

CHAPTER e27

Atlas of Blood Smears of Malaria and Babesiosis

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Five species of blood protozoan parasites cause human malaria: the potentially lethal and often drug-resistant *Plasmodium falciparum*; the relapsing parasites *P. vivax* and *P. ovale*; *P. malariae*, which can persist at low densities for years; and *P. knowlesi*, a monkey parasite that causes occasional infections in humans in tropical forests in Southeast Asia. *P. knowlesi* resembles *P. falciparum* and *P. malariae*

microscopically but is identified definitively by molecular methods (see Table e27-1, footnote a).

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 e27-1. 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/ μL . This degree of sensitivity is up to 100 times greater than that of the thin film, in which the red cells are fixed and the malaria parasites are seen inside the 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 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 e27-1 Morphologic Characteristics of Human Malaria Parasites^a

	<i>P. falciparum</i>	<i>P. vivax</i>	<i>P. ovale</i>	<i>P. 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 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.

^aThe early trophozoites of *P. knowlesi* resemble those of *P. falciparum*. The late and mature trophozoites, schizonts, and gametocytes of *P. knowlesi* appear very similar to those of *P. malariae*; the differences are that *P. knowlesi* trophozoites may have double chromatin dots and two or three parasites per RBC and that *P. knowlesi* mature schizonts have 16 merozoites rather than the 8–10 found with *P. malariae*.

Abbreviation: RBC, red blood cell.

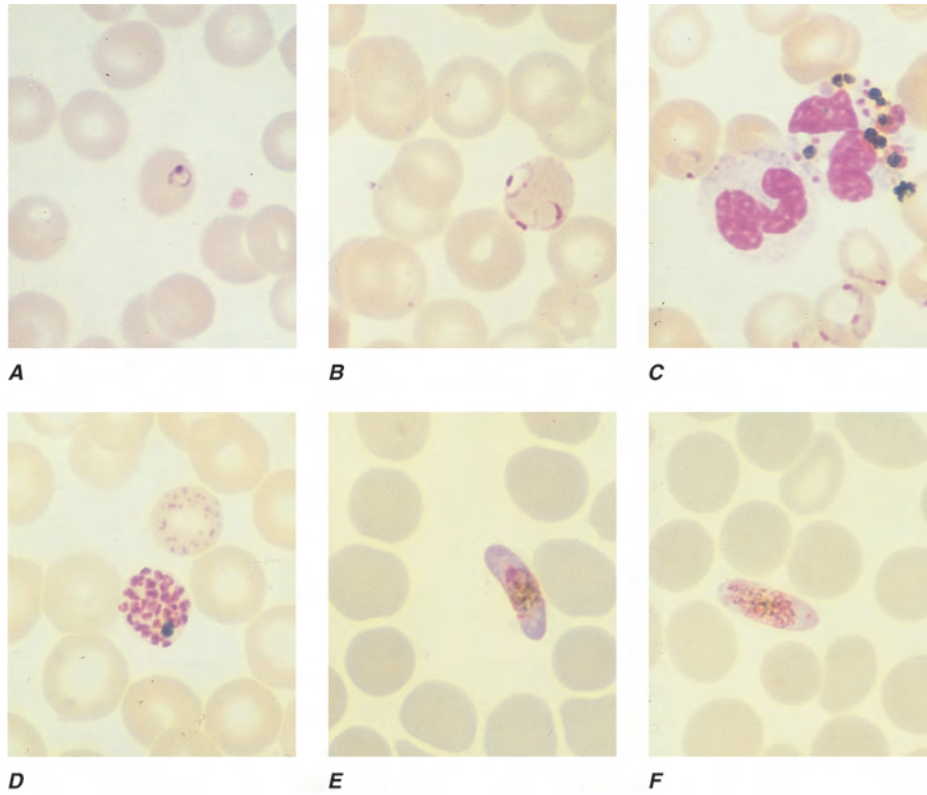


Figure e27-1 Thin blood films of *Plasmodium falciparum*. **A.** Young trophozoites. **B.** Old trophozoites. **C.** Pigment in polymorphonuclear cells and trophozoites. **D.** Mature schizonts. **E.** Female gametocytes. **F.** Male gametocytes. (Reproduced from *Bench Aids for the Diagnosis of Malaria Infections, 2nd ed*, with the permission of the World Health Organization.)

