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THE LEUCOCYTOZOIDAE OF SOUTH AFRICAN BIRDS: CAPRIMULGIDAE, COLUMBIDAE, GRUIDAE AND SPHENISCIDAE

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ABSTRACT

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Four species of *Leucocytozoon*, *L. caprimulgi* of the Caprimulgidae (nightjars), *L. marchouxi* of the Columbidae (pigeons and doves), *L. grusi* of the Gruidae (cranes) and *L. tawaki* of the Spheniscidae (penguins) are re-described. *Leucocytozoon turtur* is declared a synonym of *L. marchouxi*.

INTRODUCTION

The nightjars of the family Caprimulgidae are a group of primarily ground-nesting, nocturnal insectivorous birds widely distributed throughout both the Old and New Worlds. Only 31 species have been examined for haematozoa and 10 species have been recorded with blood parasites, three with *Leucocytozoon* (Bennett, Bishop & Woodworth-Lynas, 1982). Kerandel (1913) described *Leucocytozoon caprimulgi* from the Mozambique nightjar *Caprimulgus (= Scotornis) fossii*. The species has not been recorded in Africa since that time and is herein re-described.

The Columbidae represent about 300 species of primarily gramivorous and fructivorous birds with a cosmopolitan distribution. As a group, their haematozoa have been exceptionally well-studied and 100 species have been recorded as parasitized with one or more genera of blood parasites (Bennett *et al.*, 1982). Mathis & Leger (1910) described *Leucocytozoon marchouxi* from *Turtur humilis (= Streptopelia tranquebarica)*, a parasite recorded in over 30 species of columbids. This parasite has not been re-described since 1910.

The Gruidae represent 15 species of cranes, primarily Old World in distribution. This rather ancient family appears to be in retreat with at least one member, the whooping crane *Grus americana*, on the endangered list. Bennett, Khan & Campbell (1974) described *Leucocytozoon grusi* from *Grus canadensis* and leucocytozoids have only been recorded in two other members of this family, both in Africa (Bennett *et al.*, 1982). The species is re-described herein.

Fallis, Bissett & Allison (1976) described *Leucocytozoon tawaki* from the Fiordland crested penguin *Eudyptes pachyrhynchus* in New Zealand and detailed its sporogony in three species of ornithophilic simuliids of the genus *Austrosimulium*. Recently Earlé, Bennett & Brossy (1992) reported the occurrence of *Leucocytozoon tawaki* in the jackass penquin *Spheniscus demersus*, the first report of this species outside its type locality. *Leucocytozoon tawaki* is re-described from the parahapantotype as well as South African blood smears from the respective penguin hosts.

All descriptions and re-descriptions are based on the protocols recently developed by Bennett, Earlé, Peirce, Huchzermeyer & Squires-Parsons (1991) in an attempt to obtain more precise descriptions that will permit quantitative comparison of the various leucocytozoid species.

MATERIALS AND METHODS

Materials used in this study were deposited in the collection of the International Reference Centre for Avian Haematozoa (IRCAH) by collaborators around the world. Blood smears were air-dried and usually fixed with 100 % methanol or ethanol, although some material was also fixed in May-Grünwald-Giemsa. The smears were stained with Giemsa's stain either at the time of preparation or later when they were received at the Centre. The morphological characters (Bennett *et al.*, 1992) were obtained by drawing the appropriate cells with the aid or a camera lucida and determining the lengths and areas with a Zeiss MOP-3 Digital Analyzer. Microgametocytes were subject to the same scrutiny as were the macrogametocytes and found to have essentially the same dimensions with the exception of the much larger and light-staining parasite nucleas, a feature typical of most apicomplexan parasites. In the interests of brevity, therefore, the measurements of the microgametocytes are not presented in tabular form but if a major variation from the macrogametocyte is noted, this is cited in text. Photomicrographs were taken with a Zeiss Photomicroscope III. All material used as the basis of these descriptions have been deposited in the collection of the International Reference Centre for Avian Haematozoa.

