

# 250e Atlas of Blood Smears of Malaria and Babesiosis

Nicholas J. White, Joel G. Breman

Six species of blood protozoan parasites cause human malaria (Chap. 248): the potentially lethal and often drug-resistant *Plasmodium falciparum*; the relapsing parasites *Plasmodium vivax* and *Plasmodium ovale* (with what appear to be two morphologically identical sympatric species of *P. ovale*); *Plasmodium malariae*, which can persist at low densities for years; and, in infections in individuals living in or close to tropical forests in Southeast Asia, *Plasmodium knowlesi*, a monkey parasite that microscopically resembles *P. falciparum* (young forms) and *P. malariae* (older forms) but is identified definitively by molecular methods.

The malaria parasites are readily seen under the microscope ( $\times 1000$  magnification) in thick and thin blood smears stained with supravital dyes (e.g., Giemsa's, Field's, Wright's, Leishman's). The morphologic characteristics of the parasites are summarized in Table 250e-1. In the thick film, lysis of red blood cells by water leaves the stained white cells and parasites, allowing detection of densities as low as 50 parasites/ $\mu\text{L}$ . This degree of sensitivity is up to 100 times greater than that of the thin film, in which the cells are fixed and the malaria parasites are seen inside the red cells. The thin film is better for speciation and provides useful prognostic information in severe falciparum malaria. Several findings are associated with increased mortality risk: high parasite counts, more mature parasites ( $>20\%$  containing visible malaria pigment), and phagocytosed malaria pigment in  $>5\%$  of neutrophils.

*Babesia microti* (Chap. 249) appears as a small ring form resembling *P. falciparum*. Unlike *Plasmodium*, *Babesia* does not cause the production of pigment in parasites, nor are schizonts or gametocytes formed.

**TABLE 250e-1 MORPHOLOGIC CHARACTERISTICS OF HUMAN MALARIA PARASITES<sup>a</sup>**

	<i>Plasmodium falciparum</i>	<i>Plasmodium vivax</i>	<i>Plasmodium ovale</i> <sup>b</sup>	<i>Plasmodium malariae</i>
Asexual parasites	Usually only fine blue ring forms (some resembling stereo headsets) are seen. Parasitemia level may exceed 2%.	Irregular, large, fairly thick rings become highly pleomorphic as the parasite grows. Parasitemia level is low.	Regular, dense ring enlarges to compact, blue, mature trophozoite (rectangular or band-form). Parasitemia level is low.	Dense, thick rings mature to dense, round trophozoites. Parasitemia level is low.
Schizonts	Rare in peripheral blood; 8–32 merozoites, dark brown-black pigment	Common; 12–18 merozoites, orange-brown pigment	8–14 merozoites, brown or black pigment	8–10 merozoites, dark brown or black pigment
Gametocytes	Banana-shaped; male: light blue; female: darker blue; a few scattered blue-black pigment granules in cytoplasm	Round or oval; male: round, pale blue; female: oval, dark blue; triangular nucleus, a few orange-brown pigment granules	Large, round, dense, and blue (like <i>P. malariae</i> ), but prominent James's dots; brown pigment	Large, oval; male: pale blue; female: dense blue; large black pigment granules
RBC changes	RBCs are normal in size. As the parasite matures, the RBC cytoplasm becomes pale, the cells become crenated, and a few small red dots may appear over the cytoplasm (Maurer's clefts).	RBCs are enlarged. Pale red Schüffner's dots increase in number as the parasite matures.	RBCs become oval with tufted ends. Red James's dots are prominent.	RBCs are normal in size and shape. No red dots are seen.

<sup>a</sup>The early trophozoites of *Plasmodium knowlesi* resemble those of *P. falciparum*. The late and mature trophozoites and schizonts of *P. knowlesi* appear very similar to those of *P. malariae*. The differences are that (1) *P. knowlesi* trophozoites may have double chromatin dots, with two or three parasites per RBC, and may cause higher-level parasitemia; and (2) *P. knowlesi* mature schizonts have 16 merozoites rather than the 8–10 found with *P. malariae*. <sup>b</sup>Two morphologically identical sympatric species, according to recent evidence.

**Abbreviation:** RBC, red blood cell.