FRESHWATER BIOLOGICAL SURVEY OF LUNDY, 1993 : FURTHER STUDIES OF THE FAUNA OF PONDSBURY

By

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INTRODUCTION

Until the work carried out by J. George and her co-workers in the late 1970s and 1980s only a handful of very specialised aspects of the freshwater habitats of Lundy had been studied, namely; Diatoms (Fraser-Bastow, 1949), aquatic Hemiptera (Morgan et al. 1947), Crustacea and Rotifera (Galliford, 1953) and *Asellus meridianus* (Williams, 1962). George's work (George, 1978; George & Stone, 1979; George & Stone 1980; George & Sheridan, 1987) provided a very good and much needed introduction to the freshwater habitats of the island.

In July and August 1993 two further investigations were carried out on Lundy's freshwater habitats by P.A.T. Clabburn and P.S. Long. The work was carried out in part fulfilment of an MSc. in Applied Hydrobiology at the University of Wales, College of Cardiff. These projects provide up to date coverage of Lundy's freshwater streams (see P.S. Long's paper in this journal) and of the biology of Pondsbury.

The aims of this survey were to carry out a comprehensive study of the flora and fauna of the pond, and as such are too broad to be covered in this paper. This paper concentrates on a major aspect of the project, namely the relationship between the location and physico-chemical nature of the pond and its macro-invertebrate fauna. Pondsbury has since been dredged over a third of its area thereby making this study a useful baseline for the assessment of the impact of this operation on the pond ecosystem.

Pondsbury is the major freshwater feature on Lundy and forms the largest area of standing water on the island. It is situated at the island's centre and is surrounded by *Sphagnum* bog, heathland and rough grazing. Pondsbury would appear to be of natural origin, although damming by man has expanded its size and increased its depth.

Pondsbury receives water in the form of surface run-off from surrounding land. This run-off is concentrated somewhat in the north-east and south-west of the pond. In wet weather the marshy area of the north-east inlet can extend away from the pond by as much as 100 metres. When full a through flow of water is maintained via an outlet situated midway along the dam. This outlet forms Punchbowl stream which flows into the sea at Jenny's Cove. In dry weather the size of Pondsbury can become much reduced. Even a short dry spell is often sufficient to lower the levels so that there is no outflow. In periods of drought (e.g. 1976) Pondsbury can dry out completely.

MATERIALS AND METHODS

a. PHYSICO-CHEMICAL SURVEY

1. Physical survey: an accurate mapping of the ponds' shoreline and the outline of the seres was achieved using a theodolite and staff and sighting compass. A depth survey of the pond was carried out, taking depth readings at 5 metre intervals from a rubber inflatable dinghy.
2. Chemical survey: Six sample sites were chosen for the analysis of chemical parameters. These were selected on the basis of being sites that best represent the conditions in the pond. Parameters recorded are as follows: total hardness, pH, and

conductivity.
Total Hardness: water samples were taken in 800ml. polythene bottles at the water surface and at 20cm depth intervals at each of the six sites. Hardness of water is largely due to the presence of dissolved calcium and magnesium ions. Analysis for these ions was carried out in the Cardiff laboratory by titration with standardised EDTA at pH 10, using metallochromic indicator.
pH: pH readings were taken at 20 cm depth intervals at each of the six sample sites using a Whatman PHA300 pH meter, standardised to pH 4.
Conductivity: conductivity readings were taken at each site, again at 20 cm depth intervals, using a Whatman CDM270 conductivity meter.
Temperature and Dissolved Oxygen: these parameters were recorded together using pHOX Type 67 temperature and dissolved oxygen meter. This apparatus continually records the parameters and so provides valuable information as to the fluctuations of these variables over time. Two sites were used, site 1 in the north-east and site 2 in the south-west of the pond.

b. MACRO-INVERTEBRATE SAMPLING

Two methods were used to sample the invertebrate population of the pond; sweep netting and grab sampling. Sweep netting was used to sample beds of vegetation around the pond and also the vegetation off one of the seres. Grab sampling was used to sample organisms from the sediment. Preliminary sweeps and grabs suggested that the vegetation contained a more diverse fauna than the sediments. For this reason more sampling effort was put into sweep sampling than grab sampling, since this would yield more information into the fauna of the pond.

