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A DISCUSSION ON THE CLASSIFICATION OF THE THEILERIDAE.

W. O. NEITZ and B. C. JANSEN, Onderstepoort Laboratory.

The names assigned to members of a certain group of protozoa, at present included in the genus *Theileria,* have long been a subject of discussion, much of which has hopelessly intermixed zoological and nomenclatorial considerations. In a general review on the classification of the piroplasms Thomson and Hall (1933) mention that in the present state of our knowledge, it would seem that there is general agreement that there is only a single genus in the family Theileridae, namely *Theileria.*

We have carefully studied their paper, and have arrived at the conclusion that in the past various workers (Bettencourt, Franca and Borges, 1907; Du Toit, 1918; Theiler and Graf, 1928; Sergent, Donatien, Parrot and Lestoquard, 1929; Donatien and Sergent, 1930), believed that the presence of schizonts (Koch bodies) determined their inclusion in the genus *Theileria.* In doing so, little attention was paid to the erythrocytic stages of these parasites, even though Wenyon (1926) pointed out that in contradistinction to *Babesia mutans* (=*Theileria mutans*) the endoglobular stage of *Theileria parva* does not reproduce. In support of his assertion he states " that although the erythrocytic stages may sometimes be seen in pairs or occasionally in fours as in the cross forms, it is doubtful if these represent divisional stages as they do in the case of *B. mutans,* the morphological resemblance to which may be very striking. Actual division of *Th. parva* was never observed to take place in the living condition, though in stained films parasites which might be interpreted as in the process of division were sometimes seen. In *Th. parva* inoculation of blood will not as a rule convey infection, so that it is presumed that blood forms represent gametocytes which are destined to develop in the tick. If animals recover from the disease (East Coast fever) the parasites disappear from the blood, and this disappearance is absolute, for ticks can no longer be infected from them. In this respect again *Th. parva* differs from the species of *Babesia* (=*Th. mutans*) which, though disappearing microscopically, are still present for years after clinical recovery, as proved by the infectivity of blood on direct inoculation of other cattle, and by the fact that ticks may still infect themselves ". It should be mentioned at this stage that the development of a sterile immunity following recovery from East Coast fever is based on field observations made by Theiler (1921). His conclusion was subsequently confirmed experimentally by Du Toit (1928) and Neitz (1948).

The comments of Wenyon (1926) on the behaviour of the erythrocytic stages of *Th. parva* and *Th. mutans* are significant if one considers the basis on which the family Plasmodiidae Mesnil, 1903, is differentiated from the family Haemoproteidae *Doflein,* 1916. In the former, the schizogony occurs either in the endothelial cells lining the blood capillaries or in the hepatic cells as well as in the erythrocytes which also harbour gametocytes. In the Haemoproteidae the schizogony cycle

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occurs in the endothelial cells lining the blood capillaries, and the forms which appear in the red blood cells are gametocytes. A similar difference exists between the life-cycles of *Th. parva* and *Th. mutans*, and hence we believe that this justifies a revision of the classification of those Theilerias of which the vertebrate cycle of development is known. The hope is expressed that this amendment will lead to a clear understanding of the infectious agents responsible for East Coast fever and allied diseases.

The generic and specific nomenclatures of the *Theileria* spp. have undergone several changes. Originally the first three distinct species described from cattle were included in the genus *Piroplasma* Patton, 1895, and named *P. kochi* Stephens and Christophers, 1903 (=*P. parvum* Theiler, 1904); *P. annulatum* Dschunkowsky and Luhs, 1904; *P. mutans* Theiler, 1906. Bettencourt, Franca and Borges (1907) compared the life-cycle and morphology of *P. bigeminum* Smith and Kilborne, 1893, with that of *P. parvum* and *P. annulatum*, and concluded that the presence of schizonts in the developmental cycle of the latter two protozoa justified their removal from the genus *Piroplasma*, and placing them in a new genus *Theileria*. They were renamed *Theileria parva* and *Theileria annulata*. Franca (1909) transferred *P. mutans* to the genus *Theileria* even though he was aware that schizonts had not been demonstrated in the life-cycle of this protozoon. He considered that the resemblence that exists between the erythrocytic stages of *P. mutans* and *Th. parva* was sufficient reason for changing the generic name. Franca's modification of the nomenclature was not generally accepted. Theiler, Gray and Power (1914) who had seen the cross forms in this parasite suggested that it would be more reasonable to include *P. mutans* in the genus *Nuttallia* Franca, 1910, in which the same mode of multiplication occurs.

