LUNDY'S LENTIC WATERS: THEIR BIOLOGY AND ECOLOGY

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ABSTRACT

Research on the Lundy freshwater ecosystems in the late 1970s, 1980s and early 1990s showed that the major standing water bodies (lentic waters) supported different populations of organisms, particularly in the planktonic and macroinvertebrate groups. Recent research in the autumn of 2003, spring 2005 and winter 2006 not only demonstrated that these differences still are present, but also gained information on seasonal changes occurring in these waters. Four water bodies, Pondsbury, the Rocket Pole Pond, Quarry Pool and the larger pond at Quarter Wall have been studied at all seasons. Differences can be related to the position of the pond on the island and hence degree of exposure, the amount of plant cover and the input of decaying material and nutrients. At various times during the last 27 years smaller, often temporary, bodies of water have been surveyed e.g. pools in North Quarry, smaller pond at Quarter Wall, pond in Barton Field. Brief descriptions of these small ecosystems are given here.

Keywords: *Lundy, ponds, aquatic plants, plankton, macroinvertebrates*

INTRODUCTION

Freshwater ecosystems can broadly be separated into two categories, the moving or lotic waters and the still or lentic waters. Both types occur on Lundy and the positions of these water bodies were documented by Langham (1969). The streams (lotic) systems had received practically no attention until Long carried out a comprehensive survey in the summer of 1993. He showed that the stream fauna was impoverished compared to similar streams on the mainland (Long, 1994). The lentic waters can further be divided into the permanent or semi-permanent type such as Pondsbury, the Rocket Pole Pond, Quarry Pool and the larger pond at Quarter Wall, and the smaller seasonal often temporary pools such as the smaller pond at Quarter Wall, the pools in the quarries and in the depressions to the east of the Rocket Pole.

Until 1979 there had been no detailed investigation of the lentic waters, although there had been studies of individual freshwater organisms e.g. Hemiptera (Morgan, 1948), diatoms (Fraser-Bastow, 1950), Crustacea and Rotifera (Galliford, 1954), isopod *Asellus* (Williams, 1962), fish (Baillie and Rogers, 1977). Some freshwater organisms have been listed in surveys of terrestrial groups such as Coleoptera

(Brendell, 1976), Diptera (Lane, 1978), Hemiptera (Alexander, 1992) and in the lists of invertebrates, compiled by Parsons, in the Lundy Field Society's Annual Reports since 1982.

In the summers of 1979 and 1986 investigations of the biology and ecology of the four main bodies of water, Pondsbury, the Rocket Pole Pond, Quarry Pool and the larger Quarter Wall pond were carried out (George and Stone, 1980, 1981; George and Sheridan, 1987). Further detailed information of Pondsbury was obtained by Clabburn in his comprehensive summer survey in 1993 (Clabburn, 1994). All of these data which relate to summer conditions were reviewed by George (1997) who highlighted the need for comparative seasonal information. In the autumn (mid-October) of 2003 further investigations were carried out on the four main lentic waters (George, McHardy and George, 2004; George, McHardy and Hedger, 2004) and in the spring 2005 (April) and winter 2006 (January) which has given a seasonal perspective to the ecology of these waters. Also some of the smaller temporary pools were examined in these surveys.

This review will consider the ecology of the four permanent water bodies, Pondsbury, the Rocket Pole Pond, Quarry Pool and the larger Quarter Wall pond with a view to assessing the comparative stability of these waters over the past 27 years together with data on seasonal changes. Brief discussion on some of the temporary waters will be included.

METHODS

Physical and chemical measurements

The following factors were measured at each pond: air and water temperatures, pH (pH meter), oxygen content of surface and bottom water (oxygen meter). Mapping of the ponds was undertaken and depth measurements were also plotted.

Flora

The species of plants within and at the edges of the ponds were listed and the distribution and location of the main species were plotted on to outline maps of the ponds. In all of the seasonal surveys a subjective estimate of relative abundance of each of the species was made on a scale of 1-5 as follows:

Score	Relative Abundance	
1	*Rare*	*Less than 1% of total number of plants present*
2	*Occasional*	*1-5% of total number of plants present*
3	*Frequent*	*6-10% of total number of plants present*
4	*Common*	*11-50% of total number of plants present*
5	*Abundant*	*More than 50% of total number of plants present*

At Pondsbury plants were surveyed at 50 sites around the perimeter and recorded as present or absent and abundance noted. Relative abundance was recorded for each species by taking an average for relative abundance at all sites.

Plankton

Plankton was collected with a FBA phytoplankton net (aperture 0.075mm) and in the Rocket Pole Pond, Quarry Pool and the Quarter Wall pond two hauls were taken across each pond. At Pondsbury two hauls were taken from the mid-northern side to the mid-

west side across the deeper part of the water body. Samples were fixed in 4% formaldehyde and transferred to ethanol for microscopic 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*

Macroinvertebrates

Macroinvertebrates were collected from the plant beds and open water using a standard FBA net (aperture 0.96mm) by sweeping for five one-minute periods at each pond. No quantitative sampling was undertaken in the sediments as preliminary sampling showed that no organisms occurred that were not represented in the sweep samples.

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

Score	
1	*Less than 5 individuals*
2	*5-49 individuals*
3	*50-199 individuals*
4	*200-499 individuals*
5	*Over 500 individuals*

ORIGINS AND CHARACTERISTICS OF THE WATER BODIES

Pondsbury (OS Grid reference SS 13463 45508) which is the largest body of freshwater on the island is surrounded by *Sphagnum* bog, heathland and rough grazing pasture. It is probably of natural origin although the construction of an impounding bank on its west side has increased its size and depth. It receives surface run-off from the surrounding land and it has an outlet situated midway along the raised bank which forms the Punchbowl stream that flows into the sea at Jenny's Cove. Detailed mapping of the water body shows that it regularly changes shape due to varying water levels, macrophyte encroachment, silt deposition and human activity such as dredging and damming. Its area during the six survey periods from 1979-2006 varied from 3300m^2 to 4000m^2, although records show that in the past, e.g. summer of 1976, it dried up altogether.

The other three water bodies which have been formed from excavations in the rock and are smaller in size, maintain their shape, although their water levels fluctuate according to weather conditions.

The Rocket Pole Pond (OS Grid Reference SS 13481 43681) is a steep-sided water body cut into granite, 25m x 11.5m in size with its western side stepped and much shallower. There is no through drainage. It is fully exposed to the westerly winds that commonly blow across the island.

Quarry Pool (OS Grid Reference SS 13756 95037) is a very sheltered body of water, 22m in length and 11m wide, overshadowed by steep rocky walls and some trees e.g. willow. It is fed by a small stream falling over granite boulders and has an outlet on its eastern side.