TAXONOMIC REVIEW

FAMILY CAPRIMULGIDAE

Leucocytozoon caprimulgi Kerandel, 1913

Type host: the Mozambique nightjar *Caprimulgus fossii* (Hartlaub)

Type locality Haute Sangha, Belgian Congo (Zaïre)

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TABLE 1 Morphometric parameters (in μm) of the macrogametocytes of the leucocytozoids of the Caprimulgidae, Columbidae, Gruidae and Sphenicidae

	L. caprimulgi	*L. marchouxi*	R *L. grusi* F		*L. tawaki*
N* =	15	45	20	25	60
Parasite and nucleus					
Maximum diameter/length	14,1 (1,2)	14,6 (1,4)	13,8 (1,1)	14,4 (2,0)	15,8 (1,4)
Minimum diameter/width	11,3 (1,3)	11,7 (1,0)	11,8 (0,9)	11,5 (1,8)	13,4 (1,1)
Periphery of parasite	42,4 (3,3)	42,9 (2,5)	40,9 (2,8)	46,8 (4,2)	46,3 (3,1)
Area of parasite	127,8 (12,3)	133,9 (14,2)	126,6 (13,7)	161,3 (25,8)	163,1 (17,7)
Minimum diameter/width nucleus	4,9 (0,8)	4,3 (0,8)	4,4 (0,9)	5,0 (1,0)	5,6 (1,0)
Minimum width/diameter nucleus	2,9 (0,5)	2,6 (0,5)	2,7 (0,6)	2,8 (0,5)	3,4 (0,8)
Area of nucleus	10,9 (2,0)	8,7 (2,2)	8,8 (2,6)	10,2 (2,9)	14,6 (3,3)
Host cell-parasite complex					
Maximum length/diameter	17,2 (1,6)	15,9 (1,3)	15,4 (1,5)	24,4 (4,2)	17,6 (1,6)
Minimum length/diameter	17,2 (1,6)	13,1 (1,2)	13,1 (11,3)	14,1 (1,5)	14,9 (1,1)
Area of hot cell parasite complex	166,9 (13,2)	161,1 (15,5)	154,6 (15,0)	224,8 (27,3)	198,9 (22,0)
Length parasite periphery covered by complex nucleus	15,8 (2,6)	18,9 (4,8)	15,7 (2,2)	16,4 (2,1)	18,2 (2,3)
Area of host cell nucleus	39,1 (7,4)	27,3 (6,8)	28,0 (6,3)	27,5 (5,1)	35,8 (9,0)

* N = sample size; means followed by standard deviation in parentheses; R = round morph; F = fusiform morph

Macrogametocyte (Fig. 1–3; Table 1). Parasite with round morph only. Parasite medium to small, occupying 75 % of the area of the host-cell parasite complex, round to broadly ovoid; parasite nucleus large, round to elliptical, usually without a marked karyosome, occupying 8,5 % of the area of the parasite; numerous small vacuoles present; nucleus of host-cell parasite complex as a thick band, sometimes as a cap, covering 37 % of the periphery of the parasite and occupying 23 % of the area of the hoste cell-parasite complex.

Microgametocyte (Fig. 4). Closely similar in morphology but up to 20 % smaller than the macrogametocyte.

Basis of description. Neohapantotype. Blood film No. 107260 from the fierynecked nightjar *Caprimulgus pectoralis* Cuvier, collected by Neser, Luipershoek, Republic of South Africa on 6 October 1989.

Additional hosts and distribution. All leucocytozoids reported for the Caprimulgidae by Bennett *et al.* (1982) can be ascribed to this species. The known distribution ranges from Russia through the eastern Mediterranean and the African continent; presumably it can occur throughout the range of the family.

Comments. *Leucocytozoon caprimulgi* is a small and non-distinctive leucocytozoid that appears similar to most of the other small, round leucocytozoids. It would be difficult to identify solely on the basis of morphology without knowledge of the host. Its occurrence in a distinct non-passerine family (which have the bulk of the small, round leucocytozoids) is of sufficient weight to justify its retention as a species until experimental crosstransmissions prove it to be otherwise.

This parasite is not of common occurrence in the nightjars; only one of 44 caprimulgids examined in northern South Africa was infected with *Leucocytozoon caprimulgi* (Earlé, Bennett, Du Toit, De Swardt & Herholdt, 1991) This may be the result of the habits of these birds which tend to roost and nest on the ground and rarely perch in trees, thus effectively reducing contact and attack by the potential ornithophilic simuliid vectors which usually feed on hosts at some height above the ground.

