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THE AVONMORE BROWN TROUT FISHERY AT RATHDRUM, CO. WICKLOW

by

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and

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A massive ore body in the Vale of Avoca has been mined since 1752. Environmental consequences have included a sulphide rich effluent entering the river from the workings and creating a pollution block which effectively disrupts migrations of migratory salmonids. The angling fishery upstream of the block, in the vicinity of Rathdrum, exploits small resident brown trout. Prospects for the further development of this fishery are considered and the present arrangements are reckoned to be most suitable for the foreseeable future.

The Angler's Guide to the Irish Free State (1930) observed:

"The Aughrim River holds numerous small brown trout. The Avoca River is poisoned by the drainage from the Ballymurtagh and other copper mines, as a result of which very few salmon and sea trout succeed in getting up the river. A few survive in August and September and during heavy winter floods".

The exploitation of a large ore-body in the Vale of Avoca and the release of an acidic leachate was the cause of the problem although natural leachate had probably polluted the river before mining of the minerals commenced. The long standing problem of natural leaching from the hillsides had been documented as early as 1752. Subsequent mining activities greatly exacerbated the problem and established a pollution block on the river in the vicinity of Avoca, effectively cutting off the migrations of salmonids.

The Rathdrum Anglers who have the fishing upstream of the nuisance requested an appraisal of the current position since they wished to discover how best they should develop their fishery. This appraisal commences with an examination of the pollution block in the vicinity of Avoca, followed by a description of the fishery upstream at Rathdrum. In the context of the information emerging the prospects for the future conduct of the fishery are briefly reviewed.

The Avoca River

Mining operations

Mining in the Vale of Avoca is recorded as taking place since 1752 but it is probably of greater antiquity. The orebodies were discovered where they were exposed on the river banks and their mining has to date extended over a distance of 3.5km, north-east to south-west. The miners initially followed the copper rich chalcopyrite facies by eye, disregarding the polymetallic ores to a large extent.

The Avoca deposits are volcanogenic in origin. They consist of a copper rich pyritic zone overlain by a zone of lead and zinc pyritic ore. The original bodies are estimated to have contained 5 to 6 million tonnes of ore. Before the Second World War the Avoca mine complex is reckoned to have yielded about 4 million tonnes of sulphide ore from workings which contained 106 shafts of up to 215m deep and to have employed, in the early nineteenth century, more than 2000 men at one time. The most recent operations in Avoca commenced in 1969 and terminated in August 1982.

Layout of the mining operations

The most recent workings at Avoca occur among the excavations of earlier mining activity. The layout of the Avoca mining complex is shown in Fig.1. An underground mining area is located west of the Avoca River. Also on that side of the river is a small open pit in which low grade ore remnants rejected by past operators were re-worked. There was also some reclamation of 18 and 19th century spoil heaps there. On the east side of the river there is an open pit operation - Cronebane - where copper sulphides were mined.

Yellow spoil heaps are a prominent feature in the vicinity of the mines. They arose from stripping which consisted of the removal of topsoil, and the creation of barren areas. Other waste tips were formed by cobbing piles which resulted from ore dressing operations in which rocks were manually broken into an acceptable product and a discard. Cobbing piles in both east and west Avoca are stacked to a height of 10m.

Tailings, or fines, resulting from ore washings, are accumulated in several ponds, the latest of them to have been in use was at Shelton Abbey, approximately 6.5km to the south.

Sources of pollutants

The principal copper ores in Avoca are chalcopyrite and pyrite whose chemical formulae (CuFeS and FeS) indicate their sulphur content. Whenever sulphate in rock strata is uncovered - as in cobbing piles or by stripping - and exposed to the oxidising action of air, water and chemosynthetic bacteria, it is converted to sulphuric acid. From the remains of former mining activities there is a constant drain of acid leachate with a pH of 3.0 - 6.0. Natural hillside drainage contributes a leach liquor - a clear liquid with copper and iron in solution - with a pH of 2.5 - 4.5. The effluent from deep mine drainage contains solids in suspension and copper and iron in solution. It has a pH which varies between 3.5 and 6.0. All of these effluents drain to the Avoca River and there is no method by which they can at present be controlled.

