Irving, RA, Schofield, AJ and Webster, CJ. Island Studies (1997). Bideford: Lundy Field Society

The Freshwater Habitats of Lundy

Jennifer J George

Introduction

Although the natural history of Lundy has been fairly well-documented over the last 50 years, the emphasis has mainly been on the terrestrial flora and fauna, particularly the birds, and on the rich and varied marine life in the waters surrounding the island. In comparison, until the late 1970s the freshwater habitats had received little attention.

Organisms from the mainland often have great difficulty reaching islands and consequently habitats such as ponds and streams have a restricted fauna and flora when compared to similar habitats on the mainland. However, islands – because of their isolation – provide unique opportunities for species to evolve as there are usually fewer of their parasites, predators and competing species present. It should be emphasized that adaptation to, and hence survival in, a new environment is often very difficult for an organism; and island populations are more susceptible to changes in the environment and more likely to become extinct than mainland populations which characteristically possess greater genetic variation.

Ponds and streams

Lundy's ponds and streams are governed by the weather, with several drying up during prolonged drought periods and many temporary ponds, pools and streams appearing after periods of intense rainfall. Nearly all of the larger ponds are artificial, being formed from dammed-up springs or from flooding of quarries and depressions in the rock. Since 1945, one detailed classification of the freshwater habitats has been carried out, by Langham in 1967 and 1968 (Langham 1968), who listed all of the permanent (including reservoirs) and temporary habitats present at that time. Previous to 1978, when a study of Pondsbury was undertaken (George and Stone 1979) there had been no detailed investigation of the freshwater flora and fauna, but individual groups of freshwater organisms have been studied since 1945 by various workers: for example, aquatic Hemiptera (Morgan *et al* 1947), diatoms (Fraser-Barstow 1949), Crustacea and Rotifera (Galliford 1953) and the isopod *Asellus* (Williams 1962). Some aquatic organisms have been listed in the mainly terrestrial surveys of specific animal groups: for example, Coleoptera or beetles (Brendell 1975), Diptera (Lane 1977), Hemiptera or water bugs (Alexander 1991) and adult aerial stages of aquatic insects have often been recorded in the list of invertebrates/insects in the Lundy Field Society's Annual Reports since 1982. The fish, mainly carp, that occur in some of the ponds, were introduced by

previous island owners, such as Martin Coles Harman, and have been detailed in two small reports (Baillie and Rogers 1976; George 1981). Further to the 1978 survey, additional work has been undertaken at Pondsbury (George and Sheridan 1986, Clabburn 1993a), the other ponds (George and Stone 1980, George and Sheridan 1986) and the Lundy streams (Long 1993).

This review will consider the flora and fauna of the five major ponds (Pondsbury, Quarry Pool, Rocket Pole pond and the two main ponds at Quarterwall), and six of the more permanent streams on the island, as well as raising some more general points relating to this aspect of island ecology.

Pondsbury

Pondsbury, which is the largest body of freshwater on the island, is surrounded by *Sphagnum bog*, heathland and rough grazing pasture (Plate 30). It is probably of natural origin although damming on the west side has increased its size and depth. It receives surface runoff from the surrounding land and has an outlet stream that flows down the Punchbowl Valley and into the sea at Jenny's Cove. During dry periods, the pond becomes reduced in size and very occasionally can dry up altogether (as it did in 1976).

The detailed surveys of Pondsbury, all carried out in the months of July and August, by George and Stone (1979), George and Sheridan (1986) and by Clabburn (1993a), not only give a comprehensive account of the habitat at a particular time, but also allow conclusions to be drawn on the colonisation and disappearance of species and therefore the stability of the ecosystem over a period of fourteen years. All three surveys employed similar sampling techniques thus allowing meaningful comparisons to be made.

The detailed mapping of the pond shows that it regularly changes shape due to varying water levels, macrophyte encroachment, silt deposition and human activity. To illustrate this, during the 1993 survey, Pondsbury covered an area of 3,900 m^2 with 92% of open water, whereas fourteen years earlier it had an area of approximately 3,300 m^2 with only 20% of open water, the rest being covered by emergent beds of *Juncus* and *Hypericum* and a carpet of *Sphagnum*.

Maximum depths of 1 – 1.2 m have been recorded in the north and east regions of the pond, which became progressively shallower to the west and south. The recording of water temperatures over a 24 hour period by Clabburn (1993 a & b) showed that considerable temperature fluctuations occur with depth, and that surface daytime temperatures were only a few degrees below ambient air temperatures.

