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PROTOZOOLOGY - LETTER TO THE EDITOR

COVID-19 and parasitology

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Emerging and reemerging diseases are a challenge for public health worldwide and particularly for Brazil, where the existence of the Amazon region provides a constant source of new pathogens that are transmitted from wild animals to man. Viruses, such as the agents of Dengue, Zika, Chikungunya, and Yellow Fever, continue to infect thousands of people worldwide. Infectious diseases, such as severe acute respiratory syndrome (SARS), represent a major threat to public health. The SARS-CoV virus was the agent of the SARS epidemic during 2002/2003 (Cui et al. 2019; Zhong et al. 2003) and just a decade later, the world witnessed another outbreak, known as "Eastern Respiratory Syndrome" (MERS) caused by MERS-CoV in the Middle East (Bawazir et al. 2018; Zaki et al. 2012). While researchers still continue to investigate the underlying mechanisms of pathogenicity and develop effective therapeutic strategies against MERS, the world is now witnessing another outbreak on a global scale, COVID-19 (Wu et al. 2020), caused by SARS-CoV-2, which belongs to the *Coronaviridae* family, order *Nidovirales*. These viruses have a RNA genome in the form of single-stranded RNA with positive polarity. The RNA genome is packaged inside a helical capsid formed by the protein (N) nucleocapsid and surrounded by an envelope where at least three structural proteins exist: the membrane protein (M); the envelope protein (E), which is involved in the assembly of the virus; and the spike protein (S), which is involved in the entry of the virus into host cells. These structural proteins form spikes on the surface of the virus, giving the appearance of a crown, hence its name.

The disease (COVID-19) appeared in December 2019 in Wuhan, China, and due to the intense flow of travelers around the world, it appeared in several countries, on all continents, leading the WHO to declare it a pandemic disease on February 14, 2020. At present, the available data indicate the presence of 2.6 million infected people and 178 thousand dead (April 22), demonstrating the severity of COVID-19 due to the rapid spread of the virus and its high pathogenicity, which mainly, but not exclusively, affects the pulmonary system.

What is the interest of this infection for parasitology? I see at least three points of interest. First, it is important to note that infectious and parasitic diseases are interconnected. Those caused by viruses, such as COVID-19, strongly interfere with the immune system, at least via what is being called as a "cytokin storm," which creates ideal conditions for other co-infections, caused by fungi, protozoa, and helminths, to appear. In this sense, several groups are analyzing this issue, especially in Brazil, where we have high levels of infection by *Plasmodium vivax* and *P. falciparum, Trypanosoma cruzi, Leishmania,* and *Toxoplasma gondii*, among other agents. Second, because some viruses also infect protozoa, fungi, helminths, and insects that transmit various parasitic protozoa, in addition to interfering with their biological properties. As far as protozoa are concerned, it is worth remembering that in the 1960s, electron microscopy began to show the presence of viral particles in several members of the Trypanosomatidae family, in *Giardia*, *Trichomonas*, and *Cryptosporidium*, among others (see Miles 1988; Charon et al. 2019). Several recent studies in different countries that used meta-transcriptomic analysis of blood from patients with malaria, as well as from transmitting mosquitoes, revealed the presence of a sequence similar to that of an RNA narnavirus (designated as Mathryoskha RNA virus 1) in *Plasmodium vivax*, as well as in transmitting mosquitoes, but not in the blood of patients infected with *P. falciparum* or *P. knowlesi*. Third, because in critical moments, such as the one we are facing today, the scientific community is "summoned" by the government and society to give scientific answers to the countless questions that are raised. After all, SARS-CoV-2 (a) is an intracellular pathogen that interacts with receptors located on the surface of mammalian cells; (b) enters into cells through one of the mechanisms of endocytosis, which is also used by prokaryotic and eukaryotic microorganisms (examples include *T. cruzi, T.*

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gondii) (Barrias et al. 2019); and (c) interacts with the structures and organelles of the host cell to create the conditions for the assembly of thousands of new viral particles that (d) are then released outside the cell, usually through exocytosis. Most of these steps resemble the processes used by intracellular protozoa that the parasitology community deals with daily. Therefore, members of the parasitology community, especially those working with parasite-host cell interaction processes, can and shall contribute at this time.

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