FAMILY COLUMBIDAE

Leucocytozoon marchouxi Mathis & Leger, 1910

Type host: the red turtle dove, *Turtur humilis (= Streptopelia tranquabarica)* (Hermann)

Type locality: Hanoi (Haiphong) Vietnam

Synonyms: *Leucocytozoon turtur* Covaleda Ortega & Gallego Berenguer, 1946

Leucocytozoon turtur orientalis Yakunin, 1972

NOMEN NUDUM: *Leucocytozoon minchini* Yakunin, 1976

Macrogametocyte (Fig. 5–8; Table 1). Parasite with round morphs only. Parasite moderately small but occupying 83 % of the area of the host cell-parasite complex, round to broadly ovoid; parasite nucleas round to elliptical usually with marked karyosome, occupying 6,5 % of the area of the parasite; vacuoules not prominent; volutin granules frequently seen; nucleus of host cell-parasite complex either as a marked cap or a thin band, covering 44 % of the periphery of the parasite and occupying only 17 % of the area of the host cell-parasite complex.

Microgametocyte (Fig. 9–10). Microgametocyte similar morphologically to the macrogametocyte but 5–10 % smaller in most dimensions.

Basis of descriptions. Blood films No. 21211 from the mourning dove *Zenaida macroura* collected by Herman in Kern Co., California, U.S.A. on 11 June 1946; blood film No. 104005 from the Cape turtle dove *Streptopelia capicola* collected by Earlé, Bloemfontein, Republic of South Africa on 26 November 1988; blood film No. 104642 from the laughing dove *Streptopelia senegalensis* collected by De Swardt, Muurkraal, Republic of South Africa on 7 June 1989.

Additional records and distribution. All columbids reported with *Leucocytozoon* by Bennett *et al.*