Maximum dissolved oxygen levels are found near to the pond's surface and the 24 hour recording in 1993 showed that periods of deoxygenation occur just above the sediments in parts of the pond. However, Clabburn also showed that in these regions considerable oxygen fluctuations take place with maximum levels occurring at night, the opposite to what is normally expected. He

suggests that these fluctuations relate to a daily overturn of water brought about by the wind. A small pond can become thermally stratified during the warmer day period which prevents mixing and the transference of oxygen to the deeper areas. Deoxygenation may occur in the deeper water. At night the water temperature drops and this, together with an onshore wind, would cause an overturn of water in the pond, allowing the oxygen to penetrate into water overlying the sediments.

The water chemistry of Pondsbury relates to the geology of the island which is composed of tertiary granite. All three surveys recorded an average pH of 4.8 indicating an acidic body of water. Such a constant pH over fourteen years is probably due to the large amount of *Sphagnum* moss in and around the water (Sphagnum has the ability to bind cations and release hydrogen ions in their place thus maintaining the acidity). The 1993 survey also showed a mean total hardess of 9.4 mgl^{-1} thus classifying Pondsbury as a 'soft' water body. Levels of magnesium and calcium are therefore low, but surprisingly the conductivity readings are high. Conductivity also relates to sodium and chloride levels and the closeness of the pond to the sea may be an explanation for these high levels of 420-439mμs, more typical of chalk streams (Clabburn 1993a & b).

In all three surveys, 1979, 1986 and 1993, the same twelve species of **plant** were found, with the moss *Sphagnum cuspidatum* completely dominating the entire area. However, relative abundance of the plants varied and Table 1 shows a generalised summary of species and their abundance as different sampling techniques were used. In 1979 general vegetation mapping of the entire pond was carried out followed by the detailed examination of species and their abundance along a 40 m transect line extending from the southern bank through the central area of the pond (George and Stone 1979). In 1993 the fringing macrophytes and their abundance were assessed using a quadrat 50 x 50 cm along each of the banks of the pond (Clabburn 1993a). All data were converted to the Domin scale which records abundance on a scale of 1-10, where 10 represents 91-100%, 5 is 11-25%, and 1 is just a few individuals present.

In 1979 the dominant plant on the southern side was Marsh St. John's Wort *Hypericum elodes* being present on *Sphagnum* islands in the open water as well as around the edge of the pond (Plate 30). It grew in association with Marsh Pennywort *Hydrocotyle vulgaris* and Water Forget-me-not *Myosotis scorpioides*, both of which it shaded. In 1993 two plants dominated the south side: Common Spike Rush *Eleocharis palustris* and Soft Rush *Juncus effusus* with Bog Pondweed *Potamogeton polygonifolius flora* and *Hypericum elodes* also abundant. The Soft Rush *Juncus* also dominated the north, south and eastern sides of Pondsbury in both years. A few isolated patches of the Waterwort *Elatine hexandra*, a species fairly rare in Britain, was found in 1979 and the Marsh Bedstraw *Galium*

palustre was recorded on the pond fringes in 1993.

The macrophytes of Pondsbury, with the exception of *Juncus effusus* which is found in many types of wet habitat, are typical bog plants, often occurring widely on mainland Britain.

In all these surveys only a superficial examination of the **plankton** was carried out. Regular sampling throughout a year is required as populations of both phyto– and zooplankton in ponds are very variable with often one species dominating for a short period. In 1979 and 1986 plankton was sampled by taking two 10 m hauls across the open water area and in 1993, chlorophyll content (giving an indication of algal biomass present) was measured at different depths in the NE corner of Pondsbury.

In 1979 the plankton was completely dominated by a 'bloom' of the green flagellate *Euglena viridis* with the zooplankton cladocerans *Chydorus sphaericus* and *Alonella nana* (also recorded by Galliford in 1953), and the copepod *Cyclops* reasonably abundant. Several rotifers were recorded with the spiny *Keratella serrulata*, a common inhabitant of bog waters, being present in fairly large numbers. Seven years later, the dominating species was the cladoceran *Daphnia obtusa* with also *Chydorus sphaericus* and *Cyclops* fairly abundant. Chlorophyll analysis in 1993 indicated that the greatest algal biomass occurred in the surface waters with a progressive decrease with depth.