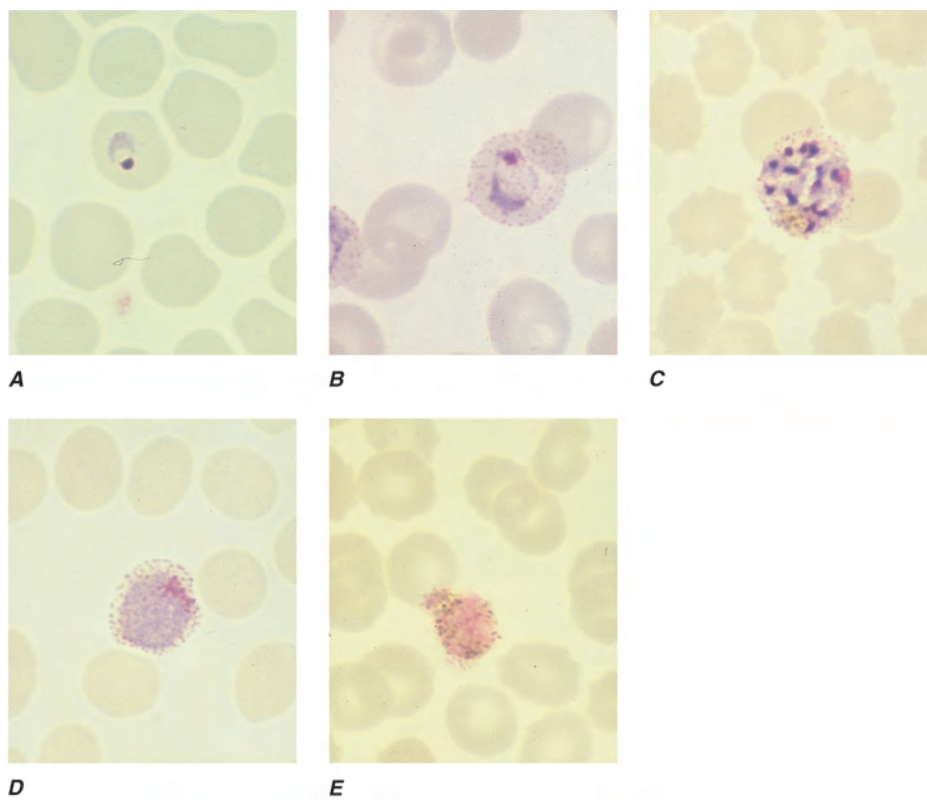


Figure e27-2 Thin blood films of *Plasmodium vivax*. **A.** Young trophozoites. **B.** Old trophozoites. **C.** Mature schizonts. **D.** Female gametocytes. **E.** Male gametocytes. (Reproduced from *Bench Aids for the Diagnosis of Malaria Infections, 2nd ed*, with the permission of the World Health Organization.)

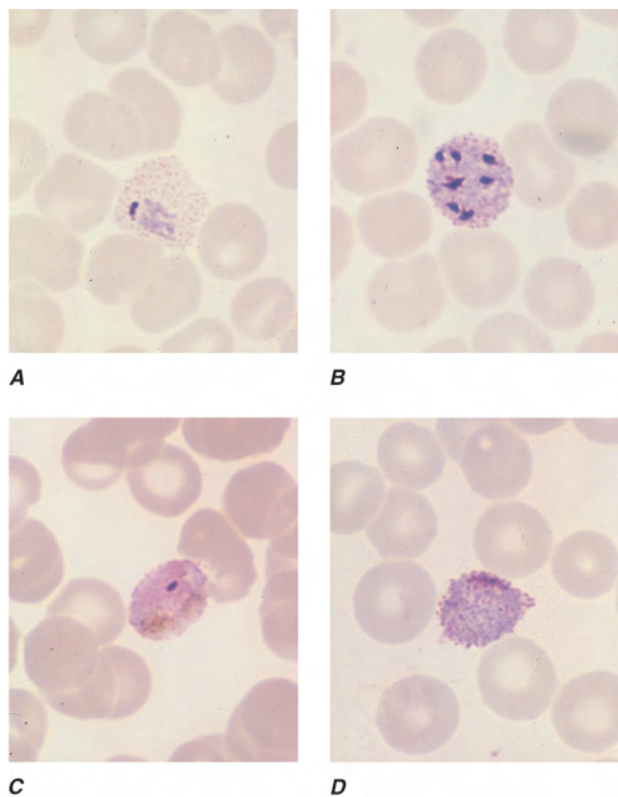


Figure e27-3 Thin blood films of *Plasmodium ovale*. **A.** Old trophozoites. **B.** Mature schizonts. **C.** Male gametocytes. **D.** Female gametocytes. (Reproduced from *Bench Aids for the Diagnosis of Malaria Infections*, 2nd ed, with the permission of the World Health Organization.)