1. Sweep sampling: this sampling was carried out on ten sites around the shore and on one off a sere in the south west corner of the pond. Of these sites ten were in areas of vegetation and one over bare substrate. Sampling at each of the sites was carried OUT using a standard IFE dip net (mesh aperture 0.96mm), for a period of two minutes. After sieving the samples were placed in 800ml. polythene bottles for final sorting and identification in the laboratory. Identification of macro-invertebrates was carried out using the following keys; Platyhelminthes, Reynoldson (1978); Mollusca, Ellis (1978); Oligochaeta, Brinkhurst (1971); Hirudinea, Elliot and Mann (1979); Crustacea, Gledhill, Sutcliffe and Williams (1976); Odonata, Askew (1988); Hemiptera, Savage (1989); Chironomidae, Wiederholm (1983); Coleoptera, Richoux (1982) and Friday (1988). Use was also made of the bivalve collection at the National Museum of Wales, Cardiff, for confirmation of *Pisidium* identification.

Previous workers on Pondsbury (George & Stone, 1980 and George & Sheridan, 1986) have employed one five minute sweep sample per study. Due to the extremely dense nature of vegetation in some of the sites used in this study the sample time for each site was reduced to a period of two minutes. Longer sampling times led to the net becoming clogged causing inconsistent sampling.

2. Grab sampling: this technique was used to sample organisms in the top layers of the sediment from eight sites around the pond bed. The grab sampled an area of 196cm^2, therefore results of the samples were multiplied up by a factor of 51; invertebrate numbers being expressed as individuals per square metre. Care was taken to ensure that a similar volume of substrate was sampled at each site. This was achieved by sampling the firmer sediments first, assessing the extent to which the grab entered the sediment and using this as a guide for the sampling of softer sediments.

RESULTS

a. PHYSICO-CHEMICAL SURVEY

1. Physical survey: Pondsbury covers an area of approximately 3900 m^2 of which approximately 3600m^2, or 92%, is open water. The remaining 8%, or 300m^2, is made up primarily by seres and to a lesser extent by areas that have become silted up. Pondsbury is a shallow pool, with an average depth of fifty-five centimetres and a maximum depth of only 120cm. This depth was recorded in the northern part of the pond, where four other depth readings were of one metre or more. To the west and the south the pond becomes progressively shallower.

2. Chemical Survey

A summary of the analysis of total hardness, pH and conductivity for each site are shown in Table 1.

Table 1: Results of Chemical Survey

Variable	Min	Mean	Max
Total Hardness (mgl-1)	7.5	9.4	11.5
pH	4.6	4.82	5.13
Conductivity (μ5)	420	430.2	439

Temperature and Dissolved Oxygen

Temperature and dissolved oxygen were recorded at two sites over 24 hour periods for three different depths at each site. Summaries of this data is shown below.

Table 2: Pondsbury Temperatures (°c): summary

Site	C1			C6		
Depth	**20**	**40**	**50**	**20**	**30**	**40**
Max	18.0	23.0	17.0	19.0	18.5	18.0
Mean	14.4	18.3	14.5	13.3	15.2	12.3
Min	11.0	15.0	12.0	11.0	13.0	9.0

Table 3: Dissolved Oxygen (% saturation): summary

Site	C1			C6		
Depth	**20**	**40**	**50**	**20**	**30**	**40**
Max	88.0	82.0	83.0	100	98.0	64.0
Mean	76.9	66.4	54.4	91.1	77.2	19.9
Min	62.0	56.0	2.0	82.0	58.0	0

Diel fluctuations of the variables at each depth are shown in Figures 1 to 6.

