Craig Goch Field Surveys Meeting, Malvern – February 1976

UWIST Paper 5

Invertebrate Studies: Ystwyth & Rheidol

Introduction

The Rivers Ystwyth and Rheidol have a history of metal pollution (Carpenter 1924, 1925: Newton 1944): many reaches still receive substantial volumes of water contaminated with heavy metals, principally zinc and lead, although there has been considerable improvement in water quality and biological status in recent years, particularly in the R. Rheidol (Jones & Howells 1969). As a consequence of proposals to divert uncontaminated water from the headstreams of both rivers in order to provide a refill source for the enlarged Craig Goch Reservoir, a surveillance programme was instituted to provide base-line data for water quality, fisheries and invertebrates. U.W.I.S.T., under contract to W.N.W.D.A., has implemented a programme which will provide information on the variety, distribution and relative abundance of aquatic invertebrates: the study of other aspects has been undertaken by South West Wales River Division (1976).

Methods and Sampling Sites

Samples of invertebrates were collected with a cylinder sampler (net aperture 400µm), modified after Neill (1938) and described by U.W.I.S.T. (1976c), at 6 sites on the R. Ystwyth and tributaries and 7 sites on the R. Rheidol and tributaries (Fig. 1, Table 1). At each site 4 cylinder samples (total area $0.2m^2$) were collected across the width of a riffle. Animals were returned to the laboratory, preserved in 5% formaldehyde solution and sorted by hand. Current velocity and water depth were measured at the location of each sample.

Results from one survey only, March 1975, are presented here.

Results

Ystwyth Catchment

In March 1975 a total of 47 taxa (species or species groups) were recorded at 6 sites in the Ystwyth catchment: at any one site the maximum number of taxa was 25 (Fig. 2Y, Appendix I). Total mean densities ranged from 750 to $2400m^2$ (Fig. 2Y, Appendix I). There was no clear relation between species richness or total invertebrate density and total zinc concentrations in the water (Fig 2Y). the Nant Magwr (Y5), where highest mean and maximum concentrations of zinc were recorded, supported only 17 species and species-groups but total invertebrate density at this site was generally similar to that at other sampling stations (Fig. 2Y). At site Y1 (Ty Mawr) the unpolluted river supported the same number of species-groups as site Y2 (Cwmystwyth), the most heavily contaminated site recorded on the main river. Furthermore there was no significant difference in total invertebrate density at these two sites (Fig. 2Y).

A comparison of sites based on the similarity between their faunas using the Jaccard Index (UWIST, 1976d) indicated two major associations in March 1975 (Fig 3a). These associations appeared to be generally related to the location of the sites along the length of the river. No detailed physical examination of sites was undertaken but faunal associations were not apparently related to water velocity or depth (Table 2).

The proportional numerical representation of the major groups in the Ystwyth and Nant Magwr indicated that Plecoptera always formed more than 35% of the total invertebrate fauna: only in the lower reaches of the Ystwyth (Y4 and Y6) did the Ephemeroptera and Simuliidae become important components of the fauna (Table 3). Plecoptera and Ephemeroptera were dominant at Y5 (Nant Magwr). Results from a survey carried out by S.W.W.R.D. in April 1974 (Jenkins, *pers. comm.*) are included for comparison.

Rheidol catchment

40 taxa were collected from seven sites in the Rheidol catchment in march 1975. the number of species-groups varied from 11 to 24 and estimates of total density from 465 to 645/m^2 (Fig. 2R, Appendix I).

As in the Ystwyth the relationship between species richness, invertebrate density and metal contamination was not clear (Fig. 2R). total density at R5, immediately below the Rheidol mine, was not significantly different from R4, immediately upstream of the mine. Clustering of the different sites using the Jaccard Index indicated two major associations, between headstream tributaries (R1 – R3) and sites in the middle to lower reaches (R4 – R6). However, sites R7 (Capel Bangor) showed a close association with R3 (Fig. 3b).

The Plecoptera was the major group (> 40% of the total invertebrate population) at all sites, the representation of Ephemeroptera increasing in the lower reaches (Table 4). At R5, below the Rhedol mine, Oligochaeta, principally *Stylodrilus heringianus* and Enchytraeidae, formed up to 35% of the benthic population: Oligochaeta were not an important component of the fauna at any other site (Table 4). In addition Simuliidae were virtually absent from sites in the Rheidol catchment while in the Ystwyth densities of up to 350/m^2 were recorded. (Appendix I).

