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A COMPARATIVE INVESTIGATION OF THE PLANKTON OF THE FOUR LUNDY PERMANENT LENTIC FRESHWATERS

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ABSTRACT

The microscopic life of the Lundy freshwater bodies has previously been studied only in the summer months. It is important to examine the plankton populations in other seasons to gain information on the progression of species that is known to occur in ponds and lakes throughout the year. This autumn investigation again demonstrates that the four main water bodies on Lundy have different plankton populations, with Pondsbury having the greatest species diversity, and that the eutrophic Rocket Pole Pond regularly has algal blooms occurring. All ponds show seasonal differences with different species dominating in the autumn plankton samples than in the summer samples. For the first time, spores of aquatic fungi from Pondsbury were examined which gave new records for such fungi for Lundy.
Keywords: *Lundy, ponds, plankton, aquatic fungi.*

INTRODUCTION

Until 1979 very little research had been carried out on the flora and fauna of the island's freshwater habitats. However in earlier years there have been investigations of some of the microscopic organisms living in the open waters of the ponds, *e.g.* diatoms (Fraser Bastow, 1949) and Crustacea and Rotifera (Galliford, 1953). In the summer of 1979 the composition of the microscopic populations in the open water of four of the Lundy freshwater bodies, Pondsbury, Rocket Pole Pond, Quarry Pool and the larger pond at Quarterwall, was studied (George & Stone, 1979, 1980). The surveys, confirmed by a further summer study in 1986 (George & Sheridan, 1986),

showed that there appeared to be no endemic species present and that the ponds supported different plankton populations.

Acid waters situated on islands possess a fairly restricted flora and fauna compared with neutral and alkaline waters on the mainland and consequently the species diversity in the plankton of the Lundy ponds, where the pH is 5.0 - 5.5, is limited. Plankton in small water bodies is very variable often with one species dominating for a short period, and this was reflected in the summer samples taken in 1979 and 1986. Consequently sampling in the four seasons is required to identify seasonal progression in plankton populations.

In the Autumn of 2003 (mid-October), opportunity arose for a further investigation of the plankton of the four ponds. In addition the formation of 'foam' on Pondsbury, caused by the strong easterly winds blowing continuously for a week across the island, allowed this foam to be examined for aquatic fungi (Hyphomycetes), which have never been looked at previously on Lundy.

The main aim of the investigation was to examine the composition of the flora and fauna of the plankton to determine seasonal changes that commonly occur in the plankton of small water bodies.

METHODS

Physical and chemical measurements

The following factors were measured at each pond: air and water temperature, pH (Whatman pH papers), oxygen content of the surface and bottom water (oxygen meter).

Plankton

Plankton was collected with a FBA phytoplankton net (aperture 0.075mm) and in Rocket Pole Pond, Quarry Pool and the Quarterwall pond, two hauls were taken across each pond. At Pondsbury two hauls were taken from west to east across the southern end of the water body. Samples were fixed in 4% formaldehyde and transferred to ethanol for microscope examination in the laboratory.

An estimate of relative abundance of each taxon was made on a scale of 1 to 5 as follows:

Score	
1	*One or two only of the taxon*
2	*3 – 25 of the taxon*
3	*26 - 100 of the taxon*
4	*101 – 500 of the taxon*
5	*Over 500 of the taxon*

Table 1. Organisms present in the plankton of the ponds (Abundance scale 1-5).