Behaviour of pollutants and their effects

The acidity of the water (expressed as its pH or hydrogen ion concentration) influences the way in which other contaminants, notably copper, zinc and iron, behave and their toxicity. In more alkaline conditions (at higher pH levels) metals may be precipitated out of solution in the water, to settle in the finer sediments of the river bed.

Of the three important constituent metals in the Avoca river, copper is known to be the most toxic and it can interact with zinc to produce effects which are more grievous.

Between the Meeting of the Waters and Woodenbridge the concentrations of chemicals and the response of invertebrates - fish food - can be described by the curves shown in Fig.2. Curve A represents in very simplified form the build-up of metals; after a time their concentration is diluted and they may be suspended into the sediments of the substratum. As the leachate builds up pH is depressed (curve B) but this later recovers with the effects of dilution and the later rise in pH may contribute to the precipitation of metals out of solution.

The curves in Fig.2, it must be stressed,are greatly simplified but repeated sampling by one of the authors (J.R.) has validated them. On specific dates there may be considerable variability,as is shown in results obtained sampling during high water in March, 1986 (Table 1).

The increasing acidity which a drop in pH represents has important consequences for the invertebrates. The number of individuals declines, then later recovers and the number of species within the community follows a similar pattern, in accordance with curve B.

All of this is very simplified and not all of the mechanisms involved are very clear. The rate of water discharge, for example, can have an important influence: higher discharge rates are believed to have an eroding effect so that, during floods, sediments may be disturbed and metals released into solution once more.

Table 1: Chemical analyses at eight points on the Avoca Rivers; samples collected during high water in March 1986.

Site No.	Location	Zn	Fe	Cu	pH
			p.p.m.		
1	20m u/s of Deep Adit	0.06	0.52	0.01	5.80
2.	Contents of Deep Adit	114.30	142.50	10.83	3.40
3.	20m d/s of Deep Adit	2.31	2.68	0.21	4.32
4.	u/s of Avoca	0.31	0.69	0.04	4.05
5.	u/s of Woodenbridge	0.45	0.98	0.05	5.95
6.	d/s of confluence with Aughrim R.	0.06	0.52	0.01	5.80
7.	Main Avoca River between Woodenbridge and Arklow	0.31	0.69	0.04	4.05
8.	u/s Road Bridge, Arklow	0.31	0.73	0.04	5.20

Consequences for the fauna

Although the effects of acid mining leachate are known to be severe they are not, in the Avoca River, toxic to all invertebrates. Some species would appear to have an inbuilt resistance; individuals of other, more susceptible, species would appear to acquire immunity from their lethal effects. The entire community however displays the stress of pollution and its biomass is low.

When observations have been made on invertebrates in acid mine leachate they have been seen to go through a sequence of symptoms prior to death. These range from hyperactivity to loss of equilibrium, tremors and convulsions. Insects may exhibit gill damage, a swelling of the abdomen, shrinkage and extrusion of the gut.

Observations on the effects of leachate on fish in the Avoca River were undertaken in April 1986 using raibow trout of approximately 15cm fork length. The fish were held in cages in the water of the Tigroney Adit which channels most of the leachate from East Avoca to the river. Death occurred less than two hours after the fish had been introduced to the channel (N = 8; Range of time = 98 - 122; mean = 114 minutes).

Examination of the fish, post-mortem, revealed considerable skin damage. The epidermis was necrosed and vacuolated and it had been destroyed in places, leaving the dermis exposed. There was no damage to the dermis nor, because death had been so rapid, was there time for an inflammatory response.

These effects were of course demonstrated in fish which were held in the main effluent stream and, in the normal course of events, trout in the Avoca River would not be exposed to such heavy concentrations of the pollutant. Conceivably some individuals might be expected to get through the contaminated stretch of the river and reports suggest that they occasionally do so (the opening quotation to this work is a case in point).

