Pondsbury and the old hotel reservoir. Other migrants passing through at this time include:—Redstart, Wheatear (including Greenland), Blackcap, Garden Warbler, Chiffchaff, Whitethroat, Goldcrest, Tree Pipit, Meadow Pipit, Skylark, Pied, Grey, and Yellow Wagtails, Scarlet Rosefinch, Wryneck, Hobby and Turtle Dove.

A Water Rail had returned to Millcombe where they often spend the winter.

Of the sea-birds there were many Fulmar still about the cliffs. Gannets were seen on most days feeding along the West coast and particularly in the tide races off Black Rock and Hen and Chickens.

The weather could only be described as "variable" and our visit really was full of interest. Lundy always shows something different every time one visits its hallowed shores. I would like to think that our "courses"—a forbidding term for such ornithological delights—will continue to be well supported. They do offer very real value and it is certainly one of the best ways to visit Lundy; that is if you can stand amusing company and the brilliant catering of Gill to whom we give our most sincere thanks.

DOMESTIC AND FERAL STOCK 1979

Goats	Only seven seen in December.
Soay	At least thirty counted.
Deer	Five are the most counted as a group, although singles are seen, the most observed at one time twenty-two in late May.
Rabbits	Still numerous, though we hope the trappers have given them a fright in the enclosed fields.
Cattle	One bull, 22 cows, five heifers, eighteen calves.
Sheep	Ten rams, 350 ewes. Despite the dreadful winter the lambs produced last year equalled the previous season, 100 lambs remain unsold.
Ponies	One stallion, ten mares, eight foals.

JOHN OGILVIE

THE FLORA AND FAUNA OF PONDSBURY

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INTRODUCTION

The freshwater ponds and streams of Lundy have been well documented by Langham (1968), but apart from some work on selected plant and animal groups (Morgan 1947, Fraser-Bastow 1949, Galliford 1953, Brendell 1975, Lane 1977) there has been no comprehensive investigation of their flora and fauna. A preliminary survey of Pondsbury and the two Quarterwall ponds (George 1978) indicated that the ponds supported different invertebrate populations both in terms of species and numbers of organisms.

In August 1979 the authors were given the opportunity (by Grants from the World Wildlife Fund and the Lundy Field Society) to carry out a comparative investigation of the main Lundy ponds. Organisms collected in this field survey are still being identified and only the results from Pondsbury are being presented here. Details of the complete survey will be given in the next Lundy Field Society Report and elsewhere.

Pondsbury (1345, 4545)

Pondsbury, which lies in a *Sphagnum* bog surrounded by *Juncus* beds, is the largest body of freshwater on the island (Plate 1). It is probably of natural origin although damming on the west side has increased its size and depth. It receives surface run-off from the surrounding land and has a stream flowing from it down the Punchbowl valley. During dry periods this fairly shallow pond becomes reduced in size and very occasionally dries up altogether (e.g. 1976).

The *aims* of the survey were as follows:

i To determine the plant species growing in and at the edges of the pond, and to investigate their distribution and abundance.

ii To examine the open water plankton community and to determine the species and numbers of invertebrates living in the pond vegetation and bottom mud.

Crucian carp, *Carassius carassius* L. are present in Pondsbury (Baillie & Rogers, 1976), but due to lack of time and suitable collecting equipment, no attempt was made to assess population numbers in this investigation.

PARAMETERS AND METHODS

1. Physical and Chemical

The following parameters were measured:—air, surface and bottom water temperature; pH (BDH Whatman pH papers); oxygen content of surface and bottom water (Winkler chemical method); turbidity (Secchi disc). A depth profile across the middle of the pond (south to north) was plotted (Fig. 1).