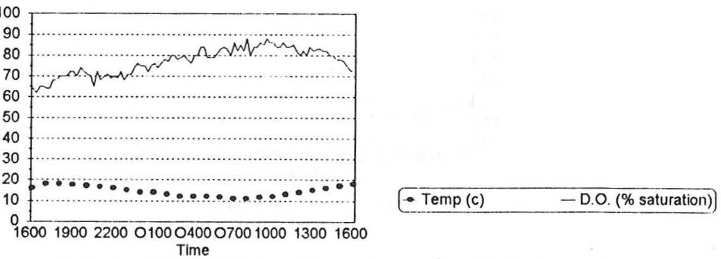

Figure 1: 24 Hour Fluctuations of Temperature & Dissolved Oxygen.

Site 1. 20 cm.

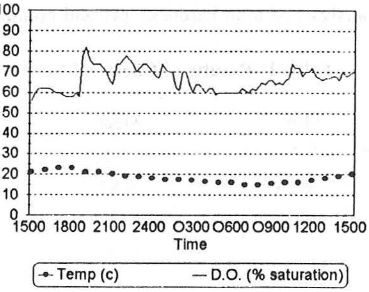

Figure 2: 24 Hour Fluctuations of Temperature & Dissolved Oxygen.

Site 1. 40cm.

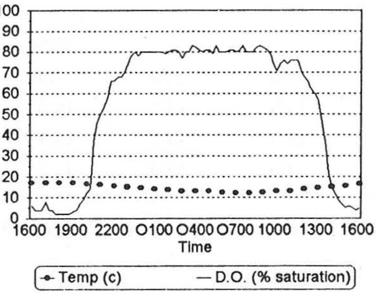

Figure 3: 24 Hour Fluctuations of Temperature & Dissolved Oxygen.

Site 1. 60cm.

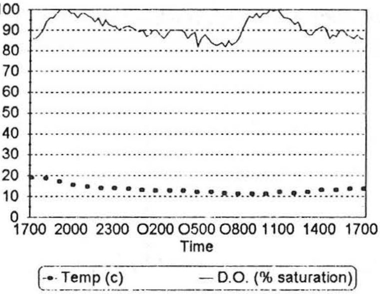

Figure 4: 24 Hour Fluctuations of Temperature & Dissolved Oxygen

Site 2. 20cm.

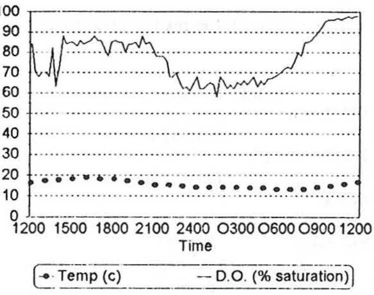

Figure 5: 24 Hour Fluctuations of Temperature & Dissolved Oxygen.

Site 2. 30cm.

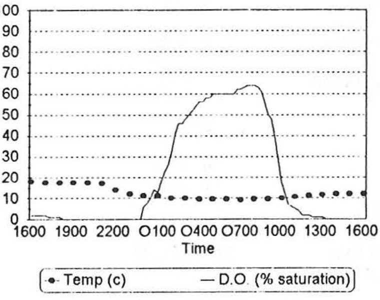

Figure 6: 24 Hour Fluctuations of Temperature & Dissolved Oxygen

Site 2. 40cm.

At both sites the fluctuations in dissolved oxygen increase with increasing depth, especially so at site 1, with a fluctuation of 81% saturation. Mid-depth readings at both sites show a similar pattern with high saturations in the late afternoon being followed by lower readings overnight. Surface readings are both higher and less extreme at each site.

The temperature readings also vary with depth; mid-depth readings being lower than surface or bottom readings.

b. MACRO-INVERTEBRATE SURVEY

1. Sweep Samples: A total of 35 macro-invertebrate species were identified in the sweep samples. A further nine were identified down to generic level. Only one species, *Asellus meridianus,* was recorded in every sample. It was also the most abundant of the species in the sweep samples. Other widespread groups are the Hemiptera and Chironomidae, both of which were recorded at all of the sweep sample sites.

2. Grab Samples: Six macro-invertebrate species were recorded in the grab samples, with a further two being identified to generic level. Only *Limnodrilus hoffmeisteri* is unique to the grab samples. No species or group was recorded in all of the grab samples. *Pisidium personatum* is the most abundant species found in the grab samples despite not being the most widespread.