Discussion

Results from a single invertebrate survey at one time of the year provide an insufficient basis for detailed comments on the status of the invertebrate communities of the Rivers Ystwyth and Rheidol.

Carpenter (1924) attributed the absence of Platyhelminthes, Mollusca, Trichoptera, Crustacea, Oligochaeta and Hirudinea from streams in these catchments to lead mine wastes. In two later studies on the Ystwyth, Jones (1940, 1958) suggested that the absence of molluscs and malacostracans resulted from pollution, but that the rarity of triclads and the absence of oligochaetes and leeches probably resulted from the scouring action of mine refuse and rubble. All of these groups were generally rare or absent in the Ystwyth and Rheidol catchments in 1975 (Tables 3 and 4), and it seems likely that the unstable nature of the substratum of these rivers contributes to the paucity of the fauna.

According to Wurtz, (1962) molluscs and malacostracans are least resistant to heavy metals in solution with oligochaetes being the next least resistant group. The occurrence of oligochaetes below the Rheidol Mine does not support this statement although no data on the toxicity of metals to oligochaetes are available. Wurtz (1962) reported that the 96h LC50 of zinc to two species of snails varied from 0.43 to 1.4mg/l – higher than the mean zinc concentrations recorded below the Rheidol mine. The toxicity of zinc to fish is intimately associated with water hardness and Lloyd (1961) reported that zinc toxicity in soft water (12 mg/l $CaCO_3$ hardness) was 10 times greater than in hard water (320 mg/l $CaCO_3$ hardness). This is particularly relevant to the likely toxicity of heavy metals in the Rivers Ystwyth and Rheidol (<10mg/l $CaCO_3$ hardnes).

Sprague *et al* (1965) reported that caddisfly and midge larvae tolerated at least 0.6 mg/l zinc in soft water (20mg/l $CaCO_3$ hardness). Clearly the effect of metal contamination on the invertebrate populations of the Ystwyth and Rheidol remains equivocal at this stage.

The Insecta was always the most abundant group, supporting the reports of Jone s(1958) and Jenkins (*pers. comm.* Table 3). In particular, the Plecoptera, which are associated with eroding substrata, were generally abundant. The relative absence of Simuliidae in the Rheidol catchment as compared with the R. Ystwyth (Appendix I) may result from the irregular and substantial generating discharges from Nant-y-Moch Reservoir to the R. Rheidol. No explanation can be offered for the substantial densities of oligochaets recorded below the Rheidol mine.

References

Carpenter, K.I. (1924). A study of the fauna of rivers polluted by lead mining in the Aberystwyth district of Cardiganshire. *Ann. Appl. Biol.* **11**, 1-23.

Carpenter, K.E. (1925). On the biological factors involved in the destruction of river fisheries or pollution due to lead mining. *Ann. Appl. Biol.* **12**, 1-13.

Jones, J.R.E. (1940). A study of the zinc-polluted river Ystwyth in North Cardiganshire, Wales. *Ann. Appl. Biol.* **27**, 368.

Jones, J.R.E. (1958). A further study of the zinc-polluted river Ystwyth. *J. Anim. Ecol.* **27**, 1-14.

Jones, A.N. & Howells, W.R. (1969). Recovery of the River Rheidol. *Eff. Wat. Treat.* **9**, 605-610.

Lloyd, R. (1961). The toxicity of mixtures of zinc and copper sulphates to rainbow trout *(Salmo gairdneri,* Richardson). *Ann. Appl. Biol.* **49**, 535-538.

Neill, R.M. (1938). The food and feeding of brown trout *(Salmo trutta* L.) in relation to the organic environment. *Trans. R. Soc. Edinburgh*, **59**, 481-520.

Newton, L. (1944). Pollution of the Rivers of West Wales by lead and zinc mine effluent. *Ann. Appl. Biol.* **31**, 1-11.

Sprague, J.B., Elson, P.F. & Saunders, R.L. (1965). Sublethal copper-zinc pollution in a salmon river – a field and laboratory study. *Int. J. Air. Wat.* **9**, 531-43.

S.W.W.R.D. (1976). Fisheries Studies – Ystwyth & Rheidol. Craig Goch Field Surveys Group Meeting, Malvern – February 1976.

