Leucocytozoids of seven Old World passeriform families

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(Accepted 16 April 1992)

Leucocytozoids of the primarily Old World passeriform families Corvidae, Hirundinidae, Irenidae, Oriolidae, Paradoxornithidae, Paridae and Pittidae are reviewed. *Leucocytozoon sakharoffi* Sambon 1908 of the Corvidae is re-described and *L. berestneffi* Sambon 1908, *L. laverani* França 1912 and *L. zuccarelli* Léger 1913 are synonymized with it. *Leucocytozoon chloropsidis* de Mello 1935 of the Irenidae and *L. majoris* (Laveran 1902) Coatney 1937 are re-described for the first time since their original descriptions. *Leucocytozoon whitworthi*, *L. irenae*, *L. oriolis*, *L. bishopi* and *L. pittae* are new species described from the Hirundinidae, Irenidae, Oriolidae, Paradoxornithidae and Pittidae respectively.

**KEYWORDS:** *Leucocytozoon*, taxonomy, systematics, distribution, new species.

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**Introduction**

The 110 species of the Corvidae (crows and jays) form a cosmopolitan family with two-thirds of its members occurring in the Old World. Blood parasites of this group have been particularly well studied at the turn of the century, with Sambon (1908) naming both *Leucocytozoon sakharoffi* and *L. berestneffi*, França (1912) naming *L. laverani*, and Léger (1913) describing *L. zuccarelli*. These species, especially *L. sakharoffi* and *L. berestneffi* have had some considerable study on the schizogonic stages, and the vectors are known but none of the species have been re-described since their original description, or their morphology carefully compared, using any of the more recent criteria now employed (Bennett et al., 1991). Hsu et al. (1973) synonymized *L. zuccarelli* with *L. sakharoffi*, without giving their reasons. These species are here reviewed.

The 79 species of swallows (Hirundinidae) are also a cosmopolitan group of birds with almost three-quarters of the species occurring in the Old World. Despite their common occurrence, the fact they are frequently examined for Haematozoa and the fact that *Leucocytozoon* infections are frequently reported (Bennett et al., 1982), no leucocytozoids have been described from them. Hsu et al. (1973) emended a parasite
described by Sergent and Sergent (1905) as *Haemamoeba danilewskyi* var. *hirundinis* to *Leucocytozoon hirundinis*, a term used frequently throughout the literature since that time. However, Hsu et al. (1973) were in error, as the illustration accompanying the Sergent and Sergent description is clearly a classical *Haemoproteus*. Hence they created a *nomen nudum* and there are no leucocytozoids described from the Hirundinidae; *Leucocytozoon whitworthi* n. sp. is described here from the swallows.

The Irenidae represent 14 species of birds endemic to the Wallacean Oriental region. In 1935 de Mello described *Leucocytozoon chloropsidis* and this species is re-described here; in addition, *L. irenae* n. sp. is described from the same family.

The 28 species of the Oriolidae (Old World orioles) are distributed primarily in Afro-Asia. *Leucocytozoon* has been reported from a variety of the species and various specific names have been attached, some of them quite obviously in error. *Leucocytozoon oriolus* n. sp. is described here and the reports of leucocytozoids infecting members of this family are reviewed.

The 20 species of parrotbills (Paradoxornithidae) are virtually endemic to the Wallacean Oriental region. This unique group of birds rarely are sampled for haematozoa and only four of 20 species have been examined (Bennett et al., 1982) and three of the four were infected with *Leucocytozoon bishopi* n. sp., which is herein described.

The 65 species of chickadees and titmice (Paridae) are another cosmopolitan avian family with a primary distribution with 80% of the species in an Old World distribution. Laveran (1902) described *Leucocytozoon majoris* from the great tit, *Parus major*, a description that was also confounded with the inclusion of stages of both *Haemoproteus* and *Plasmodium*. The species has not been re-described recently.

The 28 species of pittas (Pittidae) are among the more primitive of the passeriform birds. Their distribution is primarily Afro-Asian. Half of the species have been examined for blood parasites and only 5 species have been recorded with infections of *Leucocytozoon*, herein described as *Leucocytozoon pittae* n. sp. Curiously, none of the African pittas has been examined for blood parasites (Bennett et al., 1992).