The **macroinvertebrate fauna** in all three surveys was sampled by sweep-netting through the beds of

Table 1

Relative abundance of plant species in Pondsbury

Species	Abundance using Domin Scale	
	1979	1993
Sphagnum cuspidatum Ehrh ex Hoffm emend	10	10
Hypericum elodes L.	8	4
Hydrocotyle vulgaris L.	7	3
Callitriche stagnalis Scop.	5	4
Lythrum (Peplis) portula L.	4	4
Juncus effusus L.	4	6
Juncus articulatus L.	3	3
Myosotis scorpiodes L.	4	3
Potamogeton polygonifolius (Pourret)	3	3
Eleocharis palustris (L)	3	5
Ranunculus flammula L.	2	3
Ranunculus omiophyllus Ten.	1	1
Elatine hexandra (Lapierre)	1	–
Galium palustre L.	–	2

(Domin scale: 10 = 91-100%; 9 = 76-90%; 8 = 51-75%; 7 = 34-50%; 6 = 26-33%; 5 = 11-25%; 4 = 4-10%; 1,2,3 = <4% (3 with many individuals, 2 several individuals and 1 few individuals)

vegetation for a specified period, and grabs were used for sampling the bottom sediments. Results (Table 2) showed a greater diversity of macroinvertebrates in the vegetation in 1993 than fourteen years earlier. However, this conclusion must be treated with caution as the 1993 survey was more comprehensive than the earlier surveys and consequently probably collected more of the rarer species (abundance rating 1).

However, trends can be seen concerning the more abundant species. For instance, Pondsbury is dominated by the isopod *Asellus meridianus* being particularly abundant in 1986 and 1993, where it was recorded in every sample taken. *Asellus* feeds on organic detritus that is plentiful in the bottom of the pond. The closely-related species *Asellus aquaticus* that often coexists with *Asellus meridianus* on the mainland, does not occur on Lundy, and this is in agreement with the findings of Williams (1962, 1979) who found *Asellus meridianus* on offshore islands only.

Another abundant species from 1979-93, is the common mainland flatworm *Polycelis nigra* which is predatory, feeding on worms, insect larvae and small *Asellus*. Other well-represented groups are the Hemiptera, Coleoptera and Chironomid Diptera, all invertebrates with aerial adult stages.

An interesting record is the water spider *Argyroneta aquatica* that dominated the extensive *Hypericum* beds in 1979 and was still fairly abundant fourteen years later. Also recorded as "quite abundant" by Galliford (1953), it is obviously a long-standing member of Lundy's freshwater fauna. It is an air-breather and quite capable of withstanding drought conditions.

Fewer species were found living upon and in the bottom sediments, but again, *Asellus meridianus* was dominant in the samples in all three surveys. Only one species, the oligochaete worm *Limnodrilus hofmeisteri*, was restricted to the sediments, the others occurring also in the vegetation. The bivalve mollusc *Pisidium personatum* was not found in 1979 and 1986, but it occurred in both the vegetation and sediments in 1993. This mollusc that was very abundant (over 5,000 individuals) in the sediments in 1993, appears to be a recent immigrant to the Lundy freshwater fauna.

There have been no major surveys of **fish** populations in Pondsbury. Crucian carp *Carassius carassius* have been recorded in the pond, and several were transferred to the Quarry Pool when Pondsbury dried out completely in 1976 (Baillie and Rogers 1976). In January 1977, Pondsbury was restocked with thirty carp of varying sizes and ages from Quarry Pool, and several fish were observed in Pondsbury in the summer of 1986 (George and Sheridan 1986).

In conclusion, Pondsbury can be classified as a 'soft' water body with an acidic pH that is maintained by the luxuriant growth of *Sphagnum* moss that dominates the pond. The plant species present have remained remarkably stable since 1979 and can generally be found in similar habitats on the mainland.

The fauna present is influenced by the water

Table 2 **Macroinvertebrates recorded from the vegetation in Pondsbury**
(Rare species (Scale I) found only on one occasion, not shown here)