SPECIES	PONDSBURY	ROCKET POLE	QUARRY	QUARTER WALL
ALGAE- Cyanophyta (Blue Green)				
Microcystis sp.	~	2	~	~
Gomphosphaeria sp.	~	2	~	~
ALGAE- Chlorophyta (Green)				
Filamentous green alga	2	1	2	2
Volvox sp.	2	~	~	~
Scenedesmus sp.	2	5	~	~
Pediastrum sp.	~	4	~	~
Coelastrum sp.	2	~	~	~
Dictyosphaerium sp.	~	~	2	~
Ankistrodesmus sp.	~	1	~	~
Closterium sp.	2	~	~	~
ALGAE-Bacillariophyta (Diatoms)				
Melosira sp.	2	~	~	~
Tabellaria sp.	2	~	~	~
ROTIFERA				
Brachionus rubens Ehrb.	~	~	2	~
Keratella vulga (Ehrb.)	4	~	~	~
Keratella serrulata (Ehrb.)	2	~	5	~
Filinia longiseta (Ehrb.)	~	2	~	2
Euchlanis dilatata Ehrb.	2	3	~	~
Asplanchna priodonta Gosse	~	~	3	~
Notholca acuminata(Ehrb.)	2	~	~	~
CLADOCERA				
Daphnia obtusa Kurz	2	~	~	2
Bosmina longirostris (Muller)	2	5	2	~
Chydorus sphaericus (Muller)	2	3	2	~
COPEPODA				
Cyclops sp.	3	4	3	4
Cyclopid juveniles	3	3	3	3
Cyclopid nauplii	3	3	3	~
Harpacticoids	3	3	3	~
INSECTA – Ephemeroptera				
Cloeon dipterum (L.) l.	1	~	~	~
INSECTA – Diptera				
Chaoborus crystallinus (Deg.) e.	5	~	2	3
Chironominae l.	2	2	1	2
TOTAL NO. OF SPECIES	19	13	11	6

Key. ~ = not found. e. = larva.

Foam samples

The foam accumulated by the strong easterlies at the western end of Pondsbury was scooped into a wide-mouthed plastic bottle and preserved in ethanol. After agitation, samples were removed and 20 drops of around 0.01ml were examined under a x40 objective of a microscope. Spore types present were identified using the FBA key no.30: Aquatic Hyphomycetes (Ingold, 1975). Numbers of spores for each species in each drop were counted and totalled.

RESULTS

Physical and chemical measures

Air temperatures ranged from 11 °C–14.5°C on the sampling days and surface water temperatures from 12.5°C–14°C, with the bottom temperature only 0.5°C lower, demonstrating that the water was well mixed. The ponds were acidic, with Pondsbury at pH 5.0 and the other three ponds slightly less acidic at pH 5.5. The surface waters were well saturated (often supersaturated) with oxygen, with only a slight drop off above the bottom sediments.

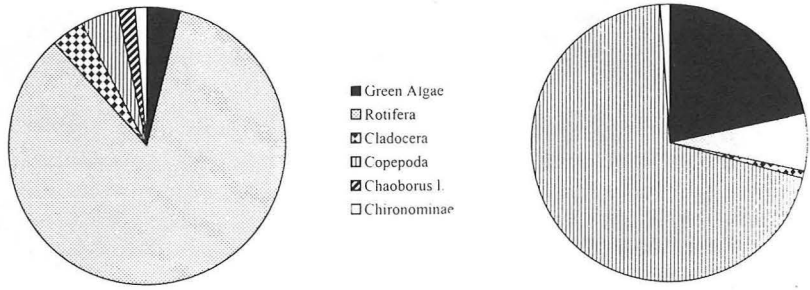
Plankton

The species present together with their relative abundance in the four ponds are listed in Table 1 and seasonal differences are shown in Figures 1 to 4.

Pondsbury, the largest body of freshwater on the island, supported the greatest number of species of plankton, nineteen, with good diversity in the phytoplankton. The plankton was dominated by the dipteran larva, *Chaoborus crystallinus*, with the rotifer *Keratella vulga* very well represented. In the Rocket Pole Pond the green algae, *Scenedesmus* sp. and *Pediastrum* sp. were very abundant with a cladoceran, *Bosmina longirostris*, dominating the zooplankton. All stages of the copepod *Cyclops* sp. were well represented in the open water of this pond. Only two species of phytoplankton were found in the Quarry Pool, but here a rotifer, *Keratella serrulata,* dominated the zooplankton. Plankton was scarce in the Quarterwall pond with only six species being found, with the most abundant organism being the adult copepod, *Cyclops* sp. *Cyclops* sp. in its various life-cycle stages, nauplii, juveniles and adults was the only species present in all four of the ponds in reasonable numbers. Many of the two rotifer *Keratella* species, *K. vulga* in Pondsbury and *K. serrulata* in Quarry Pool, carried the overwintering resting eggs. These can remain dormant for long periods in the bottom sediments under adverse conditions such as extremes of temperature and the drying-up of a water body.

AUTUMN SUMMER

Figure 1. Seasonal differences in the main planktonic taxa at Pondsbury.

