cylindrical, four times as long as broad, sometimes widest through middle, sometimes posterior to middle. Endocyte very dense in adults. Granules of protomerite different from those of deutomerite. Nucleus spherical and large, attaining half the width of deutomerite. Contains a large karyosome. Cyst and spores unknown.

Taken at Philadelphia, Pa.

Hosts: Julus and Parajulus.

Habitat: Intestine.

Thia parasite was found and described by Leidy as Gregarina juli pusilli. Both figures he gives appear to be those of immature specimens (See fig. 5). From Leidy's data alone, I should consider the species invalid.

Crawley (1903a:51) includes both G. juli pusilli and G. juli marginati with the classic Stenophora juli Frantzius under the name of the latter. That this determination was erroneous Crawley later discovered and (1903b:634-5) he separated the three species.

"This species is easily separated from S. juli by the size of the protomerite. In S. juli the length of the protomerite, according to the figures given by Schneider (1875) makes up only about 6% of the total length. In S. juli-pusilli this proportion increases to 10% in the adults and 15% in the young."

Crawley 1903b:635.

Stenophora julimarginati therefore stands as a separate, well-defined species; the species described as Gregarina juli pusilli Leidy was renamed by Crawley as Stenophora julipusilli (Leidy). Crawley's words concerning the confusion of names are as follows:

"There is a good deal of confusion regarding the gregarines occurring in the Diplopod family Julidae. These gregarines all bear a certain amount of resemblance to one another, and it has been usual to relegate them all to the species Stenophora juli Frantzius. - - -The Julidae of this region are infected with certainly two and possibly three species of Stenophora, while the classic S. juli apparently does not

occur. Of these species, one is unquestionably the form described by Leidy (1853) as Gregarina julipusilli. As indicated by the specific name, Leidy considered its host to be Julus pusillus Say. According to Bollman (1887) this millipeds, correctly Julus minutus Brandt, does not occur in Pennsylvania, and it may be that Leidy was mistaken in his identification. This matter is not, however, of any great importance, and the specific name of the gregarine must stand. Leidy spelled the specific name of the host pusullus, whereas Say's memoir (1821) renders it pusillus, which spelling will be used for the name of the gregarine."

Leidy's original spelling of the host name (1853:238) pusillus, is the correct one and the last remark of Crawley is uncalled for. The correct name of the diplopod, according to Bollman (1893) is now Nemasoma minutum (Brandt).

Since Leidy's description and figures are so inadequate and even his determination of the host possibly in error, there was no valid reason for Crawley's having retained the specific name julipusilli when he redescribed the species (1903b:634-5).

Leger & Duboscq mention (1904) S. iulipusilli (Leidy) Crawley as a distinct species.

"notre façon de voir est adoptée par Crawley dans un second travail (1903b) et il restaure le Stenophora iulipusilli Crawley ---."

In the specific diagnosis above Leidy's description was excluded. It is as follows:

"Gregarina Juli pusilli. White, transluscent, oval. Cephalic sac hexahedral, with the sides rounded or forming a double cone, base to base, with the upper apex subacute or truncated in younger individuals. Posterior sac robust, oval; granular contents, fine, transluscent; interior corpuscle, globular, transparent; nucleus transparent, without nucleolus. Whole length from the 1;1500th in. to the 1.275th in. Breadth of largest the 1.500th in. Diameter of head of largest 1.1500th in. Hab. Int. Julus pusillus."

Stenophora juli (Frantzius) Schneider
Figs. 7 and 8.

1848	Sporadina Juli	Frantzius 1848:195
1851	Gregarina juli	Diesing 1851:15
1863	Gregarina juli	Lankester 1863:94
1875	Stenocephalus juli	Schneider 1875:584-5
1880	Gregarina paradoxa	Gabriel 1880:371.
1899	Stenophora juli	Labbé 1899:15
1903	Stenophora juli	Crawley 1903a:51
1904	Stenophora juli	Léger & Duboscq 1904:363-8

Stenophora: Sporonts solitary, elongate. Dimensions not given. Ratio--length prot:total length :: 1:20 (Approx.); width: prot :: width:deut :: 1:2. Prptomerite small, cylindrical at base, sharply conical above, little wider than high, a small papilla with an apparent pore at apex. Deutomerite elongate, slightly wider in anterior third than elsewhere, tapering gradually to an acute but blunt cone. Endocyte yellow to orange. Nucleus spherical, diameter half that of the deutomerite at its widest portion, containing one large karyosome.

Cysts dehisce by simple rupture. Spores fusiform with equatorial line.

Taken at Roscoff, France.

Hosts: Julus sabulosus (L.); Julus fallax Meinert (Julus terrestris).

Habitat: Intestine.

Stenophora juli has been the source of more confusion and of greater discussion than any other gregarine parasitic in the diplopods. The too concise descriptions and the lack of any measurements of the animals by the earlier writers have led later

workers to place a number of different parasites in this same group and to regard them all as Stenophora juli.

Frantzius' beautiful drawings are accompanied by no description beyond the statement that the parasite was found in Julus.

Diesing called the parasite Gregarina juli Frantzius. His description is as follows:

> "Proboscis ? . Receptaculum capitellatum acutum brevissimum. Corpus longum fusiforme. Hab. Julus terrestris.--"

Lankester (1863:94) relegated to this species the following: Gregarina juli pusilli Leidy, G. juli marginati Leidy, and G. larvata Leidy, all of which belong elsewhere, the last two being synonymous.

Schneider (1875:584-5) described a species as Stenocephalus juli from the intestine of Julus sabulosus and what he regarded as Julus terrestris.[1] He considered his species as related if not synonymous with a species described by Leidy in 1853 as Gregarina juli marginati. His words are these:

> "Cette espèce est commune et me paraît etre identique à celle décrite par Leidy sous le nom de Gregarina juli marginati. Dans ce cas, elle serait probablement répandue chez les différentes espèces du genre Julus, puisqui'on la connâitrait déjà chez trois d'entre elles. - - -. L'espece est légèrment polymorphe; elle est tantôt très-allongée et relativement étroite, tantôt remarquablement massive; mais son protomerite demeure toujours identique a lui-même et suffit amplement au diagnostic."

Schneider overlooked the color factor in correlating the two species. Leidy described his G. juli marginati as "opaque,

1. Léger & Duboscq (1904:364) say that J. fallax Mein. (J. albipes C.Koch) is probably the J. terrestris of Schneider.

white." Schneider's Stenocaphalus juli has the endocyte colored yellow or orange. Schheider gives no dimensions, but from the figure the proportions of his species agree perfectly with those of Leidy's species. The protomerites of the two species are s slightly different in shape in the character of the papilla at the apex. The papilla in Leidy's species is large and flattened and the apparent pore is widest at the apex, narrowing as it approaches the endocyte; in Schneider's figure the papilla is smaller, more conical, either sharp or blunt at the end and slender in the middle, broadening at the base next the endocyte.

While the two species are obviously closely related, I am of the opinion that they are not identical. Crawley (1903b: 634) says "the classic Stenophora juli apparently does not occur" in the United States and to date, 1915, it has not been described from this country.

If Schneider had given a set of dimensions for his species that were identical with those of Leidy, the personal equation might have been considered to such an extent as to eliminate the color consideration and the variation in the two protomerites.

Leidy's Gregarina juli marginati is thus seen to be distinct from Schneider's S. juli and stands to day as Stenophora larvata (Leidy) Ellis.

In 1880, Gabriel (p. 371) mentioned a species which

he calls Gregarina paradoxa and says it is identical with G. juli (Frantz.) Schn. Neither description nor drawings accompany this statement and the reason for giving the species a new name, if it be S. juli, is not apparent.

Labbé (1899:15) unites under the name S. juli (Frantz.) all of the following:

1848 Gregarina juli Frantzius
1875 Stenocephalus juli Schneider
1851 Gregarina larvata Leidy
1853 Gregarina juli marginati Leidy
1880 Gregarina paradoxa Gabriel

Why Labbé regards them all as synonymous, he does not state. They appear to be alike only in that they are all parasites of the same diplopod, Julus. With the exclusion of the tast three[1] the species stands as containing the original G. juli Frantz. and Stenocephalus juli Schn. The ratios obtained from figures given by Frantzius and Schneider are almost identical. Neither author gives any dimensions, so the animals may agree not at all in actual size. The character of the endoplasm, its granular content and color, may differ considerably.

Léger and Duboscq give a detailed account of the various species which have been confused in the literature. For the entire quotation, see under the heading Stenophora larvata (Leidy) Ellis.

From a lack of positive evidence to the contrary, the

1. The third and fourth are synonymous, being now S. larvata; the fifth is synonymouw with S. juli.

two species Gregarina juli Frantz. and Stenocephalus juli Schn. stand as a single species, now called Stenophora juli (Frantzius) Schneider.

Léger and Duboscq (1904:363-8) described a parasite as Stenophora juli and considered it synonymous with the S. juli above. The animal which they described differs greatly from the classic S. juli in shape of all its parts, in its pooportions, the density of its endoplasm, and in the shape of its nucleus (!). I detailed consideration of these factors is taken up under Stenophora dauphinia.

Stenophora dauphinia Watson
Fig. 9.

1904 Stenophora juli Léger & Duboscq 1904:363-8
1915 Stenophora dauphinia Watson

Stenophora: Sporonts solitary, elongate. Total length 250-300 μ. Width 19 μ. Ratio--length prot:total length :: 1:10; width prot:width deut :: 1:0.9. Protomerite dilated in posterior two-thirds, separated from anterior part by a deep circular constriction. Apex broadly conical, papillate anterior end, with an apparent pore. Deutomerite cylindrical, attaining ten times the length of the protomerite. Width nearly the same throughout and ending in a blunt rounded posterior extremity. Endocyte not described. Nucleus ellipsoidal, 1.7 times as long as wide. Cysts spherical, 250 μ in diameter. Spores regularly ovoidal, epispore present. Equatorial line on spores.

Taken at Turin, Italy and in Dauphine, France.

Hosts: Julus mediterraneus Latzel (Schizophyllum mediterraneum Latz.); Julus boleti C. Koch (Julus londinensis Mein.); Julus fallax Mein. (Julus albipes C. Koch.)

The authors described a parasite found in the same host as that upon which Schneider based his observations in his discovery of Gregarina juli (Frantzius). The species named by Schneider as the host of his parasites was Julus terrestris (Linnaeus) Porat but Léger and Duboscq observed that this species does not occur in France (1904:363).

"Nous décrirons d'abord Stenophora iuli (Frantzius) Schneider, qui nous a fourni de bons documents pour l'étude du développment des Sténophorides, et dont il importe de préciser la diagnose. Nous entendons par Stenophora iuli (Frantz.) Schn. le parasite de Schziphyllum sabulosum L. qui correspond à la description de Schneider. Cet auteur trouvait aussi Stenophora iuli dans Iulus terrestris, Mais Iulus terrestris L. n'est pas une détermination. Depuis un siècle, les anatomistes appellent de ce nom tous les Iules qui sont de coleur noire, et le véritable Iulus terrestris (Linné) Porat ne paraît pas exister en France. - - - Et en effet, nous voyons dans un certain nombre d'Iules une Gregarine bien voisine du parasite de Schizophyllum sabulosum L. Citons notamment parmi les hôtes de Stenophora iuli, Schizophyllum mediterraneum Latz. de la Tourraine, Iulus londinensis Mein. de la Tourraine, Iulus albipes C.K. du Dauphiné."

These authors base their observations on the parasites found chiefly in Julus albipes. In Julus sabulosus the gregarine attains a length of 450μ; in J. fallax Mein. and J. boleti C.K., of 300μ. Besides the elongate form, they mention a globular form nearly as wide as long, and reaching 130μ in length.

They do not illustrate this form. The elongate sporont, only, is figured. The authors do not describe the shape of the various parts and make no comparison of their form with the classic S. juli. basing their identification rather on a similarity of hosts than of parasites.

The data and figures given by Léger and Duboscq (1904) and by Schneider (1875) compare as follows:

	Schn.	L & D
Total length	----	450 max.
Total width	----	---
Ratio l prot:total l	1:20	1:10
Ratio W prot:w deut	1:2	1:0.9
Shape prot.	Apex papillate, with pseudo-canal, lower part cylindr. upper part broadly conical, no constr. in protomerite	Apex papillate with pseudo-canal, lower part broader than upper and separated from above by a deep circular constriction. Deep constr. at septum
Shape deutomerite	Irregularly cylindrical, tapering from anterior third to a sharp but rather broad cone. Twice as wide at shoulder as protom.	Regularly cylindrical, of approx. same width throughout, tapering slightly at post. tip. Slightly narrower than protomerite.
Nucleus	SPherical. One large karyosome.	Ellipsoidal (1:1.7) with one large karyosome.
Shading in figure:		
Prot:	Dark	Very light
Deut:	Dark	Dark

The proportions of the body-dimensions, the shape of the two protomerites and the shape of the two nuclei indicate at a glance that more than one species is under consideration and the species

described by Léger and Duboscq should be renamed. I therefore designate it Stenophora dauphinia.

Stenophora spiroboli (Crawley) Ellis
Fig. 10.

1903	Stenophora spiroboli	Crawley	1903a:51
1903	Cnemidospora spiroboli	Crawley	1903b:638-9
1913	Stenophora spiroboli	Ellis	1913c:286

Stenophora: Sporonts solitary, elongate. Max. length 1000μ ; width not given. Ratio--length prot: total length :: 1:32; width prot:width deut :: 1:1.5. Protomerite small, rounded at anterior end, one-third as high as wide. Septum concave upward, thus forming a protomerite in the shape of a double convex lens. No constriction at the septum; perfectly smooth contour throughout, from end to end. Deutomerite elongate cylindrical, broadest just below septum where it attains 1½ times the maximum width of the protomerite. Slightly wider in anterior third than elsewhere, tapering slightly and terminating bluntly. Endocyte opaque in both protomerite and deutomerite. Nucleus undescribed, not visible in vivo.

Cysts spherical, 350-500μ in diam. with thick epicyst. Dehiscence by rupture, spores fusiform 12½ x 7½μ .

Taken at Raleigh, N.C.

Host: Spirobolus sp.

Habitat: Intestine (?).

Crawley first described this species as Stenophora spiroboli transferring it later to the genus Cnemidospora when the cyst and spores had been examined, probably because of the character of the spore-integument. The genus Cnemidospora Schn. (1882:446-7) is diagnosed thus:

> Protomerite subglobular, divided into two parts, the upper greenish gray, the lower yellow to brown; deutomerite elongate, cylindrical, spores ellipsoidal (nearly spherical) with a thick integument. No sporeducts in cyst.

The species in question does not coincide with the characters of the genus Cnemidospora. Neither the coloration of the protomerite nor the shape of the spores fits the generic description.

Ellis has replaced the species in the originally assigned genus, where it undoubtedly belongs because of the form and coloration of the sporonts, the character of the cyst-dehiscence and the shape of the spores.

Stenophora fontaria (Crawley) Watson
Figs. 11 and 12.

1903	Amphoroides fontariae	Crawley	1903a:53
1913	Amphoroides fontariae	Ellis	1913c:274
1915	Stenophora fontaria	Watson	

Stenophora: Sporonts solitary, ovoidal. Max. length 135 , width not given. Ratio--length prot:total length :: 1:4 to 1:5.5 ; width prot:width deut :: 1:1.5 to 1:2. Protomerite subglobose, widest in posterior two-thirds, tapering to a blunt cone. Deep constriction at septum. Deutomerite elongate ovoidal, terminating bluntly. Endocyte nearly transparent in protomerite,

very opaque in deutomerite. Nucleus not always visible in vivo, small, spherical, with one karyosome.

Cysts and spores unknown.

Taken at Wyncote, Pa., Raleigh, N.C., and at East Falls Church, Va.

Hosts: Polydesmus sp. and Fontaria, sp.

Habitat: Intestine.

Léger (1892) created the genus Amphorella, afterwards renamed Amphoroides by Labbé (1899:20) to include species with solitary ovoidal sporonts having a protomerite short, compressed and crateriform, and spores rhombus-shaped (seen in one plane) and biconical, with but one integument.

Léger and Duboscq (1904:375) compared one of their new species with the species in question. Their remarks are:

> "Stenophora chordeume nous paraît, par sa forme, une espèce trés voisine de la Gregarine des Polydesmus et Fontaria des Etais-Unis, signalée par Crawley (1903a) sous le nom d'Amphoroïdes fontariae. Les figures qu'en donne cet auteur dans sa Pl. I fig. 12, 13, 14 nous portent à croire, d'après les caracterès de l'épimérite, qu'il s'agit plutôt d'un Stenophora que d'un Amphoroïdes. Il est d'ailleurs impossible de se prononcer aves certitude sur ce point, car Crawley ne nous fait pas connaître les sporocystes de sa Grégarine, et on sait que, outre la forme de l'épimérite, celle des sporocystes distingue nettement les Amphoroïdes des Stenophora; dans Amphoroïdes, ils sont biconiques; chez Stenophora, ils sont ovoïdes."

Thus the basis for the original inclusion of the species in the genus Amphoroides is not that of spore-characteristics and until the spores are known the generic position of the species

will not be absolute. The shape of the protomerite of the species under question is, however, very unlike that of the type species of this genus, A. polydesmi Léger, and hence the species cannot consistently be left in this genus. Its logical position seems to be with the Stenophoridae because of elimination from any other genus rather than from any positive character, and I should designate it Stenophora fontaria (Crawley).

Stenophora brölemanni Léger & Duboscq
Fig. 13.

1903 Stenophora Brölemanni Léger & Duboscq 1903b:339-40

Stenophora: This gregarine is small, from 40-54 μ long and is compressed laterally, especially in the anterior part. It lives within the cell of the host during the greater part of its life-cycle. The older intracellular individuals are subspherical and occupy a cavity larger than that occupied by the younger ones, which is formed by the greater destruction and compression of surrounding cells. The protomerite is invaginated into the anterior end of the deutomerite like a cork into the neck of a bottle. When the animal leaves the epithelium the protomerite still retains its invaginated position. The protomerite in profile is cylindrical, rather flattened at the top, and when seen from the front it is as broad as high, widest anterior to the middle and possesses at the summit a small plate slightly concave upward and bearing in the center a small spher-

ical papilla. Léger and Duboscq say this papilla may correspond to a protractile epimerite, for fibrillae seem to radiate from the apex outward over the anterior third of the protomerite. The deutomerite seen in profile is much larger at its posterior end than elsewhere, i.e. the animal is compressed chiefly in the anterior half. A front view shows a deutomerite as broad as it is high. The nucleus is large, spherical or slightly ovoidal and contains one large karyosome. The parasite is characterised then by its compression, the invagination of its protomerite and by its inter- or intra- cellular location (the authors are not sure which).

Taken in Provence, France, and on the island of Corsica.

Hosts: Blaniulus hirsutus Brol., Brachyiulus superus Latzel, Brachyiulus pusillus lusitanus Verh.

Habitat: Intestine.

Stenophora nematoides Léger & Duboscq
Figs. 14 and 15.

1903 Stenophora nematoides Léger & Duboscq 1903b:335-7

Stenophora: Sporonts solitary, elongate. Average length 170 μ, max. length 300 μ. Width not given. Ratio--length prot:total length :: 1:10; width prot:width deut :: 1:3. Protomerite cylindrical, slightly dilated a little anterior to septum. Twice as long as wide, dome-shaped at apex; constriction at septum. Deutomerite normally with constriction at end of anterior third, or half, above this point considerably dilated,

especially in posterior portion. Posterior half or two-thirds of deutomerite, i.e. part below constriction, cylindrical, ending in a broadly rounded or somewhat truncate extremity. The largest sporonts without the peculuar dilated portion of the deutomerite; nematoid in shape, long, slender, cylindrical often slightly curved and with a body as much as seventeen times as long as the protomerite (170μ :10μ), and not more than 7μ wide throughout. Endocyte granules fine, homogeneous except in anterior end of protomerite where deeply staining chromatic granules are accumulated. Nucleus large and ovoidal, the long axis parallel to the long axis of the body. One large karyosome. Epimerite a large subglobular hyaline body.

Cyst and spores not known.

Taken at Bastia, Corsica.

Host: Strongylosoma italicum Latzel.

Habitat: Intestine.

The authors' conclusion concerning this species is as follows:

> "Bien que nous ne consaissions pas l'évolution complète de cette Grégarine, nous avons la conviction qu'il s'agit d'une espèce voisine du Stenophora iuli, car à part la forme générale nématoïde qui est ici très caractéristique de l'espece, toutes le autres particularities structurales (forme du protomérite, caractère du noyeau, présence de grains chromatoïdes accumulés surtout dans le protomérite, etc.) se retrouvent aussi chez les autres espèces du genre Stenophora, lequel d'ailleurs est special aux Diplopodes."

Stenophora varians Leger & Duboscq
Figs. 16 and 17.

1903 Stenophora varians Leger & Duboscq 1903b:337-9

Stenophora: Sporonts solitary, dimorphic, elongate and globular. The elongate forms cylindrical or slightly compressed, slightly attenuate at both extremities, attaining a maximum length of 250μ. Width not stated. Ratio--length prot: total length :: 1:6 to 1:7; ratio width prot:width deut :: 1:1. Protomerite cylindro-conical, 1½ times as long as wide, its summit depressed, with an apparent pore. Constriction at septum. Deutomerite just below septum a little narrower than protomerite a short distance above. Deutomerite irregularly cylindrical, slightly curved in adults, truncate or broadly rounded behind. Nucleus spherical with a large karyosome. Endocyte or protomerite consisting of large deeply staining bodies, of deutomerite large non-staining bodies with a few scattered chromatic bodies.

The globular sporonts more rare than the elongate ones but coexisting with the latter. Max. length 35-40μ. Deutomerite large, globular, protomerite cylindro-conicao and shorter than in the elongate forms. A small papilla at anterior end. Protomerite shows same staining reaction and the nucleus is relatively larger, with a much larger karyosome.

Taken at Ajaccio, Corsica.

Host: Schizophyllum corsicum Brol.

Habitat: Intestine.

Relative to the dimorphism, the authors make these remarks:

"Au sujet de interprétation de ces deux formes de Stenophora dans un même hote, on peut émettre plusieurs hypothèses: Ou bien la forme globuleuse, en raison de sa petite taille représente un stade très jeune de la Gregarine; ou elle représente une espèce distincte de la Forme allongée; ou bien enflin il s'agit d'un dimorphism sexual dans des individus d'une seule et même espèce. Nous nous rattachons d'autant plus volontiers à cette dernière hypothese que l'on observe assez souvent de jeunes formes allongées de volume bien inferieur à celui des formes globuleuses."

The great difference in maximum lengths recorded of the elongate (250μ) and the globular (40μ) forms of this species, would hardly indicate that the latter is mature. The immature specimens of most species of gregarines are more or less globular, stain deeper, have a protomerite which changes but little in shape as maturity approaches, and possess nuclei much larger in proportion than the adults, and often of a different shape from that of the adults. I have often seen these globular individuals as large or a little larger than other individuals which had already assumed their adult form, and have attributed the difference to a difference merely in the amount of nourishment they have received. I think if we are to assume that there is a sexual dimorphism , we must look for two individuals of somewhere nearly the same size rather than one six times the size of the other.

While sexual dimorphism is a factor to be looked for among gregarines, it has never been definitely proven for a single species. There may be a difference in sexes among the sporonts,

but if so, this difference seems to be of a chemical nature or of so slight morphological significance as to have been generally overlooked; and it should be evident among all or most of the members of the same family rather than confined to a few species only.

Stenophora producta Léger and Duboscq
Fig. 18.

1903	Stenophora juli	Léger & Duboscq	1903b:315
1904	Stenophora producta	Léger & Duboscq	1904:375-7

Stenophora: Sporonts solitary, very elongate. Sporonts 1000μ long, width not given. Ratio--length prot:total length :: 1:20; ratio width prot:width deut :: 1:21. Protomerite globular, slightly flattened top and bottom, sometimes slightly invaginated at the deutomerite. At apex a small papilla with an apparent pore. Deutomerite very long, cylindrical, broadly rounded behind. Endocyte of protomerite finely granular, staining deeper than the deutomerite. The nucleus ellipsoidal, with one large karyosome. An inverted xiphoid cone rounded at the summit, projecting from the septum downward into the deutomerite and consisting of homogeneous protoplasm staining deeper than that of the deutomerite. Probably consisting of a nutrient substance manufactured by the protomerite and filtered through the septum, to be eventually diffused throughout the deutomerite. Epimerite a small simple knob.

Cysts spherical, size not given. Spores ovoidal, 5μ long.

Taken at Corte, Corsica.

Host: Julus varius Fabricus (Parajulus varius Fab.).

Habitat: Intestine.

The reason for the confusion of names mentioned above appears in the following quotation from Léger and Duboscq (1904: 375).

"Nous avons déjà signalé la presence de cette Grégarine dans l'intestin de Pachyiulus varius Fab. de la Corse (1903) et nous l'avons tout d'abord confondue avec Stenophora iuli, ne l'ayant observée a cette époque que sûr le vivant. Depuis, une étude plus approfondie sur des préparations colorées nous a convaincu qu'il s'agit d'une espèce morphologiquement differénte de Stenophora iuli (Frantzius) Schneider et nous la distinguerons de cette dernière sous le nom de Stenophora producta n. sp.- - - Nous n'avons pas remarqué de ligne équatoriale à la surface des sporocystes de Stenophora producta, ce qui distingue encore cette espèce de Stenophora iuli."

Stenophora aculeata Léger & Duboscq
Figs. 19 and 20.

1904 Stenophora aculeata Léger & Duboscq 1904:368-70

Stenophora: Sporonts solitary, elongate. Max. length 60 μ; width not given. Ratio--length prot:total length :: 1:4 (approx.); width prot:width deut :: 1:1.5. Protomerite subglobular, a short cylindrical portion at base, somewhat dilated in middle, terminating in a small delicate elongate papilla 1 to 2 long. A conspicuous constriction at septum. Deutomerite cylindrical, broadly rounded behind. The endocyte of the deutomerite with protoplasmic granules smaller than those of the protomerite and less deeply staining. Nucleus very large, subspherical, in diameter two-thirds to seven-eighths the width of the deutomerite,

with a large karyosome.

Cyst and spores not known.

Taken in Dauphine, France.

Host: Craspedosoma rawlinsii simile Verh.

Habitat: Intestine.

Stenophora polyxeni Léger & Duboscq

1900	Stenophora polyxeni	Léger & Duboscq 1900:1566-8
1903	Stenophora polyxeni	Léger & Duboscq 1903a:xciii
1904	Stenophora polyxeni	Léger & Duboscq 1904:370-1

Stenophora: Sporonts solitary, obese. Average length 80 μ. Width not given. Ratio--length prot:total length :: 1:10; width prot: width deut :: 1:2 (approx.). Protomerite very small, hemispherical or somewhat flattened. No apparent pore in anterior end, as in many Stenophoridae. Protomerite twice as wide as high. Widest at or just above base. Slight constriction at septum. Deutomerite elongate ovoidal in young and sac-shaped in older sporonts. Endocyte fairly homogeneous. Nucleus spherical, half the width of deutomerite, with a large karyosome.

Cyst and spores not known.

Taken at Grenoble, France.

Host: Polyxenus lagurus (Linn.) Latreille.

Habitat: Intestine.

Stenophora silene Léger & Duboscq
Figs. 22 and 23.

1904 Stenophora silene Léger & Duboscq 1904:371-2

Stenophora: Sporonts solitary, dimorphic, an elongate and a globular form. The elongate form 100 µ in max. length, width not given. Ratio--length prot:total length :: 1:10; width prot:width deut :: 1:1. Protomerite cylindrical, slightly dilated top and bottom, nearly flattened at top, an apparent pore at apex. Constriction at septum. Deutomerite cylindrical, gradually tapering toward posterior end, this end truncate. Endocyte of protomerite with large achromatic bodies, of deutomerite very finely granular and deeply-staining. Nucleus large, half the maximum width of deutomerite, ovoidal, its longitudinal axis parallel to that of the body, containing one large karyosome.

The globose form 55-60 µ in max. length. Width not given. Ratio--length prot) total length :: 1:6; width prot:width deut :: 1:2.3. Protomerite similar to that of elongate form, but containing finely granular endoplasm as deeply staining as that of deutomerite. Deutomerite broadly ovoidal, widest below center. Nucleus less ellipsoidal than in elongate form.

Cyst and spores not known.

Taken in Dauphine, France.

Host: Lysiopetalum foetisisissimum Savi.

Habitat: Intestine.

"Howard Crawley (1903a) a signalé dans Lysiopetalum lactarium des Etas-Unis deux espèces de Grégarines: l'une qu'il nomme Grégarina Calverti dont la forme générale et la taille sont si différentes de celles de la précédente que l'on ne peut établir de confusion; l'autre espece est rapportée au Stenophora iuli. Il est possible que celle-ci soit identique à notre Stenophora silene, mais on ne peut l'affirmer, car Crawley ne donne pas de dimensions de son Stenophora." (Léger & Duboscq 1904:372).

Stenophora silene is not the species described by Crawley (1903a:51; 1903b:634-5) as Stenophora juli. Crawley's species attains a length of 400μ, S. silene of only 100μ. The protomerite of S. juli is broadly conical, 1.4 times as wide as high; of S. silene cylindrical, flattened at the apical end. Crawley's Gregarina Calverti is still another species, now called Amphoroides calverti.

Whether or not there is an actual dimorphism in the Stenophoridae is a problem still far from settled. The finding of elongate and globose forms in the same species and the difference in staining reactions can, I think, hardly be considered sexual dimorphism unless the two sporonts are of somewhere nearly the same size. In S. silene, the difference in length of the two is 100%. The difference in lengths of the elongate and globular sporonts is not to be accounted for by a mere shortening of the body, for the staining reaction and shape of the nucleus differs as well. The nucleus of the globular form is less ellipsoidal than that of the elongate form. In all Stenophoridae I have observed, the young trophozoites and younger sporonts have not

yet attained that elongation of the nucleus which is characteristic of the adults, and a gradual transition can be observed in the same series of sections from a spherical to sub-spherical and finally to the elongate ellipsoidal nucleus of the adult sporonts. In all the gregarined I have studied, the young globular trophozoites contain less protoplasm and stain more readily and deeper than the adults.

If globular and elongate specimens of approximately the same length can be procured or, at least, with protomerites of the same approximate size, and a young cyst shown to contain two individuals with different staining reactions and differently shaped nuclei, then there will be sufficient data to make a positive statement that there is sexual dimorphism among the Stenophoridae. This has not yet been reported and there is too great a discrepancy in size of the elongate and globose forms to warrant callong them sexually unlike and the phenomenon sexual dimorphism.

Stenophora chordeume Léger & Duboscq
Figs. 24 and 25.

1904 Stenophora chordeume Léger & Duboscq 1904:372-5

Stenophora: Two forms described for the sporonts. The elongate form 140 μ long, width not given. Ratio--length prot: total length :: 1:7.5; width prot:width deut :: 1:2. Protomerite nearly twice as wide as high, widest along central portion, flattened above, with papilla and an apparent pore at apex. A

conspicuous constriction at septum. Deutomerite an elongated irregularly-shaped sac widest below the middle and tapering rapidly to a point. Endocyte of protomerite clear, containing large non-staining granules. Endocyte of deutomerite homogeneous with a few scattered irregularly shaped chromatic granules. The nucleus spherical with a large karyosome.

The globular form with maximum length of 100µ. Width not given. Ratio--length prot:total length :: 1:5; width prot:width deut :: 1:2.5. Protomerite same shape as in elongate form except that the constriction at the septum is deeper and the protomerite sometimes partially invaginated into anterior end of deutomerite. Deutomerite ellipsoidal and nearly spherical. Endocyte of protomerite deeply staining, like that of deutomerite. Deutomerite with long scattered chromatic filaments. Nucleus spherical, with a large karyosome and numerous irregular chromatic granules.

Cyst and spores not known.

Taken at Grenoble, France.

Host: Chordeuma silvestre C. Koch (C. sylvestre C.K.).

Habitat: Intestine.

Concerning the long chromatic filaments in the deutomerite, the authors say (1904:374):

"Sur la signification de ces singulières formations, ou ne peut qu'émettre des hypothèses: ou bien ce sont des productions parasitaires, ce qui nous paraît peu probable, car toutes les formes globuleuses en montrent à l'ex-

clusion des formes allongées, ou bien ce sont des produits derivés de l'activité cellulaire. Tout en nous rattachant plus volontiers à cette manière de voir, nous ne saurions dire si ces produits prennent naissance dans le cytoplasme comme substances de réserve ou de déchet comparables aux cristalloïdes déjà signalés chez certaines Grégarines, ou bien s'ils dérivent de la chromatine nucléare. Dans tout les cas, nous ne croyons pas devoir les considérer comme des éléments chromatiques ou chromatides, destinés à jouer un rôle important dans les phénomenes sexuels et nous les regardons plutôt comme des produits ergastoplasmiques."

As heretofore, the size of the two dimorphants is considerable (50%). The deutomerite of the smaller contains many long chromatic filaments. At the same time, the deutomerite of the elongate form is not devoid of scattered chromatin, which may be the broken remnants of threads in a younger stage. Only two diplopods were parasitised, one

"renfermait beaucoup de parasites, l'autre, au contraire, très peu."

It is possible, from the limited material at hand, that still longer and more mature elongate forms may exist and bring up the percentage still higher.

"Stenophora chordeume nous paraît, par sa forme, une espèce très voisine de la Grégarine des Polydesmus et Fontaria des Etats-Unis, signaleé par Crawley (1903a) sous le nom d' Amphoroïdes fontariae. Les figures qu'en donne cet auteur dans sa Pl. I fig. 12, 13, 14 nous portent à croire, d'apres les caracteres de l'épimérite, qu'il s'agit plutôt d'un Stenophora que d'un Amphoroïdes. Il est d'ailleurs impossible de se prononcer avec certitude sur ce point, car Crawley ne nous fait pas connaîtres les sporocystes de sa Grégarine, et on sait que, outre la forme de l'épimérite, celle des sporocystes distingue nettement les Amphoroïdes des Stenophora; dans Amphoroïdes ils sont biconiques; chez Stenophora, ils sont ovoïdes."

From the data given, then, it is impossible to state with certitude that the species are or are not the same. Dimensions correspond closely. I have not included Crawley's species here because of differences in shape of the sporonts but have left it as a distinct species and placed it among the Stenophoridae, the name now being Stenophora fontaria (Crawley).

Stenophora corsica Léger & Duboscq

1903 Stenophora corsica Léger & Duboscq 1903b:314

No description or figure is given for this species. It is merely mentioned as a parasite found in Craspedosoma légeri Brol. at Vizzanova, on the island of Corsica.

Stenophora robusta Ellis
Fig. 26.

1912 Stenophora robusta Ellis 1912b:8-10

Stenophora: Sporonts solitary, relatively short and thick. Average length 153μ ; minimum 140μ ; maximum 180μ . Width 67μ , average. Ratio--length prot:total length :: 1:8; width prot:width deut :: 1:2.5. Protomerite small, dome-shaped or conical. Slight concavity in apical portion, widest at junction with deutomerite. No constriction at septum. Deutomerite broadly ellipsoidal, widest in center, slightly rounded behind. Endocyte fairly clear in all parts but especially so in protomerite. Nucleus spherical, faintly visible or obscured in vivo. One or more karyosomes.

Cyst and spores not known.

Taken at Boulder, Colo.

Hosts: Parajulus venustus Wood; Orthomorpha gracilis (Koch); Orthomorpha sp.

Habitat: Intestine.

Stenophora cockerellae Ellis
Fig. 27.

1912 Stenophora cockerellae Ellis 1912a:681-5

Stenophora: Sporonts solitary, elongate. Average length 500-800μ. Minimum length 186μ, maximum 850μ. Width deutomerite not given. Ratio--length prot:total length :: 1:14.5 to 1:17 in adults; width prot:width deut :: 1:2. Protomerite more or less globose, widest in posterior half. Slightly constricted at septum. Peculiar in that the protomerite protrudes and retracts a short rounded papilla. Deutomerite widest in anterior sixth. Posterior end broadly rounded to square. Endocyte of protomerite pale gray, rather opaque, nearly filling the protomerite. Endocyte of deutomerite dense, lead gray to almost black. Nucleus spherical, diameter two-thirds the width of the deutomerite. Not visible in vivo.

Cyst and spores unknown.

Taken at Quirigua, Guatemale.

Host: Parajulus sp.

Habitat: Intestine.

Stenophora elongata Ellis
Fig. 28.

1912 Stenophora elongata Ellis 1912a:685-6

Stenophora: Sporonts solitary, very elongate. Length 200-300 average. Minimum length 21 , maximum 390 . Width of deutomerite not given. Length of prot:total length :: 1:18 to 1:26; width prot:width deut :: 1:1.6. Protomerite more or less pentagonal (seen from the side), truncate, wider than long. Constriction at septum distinct. Deutomerite widest in anterior third, posterior end rounded. Endocyte of protomerite dense, opaque, dark gray; of deutomerite gray, very dense. Nucleus not visible in vivo, spherical, one-half to seven-eighths the width of the deutomerite.

Cyst and spores not known.

Taken at Quirigua, Guatemala.

Host: Orthomorpha coarctata (Saussure).

Habitat: Intestine.

Stenophora impressa n.s.
Fig. 53.

This parasite was found to be very common in the intestine of Parajulus impressus (Say), one of the common small diplopods found at Urbana, Illinois.

The sporonts are isolated, none being associative. They are elongate-ellipsoidal in shape, widest through the central

portion of the deutomerite or at the beginning of the posterior two-thirds. The protomerite is conical, dilated just above the base and tapering rather acutely but with a blunt point at the apex. The widest part is some little distance anterior to the septum, the constriction at the septum being conspicuous but not deep. The length of the protomerite is about one-tenth of the total length of the sporont. The deutomerite broadens gradually from the septum to the central region and then as gradually becomes narrower, ending in a very blunt rounded extremity of much the same general shape as the anterior end of the protomerite. At its widest part the deutomerite is about twice the greatest width of the protomerite.

The endocyte is gray with no trace of tan. The protomerite contains a few large granules of more or less transparent protoplasm and the deutomerite content is finely granular, homogeneous, and often so dense as to appear black in transmitted light. The epicyte is thin, transparent, of even width throughout, and is longitudinally striated. At the anterior end of the protomerite there is an invagination of the epicyte. The latter is here very thin and readily breaks, with a consequent extrusion of the endocyte. The nucleus is spherical, generally visible in the adults and contains one large karyosome which is visible without staining.

The trophozoite of Stenophora impressa was studied in

[illegible]

[illegible] the protonemata.

The [illegible]

The [illegible]

sections made of the intestine of the parasitised Parajuli. The young parasites lie embedded between the cells of the intestinal epithelium, having made a place for themselves by the destruction of the cell originally entered, and by the absorption and destruction and pushing aside of contiguous cells; and they lie with the apex of the protomerite next the mesothelial wall. As is often the case with the Stenophoridae, there is never developed an epimerite. Since the whole parasite lies embedded, there is abundant surface through which osmosis may take place without the additional presence of an epimerite. The protomerite of trophozoites is often deeply embedded in the deutomerite, like a cork in the neck of a bottle.

Two types of movement were observed. A rapid gliding over the surface at the rate of .006 mm. per sec. was very common. This form of movement persists for an hour or more after the animals are placed on the slide. Partial rotation of the body on its own axis and a bending of the body to an angle of about 45° were frequent. The epicyte in the region just below the septum is very flexible, resulting in a nodding of the protomerite from side to side. The extension of the upper part of the deutomerite which causes the protomerite to drop is effected slowly, but withdrawal of protoplasm is done by a sudden jerking movement which restores the normal shape.

Cysts of .16 mm. diameter were found, but none could be induced to develop to completion in a water medium.

This species differs from Stenophora lactaria n.sp. in a) general shape of the deutomerite b) shape of the posterior end of the body and c) shape of the nucleus.

A table showing data relative to the various dimensions follows:

Total length of body in mm.	.155	.27	.24	.27	.39	.345
Length of protomerite	.02	.03	.025	.025	.035	.03
Length of deutomerite	.135	.24	.215	.245	.355	.315
Width of protomerite	.03	.035	.035	.03	.048	.048
Width of deutomerite	.07	.07	.07	.07	.115	.10
Ratio length prot / total length	1:7.5	1:9	1:10	1:10	1:10	1:11
Ratio width prot / width deut	1:2.3	1:2	1:2	1:2.3	1:2.4	1:2.1

Stenophora lactaria n.sp.
Fig. 55.

A gregarine which was found with relative frequency is this one from the intestinal tract of the small diplopod Callipus lactarius (Say), taken at Urbana, Illinois, during the month of October, 1914. The infection per host was heavy and sections of the alimentary tract showed the latter half of the same to be heavily parasitised with trophozoites.

A table of various dimensions of the parasites at different ages follows. There is considerable discrepancy in the ratios given but the fact that there is a gradual transition from one extreme to the other indicates that a single species is involved. Measurements were made only of individuals which to all appearances were equally expanded.

Total length in mm.	.173	.216	.293	.304	.339	.455	.480
Length prot.	.028	.027	.03	.03	.02	.036	.03
Length deut.	.145	.189	.263	.264	.310	.419	.450
Width prot.	.03	.03	.039	.029	.039	.035	.039
Width deut.	.054	.053	.090	.061	.09	.065	.09
Ratio $\frac{\text{l. prot}}{\text{total l.}}$	1:6	1:7.5	1:10	1:10	1:17	1:13	1:16
Ratio $\frac{\text{w. prot}}{\text{w. deut}}$	1:1.8	1:1.8	1:2.3	1:2.1	1:2	1:1.9	1:1.6

The sporonts, as in all members of this family, are solitary until just previous to cyst formation. The body, when moderately expanded, is shaped like a classic vase, widest near the top and tapering very gradually. The protomerite is small in comparison with the deutomerite, being from one-eighth (in young specimens) to one-sixteenth the total length. It is conical, widest just anterior to the base, and its breadth exceeds its height. (.039 mm. x .03 mm; .032 x .029). It is from .4 to .6 as wide as the deutomerite at its widest part. There is a slight invagination at the anterior end. The deutomerite is widest a short distance below the constriction at the septum and tapers gradually toward the posterior end, terminating in a blunt cone.

The protomerite is quite or nearly transparent, containing but few large crystal-like granules of protoplasm which stain deeply. There is an apparent pore at the anterior end. The deutomerite is more or less dense and opaque, being pearly white in reflected light and light or dark gray, depending on the amount of protoplasm present, in transmitted light. The density depends on age, the young trophozoites containing few pale gray granules,

the oldest and largest sporonts being filled with protoplasm which gives to them a blackish appearance. The deutomerite stains a fairly homogeneous shade, and the small granules here do not absorb as much of the stain as do the larger protomerite granules.

The epicyte is colorless and very thin, even at the septum. Longitudinal striations are discernible. This epicyte is much more resistant than in many gregarines studied, for animals remain alive on the slide in a water medium or in normal saline for many hours, and when they finally become immotile, retain their shape. After several days on the slide, they have been noted to be intact with the body only a little more nearly globular from osmosis than in the normal parasites. This may be due to the thinness of the epicyte and to its great permeability. Myonemes were seen in stained, sectioned specimens as deeper-staining dots, larger than the deutomerite granules and lying along the periphery of the endocyte in the longitudinal sections.

The nucleus of sporonts is an elongate-ellipsoid, generally placed diagonally and reaching almost entirely across that part of the deutomerite in which it lies. In large specimens, it approximates .055 mm. x .03 mm. It contains one large spherical or slightly ovoidal karyosome which stains evenly and lightly throughout with Ehrlich's hematoxylin. The nucleus is not visible in vivo in the large and dense individuals. In young specimens, it is spherical, becoming ellipsoidal as the sporont stage approaches.

The trophozoite is much less dense than the sporont. The epimerite is a round, sessile transparent knob.