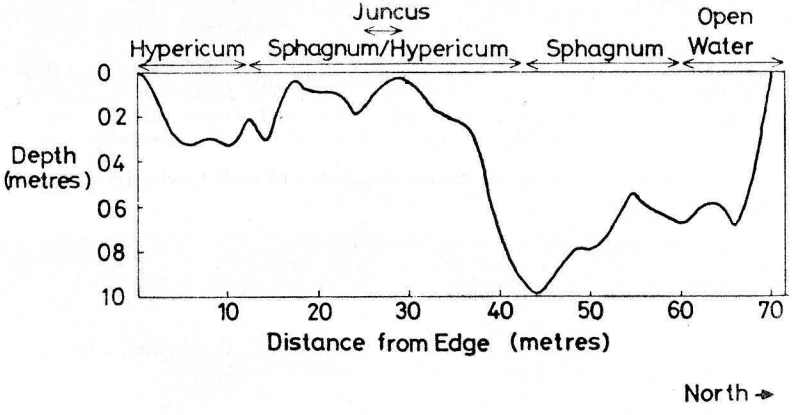

Fig. 1. *Depth profile across pond* (south to north)

2. Flora

(a) Qualitative Survey

A species list of plants within and around the pond was drawn up and note was taken of habit, i.e. floating, submerged, emergent and of whether in flower. Where possible, identification of plants was carried out in the field using the keys of Haslam et al. (1975), Bursche (1971), and Clapham et al. (1968).

(b) Semi-quantitative Survey

The size and nature of Pondsbury together with the short time available, made it impossible for a detailed 'mapping' survey to be carried out. However, the pond was divided into sections and the approximate distribution and location of the plants in each section recorded. Results were then averaged and the approximate distribution and location of the main species was plotted on to an outline map of the pond (Fig. 2).

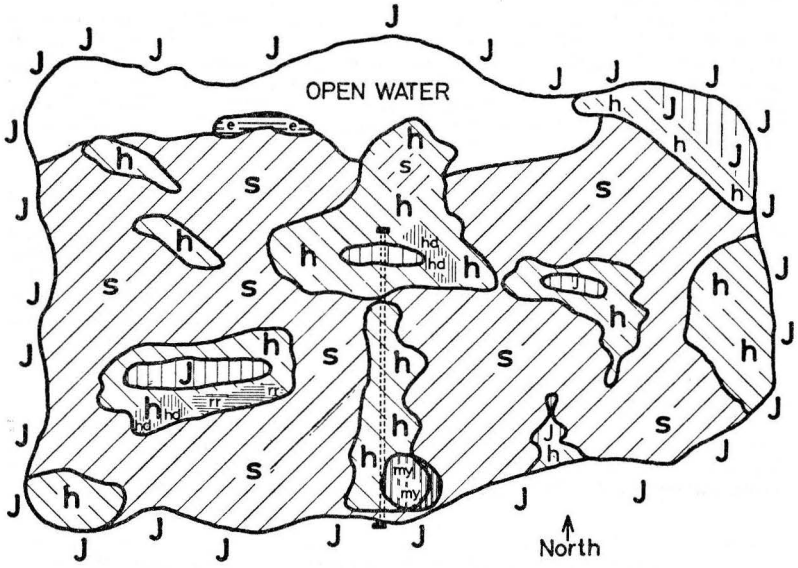

Fig. 2. *Map of Pondsbury showing the main beds of vegetation.* The dotted lines show the position of the plant transect. (Key: *S* = *Sphagnum cuspidatum*, h = *Hypericum elodes*, j = *Juncus* spp., hd = *Hydrocotyle vulgaris*, my = *Myosotis scorpioides*, e = *Eleocharis palustris*, r = *Ranunculus flammula*).

A subjective estimation of relative abundance of each species (in terms of biomass) was made on a scale of 1-5 as follows:-

Score	*Relative abundance* (biomass)
1	Rare (one or a few plants only)
2	Infrequent
3	Frequent
4	Common
5	Very abundant (numerous plants dominating and often in large clumps or colonies).

(c) Quantitative survey

Species composition and species groupings were examined using transect techniques. A 40 m transect line was laid from the southern edge to the centre of the pond (Fig. 2 and Plate 2). Every plant crossed by the line and its distance along the line was recorded. The transect was plotted (Fig. 3) and the data also enabled relative percentage frequency for each transect species to be calculated.