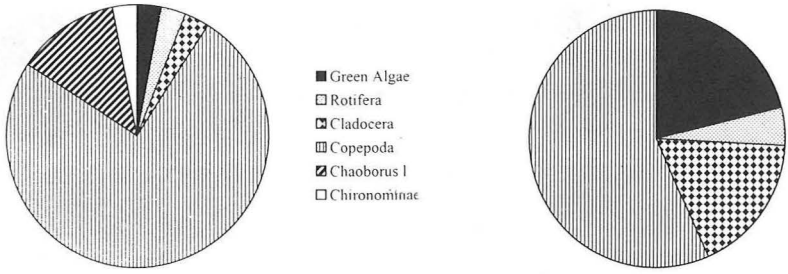


AUTUMN SUMMER

Figure 2. Seasonal differences in the main planktonic taxa at the Quarry Pool.

AUTUMN SUMMER

Figure 3. Seasonal differences in the main planktonic taxa at the Rocket Pole Pond.



AUTUMN SUMMER

Figure 4. Seasonal differences in the main planktonic taxa at the Quarterwall pond.

Aquatic Hyphomycetes

Spores of ten taxa of Ingoldian hyphomycetes were identified in the preserved samples of foam taken from Pondsbury (Table 2). The majority were of species which form branched spores. Most of these were tetraradiate with four 'arms': *Articulospora tetracladia, Lemonniera aquatica, Tetrachaetum elegans, Alatospora acuminata* and *Tricladium angulatum*, the exception being *Varicosporium elodeae*, which has a complex branching structure arising from a main axis. The other spore types present were anguilliform (eel-like) belonging to *Anguillospora longissima*, *Flagellospora curvula*, *Centrospora aquatica* and *Lunulospora curvula*. Easily the commonest spore type was *Tricladium angulatum*, a small spore with a curved axis with two branches set at an angle to each other. The spores were derived from colonies of the fungi growing on aquatic debris in Pondsbury and also on litter in the surrounding land. Their shapes cause them to become trapped in bubbles of air, so they had accumulated in the foam caused by the strong easterly winds on the western shore of Pondsbury.

Table 2. Total number of spores counted in 20 drops of foam from Pondsbury.

FUNGI	NUMBERS OF SPORES
Ingoldian hyphomycetes	
Alataspora acuminata Ingold	1
Anguillospora longissima de Wild	11
Articulospora tetracladia Ingold	2
Centrospora aquatica Iqbal	2
Flagellospora curvula Ingold	11
Lemonniera aquatica de Wild	3
Lunulospora curvula Ingold	1
Tetrachaetum elegans Ingold	2
Tricladium angulatum Ingold	20
Varicosporium elodeae Kegel	11
Other hyphomycetes	
Epicoccum purpurascens	P
Alternaria alternata	P
Torula herbarum	P
Fusarium sp.	P

Key. P = present.

Table 2 also lists spores of other fungi found in the foam samples. All are common colonisers of plant debris or soil fungi, the spores having been blown into the pond, for example *Epicoccum purpurascens*. In addition many micro-algae were found, the commonest being the desmid, *Closterium* sp., the diatom *Tabellaria* sp. and the

chlorophycean *Volvox* sp., all of which were obtained in the open water phytoplankton net samples.

DISCUSSION

As in the previous summer surveys, the four ponds demonstrate marked differences in the composition of their plankton populations. Pondsbury, in spite of the late summer dredging that had occurred in 1993 and 1995, retained a good species diversity. The Cladocera (crustaceans) and Rotifera (rotifers) which are well represented have resting egg stages that can withstand adverse conditions.

The Rocket Pole Pond is very eutrophic with algal blooms regularly occurring. There is no outflow to this pond and there is a build-up of nutrients from the large mirror carp population and the droppings from the ducks that regularly frequent this pond.

The sheltered Quarry Pool as in previous surveys has very little phytoplankton, but this may have been due this October to the extremely large population of the rotifer *Keratella serrulata* which feeds on unicellular algae using its coronal filtering mechanism.