Results of the macro-invertebrate sampling are shown in Table 4.

Table 4: Macro-invertebrates recorded from Pondsbury.

	Sweep Samples **No. individuals** : Av./ sweep	Grab Samples **No. individuals**: Av./ sq.m
PLATYHELMINTHES: TRICLADIA		
Polycelis nigra (Müller)	**358** : 32.5	**51** : 6.38
MOLLUSCA: LAMELLIBRANCHIATA		
Pisidium personatum Malm	**189** : 17.2	**5508** : 688.5
ANNELIDA: OLIGOCHAETA		
NAIDIDAE:		
Vejdovskyella comata (Vejdovsky)	**3** : 0.27	
TUBIFICIDAE:		
Peloscolex ferox (Eisen)	**3** : 0.27	
Limnodrilus hoffmeisteri Claparède		**204** : 25.5
Tubifex tubifex Claparède	**6** : 0.55	
LUMBRICULIDAE:		
Lumbriculus variegatus (Müller)	**225** : 20.45	**1275** : 159.38
ANNELIDA: HIRUDINEA		
GLOSSOPHONIDAE:		
Helobdella stagnalis (Linn)	**1** : 0.09	
HIRUDINIDAE:		
Haemopsis sanguisaga (Linn)	**1** : 0.09	
ARTHROPODA: ARACHNIDA		
ARANEAE:		
Argyroneta aquatica L.	**21** : 1.9	
HYDRACARINA:		
Arrenurus cuspidifer	**9** : 0.82	
Hydrachna sp.	**1** : 0.09	
CRUSTACEA: ISOPODA		
ASELLIDAE:		
Asellus meridianus Racovitza	**5902** : 536.55	**5455** : 681.88
INSECTA: EPHEMEROPTERA		
BAETIDAE:		
Cloeon dipterum L.	**2** : 0.18	
INSECTA: ODONATA		
ANSIOPTERA:		
Sympetrum striolatum (Charpentier)	**17** : 1.55	
ZYGOPTERA:		
Enallagma cyathigerum (Charp.)	**18** : 1.64	
INSECTA: HEMIPTERA		
NOTONECTIDAE:		
Notonecta glauca L.	**1** : 0.09	
Notonecta marmorea viridis (Delcourt)	**30** : 2.73	
Notonecta obliqua	**8** : 0.73	
Notonecta maculata (Fabricius)	**3** : 0.09	
Notonecta sp. nymphs	**45** : 4.1	**51** : 4.375
PLEIDAE;		
Plea leachii (McGregor & Kirkaldy)	**10** : 0.91	
CORIXIDAE:		
Cymatia bonsdorffi (Sahlberg)	**24** : 2.18	
Cymatia coleoptrata (Fabricius)	**3** : 0.27	
Cymatianiae nymphs	**55** : 5 .	
Glaenocorisa propinqua propinqua (Fieber)	**3** : 0.27	
Callicorixa praeusta (Fieber)	**8** : 0.73	
Corixa punctata (Illiger)	**66** : 6 .	
Hespercorixa linnaei (Fieber)	**1** : 0.09	

	Sweep Samples No. individuals : Av./ sweep	Grab Samples No. individuals: Av./ m^2
Sigara dorsalis (Leach)	**7** : 0.64	
Sigara distincta (Fieber)	**3** : 0.27	
Sigara selecta (Fieber)	**1** : 0.09	
INSECTA: CHIRONOMIDAE		
TANYPODINAE:	**330** : 30	
*Clinotanypus** (Kieffer)		
Macropelopia *(Thienemann)		
*Procladius** (Skuse)		
*Ablabesmyia** (Johannsen)		
CHIRONOMINAE:	**171** : 15.55	
*Micropsectra** (Kieffer)		
*Glyptotendipes** (Kieffer)		
INSECTA: COLEOPTERA		
HYGROBIDAE:		
Hygrobia hermanni (Fab.) adult	**2** : 0.18	
Hygrobia hermanni (Fab.) larvae	**2** : 0.18	
DYTISCIDAE:		
Agabus bipustulatus L. (adult)	**10** : 0.91	
Agabus sp. (larvae)	**8** : 0.73	
Laccophilus minutus L.	**9** : 0.82	
Hygrotus inequalis (Fab.) adult	**16** : 1.45	
Hygrotus sp. (larvae)	**40** : 3.64	
Hydroporous pubescens (Gyllenhal) adult	**1** : 0.09	
Hydroporous pubescens (Gyllenhal) larva	**3** : 0.27	
HYDROPHILIDAE:		
Hydrobius fuscipes L.	**1** : 0.09	

