R LARK

88

BIOLOGICAL MONITORING 1989-91

RE ISLEHAM WTW

OBSERVATIONS ON THE IMPACT OF ISLEHAM WTW DENITRIFICATION PLANT DISCHARGE ON THE R.LARK

1. INTRODUCTION

A detailed biological survey of the R.Lark in the vicinity of Lee Brook, Isleham was carried out in July 1989 to assess the likely impact of the discharge of saline water from Isleham Water Treatment Works denitrification plant. The survey work included mapping the occurrence and distribution of the macrophytes and the collection to benthic invertebrate samples. In October 1990 a second survey for the benthic invertebrates was carried out, following commissioning trials of the denitrification plant, which had occurred that summer,

Following one years operation of the denitrification plant, macrophyte and benthic invertebrate surveys were repeated in August 1991.

This report gives observations on the impact of the discharge on the ecology of the river.

2. METHODS

2.1 Benthic invertebrates

Eight sites were sampled (see Figure 1), 3 replicate samples were taken at each site using an Eckman Grab of $0{\cdot}025m^2$ surface area. The samples were sieved in the field using a standard pond net and returned to the laboratory for live examination. The invertebrates were identified and estimated. Result from the replicates were pooled and the data is presented in relative abundance categories (Table 1).

In addition, cluster analysis was carried out on this data. This analysis compares the results from each site with all other sites and produces an overall measure of similarity between pairs of sites. This information can then be plotted in order to show groups of similar sites.

2.2 Macrophytes

The occurrence, relative abundance and percentage cover of marginal and channel macrophytes were recorded using Methodology B in the SCA "Methods for the Use of Aquatic Macrophytes for Assessing Water Quality 1985-86 (HMSO 1987)". The river was surveyed in lengths between the benthic invertebrate grab sample points. Within each length, the relative biomass was assembled as a comparison of the relative amount of one macrophyte species against all other macrophytes. The percentage cover was based on the subjective estimate of the percentage area of river covered by each macrophyte species.

The scales used for relative biomass and for percentage cover are shown in Table 2.

3. RESULTS

Table 1 = Benthic invertebrate results 1989,90,91
Table 2 = Macrophyte result 1989,91
Figure 2 = Cluster Analyses of benthic invertebrate results 1989,90,91

4. OBSERVATIONS

4.2 Macrophytes

In the 1989 the main river channel (both upstream and downstream of Lee Brook was characterised by a mosaic of Sparganium emersum and Potamogeton pectinatus stands. Throughout this length of river the stands were generally of a "thin" nature though some stands had profuse growth. Associated with these macrophytes were moderate abundances of the algae Cladophora and Enteromorpha.

In 1991, the distribution and abundance of S.emersum was very similar to 1989. However P.pectinatus had a much more limited distribution - thin, isolated stands being restricted to the lower reaches of the length of river concerned. Cladophora and Enteromorpha were also much reduced in distribution and abundance. In contrast, the filamentous macrophyte, Ceratophylum demersum was found to be common throughtout the length of river in 1991, whereas it had not been recorded in 1989.

The composition and character of the marginal flora were very similar in 1989 and 1991. At the waters' edge, dense stands of Urtica disica, Phalaris arudinacea, Epibolium hirstum and Phragmites australis lined the bank. In the shallows, species such as Sagittaria sagittara, Elodea, Potamogeton perfoliatus and Nuphar were found as well as S.emersum and Ceratophylum.

These were some difference however, in 1991 Lemma growths were much more profuse than in 1989. The tiny, floating leaves after covering the surface for up to a metre from the river banks. Also Cladophora and Enteromorpha growths were less profuse in 1991 than in 1989.

The majority of the above changes are not what might be expected from a river suffering deleterious effects from increased saline levels Cladophora, Enteromorpha and P.pectinatus are all taxa which are tolerant to elevated saline levels - and indeed an increase in their abudance might be expected under such circumstances not a reduction! C.demersum is also tolerant of elevated salinity and this taxa has shown an increase in abundance. However in view of the decline in Cladophora, Enteromorpha and P.pectinatus abundances it is unlikely that this is significant.

