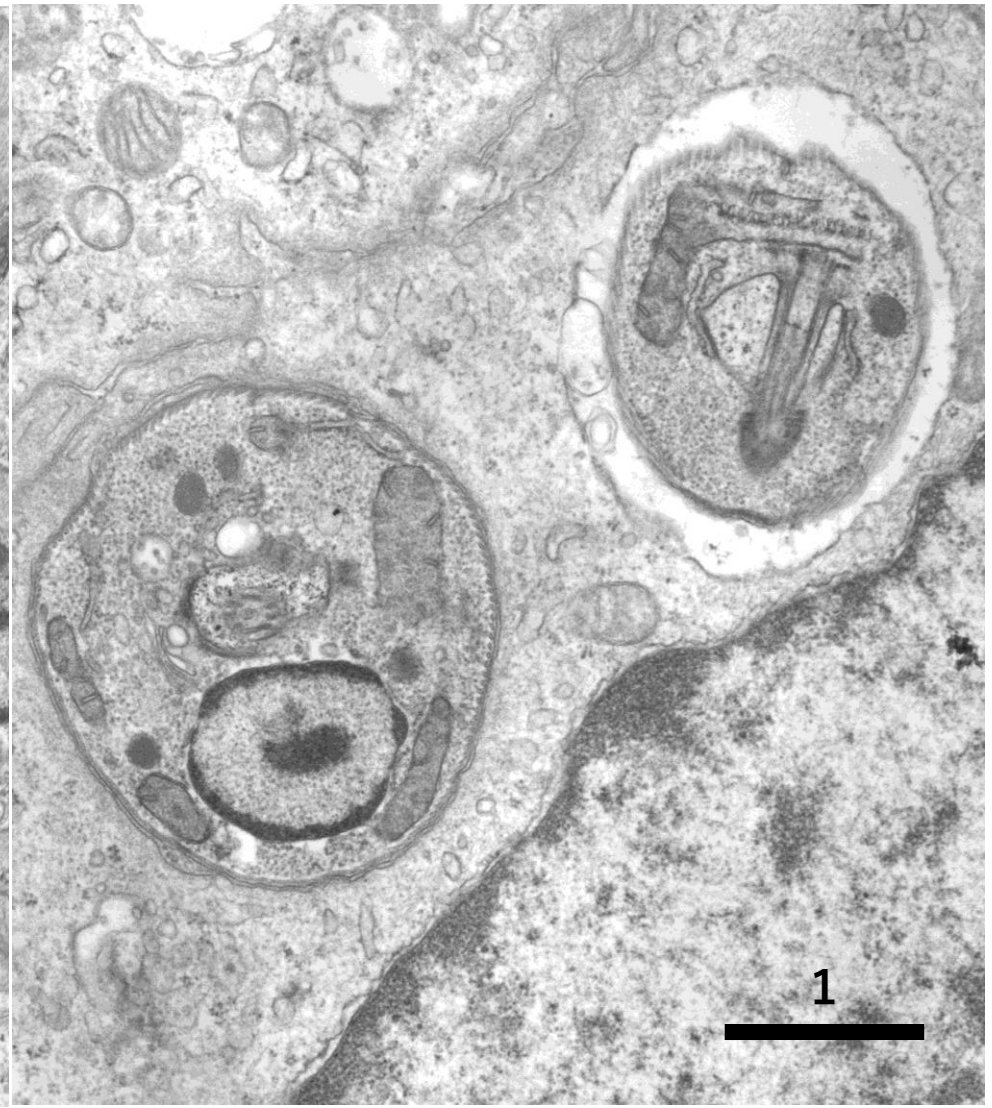
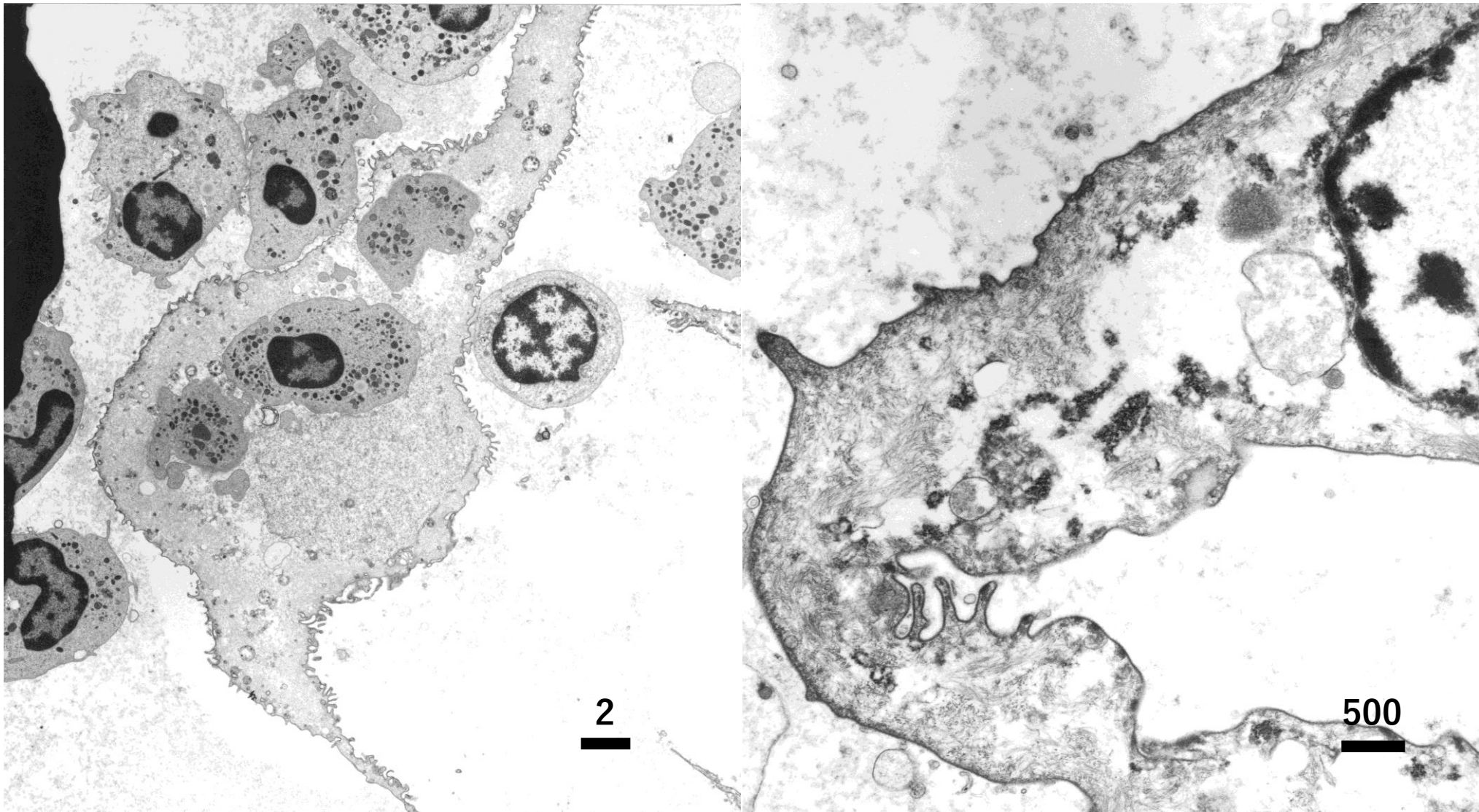