* these Chironomid groups have been identified, but to identify all chironomids to this level for all samples was too time consuming, therefore these groups have not been quantified.
** numerous empty Trichoptera cases were also recorded in both the sweep samples and the grabs but are not recorded here.

DISCUSSION

The water chemistry of Pondsbury is determined largely by the catchment geology. Lundy is of volcanic origin and is composed primarily of Tertiary granite. A mean total hardness of 9.4 mgl^{-1} classifies Pondsbury as a 'soft' water body. This figure is a direct reflection of the small and slow release of calcium and magnesium ions from igneous rock. In addition the precipitation of phosphates, such as magnesium phosphate, due to the low pH, takes magnesium ions out of the water thereby adding to its softness. The acidic nature of the pond's water is also due largely to the igneous catchment. Rainwater is naturally acidic and when it falls on a catchment such as Pondsbury's, with a low buffering capacity, it remains acidic. This acidity is sustained and enhanced by *Sphagnum* mosses. *Sphagnum* is able to achieve this by its ability to bind cations and release hydrogen ions in their place. The widespread and luxuriant growth of these mosses in Pondsbury therefore have a profound effect on its water chemistry.

Normally the hardness of a water is closely related to its conductivity. The conductance reflects the levels of calcium, magnesium, sodium, potassium and chloride ions. However, unlike the low levels total hardness the conductivity levels of Pondsbury are surprisingly high. This apparent anomaly could be due to the proximity of the pond to the sea. During windy weather the pond is swept by sea spray, which has high levels of sodium and chloride ions; thus causing the high conductivity of the pond's water.

As with the study by George and Stone (1979) maximum dissolved oxygen levels are to be found nearer to the pond's surface. However unlike their work periods of de-oxygenation were recorded above the sediment. The pHOX readouts from these levels

(Figs 1-6) show considerable fluctuations in dissolved oxygen levels. These fluctuations are the opposite to what would be expected i.e. oxygen levels sagging at night as plants start to use up oxygen in respiration. The most plausible explanation for the increase in oxygen levels over the sediment at night is a daily overturn of the pond water due to wind. Due to its shallowness and in calm conditions Pondsbury may stratify daily, causing the water over the sediments to de-oxygenate. If a wind of sufficient strength were to develop overturn would occur and oxygen rich water would reach the sediments. On an island, during calm conditions, such a wind could develop in the evening as the island cools.

The fauna of Pondsbury is influenced by the water chemistry of the pond, the degree of isolation of Lundy and also the periodic drying of the pond. In discussing the macro-invertebrate fauna of Pondsbury it is important to consider which of these factors has the major limiting effect, or indeed if a combination of these factors is in operation. To achieve this it is necessary to examine the water quality preferences, powers of dispersal and life cycle of the organisms present. It is also necessary to point out whether there are any notable absentees from the fauna and to decide whether their absence is attributable to any of the above factors.

The isolation of Lundy would appear to have an influence on the macro-invertebrates recorded in Pondsbury. Many of the orders of aquatic macro-invertebrates are represented in the pond although some are only represented by a few individuals of a single species (e.g. Ephemeroptera is represented by *Cloeon dipterum*) whereas others are represented by many species (e.g. Hemiptera are represented by 14 species, Coleoptera by 6 species). The Hemiptera and Coleoptera species recorded in Pondsbury happen to be strong fliers in the adult stages (with perhaps the exception of *Plea leachii*). Therefore the isolation of Lundy would not appear to be a limiting factor for these groups. Isolation would not be an important factor concerning the colonisation of Lundy by the two species of Odonata recorded in Pondsbury as the flight powers of the Odonata are well known.

