OBSERVATIONS ON THE DISTRIBUTION AND RELATIVE ABUNDANCE OF THE EPHEMEROPTERA AND PLECOPTERA IN THE KILLARNEY VALLEY, CO. KERRY, IRELAND

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The distribution and relative abundance of the Ephemeroptera and Plecoptera in the three Killarney Valley lakes and the two principal rivers are described. Faunal dissimilarities between the lakes are attributed to topographical, geological and trophic factors. The occurrence of these groups in the rivers is related mainly to the influence of current velocity, altitudinal zonation and water quality.

INTRODUCTION

Situated in south-west Ireland, the Killarney Valley is of world renown for its scenic beauty and is one of the most important tourist areas on the island. In 1967, concern was expressed at the discharge of untreated sewage from Killarney town into the Lower Lake (Lough Leane). As a result, a study of the Killarney Valley system was carried out by the zoological staff of University College Dublin from 1971 to 1975 (BRACKEN *et al.*, 1977). The overall objective was to assess the extent of cultural eutrophication in the area. However, in the past, the valley had received little attention from limnologists and the opportunity was taken to investigate the poorly known aquatic fauna of the lakes and rivers. Research work on the Ephemeroptera and Plecoptera in the area has also been carried out by the National Museum of Ireland. It has been possible to combine data from both sources to provide for the first time a detailed account of the stoneflies and mayflies of the lakes and principal rivers. Such information may be useful for detecting climate change (ELLIOTT, 1991) and other alterations to the environment.

STUDY AREA AND METHODS

The climatic conditions of the Killarney Valley region are characterized by heavy rainfall (annual average 1263-3000 mm), a mild climate (seasonal mean 6.5-15.2°C) and prevailing south-west winds. The three lakes lie in a north-east/south-west oriented valley in the Killarney National Park, where the adjoining mountain peaks range from 293 to 763 m a.s.l. (Table 1). All the lakes are centrally located in the River Laune catchment which has an area of 829 km^2. The Laune flows from the Lower Lake into the sea at the upper end of Dingle Bay. Both the Upper and Middle (Muckross) Lakes discharge directly into the Lower Lake, which has an estimated catchment area of 560 km^2. The River Flesk is the largest sub-catchment of the Lower Lake. Devonian Old Red Sandstone and Lower Carboniferous strata (mainly limestone) comprise the main underlying bedrock in the whole area. The landscape is rugged, with many small water bodies of glacial origin. The Upper Lake in situated in a valley created by glacial action. The Middle and Lower lakes were formed by dissolution of the underlying limestone. The gradient from the Upper to the Lower Lake is only 2.0 metres and the surface of the Lower Lake, the largest and deepest (79 m) of the three is a mere 20 metres above sea-level.

Five sampling stations were situated on the courses of the Rivers Flesk and Laune (Fig. 1, Table 2). Wide fluctuations in water levels (mean annual range <2 m) are a feature of all stations. Twelve sampling stations were situated in the littoral areas of the three lakes (Fig. 1, Table 3).

The sampling procedure employed for the river surveys was similiar to that of MACAN (1957) and HYNES (1961). A 12 meshes per cm square-framed net with 25 cm sides was used. Organisms, disturbed by excavating the substrate with a rake, were swept by the current into the net positioned immediately downstream. Large stones were removed by hand in order to dislodge attached organisms and «sweep» samples were taken in *Ranunculus* beds etc.

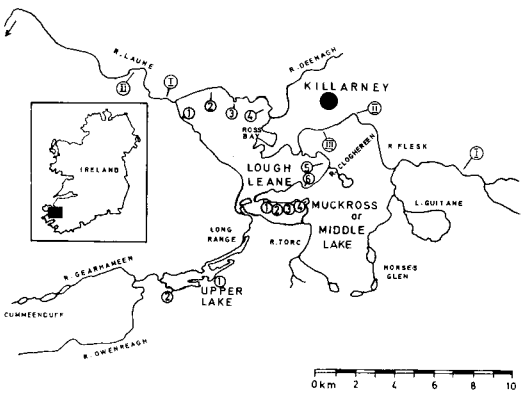

Fig. 1. Location map showing sampling stations.

Each collection took a ten minute period to complete and was carried out on a monthly basis from October 1971 to September 1972. The lake collections were also obtained each month from October 1971 to October 1972. Samples were taken, for five minutes, using the net described above.

Table 1. Limnological data for the Killarney lakes (from BRACKEN *et al.* 1977 and unpublished data).

