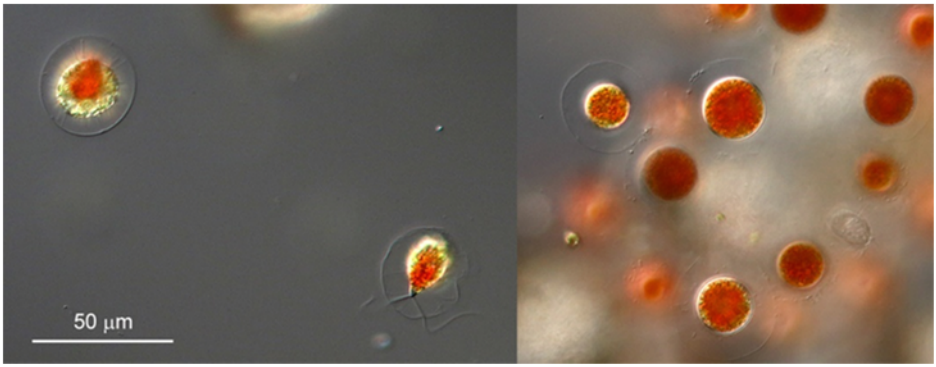
Quekett Bulletin No. 79: 14-16, September 2020

BIRDBATH ROTIFERS: MASTERS OF SURVIVAL by Aydin Örstan

Birdbaths that are allowed to dry out on hot summer days and refilled only by the rain may not be in the best interest of birds, but they are a unique habitat for a small group of organisms specialized to live exactly in those conditions. The closest natural analogues of such unattended birdbaths are rock pools that accumulate relatively small volumes, a few litres at most, of rain water. If the local climate is such that hot and sunny days alternate with rainy days, dry and wet stages of rock pools will also alternate frequently. Birdbaths are a perfect substitute for these types of rock pools and provide opportunities close to home for the microscopists interested in studying their inhabitants.

Only a handful of organisms, besides the ubiquitous bacteria, appear to have the adaptations necessary to survive indefinitely in such habitats. In many samples taken from my birdbaths over the years, the most abundant organisms that I have encountered were a few species of bdelloid rotifers, some small protists and the microalga *Haematococcus pluvialis* (Fig. 13). I have occasionally seen nematodes and insect larvae, but they were never abundant and did not appear to be permanent residents.



13. Flagellated vegetative cells (left) and cysts (right) of Haematococcus pluvialis containing the red pigment astaxanthin from one of my birdbaths (photographed using differential interference contrast).

Early in the spring of 2019, I put together a birdbath by gluing a shallow earthenware dish to an old birdbath pedestal. I placed this birdbath in my front yard and then stopped paying attention to it; for about three months, the rain filled it while the sun dried it (Fig. 14).

14. Soup of the day: a birdbath full of rotifers heating in the sun.

One day near the end of July, I decided to sample the birdbath for the first time, but it was dry. So I had to remove some dry plant fragments from inside the dish and place them in water in a small container. Ten minutes later the container was full of an immense number of active bdelloid rotifers. Obviously, rapid recovery from drying is a necessity in this habitat where the time available for feeding and egg laying may sometimes be only a few hours before the next dry stage starts. Because there were no unusual bdelloids, I ignored the birdbath for another month. The second sample taken in August produced a very large bdelloid that I had not seen before (Fig. 15). It turned out to be a carnivore that ingested the live or dead individuals of the three other smaller bdelloid species that also lived in the birdbath. I will soon describe it as a new species in the genus *Philodina*.

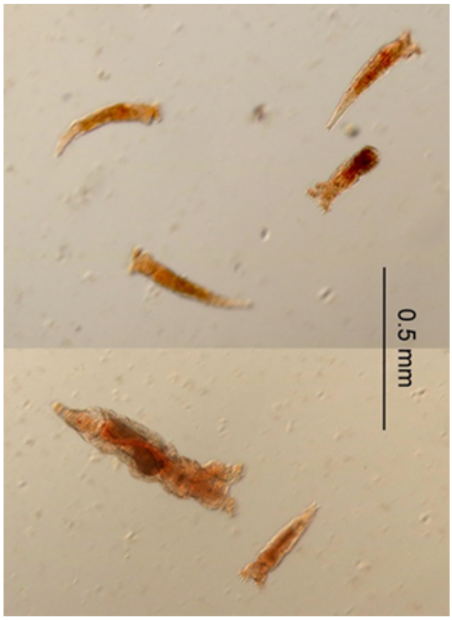
In the middle of November, I let the birdbath dry out and then moved it to my garage for the winter. Early in April of this year, I moved it back out in the yard. A few days later it rained and in subsequent samples I found the three species from the previous year, including the large carnivore. They had survived almost exactly 143 days without water, but the fourth

species had disappeared. During rare cold spells near the end of April and early in May, I found the birdbath frozen solid on two mornings. Luckily, it did not crack. Subsequent samples still had the same three species of rotifers.

On two very hot and sunny days in July, I had the opportunity to determine how tolerant these rotifers were of high temperatures. On both days, the highest air temperatures I recorded were close to 35 °C in the shade, while the birdbath, which was in the sun, reached higher temperatures. On 19 July, the highest water temperature recorded in the birdbath was 42.4 °C. I took samples on two occasions when the water temperatures were 41.6 °C and 42.0 °C. Both samples were full of feeding rotifers. On 27 July, the birdbath received direct exposure to the sun for seven hours (very little water evaporated, because the air humidity was high). During that period the water temperature in the birdbath was 40 °C or higher for about four hours. And the highest water temperature I measured was 41.4 °C. A sample taken late in the afternoon when the water temperature had fallen to 37.7 °C had active individuals of all three species (**Fig.15**). Clearly, hours of exposure to solar UV radiation and high temperatures had had no apparent ill effects on the rotifers.

These observations demonstrate that the adaptations that are necessary for surviving in birdbaths and rockpools are (1) tolerance to being frozen; (2) tolerance to being dry; (3) ability to recover rapidly upon refilling of the habitat; (4) tolerance to prolonged exposure to high temperatures; and (5) tolerance to prolonged exposure to UV radiation. The last two requirements are for both hydrated and dry individuals.

This is an ongoing project. I am continuing to study not only the taxonomy of birdbath rotifers, but also the limits of their tolerance to the extreme conditions they are likely to encounter in nature. Other potential complications to consider are increased salt concentrations and decreased oxygen concentration brought on by evaporation and increased water temperature, respectively.



15. Unscathed birdbath rotifers after a day during which the water temperature was as high as 41.4 °C. The bottom photo shows the large carnivorous Philodina near a much smaller species. These rotifers appear to derive the orange color of their bodies from the cells of Haematococcus pluvialis on which they feed.