Thomson and Hall (1933) have given the following brief review on the classification of the members of the sub-order Piroplasmidea Wenyon, 1926. Franca (1917, 1918) classified the Piroplasmata and recognised the following genera: *Achromaticus* Dionisi, 1900; *Elleipsisoma* Franca, 1912; *Nuttallia* Franca, 1910; *Paraplasma* Seidelin, 1912, *Piroplasma* Patton, 1895; *Rangelia* Carini and Maciel, 1914; *Rossiella* Nuttall, 1912; *Smithia* Franca, 1910; *Theileria* Bettencourt, Franca and Borges, 1907. The first systematic study was that of Du Toit (1918) who modified Franca's scheme. He rejected the genera *Achromaticus*, *Elleipsisoma* and *Paraplasma* on grounds that they are not piroplasms. He retained two families, the Babesidae Poche, 1913, comprising seven genera (*Babesia* Starcovici, 1892; *Piroplasma, Nuttallia, Nicollia* Nuttall, 1908, *Smithia, Rossiella* and *Gonderia* Du Toit, 1918), and the family Theileridae Du Toit, 1918, comprising two genera (*Theileria* and *Rangelia*). The separation was based on the fact that members of the Babesidae multiply within the erythrocytes giving rise to either two or four daughter cells, while those of the Theileridae reproduce by schizogony in the lymphocytes and by binary fission in the erythrocytes.

Wenyon (1926) critically reviewed and completely revised Du Toit's classification. In the family Babesidae he discarded the separate generic names *Piroplasma, Nicollia, Nuttallia, Smithia, Rossiella* and *Gonderia* as well as the generic names *Babesiella* of Mesnil (1918) and *Microbabesia* of Sohns (1918), and substituted the single genus *Babesia*. In the family *Theileridae* he retained the single genus *Theileria*, and rejected the generic name *Rangelia* (*Rangelia vitalii* Pestana, 1910) on the grounds that there is insufficient evidence to justify differentiation of this parasite from *Babesia canis* (Piana and Galli-Valerio, 1895). He regarded the schizonts of *R. vitallii* as in reality nothing other than *Toxoplasma* or phagocytosed organisms.

In adopting the single genus *Babesia* in the family Babesidae, Wenyon (1926) drew attention to the fact that both in cattle and sheep the parasites could be separated on the basis of size into three groups, namely large, intermediate and very small forms. The species in cattle became *B. bigemina* (Smith and Kilborne, 1893) (largest form), *B. bovis* (Babes, 1888) (intermediate form) and *B. mutans* (Theiler, 1906) (smallest form). The species in sheep were named *Babesia motasi* Wenyon, 1926 (largest form), *B. ovis* (Babes, 1892) (intermediate form) and *B. sergenti* Wenyon, 1926 (smallest form). However, subsequent studies on the smallest forms in cattle and sheep showed that these parasites could not be retained in the genus *Babesia*.

