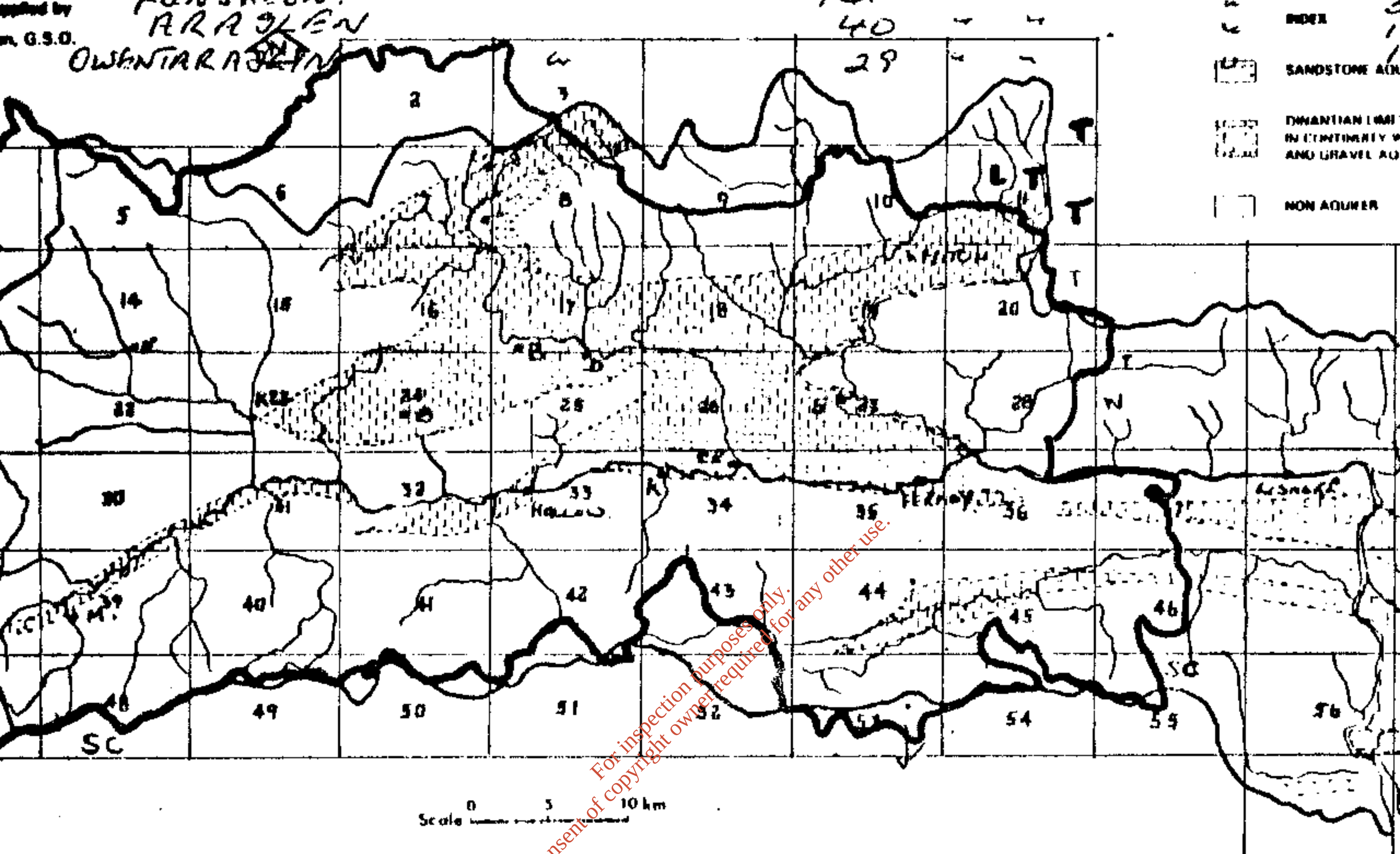
BLACKWATER CATCHMENT 1310 SQ MILES - LENGTH. 1
AWBEG " 125 " "
ALLOW " 122 SQ "
BRIDE (TO TALLOW BR). " 143 " "
FUNSHEON. " 141 " "
ARAGLEN 40
OWENTARRAGH " 29



Hydrogeology in the Blackwater Catchment

NE NORTH CORK BDY.
NE BLACKWATER CATCHMENT BDY.
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LENTH BLACKWATER.
AREA BLACKWATER CATCH
AREA OF NORTH CORK 9

Paul S. Wal

former director of the British Water Pollution Research Laboratory, acted as consultant for the project.