However, although death might not ensue in every case, it appears likely that mine leachate predisposes fish to other skin conditions. A survey of flatfish along the east coast or Ireland in 1982 reported the highest levels of lymphocystis skin disease in the marine waters at the mouth of the Avoca River.

The Fishery

The Avonmore River, in the vicinity of Rathdrum, is fished by local and visiting anglers. Reports from them to one of us (E.F.) indicated the remains of an inherently migratory salmonid stock there: silvered trout (smolts) are still occasionally taken on rod and line in the river, suggesting they are produced in small numbers upstream of the pollution block at Avoca. And there are accounts within living memory of salmon occasionally making their way upstream to Rathdrum. All of this is of course sufficiently remarkable to emphasise the essentially residential nature of the existing brown trout fishery.

Local angling interests are organized in a club of which there were approximately 100 members in 1985. In the absence of information on catch per effort and other statistics, their success is difficult to assess. The only information available is a register of catches made during four angling competitions in 1985 and these are summarised below. The bag weights average just over 0.5lb (290g) in the fly fishing competition and 1.66lb (750 g) in the "all in" contest. These competitions are believed to be well supported by club members. If that is so, the success rate and small bag size suggested by the figures indicates a low yield.

Bag weights (lb) recorded

Competition	Range	s.d.	Average (lb)	No.
Live bait	0.19-2.81	0.7428	0.98	12
Spinner	0.25-1.69	0.7379	1.06	3
Fly	0.50-0.88	0.1462	0.65	5
All-in	0.44-2.75	0.7219	1.66	7

Further details of the Avonmore catch were ascertained from fish provided by the anglers themselves in 1985. These are summarised in the Table below and in Fig. 3 which indicates that captured fish are predominantly two years of age and that very low weights are being exploited.

Characteristics of the Avonmore catch (N = 71)

	Length (cm)	Weight (g)	Age (years)
Range	14.5-32.0	25.6-422.0	1-4
Average	19.1	84.3	1.78

Using the same material, back-calculations of length at age were attempted from the scales and the results are set out below:

Age (years)	Range (cm)	Average (cm)	Number
L1	3.9 - 11.4	7.4	68
L2	10.3 - 20.6	15.0	41
L3	16.3 - 27.4	20.3	11
L4	22.2 - 30.7	26.4	2

The Avonmore fishery context

In order to evaluate the Avonmore fishery comparison is drawn with another angling fishery in an oligotrophic region. Connemara is better known for its sea run trout but some resident stocks also occur, notably on the flat terrain in the vicinity of Roundstone where extensive lake systems contain limited spawning opportunities for trout. Apparently those juvenile trout which do occur there are absorbed by the freshwater and sea trout, which also co-exist with them, are relatively less abundant. There are in Connemara recognised brown trout fisheries and from one of these 23 trout were obtained. Their characteristics at capture were:

	Length (cm)	Weight (g)	Age (Years)
Range	21.0 - 31.5	100-360	2 - 4
Average	25.2	191	2.62

The growth rates of these fish, shown as a series of lengths at age (back-calculated from scale examinations) are:

At age (years)	Range (cm)	Average cm	Number
L1	4.1 - 12.8	7.1	22
L2	8.7 - 27.2	17.5	22
L3	18.0 - 27.0	22.6	11
L4	25.5 - 26.0	25.8	2

Conclusion

Avonmore and Connemara brown trout appear to have similar growth rates although the fish in the Avonmore River are smaller at capture. A larger threshold for acceptable fish catch would, it is anticipated, improve the quality of the Avonmore landings.

The tributary streams, and the more important rivers contributing to the Avoca contain an abundance of spawning gravels but the waters, even above the pollution block, are soft and of low productivity. The invertebrate community is a widely distributed lotic one, characteristic of poor waters, and invertebrate - mainly insect - biomass is low. It is likely that the plentiful spawning and poor on-growing conditions contribute to a surfeit of "stunted brownies" and expectations cannot realistically be of the Avonmore as a producer of large, well conditioned trout.