The larger **Quarter Wall pond** (OS Grid Reference SS 13630 44965) is an open body of water, 19m x 12m in size, with fairly steep rocky banks. It is situated at a fairly high level on the island's eastern side, and probably receives little surface drainage.

RESULTS: PONDSBURY

The physical and chemical characteristics, flora and fauna of Pondsbury, together with seasonal changes will be given first of all as this water body is much larger with a greater biodiversity than the other three similarly-sized ponds.

Physical and chemical characteristics

Maximum depths occur in the northern part of Pondsbury where depths of over one metre were recorded in all the seasonal surveys (Table 1). Dredging of this area took place in 1993 and 1995. To the east and south the water becomes progressively shallower. Water temperatures relate to the ambient air temperatures at the time of sampling. Temperature recording over a 24h period showed that maximum water temperatures occur in the late afternoon/early evening with minimum temperatures in the early morning (Clabburn, 1994). Dissolved oxygen values show that at all seasons the surface waters are well-oxygenated. 24h recording showed that considerable fluctuations in oxygen take place just above the sediments (Clabburn, 1994). Pondsbury is acidic with the pH ranging from 4.8 in summer to 6.4 in winter.

Table 1: Physical and chemical measurements recorded in the north-east section of Pondsbury

	SPRING	SUMMER		AUTUMN	WINTER
	2005	1986	1993	2003	2006
Max. depth m.	1.65	1.0	1.2	1.3	1.8
Air temp. ºC	14	17	-	11	5.5
Water temp.					
Surface ºC	12	15.5	14.4*	12.5	3.5
Bottom ºC	12	15	14.5*	12	3.5
pH	6.0	4.8	4.82	5.0	6.4
Oxygen % satn.					
Surface	95	86	76.9*	97	-
Bottom	85	77	54.4*	80	-

Key: *Values represent the mean of diel fluctuations recorded (Clabburn, 1994).

Flora

Fifteen plant species have been found in and around the margins of Pondsbury, although their relative abundance varies with the time of year (Table 2). The moss, *Sphagnum cuspidatum*, dominates the entire area and the water body is surrounded by large stands of the rush, *Juncus effusus*, particularly on its western side. Another rush, *Eleocharis palustris*, which dies down during the winter months is fairly widespread, and it forms stands further out into the open water than *Juncus effusus.* Common submerged species present in all seasons were *Potamogeton polygonifolius*, the bog pondweed, *Hydrocotyle vulgaris*, water pennywort, *Callitriche stagnalis*, the mud water starwort, and *Myosotis scorpioides*, the creeping water forget-me-not. *Hypericum elodes*, marsh St John's wort. which dominated the entire southern area of Pondsbury in 1979 was far less abundant in the 2003, 2005 and 2006 surveys probably due to the dredging that occurred in the autumn of 1993 and 1995.

Table 2: Species present and relative abundance of the flora in Pondsbury

SPECIES	SPRING	SUMMER		AUTUMN	WINTER
	2005	1979	1986	2003	2006
Sphagnum cuspidatum Ehrb.	5	5	5	5	5
Hypericum elodes L.	3	5	5	2	-
Hydrocotyle vulgaris L.	3	5	5	3	2
Ranunculus flammula L.	-	2	2	1	-
Ranunculus omiophyllus Ten.	-	1	1	-	-
Callitriche stagnalis Scop.	4	2	2	4	3
Potamogeton polygonifolius Pourret	4	1	3	4	4
Juncus effusus L.	5	4	5	5	5
Juncus articulatus L.	2	3	2	3	2
Juncus conglomeratus L.	1	-	-	1	-
Eleocharis palustris L.	4	2	3	4	4
Myosotis scorpioides L.	4	5	4	3	4
Lythrum portula L.	-	2	3	-	-
Elatine hexandra (Lapierre)	-	1	1	-	-
Galium palustre L.	-	-	1	-	-
TOTAL SPECIES PRESENT 15	10	13	14	11	8

Key: 5: >50%; 4: 11-50%; 3: 6-10%; 2: 1-5%; 1: <1% of total number of plants present.

Plankton

Pondsbury showed good diversity in its plankton population with 12 species of phytoplankton and 17 species of zooplankton being recorded from the seasonal surveys (Table 3). Figure 1 shows the seasonal differences in the main planktonic groups. The Cladocera (water fleas) were present throughout the year, with *Daphnia*

Table 3: Organisms in the Pondsbury Plankton

PHYTOPLANKTON	ZOOPLANKTON
EUGLENOPHYTA *Euglena viridis* Ehrb. CHLOROPHYTA (Green algae) *Volvox sp.* *Desmodesmus(Scenedesmus) magnus* Chodat *Ankistrodemus* sp. *Coelastrum* sp. *Closterium* sp. *Cosmariu*m sp. Filamentous green alga BACILLARIOPHYTA (Diatoms) *Melosira* sp. *Tabellaria* sp. *Pinnularia* sp. *Diatoma* sp.	ANNELIDA - OLIGOCHAETA *Nais* sp. CRUSTACEA - CLADOCERA *Daphnia obtusa* Kurz *Bosmina longirostris* (Muller) *Chydorus sphaericus* (Muller) *Alonella nana* (Baird) CRUSTACEA - COPEPODA *Cyclops* sp. Immature cyclopids Cyclopid nauplii larvae Harpacticoids CRUSTACEA- OSTRACOD Cypridid ostracod ROTIFERA *Keratella vulga* (Ehrb.) *Keratella quadrata* (Muller) *Keratella serrulata* (Ehrb.) *Euchlanis dilatata* (Ehrb.) *Northolca acuminata* (Ehrb.) *Cephalodella* sp. INSECTA - EPHEMEROPTERA *Chloeon dipterum* (L.) l. INSECTA - DIPTERA *Chaoborus crystallinus* (Deg) l. Chironominae l.

obtusa being recorded in all four seasons. In the winter samples of 2006 this species constituted 75% of the total number of organisms present. The Copepoda (copepods), particularly *Cyclops* sp. were also well represented in the plankton, with all life cycle stages, larvae, immature cyclopids, adults, being present throughout the year. The Rotifera (rotifers) occurred at all seasons but were represented by different species e.g. *Keratella quadrata* was abundant in the spring, *Keratella serrulata* in the summer months and *Keratella vulga* in the autumn. Two species appeared in large numbers at particular seasons; the green alga, *Euglena viridis* produced a large bloom in the summer and the larva of the phantom midge, *Chaoborus crystallinus* appeared in large numbers in the autumn.