**Materials and methods**

Materials used in descriptions of this study were deposited in the collection of the International Reference Centre for Avian Haematozoa by collaborators around the world. Blood smears were usually air-dried, and fixed in 100% methanol or ethanol. Some of the material was stained on location, frequently with one of the 'quick' stains. Quick stains, however, while useful for short-term diagnosis, faded badly and after a few months were of little value for taxonomic study. However, most of the material was stained with Giemsa’s stain upon receipt in Canada.

Morphological variables (Bennett et al., 1991) were obtained by drawing the appropriate cell with the aid of a camera lucida and determining the lengths and areas with a Zeiss MOP-3 Digital Analyzer. Photomicrographs were taken with a Zeiss Photomicroscope III. All the morphological variables measured on the macrogametocyte were repeated for the microgametocyte, and in most cases both sets of measurements were closely similar, except for the usual characteristic large parasite nucleus in the microgametocyte. In the interests of brevity these measurements are not presented for the microgametocyte, but if there is any major difference between the two this is cited in the text; an illustration is provided for each microgametocyte. All
hapantotype, parahapantotype, neohapantotype and paraneohapantotype material has been deposited in the type collection of the International Reference Centre for Avian Haematozoa.

Taxonomic review

Family CORVIDAE (crows, jays and magpies)

*Leucocytozoon sakharoffi* Sambon, 1908

*Synonym:* L. *berestneffi* Sambon, 1908

L. *laverani* França, 1912

L. *zuccharelli* Léger, 1913

*Type host:* the common raven, *Corvus corax* L.

*Type locality:* England

*Macrogametocyte* (Figs. 1, 2 and Table 1). Parasite small, occupying 77% of the area of the host–cell parasite complex, round to broadly ovoid; parasite nucleus round to ovoid, without marked karyosome, occupying 7% of the area of the parasite; vacuoles sometimes prominent; volutin granules frequently encountered; nucleus of host cell–parasite complex extends as a thin band (never cap-like) about the parasite, covering 77% of the periphery of the parasite and occupying 24% of the area of the host cell–parasite complex.

*Microgametocyte* (Fig. 3). Closely similar in morphology to the macrogametocyte but averaging 5–10% smaller in most dimensions.

*Basis of description.* Blood film nos 107184 and 107186 from the American crow, *Corvus brachyrhynchos* Brehm, coll. Meger at Saskatoon, Saskatchewan, Canada on 26 and 27 July 1989 respectively.

*Additional hosts and distribution.* All corvids reported with *Leucocytozoon* by Bennett et al. (1982) can be considered to be infected with *Leucocytozoon sakharoffi.* The parasite presumably occurs throughout the distributional range of the Corvidae.

*Schizogony.* Clark (1965), Khan and Fallis (1971) and Wingstrand (1947, 1948) have all studied the schizogony of this species. The initial cycle is hepatic, following which schizonts can occur in kidney, spleen and reticuloendothelial system.

*Sporogony.* Sporogony occurs in a number of species of ornithophilic simuliiids including *Simulium angustitarse* in the UK (Baker, 1970) and *Simulium* (*Eusimulium*) *aureum* and *Prosimulium decemarticulatum* in Canada (Fallis et al., 1974).

*Comments.* *Leucocytozoon sakharoffi* is a distinctive round leucocytozoid in which the host cell nucleus covers nearly 80% of the periphery of the parasite. Thus, in members of the Corvidae, the parasite is easily diagnosed on this characteristic.