3. Plankton

Plankton was collected with a standard phytoplankton net (aperture 0.075 mm) and two 10 m hauls were taken across the open water areas of the pond. Estimation of relative abundance of organisms was made on a scale of 1-5:

1 One or two organisms only.
2 3-25 organisms
3 26-50 organisms
4 51-100 organisms
5 Over 1000 organisms

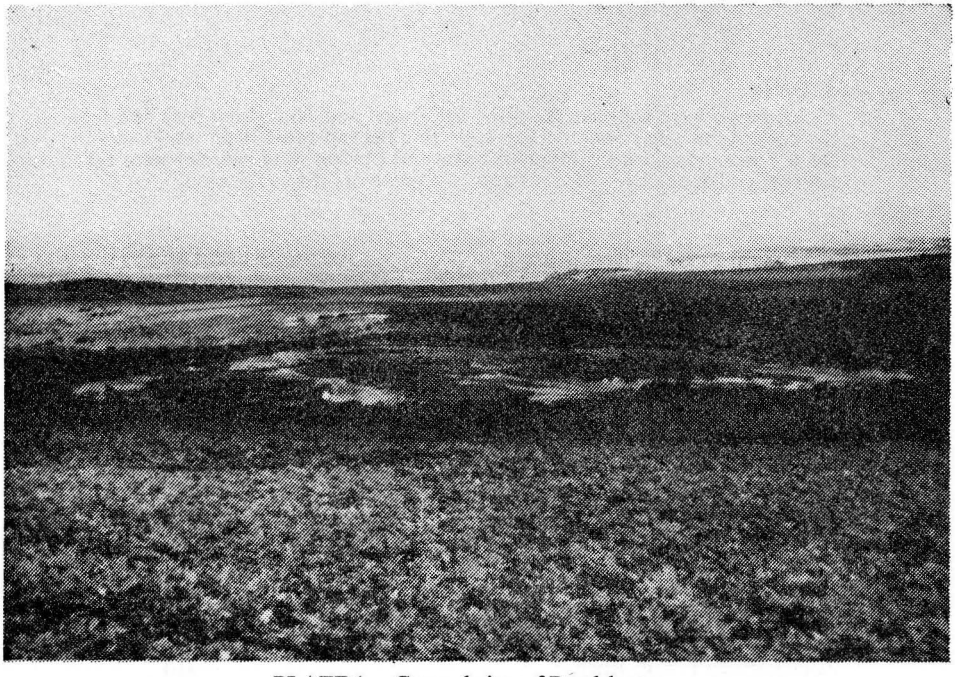

PLATE 1. General view of Pondsbury.