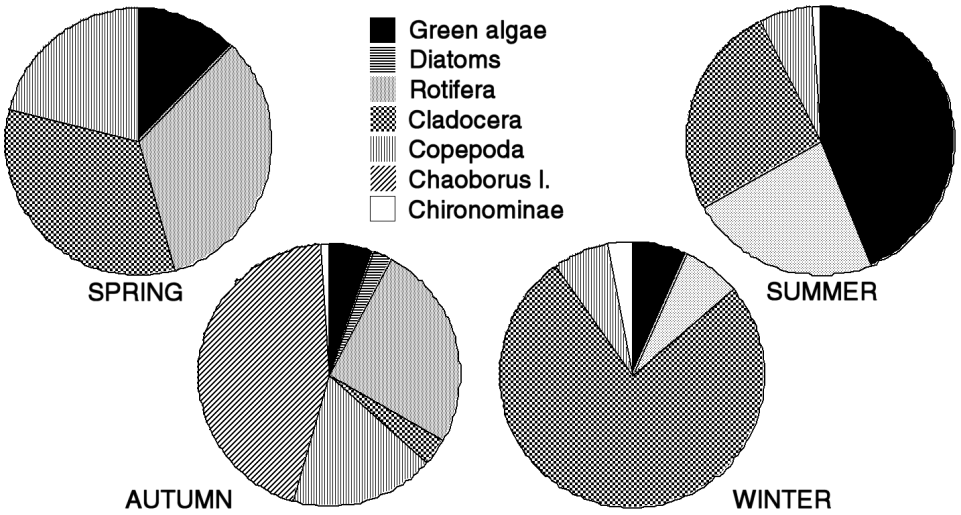

Figure 1: Seasonal differences in Pondsbury plankton

Macroinvertebrates

The species and abundance of macroinvertebrates in the sweep samples are given in Table 4 where rare species (scale 1) found only on one occasion are not shown. The greatest diversity occurred in the summer months and Clabburn (1994) in his comprehensive survey of Pondsbury (10 sites with 2-minute sweep samples at each) recorded 35 macroinvertebrate species with a further nine identified to generic level. The most abundant macroinvertebrate in Pondsbury was the isopod crustacean, *Asellus meridianus* which occurred throughout the year, although being far less abundant during the winter months. In the spring samples ovigerous females and many small individuals were found. Other species which were found at all seasons were the flatworm, *Polycelis nigra*, the oligochaete, *Lumbriculus variegatus*, the lesser water boatman, *Corixa punctata* (two comatose individuals were found in the plant beds at water temperatures of 3.5ºC in January 2006) and various chironomid larvae species. Very few species were found in the winter samples due to the extremely cold water conditions and it is likely that most were lying dormant amongst the roots of the plants or in the sediments. *Argyroneta aquatica*, the water spider. which was first recorded by Galliford in 1953, and seen again in 1979, 1986 and 1993 was again recorded in April 2005 where it was found amongst the *Sphagnum* on the south side of Pondsbury.

RESULTS: ROCKET POLE POND, QUARRY POOL, QUARTER WALL POND

Physical and chemical characteristics

Table 5 shows the physical and chemical characteristics of the three ponds together with seasonal differences. Depth recordings at the various seasons showed that the Rocket Pole Pond is the deepest water body, reaching a maximum depth of 2.2m in the summer survey of 1986. Quarry Pool appears to maintain a fairly constant body of water throughout the year with maximum depths of 1.4-1.5m being recorded during the last three years. Quarter Wall pond is a shallower body of water with a maximum depth

Table 4: Abundance of macroinvertebrate species in Pondsbury

SPECIES	SPRING	SUMMER	AUTUMN	WINTER
Platyhelminthes:				
Polycelis nigra (Muller)	3	4	2	3
Oligochaeta				
Lumbriculus variegatus (Muller)	2	3	2	2
Hirudinea:				
Helobdella stagnalis (L.)	1	1	-	-
Arachnida:				
Argyroneta aquatica L.	1	2	-	-
Hydacarina	-	2	-	-
Crustacea:				
Asellus meridianus Racovitza	3	5	3	2
Insecta: Ephemeroptera:				
Cloeon dipterum (L.) l.	1	1	2	-
Insecta: Odonata:				
Ischnura elegans (van de Linden) l.	-	2	2	-
Sympetrum striolatum (Charpentier) l.		2	1	-
Insecta: Hemiptera:				
Notonecta marmorea viridis Delcourt	2	2	2	-
Corixa punctata (Illiger)	2	2	2	1
Callicorixa praeusta (Fieber)	-	2	-	-
Cymatia bondorffi (Sahlberg)	1	2	-	-
Sigara dorsalis (Leach)	-	2	-	-
Immature corixids/cymatids	2	3	-	-
Insecta: Coleoptera:				
Hydroporus pubescens (Gyllenhal) a.	-	1	1	-
Hygrotus inaequalis (Fab.) a.	2	2	1	-
Laccophilus minutus (L.) a.	1	2	1	-
Agabus bipustulatus L. a.	1	2	-	-
Insecta:Diptera:				
Chironominae l.	2	4	2	2
Mollusca:				
Pisidium personatum Malm	-	3	-	-
TOTAL SPECIES FOUND	13	*43	12	5

Key: Abundance scale: 5: >500; 4: 200-499; 3: 50-199; 2: 5-49; 1: <5 individuals. L=larva, a=adult. *Species (Abundance 1) found on only one occasion are not recorded in the table.

Table 5: Physical and chemical measurements recorded at the three ponds

ROCKET POLE POND

	SPRING 2005	SUMMER 1979	SUMMER 1986	AUTUMN 2003	WINTER 2006
Max. depth m.	1.8	1.9	2.2	1.65	1.9
Air temp.ºC	13	18	18	12	5.5
Water temp ºC					
Surface	12.5	15	17	13.5	5
Bottom	12	15	12	13	5
pH	6	5	5.4	5.5	6.18
Oxygen % satn.					
Surface	90	82	77	120	-
Bottom	86	78	65	91	-

QUARRY POOL

	SPRING 2005	SUMMER 1979	SUMMER 1986	AUTUMN 2003	WINTER 2006
Max. depth m.	1.4	1.64	1.7	1.5	1.48
Air temp. ºC	14	19	18	12	5
Water temp ºC					
Surface	12	17	17	14	6
Bottom	12	15	16	13	6
pH	6	5	5.8	5.5	6.8
Oxygen % satn.					
Surface	92	78	81	113	-
Bottom	89	49	67	78	-

QUARTER WALL POND

	SPRING 2005	SUMMER 1979	SUMMER 1986	AUTUMN 2003	WINTER 2006
Max. depth, m.	0.75	0.4	0.8	0.4	0.75
Air temp.ºC	14	20.5	18	14.5	5
Water temp.ºC					
Surface	12.5	18.5	18	14	6
Bottom	12	17	17	13.5	6
pH	6	5	5.9	5.5	5.8
Oxygen % satn.					
Surface	96	101	104	102	-
Bottom	94	98	98	98	-