The Quarterwall pond had fewer species and individuals than the other water bodies. This may have been due to the reduced water levels this time. The most abundant organism in this pond was the copepod, *Cyclops* sp., which occurred in all of the ponds. *Cyclops* sp. is known to breed throughout the year (Harding & Smith, 1974) and it is not unusual to find nauplius larvae and juveniles as well as egg-carrying adult females in both summer and autumn. Although harpacticoid copepods occur in Lundy freshwaters the other free-living copepod group, the calanoids that commonly occur in mainland waters, have not been found on Lundy.

Figures 1 to 4 illustrate the seasonal differences in the main planktonic taxa. All species increase their populations at some time during the year but are usually present throughout the year as small residual populations (Moss, 1980). Also, new species may appear, being brought in, for example, as resting eggs by the wind or on birds.

In Pondsbury the most striking difference between the summer and autumn samples was the appearance and complete dominance of the dipteran larva, *Chaoborus crystallinus* in the autumn. This phantom midge larva was not found at all in the previous summer surveys of 1979, 1986 and 1993, but an unknown species of *Chaoborus* sp. larva was recorded in 1952 by Galliford in the Quarry Pool (Galliford, 1953) and an unknown species of an adult *Chaoborus* sp. was noted in July 1972 (Lane, 1977). *Chaoborus crystallinus,* which uses its anterior and posterior hydrostatic organs to lie horizontally in the water, feeds on crustaceans and small insects which it seizes with its prehensile antenna. Its occurrence in Pondsbury in such large numbers had an obvious effect on the overall numbers of the Cladocera which were much

lower than in previous investigations. Unicellular green algae were not so prolific in the autumn as they had been in the summer, but the rotiferan representatives remained fairly constant.

Algae again dominated the plankton of the Rocket Pole Pond, but whereas it was blue-green algae, such as *Microcystis* sp. and *Arthrospira* sp., in the summer, the autumn samples showed that they had been succeeded by the green algae, *Scenedesmus* sp. and *Pediastrum* sp. The abundance of the green algae had obviously led to the proliferation of the Cladocera in the autumn, particularly *Bosmina longirostris*, which filters off unicellular green algae for its food. Cladocera can reproduce parthenogenetically when conditions such as food supply are favourable and this leads to the build up of large populations in a very short time.

Rotifers, mainly *Keratella serrulata*, dominated the autumn plankton in the Quarry Pool (68% of the total population), whereas cyclopid copepods, which were very abundant in the summer, had reduced populations. A small number of *Chaoborus crystallinus* larvae occurred in this pool. An interesting find was the carnivorous rotifer, *Asplanchna priodonta*; this large 'sac-like' rotifer which feeds on *Keratella* spp. and other small rotifers, has not previously been recorded in the Lundy freshwater habitats, but at this time of year it was present in fairly large numbers (abundance rating 3).

Cyclopid copepods were the most abundant representatives in both the summer and autumn plankton of the Quarterwall pond. The green algae which were well represented in the summer had fewer species and individuals in the autumn and the Cladocera, mainly *Daphnia obtusa*, abundant in the summer, also had very much reduced populations in the autumn, with several individuals carrying the overwintering resting eggs.

The spores of the ten species of aquatic hyphomycetes found in the preserved foam samples from Pondsbury are new records of these fungi for Lundy. About 300 species of these fungi are known and they are found most frequently in rapidly flowing well-aerated streams, but do also occur in oligotrophic ponds and lakes like Pondsbury (Dix & Webster, 1995). They play a key role in the decomposition of plant materials, and in the food chain, by providing a nitrogen-enhanced food source for detritus-feeding animals such as asellid crustaceans and caddis larvae (Dix & Webster, 1995). It is likely that a fuller investigation of the fungi of the freshwater habitats on Lundy would add to the species total.

CONCLUSIONS

The four permanent Lundy freshwater habitats, Pondsbury, Quarry Pool, Rocket Pole Pond and Quarterwall pond, have different plankton populations which can be related

to a number of factors, *e.g.* size and position of the water body on the island, the inflow and outflow of water and usage of the water by other animals which contribute to the build up of nutrients.

Seasonal differences in the plankton populations have been demonstrated in all of the ponds for the summer and autumn periods. It is important to study the ponds in the other seasons, particularly in the spring to gain a good insight into the progression of the plankton populations throughout the year in these isolated acidic water bodies.

The survey has also listed new records of aquatic fungi for Lundy.

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