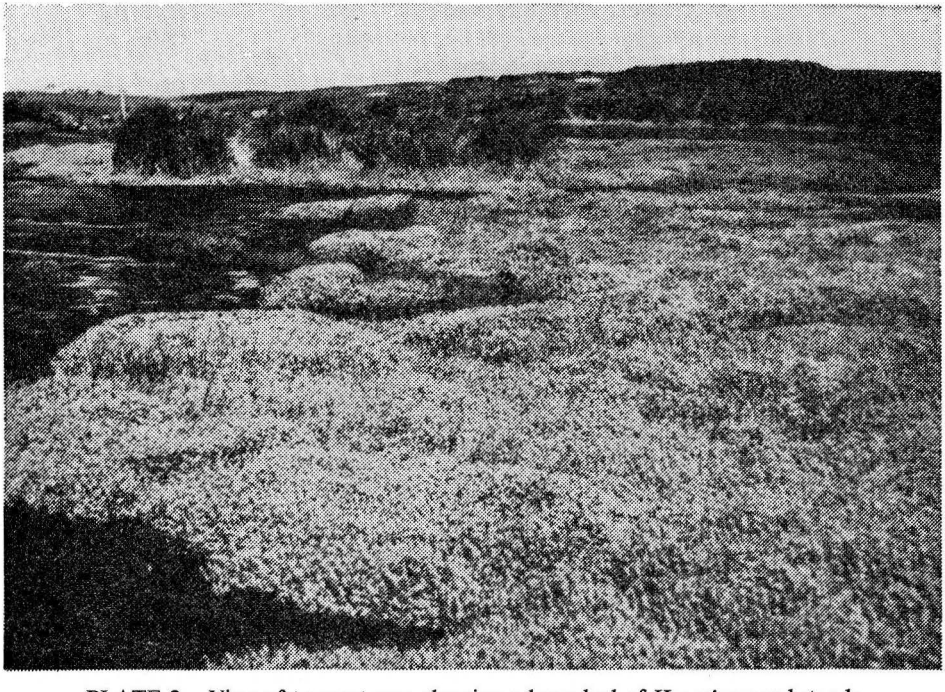

PLATE 2. View of transect area showing a large bed of *Hypericum* and stands of *Juncus*.

4. Fauna

Animals were collected from the *Sphagnum* and *Hypericum* beds and from the bottom mud. A standard FBA collecting net (aperature 0.96 mm) was used for a 5 minute period in the plant beds, and bottom mud samples were taken with net and quadrat over 1/3 m^2 area to a depth of 2 cm in the mud.

RESULTS

1. Physical and Chemical

Pondsbury is fairly shallow reaching its maximum depth (100 cm) near the centre of the pond (Fig. 1). Water temperatures were similar throughout the body of water (surface water 15.5°C, bottom water 15.0°C) and 1-2°C lower than the air temperature on that day (17.0°C). The water in the open areas was fairly turbid with the white Secchi disc disappearing from view at the depth of 12 cm. The pH of the water was 4.8, and it contained 8.6 mg/1. of dissolved oxygen (86% saturation) in the surface waters and 7.8 mg/1/O_2 (77% saturation) in the water lying immediately over the bottom mud.

2. Flora

(a) The following plant species were found:-

Sphagnum cuspidatum Ehrh. ex Hoffm. emend. *Sphagnum* moss	(S)
Hypericum elodes L. Marsh St. John's Wort	(E: fl.)
Hydrocotyle vulgaris L. Marsh Pennywort	(S)
Callitriche sp. Starwort	(S, F)
Peplis (Lythrum) portula L. Water purslane	(E, S)
Juncus effusus L. Soft Rush	(E)
Juncus articulatus L. Jointed Rush	(E, fl.)
Myosotis scorpioides L. Water forget-me-not	(E, S, fl.)
Potamogeton polygonifolius (Pourret) Bog pondweed	(S, F)
Eleocharis palustris (L) Roemer & Schultes. Common Spike Rush	(E)
Ranunculus flammula L. Lesser spearwort	(E, fl.)
Ranunculus omiophyllus Ten. Lenormand's water crowfoot	(F)
Elatine hexandra (Lapierre) DC. Waterwort	(S, fl.)
Lemna minor L. Duckweed	(F)

S = Submerged F = Floating

E = Emergent fl. = flowering

The insectivorous Sundew, *Drosera rotundifolia* L. was found on the sloping S.E. bank of the pond a short distance from the water.