The sporozoite is a deeply-staining, spindle-shaped body which penetrates the cell at its free end, becomes embedded, grows, and absorbs the host cell which it entered. The whole trophozoite, not merely the epimerite, lies embedded and after it has destroyed the originally entered cell distorts and compresses those adjoining. It remains embedded until it has practically outgrown the cells of the epithelium and easily escapes into the lumen through the canal it has formed by cell destruction. The trophozoite is able to move about while embedded. In cross-sections of the intestine, the parasite, still embedded, is sometimes cut cross-wise, indicating that it lies with its longitudinal axis parallel to that of the host, and in one instance it lay with the protomerite pointed toward the lumen rather than toward the mesothelial wall, the normal position.

The gliding movement common to most Polycystids is functional here and the animal moves forward very rapidly in a straight line, often with a constant turning of the protomerite from side to side which affects neither the rapidity nor the direction of motion. Progression has been observed at the rates of .0065 mm. and .0075 mm. per sec. Each of these rates is for a different specimen and each movement extends at a uniform rate over several minutes. No gelatinous stalk was seen trailing

behind the animal either with or without the use of a stain on the slide. Ameboid movement was noted, chiefly confined to the anterior part of the deutomerite; it results in the nodding of the 'head' as many as thirty times without ceasing or decreasing speed. The protomerite does not change in shape or size, neither does the posterior two-thirds of the deutomerite. The epicyte of the shoulder region stretches on one side, the endocyte flows into the pocket thus formed, and the inactive protomerite, its equilibrium disturbed, drops to one side and then to the other as the pockets form now on one side and now on the other. Structures which cause movement must therefore be much more numerous or else much more active physiologically in this restricted area than elsewhere.

Cysts are spherical and vary from 150 to 270 μ in diameter. I have as yet been unable to procure development of the cysts. Quite a number were kept from two days to two weeks in water and normal saline media and when opened revealed no indication of having undergone progression beyond the dissolution of the walls separating the two conjugants. Staining revealed no differentiation whatever in the apparently homogeneous protoplasm.

This species is distinguished from Stenophora larvata (Leidy) Ellis by the considerable difference in size. Leidy's species varies from 100 μ to 800 μ in length, while S. lactaria does not exceed 480 μ. His form varies in width from 30 μ to 200 μ; the other never exceeding 90 μ. The ratio of length prot:total

length in S. larvata (largest individual) is 1:26; in S. lactaria it never exceeds 1:16. The nucleus in the former is spherical and about 70μ in diameter; in the latter it is ellipsoidal and smaller, 55μ x 30μ in the largest measured. The habitant is a different diplopod found, however, in the same habitat.

S. lactaria differs from S. elongata Ellis and from S. cockerellae Ellis in size, shape of the protomerite and of the deutomerite, and in shape especially of the posterior end of the deutomerite.

Stenophora diplocorpa n. sp.
Fig. 54.

A number of most peculiar polycystid gregarines were found in the common small diplopod, Euryurus erythropygus (Brandt), at Urbana, Illinois, in October, 1914. The parasites were found in each of two specimens of this diplopod, each host containing about a dozen parasites in the intestine.

The sporonts are solitary. The shape is more or less cylindrical, the body being very much attenuated. The protomerite is as wide as it is long and is from one-sixteenth to one-twenty-fifth of the total length of the body, and there is no indentation at its anterior end as in many Stenophoridae. The anterior half of the protomerite is rather broadly conical and is blunt at the apex. There is but a slight constriction at the septum in expanded individuals. The anterior end of the deutomerite is but little wider than the protomerite just in front of the septum. The deuto-

merite gradually widens, becoming widest just anterior to the middle where it is twice the maximum width of the protomerite. It is incompletely separated into two nearly equal parts by a deep constriction at about the middle and behind this constriction the body is cylindrical, of practically the same width throughout, terminating in a blunt, well rounded cone.

The protomerite is transparent or nearly so, containing a few large irregular deelpy-staining granules clustered near the septum. The deutomerite is pale tan and contains smaller homogeneous granules densest just anteriot to the constriction, least dense at the posterior end, and otherwise fairly evenly distributed. The endoplasm is much less opaque than in many gregarines. The epicyte is thick, transparent and of even width throughout except at the constriction in the deutomerite, where it becomes considerably thicker. Longitudinal striations are easily discernible in the epicyte. The myonemes are well developed, especially at the constriction and at the septum, and are indicated by a series of delicate reticular fibrillae embedded in the peripheral layer of the endocyte and running crosswise of the body. The nucleus is visible in vivo; it is spherical and, in diameter, two-thirds the width of the body just back of the deutomerite constriction. It lies just posterior to this constriction. One large karyosome is visible within.

The epimerite evidently persists after its usefulness

is over, and was seen in one instance on a fairly large specimen free in the lumen of the intestine. It is a large hyaline smooth knob with a short stalk broad at the base.

Neither sporozoite not cyst was seen.

The parasite is fairly active. Gliding motion, accompanied by no bodily contortion was observed at the rates of .011 and .007 mm. per sec. Each rate given was fairly constant for the given gregarine for a period extending over several minutes. A contortion of the body is common, either with no displacement of the body as a whole or in connection with the gliding motion. In fact, it was difficult to find an animal in simple progression which was not at the same time performing some sort of contortion. The region of the septum is very motile. Here the epicyte expands and contracts, with an inflow or withdrawal of the endocyte, just as in the case of an amoeba. Tiny processes can be seen extruded several at a time or a large portion of the endoplasm of the region may be pushed out at one time. In the latter case, the heavy and rigid protomerite is overbalanced and drops to one side. Immediately thereupon an outpushing of protoplasm on the other side either restores the normal condition or causes a nodding to the opposite side. This movement may continue with surprising rapidity and extend over a long period of time. The deutomerite above its median constriction is very motile, but the portion below is never involved in violent contortions.

This species is similar in general outline to Stenophora nematoides Léger & Duboscq (1903b:335-7). Both have the peculiar and hitherto unique constriction at the middle of the deutomerite. They differ in the shape of the protomerite, which in Léger and Duboscq's species is much longer than wide; in the shape of the nucleus, which in S. nematoides is elongate-ovoidal and in S. diplocorpa is spherical; and in the character of movement. I have in no case observed the nematoid shape which is assumed by S. nematoides and is due to the elongation of the body and the entire disappearance of the constriction. Motion in S. diplocorpa is confined chiefly to regions above the constriction and the latter never entirely disappears.

A table of measurements follows:

Total length of body in mm.	.297	.325	.262	.335	.359
Length of protomerite	.019	.02	.012	.015	.014
Length of deutomerite	.278	.305	.25	.32	.345
Width of protomerite	.02	.02	.02	.015	.015
Width of deutomerite	.045	.057	.040	.045	.045
Ratio length prot / total lngth	1:16	1:16	1:22	1:22	1:25
Ratio width prot / width deut	1:2.2	1:2.8	1:2	1:3	1:3
Diameter nucleus	.02	.022	.018	.022	.024

Cnemidospora lutea Schneider
Figs.56 and 57.

1882 Cnemidospora lutea Schneider 1882:446-8

Cnemidospora: Sporonts solitary, elongate. Total length 500μ. Width not given. Ratio--length prot:total length :: 1:15; width prot:width deut :: 1:1.6. Protomerite subglobular,

broader than long, in the ratio of 4:3. Divided into two parts, the anterior the shape of a double convex lens, without the characteristic endocyte granules and tinted greenish; the posterior, larger, portion containing yellow or brown endoplasmic granules. Deep constriction at septum. Deutomerite cylindrical, tapering very slightly and ending in a broad flattened extremity. Endocyte of deutomerite brown, rather dense. Nucleus ellipsoidal, twice as long as wide, containing one or more karyosomes. Myocyte apparent.

Cysts not described. Spores ellipsoidal with a thick integument.

Taken at Poitiers, France.

Host: Glomeris sp.

Habitat: Intestine.

There is but one species in this genus. Crawley (1903b:638-9) described a species as Cnemidospora spiroboli but it has been removed to another genus, Stenophora, because it has none of the characters of the genus Cnemidospora. Schneider's discovery has never been corroborated.

Amphoroides polydesmi (Léger) Labbé
Fig. 58.

1892	Amphorella polydesmi	Léger	1892:132-4
1899	Amphoroides polydesmi	Labbé	1899:2o
1903	Amphoroides polydesmi	Léger & Duboscq	1903b:314

Amphoroides: Sporonts solitary, ovoidal, rather short and broad. Length 170-200 μ. Width not given. Ratio--length

prot:total length :: 1:20; width prot:width deut :: 1:2.6. Protomerite very short, depressed and cup-shaped within. Three times as broad as high. Widest part at the top, where it is wider than the deutomerite just below the septum. A constriction at septum. Septum pushed up in the middle to form a dome which is higher at its summit than the protomerite itself, the latter appearing as a crenulate flaring collar about it. The deutomerite is cylindrical through the anterior third, widening appreciably to form a shoulder, below which it gradually tapers, ending in a broad flattened extremity of approximately the same width as the anterior third of the deutomerite. The endocyte is yellow-brown, the nucleus spherical, its diameter as great as the width of the base of the deutomerite and contains one large karyosome. The epimerite is a cylindro-conical or globular papilla.

Cysts are spherical, 150μ in average diameter, dehisce by simple rupture, and the spores are biconical, 7.8 x 3.8μ.

Taken in the valleys of the Vienne and the Loire, France, and at Vizzanova and Corte, Corsica.

Hosts: Polydesmus complanatus (L.); Polydesmus dispar Silvestri.

Habitat: Intestine.

This species was first described by Léger as Amphorella polydesmi. The generic name was preoccupied and Labbé changed the name to Amphoroides. At the same time Labbé included with A. polydesmi as a synonym Gregarina polydesmivirginiensis of Leidy,

probably because of the identity of the generic name of the hosts. The character of the protomerites alone would radically differentiate the two species. The latter has since been named Stenophora polydesmivirginiensis.

Labbé says of the Actinocephalidae, to which the genus Amphoroides belongs, the members are parasites of the

"tube digestif d'Arthropodes carnassiers"

but the diplopod Polydesmus is surely not carnivorous.

Amphoroides calverti (Crawley) Watson
Fig. 52.

1903	Gregarina Calverti	Crawley	1903a:48
1903	Gregarina Calverti	Crawley	1903b:638
1915	Amphoroides calverti	Watson	

Amphoroides: Sporonts solitary, elongate. Max. length 1670μ, average length 1400μ. Average width 120μ. Ratio--length prot:total length :: 1:47; width prot:width deut :: 1:2.5 to 1:3. Protomerite greatly compressed in sporonts, shallow, five times as wide as high. Deep crater within the top. Constriction at septum sharp and deep. Deutomerite elongate, widest in anterior third, tapering to a sharp point. Endocyte of protomerite tan in color, not dense; of deutomerite opaque, white. Nucleus small, spherical, not visible in vivo. Myocyte well developed.

Cysts spherical, 380μ in average diameter. Dehiscence by simple rupture. Spores not known.

Taken at Wyncote, Pa. and Urbana, Illinois.

Host: Callipus lactarius (Say) (Lysiopetalum lactarium (Say)).

Habitat: Intestine.

This species was described by Crawley (1903a) as belonging to the genus Gregarina. Later (1903b) he described the cysts and spores as follows:

> "Cysts spherical - - -250-360μ in diameter - --. Dehiscence effected by sporeducts, from 4 to 8 in number, not exceeding in length the diameter of the cyst. - - -Spores doliform, 13 x 5μ. A single thick spore wall - - -."

I have seen one cyst from this species which measured 380μ in diameter and indicated dehiscence by rupture and not by sporeducts. Crawley probably confused the cysts of this species with those of another species which may have been in the damp chamber developing at the same time.

This gregarine bears no resemblance to the members of the genus Gregarina whose cysts dehisce by sporeducts, either in its habitat, in a diplopod, or in any of the characteristics of the sporont. The elongate shape, character of movement by slow contortiona, great size of the individual, and, chiefly, the fact that all the animals are solitary, tend to prove conclusively that this species is not a member of the genus Gregarina. I think, when the unauthentic species species have all been properly placed, it will ultimately be shown that members of the genus Gregarina are all associative during the greater part of their adult sporont life. I place this species in the genus Amphoroides because of the shape of the protomerite.

Appendix

Two and only two species have been described as Stenophoridae which are not parasitic in diplopods. These are Stenophora erratica Crawley (1907:220-8) and S. gimbeli Ellis (1913_a:462-5). The former was placed in this family on very slender evidence, viz. at the anterior tip of the protomerite is a

> "low papilla within which are traces of a pore. It is this character which led me to place the gregarine in the genus Stenophora."

The author notes later the following: (1907:221)

> "The suggestion is permissible that this form is actually the common Stenophora julipusilli Leidy, somewhat altered in appearance from being in the wrong host. Crickets and Julidae frequently occur in the same environment, and the former might readily swallow spores derived from the feces of the latter. This done, the spores might readily develop, although producing slightly atypical gregarines."

The present writer has otherwise disposed of the species and considers it Leidyiana solitaria. For argument relative to this position, see chapter on Orthopteran parasites.

Ellis (1913a) described from a Coleopteran of the family a parasite which he calls Stenophora gimbeli.

> "The epicyte of the apex of the protomerite is quite thin and the sarcocyte of this region is driven into a papilla which results from the expansion of the thin epicyte."

Such a papilla has been found nowhere else among the Stenophoridae except in S. cockerellae. The present writer has often observed an expansion of the epicyte at the apex of the protomerite after the animal has been on the slide for some time in a water medium

and it is due to osmosis and the expansion of the epicyte at its weakest point. This gregarine has been removed from the genus Stenophora and placed in the genus Gregarina. The name now stands Actinocephalus gimbeli.

With this disposition of the above two species, the family Stenophoridae is found nowhere outside of the family Diplopoda and the diplopods are parasitised almost but not exclusively by the Stenophoridae.[1]

We are led to believe that each family of gregarines has its unique order or narrowly restricted orders of insects which it infests and that each genus of gregarine is confined to a single host or to very closely related species.

1. An interesting note in this connection is the fact that very rarely is the same species of gregarine found in more than one species of host. Each species of diplopod may be expected to yield its specific parasite, although this is not without exception.

The species of parasites among the Stenophoridae do not appear to be as widely distributed, i.e. as cosmopolitan, as do those of other gregarines, e.g. of the genus Gregarina, widely separated localities seemingly yielding different parasites from the same host or from closely allied hosts. It is true, however, that much less work has been done in different parts of the world on the dilpopod parasites than on those of beetles and orthopterans.

List of the Polycystid Gregarines in the Chilopoda

Page	Gregarine	Host
	DACTYLOPHORIDAE	
128-30	Dactylophorus robustus Léger	Cryptops hortensis Leach
130-1	Nina gracilis Grebnecki	Cryptops anomalons lusitanus Verh. Scolopendra cingulata (Latr.)
131-2	Nina giardi (Léger) Sokolow	Scolopendra oraniensis ?
132-3	Nina giardi corsicum (Léger & Duboscq) Sokolow	Scolopendra oraniensis lusitanica Verh.
133-4	Nina indicia Merton	Scolopendra subspinipes Leach
134-5	Echinoderma horrida (Léger) Watson	Lithobius calcaratus Koch
136	Echinoderma hispida (Schneider) Labbé	Lithobius forficatus Linn. Lithobius coloradensis Cock.
136-7	Acutispora macrocephala Crawley	Lithobius forficatus Linn.
137-9	Trichorhynchus pulcher Schneider	Scutigera sp. Scutigera forceps (Raf.)
139-40	Rhopalonia geophili Léger	Himantarium gabrielis Linn. Stigmatogaster gracilis Mein.
141	Rhopalonia stella Léger	Himantarium gabrielis Linn.
	ACTINOCEPHALIDAE	
141-2	Actinocephalus striatus Léger & Duboscq	Scolopendra cingulata Latr.
142-3	Actinocephalus dujardini Schneider	Lithobius forficatus Linn.
143-4	Amphorocephalus amphorellus Ellis	Scolopendra heros Giard
144-6	Hoplorhynchus actinotus (Leidy) Crawley	Scolopocryptops sexspinosus (Say)
147	Hoplorhynchus scolopendras Crawley	Scolopendra woodi Meinert

Dactylophorus robustus (Léger) Labbé
Fig. 29.

1887	Dactylophorus sp.	Schneider	1887:67
1889	Dactylophorus sp.	Balbiani	1889:41
1892	Dactylophora robusta	Léger	1892:124-7
1899	Dactylophorus robustus	Labbé	1899:17
1903	Dactylophorus robustus	Léger & Duboscq	1903b:310-1

Dactylophorus: Sporonts solitary, elongate. Length 700-800μ. Width not given. Ratio--length prot:total length :: 1:30; width prot:width deut :: 1:½. Protomerite at top approximately twice as wide as deutomerite, broadest at top, six times as wide as high. Periphery of upper margin set with numerous small upwardly directed digitiform processes which constitute the epimerite. Deutomerite elongate, regularly cylindrical in anterior third then becoming much narrower and ending in a long acuminate point. Nucleus ovoidal, twice as long as wide, containing several karyosomes. Endocyte yellow.
Cysts spherical, 200μ in diam., dehiscence by pseudocyst, spores cylindrical, rounded at ends, 11 x 4.3μ.
Taken at Grenoble, France and on the island of Corsica.
Hosts: Cryptops hortensis Leach; Cryptops anomalons lusitanus Verh.
Habitat: Intestine.

Labbé (1899:17) attributed the naming of the genus Dactylophorus to Balbiani. The latter, however, says:

"C'est d'abord une Grégarine què jè crois nouvells, à moins qu'elle ne soit l'espéce que M. A. Schneider dit avoir découvérte chez les Cryptops, et á laquelle il donne le nom de Dactylophorus - - -. C'est sans doute la présence

de cet appendice qui a valu á notre espèce le nom de Dactylophorus, qui lui a été donné par M. Schneider."

Balbiani described a polycystid gregarine from the digestive tract of Cryptops sp. as follows:

"La Gregarine a la forme d'une massue étroite, étirée en une longue pointe à sa partie posterieure. Sa longuer moyenne est de 0.41 mm. et sa largeur, prise dans la portion renflée du corps, de 0.35 mm.. Le segment antérieur ou protomérite est petit, connoïde, et prolongé sur un de ses côtes, en un court appendice obtus, dirigé en avant."

Labbé considered this species identical with that later described by Léger as D. robustus, probably from the fact that the specimens were taken from the same chilopod (Cryptops). It is evident, however, from figures of the two species, that they are quite unlike. Balbiani's species lacks the dilated flattened protomerite with its digitiform processes, which is characteristic of the genus Dactylophorus, but has rather a high irregular cylindrical protomerite with an eccentric, conical, forwardly-directed projection. Moreover, the deutomerite is quite different in shape from that of D. robustus (compare figs. 29 and 47) and the nucleus in one species is spherical, in the other ovoidal. Balbiani's figure compares favorably with figures of sporonts of Echinomera hispida (Schneider) Labbe in the following respects: a) the eccentrically placed cone at the apex of the animal, b) shape of the protomerite, c) shape of the nucleus. In the case of E. hispida, the epimerite persists and the cone is a part thereof. Balbiani's figure shows no epimerite, neither does it indicate the digitiform processes character-

istic of the other. For these reasons, I do not wish to regard the two species as identical, but rather to leave the one as indefinitely placed. Its original position is obviously incorrect; and the epimerite which is needed to correctly diagnose it not having been discovered, its correct systematic position cannot be determined. Fig. 47 is copied from Balbiani's drawing.

Nina gracilis Grebnecki
Fig. 30.

1873 Nina gracilis	Grebnecki	1873: ?
1887 Pterocephalus nobilis	Schneider	1887:68-9
1909 Nina gracilis	Léger & Duboscq	1909:33-68

Nina: Sporonts solitary, very elongate. Length 4 to 5 mm. Width not given. Ratio--length prot:total length :: 1:26; width prot:width deut :: 1:1/10. Protomerite bisymmetrical, divided into two equal lobes by a perpendicular constriction, these two lobes widely separated at one extremity to form an upturned cornucopia. The free upper extremity of each lobe bordered with a longitudinal row of short sharp spines, from which project long thread-like filaments. Deutomerite constricted just below septum then dilated slightly, the lower half regularly cylindrical, and terminating in a short bluntly pointed extremity. Nucleus slightly ovoidal with several small karyosomes.

Cysts not known. Spores regularly ellipsoidal with one integument, united in chains diagonally, not pole to pole.

Taken at Grenoble (?), France.

Host: Scolopendra cingulata Latr. (Scolopendra cingulata var. hispanica Newp.).

Habitat: Intestine.

Labbé (1899:17) says Kölliker's (1849:35) Gregarina scolopendra, from Scolopendra morsitans Sieb., is probably the same gregarine as the above. But the protomerite is very different from that of the genus Nina and indicates at once Labbé's error. Kölliker gives no description of the epimerite and it is impossible to say in what genus his specimen should be placed. His drawing is reproduced in my fig. 48.

Léger and Duboscq recognize the species and fully discuss its cyst-formation.

Nina giardi (Léger) Sokolow

1899	Pterocephalus Giardi	Léger	1899:390-3
1911	Nina giardi	Sokolow	1911:281

Nina: Sporonts solitary, elongate. Length 4 mm. Width not given. Protomerite very broad at the upper extremity, bisymmetrical, consisting of two long parallel horizontal lobes separated at one extremity and confluent and upturned at the other, with a small vesicular body near this end. Each lobe set with a row of short upwardly directed teeth from which project long slender sinuous filaments. Deutomerite long, slender, cylindrical, tapering slightly at the posterior extremity and

ending bluntly.

Cysts spherical. Spores with two envelopes, 14 x 7 μ.

Taken at Wimereux, Pas-de-Calais, France.

Host: Scolopendra oraniensis (Africana Verh.).

Habitat: Intestine

Nina giardi corsicum (Léger and Duboscq) Sokolow
Fig. 31.

1903 Pterocephalus Giardi corsicum Léger & Duboscq 1903b:333
1911 Nina giardi corsicum Sokolow 1911:281-2

Nina: Sporonts solitary, very elongate. Length 2 mm. Width not given. Ratio--length prot:total length :: 1:10. Ratio width prot:width deut :: 4.5:1. Protomerite bisymmetrical, formed by two long horns which meet at one end and curve upward nearly 90°. Very wide, 4½ times maximum width of deutomerite. Extending beyond the deutomerite three times as far on one side as on the other. The periphery of the horns densely set with a row of small denticles with long slender filaments. The shorter lobes thick and blunt. A pseudo-nuclear vacuole near the apex of the opposite lobe, i.e. at the end of fusion. Protomerite transparent. Deutomerite regularly cylindrical, tapering slightly and ending bluntly. Nucleus large, spherical.

Cyst and spores not known.

Taken on the island of Corsica.

Host: Scolopendra oraniens lusitanica Verh.

Habitat: Intestine.

This species differs from N. giardi type only in that a) it attains but half the length of the former, b) the confluent lobes of the protomerite are upturned farther in the adult, c) the lobes of the protomerite are shorter and blunter.

Nina indicia Merton
Fig. 33.

1911 Nina indicia Merton 1911:119-26

Nina: Sporonts solitary, elongate. Length 500-1300 μ. Width not given. Ratio--length prot:total length :: 1:20; width prot:width deut :: 4:1. Protomerite bilaterally symmetrical, low and very broad, eight times as wide as high, formed of two long sinuous narrow plates separated at one end for a very short distance. Each bearing a narrow ridge at the upper margin set on both sides with short sharp teeth. The two ridges never confluent but nearly parallel throughout their length. Deutomerite elongate, irregularly cylindrical, dilated a short distance below the septum and tapering from the middle to a long slender and pointed posterior extremity. Endocyte dense in deutomerite, much less dense in protomerite. A deeply staining vesicle at one end of protomerite. Nucleus spherical with chromatin arranged in one much convoluted band.

Cyst and spores not described.

Taken at Heidelberg, Germany.

Host: Scolopendra subspinipes Leach.

Habitat: Intestine.

Echinomera hispida (Schneider) Labbé
Fig. 32.

1875	Echinocephalus hispidus	Schneider	1875:593-4
1899	Echinomera hispida	Labbé	1899:16

Echinomera: Sporonts solitary, obese. Measurements not given. Ratio--length prot:total length :: 1:7 to 1:11; width prot: width deut :: 1:2 to 1:2.3. Protomerite broad, flattened, surmounted by a persistant epimerite in the shape of an irregular asymmetrical cone as broad at its base as the protomerite and terminating in an eccentrically placed point. Sides of this cone set with eight digitiform, upwardly directed processes. Deutomerite regularly ellipsoidal, widest in the anterior half or nearly globular, terminating in a broadly rounded extremity eight to ten times the length of the epimerite and protomerite together. Endocyte dense, finely granular. Nucleus large, spherical , with several karyosomes.

Cysts spherical, dehiscence by simple rupture. Spores elongate-cylindrical, united in chains. Dimensions not given.

Taken at Paris, France; Cambridge, Mass.; Wyncote, Pa.; Raleigh, N.C.; and Boulder, Colo.

Hosts: Lithobius forficatus Linn. (L. forcipatus) and Lithobius coloradensis (Cock.).

Habitat: Intestine.

Crawley (1903a:52) found this gregarine rather common in Lithobius forficatus in eastern United States, and Ellis (1913a:465) found it in the West. Neither gives figures of the species. Since Schneider' gave no dimensions, these writers based their determinations on a comparison of their material with his figures. Ellis gives these measurements: length 180μ width 80μ. He says

> "---processes of the epimerite disappearing shortly after the animal frees itself from the intestinal wall of the host but the conical portion - - - persists in the sporont stage giving an asymmetrical margin to the front of the protomerite."
> "In some specimens the ratio of the length of the protomerite to the length of the deutomerite was as low as one to seven, while Schneider's original figures give it as one to eleven or more. Other specimens seemed intermediate between E. hispida (Schn.) and E. horrida (Léger). It seems probable then that E. horrida (Léger) is synonymous with E. hispida, leaving a single species in this genus."

That Ellis found the ratio of length prot:length deut as low as 1:7 is not out of harmony with Schneider's proportions of E. hispida, for the latter says

> "Deutomérite huit à dix fois environ plus long que le segments superieure réunis - - -."

E. horrida is much more nearly globose than such proportions indicate and there is no good argument for considering the two species synonymous.

Echinomera horrida (Léger) Watson

1899	Echinocephalus horridus	Léger	1899:390-5
1911	Echinocephalus horridus	Sokolow	1911:281
1915	Echinomera horrida	Watson	

Echinomera: Sporonts ovoidal, almost spherical, 100-150μ in length. Width not given. Protomerite in shape of a narrow, elongate, blunt cone, the apex eccentric and carrying a papilla which represents a primitive epimerite.

Cysts spherical or cylindrical, rounded at ends.

Taken at Wimereux, France.

Host: Lithobius calcaratus Koch.

Habitat: Intestine.

Acutispora macrocephala Crawley
Fig. 34.

1903 Acutispora macrocephala Crawley 1903b:632-3

Acutispora: Sporonts solitary, elongate. Maximum length 600μ, width not given. Ratio length prot:total length :: 1:3; width prot:width deut :: 1:1.3. Protomerite one-third the length of the sporont. Conical papilla at apex, deep constriction in posterior third and a constriction of equal depth at septum. Deutomerite just behind septum wider than protomerite just in front of it, regularly conical, tapering from shoulder to a blunt point. Endocyte dense. Nucleus not visible. Cysts spherical, 410μ in diam., dehiscence by pseudocyst. Spores navicular, slightly curved, slender, two integuments, thin and

blunt refractile rod of endospore at each end, 6 μ long; spores 19 x 4 μ .

Taken at Raleigh, N.C.

Host: Lithobius forficatus L.

Habitat: Intestine.

The genus Acutispora was created by Crawley for this unique species.

Trichorhynchus pulcher Schneider
Figs. 35 and 36.

1882	Trichorhynchus insignis	Schneider	1882:439-42
1882	Trichorhynchus pulcher	Schneider	1882:439-42
1889	Gregarina megacephala	Leidy	1889:10-11
1899	Trichorhynchus pulcher	Labbé	1899:16

Trichorhynchus: Sporonts solitary, elongate, length 420-750 μ . Width 240 μ . Ratio--length prot:total length :: 1:4 to 1:7; width prot:width deut :: 1:1 to 1:1.6. Epimerite nearly half the total length of the body without it. Protomerite conical, rounded at summit. Slight constriction at septum. Deutomerite just below septum same width as protomerite just above it, widest in anterior third. Constricted below middle portion then dilated and ending in a broad but sharply pointed cone. Epimerite a very long flexible 'tongue' preceding from the apex of the protomerite, slightly dilated at the extremity. Endocyte in both parts dense. Nucleus ovoidal with one large karyosome.

Cysts ovoidal, 316 x 303μ, dehiscing by pseudocyst. Spores cylindrical, rounded at ends, 9.7 x 5.8μ.

Taken at Poitiers, France; Philadelphia, Pa.

Hosts: Scutigera sp.; Scutigera forceps (Raf.) (Cermatia f.).

Habitat: Intestine.

This gregarine was described by Schneider under the name T. insignis, but his referencesto his plates are to figures of T. pulcher. It was probably an error in the proof which is accountable for the incorrect naming of the species, for the name of the species immediately preceeding is Lophorhynchus insignis.

Labbé referred to the species as T. pulcher.

Crawley referred to the gregarine which was described by Leidy as G. megacephala (fig. 35) to the present species because of the elongate appendage on the protomerite. That this position is correct is attested by the fact that Crawley himself found the species, the specimens agreeing with Schneider's figures and with the dimensions as given by Leidy. Crawley's description is as follows:

"This form is well described by A. Schneider whose figure also is excellent, giving a very accurate idea of the actual animal. Schneider, however, gives no dimensions, while Leidy says that the dimensions vary from 420-750 microns, these figures agreeing very closely with those which I obtained.
My own observations on this species show it to be an active, very polymorphic gregarine, with the ability to undergo extensive alterations in shape. Thus, the anterior end of

the protomerite, normally a blunt curve, frequently protrudes in a long tongue-shaped process. The peristaltic movement so frequently displayed by gregarines, may, in this species, pass forward as well as backward. This indicates that here the contractile elements are capable of operating as well in one direction as another, which is certainly not the case in most polycystid gregarines. Fusion, preparatory to encystment, was seen to take place 'head to head.'

Leidy's brief account of the species is as follows:

"One morning- - -I found a fine Cermatia forceps in my bedroom. In it was - -species which may be named Gregarina macrocephala. The body is elongated ovate and acute or short clavate and obtuse with an unusually large ovoid and often constricted head, surmounted by a small rounded or elongated appendage. Length .0.42 to 0.75 mm. to 0.24 broad; head about one-fourth the length of the body. It approximates Duforia agilis of Schneider, found in the larva of a Hydracantharis."

The latter species lacks the elongated proboscis; it is now known as Legeria agilis (Schn.) Labbé. For description and drawing, see chapter on Coleoptera.

Rhopalonia geophili Léger
Fig. 51.

1893 Rhopalonia geophili Léger 1893:1285-66
1896 Rhopalonia geophili Léger 1896:29

Rhopalonia: Sporonts solitary, dicystid, obese. Widest at anterior end, tapering to a point. Length 500 μ. Epimerite a large, hyaline, subspherical plate with a corona of ten to fifteen backwardly directed digitiform processes placed above the protomerite on a short neck. Endocyte with large yellow-orange granules. Nucleus ovoidal, containing several karyosomes. Cysts spherical, 200-250 μ, the fertile half brown, the sterile

white, a black equatorial band marking the future line of dehiscence. SPores cylindrical, rounded at ends, double walled, 16 x 6.5 μ.

Taken in Provence, France and on the island of Corsica.

Hosts: Himantarium gabrielis Linn. (Geophilus g.); Stigmatogaster gracilis Meinert.

Habitat: Intestine.

This parasite is peculiar in having no septum in the adult sporont and thus no protomerite and deutomerite. A rudiment of a protomerite is indicated by a finely granular yellow mass at the proximal end of the body, separated from the rest of the sporont by a clear area. Leger thinks this genus is transitional between the Cephalina and the Acephalina. His words are as follows:

> "La Grégarine est donc, au point de vue évolutif, une dicystidée vraie, c'est-à-direr n'ayant jamais plus de deus segments; un apparail de fixation caduc et un segment unique persistants (pseudo-monocystis) représentant a la fois le protomerite et le deutomerite des tricystidées. Elle se rapproche en cela des grégarines intestinales des vers marine."

Léger and Duboscq (1903b:311) found a parasite on the island of Corsica which may be the Rhopalonia geophili of Léger.

> "Les Stigmatogaster d'Ajaccio contenaient dans leur intestin de rares sporadin en forme de toupie, surmountés au pôle antérieur d'un plateau circulaire bordé d'un bourrelet saillant. Nous les rapportons avec quelque doute an Rhopalonia geophili Leger, fréquent dans les Stigmatogaster gracilis de Provence et dont les sporadins sont generalement de forme plus allongée."

Rhopalonia stella Léger

1899 Rhopalonia stella Léger 1899:390-5

Rhopalonia: Sporonts solitary, ovoidal, elongate or spindle-shaped. Length about 130μ . WIDTH not given. Body not differentiated into protomerite and deutomerite. The epimerite is like that of R. geophili Léger and

"- -rapelle assex bien une fleur de syanthérée."
(Sokolow 1911:281).

Host Himantarium gabrielis Linn.

Habitat: Intestine.

The comparison of the epimerite with the flower of one of the Compositae is a good one, as seen in fig. 51.

Actinocephalus striatus Léger and Duboscq
Fig. 37.

1903 Actinocephalus striatus Léger & Duboscq 1903b:334-5

Actinocephalus: Sporonts solitary, minute. Length 30-35μ . Width not given. Ratio length prot:total length :: 1:4; width prot:width deut :: 1:0.7. Protomerite wider than deutomerite, dome-shaped, broadly rounded in front with a small flattened circular papilla surmounted centrally by a short digitiform process which is surrounded by a circle of small teeth. Constriction at septum, which is curved upward. Deutomerite irregularly cylindrical, terminating in a sharp cone. EPicyte marked with very apparent longitudinal striations, from

whence the name. Nucleus ovoidal with its longitudinal axis perpendicular to that of the body.

Cyst and spores unknown.

Taken in Provence, France.

Host: Scolopendra cingulata Latreille.

Habitat: Intestine.

This gregarine is placed in the genus Actinocephalus from the character of the dentate papilla of the protomerite.

"- - - au sommet du protomérite fait saillie un petit bouton aplati, à bord régulierement festonné, comme dentelé, au centre duquel s'élève un rostre mobile asset droit. C'est là l'épimèrite qui, comme on le voit, présente de grandes analogies avec celui des Actinocephalus."

Actinocephalus dujardini Schneider
Figs. 38, 39, 40.

1875 Actinocephalus dujardini Schneider 1875:589-90

Actinocephalus: Sporonts solitary, rather obese. Length of body and width not given. Ratio length prot:total length :: 1:2.4; width prot:width deut :: 1:1. Protomerite very large, cylindrical, longer than wide, nearly one-third total length of sporont, terminating in a truncated cone, the apical region being hyaline, slight constriction at septum. Deutomerite widest just behind septum and tapering gradually to a sharp point. Endocyte of equal density in protomerite and deutomerite. Epimerite a globose sessile body resting on the apex of the protomerite, drawn out in its apical region to

a short neck upon which is set a flat corona of 16 to 20 backwardly directed rigid spines. Nucleus small, spherical.

Cyst and spores not known.

Taken at Paris, France.

Host: Lithobius forficatus Linn. (L. forcipatus).

Habitat: Intestine.

Crawley (1903a:55) records finding this little gregarine several times in L. forficatus. He gives no drawings and does not state where it was taken.

Amphorocephalus amphorellus Ellis
Figs. 45 & 46.

1913 Amphorocephalus amphorellus Ellis 1913a:463-4

Amphorocephalus: Sporonts solitary, elongate, length 500-970μ. Width not given. Ratio--length prot:total length :: 1:1.7; width prot:width deut :: 1:2.5. Protomerite dome-shaped, broadly rounded in front, a distinct constriction near middle. Deutomerite cylindrical, tapering slightly to a sharp point. Endocyte dense, nearly black. Epimerite flask-shaped with fluted apical disc, sessile on the protomerite, persisting on large free cephalonts. Nucleus not noted.

Cyst and spores not known.

Taken at Boulder, Colo.

Host: Scolopendra heros Giard.

Habitat: Intestine.

This genus contains the unique species above. It is characterised by the flask-shaped epimerite with finger-like processes at the apex and by the protomerite having a constriction at the middle, extending horizontally around the same.

Hoplorhynchus actinotus (Leidy) Crawley
Figs. 42 & 43.

1889	Gregarina actinotus	Leidy	1889:10
1903	Hoplorhynchus actinotus	Crawley	1903a:55-56
1913	Amphorocephalus actinotus	Ellis	1913c:277
1915	Hoplorhynchus actinotus	Watson	

Hoplorhynchus: Sporonts solitary. Maximum length recorded that of Leidy, 520 μ. Max. width 80 μ. Crawley's max. recorded length 485 μ, width 105 μ. Ratio--length prot: total length :: 1:9 (Leidy) to 1:12 (Cr.); width prot:width deut :: 1:2 (Leid. & Cr.). Protomerite dome, shaped, twice as broad as high. Deutomerite roughly triangular, wider than protomerite at septum. Attaining maximum width at shoulder, thence tapering to a more or less sharp point. Epimerite 80-100 long, vase-shaped, broadest near base and tapering to a neck where it again widens into a broad disc of short digitiform processes from 8 to 20 in number. Crawley says:

> " - - - amphora-shaped. Differentiated in front into four dichotomously branched lobes. - - - In the small animals making up nearly ½ the total length; in the adults from ¼ to 1/5 of the total length."

Endocyte dense and opaque. Nucleus ovoidal, diagonally placed. Cyst and spores not known.

Taken at Philadelphia, Wyncote and Wallingford, Pa., and

Raleigh, N.C.

Hosts: Scolopocryptops sexspinosus (Say) and Scolopocryptops sp.

Habitat: Intestine.

Crawley says (p. 56):

> "Apparently in this gregarine the septum tends to disappear. It is much more evident in some cephalonts than in others, and in one sporont seen no septum could be made out, and the endocyte of the protomerite was not distinguishable from that of the deutomerite."

Ellis (1913c) placed this gregarine in his genus Amphorocephalus. He characterises the genus as follows:

> "Protomerite with a constriction near the middle dividing it into two lobes, the anterior of which is the smaller; epimerite longer than wide, but not extremely elongate, widest in its posterior third, narrowed at its junction with the protomerite terminating in a somewhat concave enlargement, the edge of which has a fluted appearance because of the presence of numerous small finger-like processes; deutomerite elongate."

It is readily seen that the species in question does not fit this generic diagnosis for the following reasons: 1) the protomerite is not constricted in the middle, with a small anterior part; 2) the epimerite is elongate, from two to four times as long as wide (in Ellis' described species it is but little longer than wide, 1:1.2);3) the apex does not terminate in a broad disc the edge of which has a fluted appearance because of the presence of numerous small finger-like processes, but terminates in a disc edged with dichotomously branched, distinctly separated digitiform processes, from eight to twenty in

number; 4) the deutomerite is not elongate as in Ellis' figure in which it is from eighteen to twenty-two times the length of the protomerite, but is only from six to twelve times the length of the protomerite. I have therefore replaced the species in the genus designated by Crawley.

Hoplorhynchus scolopendras Crawley
Fig. 41.

1903 Hoplorhynchus scolopendras Crawley 1903b:636-7
1913 Amphorocephalus actinotus Ellis 1913c:277
1915 Hoplorhynchus scolopendras Watson

Crawley's description of the species is quoted:

"This species is created for a gregarine parasitic in Scolopendra woodi Meinert from Raleigh, N.C. Two specimens were present. One of these, when first seen, was a balloon-shaped sac, 350 microns long by 200 broad. The epicyte and sarcocyte were each nearly or quite 3 microns thick, and the former was plainly marked with longitudinal striations. Both of the individuals were very flexible, readily changing shape and showing extensive contortions. After having been upon the slide for perhaps an hour, the parasites became quiescent and assumed what was probably something like the typical shape. The larger then measured 825 microns long by 120 microns broad. The anterior end, as shown in fig. 19, was much narrower than the balance of the animal, but it is somewhat questionable if this narrowing is permanent. A distinct septum extended across this narrower region, cutting off a portion of granular entocyte. Backward from the broadest portion, the animal's body tapered gradually, ending behind in a point. This species is placed in the genus Hoplorhynchus on account of its close resemblance to H. actinotus Leidy and its occurrence in a centipede related to Scolopocryptops, the host of the latter."

Its position is doubtful from insufficient evidence and will not remain authentic unless corroborated and better described by some future worker.

Ellis included this species with H. actinotus under the name Amphorocephalus actinotus (Leidy). I have referred the species to the original position. The protomerite does not have the constriction necessary to place it in the genus Amphorocephalus.

Species of Uncertain Determination

Trichorhynchus lithobi Crawley. Fig. 44.

Crawley's statement concerning this species is as follows (1903b:637):

> "This animal, which is apparently specifically distinct from any of the other gregarines parasitic in Lithobius, was found in a specimen of that centipede from Raleigh, N.C. An epimerite was not found. The protomerite was subcordiform, and displayed in front a differentiation the exact nature of which could not be determined. The deutomerite varied considerably in shape, the animal being quite polymorphic. Both epicyte and sarcocyte were distinct and of about equal thickness. The septum was thick and curved backward. The endocyte was not dense; the nucleus large, with several karyosomes. The largest individual seen was 195 microns long."

There seems to be no basis for placing the parasite in the named genus. None of the characteristics of this genus are named above, the elongate epimerite, ovoidal cysts which dehisce by pseudocyst, cylindrical spores. Enough data are lacking so that the species cannot be definitely placed in any genus.

A parasite is described by Léger and Duboscq (1903b: 312) but not named. It was found on the island of Corsica, in Chaetechelyne vesuviana Newport. Their statement in full follows:

> "Sur plusieurs individus examinés, un seul (d'Ajaccio) était parasité par une Grégarine recontrée seulement au stade de sporadin. Sous cette forme, la Grégarine est allongeé et mesure 100 μ. Le deutomérite est, dans sa partie antérieure, plus large que le protomérite dont il atteint 5 ou 6 fois la longeur, puis il va en s'attenuait

pour se terminer en pointe mousse. Ces caractéres ne sont pas suffisants pour rapporter ces sporadins a un Rhopalonia plutôt q'à un Actinocephalus."

A third species of indeterminate situation is that called by Balbiani Dactylophorus sp. (1889:41). This species has been discussed in detail under the heading Dactylophorus robustus (Leger) Labbe and illustrated in fig. 47.

A fourth species of doubtful position is that described by Kolliker as Gregarina scolopendra (fig. 48). See discussion under Nina gracilis Grebnecki.

List of the Polycistid Gregarines in the Orthoptera

The species of each genus are arranged in chronological order

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MISCELLANEOUS

Gregarina sphaerulosa Dufour
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Gregarina oblonga Dufour
Figs. 177 & 178

1837	Gregarina oblonga	Dufour	1837:13
1848	Gregarina oblonga	Frantzius	1848:195
1851	Gregarina oblonga	Diesing	1851:11
1863	Gregarina oblonga	Lankester	1863:94

The only description extant is the original one of Dufour, which is as follows:

"Oblonga flavescens conico-cylindroidea; cephalothorace abdominis quintam partem vix adaequante.
Hab--Oedipodae migratoriae et
Grylli campestris

Beaucoup moins conique que la G. conique elle a une couleur jaunâtre qui ne s'observe pas dans les autres especes."

Here, as in the case of Gregarina conica, Dufour confused more than one species under a single name. Oedipoda is a genus of the order Diptera and also of the Orthoptera. If the Dipteran order is meant, the same species of gregarine would not be looked for in both Diptera and Orthoptera. Such an instance has not yet been recorded for a single species.

Dufour's drawings from both insects are, however, similar (l. I, figs. 9 and 9a; my figs. 177 and 178), Although the protomerites are slightly different in their relation to the deutomerites.[1]

Frantzius lists the species as from Oedipoda only. He

1. I have not attempted to separate the parasite in the two hosts as two species from the meagre description we have, but have recorded this species in this chapter as well as in the chapter on the list of polycystid gregarines, under the Diptera.

places it in his genus Gregarina

"stets zu zwei aneinander geheftet."