4.1 Invertebrates

No significant differences in invertebrate fauna can be discerned between those sites upstream of the WTW discharge and those sites downstream for the discharge (see table 1). Indeed cluster analysis of the sites (figs 2-4) showed significant similarities between many of the upstream and downstream sites.

It should also be noted that the greatest diversity of taxa was recorded in the 1991 survey - following a year's operation of the plant.

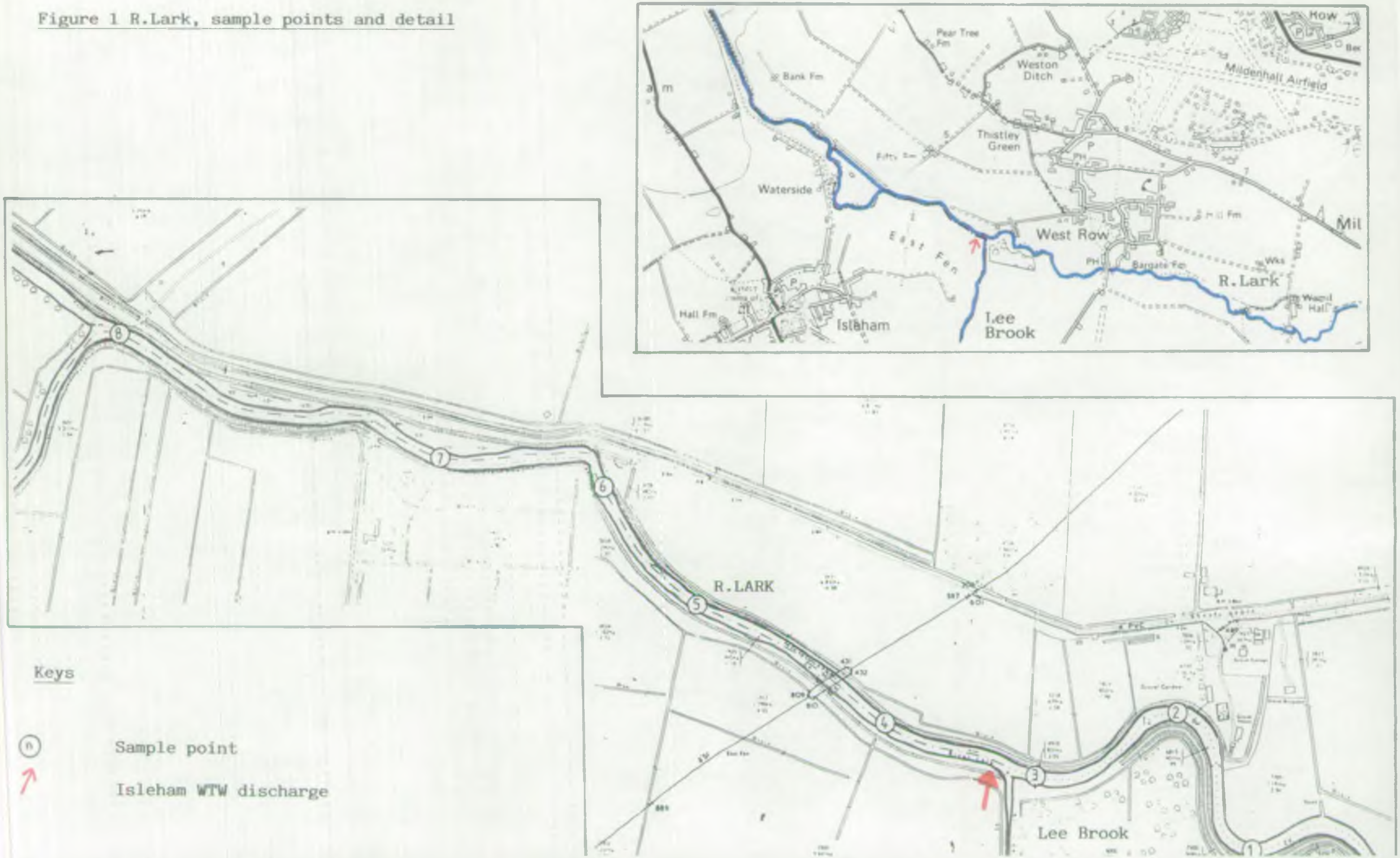
It might also be noted that in each survey, several taxa recognised as being particularly sensitive to salt (see Appendix 2) were found downstream from the discharge. These included Gammarus pulex, Glossiphonia complananta Helobdella stagnalis and Dugesia sp (Planariidae). Conversely there were no apparent increase (compared to 1989) in the abundances of those taxa which are preferent of increased salinity. For example, Chironomidae Asellus aquaticus, Hydrobia jenkinsii, Tubificidae and Halipidae.