U.W.I.S.T. (1976c). Comparison of two methods of collecting macroinvertebrates from the R. Wye. Craig Goch Field Survey Group Meeting, Malvern – February 1976.

U.W.I.S.T. (1976d). Invertebrate Studies – R. Wye. Craig Goch Field Surveys Group Meeting, Malvern – February 1976. U.W.I.S.T. Paper 4.

Wurtz, C.B. (1962). Zinc effects on fresh-water molluscs. *Nautilus*, **76**, 53-61.

Table 1

Sampling sites on R. Ystwyth and R. Rheidol

Ystwyth Catchment		Rheidol Catchment	
Y1	R. Ystwyth at Tymawr (SN 815748)	R1	Afon Myherin (SN 771782)
Y2	R. Ystwyth below Cwmystwyth mine (SN 790738)	R2	Nant Rhuddnant (SN 774776)
Y3	R. Ystwyth at Grogwynion (SN 715720)	R3	R. Mynach (SN 755770)
Y4	R. Ystwyth at Trawscoed (SN 666729)	R4	R. Rheidol above mine (SN 731780)
Y5	Nant Magwr (SN 672744)	R5	R. Rheidol below mine (SN 725781)
Y6	R. Ystwyth at Llanilar (SN 618756)	R6	R. Rheidol at Tycam (SN 681792)
		R7	R. Rheidol at Capel Bangor (SN 649798)

Table 2

Mean velocity and depth at sites on the R. Ystwyth and R. Rheidol in March 1975

Site	Velocity (cm/sec)	Depth (cm)	Site	Velocity (cm/sec)	Depth (cm)
Y1	39	24	R1	43	16
Y2	29	23	R2	34	21
Y3	52	27	R3	85	21
Y4	49	19	R4	56	12
Y5	68	21	R5	44	17
Y6	38	24	R6	63	25
			R7	72	18

Table 3

Proportional representation (% total numbers) of major groups in the Ystwyth Catchment

Sites	Y1	Y2	Y2*	Y3	Y4 T	Y4*	Y5	Y6	Y6*
Platyhelminthes	0	0	<1	0	<1	<1	1	0	0
Oligochaeta	4	0	0	2	0	0	0	0	0
Plecoptera	83	70	68	70	42	5	35	69	21
Ephemeroptera	3	<1	<1	13	20	64	51	14	23
Trichoptera	1	1	8	1	3	9	3	1	<1
Coleoptera	0	<1	2	3	1	3	0	1	<1
Chironomidae	5	26	15	7	3	0	1	13	7
Simuliidae	3	<1	6	0	30	18	9	1	43
Others	1	<1	<1	4	<1	<1	0	1	4

* Jenkins *(pers. comm.)* April 1974 collection, 2 minute kick sample.

Table 4

Proportional representation (% total numbers) of major groups in the Rheidol Catchment

Sites	R1	R2	R3	R4	R5	R6	R7
Platyhelminthes	<1	2	0	2	3	2	<1
Oligochaeta	<1	0	0	<1	36	2	<1
Plecoptera	91	92	83	52	44	51	54
Ephemeroptera	<1	0	0	8	9	18	33
Trichoptera	<1	1	2	24	0	15	7
Coleoptera	<1	0	1	10	0	8	1
Chironomidae	3	2	3	2	4	3	6
Simuliidae	0	2	9	0	0	<1	0
Others	2	1	2	1	4	1	3

Appendix I – Macro-invertebrates from the Ystwyth and Rheidol catchments (no./m^2), March 1975