From the brief historical review it becomes apparent that no less than four generic names, namely *Piroplasma, Theileria, Gonderia* and *Babesia,* had been assigned to the protozoon *Piroplasma mutans*. Brumpt (1923) concludes from circumstantial evidence that Theiler's species of *Piroplasma* belongs to the genus Theileria. No convincing evidence was available for the validity of any of the above-mentioned genera until Viljoen (1923), Martinaglia (1924), Viljoen and Martinaglia (1928), Doyle (1924) and Curson (1928) found schizonts in calves harbouring *Gonderia mutans*. These observations prompted Theiler and Graf (1928) to study the life-cycle of this protozoon more closely. In doing so, they found Koch bodies in several calves and concluded that *Gonderia mutans* should be named *Theileria mutans* and " that the genus *Gonderia* should be sunk in favour of the genus *Theileria* ". This suggestion was accepted by Sergent, Donatien, Parrot and Lestoquard (1929) who also encountered Koch bodies in cattle infected with *Theileria mutans*. Lestoquard (1929) demonstrated schizonts in splenectomized sheep and goats harbouring *Gonderia ovis* (= *Babesia sergenti* Wenyon, 1926) after the intravenous administration of cultures of Paratyphoid B. From this observation he deducted that *Gonderia ovis* Lestoquard, 1924, belongs to the genus *Theileria,* and proposed the name *Theileria recondita*.

A complete historical review of the literature dealing with Theileriosis in cattle and sheep has been given by Du Toit (1930). This contribution has done much to help workers to a clearer understanding of this important group of protozoa.

The description of *Theileria parva* by Theiler (1904), of *Theileria annulata* by Dschunkowsky and Luhs (1904) and of *Theileria mutans* by Theiler (1906) was followed by studies on this group of organisms in many parts of the world. A fourth species in cattle *Theileria dispar* Sergent, Donatien, Parrot, Lestoquard, Plantureux and Rougebief, 1924, was described in Algeria. Two parasites named *Theileria sergenti* Yakimoff and Dekhtereff, 1930, and *Theileria* (*Gonderia*) *orientalis* (Yakimoff and Sondatschenkov, 1931) have been described from cattle in Asia. It has not been possible to determine the validity of either species. They may be synonymous for either *Th. mutans* or *Th. annulata*.

The question is discussed by Du Toit (1930) as to whether all cases of Theileriosis in cattle which have been described in the literature fit into the four types mentioned above. He comes to the conclusion that there are intermediate stages between these forms. Altogether there are at least eight types of Theilerioses in cattle which can be distinguished. These he arranged in the order of virulence as follows:—

1. *Theileria parva.* South Africa. Mortality of 90 per cent to 100 per cent. Koch bodies are constantly present.
2. Theileriosis (amakebe). East Africa. The virulence is low. Mortality of about 15 per cent.

3. *Theileria dispar.* Algeria. Mortality of 20 per cent to 90 per cent.
4. Theileriosis. Morocco. A chronic or mild infection capable of becoming acute if animals are subjected to adverse conditions.
5. *Theileria annulata.* Tunis, Asia Minor, Russia. Mortality of 5 per cent to 20 per cent and sometimes even greater.
6. Theileriosis.
   (i) North Eastern Rhodesia. Koch bodies found (Turnbull, 1926).
   (ii) India. Koch bodies found (Cooper, 1926).
   (iii) Egypt. Koch bodies found (Doyle, 1924).
7. *Theileria mutans.* South Africa and Algeria. Strains with Koch bodies.
8. *Theileria mutans.* South Africa and Algeria. Strains without Koch bodies.

In (7) and (8) 999 cases out of 1,000 produce no symptoms or very slight anaemia. Under stress of circumstances Koch bodies may appear in small numbers. It would appear that *Th. mutans* (7) and (8) are identical.

In the family Theileridae there are, therefore, four named species which differ from one another in their virulence. Doubt is expressed by Du Toit (1930) whether the species of *Theileria* in cattle are "good" species. They might all be regarded as varieties or strains of one species. *Th. parva.* Recently Delpy (1949) has come to the conclusion that *Th. dispar* is synonymous for *Th. annulata,* thus leaving three named species of cattle ticks in the family Theileridae.

In sheep and goats two species of *Theileria* may be accepted provisionally. *Th. hirci* Dschunkowsky and Urodschevich, 1924, is highly pathogenic, while *Th. ovis* Rodhain, 1916, is non-pathogenic. Morphologically, however, these are indistinguishable. The history of their nomenclature has been excellently reviewed by Thomson and Hall (1933).