Ultrastructure of protozoan and some other pathogens

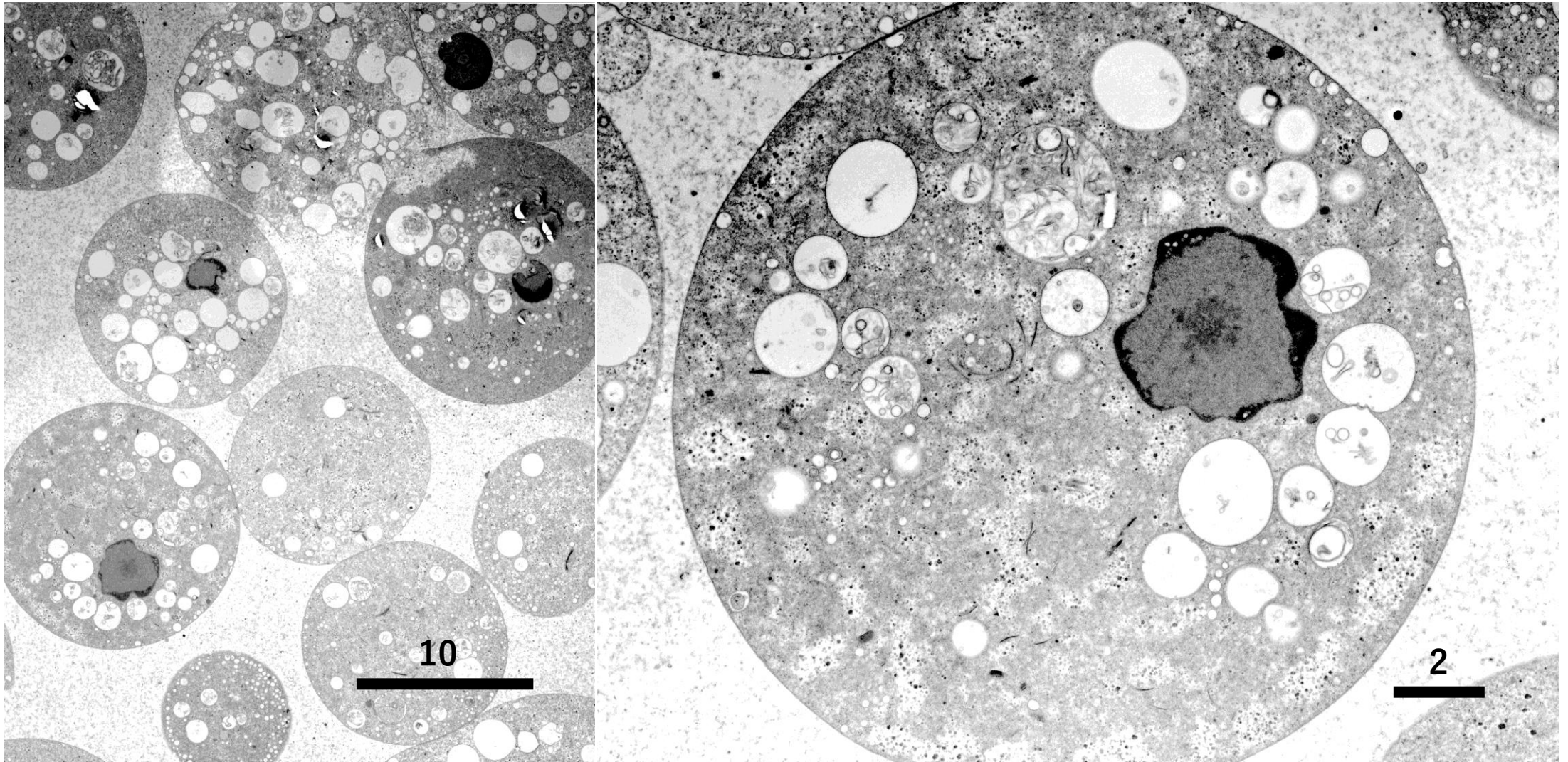
A variety of electron microscopic features of protozoa and protozoan infections are shown here. Some other pathogens, such as *Chlorella*, the ovum of *Schistosoma haematobium* and ticks, are also included. Conventional transmission electron microscopy (TEM) and scanning electron microscopy (SEM) are presented. Please enjoy the variety.



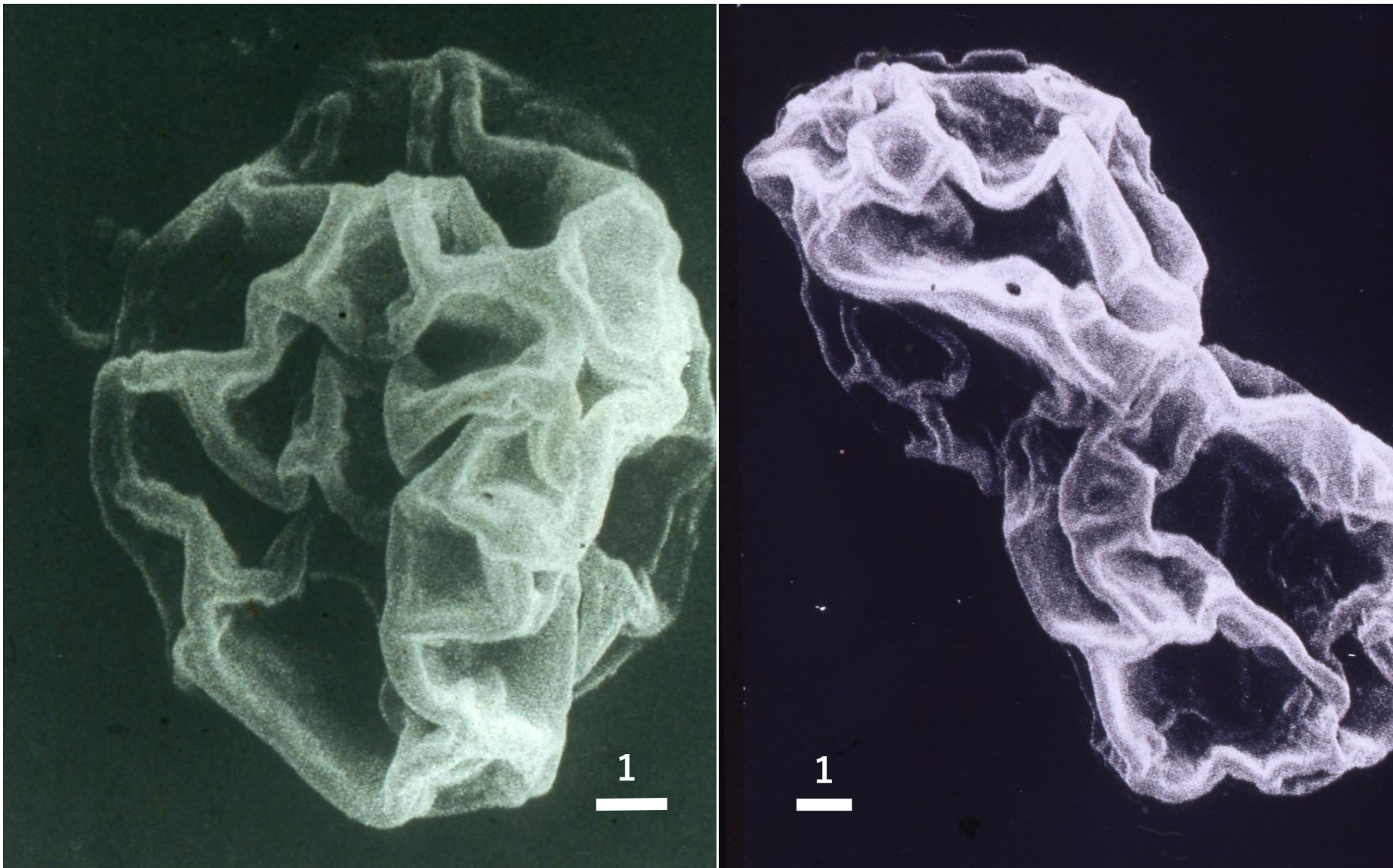
Leishmania tropica skin infection (cutaneous leishmaniasis, urban type) (TEM). A 67 y-o male patient stayed in India, and an ulcerated painless solitary ulcer was formed on the neck skin. Leishmanian particles are seen in the cytoplasm of dermal macrophages. No flagella is formed, but a kinetoplast (the basal part of the flagellum) is noted (in the right panel). Chromatin margination and central karyosome (karyosphere) formation are characteristic. Mitochondria are rich, and microtubules are distributed just beneath the plasma membrane.