Diesing mentions it with hosts as Oedipoda migratoria and O. stridula, and from Gryllus campestris.

Lankester gives the host as Gryllus. After this mention, the species passes out of the literature. I have listed it among the parasites of the genus Gregarina because Dufour states

"cephalothorace abdominis quintam partem"

and because Frantzius lists it among the parasites with both primite and satellite.

This species may be identical with Gregarina macrocephala S^c^hn. from the identity of one of the hosts, but the two cannot be correlated. Dufour describes only sporonts and Schneider only cephalonts and until the cephalonts of the former or the sporonts of the latter or both will have been described, the two species must remain separate.

The only other parasite described from a host belonging to the sub-family Oedipodinae (Acrididae) is Gregarina locustaecarolinae Leidy but the sporonts of the two species are not identical.

The second host named is now known as Nemobius sylvestris (F.).

Gregarina hyalocephala Dufour
Figs. 181 and 182.

1837	Gregarina hyalocephala	Dufour	1837:13
1851	Gregarina hyalocephala	Diesing	1851:11
1863	Gregarina hyalocephala	Lankester	1863:94
1899	Gregarina hyalocephala	Labbé	1899:34

Dufour's description is as follows:

"Oblongo-conica; cephalothorace hemisphaerico diaphano, abdominis quartam partem subadaequante - - -
Hab. in ventriculo Tridactyli."

The species is, from this description, and from the character of the epimerite (Fig. 182) quite evidently a member of the genus Gregarina.

Frantzius does not mention the species; Diesing and Lankester merely do so and Labbé places it among his Uncertain Species.

Gregarina ovata Dufour
Fig. 183.

1826	Gregarina ovata	Dufour	1826:18
1837	Gregarina ovata	Dufour	1837:12
1837	Gregarina ovata	Siebold	1837:408
1838	Clepsidrina conoidea	Hammerschmidt	1838:356
1845	Gregarina ovata	Desmarest	1845: ?
1848	Gregarina ovata	Frantzius	1848:95
1851	Gregarina ovata	Diesing	1851:10
1863	Gregarina ovata	Lankester	1863:94
1873	Clepsidrina ovata	Schneider	1873:515-33
1875	Clepsidrina ovata	Schneider	1875:578-9
1885	Clepsidrina ovata	Schneider	1885: ?
1899	Gregarina ovata	Labbé	1899:10
1904	Gregarina ovata	Paehler	1904:14-18
1905	Clepsidrina ovata	Schnitzler	1905:309
1915	Gregarina ovata	Watson	

Gregarina: Sporonts biassociative. Measurements not given in any description. Ratio--length prot:total length :: 1:5 to

1:6; width prot:width deut :: 1:2. Protomerite of primite hemispherical, slightly constricted at septum. Protomerite of satellite flattened. Deutomerite ovoidal, widest below middle in primite, above middle in satellite. Posterior end rounded. Nucleus spherical with many small karyosomes, visible in vivo. Epimerite a simple hyaline knob.

Cysts spherical or slightly ovoidal, dehiscence by sixteen, more or less, sporeducts; spores cylindrical, truncate at ends (not barrel-shaped), macrospores and microspores (15.8 x 7.9; 8.3 x 3.7μ).

Taken in France, and at Berlin and Danzig, Germany.

Host: Forficula auricularia L.

Habitat: Intestine.

Dufour designated as hosts Gryllus campestris and Forficula. He gave a good figure of biassociative sporonts taken from Forficula and a figure of a single sporont from Gryllus which differs considerably in shape from the other and probably represents another species, although I have not attempted to place it systematically.

Siebold accidentally found this species in Forficula but he did not think the organisms were animals for no motion was observed.

Frantzius represented an accurate figure of the species. He named Forficula only as host, recognizing Dufour's

error in including a parasite from Gryllus.

Diesing indicated that Hammerschmidt had described a synonymous species, Clepsidrina conoidea, from the same host. He also included as a synonym G. Psocorum Sieb. but from the fact that the host Psocus quadripunctatus is a Neuropteran, I doubt the authenticity of this statement. Siebold's paper is not available and the conjecture cannot be verified.

Schneider agreed with Diesing that Clepsidrina conoidea is a synonym of Gregarina ovata. He discussed at length (1873: 515-33) the cyst-formation in this species. In 1885, he worked upon the species in greater detail, finding and giving measurements of two kinds of spores.

The species was the subject of a monograph by Paehler in 1904.

Gregarina blattarum Siebold
Fig. 184.

1839	Gregarina blattarum	Siebold	1839:57
1848	Gregarina blattarum	Stëin	1848:223
1848	Gregarina Blattarum	Frantzius	1848:193, 5
1851	Gregarina Blattarum	Diesing	1851:10
1853	Gregarina Blattae orientalis	Leidy	1853:239
1863	Gregarina blattarum	Lankester	1863:94
1875	Clepsidrina blattarum	Schneider	1875:580
1881	Gregarina blattarum	Bütschli	1881:384-409
1891	Gregarina blattarum	Wolters	1891:115-24
1893	Gregarina blattarum	Marshall	1893:25-45
1899	Gregarina blattarum	Labbé	1899:10
1900	Clepsidrina blattarum	deMagalhaes	1900;38-44
1903	Gregarina blattarum	Crawley	1903a:44
1907	Gregarina blattarum	Hall	1907:149
1913	Gregarina blattarum	Ellis	1913c:265
1913	Gregarina blattarum	Ellis	1913d:83-4

Gregarina: Sporonts biassociative, rather stout-bodied, more or less irregular in outline. Length of sporonts 450-500μ, width 185 -200μ. Ratio--length prot:total length :: 1:5 (primite); width prot:.idth deut :: 1:2. Protomerite of primite cylindrical in posterior two-thirds, rounded anteriorly, no constriction at septum. Very little wider than high. Protomerite of satellite flattened, wider than protomerite of primite, twice as wide as high. Deutomerite irregularly cylindrical, widest in posterior half of primite and in anterior half in deutomerite. More or less pointed at posterior extremity. Sarcocyte layer thick. Nucleus small, spherical, (44μ in diam., deMagalhaes) with from four to six karyosomes. Epimerite a simple hyaline knob.

Cysts spherical or ovoidal. Sporeducts reaching to outside of transparent covering of cyst. Sporeducts eight to ten in number. Spores cylindrical to barrel-shaped, truncate at ends, 8.3 x 3.7μ and 4 x 8μ.

Hosts: Periplaneta orientalis (L.) (Blatte or.); P. americana (L.); Blatella germanica (L.) (Ectobia germ.).

Taken at Danzig, Berlin,Heidelberg, Bonn, and Leipsic, Germany, Paris, France, Philadelphia, Pa., and Rio de Janeiro, Brazil.

Habitat: Intestine.

This is a remarkably cosmopolitan species, as seen from the locations in which it has been taken. It is remarkable from another point of view, viz. the name has remained unchanged [illegible] : [illegible]

[illegible] . T[illegible]

0-00 , [illegible] 00 . A[illegible] : [illegible]

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S[illegible]

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H[illegible] : P[illegible] (L.) (N[illegible]), P. [illegible] (L.)

M[illegible] (L.) (N[illegible]).

T[illegible] D[illegible], S[illegible], B[illegible], I[illegible], [illegible]

S[illegible], S[illegible], P[illegible], P[illegible], R[illegible] T[illegible], S[illegible].

N[illegible] : I[illegible].

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and undisputed since the discovery of Siebold, save in two instances.

Leidy described briefly Gregarina Blattae orientalis from the United States, which species proved to be synonymous with the earlier named species, coinciding in measurements, proportions and host.

Schneider gave a brief description, with a good figure of an association and a dehiscing cyst.

Bütschli admirably described the process of cyst-formation from beginning to end, a process never before seen and very rarely described since.

Wolters observed some of the nuclear changes in the cyst.

Marshall contributed the third long paper on the development of the species.

deMagalhaes found G. blattarum in Brazil in 1900; three years later Crawley found it in the United States, both from the original host. The specimens found by these writers were no doubt those of the true old-world G. blattarum. The shape and proportions correspond, and in hosts of the nature of the cockroach, there is little wonder that both the host and the parasites are widely distributed.

Gregarina locustaecarolinae Leidy
Fig. 188.

1853	Gregarina Locustae Carolinae	Leidy	1853:239
1856	Gregarina Locustae Carolinae	Leidy	1856:47
1859	Gregarina fimbriata	Diesing	1859:730
1863	Gregarina Locustae	Lankester	1863:94
1899	Gregarina locustaecarolinae	Labbé	1899:35
1903	Stephanophora locustaecarolinae	Crawley	1903a:54
1907	Gregarina locustaecarolinae	Crawley	1907:223
1913	Gregarina locustaecarolinae	Ellis	1913c:268

Gregarina: Sporonts biassociative. Maximum length of sporonts 350μ, average length 250μ. Ratio length prot:total length :: 1:6.8 (primite); width prot:width deut :: 1:1.7. Protomerite a little more than hemispherical, one and one-half times as wide as high. Deutomerite cylindrical, rather square-cornered posteriorly, nearly twice as wide as the protomerite. Nucleus large, spherical, with one karyosome. Epimerite a small rounded knob with a very short neck.

Taken at Philadelphia and Wyncote, Pa.

Host: Dissosteria carolina (L.).

Habitat: Intestine.

Crawley recognized (1907) the fact that Leidy described and illustrated two distinct species under the same name. Leidy's figures 35 and 36 (1853), the former my fig. 188, represent isolated sporonts typical of the genus Gregarina, in relative length and width of the protomerite and deutomerite. Associations were not mentioned, however. His fig. 37 (fig. 189) is quite different in shape and the epimerite is an inverted campanular

structure furnished with slender upwardly directed digitiform processes. Because of the epimerite, Crawley (1903a) placed the species in the genus Stephanophora. In 1907, he found cephalonts in locusts quite unlike those seen by Leidy. They possessed simple knobbed epimerites, like those of other species of the genus Gregarina. He saw the sporonts also, and they compared favorably in length with those described by Leidy. At the same time Crawley dubstantiated Leidy's discovery of the digitiform epimerite for he found similar cephalonts and also sporonts which compared. Thus it was discovered that two species were involved, the one a true Gregarina, the other not. The latter species is now known as Actinocephalus pachydermus (Crawley) Ellis.

Gregarina achetaeabbreviatae Leidy
Figs. 191 & 192.

1853	Gregarina Achetae Abbreviatae	Leidy	1853:238
1856	Gregarina Achetae Abbreviatae	Leidy	1856:47
1859	Gregarina oviceps	Diesing	1859:730
1863	Gregarina Achetae	Lankester	1863:94
1899	Gregarina achetaeabbreviatae	Labbé	1899:35
1903	Gregarina achetaeabbreviatae	Crawley	1903a:45
1903	Gregarina achetaeabbreviatae	Crawley	1903b:639
1907	Gregarina achetaeabbreviatae	Crawley	1907:220-1
1913	Gregarina achetaeabbreviatae	Ellis	1913c:266

Gregarina: Sporonts biassociative, obese. Maximum length 500 μ. Average sporonts 450 μ in length, 225 μ in width. Ratio length prot:total length primite :: 1:3. Ratio width prot: width deut :: 1:1.1. Protomerite hemispherical to subglobose, width twice the height. Slight constriction at septum. Deuto-

merite stout-bodied, nearly as wide as long. Widest at shoulder where it is very little wider than protomerite. Posterior end truncate. Epimerite undescribed. Endocyte dense in deutomerite, less so in protomerite. Nucleus not visible in vivo and not seen. Cysts spherical, 250μ in average diameter. Sporeducts 2-5, of maximum length of 1000μ. Spores barrel-shaped, 4.5 x 2.25μ. Taken at Philadelphia, Pa., Beach Haven, N.J., Douglas Lake, Mich., Haverford, Pa., and Urbana, Ill.

Hosts: Gryllus abbreviatus Serv. (Acheta abbreviata); G. americana.

Habitat: Intestine.

Leidy's drawing of the species (1853), my fig. 191, represents the same gregarine as that described by later writers. But later drawings from Leidy's unpublished manuscript, Crawley's 1903a paper, Pl. III, figs. 34 and 35, show two distinctly different species, one associative and the other not. Crawley confused the two in his description, under the name of Gregarina achetaeabbreviatae. In 1907 he desceibed two distinct species however, one the Gregarina achetaeabbreviatae of Leidy and a new Stenophora erratica, for the solitary species. The latter I have transferred to a new genus Leidyiana. For description, see under Leidyiana solitaria.

Ellis found Gregarina achetaeabbreviatae at Douglas Lake, Mich. and I have found it from material taken at Haverford, Pa. and at Urbana, Ill.

Gregarina macrocephala (Schneider) Labbé
Fig. 199.

1875	Clepsidrina macrocephala	Schneider	1875:574
1882	Clepsidrina macrocephala	Schneider	1882:442
1887	Clepsidrina macrocephala	Schneider	1887:73
1895	Clepsidrina sp.	Cuénot	1895:321
1897	Clepsidrina gryllorum	Cuénot	1897:54
1899	Gregarina macrocephala	Labbé	1899:10

Gregarina: Sporonts biassociative.

The following synopsis refers to the cephalont only, there being no available description of the sporont.

Ratio--length prot:total length primite :: 1:5; width prot:width deut :: 1:1.2. Protomerite rounded laterally, as wide as high. Constriction at septum. Epimerite superimposed upon protomerite on a short stout neck. Epimerite a large hyaline ovoidal body a little longer than the protomerite of the cephalont. Deutomerite elongate cylindrical, tapering suddenly to a sharp point. Endocyte with large irregularly arranged protoplasmic granules.

Cysts spherical, dehiscing by sporeducts. Spores doliform.

Taken in the Departments of Aisne, Indre-et-Loire, and Vienne, France.

Host: Nemobius sylvestris (F.) (Gryllus sylv.); Gryllus domesticus L.

Habitat: Intestine.

In 1875 Schneider merely mentioned the character of the epimerite of the undescribed species. In 1882 he described

the cephalont only.

This species may be identical with Gregarina oblonga Dufour, from the same host. It is impossible, however, to correlate the two named species for the reason that Dufour described only sporonts and Schneider only sporonts.

Leidyiana gryllorum (Clepsidrina g.) was erroneously included with this species by Labbe. For discussion, see under Leidyiana gryllorum.

Gregarina panchlorae Frenzel
Fig. 187.

1892 Gregarina panchlorae Frenzel 1892:299-300

Gregarina: Sporonts biassociative, long and slender. SPoronts 180μ long, 35μ wide. Protomerite of satellite cylindrical, constricted slightly in anterior half. Deutomerite of primite fits into a deep depression in anterior end. Deutomerite cylindrical. Nucleus spherical, 18-20 in diam., with one karyosome.
Taken at Cordoba, Argentina.
Host: Panchlora exoleta Klug.
Habitat: Intestine.

Frenzel gave a meagre description and drawing of this species, illustrating only the manner in which the protomerite of the satellite fits into the deutomerite of the primite. This part of the association is intermediate between that of the same portion of G. serpentula deMagalhaes, as shown in his two figures,

the one of a young, the other of a mature association. (Figs. 135 and 136.)

The lengths of the two species are, however, widely at variance so they are not identical.

Gregarina acridiorum Léger

1893	Clepsidrina acridiorum	Léger	1893:811-13
1896	Clepsidrina acridiorum	Léger	1896:27
1899	Gregarina acridiorum	Labbé	1899:10

Gregarina: Sporonts biassociative, cylindrical. Maximum length of associations 1000 μ. Sporonts average 400 μ in length, 160 μ in width. Ratio--length prot:total length ::1:5; protomerite subglobular in primite, indented at anterioe end in satellite. Deutomerite cylindrical , rounded at posterioe end. Sarcocyte thick, especially in protomerite near septum. Endocyte yellow-orange. Epimerite a simple spherical globe.
Cysts spherical, 500 μ in diameter. Sporeducts 12 to 15 in number. Very long, yellow at base. Spores extruded in long chains. Spores doliform, 7.6x 3.3 μ .
Hosts: Various Acrididae, especially Pamphagus sp., Tryxalis sp. (Truxalis), and Sphingonotus sp.
Taken at Nemours, Algeria.
Habitat: Intestine.

Gregarina paranensis (Kunckel d'
Herculais) Watson

1899	Clepsidrina paranensis	Kunckel d'Herculais	1899:622
1915	Gregarina paranensis	Watson	

[illegible]

Gregarina: Sporonts biassociative. Length not given. Deutomerite four times as long as protomerite. Ellipsoidal, pale yellow.

The author says the species differs from G. acridiorum Leger in having the deutomerite ellipsoidal instead of cylindrical, and the endocyte pale yellow instead of yellowish-red. He says between the moults of the insect the parasites are abundant. They diminish in numbers after each moult.

Taken at Parana, Argentina.

Host: Schnstocerca paranensis.

Habitat: Intestine.

Gregarina serpentula Magalhaes
Fig. 185

1900 Gregarina serpentula Magalhaes 1900:40-44

Gregarina: Sporonts biassociative, slender, elongate. Length association 1200μ. Width 180μ. Average length 800μ, width 60μ. The protomerite is 50 long. Ratio length prot:total length :: 1:8; width prot:width deut :: 1:1.3. Protomerite subspherical, flattened at septum, width equal to length. Constriction at septum. Deutomerite elongate cylindrical, broadly rounded behind. Nucleus spherical with several karyosomes. Young associations more slender, protomerites greatly attenuated.

Cysts spherical or ovoidal.

Host: Periplaneta orientalis.

Taken at Rio de Janeiro, Brazil.

Habitat: Intestine and coelom.

Magalhaes names the species serpentula from the manner of movement.

"- - m'ont paru rappeler la forme de la tête d'un serpent et ses mouvements."

The author found instances in which more than two sporonts were attached:

"Celle-ci (espèce) fournit fréquement des examples d' association de plusieurs individus disposes en file; deux trois et plus sont accolés par leurs extrémités opposées. D'autres fois, ils forment des groupes constitués d'un plus gros exemplaire, à l'extrémité postérieure duqûel sont accolés deux, trois, cinq satellites plus petîts."

These phenomena are observed in rare instances throughout the genus Gregarina.

This species is quite distinct in characteristics from G. blattarum Sieb., from the same host and its authenticity is not questioned.

Gregarina rigida (Hall) Ellis
Figs. 194, 197 & 198.

1907	Hirmocystis rigida	Hall	1907:
1907	Gregarina melanopli	Crawley	1907:223
1913	Gregarina rigida	Ellis	1913c:267
1913	Gregarina melanopli	Ellis	1913d:82-3

Gregarina: Sporonts biassociative but rather stout-bodied. Max. length of association 1425 μ. Average length 550 μ. Sporonts 250-750 μ long, 130-210 μ wide. Ratio length prot:total length :: primite :: 1:3 to 1:6; length prot:total length satellite :: 1:5 to 1:16; width prot:width deut :: 1:1.4. Protomerite

somewhat flattened, width sometimes three times the height, generally less. Constriction at septum more or less indistinct. Deutomerite cylindrical or barrel-shaped, little wider than protomerite, ending in a broadly rounded or flattened square-cornered extremity. Endocyte very dense and brownish-yellow in deutomerite, tan in protomerite. Epimerite a small spherical hyaline knob.

Cysts yellow-orange, 300μ in diameter, sporeducts short, ten or more in number. Spores extruded in chains, barrel-shaped, 5 x 8μ.

Taken at Wyncote, Pa.; Douglas Lake, Mich.; Lincoln, Nebr.; Colorado Springs, Colo.; Boulder, Colo.; Urbana, Illinois.

Hosts: Melanoplus femoratus (Burm.); M. luridis (Dodge); M. femur-rubrum (deGeer); M. atlanis (Riley) M. atlantis): M. differentialis (Uhler); M. coloradensis ? ; M. angustipennis (Dodge); Encoptolophus sordidis (Burm.); Schistocerca americana Burm.; M. bivitattus (Say); Hesperotettix pratensis Scudder; Brachystola magna Giard.

Location: Intestine and caeca.

This species was first described by Hall as Hirmocystis rigidis. He mentioned dehiscence of the cysts by rimple rupture, and he saw neither the spores not the epimerite. The only character in common with the genus Hirmocystis was the simple rupture of the cysts, and this character is possessed by some thirty genera. Crawley (1907), two months later published an article

describing a new species, Gregarina melanopli which proves to be the same species. He found dehiscence to be by means of numerous sporeducts. The epimerite was still unknown.

Ellis changed the name of the species to Gregarina rigida (Hall).

The present writer has taken the parasite from various Acrididae in material from Colorado Springs, Lincoln and Urbana.

Gregarina kingi Crawley
Fig. 193.

1907	Gregarina kingi	Crawley	1907:221-3
1913	Gigaductus kingi	Ellis	1913c:271
1915	Gregarina kingi	Watson	

Gregarina: Sporonts biassociative, rather stout-bodied. Maximum length of associations 350 μ. Sporont measurements not given. Ratio--length prot:total length :: 1:3; width prot:width deut :: 1:1. Protomerite saddle-shaped, i.e. broadly dilated and nearly flattened apically, with deep constriction just below middle, dilated again less extremely below. Widest part twice the width of narrowest part. Protomerite equal in length to its greatest width, a slight constriction at septum. Deutomerite widening out rapidly from septum to shoulder, and quite regularly cylindrical from thence downward. Very broadly rounded at distal end. Nucleus spherical, small. Endocyte not dense.
Cysts spherical, 110 μ in max. diam., one sporeduct only, spores barrel-shaped, 5 x 2.75 μ in dimensions.

Taken at Wyncote, Pa.

Host: Gryllus abbreviatus Serv.

Habitat: Intestine.

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Ellis placed the species in question in the genus Gigaductus, originally created by Crawley himself, for G. parvus. I have allowed the genus to drop out, removing the type species to the genus Gregarina, for its only differentiating character was the large single sporeduct. A discussion of the matter is found in the chapter on Coleoptera, under the species Gregarina parva.

Gregarina longiducta Ellis
Fig. 195.

1913 Gregarina longiducta Ellis 1913d:78-82

Gregarina: Sporonts biassociative, obese. Length associations 800-900μ. Ratio length prot:total length primite :: 1:3.5; width prot:width deut :: 1:1. Protomerite broadly rounded in front, widest through middle, twice as wide as high, and deeply constricted at septum. Deutomerite slightly broader than high, barrel-shaped, widest through middle. Very broadly rounded or flattened at posterior end. Satellite longer than primite in all associations observed. Nucleus not observed. Endocyte very dense, black. EPimerite a short digitiform process equal in length to protomerite of cephalont.

Cysts spherical, 560μ in avg. diam. SPoreducts 3 to 3.5mm. in length, four in number, arranged around one pole of cyst. SPores

discharged in chains. Cylindrical , 3 x 6.5 μ .

Taken at Douglas Lake, Mich.

Hosts: Ceuthophilus latens Scudder and C. maculatus (Say).

Habitat: Intestine.

Gregarina consobrina Ellis
Fig. 196.

1913 Gregarina consobrina Ellis 1913c:267

Gregarina: Sporonts biassociative, obese. Average length of sporonts 600 μ , average width 450 μ . Ratio--length prot:total length :: 1:3.5 to 1:4; width prot:width deut :: 1:1.5. Protomerite hemispherical, no constriction at septum. Deutomerite subspherical to ovoidal, nearly or quite as wide as long, broadly rounded posteriorly. Endocyte not described. Nucleus not seen. Epimerite short, simple, digitiform.

Cysts spherical, 250-300 μ in diameter. Sporeducts 4-6, all in one hemisphere, 900-1200 μ in length. Spores extruded in chains. Cylindrical, 3.2 x 8 μ .

Taken at Boulder, Colo.

Host: Ceuthophilus valgas Scudder.

Habitat: Intestine.

Gregarina illinensis n.sp.
Fig. 207.

Host Ischnoptera pennsylvanica (deGeer).

The species was taken at Urbana, Illinois in November 1914. The intestine of one field cockroach was found to contain

twenty-five associations. A dozen or more immature specimens of the cockroach were collected at various times throughout the fall but only this one was infected.

The sporonts are biassociative and elongate-cylindrical in shape. The maximum length of an association seen was 1110μ, length of the primite being 540μ, its width 180μ. Ratio length prot:total length primite :: 1:5; width prot:width deut :: 1:1.1 to 1:1.5. The protomerite of the primite is dome-shaped, the width equalling the height. The widest part of the primite is the middle portion. There is a constriction, not very deep, at the septum. The protomerite of the satellite is rectangular in shape, 1.5 times as wide as high and depressed at the anterior end into which concavity the primite fits. The deutomerite is regularly cylindrical, elongate and well rounded at the posterior end. The nucleus is large and spherical, and contains many small chromidia. The endocyte is dense in both protomerite and deutomerite and is black in transmitted light. The nucleus is not visible in vivo.

Cephalonts and cysts were not recovered from the host.

A table of measurements follows:

Total length association	1.110	1.110	1.080	1.050	mm.
Primite:					
Length protomerite	.10	.10	.10	.09	
Length deutomerite	.45	.45	.44	.41	
Width protomerite	.13	.13	.11	.11	
Width deutomerite	.17	.18	.18	.17	
Total length sporont	.55	.55	.54	.50	

Ratio length prot / total length	1:5.5	1:5.5	1:5.4	1:5.5
Ratio width prot / width deut	1:1.3	1:1.4	1:1.7	1:1.5
Satellite:				
Length protomerite	.07	.13	.08	.07
Length deutomerite	.53	.43	.44	.48
Width protomerite	.13	.13	.13	.12
Width deutomerite	.19	.21	.17	.18
Total length sporont	.56	.56	.52	.55
Ratio length prot / total length	1:8	1:4.3	1:6.5	1:8
Ratio width prot / width deut	1:1.5	1:1.6	1:1.3	1:1.5

This species and the old-world Gregarina blattarum Siebold, of Blatta orientalis are differentiated as follows:

	G. blattarum	G. illinensis
Shape	Irreg. cylindr.	Very regularly cylindr.
Posterior end of satellite	Not well rounded, often pointed	Well rounded always
Sarcocyte	Very thick	Thin except in prot.
Shape of prot. of sat.	Flattened, wider at base than elsewhere, 1.7 x as wide as at top. 2½ x as wide as high.	But slightly flattened, as wide at base as at top, 1½ x as wide as high

In the following characteristics, the two species agree:

Ratio length prot / total length primite	1:5	1:5
Ratio length prot / total length satellite	1:8	1:8
Shape prot. of primite	Hemispherical	Hemispherical
Nucleus	Spherical	Spherical

Thus, on the strength of the shape of the posterior end of the body, shape of the satellite, and in the matter of regularity of shape of the body, , there is basis for the creation of a new species, although in one important factor, proportions, the two species agree. There are no measurements stated for the

old-world species by any of the numerous workers. Schneider says

"- - elle devient trés-volumineuse"

which indicates that the species may be as large as the one here described. The species described by Leidy (1853:239) from Blatta orientalis agrees in size with both species. His drawings indicate an irregularly shaped body and a more or less sharply pointed posterior extremity and the hosts he dissected were probably the introduced European cockroach and the gregarine the old-world G. blattarum.

Crawley records (1903:44) the species G. blattarum as

> "Common in Periplaneta orientalis, P. americana and Ectobia (Blatta) germanica. A few specimens of Ischnoptera pennsylvanica, the field cockroach, were examined, but none contained gregarines."

These hosts undoubtedly yielded the same parasites which Leidy also had found at Philadelphia.

Ellis (1913a:83) says

> "This gregarine was found in several specimens of the native roach Ischnoptera pennsylvanica from the woods near Douglas Lake. - - Although no introduced roaches have been collected in the vicinity ---, this gregarine from native roaches seems undoubted the typical G. blattarum, agreeing in spores, cysts and sporonts with that species. The biological question of interest is, of course, the source of infection of these native roaches - -; it is possible however, that G. blattarum is established in the native roaches in the new world. - - -both Frenzel and Magalhaes found the native roaches to be infected with gregarines other than G. blattarum - - -."

In his Syllabus (1913c:265) Ellis gives measurements which coincide fairly well with those recorded above in the table. The

maximum length of a sporont he states is 520μ , while that of the above species is 560μ . Ellis says

> "Cysts prolate spheroids, average 450 x 900μ - - -, sporeducts 10 or more, reaching the length of 200 ; sporocysts barrel-shaped, 4 x 8μ ."

Ellis' drawing differs somewhat in shape from that of any specimen seen by the present writer (ratio length prot: total length primite in the former 1:3.3; in the latter 1:5) but this is not sufficient to constitute a new species as it is the only difference in the two. It is highly probable that but one species is involved. Ellis' specimens were taken from Ischnoptera pennsylvanica (deGeer), at Douglas Lake, Mich.

Hall (1907) makes the simple statement that Periplaneta americana contains Gregarina blattarum. I have no reason to doubt its presence.

It is noted that the terms Blatta orientalis and Periplaneta o. are used interchangeably by various authors, the name now accepted being Blatta orientalis L.

Gregarina galliveri n.sp.

Fig. 205.

Host Gryllus abbreviatus Serv.

This species was takenat Oyster Bay, Long Island, N.Y. in August, 1914. The parasite lives in the intestine of the host. The species is rare, seen only twice in a hundred or more crickets opened, sixty-five associations and five cysts being found

in one host and a dozen associations in another. In the former instance, nearly all the associations were engaged in cyst-making.

The sporonts are biassociative, even to the smallest seen. The maximum length of an association seen was 590 μ, the maximum width 180 μ. The animals are quite polymorphic but certain generalizations can be made. The protomerite of the primite is always wider than the deutomerite. Measurements indicate that it is but little wider, but the difference seems much greater because the two places of greatest width, those used in measurements, are widely separated. The protomerite is low and broad, either flat or very slightly rounded at the anterioe end and from two to four times as wide as high, the average being three. Its widest part is the middle portion where it is approximately one and one-half times as wide as the septum. The protomerite of the satellite is considerably narrower than that of the primite. It is greatly flattened and from two to four times as wide as high. The deutomerite of the primite is constricted a little just below the septum, widening out below the middle where it attains nearly the measured width oft he protomerite. In some instances it is nearly cylindrical. The deutomerite of the satellite is irregularly subglobular to broadly ellipsoidal in shape and is of approximately the same width as the protomerite of the primite. The ratio of length prot: total length primite (for twelve asso-

ciations) remains nearly constant and is approximately the same in the satellite as in the primite, being 1:5. The ratio of width prot:width deut primite is approximately 1.3 to 1;in the satellite it is 1:1.4.

The endocyte is very dense in both protomerite and deutomerite, and brown in color, not black as in so many species. The protomerite granules are much larger than those in the other species seen in the same host. The nucleus is small and spherical. It is not visible in vivo except in young individuals.

Upon carefully flattening out the association on the slide, by slight pressure, it was rendered transluctent enough to make visible a large inflated papilla on the anterior end of the satellite which fits into a corresponding depression in the primite and makes the union firmer. This was well demonstrated in some specimens from a starved host in which the protoplasm of the parasite was pale tan throughout and both the papilla and the nuclei were clearly visible.

The trophozoites possess a knob-shaped hyaline epimerite.

Cysts are 300-350 μ in diameter[1], very dense like the sporonts and deep brown in color. In one cricket, as stated above, almost all the associations were engaged in making cysts. Two such processes were watched from the incipiency to the complet-

1. The diameter, exclusive of the transparent layer is 50 μ less.

tion of the two cysts and took place in less than half an hour. At 11 A.M., five cysts were present on another slide, and at 2 P.M. there were seven. Several of the cysts which when first observed were sporonts developed to completion with the exudation of ripe spores. The maximum number of sporeducts seen on a cyst was nine. The ducts are very long. The spores are barrel-shaped, 3 x 6μ.

It was anticipated that this species was identical with Crawley's Gregarina kingi because of the peculiarly shaped protomerite of that species, but such was found not to be the case; they differ in many respects. The following table indicates the chief differences:

	G. galliveri	G. kingi
Max. length of ass'n	590μ	350μ
Ratio $\frac{\text{length prot}}{\text{total length primite}}$	1:5	1:3
Ratio $\frac{\text{width prot}}{\text{width deut}}$	1:0.8	1:1.1
Shape prot of primite	Broad and flat, shape slightly irregular, 3 x as wide as high. Wider than deut.	"Saddle-shaped, broad and swollen in front, much narrower behind." Narrower than deut.
Shape prot of satellite	Flattened, 4 x as wide as high	"Subspherical to compressed", twice as wide as high.
Shape deut of primite	Constricted below septum, dilated below and widest in posterior 2/3.	"Cylindr. generally broader in front. Outline often irregular."
Shape deut of satellite	Subspherical to broadly ovate	
Nucleus	Spher, small	Spher, small
Endocyte	Very dense, deep brown in both	"Not dense".

	prot and deut.	"Not dense."
Anterior surface of sat.	Provided with a very large, flattened papilla which fits into a corresponding depression in primite	Shows a slightly raised ring, primite fitting into a very shallow saucer on anterior end of satellite
Cysts, diam.	350μ	90-110μ
Dehiscence	Many sporeducts	Single long sporeduct
Frequency	Rare, not more than one cricket in 50 harboring it	25% of crickets opened contained these parasites in countless numbers

No other allied species has been described from crickets.

Measurements of a few associations are as follows:

Total length association	.590	.570	.540	.490	.440 mm.
Primite:					
Length protomerite	.06	.07	.06	.06	.04
Length deutomerite	.23	.20	.21	.21	.19
Width protomerite	.15	.14	.15	.15	.10
Total length sporont	.29	.27	.27	.27	.23
Ratio length prot / total length	1:5	1:4	1:4.5	1:4.5	1:5.7
Ratio width prot / width deut	1:1.1	1:1	1:1.1	1:1	1.4:1
Satellite:					
Length protomerite	.05	.05	.05	.04	.05
Length deutomerite	.25	.25	.22	.18	.17
Width protomerite	.11	.13	.14	.12	.09
Width deutomerite	.15	.18	.18	.17	.12
Total length sporont	.30	.30	.27	.22	.21
Ratio length prot / total length	1:6	1:6	1:5.4	1:5.5	1:4.2
Ratio width prot / width deut	1:1.3	1:1.4	1:1.3	1:1.4	1:1.3
Diameter cysts	.350	.300	.350		

Gregarina stygia n. sp.
Fig. 206

This new species was taken from Ceuthophilus stygius (Scudder) from hosts found in an unused cistern on Dr. Davenport's grounds, at Cold Spring Harbor, Long Island, N.Y.

The infection was heavy, as many as five hundred parasites being found in each of several hosts, and all of the twelve hosts examined contained each at least a few parasites. The region infected is the intestine.

The sporonts are biassociative as adulte. The longest association measured 360 μ. The sporonts are barrel-shaped, the maximum length recorded being 180 μ and the maximum width 100 μ. The protomerite is nearly hemispherical in the primite and is flattened in the satellite. The deutomerite is widest at or in front of the middle portion. The satellite is somewhat more slender than the primite and of the same length of a little shorter. The endocyte is dark tan in color, not being very dense in either deutomerite or protomerite, and the nucleus is easily visible in vivo. The sarcocyte is thicker at the septum and anterior ends of the protomerites than elsewhere, but it is fairly thick throughout. The nucleus is small and spherical and contains one or more large karyosomes.

Sections show that the cephalont possesses a simple knobbed epimerite, slightly stalked. The s porozoite is spindle-shaped and contains a large nucleus. Several sporozoites were

seen in the sectioned intestine free in the lumen or lying contiguous to the epithelial wall.

Movement is sluggish and of the ordinary two types, gliding and contortive.

Cysts average 150μ in diameter. Dehiscence was not observed.

This species is not identical with Gregarina longiducta Ellis (1913b:78-82) from Ceuthophilus latens and C. maculatus. Associations of the latter average 800-900μ in length, the smallest observed being 465μ long. Large associations of G. stygia are only 360μ in length. Proportions vary as well as lengths.

The species differs from G. consobrina Ellis (1913a: 267) in size. Sporonts of the latter species attain a length of 600μ , those of C. stygia not becoming longer than 180μ .

No other species is recorded from the genus Ceuthophilus.

A table of measurements is appended herewith:

Total length association	.360	.330	.300 mm.
Primite:			
Length protomerite	.03	.02	.03
Length deutomerite	.15	.14	.12
Width protomerite	.06	.04	.055
Width deutomerite	.10	.10	.08
Total length sporont	.18	.16	.15
Ratio $\frac{\text{length prot}}{\text{total length}}$	1:6	1:8	1:5
Ratio $\frac{\text{width prot}}{\text{width deut}}$	1:1.6	.1:2.5	1:1.5
Satellite:			
Length protomerite	.02	.025	.03
Length deutomerite	.16	.145	.12

Width protomerite	.06	.05	.07
Width deutomerite	.08	.06	.08
Total length sporont	.18	.17	.15
Ratio length prot / total length	1:9	1:7	1:5
Ratio width prot / width deut	1:1.3	1:1.2	1:1.1

Gregarina nigra n. sp.
Fig. 210.

Hosts Melanoplus femur-rubrum (deGeer); Encoptolophus sordidis (Burm.).

This parasite seems to be present only as a secondary one. It never occurs in large numbers but is generally found in the same host with Gregarina rigida. During the season of 1913 I found the parasite comparatively frequently, but not over half a dozen Acrididae yielded the species in the collections made in the fall of 1914. It is easily differentiated from the more commonly found species in both color and shape especially of the protomerite. It was collected at Urbana, Illinois.

The maximum length of an association found was 1000μ. The ratios ofvarious parts of the body are about the same as those for G. rigida. The shape of the body is, however, quite different. The protomerite is shaped like a truncated cone; it is widest at the base, flättened on the top and square-cornëred. It is approximately as high as wide at the base; there is no constriction or only a very slight one at the septum. A slight indentation persists at the apex of the pro-

tomerite left by the detatchment of the knob-like epimerite. The deutomerite is cylindrical, of the same width throughout and very little wider than the protomerite. It terminates in a broadly rounded extremity. The protomerite of the satellite is often not at all flattened but is a little shorter than that of the primite and of approximately the same shape.

The endocyte of the deutomerite is very opaque and dense, being black in trnnsmitted light. The protomerite is somewhat less dense than thē deutomerite. The nucleus is not visible in vivo. It is spherical, in diameter about one-third the width of the deutomerite and contains many karyosomes. The epicyte is thick at the anterioe end of the protomerite, being thin elsewhere.

I have not been able to differentiate the cysts of this species (if present in my collections) from those of G. rigida. The size would be about the same, judging from the size of the associations. I have never seen an infection in which this species alone was present so have no way of knowing exactly which species yielded the cysts found when both species were present. In the instance of every cyst from Acrididae which I have watched develop, sporeducts grew from small orange-colored discs on the surface. The sporeducts were always short and the spores doliform.

A table of measurements follows:

Total length association	.990	.880	1.000	millimeters
Primite:				
Length protomerite	.14	.15	.15	.14
Length deutomerite	.39	.29	.38	.44
Width protomerite	.12	.13	.14	.13
Width deutomerite	.15	.17	.18	.15
Total length sporont	.53	.44	.53	.58
Ratio length prot / total length	1:3.8	1:3	1:3.5	1:4
Ratio width prot / width deut	1:1.2	1:1.4	1:1.3	1:1.1
Satellite:				
Length protomerite	.11	.10	.09	
Length deutomerite	.35	.34	.38	
Width protomerite	.11	.12	.13	
Width deutomerite	.17	.15	.16	
Total length sporont	.46	.44	.47	
Ratio length prot / total length	1:4.2	1:4.4	1:5.2	
Ratio width prot / width deut	1:1.5	1:1.2	1:1.2	

Leidyiana solitaria n.g., n.sp.
Fig. 208, 218-55.

Host Gryllus abbreviatus Serv. and Gryllus pennsylvanica Burm.

The parasites were taken at Cold Spring Harbor and Oyster Bay, Long Island, N.Y., Haverford, Pa., and at Urbana, Ill., during the summer and fall of 1914.

The intestine is the seat of infection, althoughthe pyloric caeca is not infrequently found to contain parasites. The latter are generally present in small or moderate numbers, from 1 to 25 per host, and nearly every cricket examined at this season was parasitised. Sometimes the number per host runs up to 100 or more, but this is rare.

The parasites are solitary, never associative in the

normal sporont life. The maximum recorded length is 500μ, the maximum width 160μ. The ratio of length prot:total length for fifteen specimens is 1:5 to 1:7. The ratio width prot:width deut is 1:1.3 to 1:1.7. The protomerite is slightly wider than high. It is broadly cone-shaped dilated in the middle and constricted at the septum. The constriction is very conspicuous in the young individuals and fairly deep in the adults. There is no papilla at the anterior end. The deutomerite is cylindrical to elongate-ellipsoidal, sometimes tapering but always rounded at the postdrior extremity. (Figs. 218, 21.)

The endocyte is very dense and black in the deutomerite (in transmitted light) and pale tan in the protomerite, the two parts being sharply contrasted. Longitudinal striations are easily discernible with the aid of an intra vitam stain or after crushing the body and releasing the dense endocyte. (Fig.243) The nucleus is spherical and contains one or two small karyosomes. It is not visible in the dense adults, but is seen in vivo in the younger sporonts and in the trophozoites.

The epimerite is a large simple spherical hyaline knob set upon a short slender stalk. (Figs. 224-7). The sarcocyte is very distinctly visible in contrast to the contiguous black endocyte. It is thin and of even width throughout.

Trophozoites with epimerites are common, both free in the lumen and attached to the cells of the intestine. They are [illegible] 1:1.6. The [illegible]

[illegible] 1:3. The ratio of length proportional length [illegible]

fifteen specimens is 1:0 to 1:7. The [illegible] width [illegible]

is 1:1.3 to 1:1.7. The protomerite is slightly wider than [illegible].

It is usually [illegible] dilated in the middle and constricted

at the septum. The constriction is very conspicuous in the young

individuals and fairly deep in the adults. There is no papilla

at the anterior end. The deutomerite is cylindrical in [illegible]

cylindroidal, sometimes tapering but always rounded at the

posterior extremity. (Figs. 10, 11.)

The endocyte is very dense and black in the deutomerite (in transmitted light) and pale tan in the protomerite, the two parts being sharply contrasted. Longitudinal striations are easily discernible with the aid of an intra vitam stain or after crushing the body and releasing the dense endocyte. (Fig. 12) The nucleus is spherical and contains one or two small karyosomes. It is not visible in the dense adults, but is seen in vivo in the younger sporonts and in the trophozoites.

The epimerite is a large simple spherical knob-like [illegible] set upon a short slender stalk. (Figs. 13-?) The epimerite is very distinctly visible in contrast to the conspicuous black endocyte. It is [illegible] and of even width throughout.

Trophozoites with epimerites are common, both free in the lumen and attached to the walls of the intestines. They are [illegible] transparent or nearly so. Some individuals are surprisingly large.

Cysts average 350μ in over-all diameter, the transparent envelope being about 30μ in thickness when the cyst is new. Dehiscence is by sporeducts from one to twelve or more in number. SPores are extruded from the long ducts in chains. The spores are barrel-shaped and measure 3 x 6μ .

This species was described by Crawley (1903a:45) as Gregarina achetaeabbreviatae Leidy and later as Stenophora erratica. Crawley first considered the species identical with Leidy's Gregarina achetaeabbreviatae from the same host but later created for it a new species because

> "- - -at the anterior tip of the protomerite the ectosarc is often thickened to form a low papilla, within which are traces of a pore." (1907:221)

It is this character which led him to place the gregarine in the genus Stenophora. He adds

> "The suggestion is permissible that thie form is actually the common Stenophora julipusilli Leidy, somewhat altered from being in the wrong host - - -".

The suggestion that the species belongs to the family Stenophoridae is excluded when we consider the method of cyst-dehiscence, which is that characteristic of the family Gregarinidae rather than that of the Stenophoridae.

The sarcocyte at the anterior end of the protomerite is often thickened and papillate but I have not seen a trace of a pore.

I wish to thank Mr. Elmer Shafer, of Haverford College, for so kindly sending me live crickets which contained this parasite and established the record in the region of Philadelphia.