5. Overall Assessment

Up to August 1991 there would appear to have been no adverse impact from Isleham WTW effluent on either the macrophytes or inverteberates of the R. Lark, downstream from the discharge.

Biology Central 1991

Figure 1 R.Lark, sample points and detail



Keys

(n) Sample point

Isleham WTW discharge

TABLE 1 R.LARK, BENTHIC INVERTEBRATE RESULTS 1989,90,91

	UPSTREAM SITES									DOWNSTREAM SITES														
	1			2			3			4			5			6			7			8		
TAXA	225m U/S			115m U/S			20M D/S			80M D/S			210m D/S			300M D/S			520M D/S			960M D/S		
	89	90	91	89	90	91	89	90	91	89	90	91	89	90	91	89	90	91	89	90	91	89	90	91
Oligochaeta		2	3		3	3	3	3	2	3	2	2	3	3	2	3	4	2	3	3	2	3	4	2
Chironomidae	4	3	2	4	2	2	4	3	2	3	3	2	2	3	3	3	4	2	4	2	2	4	3	2
Planariidae					1	2								1			1							
Erpobdelliade	1		2			1											2							1
Glossiphonidae			2			2						2			2		2	2						2
Piscicolidae								1												1				
Asellidae		1	2		1	2		1	2			2			2			2			2			3
Gamarus pulex			2			2		1	2						2		3	2						2
Crangonyx								1															2	
Dytiscidae																					1			2
Ostracoda	3	1	1			1													2	1		1		2
Corixidae			1																					1
Caenidae	1	1		3			1						1						2			1		1
Baetidae																							1	
Ephemeridae		1	1		2	1		1														2		
Coenoagriidae		1	2									1												1
Sialidae			2		2	2			2			2			2			2	2	1	2	2	2	2
Phryganeidae																				1				
Goeridae																								1
Molannidae					1												1						1	
Leptoceridae				1																				2
Psycomyidae					2																			
Hydroptilidae																						1		
Polycentropidae				3							1	1			1								1	1
Elminthidae					1																			
Haliplidae							1																	
Sphaeridae	1		1	2	2	2	2	1	1		1	2	2		2		2	2		2	2	1	2	2
Hydrobidae					1	2			1						2		2	2			1	1		2
Planorbidae																								2
Ancylidae																								
Lymnaeidae			1			2									1									1
Valvatidae						2			1						2		1				2			2
Physidae																								1
Unionidae	1		1	1	1	1	1	1	2		1	1		1	1		1	1	1		1	2		2
NUMBER OF TAXA (34)	6	6	14	6	12	15	6	9	9	2	4	9	4	4	12	3	11	9	6	7	9	9	8	22