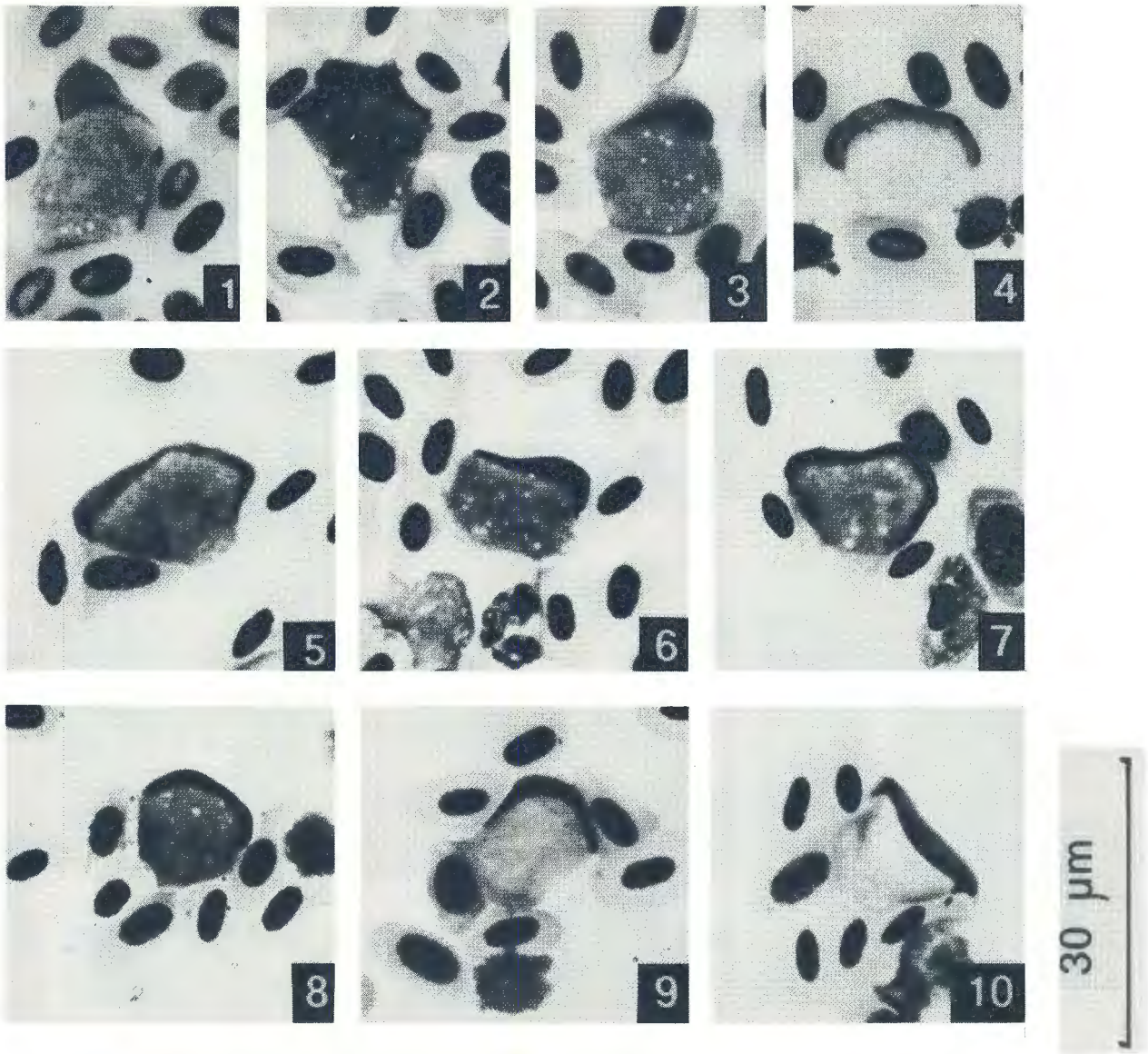

FIG. 1–4 *Leucocytozoon caprimulgi.* Fig. 1–3, macrogametocytes; Fig. 4, microgametocyte
FIG. 5–10 *Leucocytozoon marchouxi.* Fig. 5–8, macrogametocytes; Fig. 9–10, microgametocytes

(1982) can be referred to *L. marchouxi.* The parasite is presumably distributed throughout the cosmopolitan range of the Columbidae.

Comments. *Leucocytozoon marchouxi* is a small, round leucocytozoid with little to distinguish it from a number of other similar parasites. Its occurrence in the Columbidae is the primary characteristic to separate it as a distinct species. Experimental confirmation of this point is required, but the ease of maintaining columbids in captivity should provide ready host and experimental material to test cross-infectivity.

In 1946, Covaleda Ortega & Gallego Berenguer described a leucocytozoid from the turtle dove *Streptopelia turtur* which was identical in morphology and measurements presented to *L. marchouxi.* Although the Spanish authors referred to Giovannola's (1936) illustration of a leucocytozoid from *Trutor communis* (?) and Franchini's (1924) description of leucocytozoid from a columbid as being the same as *Leucocytozoon turtur,* they were unaware that Mathis & Leger had named the same parasite in 1910 from *Streptopelia tranquebarica* and that Leger (1913) had identified *L. marchouxi* from *Streptopelia turtur.* Clearly, *Leucocytozoon turtur* is the same parasite as *Leucocytozoon marchouxi* and *L. turtur* is herein synonymized with *Leucocytozoon marchouxi.*

Yakunin (1972) isolated a leucocytozoid from the blood of the "eastern" turtle dove *Streptopelia turtur* which he termed *Leucocytozoon turtur orientalis.* The few measurements and illustration provided are