Only in the circumstances where a sufficiently numerous angling clientele fished out the introductions within a short period of their being placed in the river should the possibility of a put-and-take fishery be considered.

Acknowledgements

Sincere thanks are offered to the Rathdrum Anglers for their co-operation in these investigations and for their collection of scales and life data from a sample of their catch in 1985. Mr. Joe Crane of Clifden, Co. Galway, supplied the sample of brown trout from the vicinity of Roundstone and John McArdle of the FRC examined the rainbow trout sacrificed during the timed mortality tests.

Further reading

The foregoing is a much condensed account of a phenomenon on which there is a great deal of technical information. The reader who wishes to pursue the matter further is referred to the following

Fahy, E. (1985) Child of the Tides: a sea trout handbook Dublin: Glendale Press

McArdle, J., T. Dunne, M Parker, C. Martyn and D. Rafferty (1982). A survey of diseases of marine flatfish from the east coast of Ireland in 1981. ICES cm 1982/E:47.

Platt, J.W. (1972) Geological context of the Cu/Pb/Zn sulphide orebody at Avoca, Co. Wicklow, Ireland. Waste control and disposal in mining Technology Ireland October, 1972:9-12.

Reynolds, J.V. (1983). Heavy metal pollution in the Avoca River and its impact on the macroinvertebrate population. BA mod Thesis, Trinity College, Dublin 103pp

——————— (1986) Insect populations in a river receiving acid mine drainage. Irish Journal of Environmental Science 4 (1): 35-41.