"The non-pathogenic form, *Th. ovis,* like *Th. mutans* in cattle, is associated with the presence of scanty Koch bodies (Lestoquard, 1929; Jansen and Neitz, 1955). Rodhain (1916) described a parasite in sheep which did not seem to produce Koch bodies, and thus resembled *Th. mutans* in that it was non-virulent. This parasite in sheep Rodhain considered as a new species, and he named it *Th. ovis.* Yakimoff (1916) commented on Rodhain's paper, and stated that at the third veterinary conference of Russia at Kharkov in 1913 he had already suggested the name *Th. ovis* for this parasite. In this statement Yakimoff (1916) gives no reference to a publication, and Thomson and Hall (1933) have been unable to trace in the literature any reference to a published account by Yakimoff in which the specific name suggested by him was mentioned.

The name for the non-pathogenic *Theileria* in sheep and goats would seem, therefore, to be *Th. ovis* Rodhain, 1916. Sergent, Parrot and Hilbert (1922) named the parasite *Gonderia ovis,* but Lestoquard (1929), having described Koch blue bodies in such infections, renamed the parasite *Th. recondita.* Wenyon (1926), in view of the fact that Koch bodies had not been described in the non-pathogenic form, considered it justifiable to transfer this organism to the genus *Babesia* and in doing so suggested a new specific name *Babesia sergenti.*

According to the evidence available the correct name for non-pathogenic *Theileria* of sheep is *Theileria ovis* Rodhain, 1916, and *Babesia sergenti* Wenyon, 1926, and *Theileria recondita* Lestoquard, 1929, become synonyms.

The pathogenic form in sheep, with Koch bodies, was first described in Sudanese sheep by Mason, 1915, and the following year in Egyptian sheep by Mason, 1916. Mason placed this parasite in the genus *Theileria* but did not give it a specific name. In 1918, however, Du Toit in his classification of the piroplasms gives this parasite the name *Th. ovis* and attributes the name to Littlewood, 1914. Donatien and Lestoquard (1920), without giving any references, again quote *Th. ovis* Littlewood, 1914, as the correct name for the pathogenic form in sheep and goats. The only justification for giving the name of Littlewood seems to be the fact that in his annual report he incorporated the work of Mason. This report was actually published in 1915. As far as can be ascertained there is no mention of specific names in Mason's account of this parasite either in 1915 or 1916, so that it would seem that neither Littlewood nor Mason named this species. On the other hand, Du Toit (1918) records the name *Th. ovis* which he attributes to Littlewood (1914). As the specific name—*ovis*—had, however, been already used for the non-pathogenic form of *Th. ovis* by Rodhain, 1916, it would seem that the correct name for the pathogenic form in sheep and goats is *Th. hirci* Dschunkowsky and Urodschevich, 1924, as correctly pointed out by Wenyon (1926). The name *Th. ovis* wrongly attributed to Littlewood in 1914 by Du Toit (1918) must be abandoned."

It is beyond the scope of this paper to consider the relatively large number of *Theileria* spp. of wild animals in detail. Priestly (1915) described *Th. tachyglossi* a small parasite of the erythrocytes of *Tachyglossus aculeatus,* an echidna of Australia. The blood forms resembled those of *Th. mutans* of cattle, while in the organs and also in the blood, structures resembling the schizonts of the same parasite were said to occur. *Theileria* spp. have been described in the giraffe, camel, warthog, monkey, polecat, mouse and in several species of antelopes and deer. In many of them no schizonts were found and hence, they were originally included in the genus *Gonderia.* In antelopes, namely the eland (*Taurotragus* sp.) Lichtenheld (1911), Bright's gazelle (*Gazelle* sp.) Montgomery (1924), topie (*Damaliscus* sp.) Hutchins (1924), hartebeest (*Sigmoceros* sp.) Ross (1924), and the bushbuck (*Tragelaphus* sp.) *Theiler* (1909) and Neitz (1931), Koch bodies as well as the erythrocytic stages of the parasites were found. These observations prompted the investigators to include them in the genus *Theileria.* However, from the description of *Cytauxzoon sylvicaprae* Neitz and Thomas, 1948, a parasite of the duiker (*Sylvicapra grimmia* L.) which multiplies by schizogony in the histiocytes and by fission in the erythrocytes, it appears that at least some of the above-mentioned *Theileria* spp. may in reality be *Cytauxzoon* spp. In order to avoid unnecessary confusion in the generic nomenclature only the species *Th. tachyglossi* and *C. sylvicaprae,* of which the vertebrate life-cycle is known, will be included in the family Theileridae.