Macroinvertebrates	1979	1986	1993
PLATHYHELMINTHES	3	5	4
Polycelis nigra (Müller)			
ANNELIDA: OLIGOCHAETA			
Lumbriculus variegatus (Müller)	2	2	4
CRUSTACEA			
Daphnia obtusa Kurz	–	3	–
Chydorus sphaericus (Muller)	2	2	–
Alonella nana (Baird)	2	–	–
Cyclops sp.	2	2	–
Asellus meridianus Racovitza	3	5	5
ARACHNIDA			
Argyroneta aquatica L.	4	2	2
Hydracarina (water mites)	2	2	2
INSECTA: ODONATA			
Sympetrum striolatum (Charpentier)	1	1	2
Enallagma cyathigerum (Charpentier)	–	–	2
INSECTA: HEMIPTERA			
Notonecta glauca L.	1	–	1
N. obliqua Thunb	2	2	2
Immature notonectids	1	2	2
Plea leachii (McGregor & Kirkaldy)	–	–	2
Callicorixa praeusta (Fieber)	1	2	3
Hespercorixa linnaei (Fieber)	–	–	2
Sigara spp.	–	–	2
Immature corixids/cymatids	1	3	3

Macroinvertebrates	1979	1986	1993
INSECTA: COLEOPTERA			
Gyrinus substriatus Stephens	2	–	–
Ilbyius quadriguttatus L.	2	–	–
Agabus bipustulatus L.	2	3	2
Hygrotus inequalis (Fabricius)	2	2	2
Hydroporus pubescens Gyllenhal	1	1	1
INSECTA: TRICHOPTERA			
Limnephilus vittatus (Fabricius) larvae	2	–	–
INSECTA: CHIRONOMIDAE			
Tanypodinae	3	2	4
Chironominae	2	2	3
MOLLUSCA			
Pisidium personatum Malm	–	–	3
TOTAL NUMBER OF SPECIES/GROUPS	**23**	**16**	**36**

Note: Abundance scale of 1-5 5 = over 500 individuals, 4 = 200-199, 3 = 59-199, 2= 5-49, 1 below 5.

chemistry, periodic drying up of the pond and the isolation of Lundy from the mainland. There appear to be no endemic species. Coleoptera (beetles) and Hemiptera (water bugs) are the most diverse groups in the pond, and these are characteristic of acid waters. The crustacean isopod *Asellus meridianus* has been an abundant member of the fauna for over fourteen years, and the water spider *Argyroneta aquatica* has maintained its population since 1953 when it was first recorded.

Other freshwater habitats

The other bodies of standing freshwater that have been studied in detail are the Quarry Pool, Rocket Pole pond, and the two main ponds at Quarterwall (George and Stone 1980; George and Sheridan 1986).

Quarry Pool (Plate 31)
This is a true quarry pool, a deep body of water overshadowed by steep rocky walls and some trees. It has a maximum depth of 1.7 m, and there is an outlet at the eastern side of the pool.

Rocket Pole pond (Plate 32)
This is the deepest pond on the island with a depth of 2.2 m. It has been formed from an excavation in the rock and has no through drainage.

Quarterwall pond 1 (Plate 33)
This is the larger of the two ponds and is an open body of water with fairly steep rocky banks and only a few weed beds. A maximum depth of 0.8 m was recorded in 1986. It is situated at a fairly high level on the island and probably receives little surface drainage.

Quarterwall pond 2
This is a shallow pond (maximum depth 0.4 m) with a fairly dense weed cover in the summer months. Although there are a few large rocks, the edges are marshy, and the pond has no through drainage.

All four ponds are acidic with pHs ranging from 5.0 to 5.9. At the time of sampling (summer period) the water temperatures were closely related to the ambient air temperature, and there was evidence of temperature stratification, with lower temperatures in the deeper parts of the Quarry pool and Rocket Pole pond. Light penetrates furthest in the clearer Quarry Pool and the shallower Quarterwall pond 1, whereas light penetration is poor in Rocket Pole pond which frequently has dense algal blooms in the summer. The surface waters of all four ponds appear to be well-oxygenated, but in both 1979 and 1986 the oxygen content dropped off markedly in the deeper regions of Quarry Pool and Rocket Pole pond.

Ten different **plant species** are found growing in

Table 3 Relative abundance (Domin scale) of plant species at the four ponds

Species	Quarry Pool	Rocket Pole pond	Quarterwall 1	Quarterwall 2
Fontinalis sp	4	–	–	–
Juncus effusus L.	4	4	4	9
Eleocharis palustris L.	4	7	9	4
Potamogeton polygonifolius (Pourret)	8	–	4	10
Hydrocotyle vulgaris L.	–	6	9	3
Callitriche sp	3	–	–	–
Peplis portula L.	3	–	7	8
Myosotis scorpioides L.	–	–	2	6
Anagallis tenella (L)	–	–	–	2
Ranunculus flammula L.	5	–	–	2
Total number of Species	**7**	**3**	**6**	**8**

the ponds with the most diverse flora occurring in the small Quarterwall pond 2 (Table 3). Rocket Pole pond contained the lowest numbers of plant species in both 1979 and 1986. Quarterwall pond 2 is normally completely covered with vegetation in the summer with no open water present. Quarry Pool possesses some reasonably-sized plant beds, but the least vegetation cover occurs in the Quarterwall 1 and Rocket Pole ponds that both have large stretches of open water.