For those orders that have poor flying abilities then isolation may be an important factor. Ephemeroptera are only represented by a single species, which has been recorded in other freshwater habitats on the island (George and Stone, 1981). Likewise the absence of any Plecoptera is also likely to be due to isolation; adult Plecoptera are very reluctant fliers (Illies, 1955).

It would therefore appear, at first sight, that isolation plays an important part in determining the fauna of Pondsbury. I, however, do not consider it to be the case and suggest other factors may be more important. That Hemiptera and Coleoptera are the most diverse orders in Pondsbury cannot be solely due to their flight powers. Diverse populations of Hemiptera and Coleoptera happen to be characteristic of acid ponds (Jeffries & Mills, 1990), therefore their presence is probably more due to the water conditions. Additionally Pondsbury does support populations of holoaquatic organisms, having their entire life cycle in the water, that have been able to overcome Lundy's isolation.

Of the forty-eight species of British Ephemeroptera thirty occur predominantly in lotic environments. Therefore the number of species that could occur in Pondsbury is eighteen. This figure only takes into account the broadest habitat characterisation and is reduced even further when one considers water quality characteristics (Elliot et al. 1988). Of the species of Ephemeroptera that could colonise Pondsbury *Cloeon dipterum* is the most likely, due primarily to habitat preference. Pondsbury is a very stressful habitat in which to live. The water reaches quite high temperatures which in mid summer are likely to be higher than those recorded in this study. High water temperatures are lethal to many Ephemeroptera. *Cloeon dipterum*, however has a thermal index (the temperature at which 50% of individuals die in 24 hours) of 28.5 to 30.2^{o}c (Whitney, 1939) and is therefore more able to tolerate the thermal stresses of a shallow pond than are other species of Ephemeroptea..

Island isolation does not therefore seem to be the major factor limiting the fauna of Pondsbury. Organisms are more likely that are absent from the fauna due to the water chemistry and periodic drying than their inability to reach the island.

The fact that macro-invertebrates are recorded at all in Pondsbury is a measure of their tolerance to the prevailing water chemistry. Many of the species present could be said to be characteristic of an acid environment. Tolerance to acid pH is therefore an important precursor to the colonisation of this pond.

The water chemistry of Pondsbury does not seem to limit the macro-invertebrate orders that occur on Lundy; the major orders are represented here. In some instances it does, however, appear to limit which species from a certain order are present in Pondsbury. The best example of this is shown by the occurrence of *Polycelis nigra. P. nigra* is very similar to another species of planarian, *Polycelis tenuis*. In many places on the mainland their ranges overlap and it is probably reasonable to assume that both species had an equal chance of colonising Lundy. In a study carried out by Reynoldson (1958), *Polycelis nigra* was found to be more abundant than *P. tenuis* in waters with less than 7.5mgCa.l^{-1}. The mean total hardness of Pondsbury is 9.4mgl^{-1}. This figure is a measure of both magnesium and calcium salts, therefore the concentration of calcium is likely to be somewhat less than this figure suggests. It is possible that *P. nigra* is present on Lundy, rather than *P. tenuis* due to its tolerance of low calcium levels.

Similarly the presence of *Pisidium personatum* rather than *Pisidium subtruncatum*, which is found in the Quarterwall ponds (George and Sheriden 1987), may be due to differences in water quality between the ponds. Pondsbury has a considerably lower average pH than that of the Quarterwall ponds, 4.8 as opposed to 5.9. *P. personatum* has been quoted as being 'a molluscan slum-dweller...in unpromising habitats (it) may be the only bivalve present', (Ellis, 1978). It would appear that the physical and water chemistry characteristics of Pondsbury exclude any other bivalves.