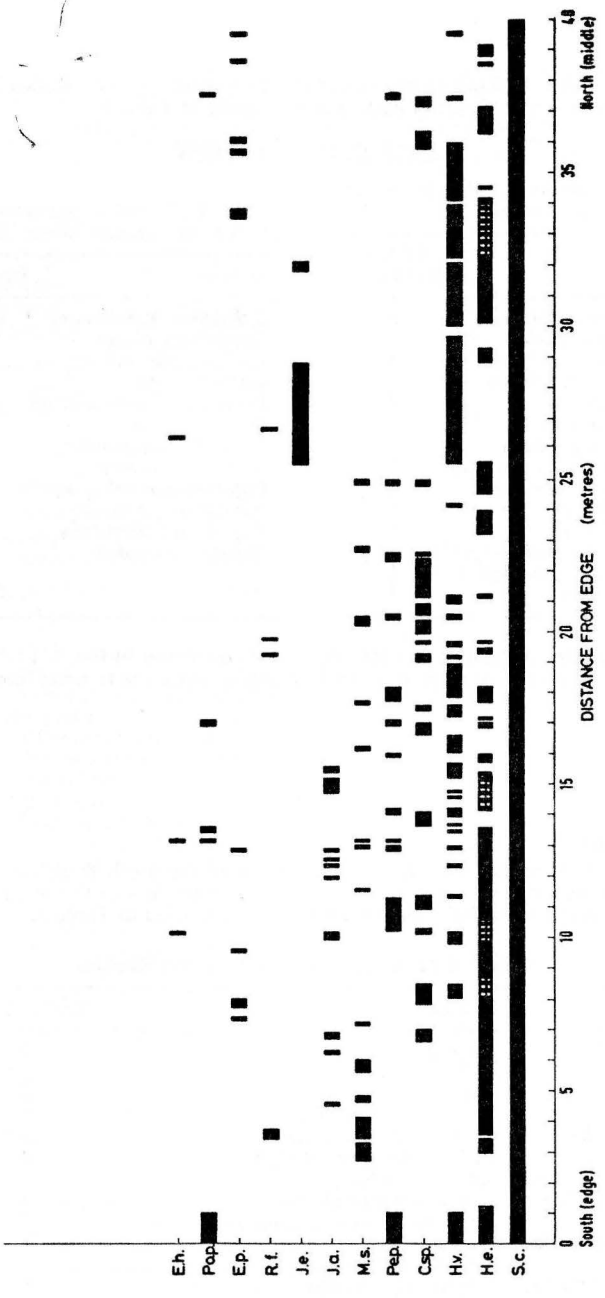

Fig. 3. *Vegetation transect of Pondsbury* (south to north). Key: E.h. = *Elatine hexandra*, Po.p. = *Potamogeton polygonifolius*, E.p. = *Eleocharis palustris*, R.f. = *Ranunculus flammula*, J.e. = *Juncus effusus*, J.a. = *Juncus articulatus*, M.s. = *Myosotis scorpioides*, Pe.p. = *Peplis portula*, C.sp. = *Callitriche* sp., H.v. = *Hydrocotyle vulgaris*, H.e. = *Hypericum elodes*, S.c. = *Sphagnum cuspidatum*). The chequered bars represent regions of sparse plant growth.

(b) The distribution and location of the main plant species is shown in Fig. 2 and the relative abundance of each species is given in Table 1.

Table I. Relative abundance of species

Species	Relative Abundance
Sphagnum cuspidatum	5
Hypericum elodes	5
Hydrocotyle vulgaris	5
Myosotis scorpioides	5
Juncus effusus	4
Juncus articulatus	3
Eleocharis palustris	2
Peplis (Lythrum) portula	2
Ranunculus flammula	2
Callitriche sp.	2
Elatine hexandra	1
Potamogeton polygonifolius	1
Ranunculus omiophyllus	1
Lemna minor	1

Table 2. Relative percentage frequency of Species along transect.

Species	% frequency
Sphagnum cuspidatum	100.0
Hypericum elodes	56.5
Hydrocotyle vulgaris	41.5
Callitriche sp.	16.5
Peplis (Lythrum) portula	10.7
Juncus effusus	9.0
Myosotis scorpioides	8.0
Juncus articulatus	4.5
Potamogeton polygonifolius	4.0
Eleocharis palustris	3.75
Ranunculus flammula	1.5
Elatine hexandra	0.75

(c) Results of the 40 m transect survey are displayed in Fig. 3, and Table 2 shows the relative percentage frequency of species along the transect line.

3. Plankton

The plankton was dominated by a bloom of the green flagellate, *Euglena viridis*, which formed a green surface 'scum' in some parts of the pond. Species present together with their relative abundances are listed in Table 3.