Two rushes, the Soft Rush *Juncus effusus* and the Common Spike Rush *Eleocharis palustris* occur at the margins of all of the ponds, with *Juncus* being particularly abundant at Quarterwall pond 2 where it almost surrounds the whole pond. The bog pondweed *Potamogeton polygonifolius* completely dominates the small Quarterwall pond 2 and is also fairly abundant

in the Quarry Pool. It is a plant characteristic of upland oligotrophic acidic waters, and there is evidence that it prefers sheltered conditions, and this may be a reason for its absence from the more exposed Rocket Pole pond.

The absence of the Marsh Pennywort *Hydrocotyle vulgaris* from the Quarry Pool may be due to the depth of the water and the lack of muddy regions in this pond. The Water Purslane *Peplis portula* is another plant restricted by depth, and this may explain its absence from Rocket Pole pond and its occurrence only in the shallow muddy area near the outflow of the Quarry Pool.

Plankton samples taken in 1979 and 1986 show that the Rocket Pole pond is very eutrophic with blooms of blue-green algae (*Microcystis, Arthrospira*) frequently occurring. This pond is used by birds, and their droppings obviously contribute nutrient to the water, thus allowing these 'pea-soup blooms' to develop. Evidence of eutrophy in the summer is also seen in the larger Quarterwall pond which is used by cattle and ponies: fairly large populations of filamentous and green algae and the desmid *Closterium* frequently occur in this pond.

Cyclopoid copepods are present in all the ponds, but appear to be particularly abundant in the larger Quarterwall pond and Quarry Pool where they dominate the zooplankton. Calanoid copepods, which are common in mainland ponds, appear to be absent on Lundy. Cladocera are reasonably abundant in the weedy Quarterwall pond and species of Rotifera are found in the open water of the other three ponds.

Macroinvertebrates found in the four ponds are listed in Table 4. The small pond at Quarterwall (Quarterwall pond 2) possesses the greatest diversity and numbers of macroinvertebrates, due mainly to the prolific plant growth in this pond. Very large numbers of the isopod crustacean *Asellus meridianus*, occur here where the decaying vegetation provides an ideal habitat for this detritus-feeding animal.

The large Quarterwall pond with its open water, appears to be an excellent habitat for water boatmen (Hemiptera) and beetles (Coleoptera) which dominate in this pond, while the sheltered waters of the Quarry Pool provide suitable conditions for the surface-dwelling forms, pond skaters (*Gerris*) and whirligig beetles (*Gyrinus*), whose presence demonstrate the importance of exposure as an environmental factor in pond ecology. The Rocket Pole pond has the smallest number of species and organisms probably due to the recurring blooms of blue-green algae which occur there.

The bottom sediments of the ponds are not rich in animal species, and only two groups are represented in all four ponds: oligochaete worms and red chironomid larvae, both tolerant of low oxygen conditions. In 1986 the pea-mussel *Pisidium*, not previously recorded, was found in the smaller pond at Quarterwall.

There have been no detailed surveys of fish in the ponds. Golden carp *Carassius auratus* are often

Table 4 Species and numbers of macroinvertebrates in the plant beds and openwater of the four ponds (Abundance scale as in Pondsbury data)