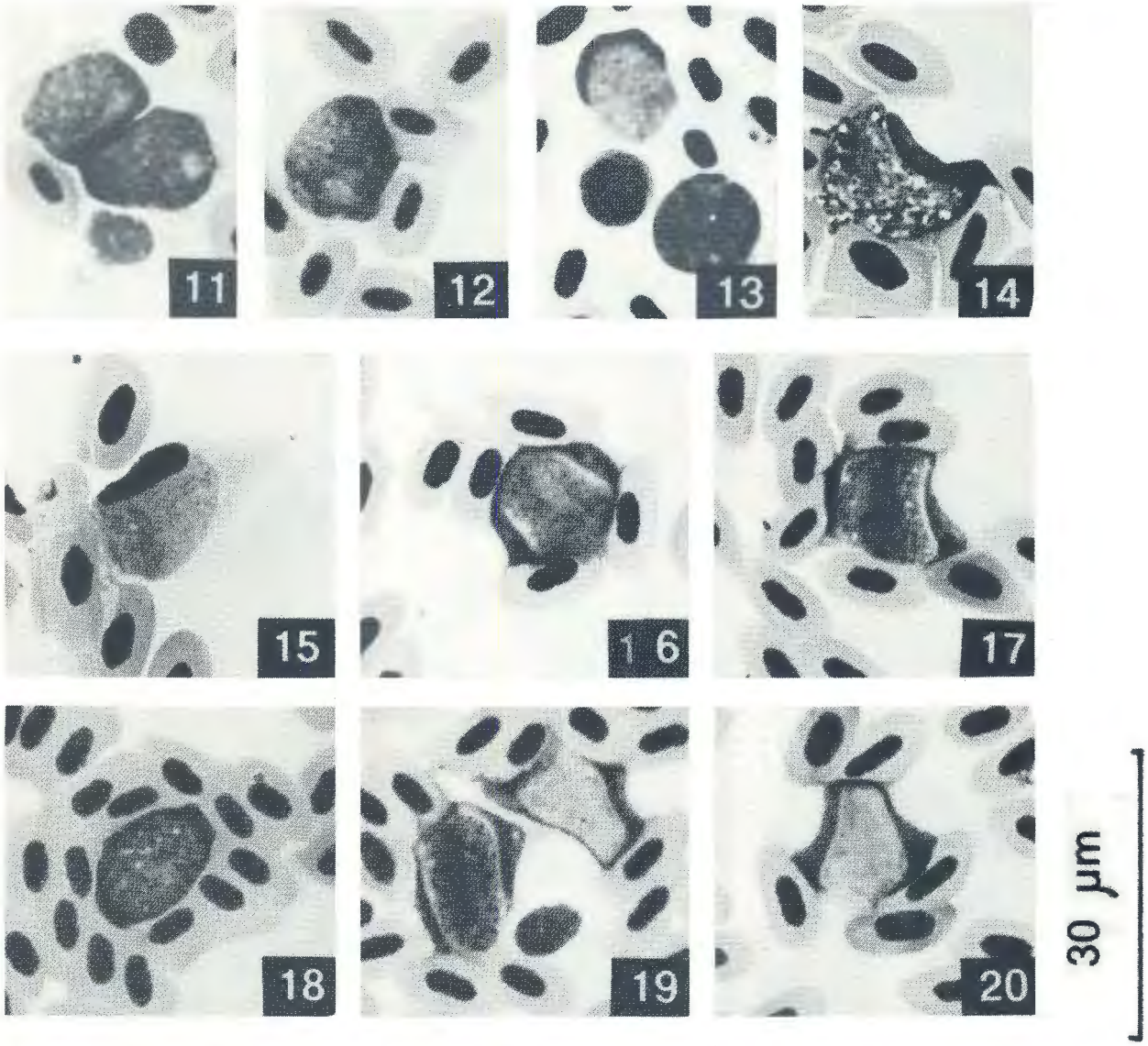

FIG. 11–15 *Leucocytozoon grusi*. Fig. 11–13, round morphs or macrogametocytes; Fig. 14, fusiform macrogametocyte; Fig. 13, round microgametocyte; Fig. 15, fusiform microgametocyte

FIG. 16–20 *Leucocytozoon tawaki*. Fig. 16–19, macrogametocytes; Fig. 19–20, microgametocytes

clearly those of *Leucocytozoon marchouxi* and *L. turtur orientalis* falls in synonymy with *L. marchouxi*.

In 1976, Yakunin used the term *Leucocytozoon minchini* for a leucocytozoid he found in turtle doves *Streptopelia turtur* in Kazakhstan. This designation was used in a list of parasites found and is unaccompanied by description or illustration. It is a classic *nomen nudum* and is herein so declared.

FAMILY GRUIDAE

***Leucocytozoon grusi* Bennett, Khan & Campbell, 1974**

Type host: the sandhill crane *Grus canadensis* L.

Type locality: Payne's Prairie, Florida, U.S.A.

Macrogametocyte (Fig. 11–15; Table 1). Parasite with both round and fusiform morphs. Round morph (Fig. 11–13). Parasites medium large, occupying 82 % of the area of the host cell-parasite complex, round to broadly ovoid; parasite nucleus broadly ovoid to elliptical, usually with marked karysome, occupying 7 % of the area of the parasite; vacuoles not prominent and volutin granules usually absent; nucleus of host cell-parasite complex as a short, blocky cap, covering 39 % of the periphery of the parasite and occupying only 18 % of the area of the host cell-parasite complex. Fusiform morph (Fig. 14; Table 1). Parasite of moderately large size, occupying 72 % of the area of the host cell-parasite complex, round to broadly ovoid; parasite nucleus round to broadly ovoid and elliptical, usually with a marked karyosome, occupying 6 % of the area of the parasite; vacuoles prominent in some speci-

mens, not as marked in others; volutin granules frequently present; nucleus of host cell-parasite complex as a short, thin band, rarely cap-like, covering 36 % of the periphery of the parasite and occupying only 12 % of the area of the host cell-parasite complex.