Desiccation is a major threat to aquatic organisms, especially those that remain in the water all year round. Whilst adult stages of the Coleoptera and Hemiptera are able to simply fly away to avoid desiccation the larval stages and holoaquatic organisms do not have this capacity.

The importance of this to the fauna of Pondsbury is evident in the small number of holoaquatic organisms recorded in this survey. Only 12 such species were recorded. However behavioural and physiological adaptations ensure the survival of these holoaquatics in the event of Pondsbury drying up. Platyhelminthes and oligochaetes are able to survive periods of desiccation due to the production of drought resistant eggs and the production of resistant cysts. Leeches are able to survive as dehydrated individuals and some species are able to construct resistant mucous lined cocoons.

Other groups employ behavioural adaptations. Larval stages of many of the orders in this study (e.g. Odonata, Trichoptera, Coleoptera and Diptera) will bury into the exposed sediments and peat and aestivate (Jeffries and Mills, 1990). Hydracarina also undergo aestivation. Furthermore Hydracarina are able to attach to migrating insects and so they avoid desiccation. Similarly the molluscs are able to burrow into the sediment. Therefore *Pisidium* can withstand drought. *Asellus* too may be able to withstand periods when Pondsbury dries, by burrowing into the sediment. *Argyroneta aquatica* is physiologically identical to a terrestrial spider and so is probably able to withstand periods of drought. A review of the processes used to withstand drought can be found in Williams (1987).

The macro-invertebrate organisms in Pondsbury possess either physiological or behavioural adaptations that allow them to withstand the periodic drying up of their habitat. This indicates that desiccation is a major limiting factor to the fauna of this pond. No organisms were recorded that do not have one of these adaptations

Examination of the sweep and grab sample results immediately reveals an obvious feature of the faunal distribution. Far fewer species were recorded from the sediment grabs than from the sweep samples. This could merely be an effect of disproportionate sampling effort although some effect of habitat is probably also involved. Earlier studies also show that the macro-invertebrate fauna occurring in the sediments is less diverse than in the vegetation. This is due primarily to the higher diversity of micro-habitats in the beds of vegetation.

Conditions on the sediment are far more rigorous than those in the beds of vegetation. As can be seen from the data generated by the pHOX meter, deoxygenation occurs at certain times of the day over the sediment, therefore only organisms that are adapted to such conditions can exist here.

Comparisons between this survey and earlier works must be viewed with caution. Due to the length of time allowed for this study the invertebrate survey is more thorough, with a greater number of habitats being sampled. This means that organisms recorded in this study may have been present in the pond during earlier work, but were not sampled.

In the study of 1987 the fauna of Pondsbury was dominated by *Polycelis nigra* and *Asellus meridianus* (representing 46 and 42% of organisms sampled, respectively). Chironomids made up 8.6% of the sample, Annelids 6.3% and Hemiptera and Coleoptera

5% each. In this study the sweep samples are dominated by *Asellus meridianus* (~70%). Hemiptera make up 12% of the samples, Chironomids 6%, *Polycelis* 4% and Oligochaetes 3%. This could be an indication of a shift in dominance to *Asellus* although I feel that it is merely a more representative indication of population structure.

The timing of this sampling survey may be a further factor affecting the species compositions of the samples. Species with flying adult stages that coincide with the timing of this survey are likely to be under represented. *Cloeon dipterum* is a bivoltine species with a slow growing winter generation that is often followed by a rapidly growing summer generation (Brown, 1961). By late summer most adults have emerged and have laid or are in the process of laying eggs. The population of *Cloeon* is therefore reduced to tiny larvae and eggs. It is possible that these were missed in the sampling procedure. However to have only recorded two individuals suggests that the population in Pondsbury is small.

A similar situation occurs with the Trichoptera cases recorded in the pond. These were all empty, the adults having emerged before the study was carried out. It was therefore not possible to accurately identify the species although they all belonged to Limnephilids. *Limnnephilus vittatus* has been previously recorded in Pondsbury in abundance, so it is probable that those recorded in this survey are of this species. Due to the resistant nature of Limnephilid cases the numbers recorded in this study are a result of an accumulation over time and are thus an over representation of the population.