Species	Quarry	Rocket Pole	QW1	QW2
ANNELIDA				
Lumbriculus variegatus (Müller)	---	---	2	2
CRUSTACEA				
Daphnia obtusa Kurz	---	2	---	2
Simocephalus vetulus (Müller)	---	---	---	2
Harpacticoid copepods	---	---	---	1
Asellus meridianus Racovitza	2	1	3	5
ARACHNIDA				
Hygrobatid mite	---	---	---	2
INSECTA				
Cloeon dipterum (L.)	---	1	---	2
Ischnura elegans (Van de Linden)	1	1	---	1
Sympetrum striolatum (Charpentier)	1	---	---	---
Gerris gibbifer Schum.	2	---	2	---
Notonecta obliqua Thunb.	---	---	2	2
Corixa panzeri (Fieb)	---	---	3	---
Callicorixa praeusta (Fieb.)	---	---	2	---
Sigara nigrolineata (Fieb.)	---	---	1	---
Immature corixids	---	1	2	2
Gyrinus substriatus Stephens	2	---	---	---
Hydroporus pubescens (Gyllenhal)	---	---	----	1
Ilybius quadriguttatus L	1	---	1	2
Dytiscid larvae	2	---	2	1
Helophorus grandis Illiger	---	---	---	2
Limnephilus vittatus (Fieb.)	---	---	2	1
Chironomid larva	1	2	3	2
MOLLUSCA				
Lymnaea truncatula (Muller)	---	---	---	1
TOTAL NUMBER OF SPECIES/GROUPS	**8**	**6**	**12**	**17**

observed in Quarry Pool (over 100 in 1986) and Crucian carp *Carassius carassius* have also been recorded in this pond. A very large population of the mirror carp *Cyprinus carpio* occurs in the Rocket Pole pond (George 1981), and it is difficult to see how this pond with its sparse macroinvertebrate fauna and plant life can support these fish. Feeding by visitors in the summer and cannibalism of the young forms are probably contributing factors to the apparent success of this population.

Streams

Only one major survey, by Long in the summer of 1993, has been carried out on the Lundy streams. He examined the water quality and macroinvertebrate composition of six streams, four on the west side of the island and two on the east side (Fig.1).

Various physico-chemical parameters were measured, such as flow/discharge, dissolved oxygen, temperature, pH, hardness, conductivity, suspended solids, Biochemical Oxygen Demand, and these together with macroinvertebrate data were used to assess water quality. The Extence method of classifying streams into 'Excellent' to 'Unsuitable' (Extence *et al* 1987) showed that four of the streams (West 2, 3, 4 and East 2) are in the 'Good' category and that West 1 and East 1 are classified as 'Moderate'. The pH of the streams ranges from 4 – 6, and all are poor in nutrients. There is no evidence of organic pollution that may result from livestock farming; however, the lower

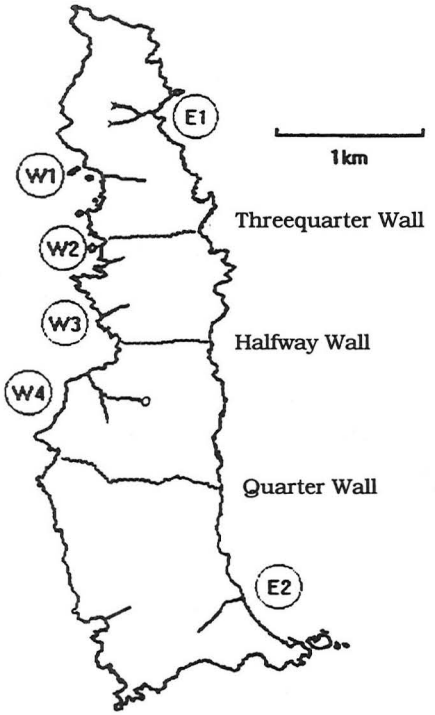

Figure 1 Location of streams (after Long 1993a)

W1 – St. Peter's Shore Stream	MR 1333 4697
W2 – St. Marks Bay stream	MR 1329 4634
W3 – Pyramid stream	MR 1330 4609
W4 - Punchbowl stream	MR 1318 4548
E1 – Gannets Bay stream	MR 1332 4570
E2 – St. John's stream	MR 1385 4384

Table 5 Summary of macroinvertebrate sampling data from the streams

	E1	E2	W1	W2	W3	W4
TRICHOPTERA						
Beraeidae	---	*	---	---	---	---
Hydroptilidae	---	---	---	*	*	*
Limnephilidae	---	*	---	---	---	---
Philopotamidae	---	*	---	*	---	*
Polycentropodidae	*	*	*	*	*	*
Psychomyidae	---	*	*	*	*	---
DIPTERA						
Ceratapogonidae	*	---	---	*	*	---
Chironomidae	*	*	*	*	*	*
Culicidae	---	*	---	---	---	---
Dixidae	---	*	---	---	---	---
Psychodidae	---	*	---	---	---	---
Simulidae	*	*	---	*	*	*
Tipulidae	*	*	*	*	*	*
COLEOPTERA						
Dryopidae	---	---	*	*	*	---
Dytiscidae	---	*	---	---	---	---
Elmidae	*	---	---	---	---	---
Hydrophilidae	---	*	*	*	*	*
Hygrobiidae	---	---	---	---	---	*