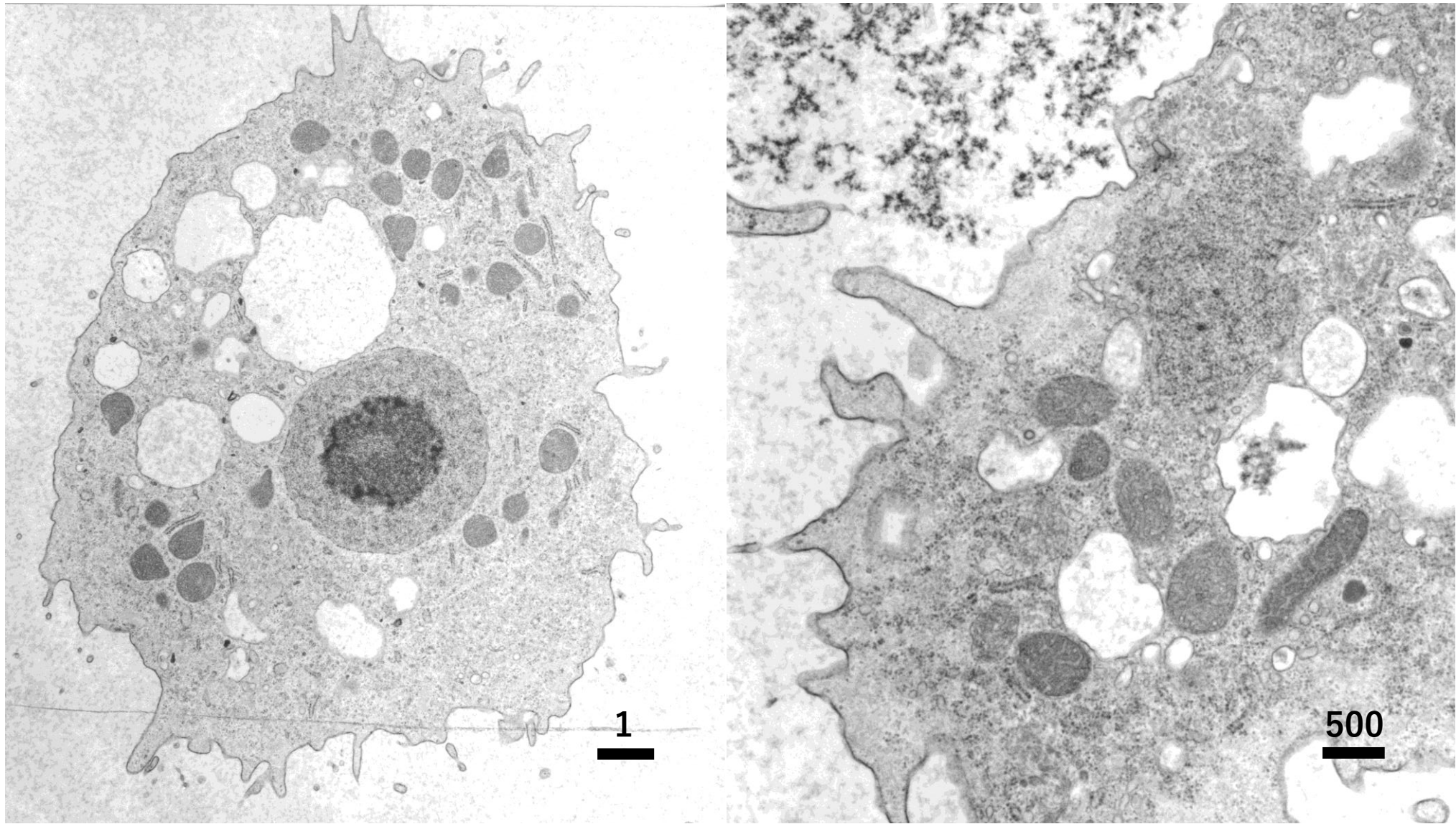
Trichomonas vaginalis seen in the cervical smear of a reproductive woman (TEM). *T. vaginalis* provokes neutrophilic reactions, and some neutrophils invaded the pathogen. Of note is that *T. vaginalis* lacks conventional mitochondria and instead contains divergent mitochondrial-related organelles, termed hydrogenosomes. Glycogen particles are seen in the cytoplasm of the anaerobic organism.



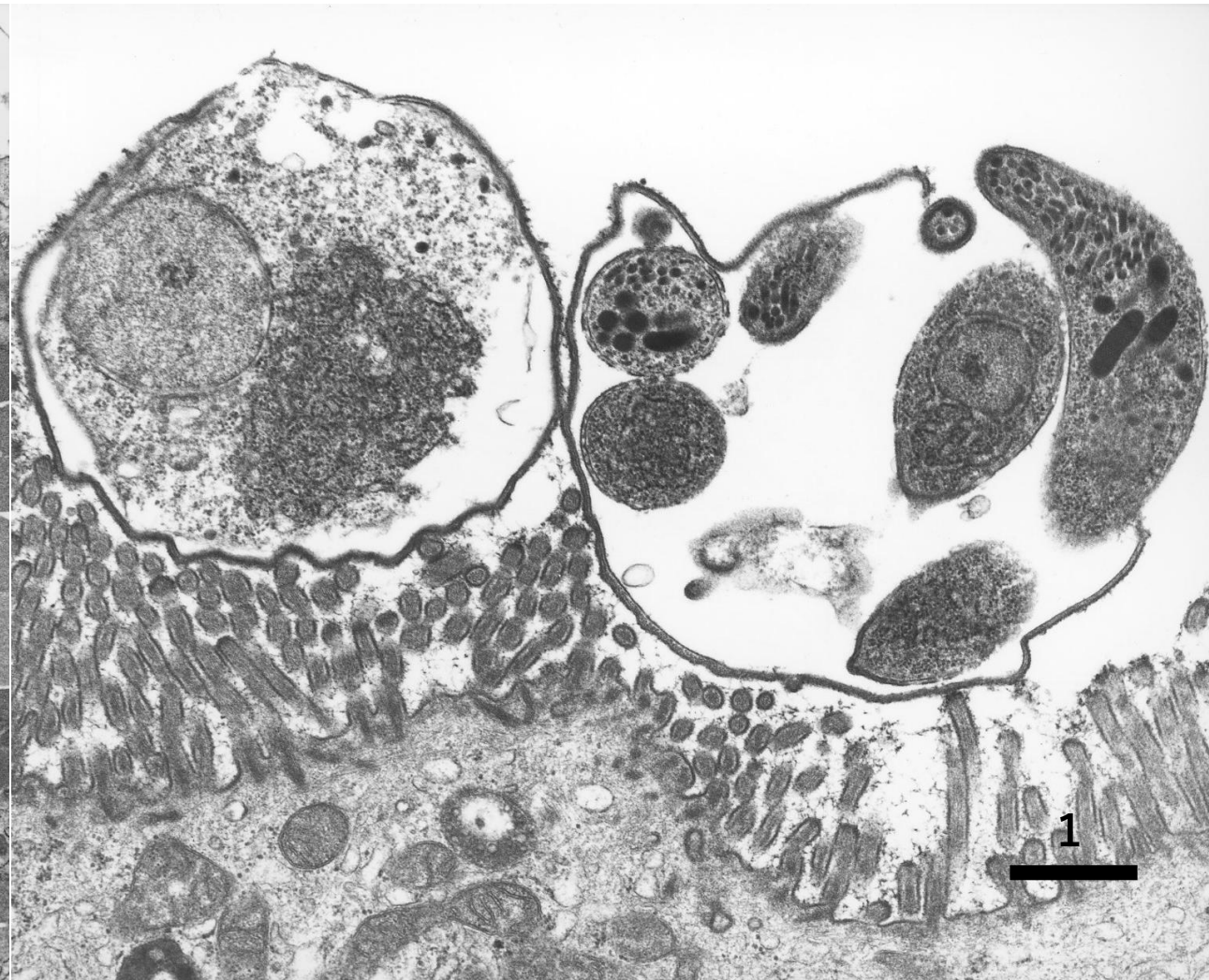
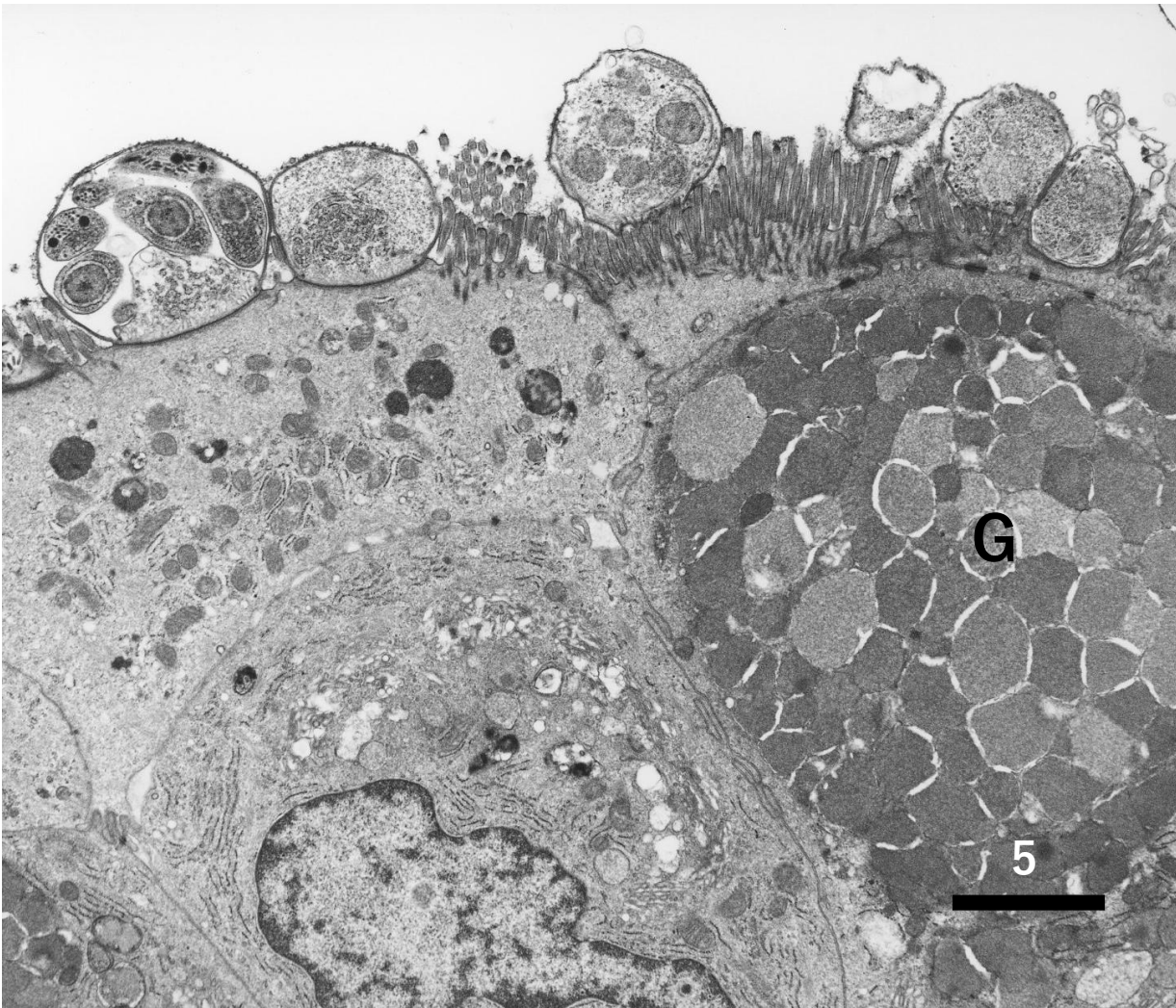
Entamoeba histolytica (TEM). Round-shaped trophozoites of cultured *E. histolytica* contain numbers of cytoplasmic vacuoles. There is no mitochondrion, representing a completely anaerobic organism. The nucleus reveal chromatin margination and centrally located karyosomes (karyospheres).