Table 3. Organisms present in Plankton Samples

	Species	Abundance 1-5
Algae:	*Ulothrix* sp.	2
	Closterium sp.	1
Protista:	*Volvox* sp.	2
	Euglena viridis Ehrb.	5
Rotifera:	*Euchlanis dilatata* Ehrb.	2
	Keratella serrulata (Ehrb.)	4
	Cephalodella sp.	1
Cladocera:	*Alonella nana* (Baird)	4
	Chydorus sphaericus (Müller)	3
Copepoda:	*Cyclops* sp.	3
	Cyclcpoid nauplii	2
Ostracoda:	Fam. Cyprididae	1
Hemiptera:	Corixid nymphs	2

4. Fauna

The species and numbers of the invertebrate fauna in both the plant and bottom mud are given in Table 4.

Table 4. Invertebrate fauna of plant and mud samples

Species	Plant beds 5 mins. sampling	Bottom mud Nos/m²
PLATYHELMINTHES:		
Polycelis nigra (Müller)	30	36
ROTIFERA:		
Keratella serrulata (Ehrb.)	3	—
Bdelloids	12	—
ANNELIDA:		
Lumbriculus variegatus (Müller)	12	36
Nais sp.	3	—
CRUSTACEA:		
Cladocera—		
Chydorus sphaericus (Müller)	4	—
Alonella nana (Baird)	6	—
Isopoda—		
Asellus meridianus Racovitza	12	423
UNIRAMIA-CHELICERATA:		
Argyroneta aquatica L.	57	—
UNIRAMIA-INSECTA:		
Odonata-		
Sympetrum striolatum (Charpentier) larva	3	—
Hemiptera-		
Notonecta obliqua Thunb.	5	—
Corixa punctata (Illiger)	3	—
Corixid nymphs	4	—
Coleoptera-		
Ilbyius quadriguttatus L.	5	—
Agabus bipustulatus L.	5	—
Hygrotus inaequalis Fabricius	5	—
Hydroporus pubescens Gyllenhal	2	—
Hydroporus pubescens larva	1	—
Enochrus quadripunctatus (Herbst)	4	
Enochrus quadripunctatus larva	1	—
Trichoptera-		
Limnephilus vittatus (Fabricius) larva	15	—
Diptera-		
Chironomid larva	20	18
Total number of species	19	4
Total number of organisms	214	513/m²

DISCUSSION

Pondsbury is a large, reasonably shallow body of water with an acid pH. It contains several species of water and marsh plants and has an invertebrate fauna fairly typical of acid moorland waters on the mainland.

During the daytime due to plant photosynthesis, the water is well-saturated with oxygen, and its temperature is a few degrees lower than that of the surrounding air. At night the oxygen content will fall due to plant and animal respiration but it is unlikely that completely anaerobic conditions will occur in the summer due to the high production of oxygen by the plants in the daytime. Decaying

organic matter is present in the bottom mud and around the *Sphagnum* roots, but the through drainage of the pond (in all but excessively dry weather) prevents a large build-up in the bottom sediments, which can often lead to completely deoxygenated conditions.

Fourteen different plant species were found in Pondsbury and of these, four were really dominant. Nine species could be defined as 'true aquatics', while the remainder were simply 'plants which prefer wet places'.

As expected, *Sphagnum* was the dominant species often acting as a support in the open water for growth of 'islands' of vegetation. The other dominants were *Hypericum elodes*, *Hydrocotyle vulgaris* and *Myosotis scorpioides*. *Hypericum*, the Marsh St. John's Wort, with its orange/yellow flowers and characteristic smell was the most striking plant in the pond during the survey period. It was widespread on the *Sphagnum* 'islands', in the open water and around the edges of the pond. *Hypericum* never occurred in isolation but always grew in association with *Hydrocotyle* and *Myosotis* both of which it shaded. Both *Hypericum* and *Hydrocotyle*, the marsh pennywort, are typical bog plants occurring widely in Britain. *Myosotis*, the water forget-me-not, also common throughout Britain is tolerant of a wide range of soils but only occurs in wet places.