	E1	E2	W1	W2	W3	W4
HEMIPTERA						
Corixidae	---	---	---	---	*	*
Veliidae	*	*	---	---	---	*
CRUSTACEA						
Asellidae	*	*	*	*	*	*
Crangonictidae	---	---	---	*	---	*
Cyprididae	---	*	---	*	*	---
Gammaridae	---	---	---	---	*	*
MOLLUSCA						
Hydrobiidae	---	*	*	*	*	*
Lymnaeidae	---	*	*	*	---	---
Sphaeriidae	---	*	*	*	---	---
OLIGOCHAETA	*	*	*	*	*	*
HIRUDINEA	---	---	---	*	---	---
HYDROZOA	---	---	*	*	---	---
PLATYHELMINTHES	---	*	---	---	---	*

KEY * PRESENT --- ABSENT (After Long 1993a&b)

half of St. John's stream (East 2) appears to be influenced on occasions by organic pollution of domestic origin.

In terms of **flora**, samples of Bryophytes were collected by Long along the length of each stream, but there was no attempt at quantitative assessment. Four species were present in all six streams: *Pellia epiphylla, Scapania undulata, Fontinalis antipyretica* and *Sphagnum* sp.

Samples of **plankton** taken at each stream's point of discharge with a FBA plankton net (0.96 mm mesh) show that there is a reasonable plankton community present with the copepod *Cyclops* and cladoceran *Daphia* predominating. A more diverse community appears to exist in the streams that have large areas of bogland in their catchments, such as Punchbowl Stream (West 4).

The comprehensive **macroinvertebrate** survey undertaken by Long (1993a & b) shows that different groups occur in different streams on the island. However, Dipteran and Trichopteran larvae are dominant in all six streams with the midge (Chironomid) larvae and the net-spinning caddis (Polycentropid) larvae families being particularly abundant. Table 5 shows the main families present in the six streams.

Molluscs are fairly prominent in the streams with the exception of the Gannets Bay stream (East 1). Hydrobiids are very abundant in St. John's stream (East 2), and the Pyramid stream (West 3). Two species of crustaceans that are commonly found on small islands, *Asellus meridianus* and *Gammarus duebeni*, are dominant members of the community.

St. John's stream (East 2) has the greatest diversity and the greatest abundance of macroinvertebrates. It is a stream that rarely dries up, and obviously provides a fairly stable environment for its fauna. It rates as 'good' on the Extence water quality scale and has a near neutral pH.

As Long points out, the fauna of the Lundy streams is impoverished when compared to similar streams on the mainland, with the mayflies (Ephemeroptera) and the stone-flies (Plecoptera) notable absentees. Adult stone-flies (and mayflies to a lesser extent) are however weak fliers and may not be able to reach Lundy from the mainland. One mayfly larva *Cloeon dipterum*, found in running waters on the mainland, has been recorded in the ponds (1979, 1986, 1993) suggesting that the short steep streams on Lundy are not a suitable habitat.

On Lundy, the main factor affecting the survival of freshwater macroinvertebrates is the periodic drying up of streams (excluding St. John's). Some organisms have mechanisms for withstanding drought conditions, and there is obviously colonisation from other habitats on the island, such as Pondsbury and St. John's stream, when favourable conditions return.

Irving, RA, Schofield, AJ and Webster, CJ. Island Studies (1997). Bideford: Lundy Field Society

Conclusions

The flora and macroinvertebrate fauna of the Lundy freshwater habitats is fairly typical of acidic waters on the mainland. There appear to be no endemic species or varieties present, which indicates a fairly frequent renewal of organisms from the mainland. Overall, however, the fauna is impoverished compared to mainland waters, but the isolation of Lundy is probably not a major limiting factor. An important environmental factor affecting the habitats is drought, with most of the streams and several of the ponds (including Pondsbury) drying up in past years. Research in Pondsbury over fourteen years shows a remarkable stability in the composition of the flora and fauna in spite of the periodic dredging and drought that have occurred. True holoaquatic organisms, that are unable to leave the water, such as Crustacea and Oligochaeta, are able to survive periods of desiccation by encystment or production of resistant eggs. Others, such as insect larvae and molluscs, can aestivate in the bottom sediments until favourable conditions return.