	Lower Lake	Middle Lake	Upper Lake
Area (Hectares)	2023	275.2	174
Axis	SE-NW	E-W	W/SW-E/NE
Maximum length (Km)	8.46	3.05	3.83
Maximum width (Km)	4.83	1.38	1.01
Shore length (Km)	29.6	10.0	14.4
Maximum depth (M)	charted	uncharted but at least 79	uncharted but at least 65.3
Trophic status	Mesotrophic (Meso-eutrophic)	Oligotrophic (Oligo-mesotrophic)	Oligotrophic (Oligo-mesotrophic)
Pollution status	Localised areas of enrichment from sewage tending to promote eutrophic conditions	Generally unpolluted but St.4 has experienced enrichment from sewage	Unpolluted
Average Specific Conductivity (μs)	95	75	70
pH	6-7.9	6-7	5-6

Table 2. Sampling stations on the River Flesk and River Laune.

RIVER FLESK

1 (W036876). Elevation 61 m a.s.l. Mean current velocity 53 cm/sec.
A shallow area characterized by a lush growth of macrophytic vegetation (dominant *Ranunculus pseudofluitans*) which tends to impede flow. The substrate between the weed beds consists of cobbles and boulders.

2 (V987904). Elevation 30 m a.s.l. Mean current velocity 67 cms/sec. A shallow, stony «riffle» area with a sparse growth of *Ranunculus*. The substrate is stable.

3 (V967895). Elevation <30 m a.s.l. Mean current velocity 77 cm/sec. An extensive shallow «riffle» with a substrate predominantly of cobbles and pebbles. Angiosperms are dominated by beds of *Ranunculus* and the bryophytes are represented mainly by growths of *Fontinalis*.

RIVER LAUNE

1 (V893911). Elevation <30 m a.s.l. Mean current velocity 34 cm/sec. A deep region below the Lower Lake. The substrate consists of pebbles with patches of gravel and silt deposits. There are extensive beds of *Ranunculus* and some *Potamogeton*.

2 (V881927). Elevation <30 m a.s.l. Mean current velocity 81 cm/sec. A broad shallow «riffle». The substrate consists of cobbles. *Ranunculus pseudofluitans* is the only angiosperm but bryophytes (mainly *Fontinalis*) are well represented.

The procedure was similar to that of MACAN & MAUDSLEY (1968). Large stones were washed into the net and weed beds and sand were swept in a standardized manner. On stony shores, a rake was used to disturb the substrate and dislodged specimens were caught by sweeps of the net.

Table 3. Sampling station on the Killarney lake.

UPPER LAKE

1 (V893817). A large sheltered bay with a substrate of peat and fine organic material. There is a marginal growth of *Juncus bulbosus* and *Carex* spp.

2 (V918819). An exposed boggy shore. The substrate consists of peat, organic litter and occasional stones. There is a marginal stand of *Carex*.

MIDDLE LAKE

1 (V937858). An exposed rocky headland with a steep gradient. The substrate consists of large angular fragments of rock derived from the disintegration of the Old Red Sandstone bedrock.

2 (V937858). A sheltered inlet with a growth of *Phragmites*. The stony substrate is completely overlaid with silt and organic litter.

3 (V950859). An exposed shore comprising a flat area of sand interspersed by large bare stones and a narrow marginal belt of wave-washed stones. The limestone bedrock shelves rapidly into the lake.

4 (V965858). A large bay, partially sheltered. The substrate is predominantly sand but a *Phragmites* bed was included in the sampling area. It was underlaid with stones and a dense sward of *Littorella*. At the time of sampling, the bay was receiving a discharge of sewage but this has now been eliminated.

LOWER LAKE

1 (V899908). An exposed rocky shore near the River Laune outflow. The gradient is shallow and the substrate composed of stones, interspersed with large boulders. These are embedded in a sand/gravel matrix with a well established growth of *Littorella uniflora*.

2 (V915916). An exposed rocky shore with a shallow gradient. The substrate consists of an uniform layer of rock «rubble» derived from glacial drift. Macrophytic vegetation is absent. In summer, due to inshore nutrient loading from sewage, this littoral area had dense growths of algae.

3 (V928908). Situated at the exposed extremity of a rocky headland, it is subject to severe wind/wave action. The gradient is comparatively steep and the substrate consists of coarse «rubble» and large boulders characteristic of eroded boulder clay. A dense growth of periphyton, resulting from the nutrients in sewage, was present during the summer.

4 (V946900). A large shallow bay, partially sheltered. The substrate is predominantly sand with a sparse stand of *Phragmites communis*.

5 (V975880). Situated at the exposed end of a large shallow bay. The substrate consists of an extensive area of sand with a narrow stony margin and no vegetation.