Table 6: Species present and relative abundance of the flora of the three ponds

ROCKET POLE POND

SPECIES	SPRING 2005	SUMMER 1979	SUMMER 1986	AUTUMN 2003	WINTER 2006
Hydrocotyle vulgaris L.	2	4	2	4	-
Juncus effusus L.	3	2	2	5	5
Juncus conglomeratus L.	1	-	-	2	1
Eleocharis palustris L.	2	4	4	4	2
Myosotis scorpioides L	1	-	-	1	1
TOTAL SPECIES PRESENT 5	5	3	3	5	4

QUARRY POOL

SPECIES	SPRING 2005	SUMMER 1979	SUMMER 1986	AUTUMN 2003	WINTER 2006
Fontinalis sp.	-	2	-	-	-
Hydrocotyle vulgaris L	2	-	-	-	-
Ranunculus flammula L	-	3	2	2	-
Callitriche stagnalis Scop.	-	1	1	-	-
Potamogeton polygonifolius Pourret.	-	5	3	-	-
Juncus effusus L.	3	2	2	3	3
Eleocharis palustris L.	2	2	2	3	2
Myosotis scorpioides L.	1	-	-	1	2
Lythrum portula L.	-	1	-	-	-
TOTAL SPECIES PRESENT 9	4	7	5	4	3

QUARTER WALL POND

SPECIES	SPRING 2005	SUMMER 1979	SUMMER 1986	AUTUMN 2003	WINTER 2006
Hydrocotyle vulgaris L.	1	5	3	1	-
Callitriche stagnalis Scop.	-	-	2	-	-
Potamogeton polygonifolius Pourret	-	-	2	-	-
Juncus effusus L.	4	2	3	3	3
Eleocharis palustris L.	3	5	3	4	3
Myosotis scorpioides L.	2	1	2	2	2
Lythrum portula L.	2	4	2	1	1
TOTAL SPECIES PRESENT 7	5	5	7	5	4

Key: 5: >50%; 4: 11-50%; 3: 6-10%; 2: 1-5%; 1: <1% of total number of plants present.

of 0.8m being recorded on one occasion. In the three ponds at all seasons the water temperatures follows the ambient air temperatures, and there is little evidence of temperature stratification. All of the ponds are acidic with lower values (more acidic) being found during the summer and autumn months.(5.0-5.9) The surface waters appear to be well-oxygenated but the oxygen content can drop off in the deeper parts of the Rocket Pole and Quarry water bodies in the summer and autumn seasons.

Flora

Ten different plant species were found with the two rushes, *Juncus effusus* and *Eleocharis palustris* occurring at the margins of all three ponds (Table 6.) Both species have spread further around the ponds since 1979. The compact rush, *Juncus conglomeratus*, which also occurs at Pondsbury, was noted for the first time in Rocket Pole Pond in the autumn of 2003. Floating and submerged plants only occurred in the shallow regions of these ponds, e.g. *Hydrocotyle vulgaris*, marsh pennywort, in Rocket Pole and Quarter Wall ponds and *Myosotis scorpioides*, water forget-me-not, near the muddy outflow at Quarry Pool and in the shallow 'beach areas' at the Quarter Wall and Rocket Pole ponds.

Plants apart from *Juncus effusus* were scarce in January 2006; small shoots of *Eleocharis palustris* were appearing and very small plants of *Lythrum portula* (in Quarter Wall pond) and *Myosotis scorpioides* (in all three ponds) were present.

Plankton

Table 7 shows the organisms found in the plankton and indicates the species showing high abundance during the various seasons. The Rocket Pole Pond is eutrophic and experiences algal blooms with different species dominating at different times of the year. The green alga, *Botryococcus braunii*, which appears reddish-brown due to the presence of oil droplets, coloured the water in the spring and in the summer the water appeared 'soupy green' due to blooms of species of blue-green algae, *Microcystis* sp., *Arthrospira* sp. In the autumn the green alga *Desmodesmus magnus* dominated the phytoplankton. No blooms were evident in January 2006, but 'green soupy' water was noted in the Rocket Pole Pond in January 1996 (Richardson *et al*., 1998). Phytoplankton is less diverse in the other two ponds, but diatoms can build up to fairly large populations in the Quarry Pool in the spring.

In the zooplankton, the Cladocera (water fleas) occur in all of the ponds with *Daphnia obtusa*, *Bosmina longirostris* and *Chydorus sphaericus* present. However *Bosmina longirostris* dominates at all seasons in the Rocket Pole Pond, but appears mainly in the spring in the Quarry and Quarter Wall water bodies. Quarry Pool has the most diverse number of species of rotifers with four species of *Keratella* occurring. The carnivorous rotifer, *Asplanchna priodonta* which feeds on *Keratella* and other smaller rotifers was present in fairly large numbers (abundance rating 3) in Quarry Pool in the autumn. All stages, adults, immature cyclopids, nauplii larvae, of the copepod *Cyclops* were present in all three ponds throughout the year. The larva of the phantom midge, *Chaoborus crystallinus*, which occurred in great abundance in the autumn in Pondsbury also appeared in much smaller numbers in the Quarter Wall pond.

Table 7: Organisms in the plankton of the Rocket Pole Pond, Quarry Pool and the Quarter Wall pond

ROCKET POLE POND	QUARRY POOL	QUARTER WALL POND
CYANOPHYTA (blue-green algae) *Microcystis* sp.*S *Arthrospira* sp.*S *Gomphosphaeria* sp. CHLOROPHYTA (green algae) *Botryococcus braunei* Kutzing *Sp *Pediastrum boryanum* (Turpin) *Desmodesmus magnus* Chodat*A *Ankistrodesmus* sp. Filamentous green alga ZOOPLANKTON CLADOCERA *Daphnia obtusa* Kurz *Bosmina longirostris* (Muller)*A*W *Chydorus sphaericus* Muller *Simocephalus vetulus* (Muller) ROTIFERA *Brachionus calcyflorus* Pallas *Brachionus rubens*(Ehrb.) *Keratella quadrata* (Muller) *Keratella cochlearis*(Gosse) *Keratella vulga* (Ehrb.) *Filinia longiseta* (Ehrb.) CRUSTACEA *Cyclops* sp. Immature cyclopids Cyclopid nauplii Harpacticoids INSECTA Chironominae larvae	CHLOROPHYTA *Pediastrum boryanum**W *Dictyosphaeriu*m sp. Filamentous green alga BACILLARIOPHYTA (Diatoms) *Pinnularia* sp.*Sp *Tabellaria* sp ZOOPLANKTON CLADOCERA *Daphnia obtusa* *Bosmina longirostris* *Chydorus sphaericus* *Simocephalus vetulus* ROTIFERA *Brachionus rubens* *Keratella quadrata* *Keratella cochlearis* *Keratella serrulata*(Ehrb)*A *Keratella vulga* *Filimia longiseta* *Euchlanis dilatata* Ehrb. *Asplanchna priodonta* Gosse CRUSTACEA *Cyclops* sp. Immature cyclopids Cyclopid nauplii Harpacticoids INSECTA Chironominae larvae	CHLOROPHYTA *Closteri*um sp. *Pediastrum boryanum* Filamentous green alga ZOOPLANKTON CLADOCERA *Daphnia obtusa* *Bosmina longirostris* *Chydorus sphaericus* ROTIFERA *Brachionus calcyflorus* *Brachionus rubens**W *Keratella quadrata**Sp*W *Keratella vulga* *Filinia longiseta**W *Polyarthra minor* Voigt CRUSTACEA *Cyclops* sp. Immature cyclopids*S Cyclopid nauplii*S Harpacticoids Cypridid ostracod INSECTA *Chaoborus crystallinus* (Deg.) larva Chironominae larvae