The ponds and streams do display interesting differences in their flora and fauna, and these can be related to factors such as position and exposure, water chemistry, vegetation cover, amount of decaying matter present and algal blooms.

The study of Lundy's freshwater habitats provides valuable information on the composition and evolution of small island flora and fauna. Unfortunately, there have only been two major surveys of the ponds (1979, 1993) and only one of the streams (1993) in the past 50 years, all of which have been in the summer months. In future years more survey work is required at different times of the year so that the nature and evolution of the island's freshwater flora and fauna can be discussed with confidence.

References

Alexander, K N A, 1991. The Hemiptera of Lundy. *Annual Report of the Lundy Field Society* 42, 101-105.

Baillie, C C, and Rogers, M, & W, 1976. Sizes and ages of some Crucian carp on Lundy. *Annual Report of the Lundy Field Society* 27, 65-66.

Brendell, M, 1975. Coleoptera of Lundy. *Annual Report of the Lundy Field Society* 26, 29-53.

Clabburn, P A T, 1993a. *Pondsbury, Lundy Island: the study of an acid pool*. Unpublished MSc thesis. University of Cardiff.

Clabburn, P A T, 1993b. Freshwater Biological Survey of Lundy 1993: Further studies of the fauna of Pondsbury. *Annual Report of the Lundy Field Society* 44, 73-83.

Extence, C A, Bates, A J, Forbes, W J, & Barham, P J, 1987. Biologically based water quality management. *Environmental Pollution* 45, 221-236.

Fraser-Bastow, R, 1949. Freshwater Diatom Flora. *Annual Report of the Lundy Field Society* 3, 32-41.

Galliford, A L, 1953. Notes on the freshwater organisms of Lundy with especial reference to the Crustacea and Rotifera. *Annual Report of the Lundy Field Society* 7, 29-35.

George, J J, 1981. The mirror carp, *Cyprinus carpio*, of the Rocket Pole pond. *Annual Report of the Lundy Field Society* 32, 38– 39.

George, J J, and Sheridan, S P, 1986. Further investigations of the flora and fauna of the Lundy freshwater habitats. *Annual Report of the Lundy Field Society* 37, 35-46.

George, J J, and Stone, B M, 1979. The flora and fauna of Pondsbury. *Annual Report of the Lundy Field Society* 30, 20-31.

George, J J, and Stone, B M, 1980. A comparative investigation of the freshwater flora and fauna of the Lundy ponds. *Annual Report of the Lundy Field Society* 31, 19-34.

Lane, R P, 1977. The Diptera (two-winged flies) of Lundy Island. *Annual Report of the Lundy Field Society* 28, 15-31.

Langham, A F, 1968. Water courses and reservoirs on Lundy. *Annual Report of the Lundy Field Society* 19, 36-39.

Long, P S, 1993a. *A study into the effects of water quality, climate, and geographical isolation on the lotic environment of Lundy Island in the Bristol Channel*. Unpublished MSc thesis, University of Cardiff.

Long, P S, 1993b. A study into the macroinvertebrate fauna and water quality of Lundy Island's lotic environment. *Annual Report of the Lundy Field Society* 44, 59-72.

Williams, W D, 1962. The geographical distribution of the isopods *Asellus aquaticus (L.) and Asellus meridianus* Rac. *Proceedings of the Zoological Society of London* 139, 75-96.

Williams, W D, 1979. The distribution of *Asellus aquaticus* and *A. meridianus* (Crustacea, Isopoda) in Britain. *Freshwater Biology* 9, 491-501.

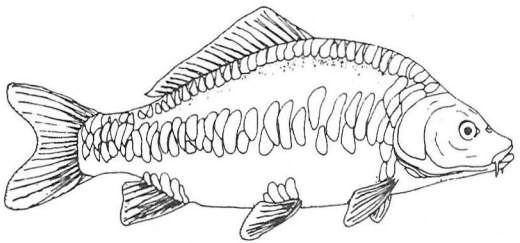

Plate 30 View of Pondsbury in August 1979

FRESHWATER HABITATS OF LUNDY — JENNIFER J GEORGE

Plate 31 The Rocket Pole pond

FRESHWATER HABITATS OF LUNDY — JENNIFER J GEORGE

Plate 32 View of the larger pond at Quarter Wall

FRESHWATER HABITATS OF LUNDY — JENNIFER J GEORGE

Plate 33 The Quarry Pool in June 1996

FRESHWATER HABITATS OF LUNDY — JENNIFER J GEORGE