Protistology 4 (2), 145-148 (2005)

Protistology

Rate of amoebae dispersion in a model ecosystem

Alexey V. Smirnov

Marine Biological Laboratory University of Copenhagen, Helsingør, Denmark, and Department of Invertebrate Zoology, Faculty of Biology and Soil Sciences, St. Petersburg State University, Russia

Summary

The dispersion rate of *Platyamoeba* sp. was estimated in marine aquaria containing 1 cm layer of sterilized sand. Amoebae were inoculated in the center of the aquarium; the dynamics of their distribution across the aquarium was monitored and recorded. From eight days to three weeks were sufficient for *Platyamoeba* sp. to explore a 22 × 30 cm aquarium. The results suggest a relatively high dispersion rate of amoebae in a 3-D environment.

Key words: amoebae, *Platyamoeba*, Lobosea, Gymnamoebia, dispersion, mobility

Introduction

Amoebae are believed to be relatively low-mobile protists, as compared with ciliates or flagellates. The locomotion rate of various amoebae species measured on the glass surface ranged from 10 to 55 μm/min in lobose amoebae (Schaeffer, 1926; Sawyer 1975a, 1975b) and reached 78 μm/min in Heterolobosea (Levandowsky et al., 1997). If we extrapolate these data, it seems that theoretically an amoeba can relocate to 15 - 112 cm in 24 hours. Of course, such direct extrapolation is incorrect, because an amoeba does not move strictly forwards. Experimental studies indicate that the amoebae on glass or plastic surface move in complex manner that may be approximated by a 1-parameter class of self-similar random processes termed Levy walks (Levandowsky et al., 1997). In their experiments the cells covered the distance 0.6 - 4.6 mm during one hour. However, the behavior of amoebae on the flat surface in the absence of chemical and physical gradients evidently differs from that in the environment.

Natural habitats of amoebae have a complicate 3D structure and a complex pattern of overlapping chemical and physical gradients that organisms follow according to their preferences. Distribution of food objects and predators further complicates the pattern. There is experimental evidence that amoebae show patched distribution in the environment (Anderson, 2002; Bischoff, 2002). Smirnov (2002) and Smirnov and Thar (2003, 2004) suggested that it is related to the presence of microhabitats, selectively occupied with amoebae species. However, another possible explanation for the patched distribution of organisms can be the founder effect. Theoretically, it can be suggested that amoebae

have no clear ecological preferences, and form patches due to the multiplication of randomly dispersed cells distributed in the habitat by bioturbation of other random events. It looks unlikely that in this case the amoebae will form as small patches as 1-2 cm in size, which were found by Smirnov and Thar (2003, 2004), but the question cannot be answered without the data on the possible rate of amoebae dispersion in the 3-D environment. A simple experiment described in the present paper is intended to estimate the potential dispersion rate of amoebae in sterile habitat with a complex 3D structure.

Material and Methods

Three different experiments were performed. In the first one, an aquarium 22×30 cm in size was sterilized and filled with 1 cm layer of heat-sterilized Fontana sand (Prolabo, size of granules 150-300 μm). The aquarium was filled with 0.05% Cerophyl infusion (Page, 1988) made on artificial 15 ‰ seawater. Routine pump was used to aerate the aquarium. In the second experiment conditions were the same, but the aquarium was not aerated. The third experiment was performed in the similar manner in round aquarium, 19 cm in diameter (also not aerated). Negative controls show the absence of native amoebae fauna in aquaria. All experiments were performed at the room temperature.

All three aquaria were left for three days to allow for some bacterial growth and then inoculated with the suspension of *Platyamoeba* sp. (non-identified isolate from the Ebro Delta, Spain) using a syringe. This isolate was chosen because it shows perfect growth in the medium used for experiments and thus there was no reason to expect the artifacts related with the inability of amoebae to grow under the given conditions. The 0.5 ml of the suspension of cells was gently inoculated into the sand so as not to allow their dispersion in the water. All aquaria were placed on the solid basis preventing any vibrations and covered from direct light.

Sampling was performed at different time intervals using the 4-channel Eppendorf dosator and cut 0.5 ml tips. About 0.3 ml of sand and water were collected from every point of the sampling grid. The samples were inoculated into the 24-well plates (Greiner) filled with the same medium. Examination was performed twice, at 7 and 12-14 days of incubation, using phase-contrast inverted microscope under 200× and 400× magnifications.