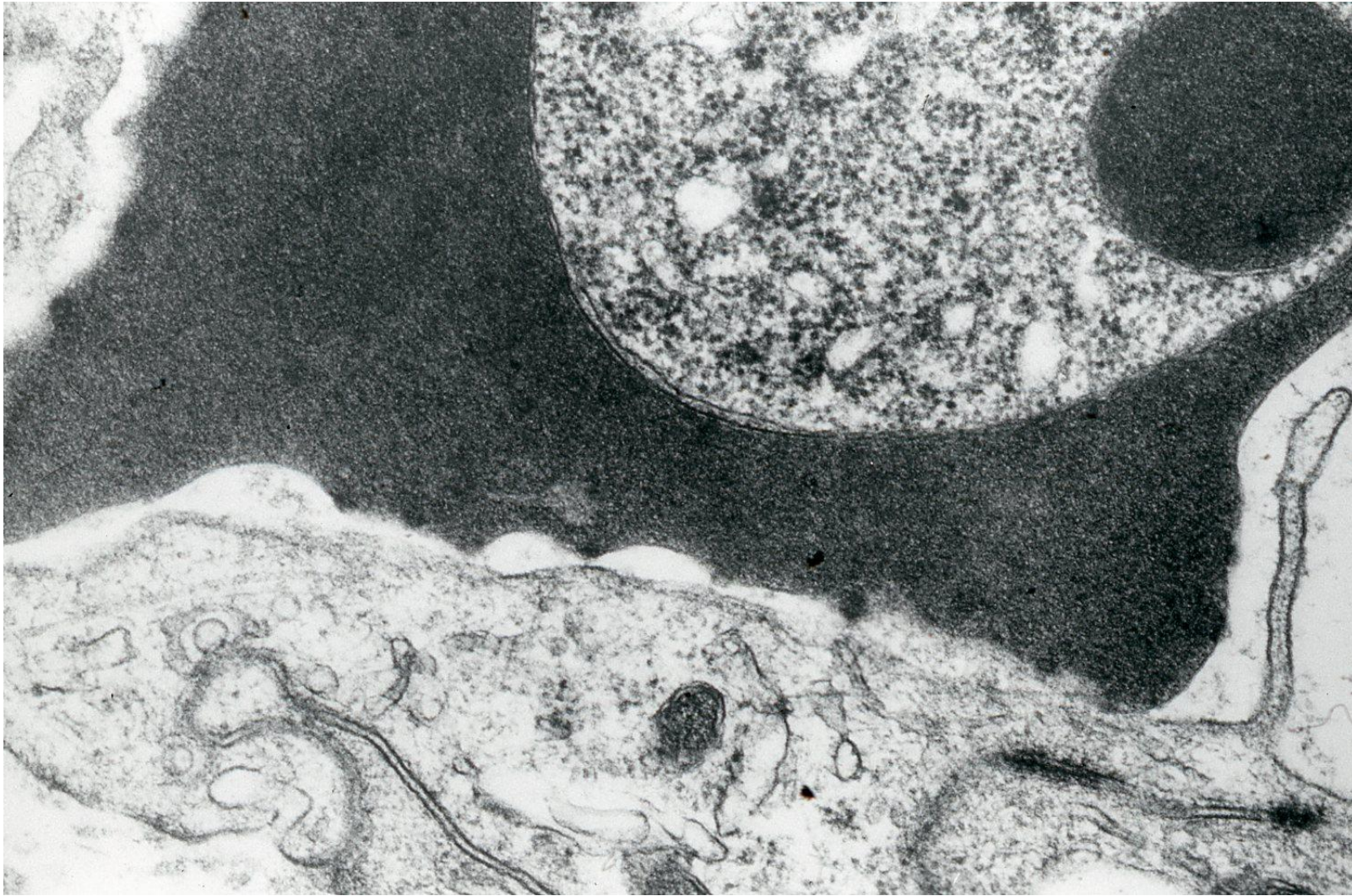
Acanthamoeba catellani (SEM). Cyst (left) and trophozoite (right) are shown. *Acanthamoeba* is a free-living amoeba, one-celled organism living in water, soil and dust. The cell surface contains spike-like acanthopodia and wrinkled microprojections.