A table of measurements follows:

Length sporont	.50	.49	.47	.42	.37	.29	mm.
Length protomerite	.08	.07	.08	.06	.06	.05	prot.without epim.
						.03	epimerite
Width protomerite	.11	.15	.08	.08	.08	.05	
Width deutomerite	.15	.15	.16	.14	.13	.06	
Ratio length prot / total length	1:6.3	1:7	1:6	1:7	1:6.1	1:6	
Ratio width prot / width deut	1:1.3	1:1.7	1:2	1:1.7	1:1.6	1:1.2	

Leidyiana gryllorum (Cuénot) Watson
Fig. 209.

1897	Clepsidrina gryllorum	Cuénot	1897:52-54
1899	Gregarina macrocephala	Labbé	1899:10
1901	Gregarina Gryllorum	Cuénot	1901:594-5
1915	Leidyiana gryllorum	Watson	

Leidyiana: Sporonts solitary, never associative, cylindrical. Length 420 μ. Ratio--length prot:total length :: 1:5; width prot:width deut :: 1:1.1. Protomerite subspherical, a deep constriction at septum. Deutomerite cylindrical, conical at end. EPimerite globular, nucleus small, spherical. Cysts spherical or ovoidal, 190-240 μ in diameter. Sporeducts 3-8. SPores barrel-shaped, 7 μ in longest axis.

Taken in the Departments of Ardennes and Meurthe-et-Moselle, France.

Host: Gryllus domesticus (L.).

Labbé placed this species which had been mentioned but not described by Cuénot as a synonym of Gregarina macrocephala Schneider, which is only known from the cephalont. Cuénot (1901) says regarding the disposition of the species

> "Labbé - - -l'a réunit de son propre chef à la G. macrocephala A. Schn.; or, cette dernière espèce est trop mal connue pour qu'il y ait quelque avantage à l'identifier à la mieune; le grand épimérite en forme de massue de 'macrocephala' n'est certainment pas pareil a celui de 'gryllorum.'

In a footnote he says

> "Schneider ne décrit pas la forme adulte et ne parle pas du nombre de sporeductes des kystes."

Therefore the species has an individuality. It is very similar to the species described under a new genus, Leidyiana solitaria. Both are solitary, size of the two are very nearly the same, ratios of various parts not radically different and shape of the deutomerite quite similar. The cysts are slightly smaller than in the new species, but they dehisce by approximately the same number of sporeducts and the spores are similar. The epimerites of the two species are spherical and large. The nuclei are spherical. The only difference seems to be in the shape of the protomerite. In all the hundreds of specimens seen of L. solitaria, none has possessed a protomerite rounded at the anterior end; all have been decidedly conical at the apex. In the present species, the protomerite is broadly rounded--subspherical--in shape; the constriction at the septum is consider-

ably deeper than in the other species. I have separated the two on the basis of this character alone, deeming it of sufficient import to differentiate the species. Both species are parasites of the genus Gryllus, but of different species. The host of the former, Gryllus domesticus, flourishes in the old world and is rare in the United States, having formerly been found about old log houses--the former occupants of which undoubtedly introduced it from Europe. (Blatchley). The host of Leidyiana solitaria, Gryllus abbreviatus, is the common field cricket in the United States. The infection is unlikely to have spread from the one host to the other.

Hyalospora roscoviana Schneider

For detailed synopsis and discussion of this species, see the chapter on Coleopteran parasites, under the same species name. The host is Petrobius matitimus, but as the genus Petrobius has been described for both Coleoptera and Orthoptera, it is impossible to state whether the host was a beetle or an orthopteran.

Hyalospora affinis Schneider
Fig. 201.

1882 Hyalospora affinis	Schneider	1882:445-6
1899 Hyalospora affinis	Labbé	1899:14

Hyalospora: Sporonts biassociative, slender and elongate. Length of cephalonts 300μ . SPoront measurements not

given. Ratio length prot:total length primite :: 1:5 (without epimerite). Ratio width prot:width deut :: 1:1.8. Endocyte yellow. Epimerite a hyaline sessile knob, present on the primite of an association in the figure given (Fig. 201). Nucleus ellipsoidal, with one or two karyosomes.

Cysts spherical or subspherical, yellow in color, 60μ in diam.

Spores 8.7μ x 6μ.

Taken at Rosfocc, France.

Host:Machilus cylindrica E. Geoff.

Habitat: Intestine.

Schneider's figure is a paradox. It shows an association, the primite of which is a cephalont, with an epimerite. This condition is almost unique in the history of gregarines, for it is an unwritten law that only sporonts couple themselves together.

Gamocystis tenax Schneider
Fig. 202.

1875	Gamocystis tenax	Schneider	1875:586-7
1899	Gamocystis tenax	Labbé	1899:12
1913	Gamocystis tenax	Ellis	1913c:271

Gamocystis: Sporonts biassociative, in apposition, head to head; obese. No protomerite in the sporonts. Body ovoidal to subconical, posterior extremity rounded, nucleus spherical with one karyosome. Endocyte with large irregular granules. Cysts spherical, sporulation partial, sporeducts 15 or more,

short, extending only into the thick transparent layer of the cyst. Spores elongate-cylindrical, rounded at the ends.

Taken at Roscoff, France.

Host: Blatella laponica (Ectobia lapponica (L.); Blatta laponica).

Habitat: Intestine.

Hirmocystis gryllotalpa (Léger) Labbé
Fig. 211.

1892 Eirmocystis gryllotalpae Léger 1892:112
1899 Hirmocystis gryllotalpae Labbé 1899:13

Hirmocystis: Sporonts in associations of two or three. Length of sporonts 80-90 µ. Protomerite subspherical. Cysts spherical, 60 µ in diameter. Spores elongate-ovoidal, 5 x 2.1 µ.

Taken at Poitou, France.

Host: Gryllotalpa gryllotalpa (L.) (G. vulgaris).

Habitat: Intestine.

Léger and Labbé include here, as a synonym, Gregarina sphaerulosa Dufour (1837:12), probably on the strength of the fact that the latter was found in the same host-genus.

At the end of the chapter will be found a statement that Dufour's G. spherulosa was described from cysts instead of from sporonts. Dufour did not know the mode of reproduction of the little animals he had discovered a few years previous and looked upon the white spherules as a new species. It is interesting to note that he described cysts from two unallied hosts and he found enough differences between the cysts to designate them

as two separate species.

Pileocephalus blaberae Frenzel
Figs. 203 and 204.

1892	Gregarina blaberae	Frenzel	1892:300-14
1899	Pileocephalus blaberae	Labbé	1899:
1913	Gregarina blaberae	Ellis	1913c:266

Pileocephalus: Sporonts solitary, rather stout-bodied. Length of sporonts 500 μ, width 150 μ. Ratio--length prot:total length :: 1:5; width prot:width deut :: 1:1.6. Protomerite hemispherical to subglobular, 1.4 times as wide as high, very deeply constricted at septum. Deutomerite ovoidal, widest through central portion or just in front thereof, rounded at posterior end. Nucleus spherical, with one karyosome. Epimerite long, cordiform, dilated at the base into a flattened sphere which is over half the width of the protomerite inits width. Epimerite equal in length to half the whole cephalont length (without the epimerite).

Cyst and spores not known.

Taken at Cordoba, Argentina.

Host: Blabera claraziana Sauss. and related species.

Ellis replaced this species in the genus Gregarina although the only known diagnostic character, the epimerite, does not coincide with that of the genus. This structure does, however, agree in shape with that of the genus Pileocephalus Schneider (1875:591) and Labbé (1899:19):

"Epimérite regulier simple conoide ou en fer de lance." L.

Actinocephalus pachydermus (Crawley) Ellis
Figs. 189 and 190.

1853	Gregarina Locusta Carolinae	Leidy	1853:239
1856	Gregarina Locustae Carolinae	Leidy	1856:47
1859	Gregarina fimbriata	Diesing	1859:730
1903	Stephanophora locustaecarolinae	Crawley	1903a:54
1907	Stephanophora pachyderma	Crawley	1907:226
1913	Actinocephalus pachydermus	Ellis	1913c:278

Actinocephalus: Sporonts solitary, obovate. Maximum length of sporonts 500 μ. Protomerite hemispherical, not constricted at septum but contour continuous with that of deutomerite. Latter tapers slightly, ending in a blunt point. Sarcocyte very thick especially over anterior end of protomerite. Endocyte black in deutomerite, less dense in protomerite. Nucleus spherical with 12 or more small karyosomes. Epimerite an inverted campanula, sessile, with 10 or more slender digitiform processes directed upwardly along the periphery.

Cyst and spores unknown.

Taken at Wyncote, Pa.

Host: Dissosteria carolina (L.).

Habitat: Intestine.

A cephalont of this species was first seen by Leidy in 1853. He described it and the sporonts of Gregarina locustaecarolinae together under the latter name.

In 1903, Crawley renamed the species Stephanophora locustaecarolinae from the character of the epimerite, as drawn by Leidy. Crawley did not see the species then. The error of

inclusion was discovered by Crawley from new material in 1907, and he then separated the two species, describing each in detail. The former he called Stephanophora pachyderma, the latter by the original name.

Ellis transferred the species in question to the genus Actinocephalus, where it belongs because of the character of the epimerite. The genus Stephanophora was distinguished by its flat cushion-like epimerite with stout broad digits rising from the periphery. The genus has now been merged with another and the name discontinued.

Indeterminate Species

Gregarina conica Dufour
Fig.102.

1837	Gregarina conica	Dufour	1837:12
1851	Gregarina conica	Diesing	1851:8
1863	Gregarina conica	Lankester	1863:94

Dufour's description is as follows:

"Oblongo-conica; cephalothorace subgloboso abdominis tertiam partem adaequante. Hab. Coleopterorum et Gryllorum."

In 1826, Dufour described an intestinal parasite from Coleoptera. In 1828 he named it Conica; in 1837 he gave as hosts the above animals and named the parasite Gregarina conica. The parasite is illustrated in his 1837 paper. That he had two species under consideration is obvious from his drawings, see figs. 101 and 102, one being labelled as from Coleoptera and the other from Gryllus. The former has a crenulate, stalked epimerite,

the latter a simple spherical stalked one. The former figure has been homologized with several drawings by subsequent writers and represented the parasite described in the chapter on Coleopteran parasites under the name of Actinocephalus conicus (Dufour) Stein.

Stein described a parasite, Actinocephalus Lucani, from a beetle, which is identical with Dufour's drawing 7. He did not know of Dufour's paper and the previous discovery of the species, but Frantzius (1848:195) did, and mentioned Stein's Actinocephalus Lucani from Lucanus, leaving the original Gregarina conica Dufour from Gryllus only.

Diesing (1851) listed both G. conica Dufour from Coleoptera and Gryllus and G. Lucani Stein from Lucanus parallelipipedus).

Lankester did likewise. After his citation, G. conica dropped out of the literature. It is obvious that Dufour found a parasite in Orthoptera but what it was no one can say. He did not find associations and we do not know whether he say only the isolated cephalonts with the epimerites (which he shows in his drawing) or whether he saw sporonts which were not associative.

So the generic position of the species is doubtful. The family determination is fairly definite, from the simple spherical epimerite, but the species must be relegated to the group of the Indeterminate.

Gregarina davini Léger and Duboscq
Fig. 200.

1899 Gregarina Davini Léger and Duboscq 1899: xxxviii-xl

Gregarina: Sporonts not described, cephalonts alone known. Nucleus spherical, with a large irregularly shaped karyosome. Epimerite large and spherical, set upon a rather long stout collar formed by a projection of the anterior end of the protomerite.

Cysts spherical, with 12 or more long sporeducts from which spores are extruded in chains. Spores barrel-shaped, 8µ long.

Taken at Marseilles, France.

Host: Gryllomorpha dalmatina Ocsk.

Habitat: Intestine and caecum.

Although sporonts have not been found, the species is undoubtedly a member of the genus Gregarina from the mode of dehiscence and the shape of the epimerite. It cannot be determined whether or not the species has been described elsewhere from the sporontd in addition to these other factors under a different name. Until sporonts are found and correlated withthe description herewith, the species must remain incomplete.

Miscellaneous

1837	Gregarina sphaerulosa	Dufour	1837:12	Fig. 179.
1851	Gregarina sphaerulosa	Diesing	1851:11	
1863	Gregarina sphaerulosa	Lankester	1863:94	
1899	Hirmocystis gryllotalpae	Labbé	1899:13	

Dufour described this form as follows:

"Subspherica alba, cephalothorace abdomen adaequanta. Hab. in ventriculo Aedipodarum et Gryllotalpae.

Elle est - - - égalant à peine la grosseur d'une tête de fine épingle à insectes; - - -. Les individus bien adultes semblent résulter de l'union de deux hémisphères. Des yeux peu rigoreux pourraient croire que ce sont deux individus accouplés bout à bout."

It is obvious from the description and from the figure that what Dufour saw and named were not sporonts but cysts formed by the union of two equal or sub-equal sporonts. None of his other descriptions of sporonts applies to the particular species of Orthoptera from which these cysts were taken, so no sporonts, but only cysts, must have been present in the host. Dufour did not, as might have been the case, describe the cysts and sporonts in the same host as separate species. These cysts were taken from Oedipoda coerulescens and from Gryllotalpa sp.

Frantzius did not mention the'species,'probably realizing the error. Diesing mentioned the 'species' and the host. Lankester did likewise. Labbé mentioned it as a synonym of Hirmocystis gryllotalpae (Léger) Labbé, probably from an identity of host genera and certainly not because of any similarity in appearance.

Fig. 180.

1837	Gregarina soror	Dufour	1837:12
1851	Gregarina soror	Diesing	1851:11
1863	Gregarina soror	Lankester	1863:94
1899	Gregarina soror	Labbé	1899:34

Just as in the instance above, Dufour has here described cysts instead of sporonts. His words are as follows:

"Subspherica alba, cephalothorace abdominis dimidiam partem adaequante."

"Celle-ci n'est peut-être qu'une variété de la précédente; mais le céphalothorace ne forme pas, comme dans cette dernière, la moitié de tout le corps."

The cyst in question consists of two unequal parts, making the "cephalothorax" less than half the sphere.

Diesing and Lankester mention the form and Labbé places it in his "Uncertain" Group under the original name.

List of Polycystid Gregarines in the Coleoptera

The species are arranged in families, the families including genera in alphabetical order, and under each genus the species are placed in chronological sequence

Page	Names of parasites	Names of hosts
	DIDYMOPHYIDAE	
204	Didymophyes gigantea Stein	Oryctes sp. larv. Oryctes nasicornis (L.) larv. Phyllognathus sp. larv.
205	Didymophyes paradoxa Stein	Geotrupes stercorarius (L.) SCARABAEIDAE
205-6	Didymophyes leuckarti Marshall	Aphodius pradomus (Brahm) Aphodius nitidulus F. "
206-7	Didymophyes minuta (Ishii) Watson	LUCANIDAE Tribolium ferrugineus F.
	ACTINOCEPHALIDAE	
208-11	Actinocephalus conicus (Dufour) Stein	Dorcus parallelipipedus (L.) LUCANIDAE
211-12	Actinocephalus dytiscorum (Frantzius) Watson	Dytiscus sp. DYTISCIDAE
212-13	Actinocephalus stelliformis Schneider	Ocypus olens Mull. larv. & ad. STAPHYLINIDAE Carabus auratus L. CARABIDAE C. violaceus L.
213-4	Actinocephalus digitatus Schneider	Claenius vestitus (Payk.)
214-5	Actinocephalus acutispora Leger	Silpha laevigata F. SILPHIDAE
215	Actinocephalus americanus Crawley	Galerita bicolor Drury CARABIDAE
216	Actinocephalus harpali (Crawley) Crawley	Harpalus caliginosus Fab. CARABIDAE
216-7	Actinocephalus discoeli (Crawley) Ellis	Discoelus ovalis

Actinocephalus crassus (Ellis) Ellis		
217-8	Leptochirus edax Sharp	
Actinocephalus zophus (Ellis) Ellis		TENEBRIONIDAE
218-20	Nyctobates barbata Knoch	
Actinocephalus gimbeli (Ellis) Watson		
220-1	Harpalus pennsylvanicus Dej.	
		CARABIDAE
Asterophora philica (Leidy) Crawley		
221-3	Nyctobates pennsylvanicus deGeer	
		TENEBRIONIDAE
Asterophora cratoparis Crawley	Cratoparis lunatus	
223-4		
Beloides firmus (Leger) Labbe	Dermestes lardarius L. larv.	
224-5		DERMESTIDAE
Beloides tenuis (Leger) Labbe	Dermestes undulatus Brahm. larv.	
225		
Bothriopsis histrio Schneider	Hydaticus cinereus l.	DYTISCIDAE
225-6	Colymbetes fuscus	"
	Acilius sulcatus	"
	Dytiscus sp. l.	"
Bothriopsis terpischorella (Ellis) Watson		
227-9	Hydrophilus sp.	HYDROPHILIDAE
Legeria agilis (Schneider) Labbe	Colymbetes sp. l.	DYTISCIDAE
229		
Phialoides ornata (Leger) Labbe	Hydrophilus sp. l.	HYDROPHILIDAE
230-1	H. piceus (L.) l.	"
Pileocephalus bergi (Frenzel) Labbe		
231	Necrobia ruficollis Fabr.	CLERIDAE
Pyxinia rubecula Hamm.	Dermestes lardarius L. lv.	
232	D. vulpinus Fabr.	DeRMESTIDAE
Pyxinia crystalligera Frenzel	Dermestes vulpinus Fabr. l.	
232-3	D. peruvianus Cateln. l.	"
Pyxinia frenzeli Laveran & Mesnil	Attagenus pellio	DERMESTIDAE
233-4		
Pyxinia mobuszi Leger & Duboscq	Anthrenus verbasci Oliv. l.	
234-5		DERMESTIDAE
Stictospora provincialis Leger	Melolontha sp. l.	
235	Rhizotrogus sp. l.	

Steinina ovalis (Stein) Leger & Duboscq
236-7 Tenebrio molitor L. l.TENEBRIONIDAE

Steinina obconica Ishii Tribolium ferrugineum F. "
237-8
Steinina rotunda Watson Amara angustata Say ?
238-40
Stylocystis ensiferis (Ellis) Ellis
241 Leptochirus edax Sharp.

STYLOCEPHALIDAE
Cystocephalus algerianus Schneider Pimelia sp.
241-2
Lophocephalus insignis (Schneider) Labbe
242-3 Helops striatus TENEBRIONIDAE

Oocephalus hispanus Schneider Morica sp.
243
Stylocephalus oblongatus (Hammerschmidt) Schneider
244 Opatrum sabulosum)L.)
Asida grisea (F.)

Stylocephalus longicollis Stein Blaps mortisaga
245
Stylocephalus brevirostra (Kolliker) Frantzius
246-7 Hydrophilus sp. l. HYDROPHILIDAE

Stylocephalus gladiator Blanchard
248 Helenophorus collaris L.

Stylocephalus gigantea (Ellis) Watson
248-9 Eleodes sp.
Asida sp.
Asida opaca Say

Sphaerorhynchus ophioides (Schneider) Labbe
249 Acis sp.

ACANTHOSPORIDAE
Acanthospora pileata Leger Omoplus sp. l.
249-50
Acanthospora polymorpha Leger Hydrous caraboides (L.) lv.
250
Ancyrophora gracilis Leger Carabus sp. l. & ad. CARABIDAE
251 Carabus auratus L. l. & ad.
Carabus violaceus L. l. & ad.

Ancyrophora uncinata Leger	Dytiscus sp.	DYTISCIDAE
252	Colymbetes sp.	"
Cometoides capitatus (Leger) Labbe		
253	Hydrous sp. lv.	
Cometoides crinitus (Leger) Labbe		
253-4	Hydrobius sp. lv.	HYDROPHILIDAE
Corycella armata Leger	Gyrinus natator (L.) lv.	
254-5		GYRINIDAE
GREGARINIDAE		
Euspora fallax Schneider	Rhizotrogus aestivus	
256-7		
Gregarina cuneata Stein	Tenebrio molitor L. lv. & ad.	
258-61		TENEBRIONIDAE
Gregarina polymorpha (Hammerschmidt) Stein		
261-3	Tenebrio molitor L. lv. & ad.	
Gregarina amara Frantzius	Poecilus cupreus)L.)	
263-4		
Gregarina tenuis Hammerschmidt	Allecula sp.	
264		
Gregarina elongata Frantzius	Crypticus sp.	
264		
Gregarina scarabeirelicti Leidy	Scarabeus relictus lv.	
264-5		SCARABAEIDAE
Gregarina passalicurnuti Leidy	Passalus cornutus Fab.	LUCANIDAE
265-6		
Gregarina melalonthaebrunneae Leidy		
266	Melalontha brunnea	
Gregarina munieri (Schneider) Labbe		
267-8	Timarcha tenebricosa (F.)	
	Chrysomela violacea (Goeze)	
	C. haemoptera L.	CHRYSOMELLIDAE
Gregarina laucornetensis (Schneider) Labbe		
269	Parnus sp.	PARNIDAE
Gregarina statirae Frenzel	Statira unicolor Blanch.	LAGRIIDAE
269		
Gregarina longirostris (Leger) Labbe		
270	Thanasimus formicarius (L.)	
		CLERIDAE

Gregarina acuta (Leger) Labbe Trox perlatus Scriba SCARABAEIDAE
270
Gregarina steini Berndt Tenebrio molitor L. lv. TENEBRIONIDAE
271
Gregarina parva Crawley Harpalus pennsylvanicus Dej.
272-3 Harpalus caliginosus Fab. CARABIDAE
Gregarina lucani (Crawley) Watson
273-4 Lucanus dama LUCANIDAE

Gregarina cavalieriana Blanchard Dendarus tristis Rossi-coarcti-
274 collis Mes.

Gregarina socialis Leger Eryx ater Fabr. lv.
275
Gregarina guatemalensis Ellis Ninus interstitialis Esch.
275-6 LUCANIDAE

Gregarina grisea Ellis Tenebrio castaneus Koch
276 TENEBRIONIDAE

Gregarina minuta Ishii Tribolium ferrugineum F. "
277
Gregarina barbarara Watson Coccinella sp. COCCINELLIDAE
280-2
Gregarina katherina Watson Coccinella sp. "
277-9
Gregarina tenebrionella Watson Tenebrionidae sp. lv.
284-6
Gregarina gracilis Watson Elateridae sp. lv.
286-8
Gregarina intestinalis Watson Pterostichus stygicus (Say).
288-9 CARABIDAE

Gregarina monarchia Watson Pterostichus stygicus (Say). "
289-91
Gregarina fragilis Watson Coccinella sp. COCCINELLIDAE
282-4
Gregarina globosa Watson Coptotomus interrogatus (Fab.)
291-2 DYTISCIDAE

Hyalospora roscoviana Schneider Petrobius maratimus
255-6
Hirmocystis asidae Leger Asida servillei Sol.
257
Sphaerocystis simplex Leger Cyphon pallidulus Boh. DASCYLLIDAE
256

Gregarina elaterae Crawley 292	Elater sp. lv.	ELATERIDAE
Gregarina curvata Frantzius 293	Cetonia aurata lv.	
Gregarina (?) boletophagi (Crawley) 294	Boletophagus cornutus	TENEBRIONIDAE
Gregarina (?) microcephala Leidy 294-5	Arrhenoplita bicornis Olivier	TENEBRIONIDAE
Gregarina (?) ovalis (Crawley) Watson 295	Cucujidae larv.	
Stylocephalus sp. 297	Xylopinus saperdoides	TENEBRIONIDAE
Asterophora philica Leidy 298	Host not given	
sp. Watson 296	Coptotomus interrogatus Fab.	dytiscidae

Didymophyes gigantea Stein
Figs 61 & 63.

1848 Didymophyes gigantea	Stein	1848:186
1863 Gregarina gigantea	Lankester	1863:95
1889 Didymophyes gigantea	Mingazzini	1889:234-9
1892 Didymophyes gigantea	Léger	1892:106

Didymophyes: Sporonts biassociative, slender, very much attenuated. Average length 1 cm., avg. width 80-100 μ . Ratio -- length prot:total length :: 1:30 to 1:40; width prot: width deut :: 1:0.66 to 1:1. Protomerite dome-shaped with a short wide neck just anterior to septum. Deutomerites two in number, cylindrical, widest at septum and tapering gradually, ending in a blunt, rounded extremity.[1] Septa convex upward. Deutomerites nearly equal in length. Nuclei not visible in vivo and not described. Endocyte dense, deeply staining. Epimerite a cylindro-conical papilla.

Cysts spherical, 600-700 μ in diameter. Spores ovoidal, bi-integumentary, 9 x 6.5 μ .

Taken at Berlin, Naples and Poitiers (France).

Hosts: Larvae of Oryctes nasicornis (L.); ~~and~~ of Phyllognathus sp; and of Oryctes sp.

Habitat: Intestine.

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1. Stein's figure indicates that the first deutomerite in its anterior third is narrower than at the first septum, becoming as wide at the septum between the two deutomerites as it is at the septum between protomerite and the first deutomerite. This width is retained throughout the second deutomerite.

Didymophyes paradoxa Stein
Figs. 62 & 72.

1848	Didymophyes paradoxa	Stein	1848:223
1863	Gregarina paradoxa	Lankester	1863:95
1892	Didymophyes rara	Léger	1892:106
1899	Didymophyes paradoxa	Labbé	1899:8

Didymophyes: Sporonts biassociative, short. Length and width not given. Ratio--length prot:total length :: 1:7 to 1:9; width prot:width deut :: 1:1 to 1.1 : 1. Protomerite dome-shaped, considerably flattened, twice as wide as high, a little wider than deutomerite. First deut. cylindrical, of same length or 1½ times longer than second; second tapering to a blunt point. Septa convex upward. Nuclei visible, spherical and large, one in each deutomerite. Cyst and spores unknown.

Taken in Berlin, Germany and Poitiera, France.

Hosts: Geotrupes sp. and Geotrupes stercorarius (L.).

Habitat: Intestine.

Didymophyes leuckarti Marshall
Figs. 59 and 60.

1893	Didymophyes leuckarti	Marshall	1893:41-2

Didymophyes: Sporonts bi- or tri- associative. Length 280-1120 μ. Width not given. Ratio--length prot:total length :: 1:4 in the association of two; 1:11 in the triple association. Ratio width prot:width deut :: 1:1.3 to 1:5. Protomerite dome-shaped, broadly rounded, twice as wide as high, constriction at septum. Either 2 or 3 deutomerites, attached one behind the other,

each nucleated and separated from others by a straight septum and a conspicuous constriction. Deutomerites barrel-shaped, but little wider than protomerite, last one tapering and ending in a more or less broadly rounded extremity. Endocyte dense in both protomerite and deutomerites. Nuclei spherical, containing many small chromatin bodies.

Cysts spherical, one long spore-duct. Spores not known.

Taken at Leipsic, Germany.

Hosts: Aphodius pradomus (Brahm.) and A. nitidulus F.

Habitat: Intestine.

The cyst-dehiscence as seen by Marshall does not coincide with that reported by Leger. The latter mentions simple rupture; the former dehiscence by one long sporeduct. If the methods described by both authors are to be accepted, various species in the same genus must have different modes of dehiscence.

Didymophyes minuta (Ishii) Watson
Fig. 71.

1914	Gregarina minuta	Ishii	1914:436-7
1915	Didymophyes minuta	Watson	

Didymophyes: SPoronts elongate. Length 188 μ, width 26 μ. Ratio--length prot: total length :: 1:23; width prot: width deut :: 1:1.5. Protomerite flattened somewhat, twice as wide as high, deep constriction at septum. Deutomerites cylindrical, about equal in length, constriction between the two, posterior end broadly rounded. Nuclei spherical, one large karyosome

in each. Endoplasm not dense.

Cyst and spores unknown.

Taken in the Province of Izu, Japan.

Host: Tribolium ferrugineum F.

Habitat: Intestine.

Under the name Gregarina minuta, Ishii described and illustrated two species of gregarines, one proving to be the above member of the family Didymophyidae, the other a true Gregarina. The two forms were shewn to be different by the absence of a protomerite in the satellite in the former and its presence in the latter. There was also a difference in the shape of the protomerite in the two forms and a difference in the size of the two kinds of associations. The smaller were those of a true Gregarina, having a protomerite in the satellite, and the name used by the author, Gregarina minuta, applies to them only; the larger associations were those of the other form, and I have called this species Didymophyes minuta (Ishii). For a more detailed argument concerning these species, see appendix at end of this chapter.

Actinocephalus conicus (Dufour) Stein
Figs. 75, 76, 101, 102
and 103.

1826	sp.	Dufour	1826:43
1828	--- Conica	Dufour	1828:367
1837	Gregarina conica	Dufour	1837:12
1848	Actinocephalus Lucani	Stein	1848:223
1848	Actinocephalus conicus	Frantzius	1848:195
1848	Actinocephalus Lucanus	Frantzius	1848:195
1851	Gregarina Lucani	Diesing	1851:14
1851	Gregarina conica	Diesing	1851:8
1863	Gregarina Lucani	Lankester	1863:95
1863	Gregarina conica	Lankester	1863:95
1892	Stephanophora radiosa	Léger	1892:127
1899	Stephanophora lucani	Labbé	1899:23
1913	Actinocephalus lucani	Ellis	1913c:277
1915	Actinocephalus conicus	Watson	

Actinocephalus: Sporonts solitary, length 300-400 μ. Width not given. Ratio--length prot:total length :: 1:5 (without epimerite); width prot:width deut :: 1:1.3. Protomerite nearly globular, carrying at the apex a persisting epimerite, situated upon a thick prominent neck. Epimerite larger than protomerite, consisting ofn hemispherical plateau around the periphery of which is situated a corona of 12 or more large upwardly-directed digitiform processes. Deep constriction at septum. Deutomerite widest above middle, tapering but ending in a blunt, rounded extremity. Nucleus spherical, with several karyosomes or a band of chromidial bodies. Endocyte yellowish.

Cysts spherical, 250 μ in diam. Spores long, cylindrical, biconical at ends, 13.5 x 4.5 μ.

Taken at Berlin, Germany and Touraine, France.

Host: Dorcus parallelipipedus)L.) (Lucanus p. Fabricus).

Habitat: Intestine.

There was considerable confusion regarding this species more than half a century ago. Dufour (1826:43) said

> "Dans le tube alimentaire de divers Coléoptères, notamment du Lucanus paralleilpipedus, de plusieurs Mélasomes et de la Timarcha tenebricosa, j'ai trouvé abondamment une espèce de Vers intestineaux, dont je joins ici le dessin."

It is interesting to note that he called the gregarine an intestinal worm. Two years later, he added:

> "L'espece que j'ai dit habiter les entrailles de divers Coleopteres, merite, a cause de sa forme, le nom Conica."

By this time, Dufour was evidently including many species of gregarines under the same name, not differentiating them from one another.

In 1837, he described in detail, covering two pages, a new genus he established to include a half dozen species which he had discovered, and called the genus Gregarina. One of the species enumerated is Gregarina conica and its hosts are given as Coleoptera and Gryllus. That at least two species were concerned in this inclusion is indicated by his figures 7 and 7a, Pl. I, my figs. 101 and 102. The figures are similar in one respect, they are both conical at the posterior ends. The protomerites, however, are very unlike. Fig 101 compares favorably, despite its fanciful epimerite, with Stein's figure 33 Pl. IX, 1848, my fig. 75, from the intestine of the same beetle. These two species are quite probably the same and the name of the species should thus be Actinocephalus conicus (Dufour) Stein, Dufour having first

named the species and Stein having given the correct genus name.

Frantzius (1848) recorded both Actinocephalus conicus Dufour and A. Lucanus Stein and he mentioned as host of the former Gryllus, and of the latter Lucanus.

Diesing recorded Gregarina conica Dufour from "col-eopterorum et Gryllorum ventriculus (Dufour)" and G. Lucani Stein from "Lucanus paralleilpipedus".

Lankester listed both species. Léger (1892) described the species as a new one under the name Stephanophora radiosa. His description of the new genus Stephanophora does not differ from Stein's genus Actinocephalus. Léger's words are as follows:

> "Appareil de fixation - - - constitué par un plateau épais
> borde d'une couronne de tentacules globuleux.
> Gregarines toujours solitaires, fixées pendant la plus
> grande partie de leur existence; ---.
> Kystes spheriques dehiscents par simple rupture ---.
> Spores cylindro-biconiques."

Stein's diagnosis of the genus is as follows:

> "Die andere Form des Haftapparates ensteht dadurch, dass
> sich der Kopf nach vorn in einen Kurzen stiel verengert,
> der sich in eine flache, runde, am Rande gekerbte, auf dem
> Stiel senkrecht stehende Schiebe erweitert. (My fig. 75).
> Die vordere, zum Anheften dienende Fläche der Schiebe ist
> in der Mitte in einer, dem Durchmesser des Stiels gleich-
> kommenden Ausdehnung glatt, von diesem glatten Centrum
> aus aber bis zur Peripherie sehr regelmässig strahlenförmig
> in Falten gelegt. Jede Einfaltungsfurche fällt mit einer
> Einkerbung des Seheibenrandes zusammen, Ich vereinige die
> mit einem solchen Haftapparat verschenen Formen zu der
> Gattung Actinocephalus."

The two descriptions are, thus, synonymous and but one species is involved, as well as but one genus. The epimerite

1. Dufour's Fig. 7a is placed in the Chapter on Orthopteran parasites, under the heading Indeterminate Species, G. conica Duf.

being stalked, with digitiform processes radiating from a flat central plate. In Stein's drawing, the processes turn backwards, in Leger's they point directly forward, but this is of no import.

Labbe saw the error in considering the two species distinct. He united them under the species name given by Stein, leaving the species in the genus of Leger, calling the form Stephanophora lucani (Stein). Ellis replaced the species in the genus to which it was assigned by Stein. But, according to priority, and from the exhibition of all the evidence in the case, the species name given by Dufour should stand valid and the species be called Actinocephalus conicus (Dufour) Stein.

The removal of the species from the genus Stephanophora takes from the genus the type and only species and the genus thus drops out of usage.

Actinocephalus dytiscorum (Frantzius)
Watson
Fig. 148.

1848	Sporadina Dytiscorum	Frantzius	1848:195
1851	Gregarina Dytiscorum	Diesing	1851:12
1863	Gregarina Dytiscorum	Lankester	1863:94
1890	Anchrophora uncinata	Labbé	1899:28-9
1915	Actinocephalus dytiscorum	Watson	

Actinocephalus: Sporonts robust. Ratio--length prot: total length :: 1:7; width prot:width deut :: 1:1. Protomerite broad and low, twice as wide as high, flattened in front. Very slight constriction at septum. Deutomerite at septum same width as protomerite in front of septum, retaining same width throughout

anterior half. Posterior half much narrower, tapering to a blunt point.

Cysts large, spherical, spores not known.

Taken at ----, Germany.

Host: Dytiscus sp.

Habitat: Intestine.

This species is known from the drawings of Frantzius, one being of an adult sporont (?) and the other of a cyst.

Diesing gives as host Dytiscus marginalis, larva.

Labbé regards the species as synonymous with Ancyrophora uncinata Léger, from a similarity of the host, Dytiscus.

The sporont, however, has no resemblance to that of Léger's species, and, although the epimerite of the species in question is not known, it seems to have an individuality.

Actinocephalus stelliformis Schneider
Figs. 67, 69 and 73.

1875	Actinocephalus stelliformis	Schneider 1875:588-9
1893	Actinocephalus stelliformis	Pfeiffer 1893:5-11

Actinocephalus: Dimensions not given. Ratio length prot:total length 1:4.5 to 1:8; width prot:width deut :: 1:1.4. Protomerite cylindrical, surmounted by a broadly rounded anterior extremity; same width throughout posterior half, width equal to length. Constriction at septum. Epimerite persisting, a small globular structure surmounted by a corona of recurved processes,

each slender at the base, dilated and bifid at the distal extremity. Deutomerite widest above the middle, tapering to a long, sharply pointed extremity. Endocyte very dense. Nucleus small, spherical.

Cyst and spores unknown.

Taken at Paris, France.

Hosts: Ocypus olens (Mull.) (Staphylinus o.) lv. and ad.; Carabus auratus L.; Carabus violaceus L.; and Rhizotrogus sp. lv.

Habitat: Intestine.

Schneider mentions three varieties of this species, a) the body regularly lanceolate, epimerite persistant, b) body subspherical, c) body extremely elongate.

Pfeiffer found the species in Carabus violaceus L.

Actinocephalus digitatus Schneider
Fig. 66.

1875 Actinocephalus digitatus Schneider 1875:590

Actinocephalus: Sporonts solitary, short, obese. Measurements not given. Ratio--length prot:total length :: 1:4.5 Ratio--width prot:width deut :: 1:1.4. Protomerite dome-shaped, widest in posterior half, width equal to height. Constriction at septum. Deutomerite rather short, widest a short distance below septum and tapering gradually to a sharp point. Nucleus small, spherical. Epimerite persistant, a globular structure surmounted by a rosette of 8 to 10 recurved digitiform processes

rounded at their extremities.

Cyst and spores unknown.

Taken at Paris, France.

Host: Claenius vestitus (Payk.).

Habitat: Intestine.

Schneider says:

"L'Actinocephalus Lucani de Stein, provenant de la larva d'un Lucanus paralleli pipedus, est une espèce fort voisine de celle-ci."

Actinocephalus acutispora Léger
Figs. 212 and 213.

1892 Actinocephalus acutispora Léger 1892:142
1899 Actinocephalus acutispora Labbé 1899:26

Actinocephalus: Sporonts solitary, length 1000-1500 μ. Width not given. Ratio--length prot:total length :: 1:11; ratio width prot:width deut :: 1:1.4. Protomerite 1½ times as long as wide, cylindrical, rounded at the top and slightly dilated in posterior fourth. Constriction at septum. Deutomerite very long and slender, slightly wider than protomerite at shoulder and tapering to a long acutely pointed posterior extremity. Epimerite a spherical button situated upon a short collar and consisting of 12 slender incurved processes terminating in obtuse points. Endocyte brownish-yellow. Nucleus spherical, containing 3 to 7 karyosomes. Cysts ovoidal, 550-600 μ x 280 μ. Dehiscence by simple rupture. Spores obese, acutely pointed, two sizes, 4.5 x. 2.8 μ and 6.4 x 3.6 μ.

Taken at Poitiers, Fmance.

Host: Silpha laevigata F.

Habitat: Intestine.

Actinocephalus americanus Crawley
Fig. 64.

1903 Actinocephalus americanus Crawley 1903b:636

Actinocephalus: The generic determination of this species is not absolute. Crawley's description is quoted below:

"This species is created for a single individual found in Galerita bicolor Drury. - - - It is placed in the genus Actinocephalus on account of the form of both protomerite and deutomerite, the presence of several karyosomes in the nucleus and the fact that the host was a carnivorous Arthropod.
The gregarine was 200μ long, 35μ of which represented the length of the protomerite. 45μ broad. The epicyte - - - showed a little papilla at the anterior tip of the protomerite. - - -The endocyte was much denser in the deutomerite than in the protomerite. - - -."

It is probable that Crawley's determination is correct but the recovery of cysts and spores as well as the epimerite is needed to substantiate the determination.

Actinocephalus harpali (Crawley)
Crawley
Fig. 70.

1903 Gregarina harpali Crawley 1903a:49
1903 Actinocephalus harpali Crawley 1903b:637-8

Actinocephalus: Sporonts solitary, obese. Length 225-1200 μ. Width not given. Ratio--length prot:total length ::1:6.5; width prot: width deut :: 1:1.2. Protomerite broadly dome-

shaped, twice as wide as high, flattened at the free end, deeply constricted at the septum. Deutomerite widest a short distance below septum where it is but little wider than the protomerite. Tapering from anterior fourth to a blunt posterior end. Endocyte very dense, blackish, of equal density in protomerite and d eutomerite. Nucleus large, spherical, containing several karyosomes. Cysts spherical, 640μ in diameter, dehiscing by simple rupture. Spores 9 x 7.5μ, diamond-shaped.

Taken at Wyncote, Pa.

Host: Harpalus cal iginosus Fab.

Habitat: Intestine.

"These gregarines were present in the intestine of the one beetle examined in hundreds."

Crawley, p. 50.

Actinocephalus discoeli (Crawley) Ellis
Fig. 100.

1903	Gregarina discoeli	Crawley	1903a:47
1913	Actinocephalus discoeli	Ellis	1913c:279

Actinocephalus: Sporonts solitary, greatly elongate. Length 1200μ. Ratio--length prot:total length :: 1:15; width prot:width deut :: 1:1.2. Protomerite pentagonal, seen in lateral optical section, widest through middle, flattened on top, width about equal to height. Slight constriction at septum. Deutomerite very elongate, cylindrical, slightly tapering to a blunt point. Epimerite not known. Endocyte dense, opaque in deutomerite, nearly trapsnarent in protomerite. Nucleus spherical,

with several karyosomes.

Cyst and spores not known.

Host: Discoelus ovalis.

Habitat: Intestine.

Crawley placed this species in the genus Gregarina, with a question. In his 1903b paper he left it in the same genus but in a list of eight doubtful species.

Ellis says

> "This gregarine is placed in the genus Actinocephalus because of the general shape of the sporont and the coleopteran host; it was removed from the genus Gregarina because the sporonts do not form associations."

Its generic position is still doubtful and from the data at hand might belong to any of these families: Actinocephalidae, Stylocephalidae or Acanthosporidae.

Actinocephalus crassus (Ellis) Ellis
Fig. 68.

1912 Stephanophora crassa	Ellis	1912c:688-9
1913 Actinocephalus crassus	Ellis	1913c:278

Actinocephalus: Sporonts solitary, obese. Length 50-60 μ width not given. Ratio--length prot;total length :: 1:3.3, to 1:3.5. Width prot:width deut:: 1:1 to 1:5. Protomerite dome-shaped, a little wider than high, constricted at septum. Deutomerite widest in anterior third, where it is a little wider than the protomerite, narrowing abruptly to a rather sharply pointed posterior extremity. Nucleus small, spherical.

Cyst and spores not known.

Taken a t Quirigua, Guatemala.

Host: Leptochirus edax Sharp.

Habitat: Intestine.

The determination of the species above is not absolute. Since generic diagnoses depend on the character of the epimerite and the spores as well as on other factors, the absence of these factors tends to make the determination indeterminate. By elimination of negative factors, however, the family determination is probably correct.

Actinocephalus zophus (Ellis) Ellis
Fig. 74.

1913	Stephanophora zopha	Ellis	1913b:201-2
1913	Actinocephalus zophus	Ellis	1913c:278

Actinocephalus: Sporonts elongate, length 1200-1600 μ. Width not given. Ratio--length prot:total length :: 1:8 to 1:13; width prot:width deut :: 1:1.7.. Protomerite globose, rounded in front. Constriction at septum. Width same as length. Deutomerite slender, elongate. Widest at shoulder, cylindrical, tapering at posterior end to a sharp point. Epimerite persistant, constriction at base and terminating in a corona of 8 or more small regular, rounded, digitiform processes. Endocyte brown, nucleus not seen.

Cyst and spores not known.

Taken at New Orleans, La. and East Falls Church, Va.

Hosts:Nyctobates barbata Knoch (N. barbarata Kn.); Alobates pennsylvanicus deGeer.

Habitat: Intestine.

This species was described by Ellis as belonging to the genus Stephanophora, an error afterwards corrected by him and the species placed in the genus Actinocephalus.

Ellis mentions mentions the fact that the record of a species found by Crawley among Leidy's manuscripts seems to indicate that the latter is the same species as that which he describes as A. zophus. His words are as follows:

> "Figs. 29 and 30 (Crawley 1903a, Pl. III) as taken from Leidy's MMs. are of different gregarines, a fact recognized by Crawley. Fig. 30 represents a gregarine closely related to G. grisea, while Fig. 29 is apparently of a sporont of S. zopha."