Results and Discussion

Amoebae explored the aquaria with different intensity (Fig. 1). The fastest case was 8 days, (Fig. 1 B); while in the last experiment (Fig. 1 C) the whole aquarium was not populated even after 45 days. Surprisingly, the non-aerated aquarium (Fig. 1 B) was populated even faster than the aerated one (Fig. 1 A). Sampling next day after inoculation shows that this result is not due to inaccurate inoculation, because amoebae show rather restricted distribution.

Possible factors that allow dispersion of amoebae in the aquarium may be the mobility of cells, unavoidable convention of the water in the aquarium due to evaporation from the surface and, in aerated aquarium, the water currents caused by the aeration. Other factors contributing to the formation of the distribution pattern observed are the random sampling events (amoebae specimens may not appear in the collected volume of sand, even if they are actually present in the area of sampling) and the occasional death of inoculated cells in culture. Thus, the results of the experiment should be interpreted with care. However, at least some conclusions are possible.

First, amoebae show relatively high general dispersion rate. In both 22×30 cm aquaria the cells were found near the walls of the aquarium already at 8th day. It means that the mean distribution rate was not less than 2 cm/day. It may be performed both by the active migration and passive dispersal of floating amoebae. It is yet unclear why the non-aerated aquarium was populated faster than aerated one, but I guess it is the influence of the above listed random factors.

More complex dynamics was shown during the long-term observations of the round 19 cm aquarium. Perhaps in this case the observed distribution pattern is complicated with the heterogeneous conditions in the aquarium that appeared due to differential growth of bacteria and other non-controlled factors. Split of amoebae population and the occurrence of separate spots populated with amoebae may be due to the dispersion of floating forms. Anyway, already at the first sampling event, on 17th day the amoebae already reached the wall of the aquarium at least in one area.

The above data show that amoebae need less than one day to occupy an area about 2 cm across. Thus, the patchiness scaled as 1-2 cm can hardly be explained solely with the founder effect. In this case we have to accept that the complete bioturbation of sediments accompanied with the random re-distribution of amoebae takes place not less that twice per day, which is not realistic. The presented data support the idea that ecological preferences of amoebae and the microenvironmental conditions play considerable role in the formation of the amoebae distribution patterns observed.

Acknowledgements

Supported by the Danish Natural Science Research Council (contract no. 57069) and RFBR grant 03-04-48718.