6 (V963867). A small deeply indented area characterised by well established stands of *Phragmites* and in deeper water *Nymphaea alba*. The substrate is composed of fine organic debris and litter derived from the decomposing fragments of higher plants.

Between 1971 and 1995, adults and nymphs were extensively collected on the rivers and lakes by the junior author. This material confirmed the nympal identifications of and the distributions recorded by the senior author at the above sampling stations.

RESULTS AND DISCUSSION

Rivers

Thirteen species of Ephemeroptera and eleven species of Plecoptera were recorded (Table 4). An additional two species of Plecoptera are known from the area. *Capnia atra* MORTON occurs in a small lake at an altitude of over 700 m a.s.l. on Mangerton Mountain beside the Upper Lake (O'CONNOR, 1978). *Nemurella pictetii* KLAPÁLEK was collected at Galway's Bridge near the Upper Lake (O'CONNOR, unpublished data). In comparison with similar studies in Britain (e.g. MACAN, 1957; MACKERETH, 1957; HYNES, 1961, 1968; MINSHALL & KUEHNE, 1969), the low species diversity is a reflection of the general paucity of the Irish fauna (MCCARTHY, 1986). Forty-eight species of Ephemeroptera and 32 species of Plecoptera are known from Britain (HYNES, 1977; ELLIOTT *et al.*, 1988) but only 34 and 19 species respectively are recorded from Ireland (COSTELLO, 1988; CONNOLLY & MCCARTHY, 1993).

The results indicated certain marked differences in the faunas of these two rivers. Evidence of natural longitidunal zonation is provided by the confinement of *Electrogena lateralis* to the upper Flesk and the successional increases in the densities of certain species with decreasing altitude (e.g. *Ephemerella ignita, Isoperla grammatica*). Also the association of certain species with the slow flowing conditions of Laune 1 is marked (*Ephemera danica, Caenis luctuosa, Centroptilum luteolum, Procloeon bifidum*). The eutrophication of the Lower Lake appeared to affect the Plecoptera in the Laune. With the exception of *I. grammatica* and *Leuctra fusca*, the order was poorly represented there. Several ephemeropteran species, known to be intolerant to mild organic contamination (ELLIOTT *et al.*, 1988), are similarly scarce or absent. The fauna of the Flesk is broadly similar to that of the River Caragh, an unpolluted river also in south-west Ireland (DOWLING *et al.*, 1981).

Lakes

Ten species of Ephemeroptera and four species of Plecoptera were recorded from the sampled

Table 4. The distribution and relative abundance of Ephemeroptera and Plecoptera in the Rivers Flesk and Laune.

	RIVER FLESK			RIVER LAUNE	
STATIONS	**1**	**2**	**3**	**1**	**2**
EPHEMEROPTERA					
Baetis fuscatus (L.)	13	75	18	3	3
B. rhodani (Pictet)	1443	467	1417	42	537
B. muticus (L.)	67	66	152	1	14
Centroptilum luteolum (Müller)	–	–	–	21	–
Procloeon bifidum (Bengtsson)	–	–	–	7	–
Rhithrogena semicolorata (Curtis)	152	96	74	–	1
Heptagenia sulphurea (Müller)	19	15	39	15	90
Electrogena lateralis (Curtis)	27	7	–	–	–
Ecdyonurus venosus (Fabr.)	154	86	150	–	2
Ephemerella ignita (Poda)	597	606	1113	1645	1808
Ephemera danica Müller	–	–	–	34	–
Caenis luctuosa (Burmeister)	–	–	–	127	–
C. rivulorum (Eaton)	15	303	40	18	19
PLECOPTERA					
Brachyptera risi (Morton)	2	–	–	–	–
Protonemura meyeri (Pictet)	25	17	120	–	10
Amphinemura sulcicollis (Stephens)	15	20	53	–	–
Leuctra inermis (Kempny)	6	7	2	–	–
L. hippopus (Kempny)	25	11	4	–	–
L. fusca (L.)	29	78	5	23	22
Capnia bifrons (Newman)	1	–	–	–	–
Isoperla grammatica (Poda)	7	4	107	85	347
Perla bipunctata (Pictet)	46	65	117	–	–
Siphonoperla torrentium (Pictet)	39	79	43	7	1
Chloroperla tripunctata (Scopoli)	3	12	10	2	3