Stations -	Y1	Y2	Y3	Y4	Y5	Y6	R1	R2	R3	R4	R5	R6	R7
Platyhelminthes													
Phagocata vitta	-	-	-	5	20	-	-	20	5	-	-	30	5
Polycelis nigra/tenuis	-	-	-	-	-	-	-	-	-	15	15	-	-
Annelida (Oligochaeta)													
Lumbriculidae													
Stylodrilus heringianus	-	-	15	-	-	-	-	-	-	-	65	-	5
Enchytraeidae	30	-	-	-	-	-	-	-	20	-	105	15	-
Lumbricidae	-	-	-	-	-	-	-	-	-	5	5	15	-
Arthropoda (Insecta)													
Leuctridae													
L. hippipus	15	30	5	-	-	5	-	-	20	-	-	-	5
L. moselyi	-	-	-	-	95	-	-	-	-	-	-	-	-
L. inermis	50	405	35	10	-	20	135	100	430	15	15	625	700
Nemouridae													
Protonemura meyeri	-	20	10	45	-	35	20	5	-	-	-	25	20
Amphinemoura sulcicollis	145	110	125	60	50	185	120	125	175	15	5	165	105
Nemoura sp.	-	-	-	-	-	-	-	-	-	-	-	-	5
Chloroperlidae													
Chloroperla torrentium	80	240	35	45	45	5	55	710	390	40	-	50	5
C. tripunctata	325	220	420	375	65	1375	50	-	75	320	145	-	30
Perlodidae													
Isoperla grammatical	20	10	5	10	10	10	25	30	155	-	10	45	35
Taeniopterygidae													
Brachyptera risi	5	-	-	30	170	25	5	-	15	-	5	-	15
Rhabdiopterys acuminata	-	-	-	-	-	5	-	-	-	-	25	-	-
Taeniopteryx nebeculosa	-	-	5	-	-	-	-	-	-	-	-	-	-
Baetidae													
Baetis rhodani	15	5	60	75	40	140	-	-	5	-	-	105	220
B. scambus	-	-	-	5	-	-	-	-	-	-	-	-	20

Stations -	Y1	Y2	Y3	Y4	Y5	Y6	R1	R2	R3	R4	R5	R6	R7
Heptageniidae													
Ecdyonurus dispar	-	-	10	-	-	-	-	-	-	-	-	-	**-**
E. venosus	-	-	-	-	-	45	-	-	-	-	-	-	**-**
Rhithrogena semicolorata	-	-	55	185	615	150	-	-	-	65	45	180	**310**
Heptagenia sp.	-	-	-	-	-	-	-	-	5	-	-	-	**-**
Limoniinae													
Dicranota sp.	10	30	10	-	-	-	10	40	-	5	-	-	**30**
Rhagionidae													
Atherix sp.	-	-	15	5	-	5	-	-	-	-	-	-	**-**
Glossomatidae													
Glossosoma conformis	-	-	-	-	-	-	-	-	-	105	-	65	**-**
Hydropsychidae													
Hydropsyche sittalai	-	-	-	10	25	5	25	-	-	10	-	170	**80**
H. pellucidula	-	-	-	-	5	-	-	-	-	25	-	-	**15**
Polycentropidae													
Polycentropus conspersa	-	5	-	-	-	-	-	-	-	-	-	-	**-**
P. kingi	-	-	-	-	-	5	-	-	-	-	-	-	**5**
P. sp.	-	-	-	-	-	-		-	5	-	-	-	**-**
Rhyacophilidae													
Rhyacophila dorsalis	-	5	-	10	10	5	-	-	10	10	-	5	**-**
Limnephilidae													
Drusus sp.	-	-	-	-	-	-	10	-	-	-	-	-	**-**
Elminthidae													
Elmis aenea	-	-	-	-	-	-	5	-	-	-	-	-	**5**
Esolus parallelepipedus	-	10	-	5	-	10	-	-	-	-	-	5	**-**
Limnius volkmari	-	-	10	5	-	-	-	-	10	15	-	120	**15**
Oulimnius tuberculatus	-	-	15	-	-	10	-	-	-	-	-	-	**-**
Gyrinidae	-	-	-	-	-	5	-	-	-	60	-	5	**-**
Coleopteran sp. indet.	-	-	5	5	-	-	-	-	-	-	-	-	**-**
Chironomidae (Tanypodinae)													
***Pentaneura* sp. 1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**5**	**5**	**-**	**-**	**-**