The classification of the family Theileridae by Du Toit (1918) which has been modified by Thomson and Hall (1933), Neitz and Thomas (1949) and Delpy (1950) is as follows:—

Sub-order: **PIROPLASMIDEA** Wenyon, 1926.

Family: **Theileridae** Du Toit, 1918.

Genus: *Theileria* Bettencourt, Franca and Borges, 1907.

Members of this genus are minute and rounded or rod-shaped organisms. Schizogony occurs in the cells of the lymphatic system. Members of the family Ixodidae serve as vectors.

Th. parva (Theiler, 1904).

Th. annulata (Dschunkowsky and Luhs, 1904).

Synonyms:

Th. dispar Sergent, *et al.*, 1924.

Th. turkestanica Oboldueff and Galouzo, 1928.

Th. mutans (Theiler, 1906).

Synonyms:

Babesia mutans Wenyon, 1926.

Gonaeria mutans Du Toit, 1918.

Th. hirci Dschunowsky and Urodschevich, 1924.

Synonym: *Theileria ovis* Du Toit, 1918.

Th. ovis Rodhain, 1916.

Synonyms:

Gonaeria ovis Lestoquard, 1924.

Babesia sergenti Wenyon, 1926.

Theileria recondita Lestoquard, 1929.

Th. tachyglossi Priestly, 1915.

Genus: *Cytauxzoon* Neitz and Thomas, 1948.

C. sylvicaprae Neitz and Thomas, 1948.

The nomenclature used in this classificatory list is based on the morphology and some biological characteristics presented by the Theilerias. Consideration of these criteria shows that Theiler and Graf (1928), Sergent *et al.* (1929), Lestoquard (1929), and Du Toit (1930) contend that schizogony in the lymphocytes, and division of the erythrocytic forms into two or four daughter cells justified transferring *Gonderia mutans* and *Gonderia ovis* from the family Babesidae to the family Theileridae. This mode of reproduction has also been observed in *Th. annulata* (=*Th. dispar*) by Sergent, Donatien, Parrot and Lestoquard (1945), in *Th. hirci* by Dschunkowsky and Luhs (1924), and Baumann (1929) and in *Th. ovis* by Wenyon (1926), Sergent *et al.* (1923), Lestoquard (1924, 1926), and Enigk (1953). In contradistinction to this mode of reproduction, Wenyon (1926) states that *Th. parva* multiplies only by schizogony in the lymphocytes and not by fission in the red blood cells. Reichenow (1940) also failed to demonstrate any divisional forms in the erythrocytes of cattle affected with East Coast fever. In this connection it should be mentioned that the writers have had an opportunity of studying the life-cycles of pure infections of *Th. annulata*, *Th. mutans* and *Th. ovis* in the vertebrate hosts. The infectious agents were transmitted by means of infected ticks to animals known to be free from blood parasites. Splenectomy of naturally recovered animals was followed by a re-appearance of the erythrocytic stages of these parasites within a period of three weeks after the operation. Divisional forms could readily be demonstrated in the peripheral circulation thus confirming the observations of previous workers. In contradistinction to this manifestation Du Toit (1928) and Neitz (1948) established that splenectomy did not interrupt the immunity in East Coast fever, and that the erythrocytic stages of *Th. parva* failed to appear for periods of up to eight weeks after the operation.

The difference between the behaviour of the erythrocytic stages of *Th. parva* and that of the remaining *Theileria* spp. and the *Cytauxzoon* sp. (*vide supra*) is regarded as significant and a sound reason for revising the classification of these micro-organisms, particularly if one considers the basis on which the *Plasmodia* spp. (schizogony within the endothelial cells lining the blood capillaries or hepatic cells as well as within the erythrocytes) are differentiated from the *Haemoproteus* spp. (schizogony only within the endothelial cells lining the blood capillaries).