Relative Abundance Scale

1 = 1
2 = 2 - 10
3 = 11 - 100
4 = 101 - 1000
5 = >1000

TABLE 2 R LARK. MACROPHYTE RESULTS, 1989, 91

		UPSTREAM		DOWNSTREAM									
		1-3		-4		4-5		5-6		6-7		7-8	
GF	TAXA	89	91	89	91	89	91	89	91	89	91	89	91
S	Hydrodictyon												1/1
S	Cladophora	4/5	2/2	3/4	1/1	3/4	1/1	3/4	1/1	3/3	1/1	3/2	1/1
S	Enteromorpha	3/1	1/1	2/1	1/1	1/2	1/1	2/2	1/1	1/1	1/1	1/1	1/1
S	Ranunculus							1/1					
S	Elodea				1/1								
S	Callitriche			1/1								1/1	
S	Potamogeton perfoliatus	2/1	2/1				2/1				1/1	1/1	1/2
S	Potamogeton pectinatus	3/2		3/2		3/2		3/2	1/1	2/1	1/1	2/1	2/2
S	Ceratophllum		5/4		5/3		5/3		5/3		5/4		5/3
S/F	Spraganium emersum	5/4	5/4	5/3	3/3	5/3	5/3	5/3	5/3	5/3	5/3	5/3	5/3
S/F	Nuphar	1/1	1/1					1/1	1/1	2/1	1/1	3/1	1/1
S/F	Nymphoides				1/1								
F	Lemna	1/1	4/4	1/1	5/3	1/1	5/3	1/1	5/2	2/2	5/4	1/1	4/3
E	Phalaris arunidacea	5/2	4/2	5/1	5/1	4/1	5/2	5/3	5/3	5/1	5/3	5/1	5/1
E	Carex riparia	3/1	3/1	3/1	1/1	2/2	3/2	3/2	1/2	3/2	1/2	1/1	1/1
E	Apium	1/1	2/1			1/1	2/1	2/2	1/1	2/1	2/1	1/1	2/1
E	Spargarium erectum												
E	Epibolium Listum	2/1	3/1	3/1	3/1	3/1	3/1						
E	Oenanthe	1/1		1/1	1/1			1/1					
E	Iris	1/1							1/1				1/1
E	Rumex	1/1	1/1										
E	Phragmites australis	5/1	5/1	4/1	3/1	4/1	4/1						
E	Sagittaria sagittaria		1/1	2/2	1/1		1/1						
E	Scrophularia auriculata					1/1	1/2	1/1					
E	Symphtum officinale	1/1		2/1	1/1								
E	Urtica dioica	5/2	4/1	4/1	3/1	3/1	3/1						

Growth Form (G.F.)

S = Submerged
S/F Submerged/floating
E = Emergent

Relative macrophyte abundance

1. Very sparse
2. Sparse
3. Moderate
4. Abundant
5. Very abundant

Percentage Cover

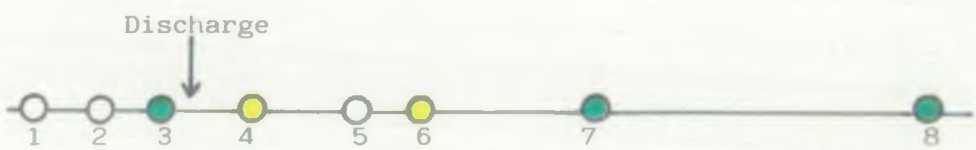
1. C 0·1%
2. 0.1·1%
3. 1-2·5%
4. 2·5-5%
5. 5·10%
6. 10·25%
7. 25·50%

BENTHIC GRAB SAMPLES : CLUSTER GROUP CHARACTERISTICS
1989

GROUP	GROUP Ave. Ni	GROUP Ave. Ns	DOMINANT TAXA
1 (n=2)	100	2.5	Chironomidae
2 (n=3)	189	6.7	Chironomidae
Ungrouped			
(1)	288	6	Chironomidae
(2)	265	6	Chironomidae
(5)	49	4	Chironomidae