A comparison of S. zopha (fig. 74 of this paper) and of Leidy's drawing (fig. 65 of this paper) will indicate that there is a difference in the shape of the sporonts. The protomerite of Leidy's species is wider than the deutomerite; in Ellis', narrower. In the former it is flattened, in the latter elongated. The deutomerite in the former tapers from the septum to a long, sharply pointed posterior extremity. In S. zopha the deutomerite is widest at the shoulder, a little below the septum and is cylindrical for two-thirds of its length, ending in a slightly tapering, bluntly pointed cone. From these facts and because the epimerite of Leidy's species was not seen, I am inclined to think the two

species are not identical and that the one in Leidy's drawing should be relegated to the list of indeterminate species. (See list of such species at end of the chapter.)

Actinocephalus gimbeli (Ellis) Watson
Figs. 126 and 127.

1913	Stenophora gimbeli	Ellis 1913a:464
1915	Actinocephalus gimbeli	Watson

Actinocephalus: Sporonts solitary, obese. Length 520μ. Width not given. Ratio--length prot:total length :: 1:5 to 1:6. Ratio width prot:width deut :: 1:2. Protomerite broadly rounded in front, widest in middle portion, twice as wide as high. Conspicuous constriction at septum. Deutomerite ovoidal, widest through middle, tapering and ending in a bluntly pointed posterior extremity. Endocyte very dense, black in deutomerite, lighter in protomerite, but dense in anterior end. Nucleus not seen. Cyst and spores not known.

Taken at Vincennes, Indiana.

Host: Harpalus pennsylvanicus Dej.

Habitat: Intestine.

Ellis described this species as a Stenophora because of

> "- - the papilla at the anterior end, which results from the expansion of the thin epicyte. Such a process has already been described by the writer (1912:681-6) in another species of this genus, S. coekerellae Ellis, from Guatemala."

The shape of the protomerite is very unlike that of the Stenophoridae, being twice as wide as high, while in this family

it is globular or subglobular. The Stenophoridae are confined to the Diplopoda. Although no positive factors are present to indicate its position, yet from exclusion of factors, this species would fall under the family Actinocephalidae. The general shape is not unlike that of Actinocephalus conicus (Dufour) Stein, figs. 75 and 76. The two most important determinative factors, eqpmerite and spores, are unknown and so the determination cannot be absolute.

Asterophora philica (Leidy) Crawley
Figs.78 & 113.

1889	Gregarina philica	Leidy	1889:9-10
1903	Asterophora philica	Crawley	1903a:53
1913	Anthorhynchus philicus	Ellis	1913c:280
1915	Asterophora philica	Watson	

Asterophora: Sporonts solitary, very elongate. Length 300-2000μ. Maximum width 150μ. Ratio length prot:total length :: 1:10 to 1:15; width prot:width deut :: 1:1.3. Protomerite conical, sharply pointed when deprived of epimerite, longer than wide. Constriction at septum not deep. Deutomerite widest at shoulder, tapering from thence to an attenuated, sharply pointed posterior extremity. Epimerite a circular, flattened cushion with a fluted periphery, situated upon a short neck at the apex of the protomerite. Endocyte and nucleus not described.

Cyst and spores unknown.

Taken at Philadelphia, Pa.

Host Nyctobates pennsylvanica deGeer (.N. pennsylvanicus).

Habitat: Intestine.

The above description is taken from Leidy (1889). He remarks that

"- - the epimerite consists of a horizontal circular disc with a round milled border."

In a review of Leidy's MMs, Crawley found three more drawings from the same beetle. Crawley's words concerning his disposition of the same are as follows:

"Asterophora philica Leidy.
Gregarina philica Leidy (1889, p. 9, 1 fig.
It is impossible to give a description of this species. Figs. 31 and 32 are very plainly of the same gregarine, whereas fig. 33 seems almost certainly to belong to a different species. Further, the form figured by Leidy in 1889 is not so closely like that shown by figs. 31 and 32 as to render it certain that the two are the same.
I therefore include the three different forms under the same name, giving only the figures and reference, until such time as sufficient material is obtained to determine accurately what the actual facts may be.
The gregarines figured were about 300 microns long."

It is quite evident that the form figured by Leidy 1889, my fig. 113, and in his MMs, my fig. 78, are the same species. The proportions agree, the shapes of the protomerite are very similar, and the epimerite shown on fig. 78 coincides with Leidy's description of the epimerite.

Crawley's fig. 32, my fig. 104, may or may not be a cephalont of the same species, but the fig. 33, my fig. 105, is obviously unlike and must be placed among the uncertain species. (See this group at end of chapter.)

Ellis placed the species in the genus Anthorhynchus, but the epimerite, as described by Leidy, coincides with Labbé's description of the genus Asterophora (1899:22):

"Epimérite en forme de bourrelet circulaire à côtes saillantes radiées en portant qu centre un mammelon saillant. Sporadin - - - allongée,"

except that Leidy does not mention the central papilla. The description of the genus Anthorhynchus does not fit the case, Labbe (1899:19):

"Epim. en gros bouton cannelé."

Asteophora cratoparis Crawley
Fig. 77.

1903	Asterophora cratoparis	Crawley	1903a:54
1913	Anthorhychus cratoparis	Ellis	1913c:279
1915	Asterophora cratoparis	Watson	

Asterophora: Length 540μ. Width not given. Ratio--length prot:total length 1:5, width prot:width deut ::1:1.1. Protomerite nearly reniform with conical projection at apex upon which rests the epimerite. Protomerite 1.5 times as wide as high. Deep constriction at septum. Deutomerite widest at shoulder, tapering thence and terminating bluntly. Epimerite consisting of a number of "ribs projecting from a central knob". Endocyte not described. Nucleus spherical, with one karyosome.

Cyst and spores unknown.

Taken at Swarthmore, Pa.

Host: Cratoparis lunatus.

Habitat: Intestine.

Ellis removed the species from the genus in which it was first placed, including it among the members of the genus Anthorhynchus. This genus and Asterophora are differentiated by the character of the epimerite and spores. In our present discussion, the latter factor may be omitted since spores are not known. The epimerite of Anthorhynchus is a large cannaliculated button; that of Asterophora consists of a circular cushion with a central knob and with a fluted, crenulate periphery. Crawley's species, therefore, coincides with the latter description and should be returned to that genus.

Beloides firmus (Léger) Labbé
Figs. 116 and 214.

1892	Xiphorhynchus firmus	Léger	1892:137-9
1899	Beloides firmus	Labbé	1899:26-7.

Beloides: Sporonts solitary, elongate. The adults 80 μ in length. Protomerite conical, dilated in center, constriction at septum. Deutomerite widest at shoulder, tapering to a sharp point. Ratio length prot:total length :: 1:3.8; width prot: width deut :: 1:1.2. Nucleus elongate ellipsoidal, with several karyosomes. Epimerite a stalked globose papilla with 12 large lateral curved spines and a long rigid central style (80 long in adults). Cysts spherical, 180-200 μ in diam., dehiscence by simple rupture, biconical, 14.5 x 6 μ.

Taken at Poitiers, France.

Host: Dermestes lardarius L. lv.

Habitat: Intestine.

Beloides tenuis (Léger) Labbé
Fig. 117.

1892	Xiphorhynchus tenuis	Léger, 1892:139
1899	Beloides tenuis	Labbé 1899:26-7

Beloides: Sporonts solitary, elongate. Epimerite a stalked globular papilla with 12 stiff lateral curved spines surmounted by a long slender sinuous style.

Cysts spherical; spores biconical, pointed.

Taken at Poitiers, France.

Host: Dermestes undulatus Brahm. larv.

Habitat: Intestine.

Labbé changed the genus name of this and the foregoing species because of priority.

Bothriopsis histrio Schneider
Figs. 79 and 81.

1875	Bothriopsis histrio	Schneider	1875:596
1892	Bothriopsis histrio	Léger	1892:136-7
1903	Bothriopsis histrio	Crawley	1903a:54-5

Bothriopsis: Sporonts solitary, max. length 425 μ. Width not given. Ratio--length prot:total length :: 1:1.6; width prot: width deut :: very variable. Length protomerite more than half that of the whole sporont~~s~~. Septum strongly convex upward into protomerite. Deutomerite stout, spindle-shaped, ending in a sharp point. Epimerite a small flattened disc from which project

a half dozen long slender filaments. Nucleus ovoidal, generally placed diagonally, containing several karyosomes. Endocyte yellow in young, brownish black in adults.

Cysts spherical, 400-500 μ. Spores obese, biconical, 7.2 x 5 μ.

Taken at Paris and Touraine, France and Wyncote, Pa.

Hosts: Hydaticus cinereus, larv; Colymbetes fuscus; ~~and~~ Acilius sulcatus; and Dytiscus sp. larv.

Habitat: Intestine.

Schneider stated that this species is highly polymorphic, and he described two varieties, the type form and a variety marginata, which is more active. He found no epimerite, but this was discovered later by Leger, who described it as consisting of six ~~long~~ slender filaments, 80-90 μ long. Leger also discovered the spores.

Crawley's observations on this species vary somewhat from those of Schneider; for instance, he says

> "- - - the protomerite is a large rounded mass, but whereas Schneider's figures represent it to be solid, I find that it contains, at least in some cases, a large cavity. Within this cavity was a fluid in which floated a few granules. - - - the septum dips backward. In a number of cases, however, the septum dipped forward, and such appears to have been the only condition seen by Schneider. - - -".

Crawley found that in the stained specimens, the protomerite is more densely granular than the deutomerite.

Bothriopsis terpischorella (Ellis) Watson
Fig. 80.

1913 Legeria terpischorella Ellis 1913b:276
1915 Bothriopsis terpischorella Watson

Bothriopsis: Sporonts solitary, average length 720 μ. Width 145 μ. Ratio--length prot:total length :: 1:1 to 1.8 :1. Ratio width prot:width deut :: 1.3:1. Protomerite equal to or longer than deutomerite, the anterior fourth hemispherical to subglobose, below which is an elevated flange-like portion, remaining two-thirds cylindrical. No constriction at septum. Septum projecting forward into protomerite like the finger of a globe. Deutomerite ovoidal, tapering, bluntly pointed posteriorly. Endocyte dense, homogeneous, light brown.

Cyst and spores not known.

Taken at Douglas Lake, Mich.

Host: Hydrophilus sp.

Habitat: Intestine.

This species was described by Ellis as a member of the genus Legeria. His description is as follows:

"Epimerite not seen; sporonts extremely active, constantly changing the shape of the anterior three-fifths of the body and proceeding rather rapidly in a serpentine path as ar esult, the protomerite often being bent almost forty-five degrees from the main axis of the body; expanded individual with a protomerite equal to or longer than the deutomerite, the anterior ¼ of the protomerite hemispherical to subglobose, below which is an elevated flange-like portion, remaining 2/3 cylindrical, the posterior portion with a cup-shaped depression some 60° deep into which the anterior conical portion of the deuto-

merite fits; deutomerite excepting the portion included by the protomerite ovoid, rather sharply rounded posteriorly; average sporonts 720 in length; - - -."

A comparison of fig. 82, a copy of Legeria agilis (Schn.) Labbe, with fig. 80, Ellis' species in question, reveals differences in the two. The genus Legeria is characterized by a) deutomerite spindle-shaped (same shape as in Bothriopsis); b) protomerite much less than half the total length; c) protomerite cylindrical, dilated in anterior third, terminating in a simple obtuse-sngled cone; d) septum broadly convex upward into the protomerite in the shape of an hemisphere; e) nucleus spherical, f) agility of movement not confined to protomerite, but equally active in both segments. The species in question does not belong in this genus for the protomerite occupies more than half the total length, it does not terminate in a cone, the septum is not broadly dome-shaped and movement is not equally active throughout the whole sporont.

Bothriopsis is diagnosed by Schneider as having a) an unusually well-developed protomerite consisting of a large polymorphic mass convex or concave at its anterior end and nearly or equally as long as, or longer than, the deutomerite, cylindrical in posterior two-thirds; b) a septum invaginated into the protomerite like the finger of a glove; c) an ellipsoidal nucleus; d) endocyte yellow to dark brown; e) agility of movement chiefly confined to the protomerite.

The species in question coincides with the genus Bothriopsis in these characteristics: 1) polymorphism chiefly confined to anterior three-fifths of body; 2) protomerite equal to or longer than deutomerite; 3) protomerite largest in anterior third, posterior two-thirds cylindrical; 4) septum invaginated into protomerite for the posterior third of its length; 5) endocyte light brown.

I have therefore changed the name of the species to Bothriopsis terpischorella.

Legeria agilis (Schneider) Labbé
Fig. 82.

1875	Duforia agilis	Schneider	1875:595-6
1899	Legeria agilis	Labbé	1899:24

Legeria: Sporonts solitary; measurements not given. Ratio--length prot:total length :: 1:2.5 to 1:3; width prot:width deut :: 1.1 : 1. Protomerite irregularly cylindrical, considerably dilated in anterior third, terminated by an obtuse angled cone as wide as high. No constriction at septum. Septum convex upward into protomerite. Deutomerite irregularly cylindrical, tapering from middle to a sharp point. Nucleus spherical, containing several karyosomes.

Cysts spherical, dehiscing by simple rupture. Spores cylindro-biconical.

Taken at Paris, France.

Host: Colymbetes sp. larv.
Habitat: Intestine.

Phialoides ornata (Léger) Labbé
Figs. 87 and 88.

1892 Phialis ornata Léger 1892:135
1899 Phialoides ornata Labbé 1899:24

Phialoides: Sporonts solitary, rather obese. Average length 1200 μ. Width not given. Ratio--length prot:total length:: 1:3.3; width protomerite:width deut :: 1:1.2. Protomerite subglobular, as wide as high, constriction at septum. Deutomerite broadly ellipsoidal, widest in middle, broadly rounded behind. Epimerite persistant, a long slender cylinder, nearly as long as the whole sporont (exclusive of the epimerite), terminating in a dome-shaped retractile structure surrounded by a thickened collar, above which is a ring of fine triangular chitinous teeth. Nucleus spherical, containing several karyosomes.

Cysts spherical, 300-400 μ in diameter, dehiscing by simple rupture.

Spores biconical, swollen in middle, 10.5 x 6.75 μ.

Taken at Poitiers, France.

Host: Hydrophilus piceus (L.) lv.

Habitat: Intestine.

Labbé included with this species, as a synonym, Kölliker's Gregarina brevirostra (1848:12), probably because of the similarity in hosts. Kölliker's species shows a 'proboscis' as does Léger's, but a much shorter and differently shaped one. The former is a short xiphoid cone, only half the length of the protomerite; the latter a long cylindrical process, three times the length of the protomerite. The latter is retractile, but

Kölliker does not mention that this is true of his species. His drawing does not indicate the circular distal collar armed with teeth. I am inclined to think the species are quite distinct, and have therefore placed Kolliker's species in the genus Stylocephalus. For further description, see under the heading Stylocephala brevirostra (Kölliker).

Pileocephalus bergi (Frenzel) Labbé
Fig. 83.

1892 Gregarina bergi	Frenzel 1892:286-98
1899 Pileocephalus bergi	Labbé 1899:20

Pileocephalus: Sporonts solitary, barrel-shaped. Length of largest 330 μ, width 90 μ. Ratio length prot:total length :: 1:5.2; width prot:width deut :: 1:1.6. Protomerite hemispherical, evenly rounded, 1.7 times wider than high, slight constriction at septum. Deutomerite broadly ellipsoidal, wider in middle, broadly rounded--nearly flattened--posteriorly. Epimerite a large hyaline centrally dilated and sharply pointed cone half the length of the whole cephalont without the epimerite. Nucleus spherical with one large karyosome. Endocyte dense, gray to black.

Cyst and spores unknown.

Taken at Cordoba, Argentina.

Host: Necrobia ruficollis Fabr. (Corymetes ruf.).

Habitat: Intestine.

Pyxinia rubecula Hammerschmidt
Figs. 119 & 159.

1838	Pyxinia rubecula	Hammerschmidt	1838:357
1848	Actinocephalus rubecula	Frantzius	1848:193, 195
1851	Gregarina rubecula	Diesing	1851:12
1863	Gregarina rubecula	Lankester	1863:95
1892	Pyxinia rubecula	Léger	1892:140
1899	Pyxinia rubecula	Labbé	1899:26

Pyxinia: Sporonts solitary, obese. Measurements not given. Ratio--length prot:total length :: 1:3.6; width prot: width deut :: 1:1.2. Protomerite large, regularly conoidal, a little longer than wide (1.2 : 1), constriction at septum. Deutomerite conical, widest at shoulder, tapering to a slender, pointed posterior extremity. Endocyte of deutomerite dense, of protomerite much less dense. Nucleus ellipsoidal.[1] Epimerite situated upon a short neck, urn-shaped, wide-mouthed, crenulate on the periphery, with a short, stout conical style projecting upward through the center.

Cysts spherical, 250-280μ in diameter, spores bluntly biconical, 14 x 7μ .

Taken at ? Germany and Poitiers, France.

Host: Dermestes lardarius L., lv. and D. vulpinus F.

Pyxinia crystalligera Frenzel
Figs. 84, 85 & 86.

1892 Pyxinia crystalligera Frenzel 1892:314-29

Pyxinia: Sporonts solitary, elongate. Max. length 750μ ,

1. Frantzius' illustration shows a spherical nucleus.

width not given. Ratio length prot:total length :: 1:5 to 1:10; width prot:width deut :: 1.1:1. Protomerite spherical in adults. Deutomerite of adults regularly cylindrical, tapering in posterior third to a long, slender, bluntly pointed extremity. Epimerite a short sharp rigid style resting upon a small crenulate corona, the whole superimposed upon the cone-shaped protomerite of the cephalont. Endocyte containing large, strongly refractile variously shaped crystals and granules of pyxinin. Nucleus irregularly ellipsoidal, containing several karyosomes.

Cyst and spores not known.

Taken at Cordoba, Argentina.

Hosts: Dermestes vulpinus Fabr.; Dermestes peruvianus Cateln; adults and larvae of both.

Habitat: Intestine.

Pyxinia frenzeli Laveran & Mesnil

1900 Pyxinia frenzeli Laveran & Mesnil 1900;554-7

Pyxinia: Sporonts solitary, obese. Length 200. Max. length of cephalonts 150 μ. Max. width 40 μ. Cephalonts, only, illustrated. Ratio--length prot:total length :: 1:4; width prot:width deut :: 1:2. Protomerite (ofcephalonts) cylindrical to subglobose, constricted at septum. Deutomerite subglobose, nearly as wide as long. Epimerite in two parts, a slender cylindrical base equal in length to protomerite, and superimposed upon same, and a short, sharp apical style equal in length to the cylinder.

Nucleus spherical, containing a large karyosome.

Cysts not seen; spores ovoidal, 14 x 6 μ.

Taken at Paris, France.

Host: Attagenus pellio (Dermestes).

Habitat: Intestine.

Pyxinia möbuszi Léger & Duboscq
Figs. 97 & 98.

1900 Pyxinia Möbuszi Léger & Duboscq 1900:1566
1902 Pyxinia Möbuszi Léger & Duboscq 1902:409-18

Pyxinia: Sporonts solitary. Length 100-140 μ. Width not given. Ratio length prot:total length :: 1:5 to 1:6; width prot:width deut :: 1:1. Protomerite hemispherical, lower margin straight, projecting beyond deutomerite at septum. Deutomerite regularly cylindrical, ending in a blunt point or in a well rounded extremity. Epimerite persistant, a long slender sinuous style attached to base of the epithelial cell, i.e. to mesothelial wall, of the host, and extending through this cell, longitudinally, to lumen, the cephalont body remaining in lumen, beyond cilia. Epimerite as long or longer than the whole cephalont itself. Endocyte containing paramylin granules and small yellow refractile bodies. Nucleus spherical, with one karyosome and several chromatic granules.

Cysts spherical, 60-70 μ in diam. Spores elongate barrel-shaped, 6.5 x 7 μ long.

Taken at Grenoble (?), France.

Host: Anthrenus verbasci Olivier, larv. (A. verbasci L.)

Habitat: Intestine.

Stictospora provincialis Léger
Figs. 90 & 91.

1893 Stictospora provincialis Léger 1893:129-31
1896 Stictospora provincialis Léger 1896:32
1899 Stictospora provincialis Labbé 1899:21

Stictospora: Length 1000-2000 μ. Width not given.

Ratio--length prot:total length :: 1:6; width prot:width deut :: 1:1.2. Protomerite subglobular, terminating in a broadly conical anterior extremity. Width equal to height. Deep constriction at septum. Deutomerite widest st shoulder, tapering to a slender, sharply pointed distal portion. Nucleus ellipsoidal, with several karyosomes. Epimerite consists of a short-stalked, globular papilla depressed anteriorly, there proceeding from the depression a dozen long, baclwardly directed, sharply pointed processes which fit closely around the papilla dna completely cover it.

Cysts spherical, 800 μ in diam., dehiscence by simple rupture; spores biconical, slightly curved.

Taken at Marseilles, France.

Hosts: larvae of Melolontha sp. and Rhizotrogus sp.

Habitat: Intestine.

But one species is known in this genus and in the subfamily Stictosporidae.

Steinina ovalis (Stein) Léger & Duboscq
Figs. 92, 93 & 94.

1838	Clepsidrina polymorpha	Hammerschmidt	1838:355
1848	Stylorhynchus ovalis	Stein	1848:182-223
1848	Stylorhynchus ovalis	Frantzius	1848:195
1851	Gregarina ovalis	Diesing	1851:9
1863	Gregarina polymorpha	Lankester	1863:95
1875	Clepsidrina polymorpha	Schneider	1875:580-2
1902	Gregarina polymorpha	Berndt	1902:405
1904	Steinina ovalis	Léger & Duboscq	1904:352-5
1910	Steinina ovalis	Pfeiffer	1910:108

Steinina: Sporonts solitary, obese. Length 100μ . Width not given. Ratio--length prot:total length :: 1:2.5; width prot: width deut :: 1:1.4.. Protomerite cylindrical, terminating in a large cone, as broad as high, no constriction at septum. Deutomerite short, ovoidal, nearly as wide as long, terminating in an obtuse-angled cone. Nucleus spherical and containing one large karyosome. Epimerite a short retractile digitiform process which later becomes a flattened button. Cysts spherical or ovoidal, 100μ in diameter, dehiscing by simple rupture. Spores biconical, broad through middle, 9 x 7.5μ .

Taken at ? , France.

Host Tenebrio molitor L. larv.

Habitat: Intestine.

This is a much discussed and confused species. Early writers grouped together all the polycystid gregarines found in the larva of Tenebrio molitor as one species. Hammerschmidt evidently found several species for he named the one species he described Clepsidrina polymorpha. Stein differentiated three

species and separated out this one, even assigning to it a different genus than the other two (C. polymorpha and C. cuneata.)

Schneider described under the name Clepsidrina polymorpha (Hamm.) three species, one of them being the Stylorhynchus ovalis of Stein. His words are as follows:

> "L'espèce Clepsidrina polymorpha a été instituée par Hammerschmidt, et plus tard démembrée par Stein, qui trouva moyen d'établir a ses dépens trois espèces, dont une fut reportée dans le genre Stylorhynchus.
> Ce prétendu S. ovalis est simplement le céphalin de l'une des variétés que nous allons décrire."

Berndt, in a long paper on the gregarines of Tenebrio molitor larva, still considered this species the cephalont of G. polymorpha in 1902.

It remained for Léger & Duboscq (1904) to clear up the discussion. They created a new genus for this species, and called it Steinina.

Steinina obconica Ishii
Fig. 95.

1914 Steinina obconica Ishii 1914:439-41

Steinina: Sporonts solitary, obese. Length 120-140μ. Width 68 - 80μ. Ratio--length prot:total length :: 1:5 to 1:7; width prot:width deut :: 1:1. Protomerite dome-shaped, three times as wide as high, placed with septum at an angle of 45^{o} from the longitudinal axis. Septum constricted slightly at periphery. Deutomerite widest just below septum, and tapering to a slender, bluntly pointed posterior extremity. Epimerite a short conical

hyaline projection $\frac{1}{4}$ as long as the protomerite is high. Endocyte dense. Nucleus spherical.

Cysts spherical to slightly ovoidal, 120 x 108 μ. Spores unknown.

Taken in the Province of Izu, Japan.

Host: Tribolium ferrugineum F.

Habitat: Intestine.

The character of the epimerite is evidence that this species is rightly placed.

Steinina rotunda n. sp.
Fig. 173.

Host Amara Angustata Say.

Location St. Joseph, Illinois, November, 1914.

Region of infection, Intestine.

Degree of infection. A dozen individuals were found in one host.

Character of sporonts. Solitary. The body is stout, short and broad. The epimerite persists even on some of the largest individuals. It is a spherical, sessile or shortly stalked hyaline knob. The protomerite just below it is broadly conical in shape, widening rapidly downward to form a cylinder bulging in the middle portion. A deep constriction is present at the septum. The protomerite is widest $\frac{3}{4}$ of its length from the anterior end, and, without the epimerite, it is as high as wide. The deutomerite is practically spherical except in its anterior end, which, at the septum is more or less flattened, or sometimes concave downward. The deutomerite widensr apidly from the septum and is as wide as

long.

In color, the body is light brown or tan, of equal density in both protomerite and deutomerite; the proteplasm is homogeneous and not very abundant. The anterior half of the protomerite and the epimerite are transparent. The nucleus is visible in vivo in specimens of all ages. In all the specimens attached to the epithelium, no matter how large, the nucleus contains but one large karyosome; in the free individuals, no matter how small, a large number of small deeply staining chromosomes are present. The epicyte is thin and of equal width throughout. Longitudinal striations are visible.

Most of the specimens seen possessed epimerites, whether free or attached. A goodly number of these, however, were free in the lumen. The epimerite disappears by being gradually constricted off. When the specimens are of a slide in a water medium for fifteen minutes, approximately, the epimerite breaks, the supposition being that it is highly porous and the sudden strain caused by media of unequal density outside and inside is reduced by the bursting of this fragile structure. When the trophozoite is attached, only the epimerite is embedded and the free ends of several cells are destroyed by the parasite.

Very slow movement of progression was noted. The power of contraction seems to be centered in the anterior part of the deutomerite, for the parasite is able to contract this portion of the body into a narrow neck.

[illegible]

[illegible] inconspicuous and not very abundant. The [illegible] consists and the [illegible]. The [illegible] is visible in view in specimens of all ages. In all the [illegible] attached to the [illegible], no matter how large, [illegible] not one [illegible] in the [illegible], or matter how small, a large number of small [illegible] are present. The [illegible] is thin and of equal [illegible] throughout. Longitudinal striations are visible.

Most of the specimens show pronounced striations, and [illegible] or attached. A goodly number of these, however, [illegible] in the lumen. The [illegible] disappears on being [illegible] off. When the specimens are [illegible] for fifteen minutes, approximately, the [illegible] the [illegible] being that it is highly porous and the [illegible] by means of [illegible] outside and inside [illegible] by the [illegible] of this [illegible] structure. [illegible] is [illegible], only the [illegible] is [illegible] of several cells are [illegible] by the [illegible].

Very slow movements of [illegible] were noted. The [illegible] of [illegible] seems to be [illegible] in the [illegible], for the [illegible] is [illegible] this [illegible] the [illegible].

This species is very probably a member of the genus Steinina, family Actinocephalidae, although the cysts and spores are not known. The globular hyaline epimerite corresponds to that of one stage of the epimerite of the type species, Steinina ovalis, as described by Léger and Duboscq (1904:352-4). The incipient stylous epimerite and the hat-shaped end-stage were not observed in this species. The adults are non-associative and in shape of the deutomerite, the protomerite, and the conoidal anterior projection of the protomerite, together with the nuclear shape and content, coincide with those of the type-species. Coupling of sporonts takes place probably just previous to cyst-formation and not, as in the genus Gregarina, near the beginning of sporont life.

Some of the important measurements are given below:

Total length sporont	.25	.22	.18 mm.
Length protomerite with epimerite	.13	.105	.07
Length epimerite	.02	.02	.015
Length prot. without epimerite	.11	.085	.055
Length deutomerite	.12	.115	.11
Width protomerite	.13	.09	.07
Width deutomerite	.15	.12	.085
Ratio length prot without epimerite / total length	1:2.3	1:2.5	1:3.3
Ratio width prot / width deut	1:1.1	1:1.3	1:1.2
Diameter nucleus	.04	.032	.04

Stylocystis ensiferis (Ellis) Ellis
Figs. 96 and 99.

1912 Stylocephalus ensiferis Ellis 1912c:686-7
1913 Stylocystis ensiferis Ellis 1913c:274

Stylocystis: Sporonts solitary, short. Average length 40-65μ. Ratio--length prot:total length :: 1:3; width prot: width deut :: 1:1 to 1:1.4. Protomerite cylindrical, conical to subglobose. Approximately as wide as high. Deep constriction at septum in adults. Deutomerite half as wide as long, widest at shoulder, tapering slightly and ending in a flattened or very broadly rounded posterior extremity. Epimerite a stout style, equal to protomerite in length.. Endocyte dark gray, opaque. Nucleus not seen.

Cost and spores not known.

Taken at Quirigua, Guatemala.

Host: Leptochirus edax Sharp.

Habitat: Intestine.

Ellis first described this species as a member of the family Stylocephalidae, later removing it to the family Actinocephalidae (1913c:274).

Cystocephalus algerianus Schneider
Figs. 115 and 160.

1886 Cystocephalus algerianus Schneider 1886:100
1899 Cystocephalus algerianus Labbé 1899:31

Cystocephalus: Sporonts solitary, ovoidal. Length 3-4 mm. Ratio--length prot:total length :: 1:6; width prot:width deut

:: 1:1.7. Protomerite dome-shaped, widest at base, twice as wide as high, no constriction at septum. Deutomerite ovoidal, widest through middle, length less thanw idth, posterior end conical, sharply pointed. Epimerite placed upon a short collar, globose, with conical apex. Nucleus elongate;-ellipsoidal, containing several karyosomes.

Cysts not known. Spores irregularly and peculiarly shaped, 10 μ x 10.5 μ.

Taken in Algeria.

Host: Pimelia sp.

Habitat: Intestine.

Lophocephalus insignis (Schneider) Labbé
Figs. 110, 114 and 161.

1882	Lophocephalus incignis	Schneider	1882:435
1885	LOphocephalus iasignis	Schneider	1885:14
1899	Lophocephalus insignis	Labbé	1889:31

Lophocephalus: SPoronts solitary, very elongate. Length 1000 μ. Width not given. Ratio--length prot:total length :: 1:15; width prot:width deut :: 1:1.3. Protomerite subglobose, flattened, twice as wide as high, constriction at septum. Deutomerite cylindrical, widest at end of anterior third, flattened at posterior extremity. Nucleus of sporont spherical with one karyosome. Epimerite a large flattened disc, depressed slightly in center, crenulate on periphery, longitudinally striated and carrying at base a circle of very many short upwardly directed digitiform processes. The cephalont which possesses the circular

disc-shaped epimerite is spherical , or nearly so. Its nucleus contains a single coiled chromatin band.

Cysts subspherical or subovoidal, 430 x 330 μ in diam., dehiscing by pseudocyst. Spores extruded in chains, irregularly hat-shaped, 10 μ long.

Taken at Tours, Indre-et-Loire, France.

Host: Helops striatus.

Habitat: Intestine.

Oocephalus hispanus Schneider

1886	Oocephalus hispanus	Schneider	1886:101
1899	Oocephalus hispanus	Labbé	1899:

Epimerite a sphere, carried on a short conical neck.

Host: Morica sp.

Habitat: Intestine.

Ellis (1913c:282) includes this genus with Cystocephalus under the name of the latter. The two geners are, however, distinct, having epimerites different in shape; the former being globular, set on a short conical neck, the latter spade-shaped (in side view), i.e. dilated in middle portion and conical at apical end, set on a short cylindrical slender collar.

Stylocephalus oblongatus (Hammerschmidt)
Watson
Figs. 106 and 120.

1838	Rhizina oblongata	Hammerschmidt	1838:357
1848	Sporadina oblongata	Frantzius	1848:195
1851	Gregarina oblongata	Diesing	1851:14
1875	Stylorhynchus oblongatus	Schneider	1875:569
1882	Stylorhynchus oblongatus	Schneider	1882:434
1915	Stylocephalus oblongatus	Watson	

Stylocephalus: Sporonts solitary, elongate. Max. length 3000μ; width not given. Ratio length prot:total length :: 1:6; to 1:8. Ratio width prot:width deut :: 1:2. Protomerite globular, constriction at septum. Deutomerite cylindrical, tapering slightly from middle, ending in a rather slender blunt posterior extremity. Epimerite a thick cylindrical neck with a terminal dilated portion with papilla on extremity. Whole epimerite equal to 1.5 to twice the length of protomerite alone. Endocyte yellow in cephalont, becoming black in adult sporont. Nucleus ellipsoidal, with several karyosomes.

Cysts irregularly spherical, with slight depressions and protuberances. Spores brown, united in chains, 7μ in long axis.

Taken at Paris and Poitiers, France.

Hosts: Opatrum sabulosum (L.) and Asida grisea (F.).

Habitat: Intestine.

Because of priority, Ellis renamed the genus Stylorhynchus, Stylocephalus. The species thus becomes Stylocephalus oblongatus.

Stylocephalus longicollis (Stein) Watson
Figs. 107 and 121.

1815	Gregarina sp.	Gaede	1815:17
1848	Stylorhynchus longicollis	Stein	1848:222
1848	Stylorhynchus longicollis	Frantzius	1848:195
1851	Gregarina Mortisagae	Diesing	1851:12
1863	Gregarina longicollis	Lankester	1863:95
1875	Stylorhynchus longicollis	Schneider	1875:572
1882	Stylorhynchus longicollis	Schneider	1882:422
1884	Stylorhynchus longicollis	Schneider	1884:1-36
1915	Stylocephalus longicollis	Watson	

Stylocephalus: Sporonts solitary, elongate. Measurements not given. Ratio--length prot:total length :: 1:10; width prot:width deut :: 1:1.1. Protomerite pentagonal in lateral optical view, truncate at apex, slight constriction at septum, width equal to length. Deutomerite elongate, cylindrical, tapering in posterior two-thirds and ending in a rather blunt point. Nucleus ellipsoidal, with several karyosomes. Endocyte dense. Epimerite consisting of a long slender cylindrical neck, terminating in a slightly dilated papillate anterior end, the whole three or four times the length of the protomerite alone. Cysts irregularly spherical, surface covered with small indentations and papillae. Spores like those of S. oblongatus.

Taken at Paris, France.

Host: Blaps mortisaga.

Habitat: Intestine.

Stylocephalus brevirostra (Kölliker)
Watson
Fig. 118.

1848	Gregarina brevirostra	Kölliker	1848:12
1848	Stylorhynchus brevirostris	Frantzius	1848:195
1851	Gregarina brevirostrata	Diesing	1851:9
1863	Gregarina brevirostris	Lankester	1863:95
1899	Phialoides ornata	Labbé	1899:24
1915	Stylocephalus brevirostris	Watson	

Stylocephalus: Sporonts solitary, stout-bodied. Ratio--length prot:total length :: 1:4; width prot:width deut :: 1:1.2. Protomerite cylindrical, of nearly equal width throughout, width equal to length, no constriction at septum, corners rounded at anterior end. Epimerite a small xiphoid-conoidal tongue projecting upward from center of protomerite, length equal to half that of protomerite. Deutomerite just below septum a little wider than protomerite, tapering to a rather sharp point. Nucleus spherical, with six to nine small karyosomes.

Cyst and spores unknown.

Taken at ? , Germany.

Host: Hydrophilus sp. larva.

Habitat: Intestine.

Kölliker illustrated another figure of this species besides the one copied in Fig. 118, in which the whole body is less angular in outline (1848, Pl. 2, Fig. 15); the epimerite is a sphere, the protomerite nearly so also, and the deutomerite ellipsoidal with a well-rounded posterior extremity. The animal is drawn under abnormal conditions, however, a drop of egg-albumen

having been used as a medium and the animal left in it some time.

Frantzius placed this species where it evidently belongs, in the genus Stylocephalidae. His definition of the genus is as follows:

"Einzeln lebend mit russelartigem Kopfanhang."

Labbé regarded this species as identical with Phialoides ornata, probably because of an identity of hosts rather than a similarity of the parasites. A table of the important characteristics of the two species follows, and speaks for itself.

	St. brevirostris	Ph. ornata
Epimerite length	½ length of prot. ⅛ l. of whole sporont	3 x l. of prot. = to whole sporont without epimerite
width	¼ that of prot.	1/10 that of prot.
shape	Xipho-conical, i.e. elongate-conoidal, dilated in middle	Cylindrical
apex	Pointed	Flattened, a thickened collar, thickly set with 20 more or less small teeth
Protomerite shape	Widest at shoulder, tapering to post. end	Ellipsoidal
where widest?	Anterior 1/5	Center
post. extremity	Tapering and pointed	Broadly rounded
Nucleus, shape	Spher., several karyosomes	Spher., several karyosomes

Ellis (1912) changed the name of the genus from Stylorhynchus to Stylocephalus because of priority, hence the species name changes.

Stylocephalus gladiator (Blanchard) WAtson

1905 Stylorhynchus gladiator   Blanchard 1905:923-8
1915 Stylocephalus gladiator   Watson

Stylocephalus: Sporonts solitary, elongate, avg. length 300-400μ, max. length 720μ; width 30μ, max. width 70μ. Protomerite short, globular. Deutomerite elongate cylindrical, with a slender attenuated posterior extremity, bluntly pointed. Epimerite in two parts, a very long slender cylindrical neck and a dilated xiphoid-shaped apical portion, often longer than the whole gregarine. Nucleus ovoidal with one large karyosome. Cysts not known.

Taken at Grenoble, France.

Host: Helenophorus collaris L.

Habitat: Intestine.

Stylocephalus giganteus Ellis
Figs. 108 & 109.

1912 Stylocephalus giganteus   Ellis 1912a:25-7

Stylocephalus: Sporonts solitary, elongate. Length 1200-1800μ. Width not given. Ratio--length prot:total length :: 1:9 to 1:18; width prot:width deut :: 1:1 to 1:1.5. Protomerite dome-shaped, widest at base, or dome-shaped dilated above base, flattened anteriorly. Constriction at septum. Deutomerite widest at shoulder. Cylindrical, terminating in an abrupt but sharply pointed cone. Epimerite a long pointed cone, situated upon a conoidal projection of the protomerite of the cephalont.

Endocyte dense. Nucleus not described.

Cysts spherical , 450 μ in diam., entire surface papillated and indented, dehiscence by pseudocyst, spores extruded in chains.

Spores irregularly subspherical, black, 7 x 11 μ.

Taken at Boulder, Colo. and at Denver, Colo.

Hosts: Eleodes sp.; Asida sp.; Asida opaca Say; and Eusattus sp.

Habitat: Intestine.

Sphaerochynchus ophioides (Schneider) Labbé

1886 Sphaerocephalus ophioides Schneider 1886:100
1899 Sphaerorhynchus ophioides Labbé 1899:32

Sporonts solitary, elongate. Length 3-4 mm. Epimerite 1/6 the total length of cephalont, consisting of a small spherical or ovoidal body carried on a long cylindrical stalk, broadest at base and gradually narrowing toward apical end. Cephalonts 1.3 mm long, 220 μ of which is length of the epimerite and 8.5 μ for the terminal sphere.

Taken at ?

Host: Acis sp.

Habitat: Intestine.

Acanthospora pileata Léger
Figs. 162 & 215.

1892 Acanthospora pileata Léger 1892:145-6
1899 Acanthospora pileata Labbé 1899:28

Acanthospora: Sporonts solitary, elongate. Length 300-400 μ. Ratio--length prot:total length :: 1:6; width prot:width

deut :: 1:1.5. Protomerite nearly hemispherical, little higher than wide, constricted at septum. Deutomerite elongate-ellipsoidal, widest just anterior to middle. Endocyte brown. Epimerite a broadly conical papilla. Nucleus ellipsoidal, with several karyosomes. Cysts spherical, 150-180 μ. in diam. Spores biconical, ends truncate, with 6 equatorial spines in a circle. Dimensions 7.5 x 10.5 μ.

Taken in the Department of Poitou, France.

Hosts: Cistelides sp.; Omoplus sp. lv (Scudder gives a genus Omophlus, not Omoplus).

Habitat: Intestine.

Acanthospora polymorpha Léger
Fig. 163.

1896 Acanthospora polymorpha Léger 1896:44
1899 Acanthospora polymorpha Labbé 1899:28

Acanthospora: Sporonts solitary, elongate, polymorphic. Protomerite irregularly cylindro-conical. Deutomerite ovoidal, widest through middle. Endocyte yellowish-brown. Cysts 500-700 μ in diam. Spores bipyramidal, each face hexagonal, each pole armed with 6 sharp spines and with a circle of 6 equatorial spines, 8 x 4.4 μ.

Taken at ?

Host: Hydrous caraboides (L.) lv.

Habitat: Intestine.

Ancyrophora gracilis Léger
Figs. 122 & 164.

18--	Gregarina acus	Stein	18--:--
1848	Actinocephalus Acus	Frantzius	1848:195
1863	Gregarina acus	Lankester	1863:95
1892	Ancyrophora gracilis	Léger	1892:146-7

Ancyrophora: Sporonts solitary, elongate. Max. length 2000μ ; max. width 400μ . Protomerite conical, dilated in central region. Constriction at septum. Deutomerite widest at shoulder, tapering to a long acuminate posterior extremity. Nucleus spherical, with several karyosomes. Epimerite a globular papilla with 8 long, backwardly-directed, flexible 'tentacles'.

Cysts spherical, 200μ in diameter. Spores biconical, truncate, with four spines at each pole and six equatorial spines, 8.5 x 5.1μ.

Taken at ? , Germany and Poitiers, France.

Hosts: Carabus sp.; Carabus auratus L.; C. violaceus L., larvae and adults; and Silpha thoracica L. larva.

This species was first described by Stein under the name Gregarina acus, according to Léger, but no mention is made of this species in Stein's 1848 article, however.

Frantzius and Lankester refer the species to Stein; Diesing does not mention it.

If the originally described species is the same as the species described by Léger in 1892 under the name Ancyrophora gracilis, then the name of the latter should be changed to A. aca (Stein) Léger. In the absence, however, of complete data, it stands as given by Léger.

Ancyrophora uncinata Léger
Fig. 216.

1892 Ancyrophora uncinata Léger 1892:147-8

Ancyrophora: Sporonts solitary, length 150-200 μ. Width not given. Epimerite garnished with twelve rigid hooks in two alternating rows.

Cysts spherical. Spores spined, both polar and equatorial, 7.5 x 4.5 μ.

Taken at Poitiers, France.

Hosts: Dytiscus sp.; Colymbetes sp.; Sericostoma sp.; and Limnophilus rhombicus (L.) (Phryganea rhomb.).

Habitat: Intestine.

Labbé placed Gregarina dytiscorum Frantz. with this species under the name of the latter, evidently from a similarity in the first host given above. The species are, however, unlike and I have separated them, calling the former an Uncertain Species, under the Actinocephalidae.

The last three hosts given by Léger are not Coleoptera but Neuroptera and the circumstance of finding the same species of gregarine in such widely separated hosts is unusual, and almost unique yet the record is authentic.

Cometoides capitatus (Léger) Labbé
Figs. 123, 124 & 165.

1892 Pogonites capitatus Léger, 1892:150-1
1899 Cometoides capitatus Labbé 1899:29

Cometoides: Sporonts solitary, elongate. Length 1500 μ. Width not given. Ratio--length prot:total length :: 1:13; width prot:width deut :: 1:1.5. Protomerite subspherical, width equal to ehight. Constriction at septum. Deutomerite widest at shoulder, tapering from thence to a very long slender bluntly-pointed posterior extremity. Epimerite globose, stalked, armed with a sub-equatorial band of 12 - 15 long slender flexible filaments 32-35 long. Nucleus spherical, with several karyosomes.

Cysts spherical, 300 μ in diameter, dehiscence by simple rupture, spores cylindro-biconical, apices truncate, each face octagonal. Poles armed with four spines each, two equatorial rows of spines. 2.5 x 5.1 μ.

Taken at Poitou and Avanton, France.

Host: Hydrous sp. larv.

Habitat: Intestine.