Rushes were very evident in Pondsbury, particularly the soft rush, *Juncus effusus*, which formed stands in the open water and on *Sphagnum* and was also very common around the edges of the pond. The jointed rush, *J. articulatus* (which was in flower at the time) and the Spike rush, *Eleocharis*, were found, often in association with one another, growing in small quantities around the pond margins. *Eleocharis* also existed as small pure stands in the open water. All three species are abundant throughout Britain, *J. effusus* and *Eleocharis* being characteristic of bogs and marshes, and *J. articulatus* occurring particularly in wet areas that have been grazed by cattle and sheep.

Peplis and *Callitriche* which are characteristic of temporary ponds were found both floating and submerged in the pond. *Peplis* always occurs on non-calcareous soils and is locally common in this country. *Ranunculus flammula*, the most common of the two *Ranunculus* species found, is a charactetistic plant of acid peat bogs, and although infrequent in Pondsbury was evident by its characteristic yellow flowers. *Potamogeton* and *Elatine*, although rare in Pondsbury are both indicative of acid conditions, *Potamogeton polygonifolius* being a common plant in British bogs. The Waterwort, *Elatine*, found growing submerged in isolated patches in the open water and at the pond edges, is known to be fairly rare in Britain. It is characteristic of peaty soils particularly those that dry out during the summer.

The very large numbers of the green flagellate, *Euglena viridis* in the plankton was not surprising as certain species often dominate for short periods in the summer plankton of such ponds. The most abundant member of the Zooplankton was the smallest known waterflea, the Chydorid *Alonella nana*, which was recorded also by Galliford in 1953. The larger *Chydorus sphaericus*, which is a very common species in ponds on the mainland was also found. Chydorids play an important role in the trophic relationships of organisms in ponds, where they fulfill the role of primary consumer in the food chain, filtering out algae and fine detritus from the water.

Three species of rotifer occurred in the plankton with the spiny *Keratella serrulata*, a common inhabitant of bog waters, being present in fairly large numbers. The closely related species, *K. valga* (Ehrb.) recorded by Galliford (1953) as one of the commonest rotifers on Lundy, was not found in this survey. The copepods were represented by immature females, copepodid stages and larval nauplii of *Cyclops*. The absence of mature females made exact species identification difficult but it was thought to be *Cyclops vernalis* (Fischer) as found by one of the authors during the previous year (George, 1978). The calanoid, *Diaptomus* was not found in Pondsbury which was rather surprising as it is fairly common in ponds on the mainland. None were found in Pondsbury during the 1978 survey and it therefore appears to be a notable absentee from the Lundy freshwaters. However, the common small pond form, *D. castor* (Jurine) is more

often found during the winter months (Harding and Smith 1974) and as yet no winter survey has been carried out.

Pondsbury supports a very large population of the water spider, *Argyroneta aquatica*, which dominated the *Sphagnum* and *Hypericum* samples. The spider was quoted by Galliford as 'quite abundant' in 1953, and in spite of droughts when the pond dries up, it is obviously one of the 'long-standing' members of the Lundy freshwater fauna. The weed samples showed the greatest diversity of invertebrate species, 19 species as compared with only 4 in the bottom samples. However the bottom mud supported large numbers of organisms, the most notable being *Asellus meridianus*, the water slater. A few *Asellus* occurred amongst the plants but the majority were found crawling over the bottom mud and between the *Sphagnum* roots. *Asellus* feeds on organic detritus which was plentiful in the bottom of the pond. It breeds from February to the end of October (Steel 1961), and males, females and immature forms were all present in the August samples. The closely related species *A. aquaticus* (L.) does not occur on Lundy, and this is in agreement with the findings of Williams (1962) who found *A. meridianus* only on other British offshore islands. The two species often coexist but recent research (Williams 1979) suggests that *A. aquaticus* is replacing *A. meridianus* on the mainland. *A. meridianus* is thought to be the original asellid in British freshwaters immediately following the end of the last Pleistocene glacial period (Williams 1963). It is an interesting speculation that the original British asellid may in the future be confined to our offshore islands, being 'pushed' off the mainland by the more "aggressive" newcomer, *A. aquaticus*!