Sambon (1908) distinguished *Leucocytozoon sakharoffi* from *L. berestneffi* on the basis that the host cell nucleus never surrounds the parasite completely but remains almost unaltered and pushed to one side; his illustrations show what are clearly immature gametocytes. Fallis *et al.* (1974) illustrate *L. berestneffi* with a figure that is clearly that of *L. sakharoffi.* Sambon (1908) probably also separated the two species on the basis that one was in a magpie and the other in a raven. Fallis (1950) believed that *L. berestneffi* was a synonym of *L. sakharoffi,* but Fallis *et al.* (1974) suggest that, on the basis of the appearance and location of the megaloschizonts, *L. berestneffi* may be a
FIGS 1-11. All photomicrographs made from blood smears fixed in 100% methanol or ethanol and stained with Giemsa’s stain. (1–3) *Leucocytozoon sakharoffi*: (1, 2) macrogametocytes; (3) microgametocyte. (4–8) *Leucocytozoon whitworthi*: (4, 5) macrogametocytes; (6) two macrogametocytes; (7), microgametocyte; (8) intense infection in young cliff swallow, with both macro- and microgametocytes. (9–11) *Leucocytozoon chloropsidis*: (9, 10) macrogametocytes; (11) microgametocyte.
valid species. Coatney and West (1938) and Wingstrand (1947) also believed that *L. berestneffi* was a synonym of *L. sakharoffi*, but contrary to Fallis *et al.* (1974), Hsu *et al.* (1973) did not synonymize the two species but felt that the two should be kept separate until cross-transmission studies confirmed they were either separate or the same species. Ramisz (1962) measured the macrogametocytes of leucocytozoids that occurred in raven, magpie and carrion crow, birds which had been listed as the type hosts of the four species of leucocytozoids described in the corvids. Contrary to Fallis *et al.* (1974), he could not separate the four species on the basis of morphology and referred to all four as *Leucocytozoon sakharoffi*. On a morphological and host basis the two species cannot be separated. Therefore, it would be wise to consider them as a single species until experimental evidence is conclusive that the two parasites are separate species or that one is a strain of the other. Therefore, on the basis of page priority, *L. berestneffi* falls as a synonym of *L. sakharoffi*.

França (1912) described a round leucocytozoid from a *Garrulus glandarius* in Portugal as *Leucocytozoon laverani*. He described the host cell nucleus as surrounding the parasite almost entirely, and his measurements of the length and breadth of the parasite fall well within the range of measurements presented herein. He was obviously unaware that Sambon had already named leucocytozoids from the corvids. Clearly, *L. laverani* cannot be morphologically separated from *L. sakharoffi* and is therefore considered to be a synonym of it.

Léger (1913) described *Leucocytozoon zuccharelli* from the carrion crow, *Corvus corone*. He compared his material with the Sambon (1908) descriptions and found certain trivial differences (he used a different stain) in coloration of the parasite. He also encountered volutin granules which he confused with the true pigment granules of *Haemoproteus* (the bird had a dual infection with both *Haemoproteus* and *Leucocytozoon*) and on the basis of these differences he erected a new species. The parasite is
clearly \textit{L. sakharoffi}, and Hsu \textit{et al.} (1973) synonymized \textit{L. zuccarelli} with \textit{L. sakharoffi}. We concur.

Family HIRUNDINIDAE (swallows)

\textit{Leucocytozoon whitworthi} n. sp.

\textit{Type host}: the tree swallow, \textit{Tachycineta bicolor} (Viellot)

\textit{Type locality}: Roy, Washington, USA

\textit{Macrogametocyte} (Figs 4–6, 8 and Table 1). Parasite small, occupying 80\% of the area of the host cell–parasite complex, usually round but sometimes broadly ovoid; parasite nucleus relatively large, usually round, but can vary to elliptical, karyosome not usually visible, occupying 8.6\% of the area of the parasite; parasite cytoplasm usually dense with only small vacuoles but in some parasites, vacuoles numerous and prominent; volutin granules not common but occur in some parasites; nucleus of host cell–parasite complex usually as a distinct cap, covering 50\% or more of the periphery of the parasite and occupying 20\% of the area of the host cell-parasite complex.

\textit{Microgametocyte} (Figs 7 and 8). Parasites closely similar in dimensions to macrogametocyte, the values being slightly smaller; host cell nucleus as a thin band rather than as a cap as seen in the macrogametocyte; parasites fragile and easily distorted.

\textbf{Basis of description}


\textbf{Additional hosts and distribution}. All leucocytozoids listed by Bennett \textit{et al.} (1982) for the Hirundinidae can be ascribed to this species. The parasite presumably occupies the distributional range of the swallows.

\textbf{Comments}. \textit{Leucocytozoon whitworthi} is a small round, leucocytozoid that is similar to many found within the Passeriformes. Although possessing a cap-like host cell nucleus it differs from \textit{L. fringillinarum}, a similar and small leucocytozoid of the Fringillidae, in that the host cell nucleus cap extends around the periphery of the parasite to a much greater extent.