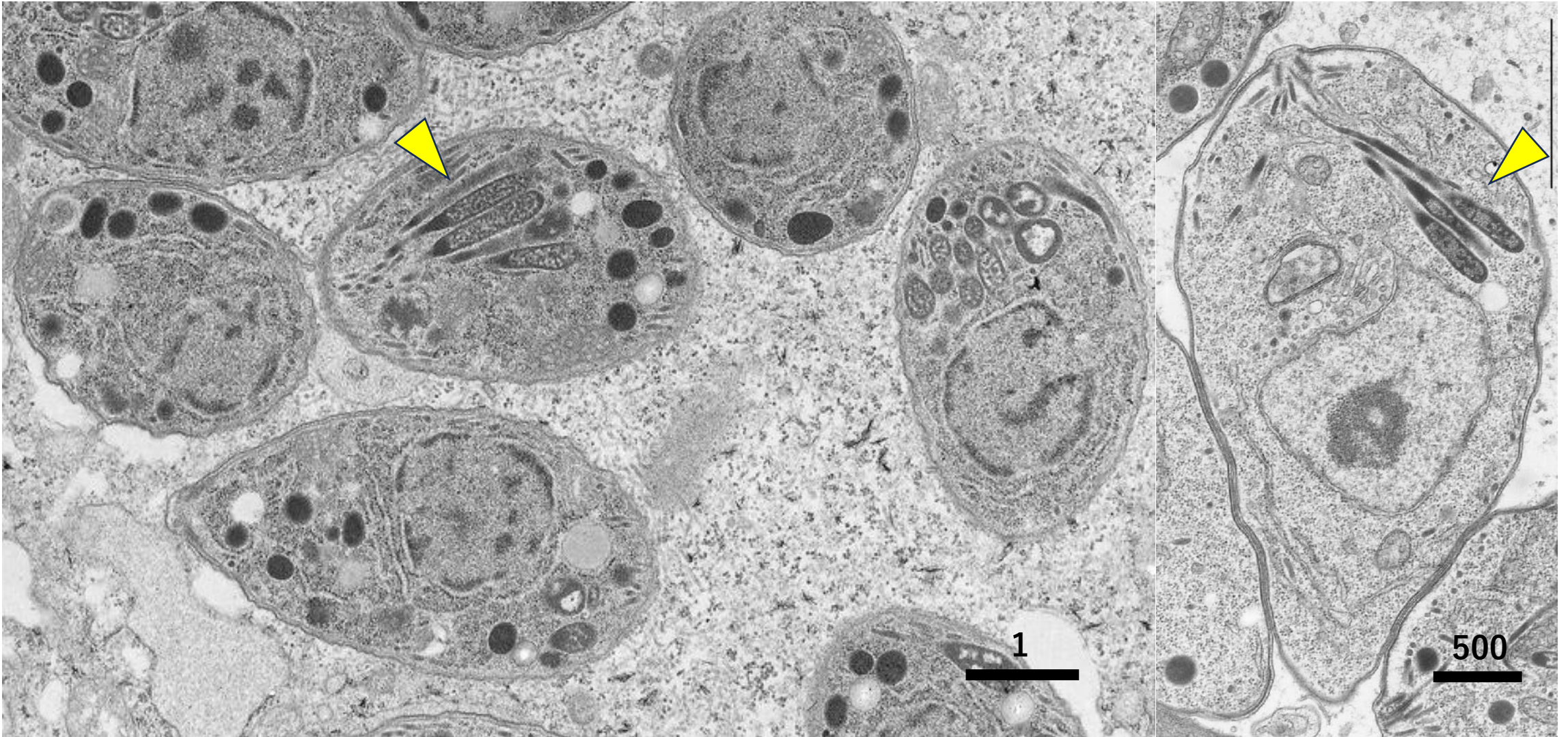
Acanthamoeba culbertsoni (TEM). The trophozoite contains spiked cell surfaces and a round nucleus with prominent karyosome. In addition to vacuoles of varying sizes, mitochondria are distributed in the cytoplasm. Compare with mitochondria-less *Entamoeba histolytica*.



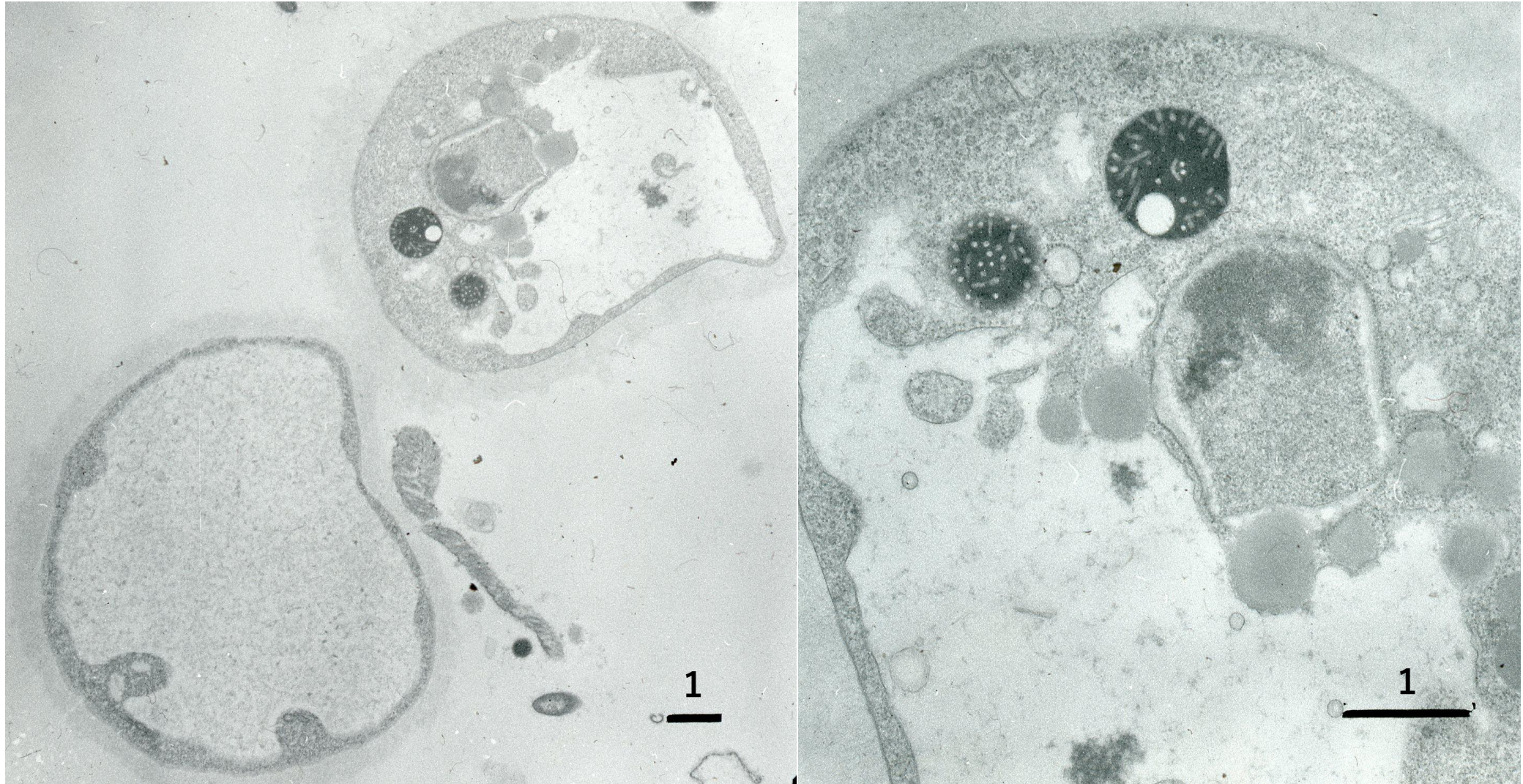
Cryptosporidium parvum (TEM). Biopsy from the small bowel mucosa in an AIDS patient reveals infection of small-sized *C. parvum* around 5 μm in diameter in the microvilli of the absorptive cell. Trophozoites and meronts (containing plural elongated or crescent-shaped merozoites) are observed. G= goblet cell