Key: *Sp., *S, *A, *W denote high abundance 5 or 4 in spring, summer, autumn and winter.

Table 8: Abundance of macroinvertebrate species in Rocket Pole Pond, Quarry Pool and Quarter Wall pond

SPECIES	ROCKET POLE POND				QUARRY POOL				QUARTER WALL POND			
Oligochaeta:												
Lumbriculus variegatus (Muller)		S1	A2			-			Sp2	S2	A2	
Hirudinea:												
Helobdella stagnalis (L.)		-				-					A1	W1
Glossiphonia complanata (L.)		-				-						W1
Crustacea:												
Asellus meridianus Racovitza		S1			Sp2	S2	A2	W1	Sp2	S2	A3	W2
Insecta: Ephemeroptera:												
Cloeon dipterum (L.)		S1						W1			A1	
Insecta: Odonata:												
Ischnura elegans (van de Linden)	Sp2	S2	A2	W1	Sp1	S1	A1				A2	W1
Sympetrum striolatum (Charp.)		-				S1				-		
Insecta: Hemiptera:												
Gerris gibbifer Schum.		-				S2	A3			-		
Notonecta marmorea viridis Delcourt		-				-			Sp2	S2	A2	
Immature notonectids		-				-				S2		
Corixa punctata (Illiger)		-				-			Sp2	S2	A2	
Corixa panzeri (Fieb.)		-				-				S3		
Callicorixa praeusta (Fieb.)		-				-				S2		
Sigara dorsalis (Leach)		S1					A1		Sp2	S3	A2	W2
Immature corixids		-				S1			Sp2	S3	A2	W2
Insecta: Trichoptera:												
Limnephilus vittatus (Fab.) larva		-				-						W1
Insecta: Coleoptera:												
Ilybius quadriguttatus L. adult		-				S1				S2		
Dytiscid Colymbetinae larva		-				S2				S2		
Gyrinus substriatus Stephens		-				S2				-		
Insecta: Diptera:												
Chironominae larva and pupa	Sp2	S2	A2	W2	Sp1	S1	A2	W1	Sp2	S2	A2	W2
Chaoborus crystallinus (Deg.) l.		-				-					A2	
Culex sp. larva	Sp2					-				-		
Mollusca:												
Pisidium personatum (Malm)		-					A1			-		
TOTAL SPECIES FOUND 21		7				12				18		

Key: Sp=Spring, S=Summer, A=Autumn, W=Winter. Abundance scale: 5: >500; 4: 200-499; 3: 50-199; 2: 5-49, 1: <5 individuals.

Macroinvertebrates

Macroinvertebrates found in the three ponds are listed in Table 8, together with an indication of seasonal abundance. The apparently greater species diversity in the Quarter Wall pond is due to members of the water boatman group (notonectid and corixid Hemiptera), which dominate the fauna. Two species of leech, *Helobdella stagnalis* and *Glossiphonia complanata* also occur in this pond. The sheltered waters of the Quarry Pool provide a very suitable habitat for the surface-dwelling species, *Gerris gibbifer*, which was present in the summer and autumn. This species overwinters in cracks and crevices in the steep quarry walls. Five species are found in all three ponds but in small numbers, the isopod *Asellus meridianus* which is so abundant in Pondsbury, the damselfly larva, *Ischnura elegans*, the mayfly larva, *Cloeon dipterum*, the lesser water boatman, *Sigara dorsalis* and a larva of the Chironominae group. The Rocket Pole Pond has fewer macroinvertebrates in both species and numbers than in the other two ponds. This is probably due to the recurring blooms of algae that occur throughout the year and the fairly large population of the mirror carp, *Cyprinus carpio* that is present in this pond.

Fish

No detailed investigations of the fish which are known to occur in two of the ponds have been carried out. Golden carp, *Carassius auratus* are often observed in Quarry Pool and crucian carp, *Carassius carassius* have also been recorded in this pond. A large population of mirror carp, *Cyprinus carpio* exists in the Rocket Pole Pond (George, 1982) but it is difficult to see how this pond with its sparse plant and animal life can support these fish. Feeding by visitors to the island is a contributory factor but cannibalism by the larger fish is highly probable.

DISCUSSION

The freshwater ecosystems on Lundy are governed by the weather with several drying up during periods of drought and many temporary water bodies appearing during periods of intensive rainfall. Their water chemistry relates to the geology of the island which is composed of Tertiary granite. Although there have been surveys of specific groups of freshwater organisms it was not until the late 1970s that detailed investigations were carried out on the flora and fauna of the entire water bodies.

Pondsbury

Dredging of Pondsbury in 1993 and 1995 and the construction of the impounding wall on the western side has affected the surface area of the water body, which in the winter of 2006 had an area of 4000m^2. The extent of open water has increased since 1979 when it was just 20% of the total area with beds of marsh St John's Wort, *Hypericum elodes*, dominating much of the water body (George & Stone, 1980). In the summer of 1993, before the dredging occurred, Clabburn found that there was 92% open water (Clabburn, 1994). This has been the situation since the dredging with a slightly greater open water area being recorded in January 2006 which is to be expected as many of the plants had died down during the winter months.