Sergent and Sergent (1905) described very briefly a parasite in a ‘hirondelle’ (no further identification was given) under the name \textit{Haemamoeba danilewskyi} var. \textit{hirundinis}. The more than adequate illustration accompanying this description clearly shows a haemoproteid of the halteridial form that has displaced the erythrocyte nucleus laterally towards the margin. They also say that the same bird had a typical \textit{H. danilewskyi}, but they had not before seen a haemoproteid that laterally displaced the host cell nucleus. On this basis they designated a varietal haemoproteid which is now known as \textit{Haemoproteus progenet} (White and Bennett, 1978). Hsu \textit{et al.} (1973) somehow misinterpreted this information and believed that the Sergent brothers were referring to
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a leucocytozoa; thus Hsu et al. emended the varietal designation and raised the parasite to species status under the term *Leucocytozoon hirundinis*. As this species does not exist, Hsu et al. (1973) created a classic *nomen nudum*, and *Leucocytozoon hirundinis* is so designated.

It is probable that all leucocytozoa of swallows, including those identified as *L. hirundinis* (Bennett et al., 1982) can be referred to *Leucocytozoon whitworthi*.

The name is chosen to acknowledge the contribution of Dr Terry Whitworth in providing the hapantotype and parahapantotype material.

Family **IRENIDAE** (leafbirds)

*Leucocytozoon chloropsidis* de Mello, 1935

**Synonym:** *Leucocytozoon enriquesi* de Mello, 1936

**Type host:** the golden-fronted leafbird, *Chloropsis aurifrons* (Temminck).

**Type locality:** Goa (= Nova Goa), India.

**Macrogametocyte** (Figs 9, 10 and Table 1). Parasite small, occupying 74% of the area of the host cell–parasite complex, round to elliptical; parasite nucleus round to ovoid, without marked karyosome, proportionately large and occupying 9% of the area of the parasite; vacuoles not prominent and volutin granules not seen; nucleus of host cell as a thick band and rarely cap-like, covering 39% of the periphery of the parasite and occupying 26% of the area of the host cell–parasite complex.

**Microgametocyte** (Fig. 11). Microgametocyte tend to be more round than ovoid and are slightly smaller (< 5%) in most dimensions.

**Basis of description**


Additional hosts and distribution. *Aegithina lafresnaye* (Hartlaub)—Thailand; *Chloropsis cochinchenensis* (Gmelin)—Thailand; *C. cyanopogon* (Temminck)—Malaya; *C. hardwickii* (Jardine and Selby)—Malaya; *C. palawanensis* (Sharpe)—Palawan; *Irena puella* (Latham)—southern Thailand.

**Comments.** *Leucocytozoon chloropsidis* is one of the many small, round leucocytozoa that occur in the passeriform families. It would be difficult to identify with certainty without knowledge of the host.

In 1936, at the 12th International Congress of Zoology, de Mello presented a long paper which was published in the Proceedings of the Congress in 1937, in which he summarized most of his work on avian blood parasites carried out during his residence in Goa. He further described in this publication *Leucocytozoon enriquesi* from *Chloropsis cochinchenensis*, differentiating it from *L. chloropsidis* on the grounds that (i) the nucleus of the macrogametocytes always stained while those of *L. chloropsidis* stained weakly or not at all, and (ii) the nucleus of the male was large and occupied the greater part of the parasite and stained deep pink while those of *L. chloropsidis* were thread-like and stained violet. These are merely characteristics of stain and slide preparation. The thread-like appearance of the nucleus resulted from a post-mortem smear in which the microgametocyte was preparing to exflagellate—a feature frequently seen in blood smear preparations made from post-mortem blood sources or
films that have dried slowly. The two parasites are otherwise identical and *Leucocytozoon enriquesi* is hereby declared a synonym of *L. chloropsidis*.

*Leucocytozoon irenae* n. sp.

*Type host:* yellow-headed green leafbird, *Chloropsis cochinchinensis* (Gmelin).

*Type locality:* Khaoluang, southern Thailand.