Ni=No. of individuals
Ns=No. of taxa

1989
DENDROGRAM FOR 8 SAMPLES



BENTHIC GRAB SAMPLES : CLUSTER GROUP CHARACTERISTICS
1990

GROUP	GROUP Ave. Ni	GROUP Ave. Ns	SUB GROUP	GROUP Ave. Ni	GROUP Ave. Ns	DOMINANT TAXA
1	41	5	1A (n=2)	50	5	Chironomidae
(n=3) ●			1B (n=1)	24	5	Chironomidae/Oligo
2	129	6.5	2A (n=2)	86	3.5	Oligochaeta
(n=4) ●			2B (n=1)	86	12	Oligochaeta
			2C (n=1)	257	7	Oligochaeta
Ungrouped (6) ○	393	11				Oligochaeta

Ni=No. of individuals
Ns=No. of taxa

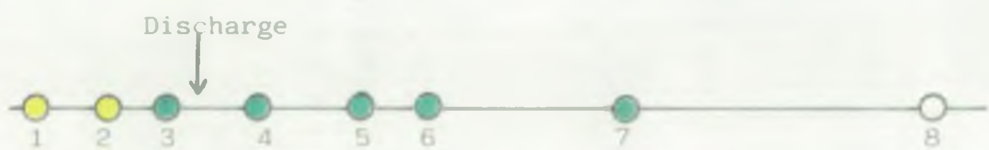
1990
DENDROGRAM FOR 8 SAMPLES

BENTHIC GRAB SAMPLES : CLUSTER GROUP CHARACTERISTICS
1991

GROUP		GROUP Ave. Ni	Ave. Ns	DOMINANT TAXA
1 (n=2)	●	[illegible]	15	Oligochaeta
2 (n=5)	●	647	9.6	Chironomidae/Oligochaeta
Ungrouped (8)	○	[illegible]	21	Asellidae/Hydrobidae

Ni=No. of individuals
Ns=No. of taxa

1991
DENDROGRAM FOR 8 SAMPLES



R Lark Imm.d/s Isleham WTW discharge

R.Lark Approx.500m d/s Isleham WTW discharge

These photographs illustrate the deep, slow flowing nature of the R.Lark between West Row and Isleham Lock and show some of the characteristic flora recorded in 1989 & 1991. The steep banks tend to be covered with herbs, grasses and fringed with reed (Phragmites australis). There are distinct marginal fringes along both banks, including Great Pond-sedge (Carex riparia) and Bur-reed (Sparganium erectum). In the channel, unbranched Bur-reed (Sparganium emersum) has been a feature of the flora in both years.

APPENDIX 2

The effects of saline effluents on freshwater ecosystems have been little studied in this country, presumably because there are very few such discharges. In other countries, attempts have been made to assess the impact of road de-icing salt, and pollution from various mining and oil drilling operations, as well as discharges from potash plants, on freshwater plants and animals.

Most freshwater animals are unable to withstand very high concentrations of salt, and a discharge which increases the concentration of a certain ion or ions may upset the natural ion balance of a receiving water and hence create toxic conditions (Hawkes, 1979). It has been shown that the faunas of the German rivers Werra and Wipper, for example, have become impoverished as salt concentrations have increased due to discharges from potash plants (Crowther and Hynes, 1977). The actual composition of the salt-solution is important because a mixture is usually less toxic than an equivalent concentration of one type of salt (Hynes, 1960). In addition to toxic effects, freshwater organisms which have become adapted to living in water of low osmotic pressure, may be affected by increases in osmotic pressure caused by increased salinity (Hynes, 1960).

Freshwater plants differ considerably in their tolerance of salt. For example, Potamogeton pusillus, P. filiformis and P. pectinatus are commonly found in brackish water, while other members of the genus will not tolerate much salt. Harding (1979) recorded large beds of P. pectinatus in the River Dane immediately downstream of the confluence with the River Croco, a tributary affected by inputs of salt and treated sewage. Myriophyllum spicatum is also tolerant of elevated salt concentrations, and together with P. pectinatus it is the dominant flora of inland saline waters in the Midlands (Hynes, 1960). Enteromorpha intestinalis, a species which normally inhabits brackish water, may become very abundant in waters receiving discharges containing salt, and the growth of Cladophora may also be enhanced under such conditions. (Alder, 1986). Alder recorded Ranunculus baudatii, a coastal species, in the Chesterfield Canal and he attributed this to a discharge containing a relatively high concentration of salts. Similarly, Harding (1979) attributed records of Elodea canadensis in the River croco and lower River Dane to the fact that this plant can also tolerate high levels of dissolved salt.