The deepest part of Pondsbury is in the northern part where depths of over 1m have been recorded since 1979 at all seasons. The maximum depth in January 2006 was 1.8m. It becomes progressively shallower towards the east and south where depths of a few cm are usually recorded. Water temperatures relate to ambient air temperatures. During the daytime in the summer the surface water temperatures usually increase and there is evidence of thermal stratification in the body of water. Similarly dissolved oxygen levels may fall in the deeper regions but Clabburn in his 24h sampling programme found that in some regions greater levels of oxygen were found at night in the deeper layers.(Clabburn, 1994) In small fairly shallow water bodies there may be overturn of water at night brought about by surface cooling and by the wind. If this occurs oxygen-rich water from the surface layers will reach the deeper regions.

Pondsbury can be classified as a 'soft' water body (mean total hardness 9.4mg/l) with an acid pH that is maintained by the extensive growth of *Sphagnum* moss that dominates the area. *Sphagnum* has the ability to bind cations and release hydrogen ions in their place thus maintaining acidity. pH values of 4.8 have been recorded in the summer surveys, but in the other seasons the pH appears to increase (become less acid). The pH can vary in acidic waters which are poorly buffered due to changes in the free carbon dioxide content. The presence of plants and animals in the water can affect CO_2 levels by their respiration which increases CO_2 content in the water. The fewer plants and animals in the water in the colder months of the year produce a smaller amount of free CO_2 in the water which allows the pH to rise, becoming less acid. pH values of 6.4 were recorded in the winter of 2006.

The composition of the **flora** reflects the acidic nature of the water with the dominant plants being characteristic of bogs and marshes (Table 2). Although the species composition has remained remarkably stable over the last 27 years, the relative abundance of most species has varied considerably. *Sphagnum cuspidatum*, the bog moss, still dominates Pondsbury and the surrounding boggy area, but the other dominant, the soft rush, *Juncus effusus* has increased during the last 27 years, particularly around the margins of the north and south side. The spike rush, *Eleocharis palustris*, dies back during the winter but the spring 2003 survey showed that it had increased particularly on the eastern side since the earlier surveys. The large 'island stands' of *Hypericum elodes*, which were so noticeable in the summers of 1979 and 1986 no longer exist, and only small patches are present, mainly on the southern side. The 1993 and 1995 dredging (Gibson 1994; Parkes 1996 & R. Lovell pers. comm.) are obvious reasons for its decline. This decline however may have favoured the growth of *Potamogeton polygonifolius*, the bog pond weed, which has become more abundant in the last 10 years.

The **plankton** population shows good species diversity with many of the Crustacea and Rotifera recorded by Galliford in 1953 still present (Galliford, 1954). The composition of both the phytoplankton and the zooplankton varies throughout the year with often one species dominating for a short period. Although species may increase in numbers at one particular season they are usually present throughout the year in small residual populations (Moss, 1980). The two well represented groups,

Cladocera (water fleas) and Rotifera (rotifers) have resting egg stages that c*an* withstand adverse conditions. *Daphnia obtusa* was a prominent species throughout the year, but its smaller numbers in the autumn were probably due to the dominating presence of the predatory larva of the phantom midge, *Chaoborus crystallinus* which formed about 50% of the total plankton numbers at that time (Figure 1). The *Keratella* rotifers are represented by three species, *K. vulga*, *K. quadrata* and *K. serrulata*, with the latter being very common in *Sphagnum* bogs and acid waters on the mainland. Both the cyclopoid and harpacticoid groups of copepods occur in Pondsbury with all life cycles of *Cyclops* sp appearing throughout the year. The other free-living group of copepods which is found on the mainland, the Calanoida, appears to be absent from Lundy. Green algae were present in Pondsbury throughout the year with different species appearing at different seasons. The dominance of green algae (Figure 1) during the summer months was mainly due to a 'bloom' of the green Euglenophyte, *Euglena viridis*.

Although there are seasonal differences in the composition and numbers of **macroinvertebrates** in Pondsbury, the fauna appears to show marked similarity to that observed 27 years ago. In spite of the dredging and the decline of *Hypericum elodes*, the isopod crustacean, *Asellus meridianus* remains the dominant member of the fauna, with the flatworm, *Polycelis nigra* and members of the Coleoptera, Hemiptera and Chironominae again well represented groups. The more common mainland form *Asellus aquaticus* does not occur on Lundy and this is in agreement with the findings of Williams (1962, 1979) and Moon & Harding (1982) who found only *Asellus meridianus* on offshore islands. *Polycelis nigra*, the black flatworm, although present all year round, was particularly abundant in the cold winter waters. The acid water and the fairly high summer water temperatures exclude some species, particularly members of the Ephemeroptera, mayfly larvae, which are much more abundant on the mainland. Only one species, *Cloeon dipterum* has been found. A long-standing macroinvertebrate, the water spider, *Argyroneta aquatica*, which lives amongst the *Sphagnum* is still at Pondsbury although in smaller numbers than in 1979 when fairly large numbers were recorded. This spider was recorded as 'quite abundant' at Pondsbury 53 years ago (Galliford, 1954). The drying up of the water body presents another hazard to macroinvertebrates particularly those that remain in the water all the time. Coleoptera and Hemiptera can fly away to other waters if conditions deteriorate. Other species survive by the formation of resistant cysts/cocoons (leeches, oligochaete worms, flatworms) and others can aestivate in the bottom sediments. The isolation of Lundy from the mainland may deter some macroinvertebrates from reaching the island, but it is more likely to be the water conditions that determine the composition of the fauna. There appear to be no endemic species in the freshwater flora and fauna.

Rocket Pole Pond, Quarry Pool, Quarter Wall pond

These three ponds which have been formed from excavations in the rock, are of similar size. They maintain their shape throughout the year although the water levels fluctuate according to weather conditions. Rocket Pole Pond is a very

exposed body of water, subject to strong winds in all seasons. Its water is well mixed and if temperature and oxygen stratification does occur during warm periods, it will quickly be overturned. The shallow Quarter Wall pond is also fairly well exposed particularly to easterly winds. The water appears fairly uniform in its temperature and oxygen content throughout its depth. Quarry Pool is a sheltered body of water particularly from the westerlies which frequently blow across the island. There is some evidence of a decrease in oxygen content in the deeper waters in the summer which may be due to decomposition of organic matter which is prevalent in the bottom sediments.

The acidic nature of all three ponds determines the type of flora and fauna present. The number of species of **plants** has remained remarkably consistent since surveys began in 1979. Due to the depth of the ponds, plants mainly occur around the margins and one in particular, *Juncus effusus* is fairly abundant at all three ponds. The spike rush, *Eleocharis palustris* has increased in recent years at all of the ponds The few other plants, all characteristic of acidic upland waters, occur in the shallow regions.