Microgametocyte (Fig. 13, 15). Microgametocyte similar in morphology and size to the macrogametocyte.

Basis of description. Parahapantotype. Blood film No. 29789 from the sandhill crane, *Grus canadensis* collected by Forrester, Payne's Prairie in June, 1973.

Additional hosts and distribution. All records of *Leucocytozoon* cited by Bennett *et al.* (1982) can be ascribed to *Leucocytozoon grusi.* Bennett *et al.* (1974) discuss the records of this parasite in the African crowned cranes *Balearica pavonina* and *B. regulorum.* The distribution of the parasite follows the distribution of the family Gruidae.

Comments. *Leucocytozoon grusi* has a distinctive fusiform gametocyte which readily separates it from all leucocytozoids with fusiform morphs. The fusiform gametocyte is distinctive because the parasite itself is round to broadly ovoid lying in a typically fusiform host cell. Other fusiform leucocytozoids are usually narrowly elongated or highly elliptical in shape, lying within the fusiform host cell. In addition, the host cell nucleus is small in comparison to those of other fusiform species of *Leucocytozoon.* The round morph, however, is rather similar to most other leucocytozoids with round gametocytes.

FAMILY SPHENISCIDAE

***Leucocytozoon tawaki* Fallis, Bisst & Allison, 1976**

Type host: the Fiordland crested penguin, *Eudyptes pachyrhynchus* Gray.

Type locality: Jackson's Head, South Island, New Zealand.

Macrogametocyte (Fig. 16–19; Table 1). Parasites with round morphs only. Parasite of medium-large size, round to broadly ovoid, occupying 82 % of the area of the host cell-parasite complex; parasite nucleus large, broadly ovoid to elliptical, frequently with marked karyosome, occupying 9 % of the area of the parasite; vacuoles prominent and volutin granules numerous and pronounced; nucleus of host cell variable but usually as a thick band but sometimes forming a cap, covering 39 % of the periphery of the parasite and occupying only 18 % of the area of the host cell-parasite complex.

Microgametocyte (Fig. 19–20). Morphology closely similar to that of the macrogametocyte but about 5 % smaller in most dimensions.

Basis of description. Parahapantotype. Blood film No. 40451 from fiordland crested penguin *Eudyptes pachyrhynchus* collected by Fallis at Jackson's Head, South Island, New Zealand on 2 February 1975. Additional material: blood film No. 114915 from the Cape (jackass) penguin *Spheniscus demersus* collected by Brossy at Plettenberg Bay, Cape Province, Republic of South Africa on 1 January 1991.

Additional hosts and distribution. *Leucocytozoon tawaki* is known only from these two hosts, distributionally at the extremes of penguin ranges. Presumably the parasite occurs throughout the distributional range of the penguins in latitudes where the simuliid vectors are present.

Sporogony. The sporogony of *Leucocytozoon tawaki* was followed by Fallis *et al.* (1976) in some detail in several species of the ornithophilic simuliids of the genus *Austrosimulium* in New Zealand.

Comments. *Leucocytozoon tawaki* is a round parasite that resembles many other round parasites throughout the avian orders. It could not be diagnosed without knowledge of the host. The fact that it occurs in the most primitive of the modern birds is justification to consider the parasite as a distinct species. The New Zealand material was slightly larger than that seen in the material from the jackass penguins in South Africa. However, the measurements for each dimension were within ± 1 standard deviation and there were no significant differences. The parasites in the jackass penguin were highly vacuolate.