Freshwater invertebrates also demonstrate a wide range of salt tolerances (Crowther and Hynes, 1977). For example, of the leeches Erpobdellids and some Glossiphonids (e.g. Helobdella stagnalis) are more sensitive to salinity than the Piscicolids (e.g. Piscicola geometra), other glossiphonids and possibly the Hirudids (Sawyer, 1947). Among the most tolerant invertebrate groups are the Astacidae, Odonta and Diptera. Certain species of these groups can withstand salt concentrations of over 15,000 mg/l (Clemens and Jones, 1954). Of the Ephemeroptera the Baetidae would appear to be the most tolerant family. The Plecoptera as an order are absent from waters of high salinity. Amongst the Trichoptera, Hydropsychidae are most tolerant of high chloride concentrations, and of the Hemiptera, Gerridae and Veliidae are most tolerant. Gyrinus is the most tolerant Coleoptera, even though the larva is truely aquatic. Of the Diptera the most tolerant species are in the Chironomidae (Hynes, 1960). In contrast, some species of Planaridae and Gammarus pulex can tolerate very little salt.

A number of workers have attempted to establish what concentration of salt is necessary to induce a change in the flora and fauna of different freshwaters. Crowther and Hynes (1977), for example, showed that Trichoptera completed their life cycles and emerged as adults when subjected to chloride levels as high as 1650 mg/l in laboratory simulations. In the field, the drift patterns of salted and control channels diverged radically at chloride concentrations greater than 1000 mg/l. Other experiments have indicated that *Gammarus pseudolinaeus*, *Hydropsyche betteni* and *Cheumatopsyche analis* are apparently unaffected by chloride pulses of up to 800 mg/l.

In general, it is apparent that discharges which result in a fairly stable saline condition result in a replacement of the natural community by one tolerant of increased salinity. Characteristic of such communities are *Artemia salina*, *Ephydra riviparia*, Tubificidae, *Asellus aquaticus*, Odonata certain Chironomidae (including *Chironomus thummi*), several species of Corixidae, Coleoptera, some Gastropods (especially *Lymnaea peregra* and *Hydrobia jenkinsi*), certain rotifers and diatoms (Hynes, 1960; Hawkes, 1979). Intermittent highly saline discharges result in conditions unsuitable for either the normal freshwater community or the replacement community, and the flora and fauna of waters affected in this way is devastated.

REFERENCES

Alder, J. (1986). *A survey of the flora of the Chesterfield Canal*. NCC Survey report.

Clemens, H.P. and Jones, W.H. (1954). Toxicity of brine water from oil wells. *Trans. Amer. Fish Soc.*, 84, 97 - 109

Crowther, R.A. and Hynes, H.B.N. (1977). The effect of road de-icing salt on the drift of stream bethos. *Environ. Pollut., 14*, 113 - 126

Harding, J.P.C. (1979) *River Macrophytes of the Mersey And Ribble Basins* NWWA (Rivers Division) Report.

Hawkes, H.a. (1979) Invertebrates as indicators of river water quality. In *Biological Indicators Of Water Quality* (Ed. by A James and L Evison). John Wiley and Sons, Chichester.

Hynes, H.B.N. (1960) *The Biology of Polluted Waters* Liverpool University Press

Sawyer, R.T. (1947) Leeches (Annelida: Hirudinea). In *Pollution Ecology Of Freshwater Invertebrates*. (Ed. by C.W. Hart and S.L.H. Fuller). Academic Press, New York and London.

PS/CF/PSBAPPENDX
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