Cometoides crinitus (Léger) Labbé
Fig. 125.

1892 Pogonites crinitus Léger, 1892:149-50
1899 Cometoides crinitus Labbé 1899:29

Cometoides: Sporonts solitary, very elongate. Max. length 2000 μ. Ratio length prot:total length :: 1:20; ratio width prot:width deut :: 1:1.3. Body shaped very similar to C. capitatus,

except that it is longer. Epimerite hemi-spherical, flattened surface upward, armed with an equatorial ring of 7 or 8 long slender flexible filaments 100 long. Endoplasm brown. Nucleus ellipsoidal, with several karyosomes.

Cysts spherical, 200-300 μ in diam. Spores cylindro-biconical, spines at the poles and in two equatorial bands.

Taken at Poitou and Vendee, France.

Host: Hydrobius sp . larv.

Habitat: Intestine.

Corycella armata Léger
Figs. 111, 112, & 166.

1892 Corycella armata Léger 1892:144-5

Corycella: Sporonts solitary, 280-300 μ long. Ratio--length prot:total length :: 1:4; width prot:width d eut :: 1:0.9. Protomerite subglobular, constriction at septum, wider in middle than deutomerite. Deutomerite widest at shoulder, tapering thence to a sharp point. Endoplasm gray-broan. Epimerite a large globular papilla set upon a stout cylindrical collar which is two-thirds as long as the protomerite itself, and armed with 8 strong, short, sharply-pointed, recurved, and backwardly-directed hooks. Nucleus spherical , containing several karyosomes.

Cysts spherical, 250 μ in diam. Spores biconical, truncate, 4 small spines at each pole, no equatorial spines. 13 x 6.5 μ.

Taken at Poitóu, France.

Host: Gyrinus natator (L.) larv.

Habitat: Intestine.

Hyalospora roscoviana Schneider
Fig. 129.

1875 Hyalospora roscoviana Schneider 1875:584

Hyalospora: Sporonts biassociative, cylindrical, very elongate. Length and width not given. Ratio--length prot:total length (primite) :: 1:9; width prot:width deut :: 1:1.6. Protomerite of primite cylindrical, conical, rounded at anterior extremity, twice as high as wide, a constriction at septum. Deutomerite elongate-cylindrical, tapering but slightly at posterior end and terminating in a rounded extremity. Nucleus elongate-ellipsoidal, with one large karyosome. Epimerite not known. Endocyte yellow to yellow-orange.
Cysts spherical (?), dehiscing by simple rupture. Spores broadly ellipsoidal but sharply pointed.
Taken at Roscoff, France.
Host: Petrobius maratimus.

The name Petrobius has been applied to genera of both Orthoptera (Thysanura) (1817) and Coleoptera (1836) and, not knowing which one Schneider found as host, I have included this species among the Coleopteran as well as in the Thysanuran list andthe Orthopteran chapter. He says of its habitat:

"Les Petrobius se recontrent, en effet, sur le mur même qui sépare le laboratorie de la mer, tapis dans les interstices des pierres. La même espèce est commune sur une grande partie du littoral - - -".

Form its habitat, the host might be either an Orthopteran or a Coleopteran.

This is the only species in the genus Hyalospora.

Sphaerocystis simplex Léger
Fig. 137.

1892 Sphaerocystis simplex Léger 1892:115-16

Sphaerocystis: Sporonts solitary, subspherical, length 100-140 μ. Width not given. Dicystid, having protomerite only when young. Shape spherical, with a large papillate extension at each end. Nucleus spherical , with a large karyosome. Cysts spherical, 100 μ in diam., without spore-ducts. Encystment solitary. Spores ovoidal, 10.5 x 7.5 μ.

Taken at Iteuil (Poutou), France.

Host: Cyphon pallidulus Boh. (C. pallidus).

Habitat: Intestine.

Euspora fallax Schneider
Fig. 131.

1875 Euspora fallax Schneider 1875:583

Euspora: Sporonts biassociative, ellipsoidal. Measurements not given. Ratio--length prot:total length (primite) :: 1:6; width prot:width deut :: 1:2.5. Protomerite of primite spherical, deep constriction at septum; deutomerite ellipsoidal,

widest through middle or just posterior to middle, posterior end flattened. N^u^cleus spherical with one karyosome. E^n^docyte dense except in anterior third of protomerite, where there is a distinct conoidal area of less dense endocyte.

Cysts spherical, dehiscing by simple rupture. Spores prismatic, square-cornered, pentagonal in optical view.

Taken at Roscoff, France.

Host: A Melolonthid (Rhizotrogus aestivus ?).

Habitat: Intestine.

Hirmocystis asidae Léger

1896	Eirmocystis asidae	Léger 1896:30
1899	Hirmocystis asidae	Labbé 1899:12

Hirmocystis: Sporonts very small, bi- or tri- associative. Cylindrical. Length 20 μ. Width not given. Ratio--length prot:total length (primite) :: 1:10 to 1:12; width prot: width deut :: 1:2. Protomerite subglobular, depressed. Deutomerite elongate. Epimerite a small , simple papilla.

Cysts spherical , dehiscence by simple rupture. Spores cylindro-ovoidal, 6 x 3.5 μ .

Taken at ? , France.

Host: Asida servillei Sol.

Habitat: Intestine.

Gregarina cuneata Stein
Figs. 132, 133, 134, 135, 136 and 152.

1838	Clepsidrina polymorpha	Hammerschmidt	1838:35-7 ?
1848	Gregarina cuneata	Stein	1848:209-10, 222
1848	Gregarina cuneata	Frantzius	1848:196
1851	Gregarina cuneata	Diesing	1851:13
1863	Gregarina polymorpha	Lankester	1863:95
1875	Clepsidrina polymorpha var. cuneata	Schneider	1875:581
1899	Gregarina polymorpha var. cuneata	Labbé	1899:11
1902	Gregarina cuneata	Berndt	1902:393-404
1903	Gregarina xylopini	Crawley	1903a:47
1904	Gregarina cuneata	Léger & Duboscq	1904:354-5
1910	Clepsidrina cuneata	Pfeiffer	1910:108
1911	Gregarina cuneata	Ishii	1911:279
1914	Gregarina cuneata	Ishii	1914:435

Gregarina: Sporonts biassociative, elongate cylindrical. Length 380μ ; width 170μ. Ratio--length prot:total length (primite) :: 1:3; width prot:width deut (primite) :: 1:1.5. Protomerite elongate cylindrical, 2½ times as wide as posterior portion, dilated at anterior end, widest part acutely angled, apex broadlt rounded. Slight constriction at septum. Deutomerite elongate, width gradually increasing from septum to posterior portion, terminating in a very broadly rounded extremity. Nucleus spherical, small, with one karyosome.

Cysts spherical. 240μ in diam. long sporeducts. Spores extruded in chains, doliform, 5.7 x 4μ.

Taken at Berlin, Germany; Roscoff, Caen, France; Philadelphia, Pa., and in the Province of Izu, Japan.

Host: Tenebrio molitor L. larv. and ad.

Habitat: Intestine.

Hammerschmidt described two gregarines from Tenebrio molitor under one name, Clepsidrina polymorpha. He regarded them as different shapes assumed by the same parasite.

Stein said, concerning his discoveries:

> "Ich fand drei verschiedend Formen, von denen zwei zur Gattung Gregarina in engern Sinne, eine zur Gattung Stylorhynchus gehört. Hammerschmidt kannte wahrscheinlich bereits zwei dieser Formen, doch geht dies selbst aus seinen Abbildungen die gar zu roh sind, nicht mit völliger Bestimmtheit hervor; er hielt sie aber für eine Art und nannte sie Clepsidrina polymorpha."

Stein's figure is reproduced in Fig. 133.

Frantzius enumerated among his species both G. polymorpha and G. cuneata Stein, not recognizing that the former included the latter. He did not illustrate the genus Gregarina cuneata, but included under the name G. polymorpha one excellent figure of G. cuneata (Fig. 135). Stein said that Frantzius knew all three gregarines in this Tenebrio, but

> "wirst sie eben falls zu einer Art unter dem Namen Gregarina polymorpha zusammen blos aus dem Grunde, weil sie in einem und demselben Thiere leben."

He named one of the species Stylorhynchus ovalis. The other two

> "sind einander sehr ähnlich und fast gleich gross. Die eine ist durch den nach vorn erweiterten, flach gedrückten, keilähnlichen Kopf, der fast 1/3 der Lange des Leibes gleichkommt, und durch den nach hintern erweiterten Leib ausgezeichnet; ich nenne sie Gregarina cuneata."

Lankester placed this species and Schneider's St. ovalis together as synonyms under the name Gregarina polymorpha Hamm.

Schneider grouped together under the name Clepsidrina

polymorpha (Hamm.) the three species from Tenebrio molitor, which Stein had separated some twenty-five years before. He designated the species which is under discussion as Clepsidrina polymorpha variety cuneata (Stein). He considered adult associations of G. cuneata as young immature associationf of G. polymorpha.

> "Les jeunes individus sont nombreux et remarquables par le volume relatif de leur protomérite (fig. 16 et 17)."

The figure 16 referred to is a typical association of G. cuneata. He says further

> "- - Ressemble beaucoup à la précédente; est arronde en arrière au deutomerite et plus massive dans son ensemble (fig. 11, le primite)."

His fig 11, my fig. 132, coincides with Stein's figure of his G. cuneata (my fig. 133).

Berndt studied the gregarines of the larva of Tenebrio molitor and isolated G. cuneata from the others.

Léger and Duboscq (1904) confirmed his work. (Their drawing is reproduced in my fig. 152).

In Leidy's unpublished manuscript, Crawley (1903a) found two drawings of gregarines taken from the Tenebrionid, Xylopinus saperdoides. One has been otherwise disposed of, but one drawing is of a species identical with or very similar to G. cuneata. No description or measurements accompanied the drawings. From a similarity of the figures of the type G. cuneata and the figure given by Crawley (my fig. 134), the species is the same.

Ishii (1911:279 and 1914:435) found the species in Japan (my fig. 136) in Tribolium ferrugineum, one of the Tenebrionidae, and very similar to Tenebrio molitor. It is quite possible that the parasite is not identical with or a variety of the classical G. cuneata for the figure does not exactly coincide with the others, but no data whatever accompanies the figures and it seems best to leave the species in the present position.

Gregarina polymorpha (Hammerschmidt)
Stein
Figs. 140, 141, 142, and 153.

1838 Clepsidrina polymorpha	Hammerschmidt	1838:357 ?
1848 Gregarina polymorpha	Stein	1848:210, 222
1848 Gregarina polymorpha	Frantzius	1848:193, 195
1851 Gregarina polymorpha	Diesing	1851:13
1875 Clepsidrina polymorpha	Schneider	1875:580
1899 Gregarina polymorpha	Labbé	1899:10
1902 Gregarina polymorpha	Berndt	1802:404-8
1904 Gregarinapolymorpha	Léger & Duboscq	1904:354-7
1910 Clepsidrina polymorpha	Pfeiffer	1910:108
1911 Gregarina polymorpha	Ishii	1911:279

Gregarina: Sporonts biassociative, elongate, cylindrical, maximum length 350 μ, max. width 100 μ. Ratio--length prot: total length :: 1:5 to 1:7; width prot:width deut :: 1:1.2 to 1:2. Protomerite dome-shaped, as wide as high, no constriction at septum. Deutomerite elongate-cylindrical, rounded at posterior extremity. Nucleus small, spherical, one karyosome. Cyst and spores unknown.

Taken at Berlin, Germany, Roscoff, and Grenoble, France.

Host: Tenebrio molitor L. larva dnd adult.

Habitat: Intestine.

Hammerschmidt knew two of the forms of gregarines parasitic in the larva of Tenebrio molitor. He called them, however, by one name. In the words of Stein,

> "Hammerschmidt kannte wahrscheinlich bereits zwei dieser Formen, - - ; er hielt sie aber für eine Art und nannte sie Clepsidrina polymorpha."

Stein differentiated the two species, calling one G. cuneata , my fig. 133, the other G. polymorpha, my fig. 142. Since the latter species agrees best with the figures of Hammerschmidt

> "da auf sie die meisten, Figuren Hammerschmidt's am besten paasen."

Frantzius gave, side by side, figures of Stein's G. cuneata and G. polymorpha, and called them both G. polymorpha. (Pl. VII, group V, figs. 1 & 2; my figs. 135 and 140).

Lankester mentioned G. polymorpha Hamm., and under this name gave as synonyms Stylorhynchus ovalis Stein and G. cuneata Stein.

Schneider brought together, again, in coincidence with Hammerschmidt's original determination, the three species which Stein had differentiated, and added another variety. He described 1) Clepsidrina polymorpha var. cuneata, 2) C. polymorpha typica, 3) C. mimosa, 4) and disposes of Stylorhynchus ovalis Stein as

> "simplement le céphalin de l'une des variétes que nous allons décrire."

Of these forms, the fir st has since been designated Gregarina cuneata Stein; the second remains Gregarina polymorpha; the third

has been dropped as an authentic species for it is obviously immature and probably, from the shape, a young individual of G. cuneata; the fourth is now Steinina ovalis (Stein) Leger & Duboscq.

Berndt separated the species G. polymorpha from G. cuneata, describing each in detail. Leger & Duboscq corroborated his work and created the genus Steinina for the species previously known as Stylorhynchus ovalis Stein.

Ishii found the species in Japan, from one of the Tenebrionidae. No description of adults is given.

Gregarina amarae Frantzius

1838	Clepsidrina ovata	Hammerschmidt	1838:356
1848	Gregarina Amarae	Frantzius	1848:195
1851	Gregarina Amarae	Diesing	1851:12
1863	Gregarina Amarae	Lankester	1863:95
1899	Gregarina amarae	Labbé	1899:36

This parasite has not been found since the original discovery by Hammerschmidt. Frantzius mentioned it by name only; Diesing gave this description:

> "Gregarina Amarae Frantzius.
> Proboscis--- Receptaculum ovatum breve. Corpus subglobosum. Longit. 9/40''', crassit ---
> Clepsidrina ovata Hamm. (Individua bina postice juncta." - - -. Habitaculum Amara cuprea, in intestinus tenuibus (Hamm.)"

Labbé says that the host is probably the beetle known now as Poecilus cupreus(L.).

That this species is a member of the genus Gregarina is attested by Diesing's words

"(Individua bina postice juncta)"

which indicates the biassociative nature of the sporonts. No drawing accompanies any available mention of the species.

Gregarina tenuis Hammerschmidt

1848	Gregarina tenuis	Frantzius 1848:195
1851	Gregarina tenuis	Diesing 1851:13
1863	Gregarina tenuis	Lankester 1863:94

Host Allecula sp.

No mention is made of this species among those in Labbe's SPorozoa or in the list of SPorozoa in Lankester's Treatise on Zoology (Pt. 1, Protozoa). The species is probably a true Gregarina, for Frantzius included in this genus only gregarines

"-- stets zu zweien aneinandergeheftet."

Gregarina elongata Frantzius
Fig. 154

1848	Gregarina elongata	Frantzius 1848:193, 195
1851	Gregarina elongata	Diesing 1851:13
1863	Gregarina elongata	Lankester 1863:94

Host Crypticus sp.

This species is well illustrated by Frantzius but does not appear in Labbe's classification of the Sporozoa.

Gregarina scarabeirelicti Leigy

1851	Gregarina scarabei relicti	Leidy 1851:208, 287
1863	Gregarina Scarabei	Lankester 1863:94

This species is known only from the original descript-

ion, which is as follows:

> "Body cylindro-fusiform. Superior division presenting four sides of a hexahedron, subacute. Nuclear body of inferior division transparent, globular or elliptical, containing several coarse granules. Length from 1/66 to 1¼ lines; head 1/400 in to 1/133 in. long, by 1/285 in to 1/111 broad. Anterior portion of inferior division 1/200 in to 1/86 in. broad, posterior division 1/666 in to 1/250 in broad. Longitudinal lines of inferior division more distinct than those of upper division, 1/8000 in apart."

No drawing accompanies the description.

Host: Scarabeus relictus larv.

Gregarina passalicornuti Leidy
Fig. 139.

1853	Gregarina passali cornuti	Leidy	1863:238
1903	Gregarina passalicornuti	Crawley	1903a:45
1913	Gregarina passalicornuti	Ellis	1913b:201

Gregarina: Sporonts biassociative, cylindrical. Length of associations 350-400 μ. Width not given. Ratio--length prot: total length (primite) :: 1:5; width prot:width deut :: 1:1. Protomerite dome-shaped, flattened, times as wide as high. Slight constriction at septum. Deutomerite cylindrical, sometimes constricted a little in middle. Posterior extremity broadly rounded or flattened. Endocyte opaque; nucleus spherical, content not mentioned.

Taken at Philadelphia, Pa. and New Orleans, La.

Host: Passalus cornutus Fab.

Habitat: Intestine.

Leidy's figure represents sporonts with the deuto-

merite much wider than long. Crawley's figure is normal. Leidy probably left the animals on the slide in a water medium until they had become greatly distended before drawing them.

Ellis recovered the same species from the same Lucanid, from Louisiana.

The beetles of this species at Urbana, Illinois seem not to be infected. Twenty-five or more have been examined without finding an instance of parasitism.

Gregarina melalonthaebrunneae Leidy

1856	Gregarina Melalonthae brunneae	Leidy	1856:47
1863	Gregarina Melalonthae	Lankester	1863:94
1913	Gregarina melalonthaebrunneae	Ellis	1913c:269

Gregarina: Sporonts biassociative, ellipsoidal. Length of primite 400 μ, width 250 μ. Ratio--length prot:total length :: 1:4; width prot:width deut :: 1:1.7. Protomerite oblate-spheroidal, slightly elevated at summit. Deutomerite oblong-ovoidal. Taken at Philadelphia, Pa.

Host: Melalontha brunnea.

Habitat: Intestine.

This species has not been redescribed. No drawings accompany Leidy's brief record. Lankester left out part of the name which Leidy used, probably because of its cumbersomeness. Ellis merely mentions the species.

Gregarina munieri (Schneider) Labbé
Figs. 128 and 147.

1875 Clepsidrina Munieri	Schneider	1875:574-8
1899 Gregarina munieri	Labbé	1899:9-10.

Gregarina: Sporonts biassociative, elongate-ellipsoidal. Length and width not given. Ratio--length prot:total length :: 1:6 to 1:7 (in primite); width prot:width deut :: 1:1.7. Protomerite cylindrical, flattened anteriorly, a little wider than high, less than 1.5 times, slight constriction at septum. Deutomerite cylindrical, ending bluntly or tapering slightly from middle and ending in a broad but rather pointed extremity. Epimerite a small spherical papilla sutiated upon the apex of a short conical projection of the protomerite of the cephalont. Endocyte reddish-orange. Nucleus spherical, with one karyosome. Cysts ovoidal. Sporeducts 3 to 6, reddish, very short, less than the radius of the cyst in length. Spores extruded in chains. Spores barrel-shape, cylindrical, dilated through middle portion, terminating bluntly.

Taken at Roscoff, France.

Hosts: Tiamrcha tenebricosa (F.);--- Chrysomela violacea (Goeze) and C. haemoptera L.

Habitat: Intestine.

Schneider's argument concerning the species in question speaks for itself and is quoted here:

Schneider's argument concerning the species in question speaks for itself and is quoted here (1875:575):

"Dans le tube alimentaire de divers Coléoptères, notamment du Lucanus parallelipipedus, de plusieurs Mélasomes et de la Timarcha tenebricosa, j'ai trouvé abondamment une espèce de Vers intestinaux, dont je joins ici le dessin. L'espèce que j'ai dit habiter les entrailles de divers Coléoptères, mérite, à cause de sa forme, le nom Conica. Si maintenant on se reporte à la figure indiquée par L. Dufour, on n'y trouve pas la désignation de l'hôte de l'individu représenté, la légende portant simplement cette mention: "Vers intestinaux trouvés dans le tube alimentaire de divers Coléoptères." Il n'y a donc aucun indice que l'auteur ait plus particulièrement visé l'espèce qui nous occupe, et comme il cite d'abord le Lucanus parallelipipedus, c'est à la Grégarine de ce Mélolonthide qu'il conviendra de réserver l'épithète de Conica. Quant à l'espèce actuelle, je l'ai dédiée à mon excellent ami M. Munier Chalmas - - -."

The species which Dufour found in Lucanus paralleilpipedus is the species now named Actinocephalus conicus (Dufour) Stein.

Gregarina laucournetensis (Schneider) Labbé

1885 Clepsidrina Laucournetensis Schneider 1885:28
1899 Gregarina laucournetensis Labbé 1899:11

Gregarina: Sporonts biassociative, obese. Length 60-70 μ; width 50-60 μ. Cysts spherical, one sporeduct. Spores elongate-ovoidal, extruded in chains.

Taken at ?

Host Parnus sp.

Habitat : Intestine.

Gregarina statirae Frenzel
Fig. 138.

1892 Gregarina statirae Frenzel 1892:234-82

Sporonts biassociative, spheroidal. Length 300-350 μ; width 200 μ. Ratio--length prot:total length primite :: 1:5; width prot:width deut :: 1:3.5. Protomerite hemispherical, widest at base, 1.7 times as wide as high. Deutomerite spherical, as wide as high. Nucleus spherical, with one karyosome. Endocyte dense except in anterior third of protomerite, where it is sparse. Epimerite a simple short cylindrical papilla, rounded at apex.

Spores and cysts unknown.

Taken at Cordoba, Argentina.

Host: Statira unicolor Blanch.

Habitat: Intestine.

Gregarina longirostris (Léger) Labbé
Fig. 155.

1892 Clepsidrina longirostris Léger, 1892:122-4
1899 Gregarina longirostris Labbé 1899:12

Gregarina: Sporonts biassociative, obese. 100 μ long. Ratio length prot:total length :: 1:4; width prot:width deut :: 1:1.1. Protomerite conical, dilated in posterior half. No constriction at septum. Protomerite obovoidal. Nucleus spherical with one karyosome. Epimerite an elongate simple cylinder, 50-60 μ long, one-half or more than half as long as whole cephalont. Endoplasm greenish-yellow.

Cysts ovoidal, 60-70 μ in diam. One sporeduct. Spores barrel-shaped, 7.4 μ x 3.8 μ .

Taken in the Vallée de la Loire, France.

Host: Thanasimus formicarius (L.).

Habitat: Intestine.

Gregarina acuta (Léger) Labbé
Fig. 217.

1892 Clepsidrina acuta Léger 1892:121-2
1899 Gregarina acuta Labbé 1899:11

Gregarina: Sporonts biassociative. Protomerite short, cylindrical, rounded in front. Deutomerite cylindrical, rounded behind. Nucleus spherical, with one karyosome. Epimerite a sharp point.

Cyst and spores unknown.

Taken at Poitou, France.

Host: Trox perlatus Scriba.

Habitat: Intestine.

Gregarina steini Berndt
Fig. 146.

1902 Gregarina steini Berndt 1902:408-13

Gregarina: Sponts biassociative, 42-150μ in length; width 16-30μ. Protomerite hemispherical. Constriction at septum. Deutomerite widest at shoulder, tapering to a more or less slender but well-rounded posterior extremity. Epimerite a simple globular papilla.

Cysts ovoidal, 70-100μ x 85-160μ. Cysts smaller than those of G. cuneata or G. polymorpha.

Taken in Berlin, Germany.

Host: Tenebrio molitor L. larv.

Habitat: Intestine.

The work on this species needs confirmation before it can be accepted absolutely. Leger and Duboscq (1904:351-60) described the gregarines of the larva of this beetle but made no mention of this species. No one of the numerous previous workers on the same beetle has mentioned it. Not knowing how polymorphic G. polymorpha may be, the present writer does not wish to comment on this species.

Gregarina parva Crawley
Fig. 130.

1903 Gigaductus parvus Crawley 1903b:633-4
1913 Gigaductus parvus Ellis 1913b:271
1915 Gregarina parva Watson

Gregarina: Sporonts biassociative, length 150µ ; width 90µ . Ratio--length prot:total length primite :: 1:5; width prot: width deut :: 1: 1.1. Protomerite subglobular, somewhat flattened anteriorly. Widest through middle portion. Width 1½ times height. Deep constriction at septum. Deutomerite elongate-ellipsoidal, widest about or a little above the middle, terminating bluntly. Nucleus large, spherical, content not noted. Endocyte coarsely granular, not dense.

Cysts 170-200µ in diam., spherical, dehiscence by "one enormous sporeduct". Spores cylindrical, 25µ x 10µ , square-cornered.

Taken at Wyncote, Pa. and Vincennes, Ind.

Hosts: Harpalus caliginosus Fab. and Harpalus pennsylvanicus Dej.

Habitat: Intestine.

Crawley created a genus Gigaductus for this species.

The genus is described thus:

"Cysts spherical, with a thin gelatinous envelope. Dehiscence by one enormous sporeduct. Maturation period short. Spores cylindrical, very large. Wall single, thick. Spores marked with diagonal lines, those on one side opposed in direction to those on the other, giving the spore a latticed appearance. These lines are apparently due to the sporozoites, which make up a hollow cylinder lying in contact with the inner surface of the spore wall. The residuum an ellipsoidal mass liberally provided with granules, occupies the cavity of this hollow cylinder."

I have placed the species in question under the genus Gregarina. Several hitherto described species of the genus Gregarina have been recorded to dehisce by one sporeduct (e.g. G. laucournetensis; G. longirostris). It is to be noted that sometimes cysts of the genus Gregarina develop only one sporeduct and others in the same fecal mass several. There is apparently no maximum-minimum limit to the number of ducts which may be present within the same species.

Gregarina lucani (Crawley) Watson
Fig. 150.

1903 Euspora lucani   Crawley 1903a:50-1
1915 Gregarina lucani   Watson

Gregarina: Sporonts biassociative, elongate-ellipsoidal. Length of associations 880 μ. Primite 520 μ long, 128 μ wide. Ratio--length prot:total length primite :: 1:10; width prot: width deut :: 1: 1.7. Protomerite flattened, widest through middle, twice as wide as high, deep constriction at septum. Deutomerite elongate-cylindrical, slightly constricted in middle portion, flattened or broadly rounded behind.

Cyst and spores unknown.

Taken at Swarthmore, Pa.

Host: Lucanus dama.

Habitat: Intestine.

Ellis (1913c:264) says:

"This species is referred to the genus Euspora because of the shape of the sporont and the coleopteran host, making

the generic determination very uncertain."

The original description gives no evidence that the species is a member of the genus Euspora. The protomerite is not spherical and does not contain the conoidal, less-dense area in its anterior third, and the spores are not known and cannot be verified with those of the genus Euspora. The fact that the host is a beetle is of no significance since the Eusporae and the Gregarinae are both found in beetles.

I have placed the species in the genus Gregarina because it is associative and does not have characteristics of the other associative genera.

Gregarina cavalieriana Blanchard

1905 Gregarina cavalieriana Blanchard 1905:926-8

Gregarina: Sporonts biassociative, the couple attaining a total length of 1500-2000 μ. Length primite 500-1000 μ, width 80-100 μ. Ratio length prot:total length primite :: 1:15; width prot:width deut :: ? Protomerite flattened, ellipsoidal, longitudinal axis perpendicular to that of deutomerite. Deutomerite cylindrical, rounded hemispherically at posterior end. Endocyte yellow in protomerite, darker in deutomerite. Nucleus spherical, 27 μ in diam., one karyosome.

Cysts spherical, 400 μ in diam., dehiscing by sporeducts, 200 μ long, 40 μ wide at base and 15 μ wide at end. Spores extruded in chains. Spores ellipsoidal, 8 μ x 6 μ.

Taken in the mountains of Maure, France.

Host: Dendarus (Pandarus) tristis Rossi-coarcticollis Mls.

Habitat: Intestine.

Gregarina socialis Léger

1906 Gregarina socialis Léger 1906:106-30
1911 Gregarina socialis Sokolow 1911:79

Sokolow gives the reference to the original paper by Leger as Arch. Prot. 7:106-30, but this reference is incorrect. The writer has perused every possible reference in order to locate the species, but in vain. It does not appear in the Zurich cards, in the files of the Archiv fur Protistenkunde or in those of the Archives de Parasitologie.

Host Eryx ater Fabr. larv.

Ellis refers to this paper (1913d:79) as it is given above, but, it is obvious, did not see the paper in question.

Gregarina guatemalensis Ellis
Fig. 144.

1912 Gregarina guatemalensis Ellis:1912c:687-8

Gregarina: Sporonts biassociative, the couple attaining 400-500 μ in length. Width not given. Ratio--length prot: total length primite :: 1:3 to 1:3.5; width prot:width deut :: 1:2.4 to 1:7.5. Protomerite subglobose, slightly flattened and pointed at apex, faint constriction at septum. Deutomerite irregularly cylindrical, narrowest at septum, widening very

gradually and greatly dilate in posterior fourth, terminating in a very broad flattened extremity, the base nearly twice as wide as the deutomerite at the septum. The whole sporont is shaped like a salt-cellar. Sarcocyte very thick, especially in posterior portion of deutomerite. Endocyte of protomerite denser than that of deutomerite. Nucleus spherical, small.

Taken at Quirigua, Guatemala.

Host: Ninus interstitialis Esch.

Habitat: Intestine.

In Ellis' 1913c paper, the host genus is given as Nelus instead of Ninus as in the original description.

Gregarina grisea Ellis
Fig. 151.

1913 Gregarina grisea Ellis:1913b:200-1

Gregarina: Sporonts biassociative, cylindrical. Length of association 500-1050 μ. Length of primite 200-500 μ. Ratio--length prot:total length primite :: 1:4.5 to 1:6.5. Ratio width prot: width deut :: 1:1 to 1:5. Protomerite hemispherical, widest at posterior margin, no constriction at septum. Deutomerite cylindrical, tapering slightly to a broadly rounded posterior extremity. Endocyte dense, dark gray. Nucleus spherical.

Cyst and spores not known.

Taken at New Orleans, La.

Host: Tenebrio castaneus Koch.

Habitat: Intestine.

Gregarina minuta Ishii
Fig. 143.

1914 Gregarina minuta Ishii 1914:436-7

Gregarina: Sporonts biassociative, length of associations 118μ; length primite 58μ. Ratio--length prot:total length :: 1:9; width prot:width deut :: 1:1.7. Protomerite somewhat flattened, rounded anteriorly, twice as wide as high. No constriction at septum. Deutomerite cylindrical, broadly rounded at posterior end. Endocyte not dense. Nucleus large, spherical, with one karyosome.

Cysts spherical, 36μ x 48μ.

Taken in the Province of Izu, Japan.

Host: Tribolium ferrugineum F.

Habitat: Intestine.

Under the name Gregarina minuta, the author described two gregarines belonging to widely different families, one, the larger, being a Didymophyes (D. minuta), from the absence of a protomerite in the satellite, and the other the gregarine described above. For a detailed statement of these facts, see article in appendix of this chapter.

Gregarina katherina n. sp.
Fig. 171.

Host Coccinella novumnotata Herbst.

Location, Oyster Bay, Long Island, N.Y., August, 1914.

Percent of Infection. Fourteen lady-beetles of various species

were examined and only two found to be parasitised, one with this species, the other with G. barbarara. The infection with this gregarine was very heavy, the whole alimentary tract being filled with parasites which numbered into hundreds. The gregarines were practically transparent and it was impossible to count them.

The sporonts are biassociative when adult. The shape is that of a typical gregarine of this genus. The protomerite of the primite is widest at the base, rounded on its free endes and more or less flattened at the apex. It is 1¼ to 1½ times as wide as high, and constricted slightly at the septum. The protomerite of the satellite is flattened top and bottom and three to four times as wide as high. Its upper and lower surfaces are about equal in width. The deutomerite is cylindrical to ellipsoidal from 1½ to two times as wide as is the protomerite; it terminates in a broadly rounded posterior extremity.

Color is practically absent from the animals for the body is almost transparent and contains very little protoplasm in either protomerite or deutomerite. The sporonts were stained with iodine or an anilin dye (safranin in water) before they could be studied.

The nucleus is small and spherical, in diameter attaining only 1/3 to ¼ the width of the deutomerite. It contains one large karyosome.

Young individuals were seen attached to epithelial cells of the intestine by large smooth sessile transparent epi-

merites. No cysts were seen.

Movement consists of very slow progression and a still slower contortion of the body.

The character of the epimerite and the biassociative sporonts leave no doubt that this species belongs to the genus Gregarina. It is differentiated from the other species found in the Coccinellidae by the shape and proportion of the sporonts, especially of the protomerite of the satellite, and by size.

A table of dimensions of a few associations is given here:

Total length association	.096	.108	.134	.141	.148
Primite: in mm.					
Length protomerite	.009	.011	.01	.01	.011
Length deutomerite	.035	.059	.052	.059	.059
Width protomerite	.011	.017	.019	.02	.014
Width deutomerite	.021	.03	.03	.034	.0[illegible]
Total length sporont	.044	.07	.062	.069	.07
Ratio length prot / total length	1:5	1:16.3	1:6.2	1:6.9	1:6.8
Ratio width prot / width deut	1:1.9	1:1.8	1:1.6	1:1.7	1:2
Satellite:					
Length protomerite	.008	.007	.008	.008	.006
Length deutomerite	.044	.071	.064	.064	.072
Width protomerite	.014	.026	.02	.02	.021
Width deutomerite	.022	.035	.027	.03	.023
Total length sporont	.052	.078	.072	.072	.078
Ratio length prot / total length	1:6.5	1:11	1:9	1:9	1:13
Ratio width prot / width deut	1:1.6	1:1.4	1:1.3	1:1.5	1:1.1
Diameter nucleus			.009		.008

Gregarina barabara n. sp.
Fig. 169.

Host Coccinella sp.

Location Oyster Bay, Long Island, N.Y., August, 1914.

Fourteen lady-beetles were examined and only two were parasitised, one with this species and the other with G. katherina. Sixteen associations of this species were found in the one host. The region of infection is the intestine.

The adult sporonts are biassociative. In shape they are similar to other members of this genus. The primite is not essentially different in shape from that of G. katherina. The protomerites of the primite in the two species are identical, viz. 1¼ to 1½ times as broad as high, cylindrical at the base and terminating in a broadly rounded, often apically flattened anterior extremity. The deutomerite of the primite of this species is more nearly globular, broadening appreciably backwards from the septum and attaining its greatest width in the middle or at the beginning of the posterior two-thirds of the body. From here the deutomerite rapidly contracts, ending in a very broadly rounded and not flattened posterior end. The shape of the satellite is quitedifferent from t hat of the primite. It has the form of an elongated egg smaller at the posterior end. The satellite is generally longer than but is never as wide as the primite. The protomerite is very different from that of G. katherina. It is approximately five times as wide as high, and

twice as wide as the protomerite of the primite. It is broadly rounded in front and but imperfectly interlocked with the primite. The septum is straight or slightly concave upward, with no constriction whatever at its periphery, the protomerite and deutomerite forming a perfectly smooth contour at the edges of the septum. The deutomerite of the satellite is widest a little behind the septum and anterior to the center of the egg-shaped mass. The body gradually tapers from the region of greatest width, ending in a blunt, well-rounded extremity.

This parasite is practically transparent with a few large scattered darkly colored protoplasmic granules accumulated in the central regions of the deutomerite of the primite; the satellite is generally free from these dark-colored inclusions. The nucleus is rarely obscured by protoplasm; it is small and spherical.

The epicyte is very thin and fragile and the animals quickly break up when exposed to the diluted digestive juices of the host.

Trophozoites were not observed, possibly because of their transparency. No cysts were present.

A list of the essential measurements is appended:

Total length association	.283	.275	.220	.192 mm.
Primite:				
Length protomerite	.017	.022	.025	.02
Length deutomerite	.103	.113	.12	.105
Width protomerite	.028	.04	.04	.04
Width deutomerite	.08	.09	.09	.075
Total length sporont	.12	.135	.145	.125

Ratio length prot / total length	1:7	1:6	1:5.8	1:6.2
Ratio width prot / width deut	1:2.5	1:2.2	1:2.2	1:1.9
Satellite:				
Length protomerite	.017	.01	.018	.015
Length deutomerite	.046	.13	.057	.052
Width protomerite	.065	.055	.06	.04
Width deutomerite	.08	.08	.08	.068
Ratio length prot / total length	1:9.2	1:14	1:4.2	1:4.5
Ratio width prot / width deut	1:1.2	1:1.4	1:1.3	1:1.7
Diameter nucleus	.01			

This species is considerably larger than Gregarina katherina.

Gregarina fragilis n. sp.
Fig. 175.

Host Coccinella sp.

Location, Urbana, Illinois, November, 1914.

The intestine of the host is the seat of infection. Out of thirty or more lady-beetles of many species which were examined, only two yielded parasites. About twenty-five associations were found in the two hosts.

The sporonts are biassociative. The protomerite of the primite is cylindrical, rounded at the corners and nearly flattened anteriorly; it is about 1 2/3 times as wide as high. A shallow constriction or none at all is present at the septum. In the satellite, the protomerite is altered slightly in shape, being both flattened and broadened. The deutomerite is subglobular, widest in the middle portion or slightly posterior

to the middle and terminates in a broadly rounded extremity. The satellite is smaller than the primite and less nearly globular in shape.

This parasite is often practically transparent and can only be seen after staining with iodine or a dye in water. The largest specimens contain endocyte tinged with tan color in the deutomerite, while the protomerite is invariably colorless. The nucleus is spherical and small, 1/3 to ¼ the width of the deutomerite in its diameter; it is visible in vivo and contains one large transparent karyosome.

Trophozoites were seen but the epimerite was not visible because of the transparency when embedded. Cysts are unknown.

Measurements of a few associations are as follows:

Total length association	.185	.208 mm.
Primite:		
Length protomerite	.02	.021
Length deutomerite	.08	.09
Width protomerite	.033	.031
Width deutomerite	.061	.06
Total length sporont	.10	.111
Ratio $\frac{\text{length prot}}{\text{total length}}$	1:5	1:5
Ratio $\frac{\text{width prot}}{\text{width deut}}$	1:2	1:2
Satellite:		
Length protomerite	.02	.02
Length deutomerite	.065	.077
Width protomerite	.033	.031
Width deutomerite	.043	.048
Total length sporont	.085	.097
Ratio $\frac{\text{length prot}}{\text{total length}}$	1:4.2	1:4.8
Ratio $\frac{\text{width prot}}{\text{width deut}}$	1:1.3	1:1.5

Diameter nucleus .01 .011

This species differs from the other two species described from Coccinellidaein size, shape of the protomerite of the satellite and in color.

Gregarina tenebrionella n. sp.
Fig. 174.

Host larva of an unidentified member of the Tenebrionidae.

Location, Urbana, Illinois, October, 1914.

The intestine of the host was heavily infected, with a hundred or more associations.

The sporonts are biassociative and the shape is that characteristic for this genus. The animals are very small and subglobular. The protomerite of the primite is as wide at the base as throughout the posterior third of the body. Its anterior end is well rounded, without a papilla at the apex. In the satellite, the width of the protomerite is about equal to the height, although it is more or less flattened top and bottom. The length of the protomerite of the primite is one-fourth the total length. The deutomerite of the primite is short, broad, globose, widest through the median portion and broadly rounded behind. In the satellite it tapers slightly and is less globular in shape, being 1/3 to 4/5 as wide as the deutomerite of the primite. The primite is larger in every instance recorded than the satellite, often longer by one-third.

The color of this species is pale gray. The proto-

plasm is not dense in any part of the body and the protomerite is almost devoid of protoplasm. The granules of the body are not homogeneous, smaller being interspersed with larger. The satellite is more nearly transparent than the primite. The nucleus is spherical, ½ to 1/3 the width of the deutomerite in its diameter; it is not visible in vivo in the primite but generally so in the satellite. The interlocking device between the sporonts is weakly developed and the indivisuald often barely touching are easily displaced.

Trophozoites and cysts were not seen. Movement consists of a slow uniform progression; contortion was not noted.

A table of measurements follows:

Total length association	.14	.137	.129	.109 mm.
Primite:				
Length protomerite	.017	.018	.015	.016
Length deutomerite	.053	.052	.046	..046
Width protomerite	.023	.020	.025	.02
Width deutomerite	.042	.037	.038	.035
Total length sporont	.07	.07	.061	.062
Ratio <u>length prot</u>				
total length	1:4.1	1:3.9	1:4	1:3.9
Ratio <u>width prot</u>				
width deut	1:1.8	1:1.8	1:1.5	1:1.7
Satellite:				
Length protomerite	.013	.017	.018	.01
Length deutomerite	.057	.05	.05	.037
Width protomerite	.028	.02	.028	.016
Width deutomerite	.032	.03	.05	.018
Total length sporont	.07	.067	.068	.047
Ratio <u>length prot</u>				
total length	1:5.4	1:4	1:3.8	1:4.7
Ratio <u>width prot</u>				
width deut	1:1.2	1:1.5	1:1.8	1:1.1
Diameter nucleus	.01	.008	.009	

Shape and size differentiate this species from all the other species found in the Tenebrionidae. For list of these gregarines, see Index of this chapter on Coleopteran parasites.

Gregarina gracilis n. sp.
Fig. 170.

Host larva of an unidentified member of the family Elateridae.
Location, Urbana, Illinois, October, 1914.

The parasites infest the intestine of the host.

The sporonts are biassociative. The satellite is generally the larger, contrary to the general rule that either the primite is slightly the larger or the two sporonts differ but little in size. The body is elongate-ellipsoidal, rather longer in proportion than is true of most biassociative members of the genus. The protomerite of the primite is hemispherical with no papilla or indentatiln at the anterior end. The constriction at the septum is shallow; the protomerite is 1 1/3 times as broad as high and averages 1/6 the total length of the sporont. The protomerite of the satellite is of practically the same width as that of the primite, but is slightly flattened. The deutomerite is elongate-cylindrical, a little wider in the middle portion and tapering slightly, ending in a broadly rounded extremity. The interlocking device is not well constructed, sporonts of an association being barely contiguous and easily dissociated by slight pressure.

The body is pearl gray, and the protoplasm is not homogeneous but consists of large and small granules sparsely scattered throughout. The anterior end of the protomerite is devoid of granules. The nucleus is not visible in adults not because of the density of the protoplasm but because of the fact that the large granules seem to cling to or lie in the region of the nucleus in a cluster. The region occupied by the nucleus can, therefore, be easily detected although its outline is obscured. The nucleus is small and spherical, containing one small karyosome. In one instance, the chromatin was arranged outside the karyosome as in the spokes of a wheel, the karyosome forming the eccentric hub. The epicyte is very thin and of even width throughout.

Cysts were seen to be spherical and of approximately .08 mm. in diameter.

A table of measurements of sporonts follows:

Total length of association	.368	.355	.31	.237 mm.
Primite:				
Length protomerite	.02	.02	.021	.02
Length deutomerite	.158	.105	.129	.097
Width protomerite	.035	.03	.03	.023
Width deutomerite	.075	.05	.057	.041
Total length sporont	.178	.125	.15	.117
Ratio length prot / total length	1:8.9	1:6.2	1:7.1	1:5.8
Ratio width prot / width deut	1:2.1	1:1.7	1:1.9	1:1.9
Satellite:				
Length protomerite	.021	.02	.02	.02
Length deutomerite	.169	.16	.14	.10
Width protomerite	.041	.035	.035	.032
W Width deutomerite	.08	.075	.065	.045

Total length sporont	.19	.18	.16	.12
Ratio length prot / total length	1:9	1:9	1:8	1:6
Ratio width prot / width deut	1:2	1:2.1	1:1.9	1:1.4

Gregarina intestinalis n. sp.
Fig. 168.

Host: Pterostichus stygicus Say. (Carabidae).

Location, Urbana, Illinois, November, 1914.

A dozen associations were found in the intestine of one beetle. The beetle was also infected with Gregarina monarchia.

The sporonts are biaasociative. The body is ellipsoidal to subglobose. The protomerite of the primite is subspherical, well rounded in front, widest along the center, equal in width to ¼ to 1/6 the width of the deutomerite, and one/fifth the total length. There is a fairly deep constriction at the septum. The deutomerite is egg-shaped, widest aboutthe middle portion or slightly posterior to the middle. The posterior end is broadly rounded in the primite and slightly more tapering in the satellite. The individuals of an association are easily detatched by slight pressure.