*Macrogametocyte* (Figs 12, 13 and Table 1). Parasite small, occupying 71% of the area of the host cell–parasite complex, broadly ovate to elliptical; parasite nucleus round to elliptical, without marked karyosome, proportionately large, occupying 10% of the area of the parasite; vacuoles not prominent, volutin granules not seen; nucleus of host cell–parasite complex as a thick band, sometimes ending in small bulbs at either one or both ends, covering 75% of the periphery of the parasite and occupying 28% of the area of the host cell–parasite complex.

*Microgametocyte* (Fig. 14). Microgametocyte similar to macrogametocyte in morphology but about 15% smaller in most dimensions.

*Basis of description*


*Comments.* *Leucocytozoon irenae* is known only from the type host in the type locality. This parasite is readily separated from *L. chloropsidis* on the basis of the band-like appearance of the host cell complex nucleus which covers 75% of the periphery of the parasite compared to the cap-like host cell nucleus of *L. chloropsidis* which covers only 39% of the periphery of the parasite.

Family ORIOLIDAE (Old World orioles)

*Leucocytozoon oriolis* n. sp.

*Type host:* southern figbird, *Sphecotheres vieilloti* (Vigors and Horsfield).

*Type locality:* Brisbane, Queensland, Australia

*Macrogametocyte* (Figs 15, 16 and Table 2). Parasite small, occupying 76% of the area of the host cell–parasite complex, round to broadly ovoid; parasite nucleus round to narrowly ovoid, frequently with a marked karyosome, relatively large and occupying 8% of the area of the parasite; vacuoles not prominent and volutin granules not seen; nucleus of host cell–parasite complex as a thick uneven band, sometimes ending in small bulbs at the ends, covering 67% of the periphery of the parasite and occupying 23% of the area of the host cell–parasite complex.

*Microgametocyte* (Fig. 17). Microgametocyte closely similar in morphology and most dimensions to the macrogametocyte.

*Basis of description*


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Figs 12–23. (12–14) Leucocytozoon irenae: (12, 13) macrogametocytes; (14) young microgametocyte. (15–17) Leucocytozoon oriolus: (15, 16) macrogametocytes; (17) microgametocyte. (18–21) Leucocytozoon bishopi: (18–20) macrogametocytes; (21) microgametocyte; (22, 23) Leucocytozoon majoris: macrogametocytes.
Table 2. Measurements (μm, linear; μm², areas) of the macrogametocytes of the leucocytozoids of the Oriolidae, Paradoxornithidae, Paridae and Pittidae

<table>
<thead>
<tr>
<th>Parasite and nucleus</th>
<th>L. oriolis (n = 50)</th>
<th>L. bishopi (n = 50)</th>
<th>L. majoris (n = 40)</th>
<th>L. pittae (n = 43)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum diameter</td>
<td>12.7 (1.3)</td>
<td>12.2 (1.2)</td>
<td>13.4 (1.0)</td>
<td>13.9 (1.4)</td>
</tr>
<tr>
<td>Minimum diameter</td>
<td>10.5 (0.9)</td>
<td>11.1 (1.3)</td>
<td>11.1 (1.3)</td>
<td>11.6 (1.1)</td>
</tr>
<tr>
<td>Periphery of parasite</td>
<td>37.5 (3.1)</td>
<td>37.2 (2.7)</td>
<td>40.6 (2.6)</td>
<td>41.4 (2.8)</td>
</tr>
<tr>
<td>Area of parasite</td>
<td>104.6 (13.6)</td>
<td>96.9 (11.4)</td>
<td>118.8 (16.2)</td>
<td>127.5 (15.7)</td>
</tr>
<tr>
<td>Maximum diameter nucleus</td>
<td>4.0 (0.7)</td>
<td>4.2 (0.8)</td>
<td>4.1 (0.9)</td>
<td>4.3 (0.9)</td>
</tr>
<tr>
<td>Minimum diameter nucleus</td>
<td>2.9 (0.6)</td>
<td>2.5 (0.4)</td>
<td>2.6 (0.6)</td>
<td>2.6 (0.6)</td>
</tr>
<tr>
<td>Area of nucleus</td>
<td>9.0 (2.8)</td>
<td>7.7 (2.0)</td>
<td>8.2 (2.1)</td>
<td>8.5 (2.8)</td>
</tr>
<tr>
<td>Host cell–parasite complex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum length</td>
<td>14.6 (1.3)</td>
<td>14.9 (1.5)</td>
<td>15.1 (1.0)</td>
<td>15.3 (1.2)</td>
</tr>
<tr>
<td>Minimum length</td>
<td>12.3 (1.1)</td>
<td>12.2 (1.1)</td>
<td>12.7 (1.4)</td>
<td>13.1 (1.2)</td>
</tr>
<tr>
<td>Area of complex</td>
<td>136.7 (16.4)</td>
<td>137.0 (16.5)</td>
<td>149.5 (18.9)</td>
<td>155.2 (18.3)</td>
</tr>
<tr>
<td>Amount of parasite periphery covered by complex nucleus</td>
<td>25.2 (3.8)</td>
<td>28.9 (3.1)</td>
<td>32.2 (2.5)</td>
<td>21.7 (4.2)</td>
</tr>
<tr>
<td>Area of complex nucleus</td>
<td>32.2 (6.2)</td>
<td>40.1 (7.3)</td>
<td>30.7 (7.1)</td>
<td>27.7 (9.8)</td>
</tr>
</tbody>
</table>