In accepting the behaviour of the erythrocytic stages of the *Theileria* spp. as an additional classificatory basis it is proposed to retain the generic and specific name of *Theileria parva,* and to transfer the remaining *Theileria* spp. to a separate genus. In order to avoid unnecessary confusion in the nomenclature it is suggested that the generic name *Gonderia,* Du Toit, 1918, be reinstated, and that for the purpose of this classification, it be redefined as indicated below in the revised classificatory list.

Reasons have been given why the *Theileria* spp. should be placed into three separate genera, namely *Theileria,* Bettencourt, Franca and Borges, 1907, *Gonderia* (Du Toit, 1918) and *Cytauxzoon,* Neitz and Thomas, 1948. The question now arises as to whether these three genera should be retained in the family Theileridae. Consideration of the criteria used for distinguishing between the family Plasmodiidae Mesnil, 1903, and the family Haemoproteidae Doflein, 1916 (*vide supra*) suggests that in principle they are equally applicable in the case of the genera *Theileria, Gonderia* and *Cytauxzoon.* It is, therefore, proposed that *Th. parva* (Theiler, 1906), be retained in the family Theileridae and that *Gonderia* (*Theileria*) *annulata* (Dschunkowsky and Luhs, 1904), *Gonderia* (*Theileria*) *mutans* (Theiler, 1906), *Gonderia* (*Theileria*) *hirci* (Dschunkowsky and Urodschevich, 1924), *Gonderia* (*Theileria*) *ovis* (Rodhain, 1916), *Gonderia* (*Theileria*) *tachyglossi* (Priestly, 1915), and *Cytauxzoon sylvicaprae* Neitz and Thomas, 1948, be included in a separate family for which the name Gonderidae is proposed. The definitions for the families Theileridae and Gonderidae are given below in the classificatory list.

The last question of systematic importance which arises out of this discussion is whether or not the two families Theileridae and Gonderidae should be retained in the sub-order Piroplasmidea, Wenyon, 1926. The difference between the developmental cycle of the family Babesidae (absence of a schizogonous cycle) and that of the families Theileridae and Gonderidae (presence of the schizogonous cycle in the leucocytes) is so great that there is no real justification for retaining the latter two families in the sub-order Piroplasmidea. It is, therefore, suggested that the families Theileridae and Gonderidae be placed into a new sub-order for which the name Leucosporidea is proposed. In doing so the writers accept the views of Gonder (1910, 1911), Cowdry and Danks (1933) and Sergent, Donatien, Parrot and Lestoquard (1936) that *Theileria parva* and *Gonderia* (*Theileria*) *annulata* (=*Theileria dispar*) multiply by schizogony and sporogony, a process of reproduction characteristic of the Order Coccidia Leuckart, and of the Class Sporozoa Leuckart. The definition for the sub-order Leucosporidea is given below in the classificatory list.

Having surveyed in detail the complicated history of the nomenclature of the protozoa commonly referred to as *Theileria* parasites, and having indicated the criteria, for what we believe to be a more satisfactory basis for their classification, we submit in summary form the revision of the classification. For the sake of completeness the generic and specific names as well as the generic and specific synonymy will be included. It is self evident that a large number of *Theileria* spp. or *Gonderia* spp. described from wild animals cannot be incorporated in this scheme. In order to avoid further confusion it is suggested that they be referred to by the generic name already assigned to them, and that their inclusion into this system be undertaken when all the phases of the life-cycle in the vertebrate host have been established.

The revised classification of the family Theileridae is as follows:—

Sub-order: **LEUCOSPORIDEA** Neitz and Jansen, 1955.

In this sub-order are included certain parasites which inhabit either lymphocytes or histiocytes and erythrocytes, but do not form pigment (haemozoin) characteristic of members of the sub-order Haemosporidiidea Danilewsky. They multiply by schizogony and finally invade the erythrocytes, within which they occur as round, ovoid, rod-like or irregular forms. These parasites, as far as is known, are transmitted by ticks of the family Ixodidae Murray, 1877. There are two families in this sub-order, the Theileridae and Gonderidae.