In color, this species is dark gray, e specially in the deutomerite; the protomerite is less dense. The nucleus is not visible in the life animal.

Trophozoites and cysts were not seen.

A table of measurements follows:

Total length association	.32	.304		
Primite:				
Length protomerite	.04	.033	.03	.035
Length deutomerite	.12	.137	.13	.135
Width protomerite	.045	.042	.042	.055
Width deutomerite	.08	.08	.07	.082
Total length sporont	.16	.17	.15	.17
Ratio length prot / total length	1:4	1:5	1:5	1:5
Ratio width prot / width deut	1:2	1:2	1:1.6	1:1.5
Satellite:				
Length protomerite	.03	.02		
Length deutomerite	.13	.114		
Width protomerite	.05	.032		
Width deutomerite	.07	.075		
Total length sporont	.16	.134		
Ratio length prot / total length	1:5.3	1:6.7		
Ratio width prot / width deut	1:1.4	1:2.3		

Gregarina monarchia n. sp.
Fig. 167.

Host Pterostichus stygicus Say. (Carabidae).

Location, Urbana, Illinois, November, 1914.

Only one parasite was seen in the intestine of the host. The same beetle was infected with Gregarina fragilis.

The sporonts are biassociative. The body is very long and sausage-shaped, easily visible to the eye. The protomerite of the primite is dome-shaped, widest just below the middle portion, is but little wider than high, and in length equal to 1/7 the total length of the sporont. There is a deep constriction at the septum. The deutomerite is cylindrical, of even width throughout and but little wider than the protomerite. It is

broadly rounded at the free extremity. The protomerite of the satellite is flattened top and bottom, twice as wide as high, and in length averages 1/16 the total length of the satellite. The interlocking device between primite and satellite is deep and well-developed.

The body is black, the protoplasm being very dense in all parts except the protomerite of the primite. This portion is nearly transparent except for its lower portion in which the protoplasm is dense and darkly colored. A deep groove runs crosswise just anterior to the middle portion of the protomerite and in front of it is a clear vesicular area rather indistinct in outline. The epicyte is rather thick and of the same width throughout except in the protomerite of the satellite. It is considerably thicker at the place of interlocking and a little thicker on the sides of this protomerite than elsewhere in the association.

Trophozoites and cysts were not recovered.

Movement of progression was not noted, but a slow contortion was evinced by slightly curving of the body.

Measurements of the one association seen are as follows:

Total length of association 1.07 mm.

	Primite	Satellite
Length protomerite	.08	.032
Length deutomerite	.49	.468
Width protomerite	.11	.115
Width deutomerite	.13	.162
Total length sporont	.57	.50
Ratio length prot / total length	1:7	1:16

Ratio $\frac{\text{width prot}}{\text{width deut}}$	1:1.2	1:1.4

Gregarina globosa n. sp.
Fig. 176.

Host Coptotomus interrogatus (Fab.) (Dytiscidae)

Location: Urbana, Illinois, November, 1914.

The intestine of the host was infected; two beetles out of six containing two parasites each.

The sporonts are biassociative. The body is subspherical, the protomerite of the primite twice as wide as high and hemispherical but rather flattened at the top. There is a constriction at the septum but it is shallow and scarcely noticeable in the satellite. The deutomerite is stout, 3/4 as wide as long; it increases gradually in width up to the beginning of the posterior third of the body, when it becomes rapidly narrower, ending in a very broadly rounded extremity. The protomerite of the satellite is larger than that of the primite, which possibly indicates sexual dimorphism. The primite and satellite are not well interlocked.

The endocyte of the primite is dense and is not visible in vivo. The endocyte of the satellite is paler, revealing the presence of a spherical nucleus. Trophozoite and cysts were not found.

A table of measurements follows:

Total length association .435 mm.

	Primite	Satellite
Length protomerite	.03	.045
Length deutomerite	.23	.165
Width protomerite	.075	.11
Width deutomerite	.18	.155
Total length sporont	.26	.21
Ratio length prot / total length	1:8.6	1:4.7
Ratio width prot / width deut	1:2.4	1:1.4

Uncertain Species in the Genus Gregarina

Gregarina sp. Fig. 158.

1903 Gregarina elaterae Crawley 1903a:46

Sporonts not seen. Crawley's description is based evidently on the cephalonts and a species can hardly be assigned to material containing no mature specimens for the cephalonts of many of the Gregarinidae are identical. Crawley's description is in part as follows:

> "Epimerite spherical, protomerite elliptical, long axis perpendicular to that of deutomerite, sharp constriction at septum. Deutomerite oval to subspherical. Endocyte characteristic of cephalonts, sparse and granular. Max. length 62 μ. Host Elater sp. larva. Taken at Wyncote, Pa."

The species is probably a member of the genus Gregarina from the epimerite, but it cannot stand as absolute. Subsequent discovery of the sporonts probably cannot be correlated with the cephalonts here described owing to a similarity of the cephalonts of so many species.

Gregarina curvata

1838	Rhizina sp.	Hammerschmidt	1838:356
1848	Sporadina curvata	Frantzius	1848:195
1851	Gregarina curvata	Diesing	1851:14
1863	Gregarina curvata	Lankester	1863:94

The following and only description of the species available is quoted from Diesing:

"Proboscis ? Receptaculum rotundatum. Corpus elongatum retrorsum attenuatum curvâtum, repeptaculo sexies longius. Lobgit. $\frac{1}{8}$ - $\frac{3}{4}$'''."

Host:Cetonia aurata larv.

Habitat: Intestine.

Frantzius merely names the species, giving neither drawing nor description. Diesing gives no clue as to whether the species is biassociative or not. Lankester places it in the genus Gregarina, which he characterises by the phrase

"two animals frequently hanging together"

giving no description.

The species has not since been mentioned in the literature, and in lieu of complete data, it is p]aced in the group of doubtful species under the genus Gregarina.

Uncertain Species of Uncertain Families

(?) Gregarina boletophagi Fig. 145.

1903 Gregarina boletophagi Crawley 1903a:47-8

Sporonts not associative, cylindrical, 320 in length.

"Protomerite large, variable in shape. Separated from deutomerite by a sharp constriction. Deutomerite cylindrical, with - - - conical end. - - -Endocyte dense, --nucleus oval to spherical, with one karyosome. Epimerite not seen. Host Boletophagus cornutus. Locality Swarthmore, P^{a}."

Ellis (1913c:280) says

"This species has been transferred to this genus (Anthorhynchus) from Gregarina although neither cysts nor epimerite are known, because it is not found in association and because the anterior portion of the protomerite is suggestive of the slightly produced protomerite of other species of the genus Anthorhynchus which bear epimerites. It is to be regarded as a provisional determination only."

No characteristics of the genus Anthorhynchus are evident. The epimerite, not being seen, cannot be compared with the very large globular canaliculated epimerite of the latter genus and the spores cannot be compared, not being seen. Size of the species in question if only one-seventh that of the type species of the genus Anthorhynchus (A. sophiae Schn.).

It seems that the only solution of the problem is the relegation of the species to an Uncertain Group.

(?) Gregarina microcephala Leidy Fig. 149.

1889 Gregarina microcephala Leidy 1889:10-1

"Body clavate, the head like a watch crystal with a little ball at the summit." Length 350 μ, width 100 μ, head 12 long x 40 wide.

Taken at Philadelphia, Pa.

Host: Arrhenoplita bicornis Olivier (Hoplocephalus bi).

Habitat: Intestine.

Ellis (1913c) corrected the host name. He left the species in the genus Gregarina.

Leidy said of the species:

> "It bears a close resemblance to Echinocephalus hispidis Schneider- - but in the one described I at no time found digitiform appendages on the head."

That the species belongs in the genus Gregarina seems doubtful; its position is left undetermined.

(?)Gregarina ovalis (Crawley) Watson   Figs. 156 & 157.

1903	Hirmocystis ovalis	Crawley 1903a:50
1913	Gregarina elaterae	Ellis 1913c:270
1915	? Gregarina ovalis	Watson

Sporonts cylindrical, 70 μ long; width not given. Ratio--length prot:total length :: 1:4; width prot:width deut:: 1:1.1. Protomerite hemispherical, widest at base. Slight constriction at septum. Deutomerite dilated at shoulder, cylindrical, ending very bluntly. Endocyte dark brown. Anterior third of protomerite usually free from granules. Nucleus not seen. Cyst and spores unknown.

Taken at Wyncote, Pa.

Host: Cucujidae larva("doubtful det.").

Habitat: Intestine.

This species is probably associative but adult sporonts have not yet been found. The specimens illustrated are probably immature. The length is less than that in most adult gregarines.

Ellis placed the species and Crawley's Gregarina elaterae together under the name of the latter. I have rather regarded the latter species as a doubtful one and have left this gregarine under its original name but questioning the correctness of the genus name. The species cannot be assigned to the genus Gregarine without a question of doubt arising. It is therefore placed with the Uncertain Species.

(?)Gregarina sp. Fig. 172.
Watson

Host: Coptotomus interrogatus Fab. Dytiscidae.

Location: Urbana, Ill., November, 1914.

Two hosts each contained one parasite in the intestine.

The sporonts are solitary. In shape the body is elongate-ellipsoidal. The protomerite is cylindrical at the base with a broadly rounded conical apex; it is as wide as high and the widest part is just anterior to the septum. There is no constriction at the septum. The deutomerite is elongate-ellipsoidal broadening rapidly from the septum and soon attaining its maximum width. It remains of the same width throughout most of the length terminating in a very broadly rounded blunt extremity. The endocyte is gray and not dense, for the nucleus is clearly

visible invivo as an ellipsoidal body twice as long as wide and containing one large spherical karyosome.

Trophozoites and cysts have not been observed.

Measurements are as follows:

Total length sporont	.21	.125 mm.
Length protomerite	.03	.018
Length deutomerite	.18	.107
Width protomerite	.035	.028
Width deutomerite	.08	.038
Ratio length prot / total length	1:7	1:7
Ratio width prot / width deut	1:2.3	1:1.3
Nucleus	.041 x .02	.023 x .01 mm.

It is very probable that these specimens are not members of the genus Gregarina. The ellipsoidal nucleus is like that of some of the Actinocephalidae. No attempt is made to place the specimens, and they are mentioned for completeness of the record only.

(?) Stylocephalus sp. Fig. 65.

The following description is copied from Crawley (1903a:47):

"GREgarina xylopini Crawley.
The two gregarines shown in figs. 29 and 30 are stated by Leidy to be parasites of the beetle Xylopinus saperdoides. Of the six beetles examined, five contained gregarines of the form shown in fig. 29, one of the form shown in fig. 30. These two forms are so dissimilar that it appears better, at present, to give only the figures, reserving the description until additional information is at hand."

Fig. 29 is reproduced in my fig. 65; fig. 30 in fig. 134.

The first gregarine, fig. 65, agrees in appearance

with sporonts of Schneider's Stylocephalus longirostris (1875: Pl. XIX, fig. 2).

Ellis considers it as synonymous with his Actinocephalus zolhus. I do not, however, regard them as so, but as separate species. See discussion under A. zophus.

The second gregarine, fig. 134, is evidently a specimen of Gregarina cuneata. The host is one of the Tenebrionidae and the drawing compares very favorably with the others listed under G. cuneata Stein.

Gregarina sp. Crawley Fig. 105.

"Asterophora philica Leidy. Gregarina philica Leidy (1889). It is impossible to give a description of this species. Figs. 31 and 32 are very plainly of the same gregarine, whereas fig. 33 seems almost certainly to belong to a different species. Further, the form figured by Leidy in 1889 is not so closely like that shown in figs. 31 and 32 as to r ender it certain that the two are the same.
I therefore include the three different forms under the same name, giving only the figures and reference, until such time as sufficient material is obtained to determine accurately what the actual facts may be.
The gregarines figured were about 300 microns long."
(Crawley, 1903a:53).

The first two gregarines have been described under the name Asteophora philica (Leidy) Crawley. The third is certainly very different from the others and merits isolation. Its generic position is undetermined from lack of data and it is mentioned here simply for completeness of the record.

Appendix

An Hitherto Unnamed Species of Didymophyes from a Japanese Beetle

In a recent article on the parasites in the intestine of a Japanese beetle, Tribolium ferrugineum F., (Tenebrionidae), S. Ishii (1914) has evidently confused two species of Polycystid Gregarines and designated them by the same name. He described two kinds of associations, large and small, as Gregarina minuta, but from his drawings and measurements the specimens are unlike. The protomerite of the primite in the first (Fig. 71) is large, subglobose, nearly flattened on the anterior surface, 5/8 as wide as the deutomerite at its widest portion, and 3/5 as high as wide. Its widest portion is some little distance anterior to the septum. At the septum, there is a deep constriction, the protomerite just anterior to it being wider than the deutomerite just posterior to it. In Fig. 143, the protomerite of the primite is smaller in proportion than in Fig. 71, hemispherical in shape, widest on its posterior margin, 2/3 as wide as the deutomerite at its widest part, and half as high as it is broad. It is narrower at the septum than is the deutomerite just posterior to the septum. Thus there is a smooth, rounded contour along the edge of the septum. The length given for the larger associations is 188 μ; for the smaller 118 μ.

In his general description, Ishii says "the protomerite

in the satellite is not infrequently hidden from view, being entirely embedded in the deutomerite of the primite.[1] In his table of measurements, he says of the satellite "protomerite absent." Later he mentions "the frequent absence of protomerite in the satellite." The figure of the larger association, fig. 71, lacks a protomerite in the satellite; the figure of the smaller, fig. 143, shows a protomerite and the table of measurements corroborates its presence.

Absence of protomerite in the satellite is not one of the diagnostic features of the genus Gregarina. If the protomerite had been absent in rare instances, the sporont might have been a sport, but its frequent absence is, clearly enough, reason for removing the specimens from the genus Gregarina.

Absence of the protomerite of the satellite is the chief diagnostic character of the family Didymophyidae (in which there is but one genus, Didymophyes), and of this family only. Therefore this polycystid gregarine which lacks a protomerite in the satellite belongs to the latter genus and I wish to designate it Didymophyes minuta (Ishii). Of course, the determination cannot be absolute without the spores and epimerite, but if the specimens belong to any known genus, they must belong to the genus Didymophyes.

1. This statement is construed to mean that the author did not see the protomerite of the satellite and inferred that it was embedded in the deutomerite of the primite.

Of the four hitherto described species in this genus, two have been recovered from Coleoptera. The present species is the smallest to be recorded by 67 (D. longissima Sieb.).

The smaller associations which Ishii described and in which the protomerite of the satellite is present, belong, without doubt, to the genus Gregarina, and the name G. minuta refers to them only.

There is also either a confusion of species or an error in observation in regard to the species Gregarina crassa (Ishii, p. 438). He illustrates but one specimen and, in this one indistinct figure, it is impossible to determine whether or not there is a protomerite in the satellite. Since only one specimen is measured and but one drawn, no comparisons can be made between the specimens with and those without protomerites in the satellites and I am unable to determine the number of species under consideration and the systematic position of the specimen described.

Part Four

A LIST OF THE CEPHALINE GREGARINES OF THE WORLD TOGETHER WITH THEIR HOSTS

A List of the Cephaline Gregarines of the World with Their Hosts

DIDYMOPHYIDAE		
Didymophyes gigantea	Oryctes nasicornis (L.) Oryctes sp. Phyllognathus sp.	COLEOPTERA
leuckarti	Aphodius pradomus (Brahm.) nitidulus F.	COLEOPTERA
longissima	Gammarus pules (L.) Orchestia littorea Leach.	CRUSTACEA
minuta	Tribolium ferrugineum F.	COLEOPTERA
paradoxa	Geotrupes stercorarius L.	COLEOPTERA
GREGARINIDAE		
Gregarina achetaeabbreviatae	Gryllus abbreviatus Serv.	ORTHOPTERA
acridiorum	Pamphagus sp. Tryxalis sp. Sphingonotus sp.	ORTHOPTERA
acuta	Trox perlatus Scriba	COLEOPTERA
amarae	Poecilus cupreus (L.)	COLEOPTERA
Barbarara	Coccinella sp.	COLEOPTERA
blattarum	Periplaneta americana (L.) Periplaneta orientalis (L.) Blatella germanica (L.)	ORTHOPTERA
boletophagi	Boletophagus cornutus	COLEOPTERA
cavalieriana	Dendarus tristis	COLEOPTERA
clausi	Phronima sp.	CRUSTACEA
conica	Coleoptera and Orthoptera	
consobrina	Ceuthophilus valgas Scud.	ORTHOPTERA
cuneata	Tenebrio molitor L.	COLEOPTERA

Gregarina curvata	Cetonia aurata	COLEOPTERA
davini	Gryllomorpha dalmatina Ocsk.	ORTHOPTERA
elaterae	Elater sp.	COLEOPTERA
elongata	Crypticus sp.	COLEOPTERA
ensiformis	Salpa aeruginosa	TUNICATA
flava	Salpa conforderata vagina	TUNICATA
fragilis	Coccinella sp.	COLEOPTERA
galliveri	Gryllus abbreviatus Serv.	ORTHOPTERA
gammari	Gammarus sp.	CRUSTACEA
globosa	Coptotomus interrogatus (Fab.)	COLEOPTERA
gracilis	Elater sp.	COLEOPTERA
granulosa	Ephemera sp.	NEUROPTERA
grisea	Tenebrio castaneua Koch	COLEOPTERA
guatemalensis	Ninus interstitialis Esch.	COLEOPTERA
hyalocaphala	Tridactylus variegatus	ORTHOPTERA
illinensis	Ischnoptera pennsylvanica (deGeer)	ORTHOPTERA
intestinalis	Pterostichus stygicus (Say)	COLEOPTERA
katherina	Coccinella sp.	COLEOPTERA
kingi	Gryllus abbreviatus Serv.	ORTHOPTERA
lagenoides	Lepisma saccharina	THYSANURA
laucournetensis	Parnus sp.	COLEOPTERA
locustaecarolinae	Dissosteria carolina L.	ORTHOPTERA

Gregarina	longiducta	Ceuthophilus maculatus (Say) latens Scud.	ORTHOPTERA
	longirostris	Statira unicolor Blanch.	COLEOPTERA
	longa	Tipula sp.	DIPTERA
	lucani	Lucanus dama	COLEOPTERA
	macrocephala	Nemobius sylvestris (F.) Gryllus domesticus L.	ORTHOPTERA
	marteli	Embia sp.	NEUROPTERA
	melalonthaebrunneae	Melalontha brunnea	COLEOPTERA
	microcephala	Arrhenoplita bicornis Ol.	COLEOPTERA
	millaria	Gammarus sp. Astacus sp.	COLEOPTERA
	minuta	Tribolium ferrugineum F.	COLEOPTERA
	monarchia	Pterostichus stygicus (Say)	COLEOPTERA
	munieri	Timarcha tenebricosa (F.) Chrysomela violacea (Goèze) haemoptera L.	COLEOPTERA
	mystacidorum	Mystacida sp.	NEUROPTERA
	nereidis denticulata	?	ANNELIDA
	nigra	Acrididae	ORTHOPTERA
	oblonga	Oedipodae migratoriae Grylli campestsis	ORTHOPTERA
	ovalis	Cucujidae	COLEOPTERA
	ovata	Forficula auricularia	ORTHOPTERA
	panchlorae	Panchlora exoleta Klug	ORTHOPTERA
	paranensis	Schistocerca paranensis	ORTHOPTERA
	passalicornuti	Passalus cornutus Fab.	COLEOPTERA

Gregarina podurae	Orchesella villosa	THYSANURA
polymorpha	Tenebrio molitor L.	COLEOPTERA
praemorsa	Platycarcinus	CRUSTACEA
psocorum	Psocus sp.	NEUROPTERA
pterotracheae	Pterotrachea sp.	MOLLUSCA
rigida	Acrididae	ORTHOPTERA
salpae	Salpa maxima	TUNICATA
scarabeirelicti	Scarabeus relictus	COLEOPTERA
serpentula	Periplaneta orientalis (L.)	ORTHOPTERA
socialis	Eryx ater Fab.	COLEOPTERA
statirae	Statira unicolor Blanch.	COLEOPTERA
steini	Tenebrio molitor L.	COLEOPTERA
stygia	Ceuthophilus stygius (Scud.)	OrthOPTERA
tenebrionella	Tenebrionidae	COLEOPTERA
tenuis	Allecula sp.	COLEOPTERA
termitis	Termes sp.	NEUROPTERA
tipula	Tipula sp.	DIPTERA
valettei	Pollicipes	CRUSTACEA
sp. (Pfeiffer)	Gammarus pulex	CRUSTACEA
sp. (Ritter)	Perophora annectena	MOLLUSCA
sp. (Moseley)	Peripatus sp.	ONYCOPHORA
sp. (Porter)	Rhyncobolus americanus	ANNELIDA
sp. (Hallez)	Dendrocoelum lacteum	PLATYHELMINTHES
sp. Kolliker)	Balanus sp.	CRUSTACEA
sp. (Mawrodiadi)	Balanus sp.	CRUSTACEA

Gregarina sp. (Solger)	Balanus improvisus	CRUSTACEA
sp. (Bolsius)	Glossophonia sp. Herpobdella sp.	ANNELIDA
sp. (Watson)	Coptotomus interrögatus Fab.	COLEOPTERA
Hirmocystis asidae	Asida servillei Sol.	COLEOPTERA
gryllotalpae	Gryllotalpa gryllotalpa (L.)	ORTHOPTERA
polymorpha	Lemnobia sp.	DIPTERA
ventricosa	Tipula sp. Pachyrhina sp.	DIPTERA
Hyalospora affinis	Machilus cylindrica Geoff.	ORTHOPTERA
reduvii	Reduvius personatus	HEMIPTERA
roscoviana	Pterobius maratimus	ORTHOPTERA or COLEOPTERA
Cnemidospora lutea	Glomeris sp.	MYRIAPODA
Euspora fallax	Rhizotrogus aestivus	COLEOPTERA
Gamocystis ephemerae	Ephemera sp.	NEUROPTERA
tenax	Blatella laponica	ORTHOPTERA
Frenzelina chtamali	Chtamalus stellatus	CRUSTACEA
conformis	Pachygraspus marmoratus	CRUSTACEA
dromiae	Dromia dromia	CRUSTACEA
fossor	Pinnotheres pisum	CRUSTACEA
ocellata	Eupagurus prideauxi	CRUSTACEA
portunidarum	Portunus arcuatus	CRUSTACEA
praemorsa	Cancer pagurus	CRUSTACEA
Uradiophora communis	Balanus sp.	CRUSTACEA
cuenoti	Atyaephyra desmaresti	CRUSTACEA

Leidyiana gryllorum	Gryllus domesticus (L.)	ORTHOPTERA
solitaria	Gryllus abbreviatus Serv.	ORTHOPTERA
DACTYLOPHORIDAE		
Dactylophorus robustus	Cryptops hortensis Leach.	MYRIAPODA
Nina giardi	Scolopendra oraniensis	MYRIAPODA
giardi corsicum	Scolopendra oraniensis lusitanica Verh.	MYRIAPODA
gracilis	Cryptops anomalons lusitanus Verh. Scolopendra cingulata (Latr.)	MYRIAPODA
indicia	Scolopendra subspinipes Leach	MYRIAPODA
Trichorhynchus pulcher	Scutigera sp. Scutigera forceps (Raf.)	MYRIAPODA
Echinomera hispida	Lithobius forficatus Linn. coloradensis Cock.	MYRIAPODA
horrida	Lithobius calcaratus Lock	MYRIAPODA
Rhopalonia geophili	Himantarium gabrielis Linn. Stigmatogaster gracilis Mein.	MYRIAPODA
stella	Himantarium gabrielis Linn.	MYRIAPODA
Acutispora macrocephala	Lithobius forficatus Linn.	MYRIAPODA
Metamera schubergi	Hirudinea sp.	ANNELIDA
ACTINOCEPHALIDAE		
Actinocephalus acutispora	Silpha laevigata F.	COLEOPTERA
americanus	Galerita bicolor Drury	COLEOPTERA
brachydactylus	Aeshna sp.	NEUROPTERA
caudatus	Sciara sp.	DIPTERA

Actinocephalus	conicus	Dorcus parallelipipedus (L.)	COLEOPTERA
	crassus	Leptochirus edax Sharp	COLEOPTERA
	digitatus	Claenius vestitus (Payk.)	COLEOPTERA
	discoeli	Discoelus ovalis	COLEOPTERA
	dujardini	Lithobius forficatus L.	MYRIAPODA
	dytiscorum	Dytiscus sp.	COLEOPTERA
	gimbeli	Harpalus pennsylvanicus Dej.	COLEOPTERA
	harpalus	Harpalus caliginosus Fab.	COLEOPTERA
	octacanthus	Phryganea sp.	NEUROPTERA
	pachydermus	Dissosteria carolina (L.)	ORTHOPTERA
	repelini	Phalangium sp.	ARACHNIDA
	sieboldi	Agrion sp.	NEUROPTERA
	stelliformis	Ocypus olens Mull. Carabus auratus L.	COLEOPTERA
	striatus	Scolopendra cingulata Latr.	MYRIAPODA
	tipulae	Tipula sp.	DIPTERA
	zophus	Nyctobates barbata Knoch Alobates pennsylvanicus deGeer	COLEOPTERA
	sp.	Ctenophora sp.	DIPTERA
Geneiorhynchus	aeshnae	Aeshna constricta Say	NEUROPTERA
	monnieri	Libellules sp.	NEUROPTERA
Pyxinia	crystalligera	Dermestes vulpinus Fabr.	COLEOPTERA
	frenzeli	Attagenus pellio	COLEOPTERA

Pyxinia mobüszi	Anthrenus verbasci Oliv.	COLEOPTERA
rubecula	Dermestes lardarius L. vulpinus Fabr.	COLEOPTERA
Beloides firmus	Dermestes lardarius L.	COLEOPTERA
tenuis	Dermestes undulatus Brahn.	COLEOPTERA
Legeria agilis	Colymbetes sp.	COLEOPTERA
Coleorhynchus heros	Nepa sp.	HEMIPTERA
Bothriopsis histrio	Dytiscus sp. Hydaticus cinereus Colymbetes fuscus Acilius sulcatus	COLEOPTERA
terpischorella	Hydrophilus sp.	COLEOPTERA
Asterophora elegans	Phryganea sp.	NeuROPTERA
mucronata	Rhyacophila sp.	NEUROPTERA
philica	Cratoparis lunatus	COLEOPTERA
Schneideria mucronata	Bibio sp.	DIPTERA
Stictospora provincialis	Melolontha sp. Rhizotrogus sp.	COLEOPTERA
Stylocystis ensiferis	Leptochirus edax Sh.	COLEOPTERA
praecox	Tanypus sp.	DIPTERA
Steinina obconica	Triboluim ferrugineum F.	COLEOPTERA
ovalis	Tenebrio molitor L.	COLEOPTERA
Rotunda	Amara angustata Say	COLEOPTERA
Taeniocystis truncatus	Sericostoma	NEUROPTERA
Amphoroides calverti	Callipus lactarius (Say)	MYRIAPODA
polydesmi	Polydesmus complanatus (L.) dispar Silvestri	MYRIAPODA

Pileocephalus bergi	Necrobis ruficollis Fabr.	COLEOPTERA
blaberae	Blabera claraziana Sauss.	ORTHOPTERA
chinensis	Mystacides sp.	NEUROPTERA
Anthorhynchus sophiae	Phalangida sp.	ARACHNIDA
fissidens	Phalangides sp.	ARACHNIDA
goronowitschi	Phalangium sp.	ARACHNIDA
Sciadophora phalangii	Phalangium sp.	ARACHNIDA
Hoplorhynchus actinotus	Scolopocryptops cingulata Latr.	MYRIAPODA
scolopendras	SCOlopendra woodi Mein.	MYRIAPODA
Amphorocephalus amphorellus	Scolopendra heros Giard	MYRIAPODA
ACANTHOSPORIDAE		
Acanthospora pileata	Omoplys sp.	COLEOPTERA
polymorpha	Hydrous caraboides (L.)	COLEOPTERA
Corycella armata	Gyrinus natator (L.)	COLEOPTERA
Ancyrophora gracilis	Carabus sp. Carabus auratus L. Carabus violaceus L.	COLEOPTERA
uncinata	Dytiscus sp. Colymbetes sp. Sericostoma sp.	COLEOPTERA
Cometoides capitatus	Hydrorus sp.	COLEOPTERA
crinitus	Hydrobius sp.	COLEOPTERA
MENOSPORIDAE		
Menospora polyacantha	Agrion sp.	NEUROPTERA
STYLOCEPHALIDAE		
Stylocephalus balani	Balanus sp.	CRUSTACEA
brevirostra	Hydrophilus sp.	COLEOPTERA

caudatus	Phalangides sp.	ARACHNIDA
giganteus	Eleodes sp. Asida opaca Say Asida sp.	COLEOPTERA
gladiator	Helenophorus collaris L.	COLEOPTERA
heeri	Phryganea sp.	NEUROPTERA
longicollis	Blaps mortisaga	COLEOPTERA
oligacanthus	Agrion sp.	NEUROPTERA
oblongatus	Opatrum sabulosum (L.) Asida grisea F.	COLEOPTERA
phallusiae	Phallusia sp.	MOLLUSCA
sp.	Xylopinus saperdoides	COLEOPTERA
Sphaerorhynchus ophoiides	Acis sp.	COLEOPTERA
Lophocephalus insignis	Helops striatus	COLEOPTERA
Cystocephalus algerianus	Pimelia sp.	COLEOPTERA
Oocephalus hispanus	Morica sp.	COLEOPTERA
STENOPHORIDAE		
Stenophora aculeata	Craspedosoma rawlinsii	MYRIAPODA
brolemanni	Blaniulus hirsutus Brol. Brachydesmus superus Latzel Brachyiulus pusillus lusitanus Verh.	MYRIAPODA
chordeume	Chordeuma silvestre Koch	MYRIAPODA
cockerellae	Parajulus sp.	MYRIAPODA
corsica	Craspedosoma legeri	MYRIAPODA
dauphinia	Julus mediterràneus Latzel boleti C. Koch fallax Meinert	MYRIAPODA
diplocorpa	Euryurus erythropygus (Brandt)	MYRIAPODA

elongata	Orthomorpha coarctata (Sauss.)	MyRIAPODA
fontaria	Polydesmus sp. Fontaria sp.	MYRIAPODA
impressa	Parajulus impressus (Say)	MYRIAPODA
juli	Julus sabulosus (L.) boleti C.Koch	MYRIAPODA
julipusilli	Julus and Parajulus	MYRIAPODA
lactaria	Callipus lactarius (Say)	MYRIAPODA
larvata	Spirobolus spinigerus Wood	MYRIAPODA
nematoides	Strongylosoma italicum Latz.	MYRIAPODA
polydesmivirginiensis	Fontaria virginiensis (Drury)	MYRIAPODA
polyxeni	Polyxenus lagurus (L.)	MYRIAPODA
producta	Julus varius Fabricus	MYRIAPODA
robusta	Parajulus venustus Wood Orthomorpha gracilis (C.Koch) Orthomorpha sp.	MYRIAPODA
silene	Lysiopetalum foetisissum Savi	MYRIAPODA
spiroboli	Spirobolus sp.	MYRIAPODA
varians	Schizophyllum corsicum Brol.	MYRIAPODA

Genera of Uncertain Position

Ulivina elliptica	Audouinia sp.	ANNELIDA
Nematoides fusiformis	Balanus sp.	CRUSTACEA
Ganymedes anaspides	Anaspides sp.	CRUSTACEA
Agrippina bona	Ceratophyllus fasciatus Bosk.	ARACHNIDA

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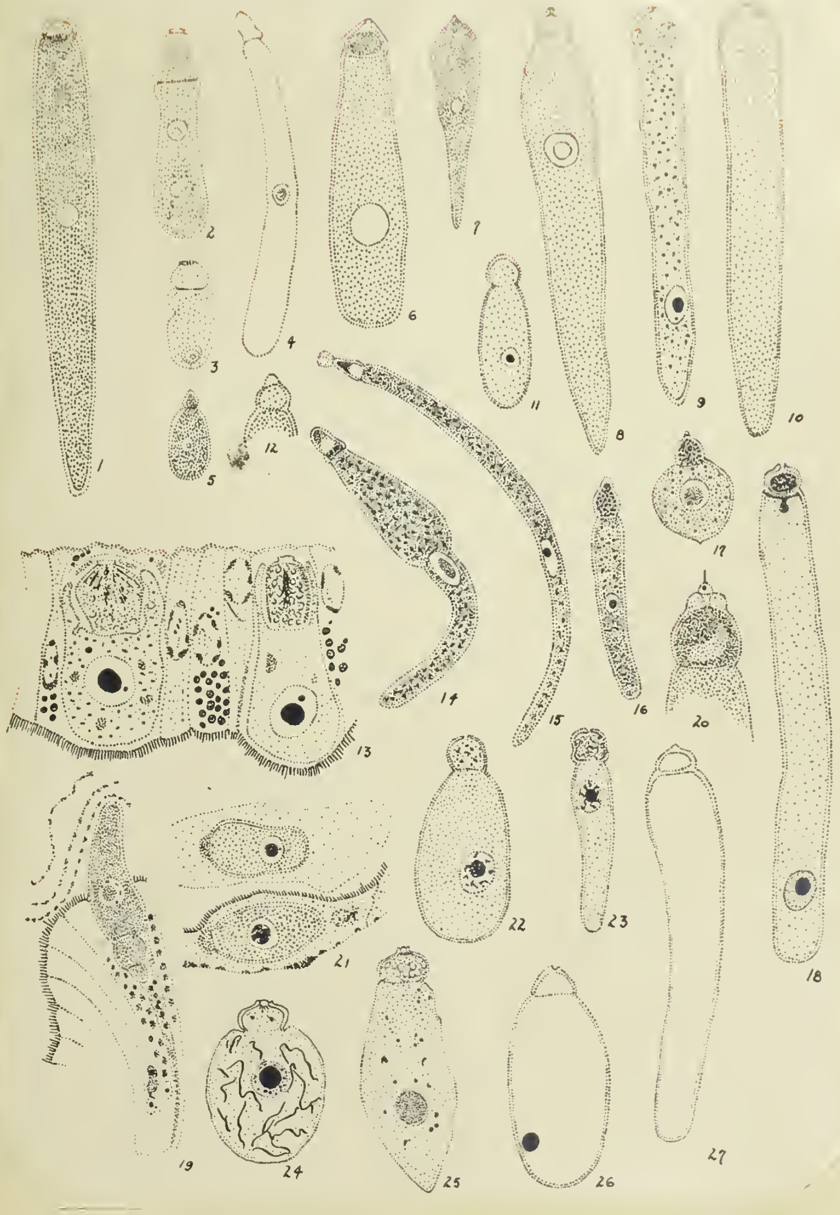
List of Drawings

The drawings are copied from the originals by means of a camera lucida

Plate I



33. Nina indicia Merton. Merton 1911 Pl. III, fig. 1.
34. Acutispora macrocephala Crawley. Crawley 1903b, Pl. XXX, fig. 1.
35. Trichorhynchus pulcher Schneider. Leidy 1889, fig. 3.
36. Trichorhynchus pulcher Schneider. Schneider 1882 Pl. XIII, fig. 14.
37. Actinocephalus striatus Leger & Duboscq. L & D 1903b, fig.16.
38. Actinocephalus dujardini Schneider. Schneider 1875 Pl. XVI, fig. 9.
39. Actinocephalus dujardini Schneider. Schneider Ibid, fig. 10.
40. Actinocephalus dujardini Schneider. Schneider Ibid, fig. 12.
41. Hoplorhynchus scolopendra Crawley. Crawley 1903b Pl. XXX, fig. 19.
42. Hoplorhynchus actinotus (Leidy) Crawley. Crawley 1903a Pl. III, fig. 37.
43. Hoplorhynchus actinotus (Leidy) Crawley. Leidy 1889, fig.2.
44. Trichorhynchus lithobi. Crawley. Crawley 1903b Pl. XXX, fig.18.
45. Amphorocephalus amphorellus Ellis. Ellis 1913a, fig. 1.
46. Amphorocephalus amphorellus Ellis. Ellis Ibid, fig. 2.
47. Species of uncertain genus, Balbiani 1889, Pl. II, fig. 34.
48. Species of uncertain genus, Kölliker 1848, Pl. III, fig.30.
49. Nina gracilis Grebnecki in section. Léger & Duboscq 1902, Pl. VI, fig. 93.
50. Nina gracilis Grebnecki, in section. Léger & Duboscq Ibid, fig. 96.
51. Rhopalonia geophilii Léger. Labbé 1899, fig. 21.
52. Amphoroides calverti (Crawley) Watson.
53. Stenophora impressa Watson.
54. Stenophora diplocorpa Watson.
55. Stenophora lactaria Watson.
56. Cnemidospora lutea Schneider. Schneider 1882 Pl. XIII, fig.44.
57. Cnemidospora lutea Schneider, protomerite. Ibid, fig. 44.
58. Amphoroides polydesmi (Leger) Labbé. Léger 1892 Pl. X, fig. 10.
59. Didymophyes leuckarti Marshall. Marshall 1893 Pl. II, fig.24.
60. Didymophyes leuckarti Marshall. Ibid, fig. 26.
61. Didymophyes gigantea Stein. Stein 1848 Pl. XI, fig.40.
62. Didymophyes paradoxa Stein. Léger 1892 Pl. VI, fig. 14.
Didymophyes gigantea Stein. Labbé 1899, fig. 4.
64. Actinocephalus americanus Crawley. Crawley 1903b Pl. XXX, fig. 22.
65. Stylocephalus sp. Crawley, 1903a Pl. III, fig. 29.
66. Actinocephalus digitatus Schneider. Schneider 1875 Pl. XVI, fig. 35.
67. Actinocephalus stelliformis Schneider. Schneider 1875 Pl. XVI fig. 32.
68. Actinocephalus crassus (Ellis) Ellis. Ellis 1912c fig. 7.