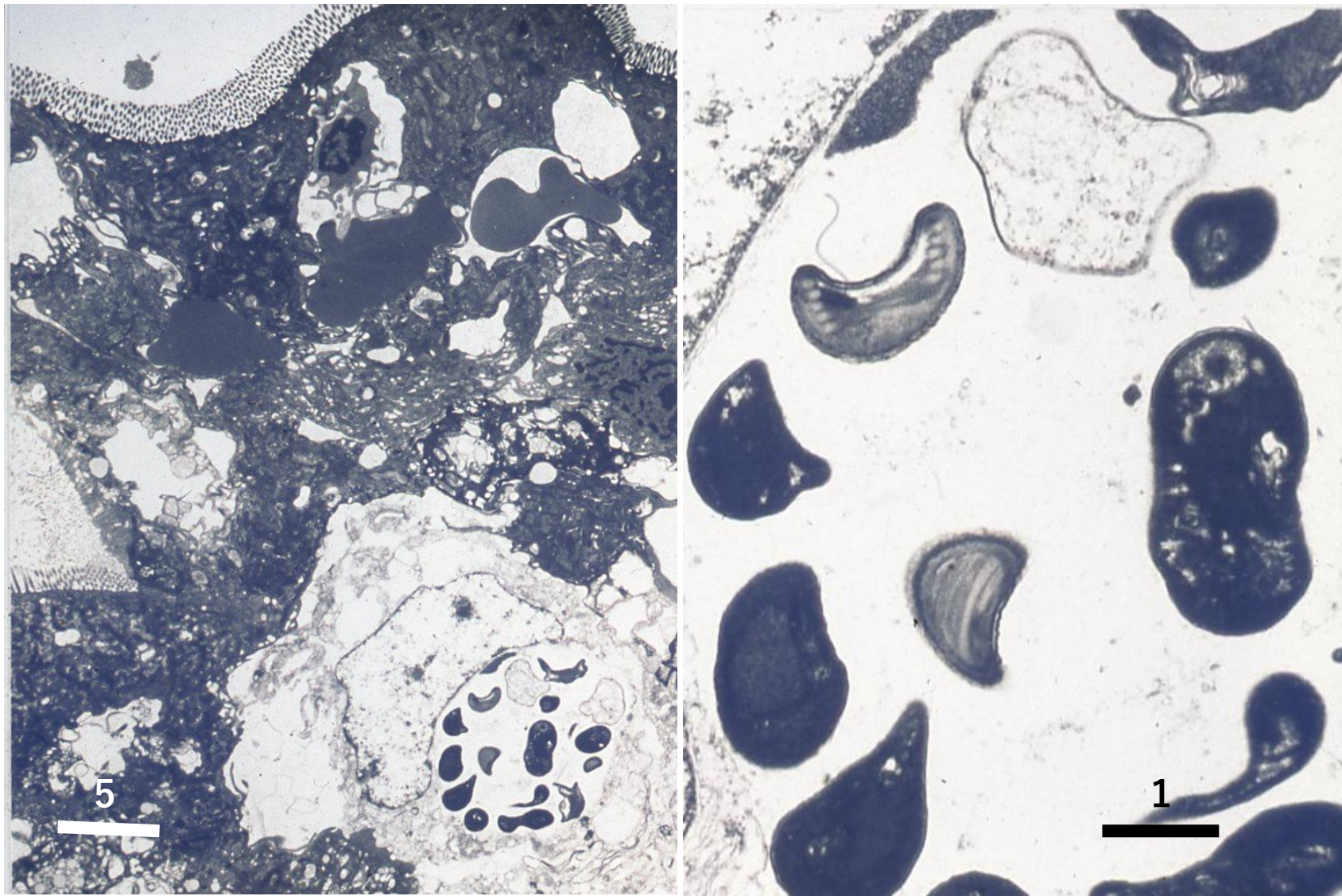
Cerebral malaria (TEM). A red blood cell infected with the trophozoite of *Plasmodium falciparum* in the cerebral capillary vessel shows knob formation on its surface. The knob, a 100 x 60 nm-sized spicule, strongly expresses cell adhesion molecules. The spiculed red blood cells thus adhere to ICAM-1 (CD36) on the endothelial cells to provoke the disturbance of cerebral microcirculation (cerebral malaria). This is the reason why trophozoite-containing red blood cells do not appear in the peripheral blood in falciparum malaria.



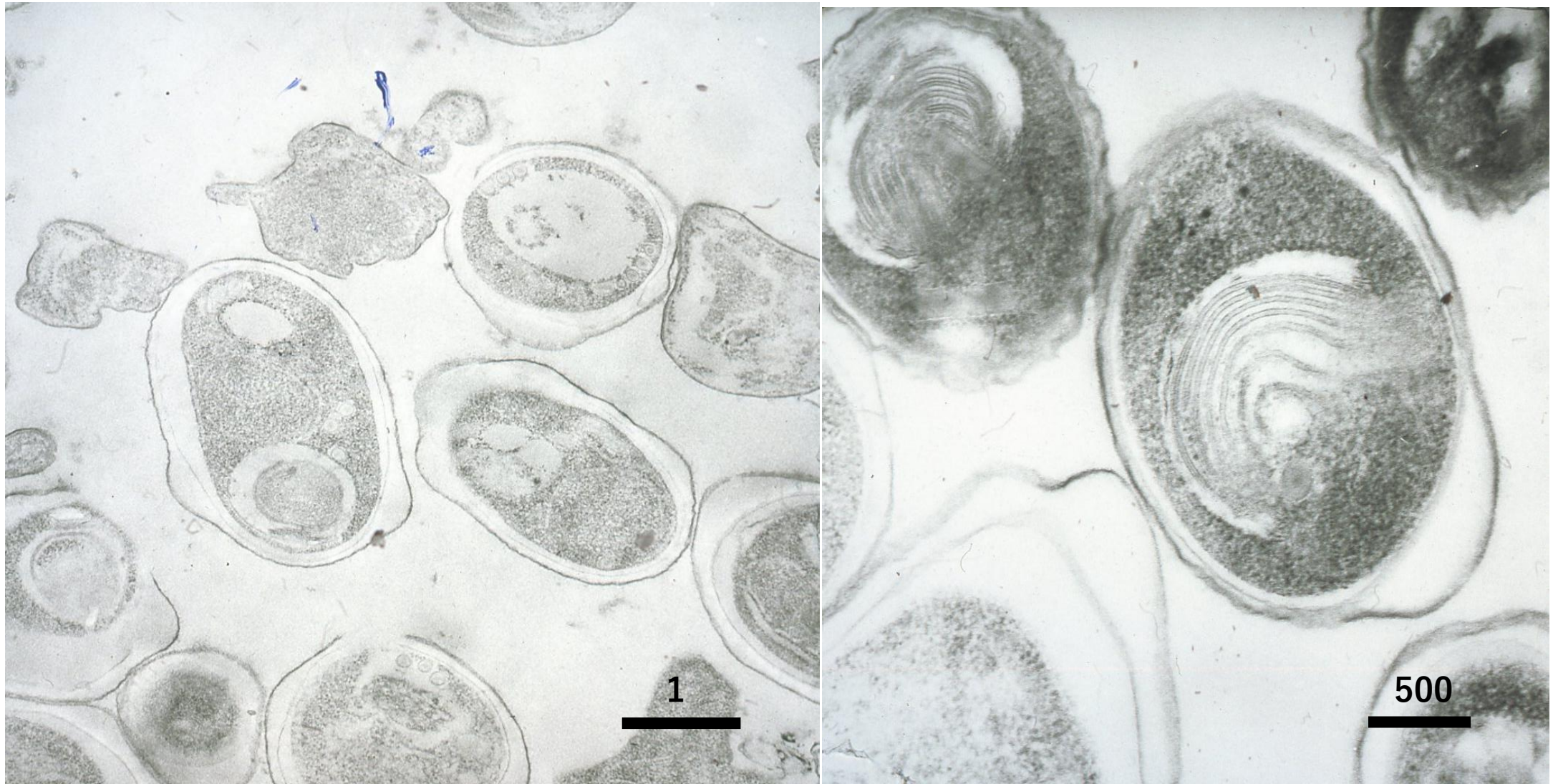
Toxoplasma gondii (TEM). A mouse peritoneal macrophage is heavily infected with *T. gondii*. Elongated or crescentic tachyzoites contain round nuclei with chromatin margination and mitochondria. Rhoptry (arrowheads) is a specialized club-shaped secretory organelle connected to the apical pole of the Apicomplexan protozoa, including *Toxoplasma gondii*. Figures were borrowed from Internet sites.