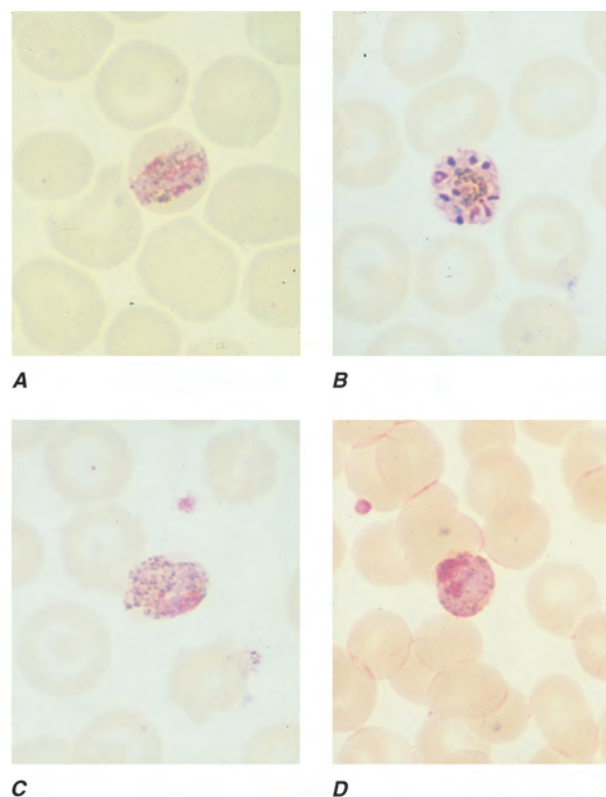


Figure e27-4 Thin blood films of *Plasmodium malariae*. **A.** Old trophozoites. **B.** Mature schizonts. **C.** Male gametocytes. **D.** Female gametocytes. (Reproduced from *Bench Aids for the Diagnosis of Malaria Infections*, 2nd ed, with the permission of the World Health Organization.)

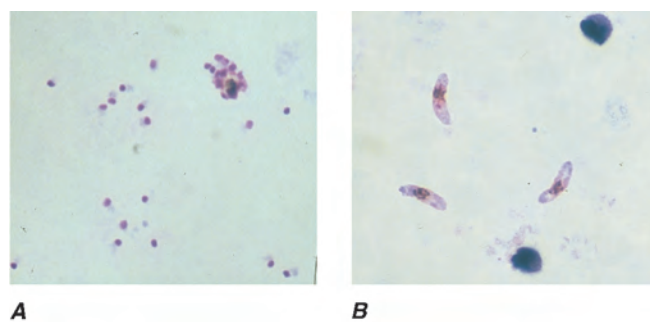


Figure e27-5 Thick blood films of *Plasmodium falciparum*. **A.** Trophozoites. **B.** Gametocytes. (Reproduced from *Bench Aids for the Diagnosis of Malaria Infections*, 2nd ed, with the permission of the World Health Organization.)

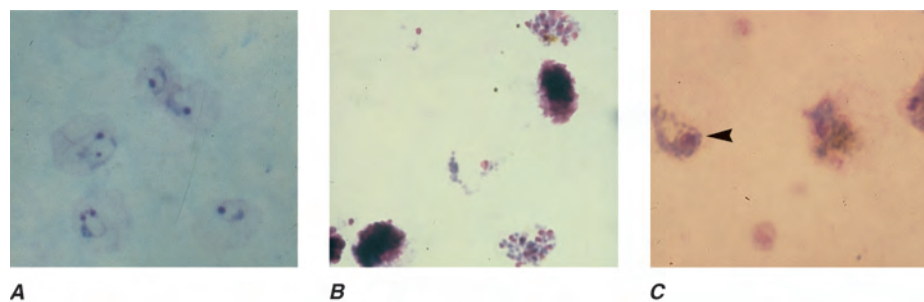


Figure e27-6 Thick blood films of *Plasmodium vivax*. **A.** Trophozoites. **B.** Schizonts. **C.** Gametocytes. (Reproduced from *Bench Aids for the Diagnosis of Malaria Infections*, 2nd ed, with the permission of the World Health Organization.)