1. Family: **Theileridae** Du Toit, 1918.

Parasites which multiply by schizogony in the lymphocytes, and finally invade the erythocytes. The forms in the red blood corpuscles do not reproduce, and are possibly gametocytes or gametes. The family is represented by a single genus, *Theileria*.

Genus: *Theileria* Bettencourt, Franca and Borges, 1907.
Theileria parva (Theiler, 1904).

Synonyms: *Piroplasma kochi* Stephens and Christophers, 1903;
Piroplasma parvum Theiler, 1904;
Theileria kochi (Stephens and Christoffers, 1903).

2. Family: **Gonderidae** Neitz and Jansen, 1955.

Parasites which multiply by schizogony in either the lymphocytes (*Gonderia* sp.) or histiocytes (*Cytauxzoon* sp.) and finally invade the red blood corpuscles. The forms in the erythrocytes reproduce by division into two or four daughter individuals, the latter giving rise to the characteristic cross forms. The final stage of the parasites is possibly a gametocyte or a gamete. This family is represented by two genera, *Gonderia* and *Cytauxzoon*.

Genus: *Gonderia* (Du Toit, 1918).

Members of this genus multiply by schizogony in the lymphocytes and by fission in the erythrocytes.

Gonderia annulata (Dschunkowsky and Luhs, 1904).

Synonyms:
Piroplasma annulatum Dschunkowsky and Luhs, 1904;
Theileria annulata (Dschunkowsky and Luhs, 1904);
Theileria dispar Sergent *et al.*, 1924;

Theileria turkestanica Oboldueff and Galouzo, 1928.

Gonderia mutans (Theiler, 1906).

Synonyms:
Piroplasma mutans Theiler, 1906;
Theileria mutans (Theiler, 1906).

Gonderia hirci (Dschunkowsky and Urodschevich, 1924).

Synonyms:
Theileria ovis Du Toit, 1918;
Theileria hirci Dschunkowsky and Urodschevich, 1924.

Gonderia ovis (Rodhain, 1916).

Synonyms:
Theileria ovis Rodhain, 1916;
Babesia sergenti Wenyon, 1926;
Gonderia ovis Lestoquard, 1924;
Theileria recondita Lestoquard, 1929.

Gonderia tachyglossi (Priestly, 1915).

Synonym: *Theileria tachyglossi* Priestly, 1915.

Genus: *Cytauxzoon* Neitz and Thomas, 1948.
Members of this genus multiply by schizogony in cells of the histiocytic series and by fission in the erythrocytes.
Cytauxzoon sylvicaprae Neitz and Thomas, 1948.

Conclusions Regarding the Classification.

The morphological similarity between the members of the genera *Theileria* and *Gonderia* in domestic animals makes their differentiation extremely difficult. In making a differential diagnosis veterinarians and zoologists often are compelled to take the pathogenicity and the epizootology into consideration. In doubtful cases it may even be necessary to resort to *in vivo* cross-immunity tests before a final identification can be made. From this it becomes evident that a great deal of work will have to be done before the " intermediate stages " of the *Theileria* spp. referred to by Du Toit (1930) can be identified. From the observations on the artificial transmission of East Coast fever (Theiler, 1912; Theiler and Du Toit, 1929) and of Tzaneen disease (*Gonderia mutans* infection) (De Kock, Van Heerden, Du Toit and Neitz, 1937) it becomes apparent that the infectious agents cannot be maintained by serial passages as has been possible in the case of *Gonderia annulata* (Sergent, Doratien, Parrot and Lestoquard, 1945). The opinion is expressed that the undetermined species referred to by Du Toit (1930) may behave in a similar way. For systematic studies, therefore, it will be necessary to determine the vectors of these parasites. From this it is obvious that many years will elapse before the classification of this group of micro-organisms can be placed on a permanent basis.

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