stations (Table 5). In addition, *Capnia bifrons* was collected on the exposed western shore of the Lower Lake. *Caenis* was the most abundant mayfly especially on the stony substrates in the comparatively rich conditions of the Lower Lake and at station 4 of the Middle Lake. *Ephemerella ignita,* a running water species only occasionally found on the stony shores of lakes, was fairly abundant on the more exposed shores of the Lower Lake. It was scarce in the Middle Lake and apparently absent from the Upper Lake, reflecting its preference for beta-mesosaprobitic conditions (ELLIOTT *et al.,* 1988). Similarly, *Heptagenia sulphurea* and *Centroptilium luteolum* were absent from the Upper Lake samples and most plentiful in those from the Lower Lake. However, *H. sulphurea* was absent from two of the stations there. By contrast, *Leptophlebia vespertina* was commonest in the humic conditions in certain sheltered areas of the Upper and Middle Lakes. Elsewhere in Ireland, it occurs also in alkaline waters (O'CONNOR & BRACKEN, 1980). *H. sulphurea* prefers calcareous conditions in lakes (ELLIOTT & HUMPESCH, 1983). It occurred only on exposed rocky shores where nutrient enrichment was not excessive. *Cloeon simile* occurred in all three lakes and showed a preference for sheltered areas where vegetation was present. *C. dipterum* had a similar distribution but was restricted to stations 4 on the Middle Lake and 6 on the Lower Lake. Trout anglers from the area report that *Ephemera danica* was once abundant on the Middle and Lower Lakes. The species is now scarce and was taken only at one station in the Middle Lake and two in the Lower Lake. *Procloeon bifidum* was only found at station 1 on the Lower Lake. Surprisingly, *Heptagenia fuscogrisea* (RETZIUS), a common species in Irish limestone lakes (MACAN & LUND, 1954; HARRIS, 1956; O'CONNOR & BRACKEN, 1980) did not occur in the Lower Lake where conditions appear to be suitable. The corixid *Sigara fallenoidea* (HUNGERFORD) has a similar distribution and is also inexplicably absent (O'CONNOR *et al.,* 1986).

The Plecoptera were poorly represented in the lakes and only five species were recorded. The occurrence of only two species and their scarcity in the Upper Lake was unexpected. Lough Dan, a very similar oligotrophic mountainous lake in eastern Ireland, has six species, four of which are widespread there (O'CONNOR & BRACKEN, 1980). *Siphonoperla torrentium* was the most abundant and widely distributed stonefly, occurring in all three lakes where the substrate was suitably stony but away from any pronounced sources of enrichment.

A serial transition from an oligotrophic mountain lake to a lowland mesotrophic lake with imposed eutrophic tendencies is reflected by the respective characteristics of the three lakes, the Upper Lake having an impoverished fauna. The distribution of the littoral fauna in different areas of the Lower Lake is not

Table 5. The distribution and relative abundance of Ephemeroptera and Plecoptera in the littoral zone of the Killarney Lakes. Nomenclature follows COSTELLO (1988) and ELLIOTT *et al.* (1988). Values given are the total number of nymphs taken between October 1971 and October 1972.

	Lower Lake						Middle Lake				Upper L.	
STATIONS	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**1**	**2**
EPHEMEROPTERA												
Centroptilum luteolum (Müller)	1	1	7	26	45	1	9	7	–	17	–	–
Cloeon dipterum (L.)	–	–		1	–	39	–	–	–	24	–	–
C. simile (Eaton)	3	7	5	40	4	12	4	19	–	47	69	44
Procloeon bifidum (Bengtsson)	–	–	–	–	–	1	–	–	–	–	–	–
Heptagenia sulphurea (Müller)	14	1	337	–	1	–	7	–	32	1	–	–
Leptophlebia vespertina (L.)	–	–	–	–	–	1	6	28	–	8	33	17
Ephemerella ignita (Poda)	208	17	87	26	1	5	3	–	–	1	–	–
Ephemera danica (Müller)	23	–	–	13	–	–	–	–	–	3	–	–
Caenis luctuosa (Burmeister)	1369	645	521	173	19	9	3	4	–	322	4	1
C. horaria (L.)	–	–	1	359	130	11	–	–	–	262	1	–
PLECOPTERA												
Nemoura cinerea (Retzius)	–	–	–	–	–	2	–	–	–	–	–	–
N. avicularis Morton	–	–	–	–	–	–	5	–	–	–	–	–
Siphonoperla torrentium (Pictet)	3	–	–	–	–	–	6	–	5	–	–	9
Chloroperla tripunctata (Scopoli)	–	–	–	–	–	–	3	–	–	–	–	2

continuous but assumes the character of discrete communities. This is mainly a response to the localised geological and topograpical factors, the degree of exposure to wave action and the nature of the substrate. Superimposed on this general scheme are the localised effects of cultural eutrophication (WISE & O'SULLIVAN, 1980).

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