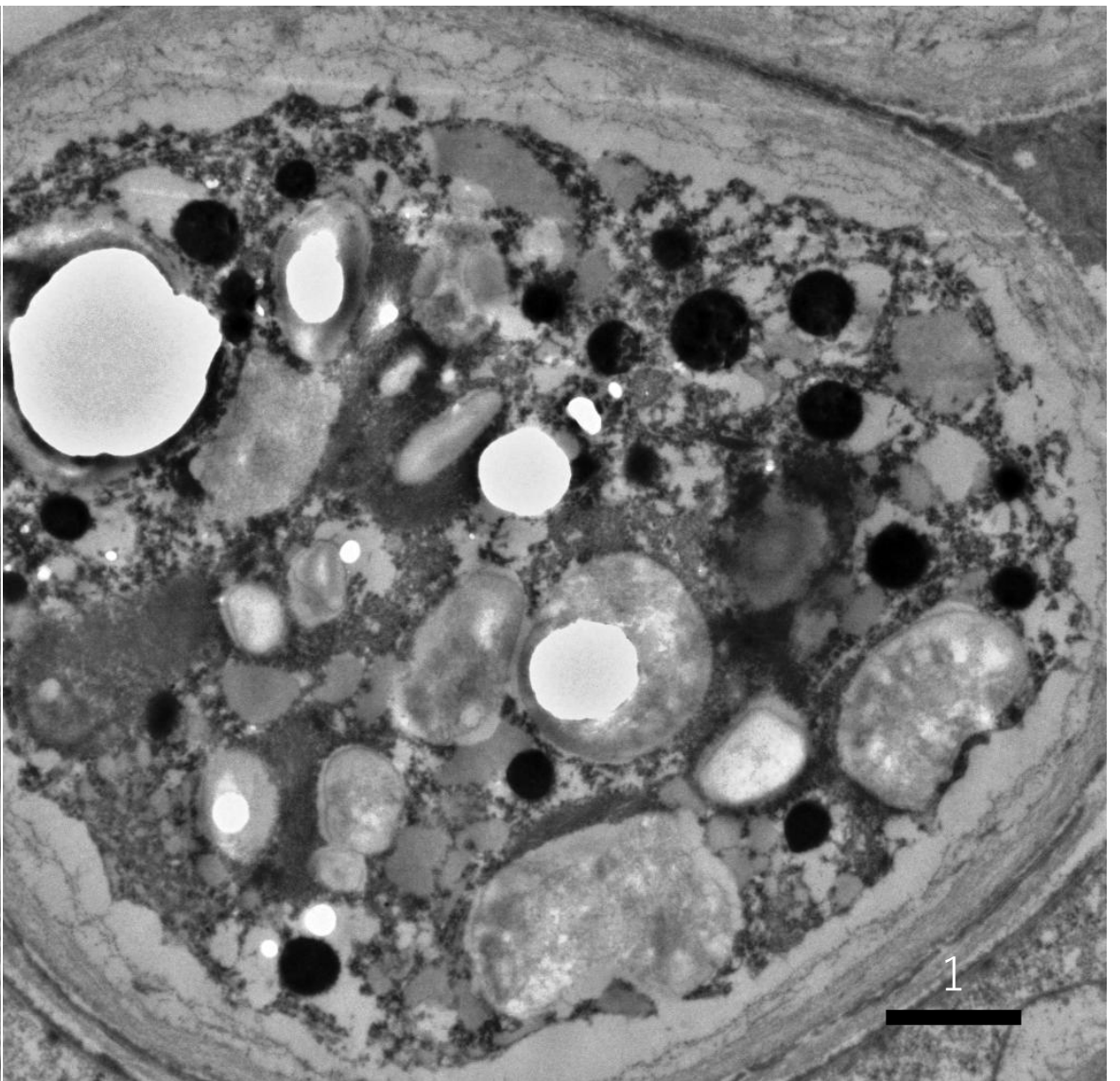
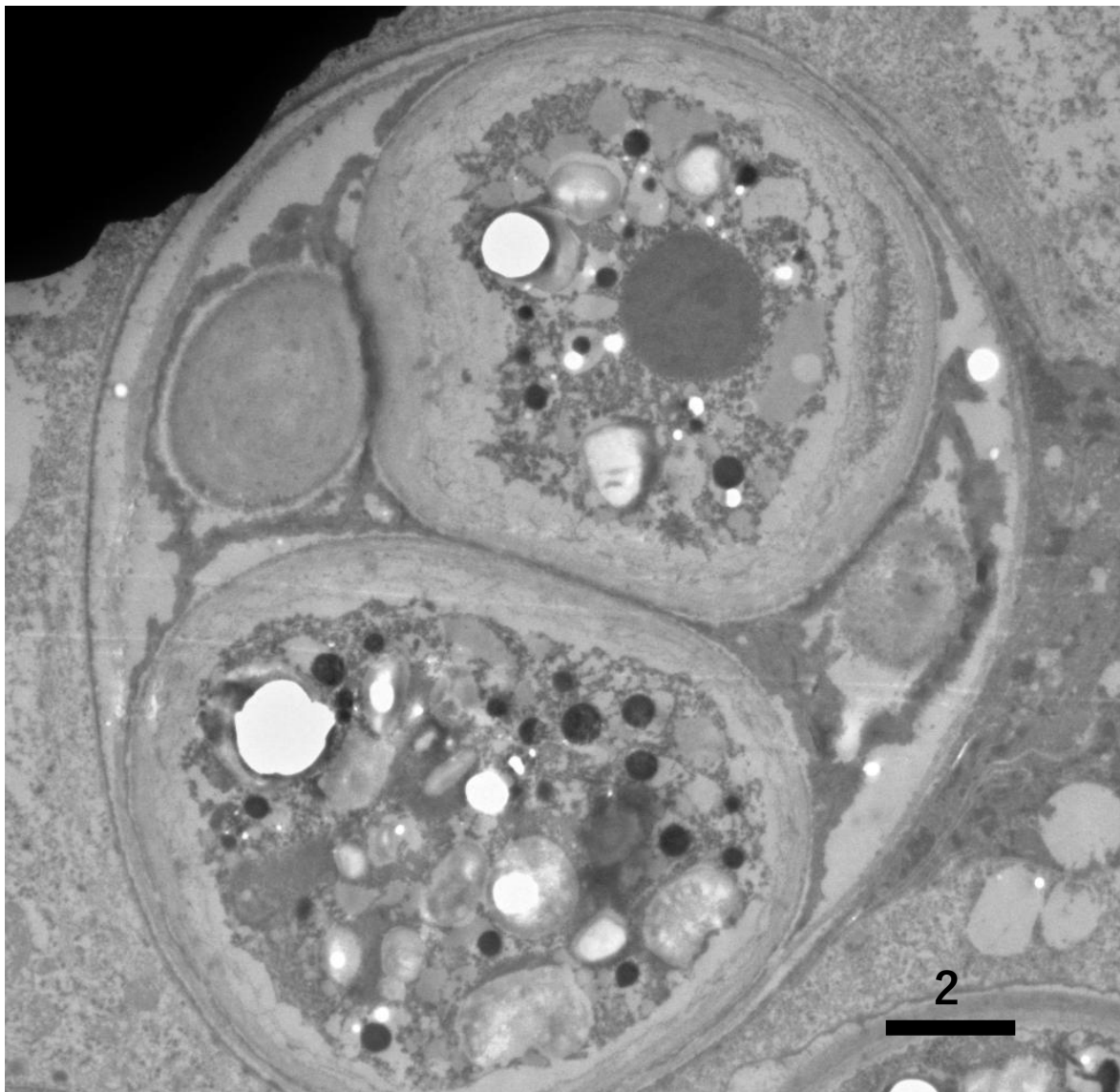
Blastocystis hominis (TEM). It may cause diarrhea in the human being. Blastocystis is a genus of single-celled parasites, belonging to the *Stramenopiles* (including algae, diatoms and water molds). As shown herein, the cultured cystic microorganism may have a thick wall focally, and has mitochondria. The roles of mitochondria in this completely anaerobic pathogen living in the gut should be clarified.