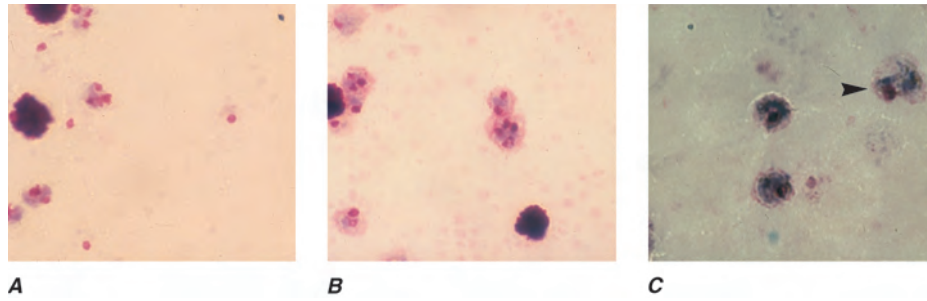


Figure e27-7 Thick blood films of *Plasmodium ovale*. **A.** Trophozoites. **B.** Schizonts. **C.** Gametocytes. (Reproduced from *Bench Aids for the Diagnosis of Malaria Infections*, 2nd ed, with the permission of the World Health Organization.)

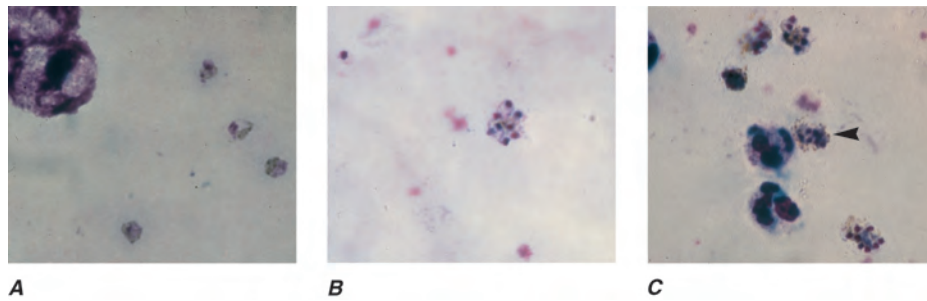


Figure e27-8 Thick blood films of *Plasmodium malariae*. **A.** Trophozoites. **B.** Schizonts. **C.** Gametocytes. (Reproduced from *Bench Aids for the Diagnosis of Malaria Infections*, 2nd ed, with the permission of the World Health Organization.)

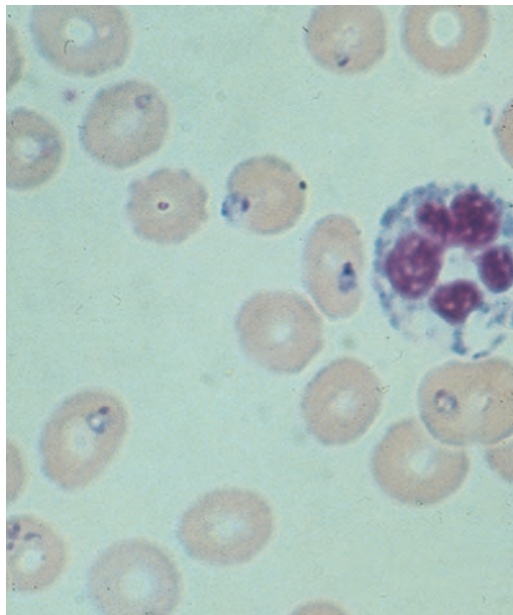


Figure e27-9 Thin blood film showing trophozoites of *Babesia*. (Reproduced from *Bench Aids for the Diagnosis of Malaria Infections*, 2nd ed, with the permission of the World Health Organization.)

FURTHER READINGS

WARHURST C, WILLIAMS JE: Laboratory procedures for diagnosis of malaria, in Abdalla SH, Pasvol G (series eds): *Malaria: A Hematological Perspective*. G Pasvol, SL Hoffman (eds): *Tropical Medicine: Science and Practice*, vol 4. London, Imperial College Press, 2004