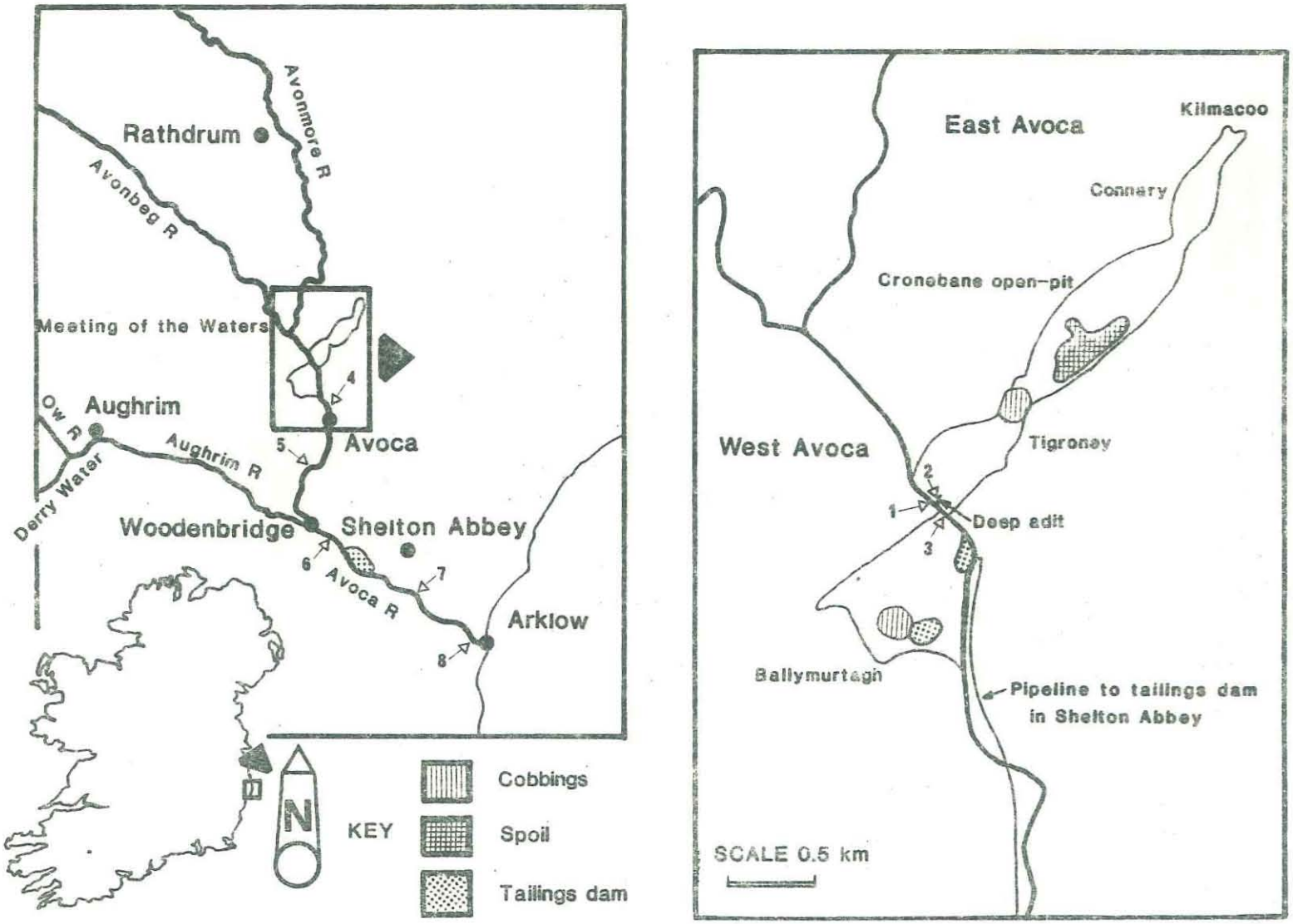

Fig.1 Rivers contributing to the Avoca and a map of mine workings in the Vale of Avoca; drawn after Platt, greatly simplified. Numbers refer to sites at which samples for chemical analysis were collected.

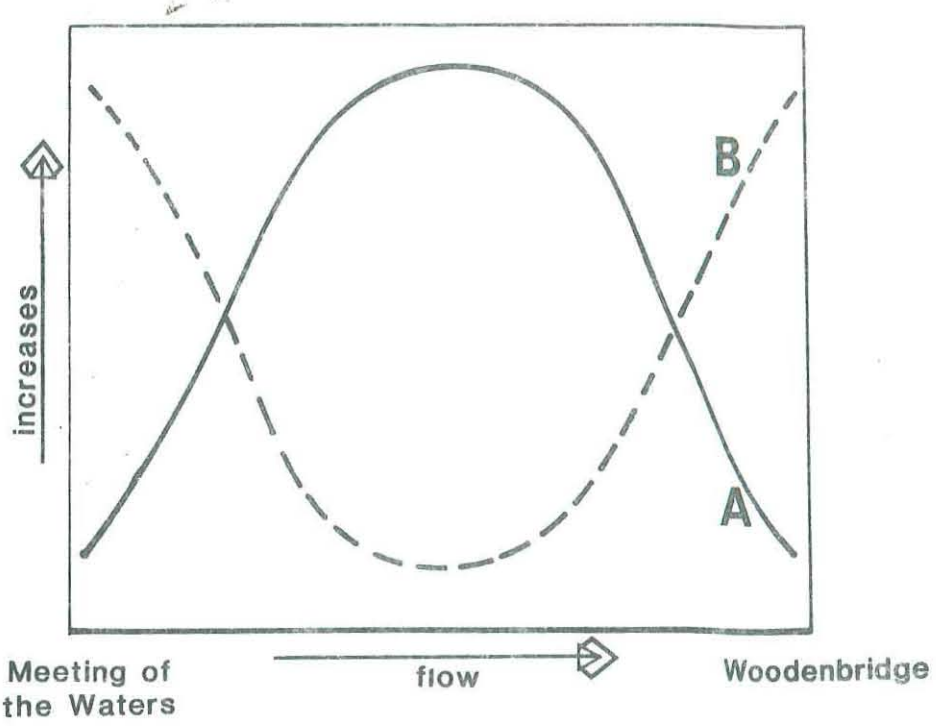

Fig.2 A very simplified account of the behaviour of pollutants and invertebrate fauna between the Meeting of the Waters and Woodenbridge. Further explanation in text.