Earlé *et al.* (1992) examined some 400 penguins for haematozoa and found *Leucocytozoon tawaki* in only three birds, birds which were taken on the mainland. The bulk of the birds breed on small offshore islands where biting flies are absent and the host birds were parasite-free. It has been suggested that under these conditions, the parasite could not possibly maintain itself and that these infected penguins contracted their leucocytozoid from another group of birds on the mainland where biting fly vectors occur and that the parasite was in a wrong host, an assumption reinforced by the highly vacuolate and pycnotic appearance of the parasites. While possibly this argument has some merit, it must be noted that in New Zealand, blood parasites are absent in the local terrestrial avifauna. Fallis *et al.* (1976) examined 43 species terrestrial birds from around the area from which they obtained their infected penguins and all were blood parasite-free. They concluded that the parasites were from the penguin and could be maintained in the penguin population on an annual basis when the birds came ashore to moult. Therefore, until proven to the contrary, we assume that the low prevalence of leucocytozoids in the jackass penguins represents *Leucocytozoon tawaki* which can be maintained in the penguin population that come ashore on the mainland where they encounter suitable simuliid vectors.

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REFERENCES

BENNETT, G. F., KHAN, R. A. & CAMPBELL, GILLIAN, A., 1974. *Leucocytozoon grusi* sp. nov. (Sporozoa: Leucocytozoidae) from a sandhill crane, *Grus canadensis* (L.). *Journal of Parasitology.* 60, 359–363.

BENNETT, G. F., WHITEWAY, MADONNA A. & WOODSWORTH-LYNAS, CARLA B., 1982. Host parasite catalogue of the avian haematozoa. *Memorial University of Newfoundland Occasional Papers in Biology* No. 5, 243 + ix pp.

BENNETT, G. F., EARLÉ, R. A., PEIRCE, M. A., HUCHZERMEYER, F. W. & SQUIRES-PARSONS, DEBORAH, 1991. Avian Leucocytozoidae: the leucocytozoids of the Phasianidae *sensu latu. Journal of Natural History,* 25, 1407–1428.

COVALEDA ORTEGA, J. & GALLEGO BERENGUER, J., 1946. Contribución al estudio de algumos *Leucocytozoon* parásitos de los aves españolas. *Revista Ibérica de Parasitologia,* 6, 203–224.

EARLÉ, R. A., BENNETT, G. F., DU TOIT, HESTER, DE SWARDT, D. & HERHOLDT, J. J., 1991. Regional and seasonal distribution of avian blood parasites from northern South Africa. *South African Journal of Wildlife Research,* 21, 47–53.

EARLÉ, R. A., BENNETT, G. F. & BROSSY, J. J., 1992. First African record of *Leucocytozoon tawaki* (Apicomplexa: Leucocytozoidae) from the jackass penguin *Spheniscus demersus. South African Journal of Zoology,* 27, 89–90.

FALLIS, A. M., BISSETT, S. A. & ALLISON, F. R. 1976. *Leucocytozoon tawaki* n. sp. (Eucoccidia: Leucocytozoidae) from the penguin *Eudyptes pachyrhynchus* and preliminary observations on its development in *Austrosimulium* spp. (Diptera: Simuliidae). *New Zealand Journal of Zoology,* 3, 11–16.

FRANCHINI, G., 1924. Observations sur les hématozoaires des oiseaux d'Italie (2e note). *Annales de l'Institut Pasteur (Paris)* 38, 470–515.

GIOVANNOLA, A., 1936. Les *Leucocytozoon:* leur dévelopement schizogonique. *Annales de Parasitologie Humaine et comparée,* 14, 369–375.

KERANDEL, J., 1913. Trypanosomes et leucocytozoons, observés chez les oiseaux du Congo. *Annales de l'Institut Pasteur (Paris),* 27, 421–439.

LEGER, M., 1913. Hématozoaires d'oiseaux de la Corse. *Bulletin de la Société de Pathologie Exotique,* 10, 28–33.

MATHIS, C. & LEGER, M., 1910. *Leucocytozoon* d'une tourterelle *(Turtur humilis)* et d'une sarcelle *(Querquedule crecca)* du Tonkin. *Comptes Rendus de Séances de la Société de Biologie et de ses filiales,* 68, 118–120.

YAKUNIN, M. P., 1972. Kroveparazity dikikh ptits Yugovostoka Kazakhstana. [Blood parasites of wild birds of south-eastern Kazakhstan]. (In Russian). *Trudy Instituta Zoologii Akademii Nauk Kazakskan SSR,* 33, 69–78.

YAKUNIN, M. P., 1976. Paraziticheskie prosteishie krovi dikikh ptits Kazakhstana. [Parasitic protozoa in the blood of wild birds from Kazahstan]. (In Russian). *Naukoa Dumka, Kiev,* 1, 166–167.

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