n = Sample size; means followed by standard deviations in parentheses.

Additional hosts and distribution All leucocytozoids listed by Bennett et al. (1982) for the Oriolidae can be referred to this species. The identification of Leucocytozoon anellobiae in Australian species of orioles by Cleland and Johnston (1910, 1912) and Cleland (1922) is in error, as too is the identification of L. fringillinarum in Oriolus auratus by Bennett and Herman (1976). The identification of Leucocytozoon danilewskii by Burtikashvili (1971) is without substance as this species is a synonym of L. ziemanni of the Strigidae. Yakunin's use (1976) of the nomen nudum L. zasukhini in the Oriolus oriolus is also without validity. Leucocytozoon oriolis is presumably distributed across the range of the Oriolidae.

Comments. Leucocytozoon oriolis is a small, round leucocytozoid, similar to many found in the Passeriformes. The host cell complex nucleus covers two-thirds of the periphery of the parasite, which is considerably more than most of the round leucocytozoids of this order. The parasites seem to be particularly fragile as they are frequently distorted and/or have the host cell complex nucleus torn off the complex in the mechanical preparation of the blood smear.

Family PARADOXORNITHIDAE (parrotbills)

Leucocytozoon bishopi n. sp.

Type host: grey-headed parrotbill, Paradoxornis gularis Gray.
Type locality: Chiang Mai, Thailand.

Macrogametocyte (Figs 18–20 and Table 2) Parasites small, occupying 70% of the host cell–parasite complex, round to broadly ovoid but easily distorted by smear preparation into irregular shapes and margins; parasite nucleus round to broadly ovoid to elliptical, without marked karyosome, occupying 8% of the area of the parasite; vacuoles not prominent; volutin granules not seen; nucleus of host cell–parasite complex as a thin band nearly surrounding the parasite, occasionally with a
cap-like bulge at either one or both poles, covering 78% of the periphery of the parasite (nearly 100% in some specimens) and occupying 30% of the area of the host cell–parasite complex.

**Microgametocyte** (Fig. 21). Morphology of microgametocyte somewhat similar to the macrogametocyte but 10–15% smaller in most dimensions; nucleus of host cell–parasite complex covers about 90% of the periphery of the parasite and frequently will cover nearly 100%.

**Basis of description**


**Parahapantotype.** Blood film nos 37652, 37654 and 37655, all from the grey-headed parrotbill, as above.

**Additional hosts and distribution.** *Paradoxornis guttaticolis* David—Thailand; *Paradoxornis nipalensis* (Hodgson)—Taiwan. Presumably the parasite is distributed throughout the range of the parrotbills in the Wallacean Oriental region.

**Comments.** *Leucocytozoon bishopi* is another small round leucocytozoid that is found in the Passeriformes but is distinctive in the large amount of the periphery of the parasite covered by the large host cell nucleus, and the fact that, in the microgametocytes, this coverage averages 90% and frequently approaches total coverage. The parasite is named after Ms Madonna Bishop, colleague and research assistant, in recognition of nearly 13 years of service and research in avian Haematozoa.