Stations -	Y1	Y2	Y3	Y4	Y5	Y6	R1	R2	R3	R4	R5	R6	R7
Chironomidae (Orthocladiinae)													
Eukiefferiella sp. 1	-	5	-	-	-	-	-	-	-	-	-	-	**-**
2	5	-	5	-	-	-	-	-	-	-	-	-	**-**
3	-	-	-	-	-	10	-	-	-	5	-	5	**-**
4	-	35	-	5	-	-	10	5	10	5	20	-	**10**
Brillia modesta	-	-	-	-	5	20	-	-	-	-	-	-	**-**
Orthocladius sp. 2	-	-	-	-	-	-	-	-	-	-	-	-	**-**
3	-	-	5	-	-	-	-	-	-	-	-	-	**-**
5	-	205	50	40	5	280	-	-	10	-	-	-	**-**
6	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Cricotopus bicinctus	-	-	-	-	-	-	-	-	5	-	-	-	**-**
Cricotopus sp. 2	10	35	-	-	-	-	-	-	-	-	-	-	**5**
Chironomidae (Diamesinae)													
Diamesa sp. 1	10	105	5	-	-	-	35	10	5				
2	10	-	-	-	-	-	-	-	-				
Chironomidae (Chironominae)													
Polypedilum nubeculosum	-	-	-	-	5	-	-	-	-	-	-	-	-
Rheotanytarsus photophilus	-	-	-	-	-	-	-	-	-	-	-	35	**-**
Ceratopogonidae	-	-	-	-	-	-	-	-	-	-	5	10	**-**
Simuliidae													
Simulium brevicaule	-	-	-	5	-	5	15	-	-	-	-	5	**-**
S. monticola	-	-	-	340	80	15	-	-	-	-	-	-	**-**
S. variegatum	-	5	-	5	45	-	-	-	-	-	-	-	**-**
S. nitidifrons	-	-	-	-	-	5	-	-	-	-	-	-	**-**
S. latipes	20	-	-	-	-	-	-	-	-	-	-	-	**-**
TOTAL DENSITIES	750	1480	910	1355	1270	2400	495	1045	1355	720	465	1495	1645

- = not collected.

Figure 1

Sampling Sites on R. Ystwyth & R. Rheidol

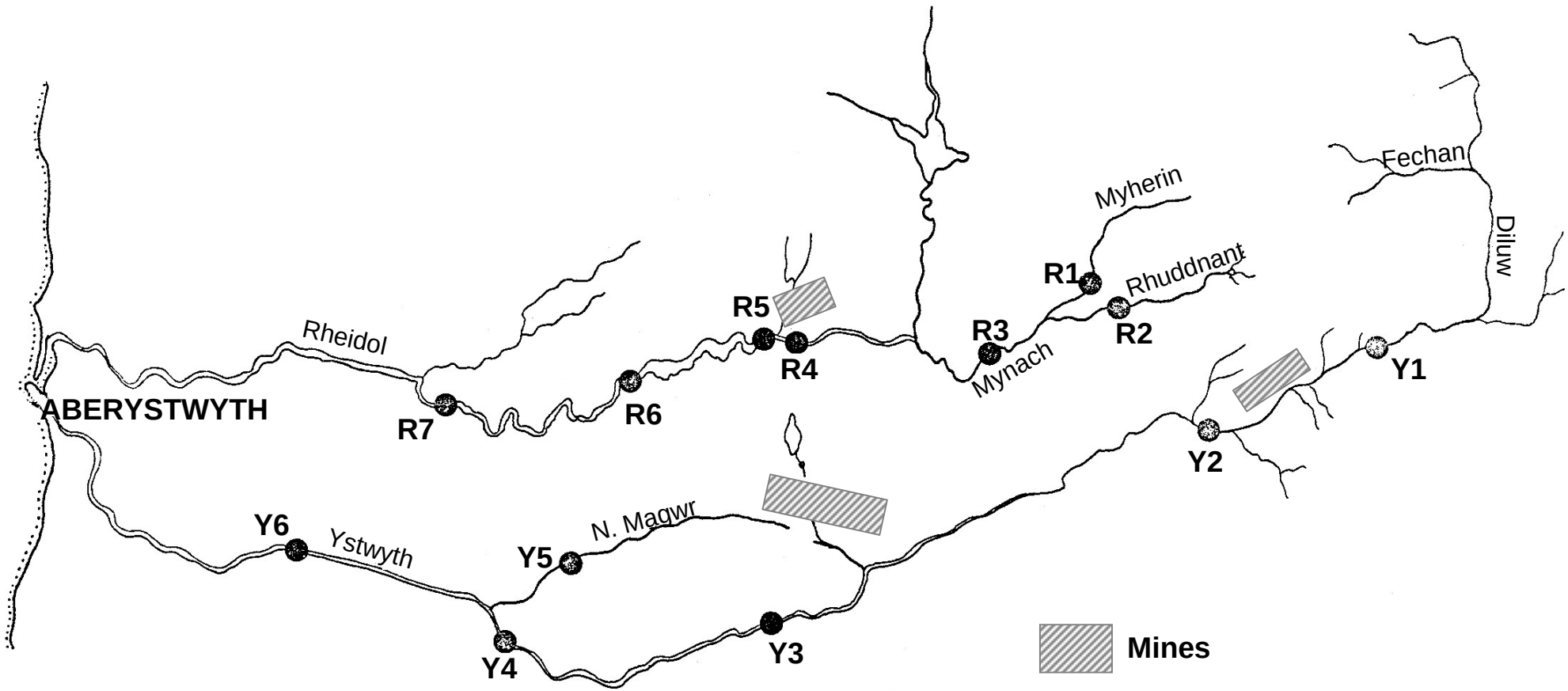

Figure 2R – Distribution of:

a) No. of taxa b) Invertebrate density c) total Zn conc., for R. Rheidol

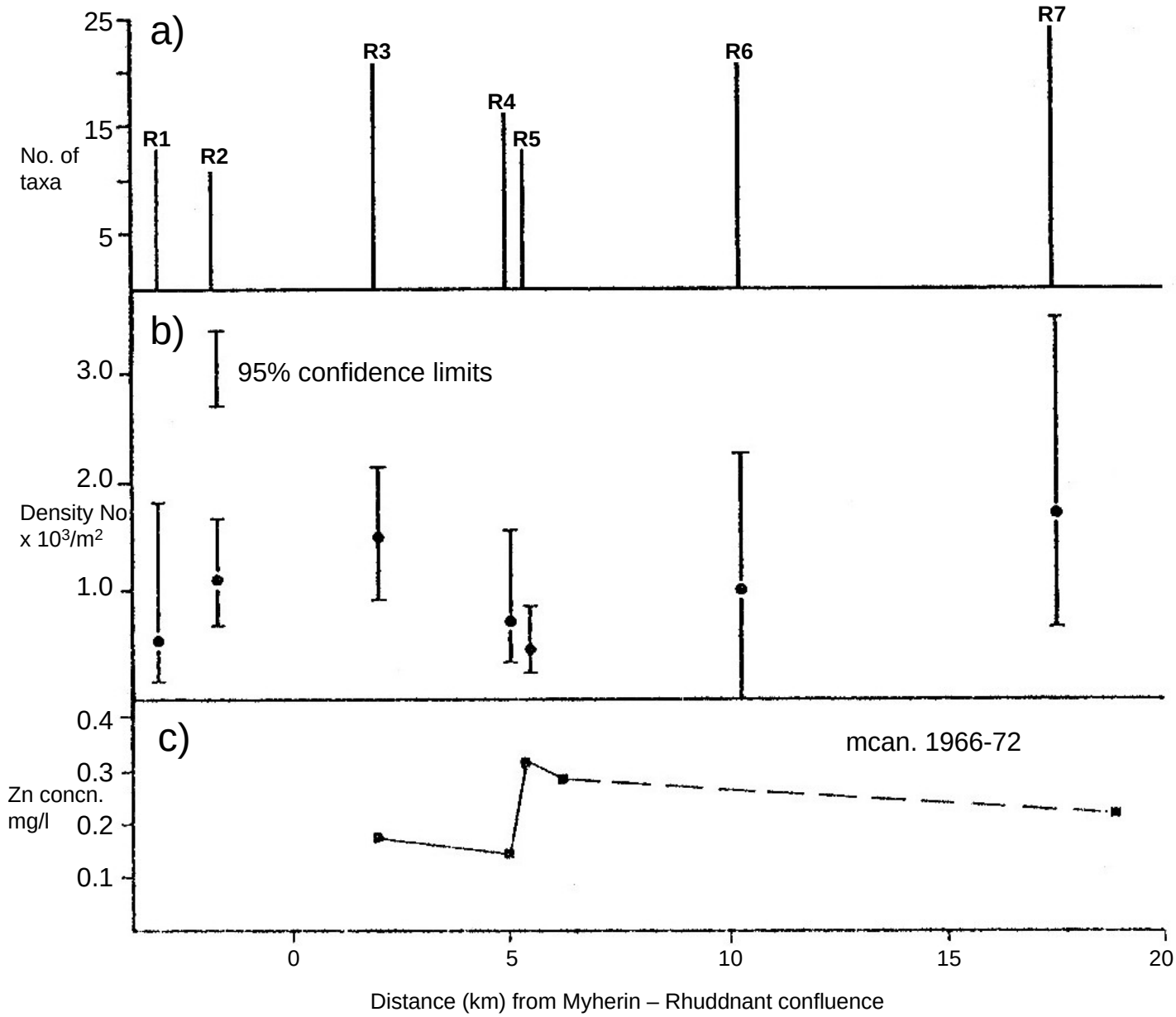

Figure 2Y – Distribution of:

a) No. of taxa b) Invertebrate density c) total Zn conc., for R. Ystwyth

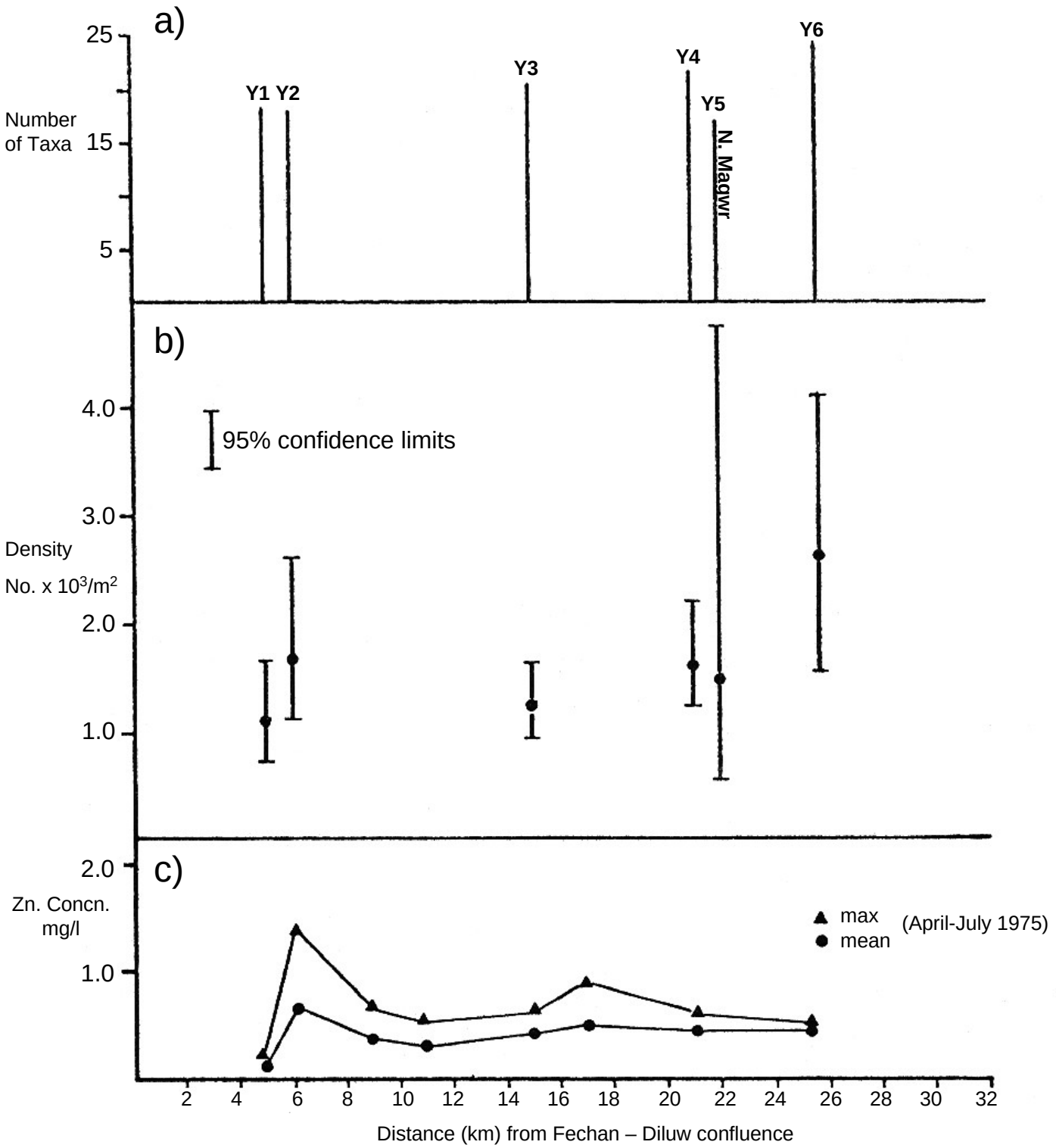

Figure 3

Average linkage cluster of Jaccard Index – March 1975