Plate 2

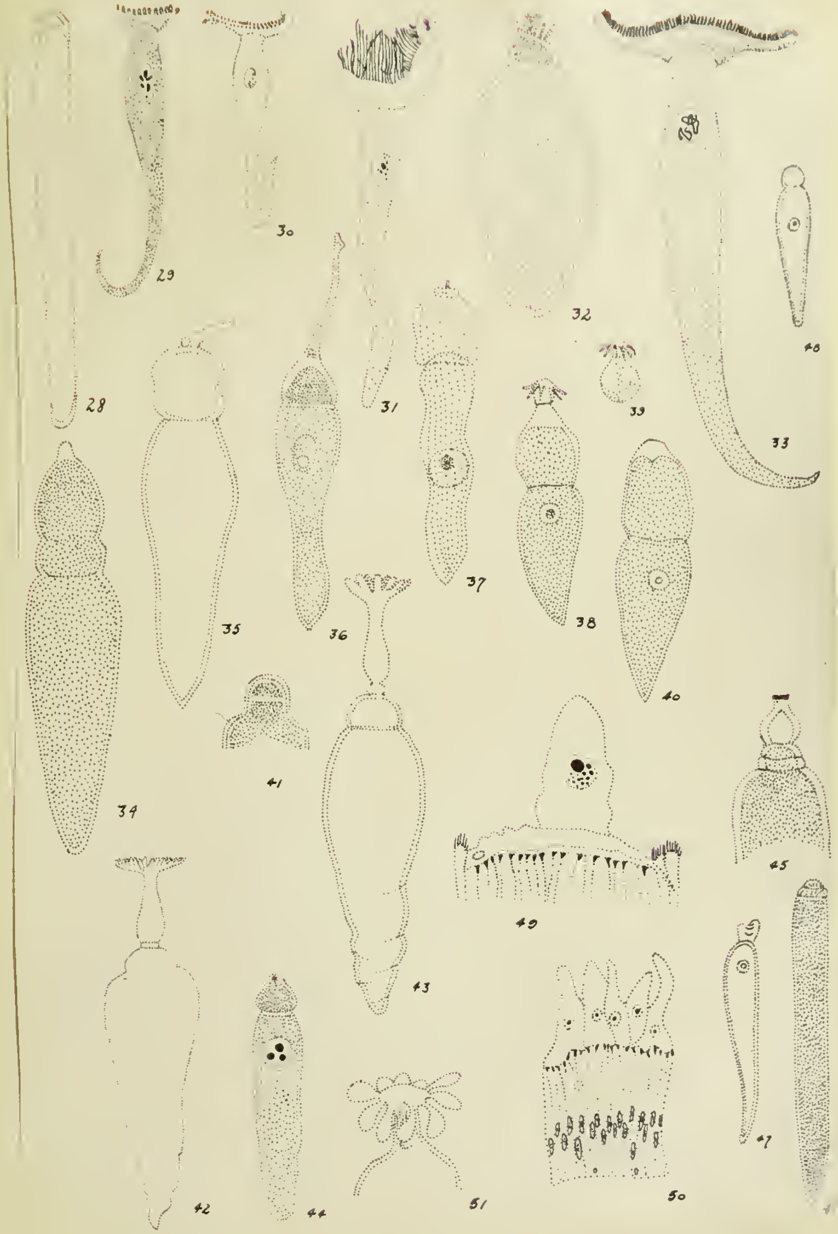
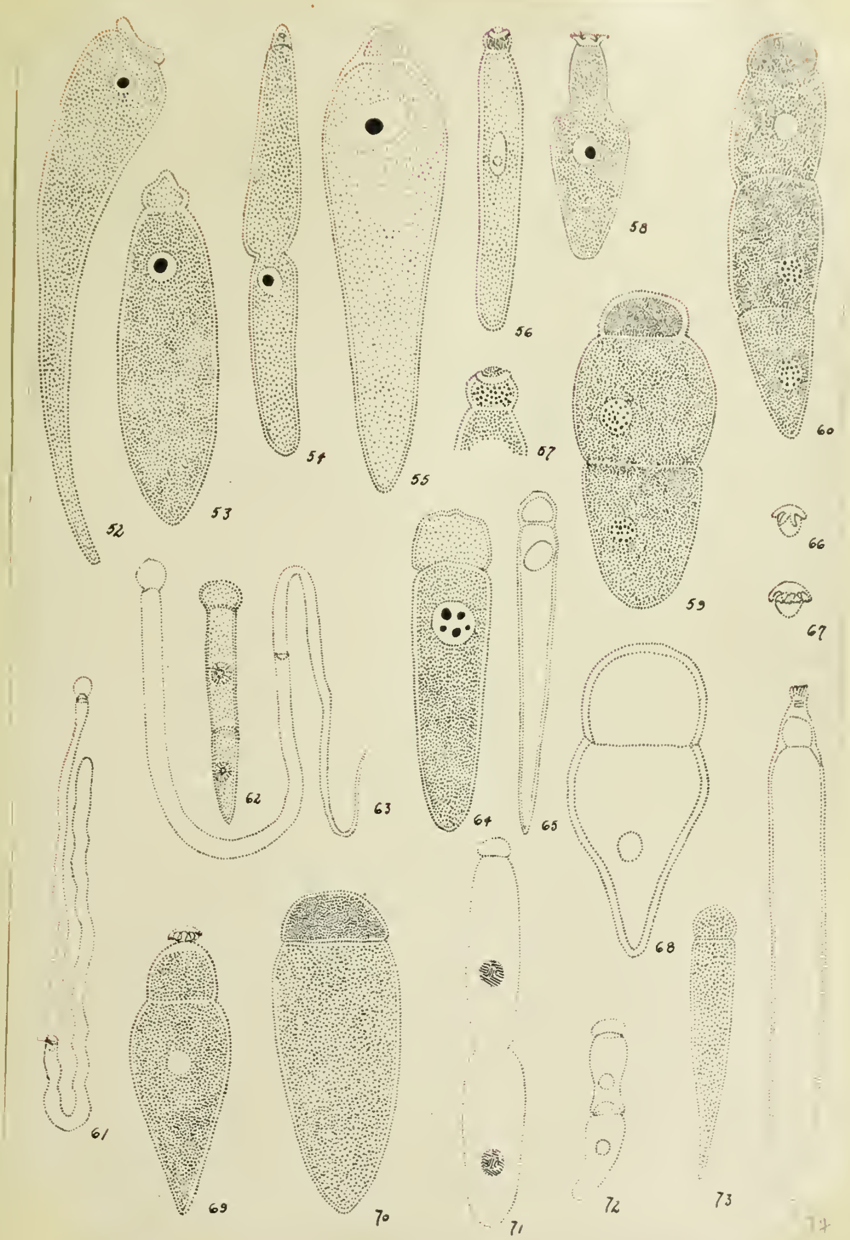
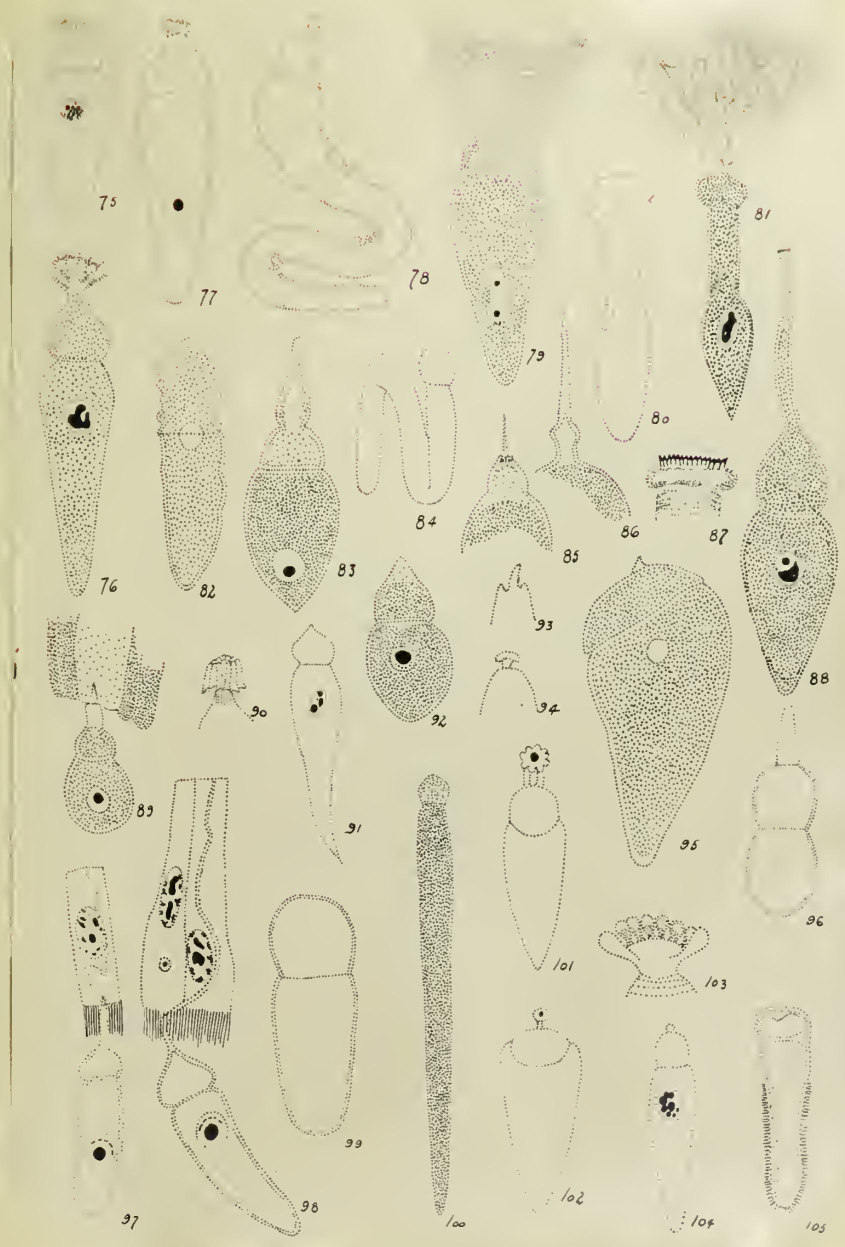


Plate 3



69. Actinocephalus stelliformis Schneider. Schneider 1875 Pl. XVI, fig. 32.
70. Actinocephalus harpali (Crawley) Crawley. Crawley 1903a Pl. I, fig. 1.
71. Didymophyes minuta (Ishii) Watson. Ishii 1914, fig. 2a.
72. Didymophyes paradoxa Stein. Stein Pl IX, fig. 34.
73. Actinocephalus stelliformis Schneider. Schneider 1875 Pl. XX, fig. 20.
74. Actinocephalus zophus (Ellis) Ellis. Ellis 1913a, fig. 2.
75. Actinocephalus conicus (Dufour) Stein. Stein 1848 Pl. IX, fig. 33.
76. Actinocephalus conicus (Dufour) Stein. Léger 1892 Pl. XII, fig. 3.
77. Asterophora cratoparis Crawley. Crawley 1903a Pl. II, fig.23.
78. Asterophora philica (Leidy) Crawley. Crawley 1903a Pl. III, fig. 31.
79. Bothriopsis histrio Schneider. Schneider 1875 Pl. XXI, fig.13.
80. Bothriopsis terpischorella (Ellis) Watson. Ellis 1913b Pl. XVIII , fig. 30.
81. Bothriopsis histrio Schneider. Léger 1892 Pl. XIII, fig. 1.
82. Legeria agilis (Schneider) Labbé. Schneider 1875 Pl. XXII, fig. 1.
83. Pileocephalus bergi (Frenzel) Labbé. Frenzel 1892 Pl. VIII, fig. 16.
84. Pyxinia crystalligera Frenzel. Ibid, fig. 40.
85. Pyxinia crystalligera Frenzel. Ibid, fig. 36.
86. Pyxinia crystalligera Frenzel. Ibid, fig. 37.
87. Phialoides ornata (Léger) Labbé. Léger 1892 Pl. XIII, fig.8.
88. Phialoides ornata (Léger) Labbé. Ibid Pl. XIII, fig. 7.
89. Pyxinia frenzeli Laveran & Mesnil. L & M 1900 fig. 5,
90. Stictospora provincialis Léger. Labbé 1899, fig. 43.
91. Stictospora provincialis Léger. Ibid, fig. 42.
92. Steinina ovalis (Stein) Léger & Duboscq. L & D 1904, fig. 3c.
93. Steinina ovalis (Stein) Léger & Duboscq. Ibid, fig. 4a.
94. Steinina ovalis (Stein) Léger & Duboscq. Ibid, fig. 4d.
95. Steinina obconica Ishii. Ishii 1914, fig. 4.
96. Stylocystis ensiferis (Ellis) Ellis. Ellis 1912, fig. 5.
97. Pyxinia mobuszi Léger & Duboscq. L & D 1902 Pl. VI, fig 60.
98. Pyxinia mobuszi Léger & Duboscq. L & D 1902 Pl. VI, fig.58.
99. Stylocystis ensiferis (Ellis) Ellis. Ellis 1912, fig 5s.
100. Actinocephalus discoeli (Crawley) Ellis. Crawley 1903a Pl.I, fig. 7.
101. Actinocephalus conicus (Dufour) Stein. Dufour 1837 Pl. I, fig. 7.
102. Gregarina conica Dufour. Dufour 1837 Pl. I, fig. 7a.
103. Actinocephalus conicus (Dufour) Stein. Leger 1892 Pl. XII, fig. 4.

Plate 4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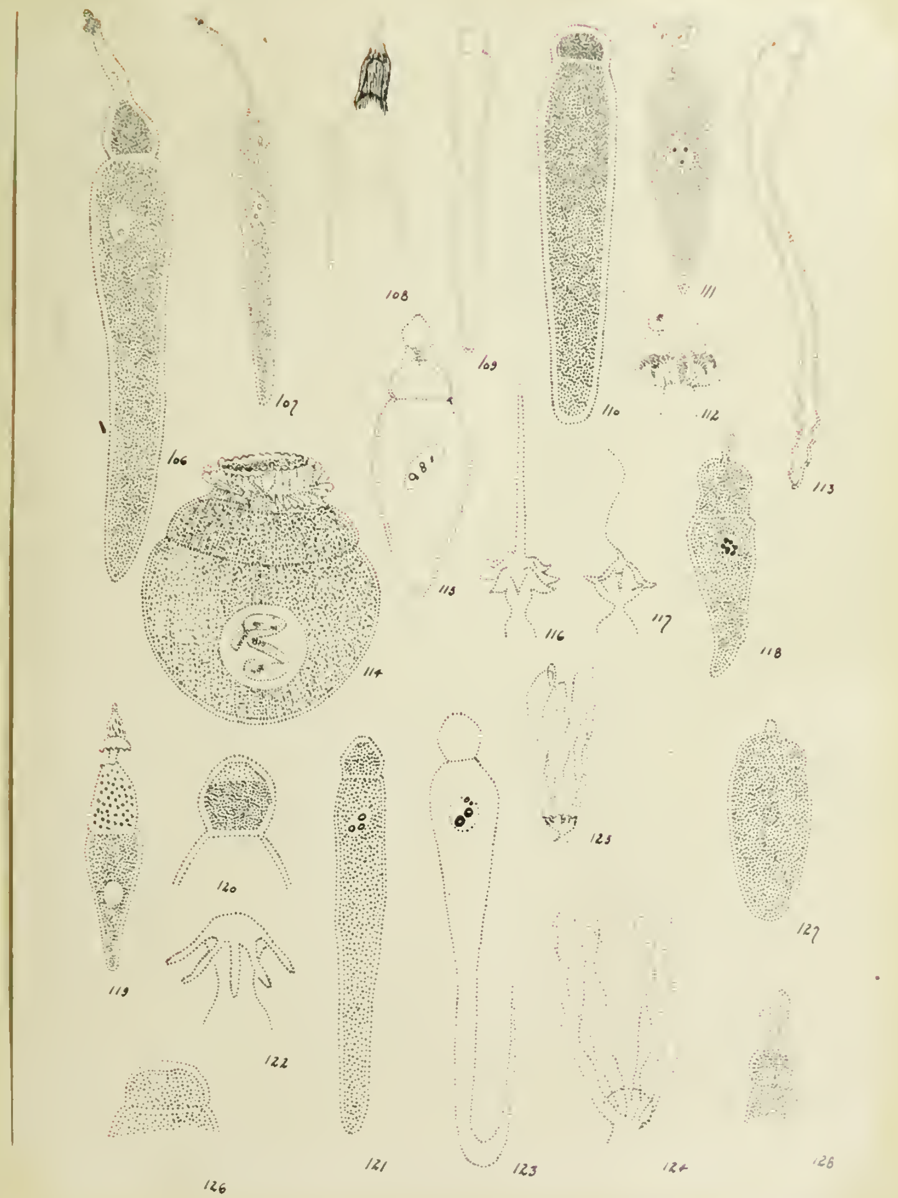
104. Indeterminate species called by Crawley Asterophora philica. Crawley 1903a Pl. III, fig. 32.
105. Indeterminate species called by Crawley Asterophora philica. Crawley 1903a Pl. III, fig. 33.
106. Stylocephalus oblongatus (Hamm.) Watson. Schneider 1875 Pl. XVIII, fig. 3.
107. Stylocephalus longicollis (Stein) Watson. Schneider 1875 Pl. XIX, fig. 1.
108. Stylocephalus giganteus Ellis. Ellis 1912c, fig. 2.
109. Stylocephalus giganteus Ellis. Ellis Ibid, fig. 1d.
110. Lophocephalus insignis (Schneider) Labbé. Schneider 1882 Pl. XIII, fig. 1.
111. Corycella armata Leger. Léger 1892 Pl. XVI, fig. 7.
112. Corycella armata Leger. Léger 1892 Pl. XVI, fig. 8.
113. Asterophora philica (Leidy) Crawley. Leidy 1889, fig. 7.
114. Lophocephalus insignis (Schneider) Labbé. Wasielewski 1896, fig. 5, after Leger.
115. Cystocephalus algerianus Schneider, cephalont. Labbe 1899, fig. 82.
116. Beloides firmus (Léger) Labbé. Labbé 1899, fig. 65, after Leger.
117. Beloides tenuis (Léger) Labbé. Labbe Ibid, fig. 65.
118. Stylocephalus brevirostra (Kölliker) Watson. Kolliker 1848 Pl. II, fig. 14.
119. Pyxinia rubecula Hamm. Frantzius 1848 Pl. VII, group II, fig. 1.
120. Stylocephalus oblongatus (Hamm.) Watson. Schneider 1875 Pl. XVIII, fig. 5.
121. Stylocephalus longicollis (Stein) Watson. Schneider Ibid Pl. XIX, fig. 2.
122. Ancyrophora gracilis Léger. Léger 1892 Pl. XIX, fig. 11.
123. Cometoides capitatus (Léger) Labbé. Leger 1892 Pl. XVI, fig. 3.
124. Cometoides capitatus (Léger) Labbé. Leger 1892 Pl. XVI, fig. 4.
125. Cometoides crinitus (Léger) Labbé. Leger 1892 Pl. XVIII, fig. 3.
126. Actinocephalus gimbeli (Ellis) Watson. Ellis 1913, fig. 4.
127. Actinocephalus gimbeli (Ellis) Watson. Ellis Ibid fig. 3.
128. Epimerite of Gregarina munieri (Schneider) Labbe. Schneider 1875 Pl. XVII, fig. 2.
129. Hyalospora roscoviana Schneider. Schneider 1875 Pl. XVI, fig. 41.
130. Gregarina parva Crawley. Crawley 1903b Pl. XXX, fig. 10.
131. Euspora fallax Schneider. Schneider 1875 Pl. XVIII, fig. 14.
132. Gregarina cuneata Stein. Schneider 1875 Pl. XX, fig. 11.
133. Gregarina cuneata Stein. Stein 1848 Pl. IX, fig. 23.
134. Gregarina cuneata Stein. Crawley 1903a Pl. III, fig. 30.
135. Gregarina cuneata Stein. Frantzius 1848 Pl. VII, group V, fig. 1.
136. Gregarina cuneata Stein. Ishii 1914, fig. 1.

Plate 5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137. Sphaerocystis simplex Léger. Léger 1892 Pl. VI, fig. 11.
138. Gregarina statirae Frenzel. Frenzel 1892 Pl. VIII, fig. 1.
139. Gregarina passacornuti Leidy. Crawley 1903a Pl. II, fig. 24.
140. Gregarina polymorpha (Hamm.) Stein. Frantzius 1848 Pl. VII, group V, fig. 2.
141. Gregarina polymorpha (Hamm.) Stein. Schneider 1875 Pl. XX, fig. O.
142. Gregarina polymorpha (Hamm.) Stein. Stein 1848 Pl. IX, fig. 24.
143. Gregarina minuta Ishii. Ishii 1914 fig. 2b.
144. Gregarina guatemalensis Ellis. Ellis 1912 fig. 6t.
145. Uncertain species (Genus ? boletophagi Crawley). Crawley 1903a Pl. II, fig. 26.
146. Gregarina steini Berndt. Berndt 1902 Pl. XIII, fig. 69.
147. Gregarina munieri (Schneider) Labbé. Schneider 1875 Pl. XVII, fig. 1.
148. Actinocephalus dytiscorum (Frantzius) Watson. Frantzius 1848 Pl. VII, group VII, fig. 1.
149. Uncertain species (Gregarina microcephala Leidy). Leidy 1889, fig. 4.
150. Gregarina lucani (Crawley) Watson. Crawley 1903a Pl. III, fig. 38.
151. Gregarina grisea Ellis. Ellis 1913, fig. 1.
152. Gregarina cuneata Stein. Léger & Duboscq 1904, fig. 5.
153. Gregarina polymorpha (Hamm.) Stein. Léger & Duboscq 1904 fig. 6.
154. Gregarina elongata Frantzius. Frantzius 1848 Pl. VII, group IV, fig. 2.
155. Gregarina longirostris (Léger) Labbé. Leger 1892 Pl. XI, fig. 5.
156. Uncertain species (Gregarina ovalis (Crawley) Watson). Crawley 1903a Pl. I, fig. 5.
157. Uncertain species Ibid. Crawley Ibid, fig. 6.
158. Uncertain species (Gregarina elaterae Crawley). Crawley 1903a Pl. I, fig. 11.
159. Pyxinia rubecula Hammerschmidt. Léger 1892 Pl. XIV, fig. 2.
160. Spore of Cystocephalus algerianus Schneider. Labbé 1899, fig 8.
161. Spores of Lophocephalus insignis (Schneider) Labbé. Schneider 1882 Pl. XIII, figs. 48 & 50.
162. Spore of Acanthospora pileata Léger. Léger 1892 Pl. XV, fig. 5a.
163. Spore of Acanthospora polymorpha Léger. Labbé 1899, fig. 68.
164. Spore of Ancyrophora gracilis Léger. Léger 1892 Pl. XIX, fig. 12b.
165. Spore of Cometoides capitatus (Léger) Labbé. Leger 1892 Pl. XVI, fig. 5.
166. Spore of Corycella armata Léger. Léger 1892 Pl. XVI, fig. 10.

Plate 6

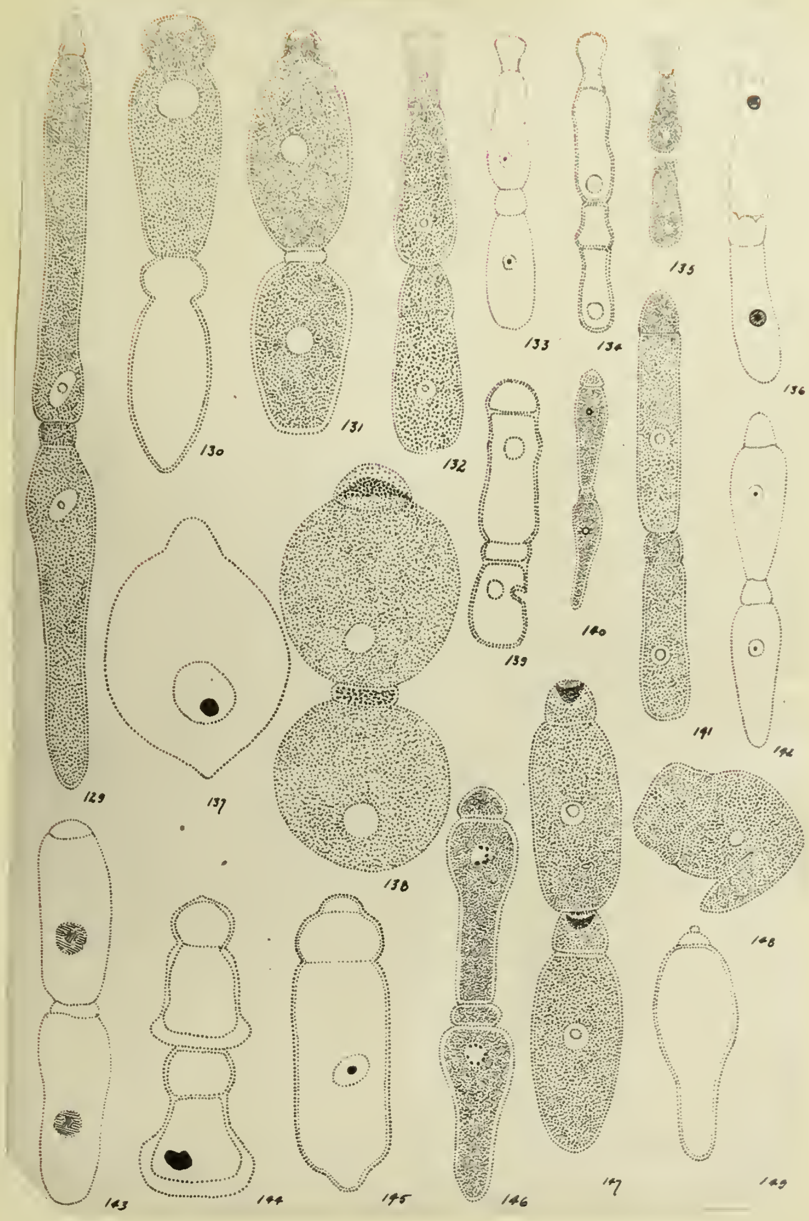
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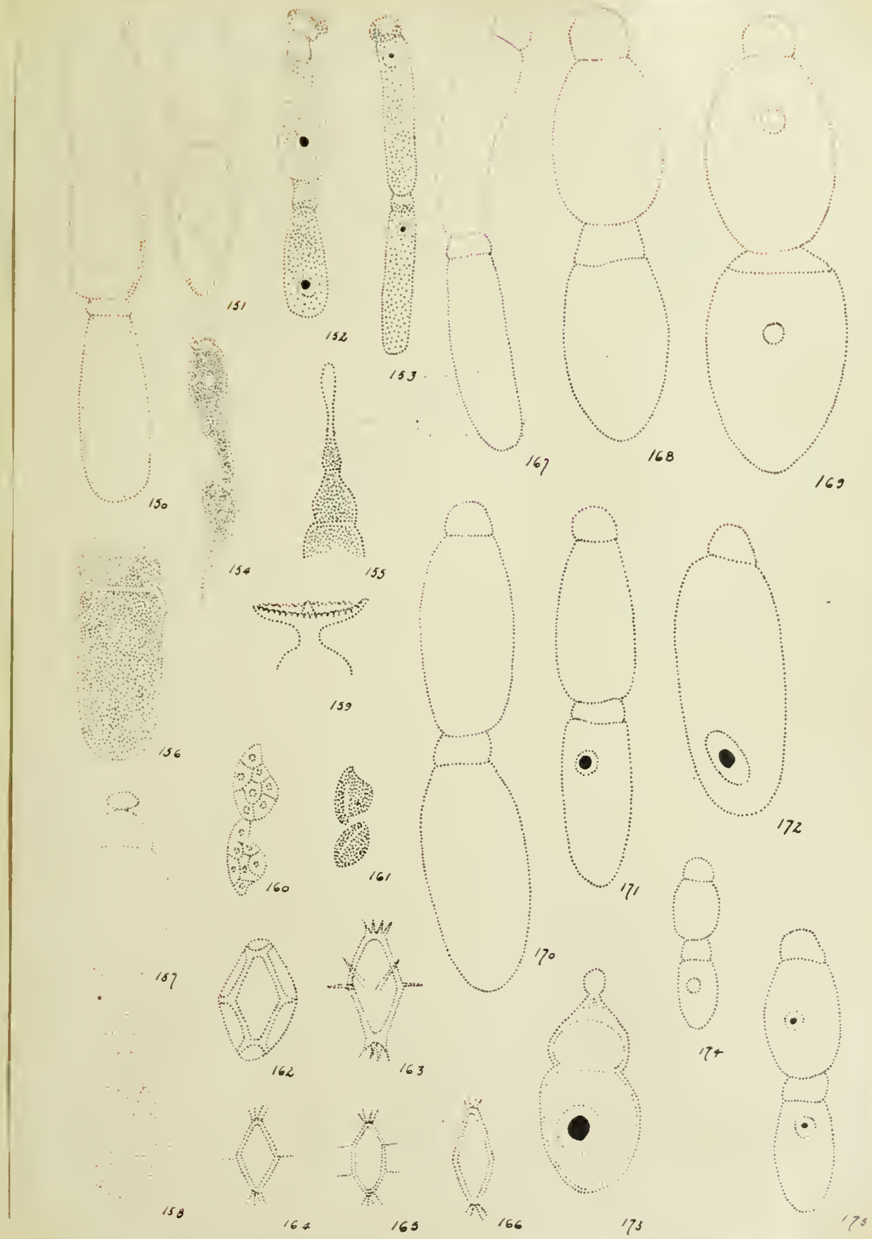
Plate 7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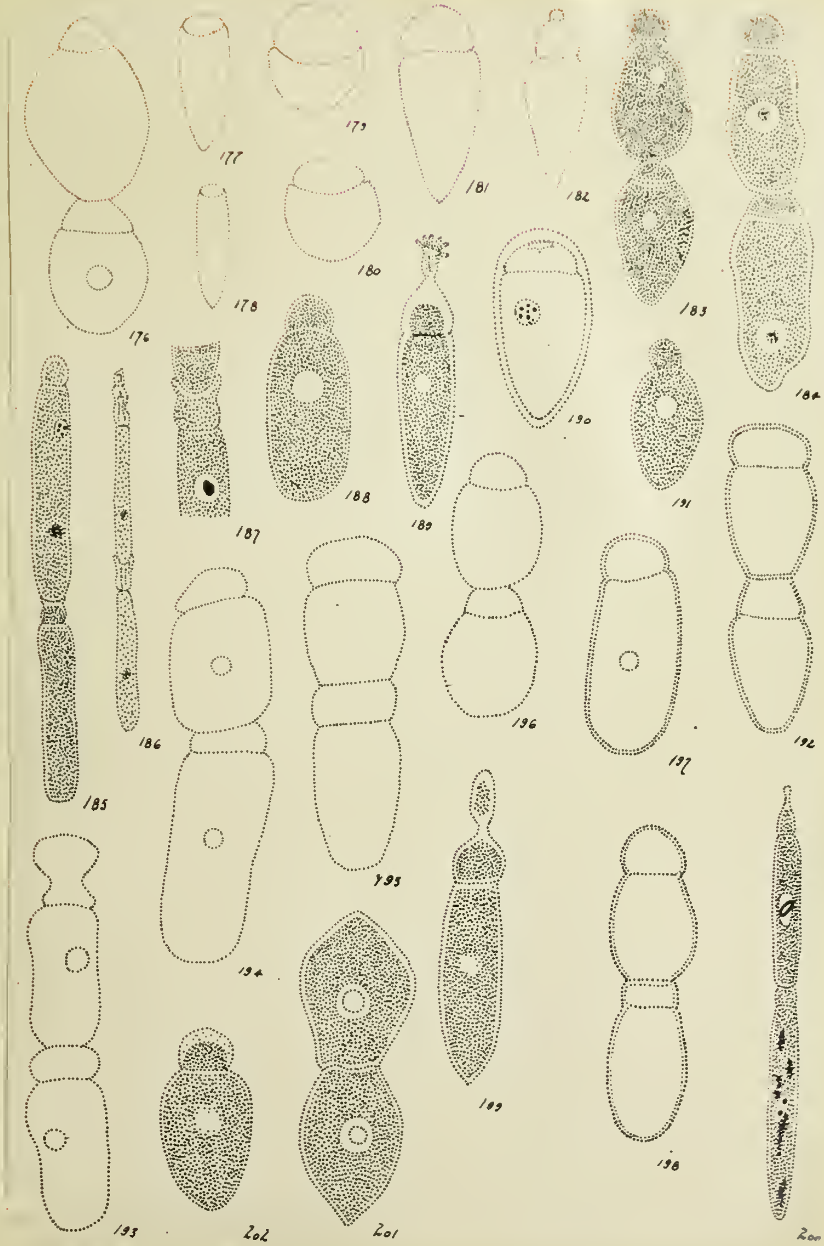
167. Gregarina monarchia Watson.
168. Gregarina intestinalis Watson.
169. Gregarina barbarara Watson.
170. Gregarina gracilis Watson.
171. Gregarina katherina Watson.
172. Gregarina sp. Watson.
173. Steinina rotunda Watson.
174. Gregarina tenebrionella Watson.
175. Gregarina fragilis Watson.
176. Gregarina globosa Watson.
177. Gregarina oblonga Dufour. Dufour 1837 Pl. I, fig. 9.
178. Gregarina oblonga Dufour. Dufour 1837 Pl. I, fig. 9a.
179. Cysts of species called by Dufour G. sphaerulosa. Dufour 1837 Pl. I, fig. 4.
180. Cysts of species called by Dufour G. soror. Dufour 1837, Pl. I, fig. 5.
181. Gregarina hyalocephala Dufour. Dufour Ibid, fig. 8.
182. Gregarina hyalocephala Dufour. Dufour Ibid, fig. 8a.
183. Gregarina ovata Dufour. Frantzius 1848 Pl. VII, group IX, fig. 1.
184. Gregarina blattarum Siebold. Schneider 1875 Pl. XVII, fig.11.
185. Gregarina serpentula deMagalhaes. deMagalhaes 1900, fig. 4.
186. Gregarina serpentula deMagalhaes. Magalhaes Ibid, fig. 4.
187. Gregarina panchlorae Frenzel. Frenzel 1892 Pl. VIII, fig.20.
188. Gregarina locustacarolina Leidy. Leidy 1853 Pl. XI, fig.35.
189. Actinocephalus pachydermus (Crawley) Ellis. Leidy 1853 Pl. XI, fig. 37.
190. Actinocephalus pachydermus (Crawley) Ellis. Crawley 1907 Pl. XVIII, fig. 3.
191. Gregarina achetaeabbreviatae Leidy. Leidy 1853 Pl. XI, fig. 32.
192. Gregarina achetaeabbreviatae Leidy. Crawley 1903a Pl. III, fig. 35.
193. Gregarina kingi Crawley. Crawley 1907 Pl. XVIII, fig. 10.
194. Gregarina rigida (Hall) Ellis. Crawley 1907 Pl. XVIII, fig.8.
195. Gregarina longiducta Ellis. Ellis 1913d, fig. 8.
196. Gregarina consobrina Ellis. Ellis 1913c Pl. XVIII, fig. 24.
197. Gregarina rigida (Hall) Ellis. Hall 1907 Pl. I, fig. 8.
198. Gregarina rigida (Hall) Ellis. Watson
199. Gregarina macrocephala Schneider. Schneider 1882 Pl. XIII, fig. 42.
200. Hyalocephala affinis Schneider. Schneider 1882 Pl. XIII, fig. 33.
201. Gamocystis tenax Schneider. Schneider 1875 Pl. XIX, fig.10.
202. Pileocephalus blaberae Frenzel. Frenzel 1892 Pl. VIII, fig.24.
203. Pileocephalus blaberae Frenzel. Frenzel Ibid, fig. 23.
204. Gregarina davini Léger & Duboscq. L & D 1899, fig. 3.

Plate 8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205. Gregarina galliveri Watson.
206. Gregarina stygia Watson.
207. Gregarina illinensis Watson.
208. Leidyiana solitaria Watson.
209. Leidyiana gryllorum (Cuénot) Watson. Cuénot 1901 Pl. XX, fig. 27.
210. Gregarina nigra Watson.
211. Hirmocystis gryllotalpae (Léger) Labbé. Léger 1892 Pl. VI, fig. 5.
212. Actinocephalus acutispora Léger. Léger 1892 Pl. XIV, fig. 6.
213. Actinocephalus acutispora Léger. Léger Ibid, fig. 7.
214. Beloides firmus (Léger), Labbé. Léger 1892 Pl. XVII, fig. 5.
215. Acanthospora pileata Léger. Léger 1892 Pl. XV, fig. 4.
216. Ancyrophora uncinata Léger. Léger 1892 Pl. XIX, fig. 8.
217. Gregarina acuta (Léger) Labbé. Léger 1892 Pl. VI, fig. 10.
218-263. Leidyiana solitaria n. sp.
218. An adult sporont.
219. A younger slender sporont, nearly transparent.
220. Another adult sporont.
221. An old sporont, dense, compact and sluggish, just preparatory to cyst-formation.
222 & 223. Drawings to illustrate the bending of the body.
224. The trophozoite attached to a host-cell.
225. A larger trophozoite with an incipient protomerite.
226. Fully developed but still attached trophozoites.
227. An individual with epimerite, free in the intestine and nearly as large as the adults.
228. A section of the caeca indicating that this organ is frequently the seat of infection.
229. The sluggish sporonts attached by the sticky secretion from their bodies. They are not attached antero-posteriorly by means of a socket, as in the genus Gregarina but haphazard and barely contiguous.
230. A cluster of sluggish, fully matured sporonts, several of which formed cysts of the slide.
231. An adult sporont from the original of Crawley and called by him Stenophora erratica. Crawley 1903a Pl. III, fig. 34.
232. Longitudinal section of a portion of the deutomerite, indicating the depply staining myonemes cut crossw-se, just within the epicyte wall.
233. A sporont in the process of contortive and progressive movement. The series was made at intervals of fifteen seconds.
234. Two sporonts in the process of rotation previous to cyst-formation. The sporonts are not attached.
235. A cyst still in rotation with a thin transparent wall.
236. A cluster of sporonts after half an hour on a slide, en-

Plate 9

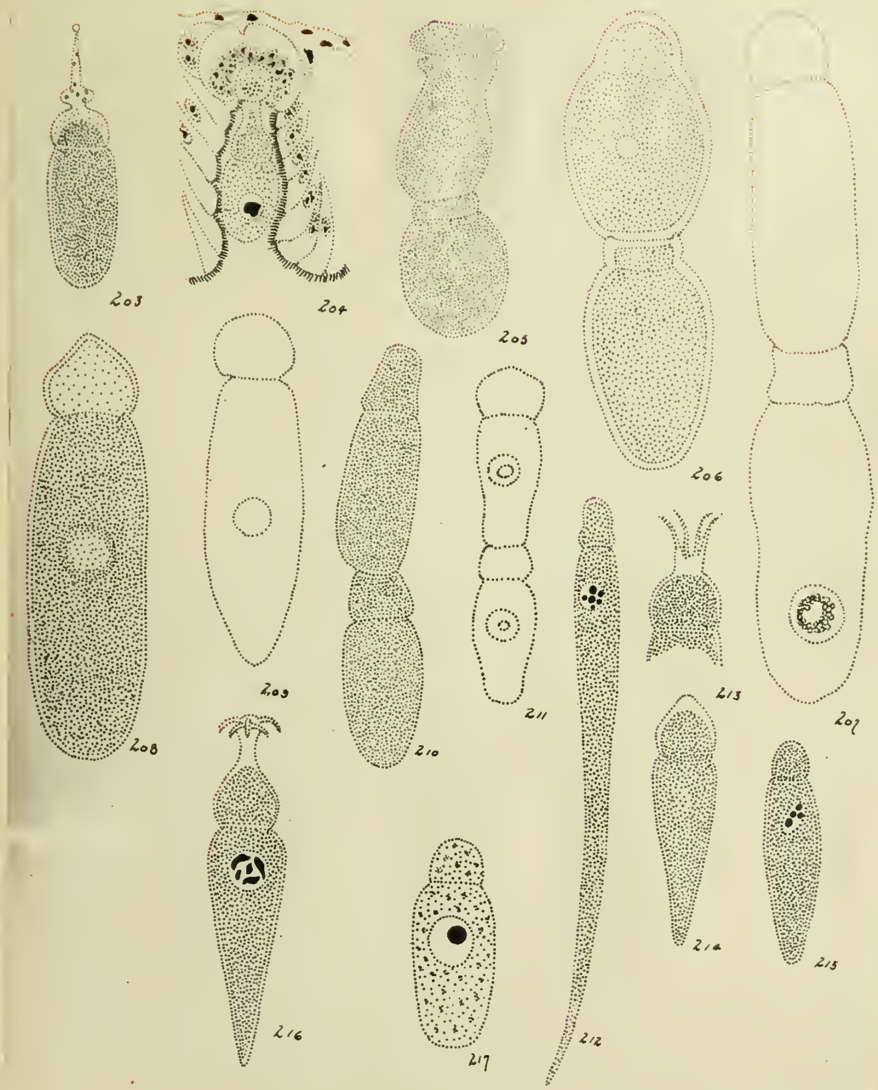
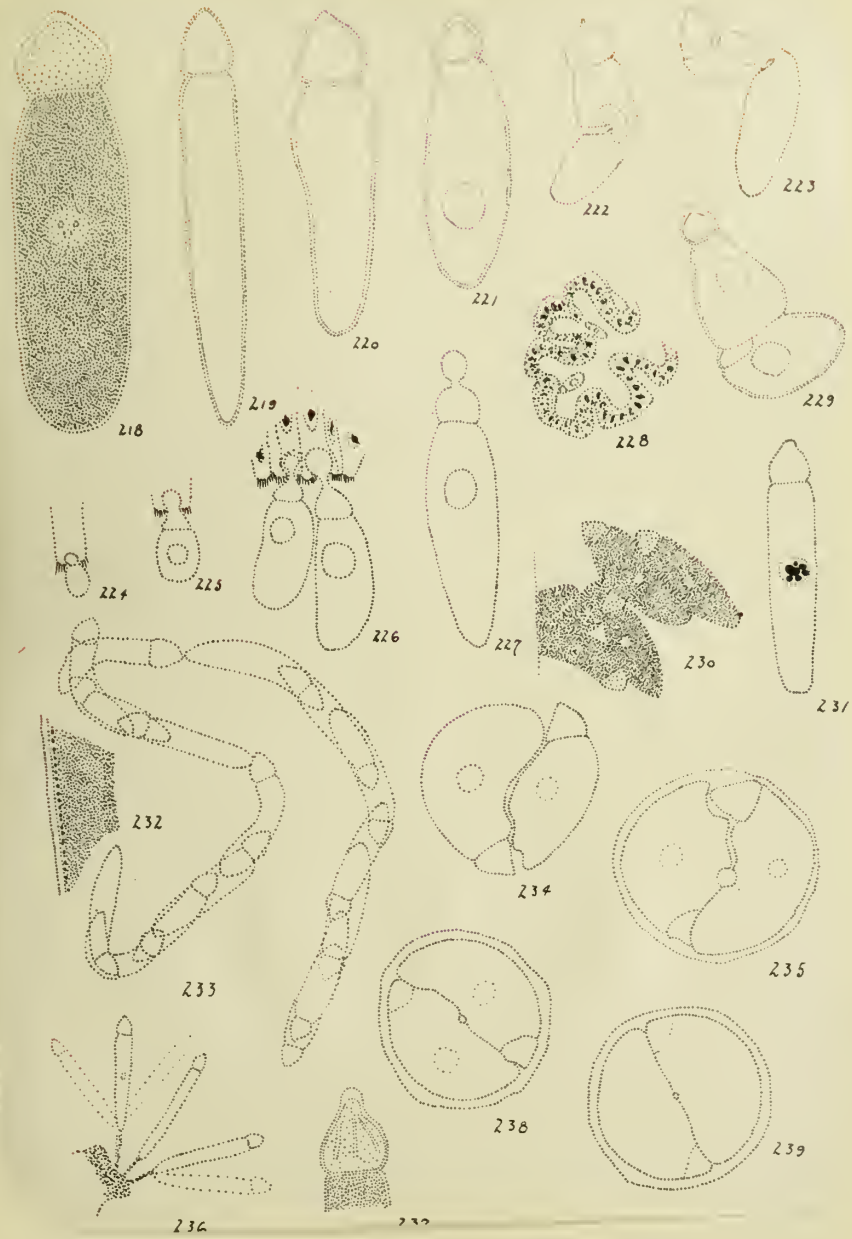


Plate 10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deavoring to free themselves from threads at the posterior end which hold them to the debris. The sporonts are greatly stretched owing to their efforts to move forward.

237. A pootomerite with an apical papilla. The animal is collapsing from evaporation of the medium.

238. A cyst still in rotation, the nuclei faintly visible, the protomerites still distinct and the transparent layer thick.

239. The nuclei have now disappeared and the protomerites are still visible as lighter areas.

240. The protomerites are visible as slightly less dense areas; the transparent layer has become still wider.

241. The outside layer is much wider than before and the inner mass smaller because of the exudation of liquids. The line of separation between the two sporonts is now obliterated and the cyst is a homogeneous mass.

242. The protoplasm is collected in small spherical masses.

243. Section of a sporont stained on the slide, showing the longitudinal striations and the myonemes which form a horizontal network of fibrillae.

244. A segment of the cyst in the stage shown in fig. 242. The gametes are being formed from the outer parts of these protoplasmic masses.

245. Six sporeducts are indicated by orange-colored condensation discs on the surface of the cyst-mass.

246. The sporeducts have grown from the periphery inward to the central part of the mass.

247, 248. The ducts extending outward from the periphery into the transparent cyst-wall.

249. A mature cyst from which the spores are being extruded in chains.

250. Cross-section of an intestine heavily infected with parasites; the gregarines remain in the epithelial region of the intestine rather than among the food masses where they would easily be swept along by peristaltic movement.

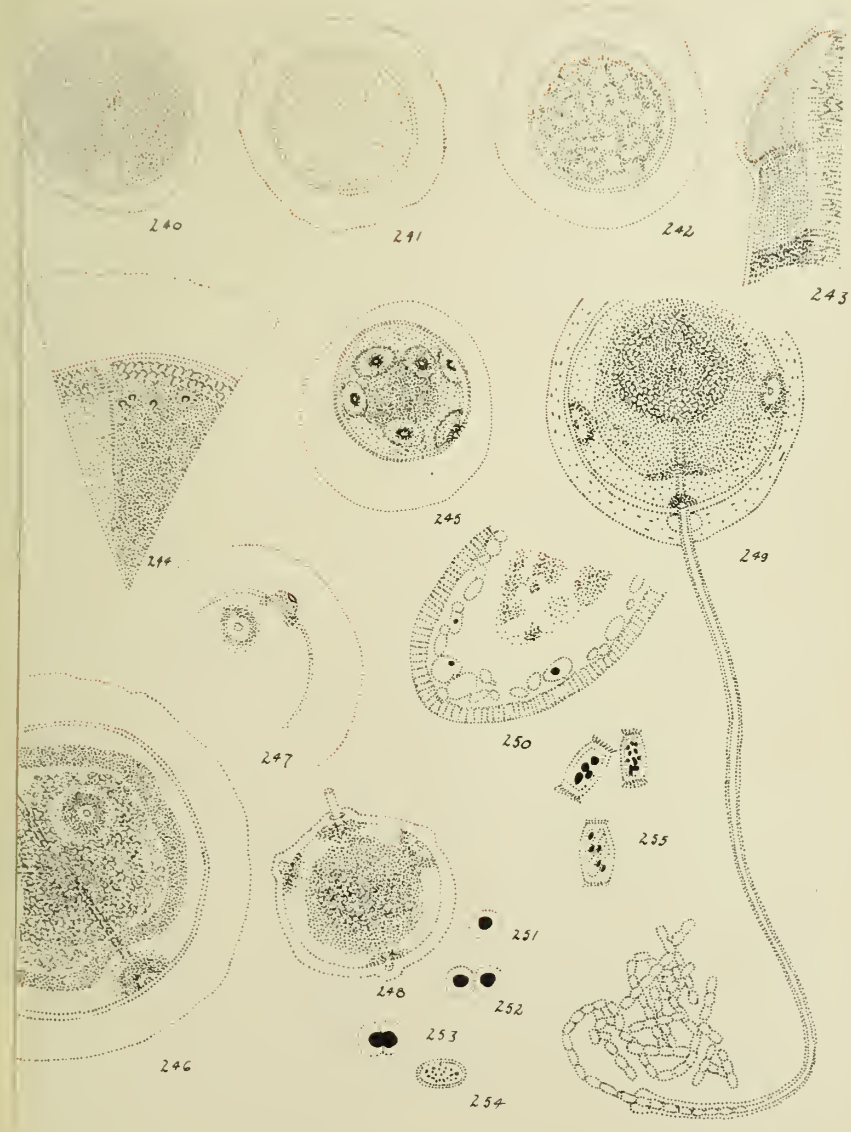
251. A gamete taken from a cyst which was crushed at the end of about thirty hours.

252. Two isogametes which have just fused, from a cyst of about thirty-five hours.

253. A later stage in the fusion of the isogametes.

254. A zygote formed by the fusion of the two gametes.

255. Ripe spores from a fully-developed cyst of about forty-eight hours.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Vita

The writer of this dissertation was born Dec. 8, 1886 at Fostoria, Michigan. She attended the graded and high school of this village and also the high school at Flint, Michigan, graduating from the latter institution in 1903. She entered Olivet College in 1906 and graduated in 1909, and taught in the high schools of Rockville Centre and Oyster Bay, Long Island, N.Y. for three years. In 1912-3 she was Assistant in Zoology in the University of Illinois, taking the M.S. degree in 1913. The summer of 1910 was spent in graduate work at Middlebury College (Vermont) and the summers of 1911, 12, 13, and 14 in course work and research at the Biological Laboratory of the Brooklyn Institute at Cold Spring Harbor, Long Island. During the years of 1913-14 and 1914-15 she has been a Fellow in Zoology in the University of Illinois.