The **plankton** samples taken during all seasons show that the Rocket Pole Pond is eutrophic with algal blooms regularly occurring. There is no through flow in this pond and there is a build up of nutrients from the mirror carp population and the droppings from ducks that regularly frequent this pond. The summer blue-green algae bloom was also noted by Galliford in 1953 (Galliford, 1954). Evidence of eutrophy in the summer is also seen in the Quarter Wall pond which is used by the ponies, where large populations of green algae, particularly the desmid, *Closterium* and filamentous green algae often occur. Quarry Pool does not appear to experience algal blooms but large populations of some species occur at certain times of the year e.g. the diatom *Pinnularia* in the spring and the green alga *Pediastrum boryanum* in the winter.

Differences can be observed in the composition of the zooplankton in the three ponds. Although the cladoceran, *Bosmina longirostris* is found in all of them, it is much more prolific in Rocket Pole Pond where it reaches large populations in autumn and winter (abundance rating 5). *Daphnia obtusa* which was the main cladoceran in Pondsbury also occurs in these water bodies, particularly in the winter and spring of Rocket Pole Pond and Quarry Pool and in the summer at the Quarter Wall pond, where it is often found with the rotifer, *Brachionus rubens* attached to it. This commensal relationship was recorded also in this pond by Galliford in 1953. Several of the female *Daphnia* in the Quarter Wall pond autumn samples were carrying the overwintering resting eggs. All life cycle stages of the copepod *Cyclops* occurred in the ponds. This species is known to breed throughout the year and it is not unusual to find nauplius larvae and immature forms as well as egg-carrying females at all seasons of the year (Harding & Smith, 1974). Harpacticoid copepods were present but in much smaller numbers, but as in Pondsbury calanoid copepods, which on the mainland are more frequent in the winter, were not found. 10 species of rotifers were present in the ponds with greater species diversity in the Quarry Pool. Here the rotifer, *Keratella serrulata* dominated the autumn plankton (68% of the total population).

Several of the cladoceran and rotifer species were recorded by Galliford 53 years ago, and appear therefore to be long standing members of the plankton e.g. *Daphnia obtusa, Bosmina longirostris, Chydorus sphaericus, Keratella serrulata, Keratella vulga, Brachionus rubens*. The resting egg stage which is found in both groups together with their parthenogenetic life cycle which ensures the fast build up of large populations, contribute to the success of these species in the Lundy lentic waters.

Differences are observed in the **macroinvertebrate** populations of the three ponds, and these can be related to the position of the pond on the island and hence exposure to the elements, the amount of plants growing in these ponds and the nutrient input. The algal blooms that occur so frequently in the Rocket Pole Pond for most of the year probably deter many macroinvertebrates and there are no large populations of any species at any time of year. A contributory factor to the low species diversity and numbers of organisms is the presence of the mirror carp, *Cyprinus carpio*, which feed on algae and invertebrates. Although more species were found in the Quarry Pool only one species, the pond skater, *Gerris gibbifer* reached reasonable numbers (abundance rating 3). Fish, golden carp, *Carassius auratus* and crucian carp, *Carassius carassius* are also present in this pool and it is likely that their predation on macroinvertebrates partly attributes to the low numbers of organisms found. This was demonstrated by Macan (1966) who studied the effects of fish predation on the fauna of upland ponds. The sheltered nature of Quarry Pool allows the surface-dwelling *Gerris gibbifer* and the whirligig beetle, *Gyrinus substriatus* which was found in the summer to live successfully here. *Gerris* in particular builds up fairly large populations and both adult and young forms occurred in the summer and autumn.

The shallower Quarter Wall pond has more plant beds e.g. *Myosotis scorpioides* and *Lythrum portula* than the other two ponds, and this explains the presence of the water boatman group of the Hemiptera, particularly the lesser water boatmen, corixids and sigarids, which are plant feeders. The greater water boatman, *Notonecta marmorea viridis*, which also occurred (abundance rating 2) although preferring stretches of open water, places its eggs in plant stems during the spring.

Seasonal differences were observed in the three ponds with fewer species being found during the winter months. Water temperatures were very low in January 2006 at the time of sampling. More species were recorded at the Quarter Wall pond where two species of leech, *Glossiphonia complanata* and *Helobdella stagnalis* were found amongst the emerging *Myosotis* beds, as well as *Asellus meridianus*, *Sigara dorsalis* and immature corixids. It is unlikely that the fairly deep Rocket Pole Pond and Quarry Pool dry up during long periods of drought although water levels can drop. The Quarter Wall pond however has suffered severe water loss in some years e.g. in the summers of 1981, 1995 and 2006, but the dredging of part of the pond in the autumn of 1995 (Parkes, 1996 and R. Lovell pers. comm.) has helped its survival in the past 10 years. Many of the animal species can survive periods of desiccation by the production of resting eggs (Cladocera, Rotifera), as resistant cysts (Oligochaeta, Platyhelminthes), aestivation in the bottom sediments

(*Asellus meridianus*, insect larvae) or by flying off to more permanent water bodies (adult Coleoptera, Hemiptera).

TEMPORARY WATERS

During the five surveys since 1979 some of the smaller temporary waters were studied and descriptions of their flora and fauna have been given in previous papers (George & Stone, 1981; George & Sheridan, 1987; George, McHardy & George, 2004). Brief descriptions of the water bodies are given here.

Small pond at Quarter Wall (OS grid reference: SS 13630 44965)

The smaller pond at Quarter Wall is shallow with a dense weed cover and no open water. It is situated in a depression (3m x 6m) in a marshy area where there are stands of the soft rush, *Juncus effusus* and there is a small outlet on the eastern side. Its depth varies according to weather conditions and the maximum depth recorded during the surveys was 0.3m. In dry periods e.g. summer of 1995 and summer/ autumn 2003, it dries up altogether. The water temperature follows the ambient air temperature and usually there is abundant oxygen due to the prolific growth of plants. The pH varies from 5.0 in summer to 6.2 in spring. Clumps of *Juncus effusus* surround the pond and the dominant plant in the pond is the bog pondweed, *Potamogeton polygonifolius* which is present all year round. In the spring *Myosotis scorpioides*, *Callitriche stagnalis* and *Lythrum portula* appear and in the summer *Hydrocotyle vulgaris* has been found.

The pond supports a good population of *Asellus meridianus*, which feeds on the large amounts of decaying vegetation that are present. Hygrobatid mites are common in the summer and several insects have been found e.g. the damselfly larva, *Ischnura elegans*, mayfly larva, *Cloeon dipterum*, various corixids and water beetles. It is interesting to note that the water beetle, *Helophorus grandis* which prefers to crawl amongst plants and does not swim, occurs in this small pond.