Since this work was completed a third of Pondsbury's area has been dredged. The dredged material has been used to heighten the dam that forms the western bank. On a visit to Lundy in the spring of 1994 I noticed that the surface area of the pond had been significantly increased, the depth too is also greater, up to 2 metres in the dredged areas. Further dredgings have been planned for the future. The effects of these operations are difficult to predict; however the results of this and of earlier studies will make it easier to ascertain any impacts should future studies on Pondsbury be carried out.

ACKNOWLEDGEMENTS

I would like to express my gratitude to the Lundy Field Society for financial assistance during my work on Lundy. Support from the National Environmental Research Council throughout my studies is also gratefully acknowledged. I would also like to thank Dr. Mike Learner at Cardiff for help with macro-invertebrate identification and for his comments and suggestions. I would like to thank Pete Long for all his help and company during the long nights in the Marisco. Finally I would like to thank all the people of Lundy who made my stay an enjoyable one.

REFERENCES

Askew, R.R. (1988) *The Dragonflies of Europe.* Harley Books.

Brinkhurst, R.O. (1971) *Aquatic Oligochaeta.* Freshwater Biological Association Scientific Publication. No. 22.

Brown, D.S. (1961) The life cycle of *Chloeon Dipterum* L. (Ephemeroptera: Baetidae). *Entomologist,* **94,** 114-120.

Elliot, J.M., Humpesch, U.H. & Macan, T.T. (1988) *Larvae of the British Ephemeroptera: A Key with Ecological Notes.* Freshwater Biological Association Scientific Publication. No.49.

Elliot, J.M., & Mann, K.H. (1979) *A Key to the British Freshwater Leeches.* Freshwater Biological Association Scientific Publication. No.40.

Ellis, A.E. (1978) *British Freshwater Bivalve Mollusca.* Linnean Society of London. Academic Press.

Fraser Bastow, R (1949) Lundy - Freshwater diatom flora. *Annual Report of the Lundy Field Society,* **3,** 32-41.

Friday. L.E. (1988) A key to the adults of British water beetles. *Field. Study*, **7**, 1-151.

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

George, J.J. (1978) The freshwater fauna of Lundy. *Annual Report of the Lundy Field Society*, **29**, 36-39.

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

George J.J, & 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.

George, J.J & Sheriden, S.P. (1987) Further investigations of the flora and fauna of the Lundy freshwater habitats. *Annual Report of the Lundy Field Society*, **37**, 35-46.

Gledhill, T., Sutcliffe, D.W. & Williams, W.D. (1976) *A Key to British Freshwater Crustacea Malacostraca.* Freshwater Biological Association Scientific Publication. No.32.

Illies, J. (1955) Die Bedeutung der Plecopteren für die Verbreitungsgeschichte der Süsswasserorganismen. *Mitteilungen Internationale Vereinigung Für theoretische und angewandte Limnolozie.* **12**, 643-653.

Jeffries, M. & Mills, D. (1990) *Freshwater Ecology.* Belhaven Press.

Morgan, H.G. et al. (1947) Aquatic habitats. *Annual Report of the Lundy Field Society*, **1**, 12-13.

Reynoldson, T.B. (1978) *A Key to the British Species of Freshwater Triclads.* Freshwater Biological Association Scientific Publication. No. 23.

Richoux, P. (1982). *Coléoptères Aquatiques.* Bulletin mensuel de la Société Linnéenne de Lyon 51e année no 4, 8 + 9 (extaits). Association Française de Limnologie.

Savage, A.A. (1989) *Adults of the British Aquatic Hemiptera Heteroptera.* Freshwater Biological Association Scientific Publication. No. 50.

Wiederholm, T. (1983) *Chironomidae of the Holarctic region, keys and diagnoses. Part 1: larvae.* Entomologica Scandinavica. Supp. No. 19.

Williams,D.D (1987) *The Ecology of Temporary Waters.* Croom Helm.

Whitney, R.J. (1939) The thermal resistance of mayfly nymphs from ponds and streams. *Journal of Experimental Biology*, **16**, 374-385.