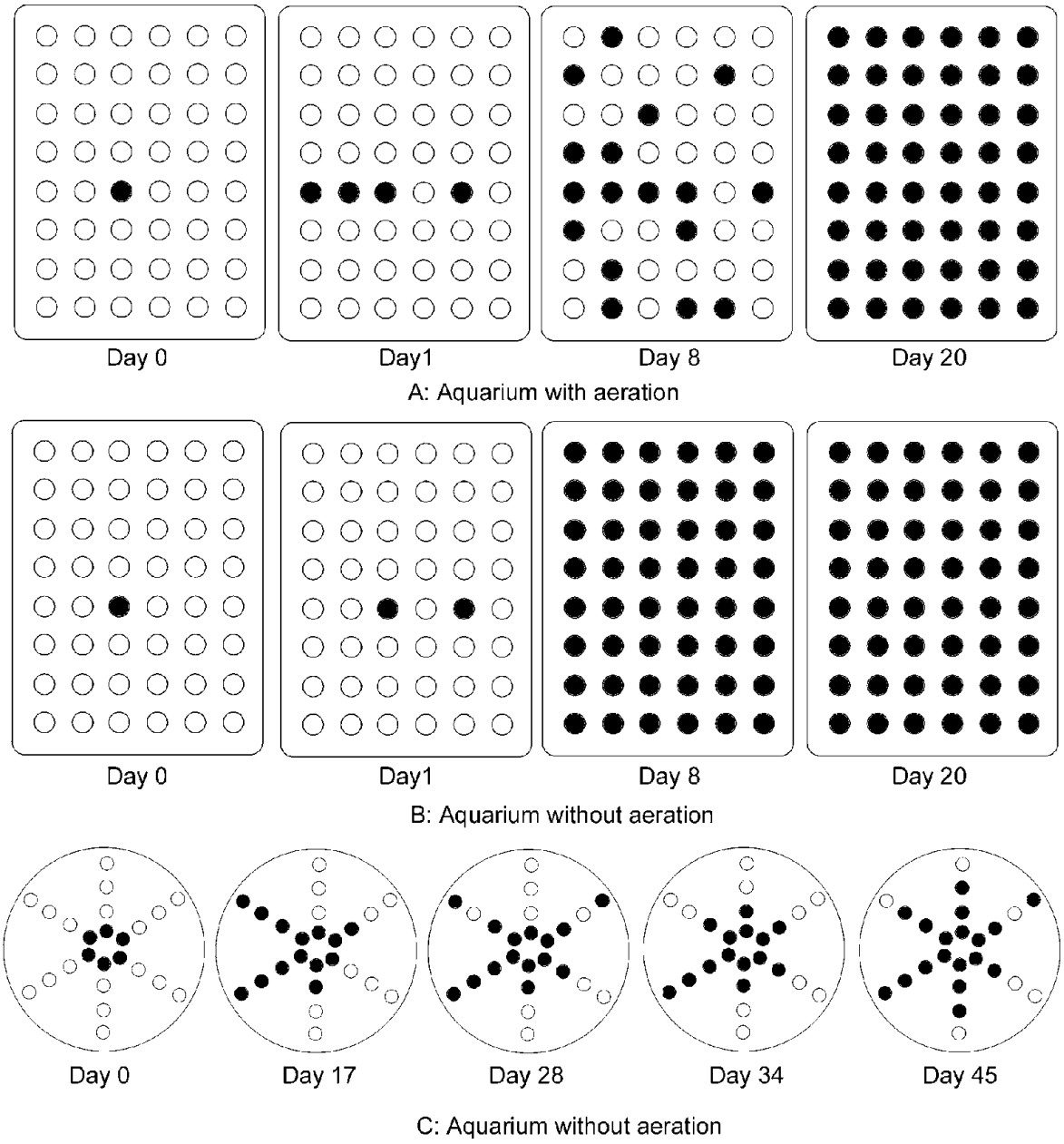

Fig. 1. Dispersion of amoebae in the aquaria. Black circles indicate the presence of amoebae. Dates of sampling are indicated under the graphs; Day 0 illustrates the point of initial inoculation of the aquarium. Not to scale.

References

Anderson O.R. 2002. Laboratory and field-based studies of abundances, small-scale patchiness and diversity of gymnamoebae in soils of varying porosity and organic content: evidence of microbiocoenoses. J. Euk. Microbiol. 49, 17-23.

Bischoff P.J. 2002. An analysis of the abundance, diversity and patchiness of terrestrial gymnamoebae in relation to soil depth and precipitation events following a drought in Southeastern USA. Acta Protozool. 41, 183-189.

Levandowsky M., White B.S. and Schuster F.L. 1997. Random movements of soil amebas. Acta Protozool. 36, 237 - 248.

Page F.C. 1988. A new key to freshwater and soil Gymnamoebia. Freswater Biol. Ass., Ambleside.

Schaeffer A.A. 1926. Taxonomy of the amebas. Pap. Dept. Mar. Biol., Carnegie Inst. of Washington. 24, 1-116.

Sawyer T. K. 1975a. Marine amoebae from surface waters of Chinocoteague Bay, Virginia: two new genera and nine new species within the families Mayorellidae, Flabellulidae, and Stereomyxidae. Trans. Amer. Microsc. Soc. 94, 71-92.

Sawyer T.K. 1975b. Marine amoebae from surface waters of Chinocoteague Bay, Virginia: one new genus and eleven new species within the families Thecamoebidae and Hyalodiscidae. Trans. Amer. Microsc. Soc. 94, 305-323.

Smirnov A.V. 2002. Vertical distribution and abundance of gymnamoebae (Rhizopoda) in bottom sediments of the brackish-water Nivå Bay (Baltic Sea, The Sound). Protist. 153, 239-250.

Smirnov A.V. and Thar R. 2003. Spatial distribution of gymnamoebae (Rhizopoda, Lobosea) in brackish-water sediments at the scale of centimeters and millimeters. Protist. 154, 359-369.

Smirnov A.V. and Thar R. 2004. Vertical distribution of Gymnamoebae (Rhizopoda, Lobosea) in the top layer of brackish-water sediments. Protist. 155, 437-446.

Address for correspondence: Alexey V. Smirnov. Department of Invertebrate Zoology, Faculty of Biology and Soil Sciences, St. Petersburg State University. St.Petersburg, 199034 Russia. E-mail: polychaos@mail.ru

Editorial responsibility: Andrew Goodkov