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Arcella peruviana sp. nov. (Amoebozoa: Arcellinida, Arcellidae), a new species from a tropical peatland in Amazonia

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Abstract

There has only been one study on the ecology of testate amoebae from Amazonian peatlands, despite Amazonia being a biodiversity hotspot of global importance. During analysis of litter samples from Aucayacu peatland, western (Peruvian) Amazonia, we discovered a testate amoeba with a distinct morphology unlike any other species reported previously. We describe a new species, *Arcella peruviana*, based on its distinct morphology, compare it to morphologically similar species and provide information about its ecology. This new species is characterised by a distinct cruciform aperture (diameter ranges between 12 and 17 μm) which is slightly invaginated. The test is small (height 43–57 μm) and polygonal in cross-section. Our discovery suggests the existence of an unknown diversity of testate amoebae in Amazonia. The absence of the new *Arcella* species in more intensively-sampled regions supports the view that protists have restricted distributions.

Keywords: Microbial diversity; Peatlands; Protist distribution; Rainforest; Testate amoebae; Tropics

Introduction

It has been suggested that the failure to describe new species of protists has contributed to the underestimation of their true diversity (Corliss 2001; Epstein and López-García 2008). Only a small fraction of potential protist habitats have been investigated, mainly in Europe and North America (Foissner 1999). The need to investigate protists in less-intensively sampled regions of the world has been highlighted by Foissner (2008): "Further, greatly intensified research is required on morphospecies in heterotrophic protists because their diversity has never been investigated in large areas of the earth". However, many new species of protist may never be discovered given the current extinction rate (Pimm et al. 2014) and loss of habitats across the globe (Cotterill et al. 2008).

Estimation of true diversity is hampered by the fact that there is no single, generally accepted species definition (Boenigk et al. 2012). In the case of protists, the

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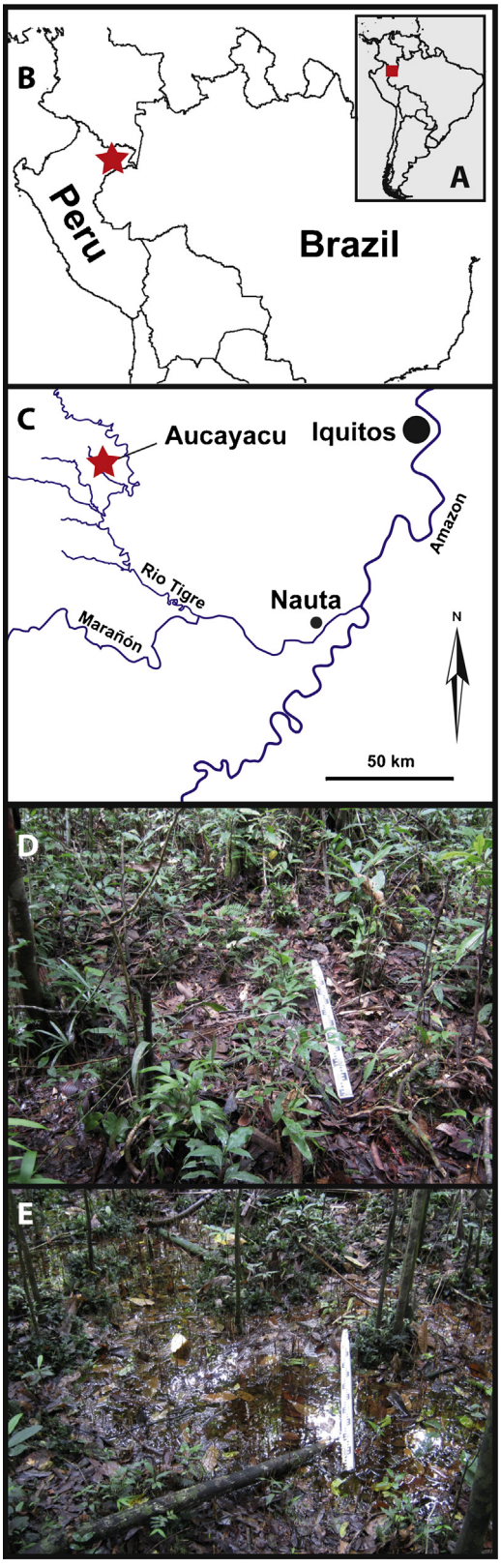

Fig. 1. Location map of the study site in: A – South America; B – Peru; C – Loreto region and images illustrating the study site: D – dry litter-covered area typical of the Aucayacu peatland; E – the pool containing the largest abundance of *Arcella peruviana*. The scale in the pictures D and E represents 1 m and each set of black lines in the scale represents 5 cm.

morphospecies concept has been proposed as a pragmatic definition (Finlay 1998). However, it has been suggested that this concept does not reflect the true diversity of protists compared to macro-organisms (Weisse 2008), and that the morphological variability does not necessarily reflect the taxonomic units (Bobrov and Mazei 2004). Nevertheless, Bobrov and Mazei (2004) point out that this is a convenient concept in ecological research as morphology reflects the ecological niche to a great extent.

Descriptions of new species from poorly-studied regions may also contribute to the cosmopolitanism vs. endemism debate in microbial ecology. The low numbers of reported endemic species from poorly-studied regions may be an artefact of sampling, but this is much less probable when species have not been found in intensively-sampled regions (e.g. Europe and North America), as in case of the flagship species *Apodera vas* (Smith and Wilkinson 2007). In addition, our knowledge of the endemic distribution of protists may change as new data are published. One example of this is the testate amoeba *Difflugia biwae*, which was considered endemic to Lake Biwa in Japan until it was recorded in Chinese lakes (Yang and Shen 2005).

Testate amoebae inhabiting less-intensively sampled regions are poorly understood due to additional challenges in studying these environments. Under-studied regions are often hardly accessible, making it difficult to bring back living specimens for molecular work nor to obtain enough material to do SEM. This kind of limitation is especially frequent when studying under-studied regions and hence it may be justified to describe species even if not all the data is available for an ideal species description. This can only be justified if the new taxa is clearly different from the known taxa from a morphological point of view.

One example of less-intensively sampled environments are the tropical peatlands of Amazonia. Swindles et al. (2014) recently published the first study on the ecology of testate amoebae from Aucayacu peatland in western Amazonia (Peru). During our investigations on the same material, we recorded a taxon from the genus *Arcella* with a morphology unlike any other testate amoeba reported in any previous studies. Despite the fact that no living specimen could be isolated and molecular analyses are therefore not possible, based on the very distinct morphology we believe this morphotype clearly corresponds to a new species. In this paper we: (i) describe the morphology of this new species, (ii) compare the characteristic features of the species to others within the same genus and (iii) provide information on its ecology.

Material and Methods

One hundred surface litter samples (of approximately 5 cm^3) with associated environmental data were collected