Protists on the spot: opening the field of view on protistology

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Discovery of protists

When it comes to the natural world, most knowledge, including that of the general public, is focused on animals and plants. Until a few centuries ago, one of the major reasons for this was the lack of technology to make micro-organisms visible. This changed when Antoni van Leeuwenhoek (1632–1723), a trained linen draper and haberdasher, developed a single-lensed microscope out of his own interest to study what lay beyond his eyes. Leeuwenhoek spent a lot of time making lenses to find the perfect one. The range of magnification of these lenses was between 50 and 300 times. Driven by his curiosity, he used these simple microscopes to describe the little critters he discovered in environments that ranged from rainwater to the human intestine, as animalcules. Even though he was not a trained scientist, his thorough observations enabled him to make some fundamental discoveries, which he sent in the form of letters to the Royal Society. In the beginning, his discoveries were often disputed due to his background, but this changed over his lifetime, and his work (~375 contributions) was mostly published in Philosophical Transactions. He has been coined as the father of microbiology as his microscopes enabled him to describe bacteria and protists for the first time ever. He was motivated to answer essential questions, some of which we are still trying to answer today: why is there such a diversity (morphology/behaviour) of these organisms and how did it evolve? How can they be distinguished and classified?

Why is protistology important?

Protists or protozoa are a large group of single-celled eukaryotes that have been identified across the eukaryotic tree of life. They are not a monophyletic group, and some species are close relatives of plants, animals and fungi.

They contribute significantly to microbial ecology, soil fertility and water quality. They also have an enormous impact on animal and human health, with many species known as emerging pathogens. Protists interact with other microbes (viruses, archaea, bacteria and fungi) through predatory, mutualistic or symbiotic relationships. This makes the study of protists (protistology) an important node in the different fields of biology, including ecology, infectious diseases and evolution.

Ecology: Protists have been isolated from diverse habitats, including extreme environments, such as polar regions, deserts or deep-sea ocean vents. Advances in protistology reveal new species and ecological interactions with other organisms. Their key roles in environmental niches highlight their importance in influencing environmental health.

Infectious disease: Many human and animal obligate and opportunistic parasites are protists. They use different routes to transmit infections, e.g. through vectors (Plasmodium, Leishmania, Trypanosoma) or the oral-faecal route (Cryptosporidium, Toxoplasma oocysts, Eimeria, Entamoeba, Giardia). A common challenge with all protist pathogens is the tremendous difficulty in treating and preventing the disease they might cause. In addition to causing infection, some protists are themselves vectors of infectious agents. For example, the opportunistic pathogen Acanthamoeba harbours pathogenic bacteria itself, such as Legionella. By contrast, some protists are described as key determinants in animal and plant health, due to their ability to phagocytose and therefore remove pathogenic bacteria.

Evolutionary biology: Protists are excellent models for understanding evolution. Their genomes often include evidence of lateral gene transfer, in particular from bacteria, archaea or other protists. This is no surprise in view of their intimate relationships with other micro-organisms. Genetic data strongly suggest protist–microbe symbioses, from the first studies identifying mitochondria, plastids and other organelles as products of early endosymbiosis of bacteria. Moreover, several protists, such as choanoflagellates, are used as models to understand the evolution of multicellularity.

Modern technologies

Over the last few decades, there has been an explosion of new technologies that have been used to understand the biology of all lifeforms. These 'omic' technologies have also revolutionised protistology research. Scientists have identified novel species at a rapid rate using a combination of single cell genomics, metabolomics and proteomics, and this has also increased knowledge of symbiotic relationships between protists and other microbes. Despite this tremendous progress in the field, the major challenge is to understand how protists survive, develop relationships with other microbes and adapt to new environments in a temporal manner. Traditional protistology includes cell culturing, single-cell isolations, staining and microscopy (from light to advanced electron microscopy), techniques that are slowly being ignored by researchers due to lack of time and expertise. Whilst modern omics technologies have allowed us to study communities, from molecules via species to the system level, they do not provide deep insights into the basic biology and ecology of protists. The strength of observations, that can be made with even the simplest microscopes like Leeuwenhoek developed and used, are not to be underestimated when it comes to understanding the biology and ecology of protists and should be a valid aspect in combination with new advanced technologies.

With this Microbiology Today issue we would like to increase cross-sector awareness of the field of protistology, emphasising the role of protists in ecology, health, disease and evolution and their importance in the environmental and health sectors, including the benefits and challenges associated with their presence in certain niches.