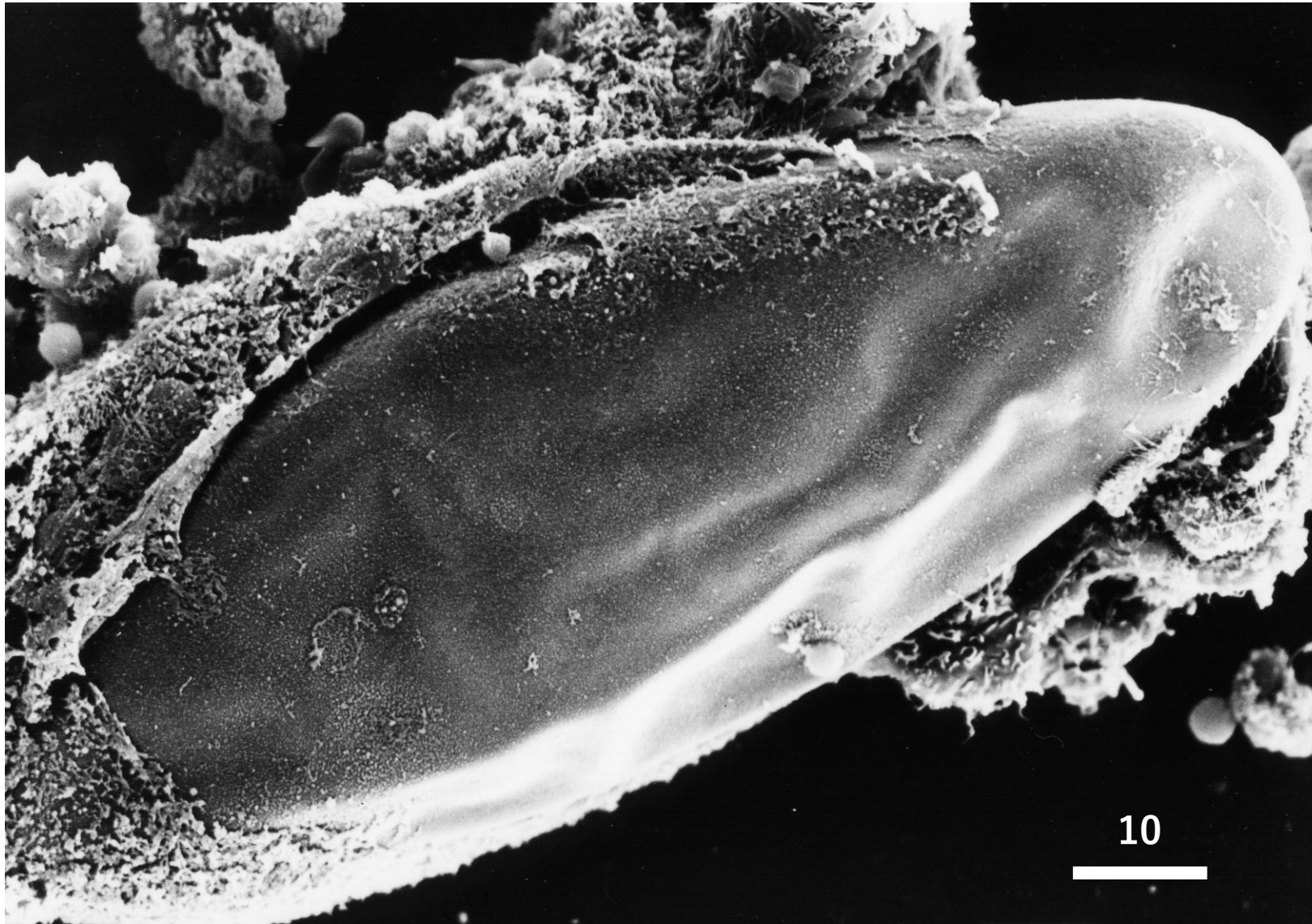
Microsporidiosis-1 (*Enterocytozoon bieneusi* infection) (TEM). Biopsy from the duodenal mucosa of an AIDS patient shows an intracytoplasmic inclusion, containing crescent- or teardrop-shaped spores. Coiled polar tubules are seen in some spores. Microspora, 1-5 μm in size, are not protozoa, but belong to a genus of green algae (or parasitic fungus). Opportunistic infection may occur in immunocompromised patients.



Microsporidiosis-2 (*Enterocytozoon cuniculi* infection) seen in the ascites fluid of an experimentally infected mouse (TEM). The spores of *E. cuniculi* consist of electron-lucent cell wall and electron-dense matrix. Coiled polar tubules are recognized.



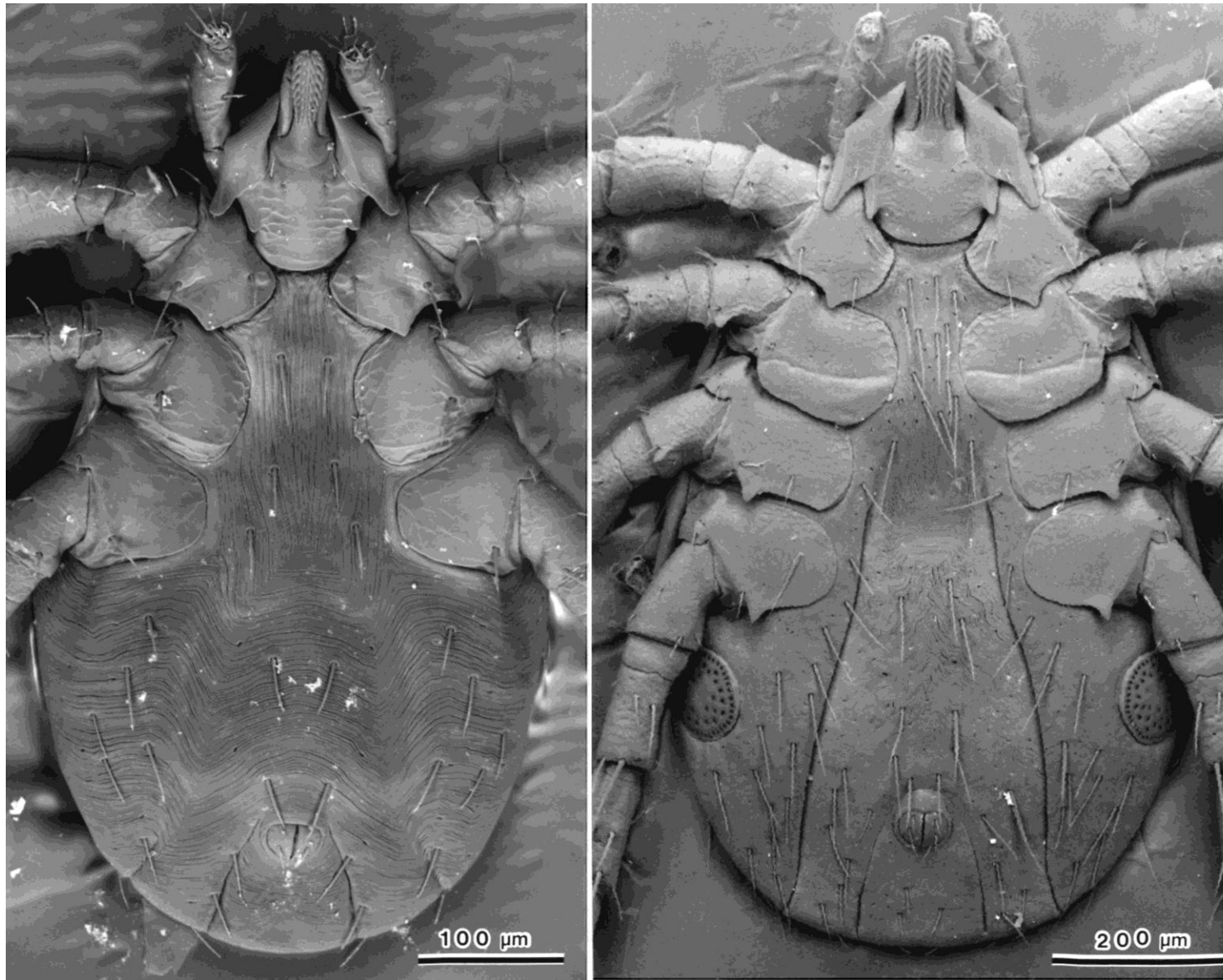
Chlorella infection in a bharal (*Pseudois nayaur* or blue sheep) (TEM). Infection of single-celled green algae, *Chlorella* spp., around 10 μm in size, provoked lethal systemic dissemination of green-colored lesions in a bharal. In addition to a thick cell wall, *Chlorella* ultrastructurally has chlorophyll-containing chloroplasts, the organelle responsible for photosynthesis. Achloric algae, *Prototheca* spp, may infect in the human being.



Ovum of *Schistosoma haematobium* seen in the urine (SEM). In the bilharziasis, the adult flukes of both sexes reside in the pelvic vein to cause gross hematuria with excretion of the eggs into the urine. The large-sized oval egg (110-170 x 40-70 μm) has a smooth surface with a sharp terminal spine.



Ixodes persulcatus (SEM). Left larval tick, right: nymph. The tick consists of two parts: capitulum (gnathosoma) and the body (idiosoma). The legs attach to the body. The larval tick contains 3 pairs of legs, while the nymph and adult have four pairs of legs.



Ixodes ovatus (SEM). Left larval tick, right: nymph. The tick consists of two parts: capitulum (gnathosoma) and the body (idiosoma). The legs attach to the body. The larval tick contains 3 pairs of legs, while the nymph and adult have four pairs of legs.