**Family PARIDAE (titmice and chickadees)**

*Leucocytozoon majoris* (Laveran, 1902) Coatney, 1937

**Type host:** the great tit, *Parus major* L.

**Type locality:** Metz, France

**Macrogametocyte** (Figs 22–25, Table 2). Parasite of medium size, occupying 80% of the area of the host cell–parasite complex, round to broadly ovoid, with margins entire and not easily distorted; parasite nucleus round to elliptical, frequently with marked karyosome, occupying 7% of the area of the parasite; small vacuoles usually present, occasionally numerous; volutin granules frequently seen; nucleus of host cell parasite complex as a thin band, never cap-like or with bulbs, extending 80% around the periphery of the parasite and occupying 20% of the area of the host cell–parasite complex.

**Microgametocyte** (Figs 26–28). Microgametocyte closely similar in morphology and measurements to the macrogametocyte, differing only in the large nucleus that is typical of the Haemosporidina.

**Basis of description**


**Paranoeohapantotype.** Blood film no. 22005 from the boreal chickadee, *Parus hudsonicus*, coll. Bennett, Cape St Francis, Newfoundland, Canada on 21 June 1971; blood film no. 22389 from boreal chickadee, *Parus hudsonicus*, coll. Bennett, Pickavance Creek, Newfoundland, Canada on 19 July 1971; blood film no. 22416 from

*Additional hosts and distribution.* All leucocytozoids reported for the Paridae by Bennett et al. (1982) can be referred to *Leucocytozoon majoris*. The distribution of the parasite is the same widespread distribution as the host family.

*Comments.* *Leucocytozoon majoris* was one of the first of the leucocytozoids to be described, and was early recognized as distinctive because the host cell nucleus covered 80% of the periphery of the parasite. This characteristic, together with its large size (for a round leucocytozoid) makes the species easy to recognize.

Laveran (1902) first described *L. majoris* under the term *Haemamoeba majoris*. The bird in question had at least a triple infection, as Laveran, in his description,
incorporates stages of *Haemoproteus, Plasmodium* (possibly *P. relictum* from the illustration) as well as *Leucocytozoon*. The haemoproteid in the description is now known as *Haemoproteus majoris* and the leucocytozoid is *Leucocytozoon majoris*.

**Family PITTIdae** (pittas)

*Leucocytozoon pittae* n. sp.

*Type host:* red-breasted pitta, *Pitta erythrogaster* (Temminck).

*Type locality:* Luzon, Philippine islands.

*Macrogametocyte* (Figs 29, 30, Table 2). Parasite of medium size, occupying 82% of the area of the host cell–parasite complex, round to broadly ovoid with margins entire; parasite nucleus small, normally round but sometimes ovoid, karyosome not seen, occupying 6-7% of the area of the parasite; vacuoles small but not prominent, volutin granules not seen; host cell–parasite complex nucleus as a band (not cap-like or expanded into bulbs), covering 52% of the periphery of the parasite and occupying 17% of the area of the host cell–parasite complex.

*Microgametocyte* (Figs 31 and 32). Microgametocyte similar in measurements to the macrogametocyte but smaller, up to 10% smaller in some dimensions; host cell nucleus covers much more of the microgametocyte than the macrogametocyte (70% compared with 52%).

**Basis of description**


*Additional hosts and distribution.* All records for *Leucocytozoon* in pittas recorded by Bennett *et al.* (1982) can be referred to *Leucocytozoon pittae*. The parasite presumably is distributed throughout the range of the pittas.

*Comments.* *Leucocytozoon pittae* is another of the round leucocytozoids seen in the Passeriformes. The large size of the parasite, the appearance of the host cell nucleus and the difference in coverage of the perimeter of the parasite in macro- and microgametocytes, together with the fact that the parasite occurs in one of the most primitive of the Passeriformes, serves to identify the species.

*Leucocytozoon pittae* has so far only been recorded from the pittas of southeastern Asia (Bennett *et al.*, 1982), where it represents 59% of all the haematozoan infections in this family (McClure *et al.*, 1978). The birds of this family are not common in sub-Saharan Africa or in Australia/New Guinea, and no pittas from these regions have been examined for blood parasites. Presumably, if pittas are examined in these regions, *L. pittae* will be found, possibly quite commonly.

**Acknowledgements**

The financial support of the Natural Sciences and Engineering Research Council of Canada to the first author through an operating and infrastructure grants made this study possible.
References


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