Nature's misfits: Reclassifying protists helps us understand how many species remain undiscovered

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Since the Victorian era, categorizing the natural world has challenged scientists. No group has presented a challenge as tricky as the protists, the tiny, complex life forms that are neither plants nor animals. A new reclassification of eukaryotic life forms, published in the *Journal of Eukaryotic Microbiology*, draws together the latest research to clarify the current state of protist diversity and categorization, as well as the many species that remain to be discovered.

"Protists include species traditionally referred to as protozoa and algae, some fungal-like organisms, and many other life forms that do not fit into the old worldview that divided species between plants and animals," said Professor Sina Adl, from the University of Saskatchewan. "By the 1960's it had become clear that these species could no longer fit within such a narrow system, yet the first community-wide attempt to rationally categorize all the protists in the natural evolutionary groups was only made in 2005."

The 2005 classification, led by Professor Adl and published by the *Journal of Eukaryotic Microbiology*, gave scientists a structure for understanding these species; however, it was limited to the technology available at the time and recent advances have prompted the need for a reclassification.

"With environmental genomics we are experiencing a renaissance of new

protist discoveries," said Adl. "These new species allow us to better appreciate how little we know about the biodiversity around us and how they contribute to maintaining the planet's chemical balance."

The most significant changes are the introduction and recognition of new super groups, larger than traditional biological kingdoms. This reflects a greater understanding of the most ancient relationships between protists, their shared ancestry and their connections to animals and plants.

This includes recognition of the Amorphea, a group that links animals, fungi and their protist relatives, including the marine choanoflagellates, to a diverse group of protists largely dominated by various amoeboid cells. This includes macroscopic slime molds, shell-dwelling amoebae, small flagellated amoebae and large voracious amoeboid predators of bacteria, algae and even small crustaceans.

A second new super group, SAR, brings together many of the most common and successful algae, microbial predators, and parasites on earth. Members of this group range from giant kelp and other brown seaweeds, to the forams (living sand grains), and the parasite that causes malaria in humans. Large scale DNA and RNA sequencing studies conducted since 2005 have shown that these profoundly dissimilar forms are all actually related to each other.

"This new classification, that better reflects how species are related, improves our ability to predict the number of species that remain to be discovered," concluded Professor Adl. "There is a huge unknown diversity in the deep sea, but probably even more in the soil we walk on."

More information: Sina Adl, Alastair Simpson, Christopher Lane, Julius Lukes, David Bass, Samuel Bowser, Matthew Brown, Fabien Burki, Micah Dunthorn, Vladimir Hampl, Aaron Heiss, Mona Hoppenrath, Enrique Lara, Line Le Gall, Denis Lynn, Hilary McManus,

Edward Mitchell, Sharon Mozley-Stanridge, Laura Parfrey, Jan Pawlowski, Sonja Rueckert, Laura Shndwick, Conrad Schoch, Alexey Smirnov, Frederick Spiegel, "The Revised Classification of Eukaryotes", September 2012, DOI: 10.1111/j.1550-7408.2012.00644.x