The black flatworm, *Polycelis nigra*, occurred in fairly large numbers both on the plants and on the surface of the bottom mud. It is an active carnivore feeding particularly on oligochaete worms, insect larvae and *Asellus*. It is one of the commonest species on the mainland, occupying a wide range of habitats. Chironomid larvae and the red oligochaete, *Lumbriculus variegatus*, both occurred living in tubes within the bottom sediments of the pond. These detritus-feeding forms possess the blood pigment, haemoglobin, which enables them to live in low oxygen conditions.

Insects, together with their larvae, contributed to the great diversity of species in the *Sphagnum* and *Hypericum* samples. Larvae of the dragonfly *Sympetrum striolatum* were seen stalking their prey, *Asellus*, amongst the *Sphagnum*. It is a common dragonfly in the South of Britain, the adult frequently being the last dragonfly to be seen in the year, often flying as late as October/November. *Notonecta obliqua* was the only large water boatman found in Pondsbury, although other species occurred in some of the other ponds. This active carnivore, often feeding on animals larger than itself is common in acid waters elsewhere. It is an air-breather coming to the surface periodically to renew its air supply which is carried between hairs on either side of the abdomen. The lesser water boatman, *Corixa punctata*, a debris-feeding form, was also present together with immature corixids.

Five species of beetle were found living amongst the plants, four belonging to the family Dytiscidae and one to the Hydrophilidae. The dytiscid *Agabus bipustulatus* which is a very common beetle in the U.K. has reached many offshore islands, including the outer Hebrides. It inhabits many kinds of freshwater but it particularly is common in 'detritus ponds' and marshes. *Ilybius quadriguttatus* another dytiscid inhabitant of Pondsbury is common in the SW of Britain, occurring in stagnant brackish as well as freshwaters. The other dytiscids, *Hygrotus inaequalis* and *Hydroporus pubescens* are common throughout the U.K. Both produce larvae during the summer months, and one of these characteristic larvae with the large curved jaws (mandibles) was found. The hydrophilid, *Enochrus quadripunctatus* which was both represented by adults and larvae in Pondsbury is another common beetle on the mainland. All five species were recorded on Lundy by Brendell in 1975.

The caddisfly larva, *Limnephilus vittatus*, which was found in the pond in 1978, was also present in 1979. It lives in a case neatly constructed from plant material and is characteristic of such ponds. Surface dwellers such as the pond-

skaters (Gerrids) and the whirligig beetles (Gyrinids) appeared to be absent, although being present in some of the other ponds (e.g. Quarterwall and Quarry). Gerrids have been observed on the surface of Pondsbury on other occasions (1977 and 78) and it is likely that the gale-force winds on the two days that Pondsbury was studied were a major reason for this apparent absence. The extremely strong winds (the survey was carried out a few days before the Fastnet disaster) 'roughened' the water surface, and it is likely that the surface-dwellers were sheltering under the banks or amongst the rushes. Other notable absentees from Pondsbury were the molluscs. This however was expected as most molluscs occur in alkaline calcareous waters and few species can tolerate such acid conditions as are found in the pond.

On the whole, the invertebrate fauna of Pondsbury is fairly typical of *Sphagnum* bog waters on the mainland. There appear to be no species or varieties endemic to the island and this is not surprising as in terms of geological time the freshwater habitats are transient. The evolution of new freshwater species demands isolated stable permanent habitats (e.g. Lake Baikal in the USSR where such evolution has occurred), whereas the small freshwater ponds of Lundy are subject to the vagaries of the weather. Pondsbury can be classified as a 'temporary pond' as it is subject to drying-up during droughts. Since the last dry period of 1976 it is evident from the species and numbers of organisms occurring now, that recolonization of the pond has occurred quite rapidly over the last three years. It is likely that several species spent the drought period as 'resting eggs' (Rotifera), or as resistant cysts (Oligochaete and flatworms) in the bottom mud. Strongly-flying fauna such as the dragonflies, bugs and beetles can easily reach Lundy from the mainland, and other organisms may be carried there by birds.

Acknowledgements

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