Pools in the North Quarry (OS Grid Reference: SS 138833 45597)

The two pools in the North Quarry are shallow and covered with aquatic plants. The maximum depth in the pool nearest to the quarry entrance on the south side was 0.73m in October 2003 and 0.57m in April 2005. The pool adjacent to the steep quarry wall on the south side and completely surrounded by large rocks, had a maximum depth of 0.9m in October 2003 and 1.25m in April 2005. pH values for both varied from 5.0 in the autumn to 5.35 in the spring. The greatest diversity of plants occur in the shallower pool where seven species were recorded in April 2003. Three species were found in the deeper pool. Small stands of *Juncus effusus* occur in both pools, but *Callitriche stagnalis* dominated forming a green carpet across both water bodies. *Sphagnum cuspidatum* occurs in the shallow marginal areas. The shallower pool also has, *Myosotis scorpioides*, the water forget-me-not, *Ranunculus flammula*, the lesser spearwort, *Caldesia parnassifolia*, water plantain and the duckweed, *Lemna minor*. In the 2006 winter both pools were covered with *Lemna minor* and in the shallower pool small shoots of *Myosotis* were emerging.

The dense weed cover in both pools provides good shelter for several macroinvertebrates, particularly *Asellus meridianus* and aquatic beetles. A caddis larva, *Plectrocnemia conspersa* which was not found in the permanent ponds, occurred in the deeper pool. This larva which spins a net to catch its prey, usually emerging insects, has been found in the Lundy streams (Long, 1994). It has been recorded living in upland pools and lakes as well as rivers and streams (Edington & Hildrew, 1995).

David's Pool (OS Grid Reference: SS 13846 44228)

This small pool is situated adjacent to the Pondsbury raised dam on the western side. Maximum depths in Autumn 2003 and Spring 2005 were 0.6m and 0.66m respectively. As expected the same seasonal pH values as Pondsbury were recorded, *Callitriche stagnalis*, the mud water starwort, dominated the pool throughout the year, with stands of *Juncus effusus* surrounding and encroaching into the water body. As the water temperatures increased, patches of *Hydrocotyle vulgaris*, and *Potamogeton polygonifolius* appeared with the water crowfoot, *Ranunculus omiophyllus* appearing later in the season.

Several of the animals found in Pondsbury occurred in this pool as expected, and they included several of the planktonic organisms, e.g. *Daphnia obtusa*, *Bosmina longirostris*, *Cyclops* sp. The black flatworm, *Polycelis nigra*, *Asellus meridianus*, various beetles and chironomid larvae were present.

Ray's Pool (OS Grid Reference SS 13486 44228)

For the first time in April 2005 the pool (named Ray's Pool after the farmer's sheepdog) at the bottom of Barton Cottages field was surveyed and again visited in January 2006. This spring-fed pool had a maximum depth of 0.75m and the pH varied from 6.0 in the spring to 6.52 in the winter. In both seasons it was covered with the water cress, *Nasturtium officinale* and *Juncus effusus* surrounded the banks on the north and south sides. *Ranunculus omiophyllus* occurred in the spring in the shallower areas neat the outlet on the eastern side but was not evident in January 2006.

The most dominant macroinvertebrate present at all seasons is the gastropod mollusc, *Lymnaea peregra*. This mollusc, one of the commonest in Europe is not found in other Lundy lentic waters, where only a few molluscs have been recorded. Molluscs prefer more alkaline calcareous waters, but some species such as *Lymnaea peregra* can tolerate soft acid waters. A total of over 200 *Lymnaea* were collected in two one-minute net sweeps through the water cress beds. Other macroinvertebrates found were the ubiquitous *Asellus meridianus*, the mayfly larva, *Cloeon dipterum*, corixids and chironomid larvae. The small beetle *Laccophilus minutus* was fairly abundant.

Johnny's Pool (OS grid Reference SS 132879 47237)

A small pool, 4.8 m long and 1 m wide, on the west side of the main track at Gannets Combe was covered with the floating club-rush, *Eleogiton fluitans* in April 2005 and January 2006. This is a perennial species typical of shallow acidic waters and it frequently grows in dense masses forming a bright green carpet throughout the

year. The pool which has a depth range of 0.2-0.9m has a pH of 6.0. *Ranunculus omiophyllus* and *Lythrum portula* also occur. Adults and larvae of the Hydroporinae beetle sub-family were found amongst the *Eleogiton* and the oligochaete worm *Lumbriculus variegatus* was also recorded.

Rocket Pole Temporary pond (OS Grid Reference SS 13481 43681)
The large depression to the east of the Rocket Pole contains water at various times of the year. In January 2006 it contained dense mats of *Eleogiton fluitans* and filamentous green algae. A pH of 6.3 was recorded at this time and this is in accord with the January pH values recorded in ponds in the Rocket Pole area in January 1966. (Richardson *et al*., 1998). Microscopic Crustacea, such as *Daphnia obtusa* and ostracods were abundant in the water body.

CONCLUSIONS

The flora and fauna of the Lundy lentic waters although typical of acidic waters on the mainland, are impoverished compared with them, but the isolation of Lundy is probably not a major limiting factor. There are no endemic species or varieties present.

The four main ponds display differences particularly in their plankton and macroinvertebrate communities and these can be related to the position of the water body on the island and hence exposure to the elements, the amount of vegetation present and their nutrient content. Pondsbury, the largest water body has the greatest species diversity and numbers of organisms. The Rocket Pole Pond frequently experiences algal blooms which markedly affect the macroinvertebrate populations.

The seasonal surveys of the four main ponds have shown that plankton is present throughout the year but with different species dominating at different times. Many of the plants die down during the winter months and the macroinvertebrates decline in numbers. The temporary pools which frequently occur on the island quickly become colonized and their communities, particularly the plants and some macroinvertebrates appear to survive periods of desiccation.

The flora and fauna of Lundy's lentic freshwaters has shown a remarkable stability in the species composition over the last 27 years since the main surveys began in 1979. Some of the organisms which were recorded by early field workers over 50 years ago are still present such as *Asellus meridianus*, and the water spider, *Argyroneta aquatica* It is the isolation of these waters on the island and little human interference that has contributed to the long term stability of these ecosystems.

Pictures of the ponds taken in various years and seasons are given in Plates 1-6, pages 126-128.

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Plate 1: Pondsbury in October 2003. *(Photo: David George)*

Plate 2: Pondsbury in August 1979 showing the extensive beds of Marsh St John's Wort, *Hypericum elodes. (Photo: David George)*

Plate 3: The Rocket Pole Pond in April 2005 with St Helena's Church in the background. *(Photo: David George)*

Plate 4: Depth measurements being taken at Quarry Pool in October 2003. *(Photo: Jennifer George)*

Plate 5: The larger pond at Quarterwall in April 2005. *(Photo: David George)*

Plate 6: The larger pond at Quarterwall in August 2006 showing the effects of the summer drought. In September it dried up completely. *(Photo: Alan Rowland)*