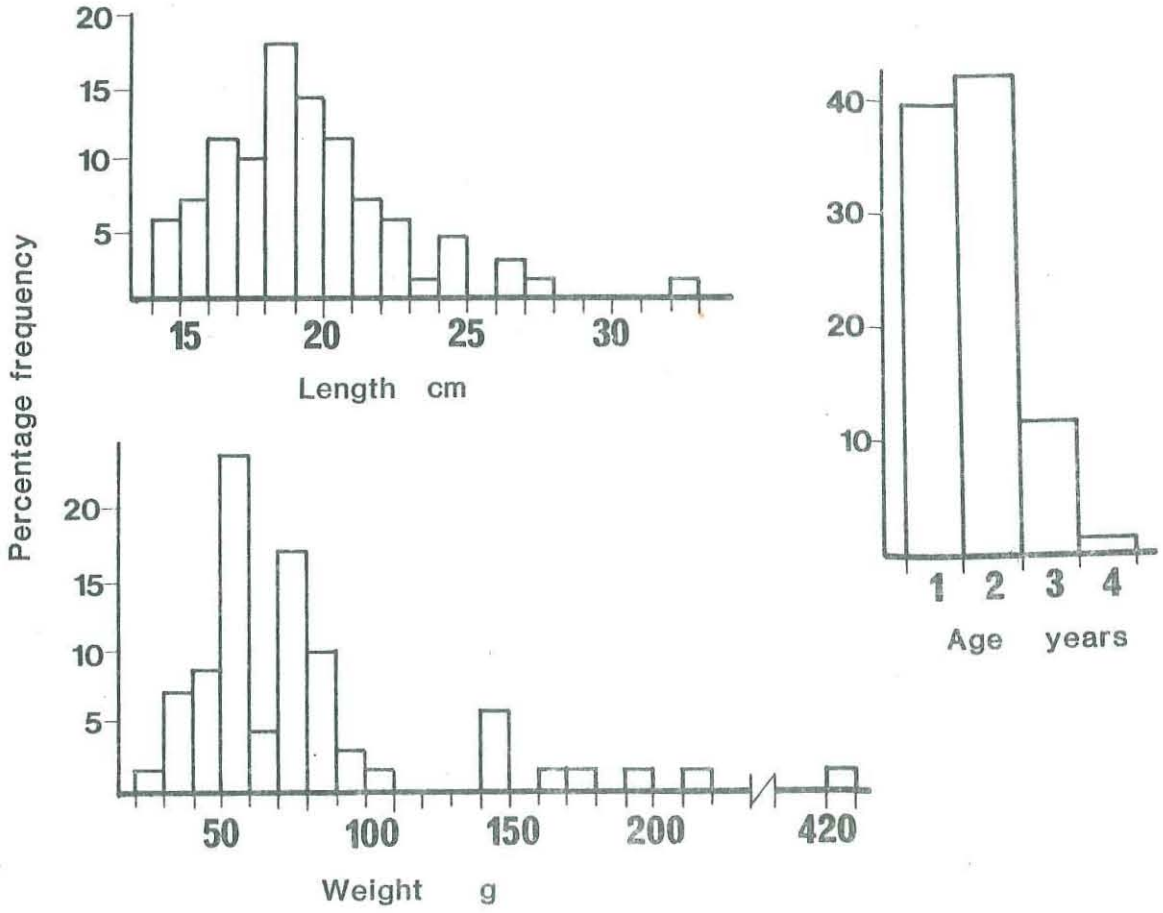

Fig.3 Characteristics of the anglers' catch deduced from 71 brown trout taken by the Rathdrum anglers in 1985: length, weight and age of the fish.