A preliminary survey of the rivers in June and July of 1966 showed that the towns of Rathmore and Mallow on the main Blackwater, Mitchelstown on the Funcheon (a tributary of the Blackwater) and Rathduff and Blarney on the Martin (a tributary of the Lee) were the points of greatest interest from the point of view of the project since the bulk of the waste discharges arises at these points. The greater part of the project was concerned with the changes in water quality caused by pollution at these places, though in August 1967 and August 1968, short investigations of the Blackwater estuary were carried out and in July 1969, a number of points on the main tributaries of the Blackwater (excluding the Funcheon at Mitchelstown) were also investigated.

The method of investigation entailed comparisons of physically similar areas of the rivers above and below the main waste outfalls in relation to water quality and plant and animal communities and the determination of the distances over which any deterioration in these features extended, by sampling at several points beyond that at which the river first received polluting matter in each area. The chemical and physical criteria of water quality used were dissolved oxygen, suspended solids, ammonia, nitrate, temperature, pH and 5-day biochemical oxygen demand (B.O.D.) - a measure of the biologically degradable organic matter in the water. The fish stocks, flora and invertebrate fauna were also investigated.

The bulk of the wastes discharged into the Blackwater and Martin is of an organic nature, arising from the industries based on milk at Rathmore, Mallow, Mitchelstown and Rathduff and from beet-sugar and food processing factories at Mallow. Such industries operate on a seasonal basis so that large amounts of waste are discharged during a part of the year only in each case e.g. during autumn and winter in the case of the beet-sugar factory at Mallow. Domestic sewage, though arising from relatively small communities, is the most commonly encountered and persistent source of pollution on the rivers and at several locations is discharged without treatment.

The magnitude of an organic trade waste as a pollution source is best expressed in terms of its population equivalent which is calculated on the basis that the sewage of one person in a modern urban community has a B.O.D. equivalent of 0.12 lb per day. Thus if the strength (B.O.D.) and volume of the trade waste is known it is possible to calculate the size of the human population which would contribute a similar amount of waste. It has been calculated that the amount of trade waste discharged per day in summer and autumn to the Blackwater at Rathmore is equivalent to the sewage of some 7,000 persons and at Mallow to that of about 20,000 persons. During the beet campaign in winter at Mallow trade wastes entering the river have a population equivalent of nearly 175,000. Trade and domestic wastes are treated together at Mitchelstown so that it is not possible to gauge exactly the strength and volume of trade wastes entering the River Gradoge, (a small stream which flows into the Funcheon about half a mile below the sewage works outfall); however, prior to treatment, trade wastes arising in Mitchelstown have a population equivalent of nearly 140,000. The only waste discharge investigated which has a relatively small organic content is that from a woollen at Blarney. The only marked effect caused by this effluent appears to be an increase in the concentration of pesticides, particularly dieldrin, which may arise from the treatment of wool yarn in the mill.

NOTE

The investigations described herein were carried out under normal conditions of river flow. That the final conclusions would not hold good for conditions of abnormally low river flows is borne out by the fish kills between Mallow and Fermoy in the month of October, 1969, which appear to have been caused by deoxygenation of the river water. The Meteorological Office Report for 1969 comments on the unusually small precipitation which occurred over the country, particularly the south, during late summer and autumn of 1969.

B2/230(3)

12 Márta, 1970.

Water Quality Surveys of the Rivers Blackwater and Martin.

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Following the completion of the above project a brief outline of the investigations carried out has been prepared and is enclosed for your information.

The full report by the two Research Fellows (Mr. Paul Toner, B.Sc. and Miss Clodagh O'Connell, B.Sc.) will be published in the Irish Fisheries Investigations Series.

Mise, le meas,

E. [illegible]

Chief Asst. Co. Engineer (San.),
Room 902.

Copy for your information.

23rd March, 1970.

Water Quality Surveys in the Rivers Blackwater and Martin, Co. Cork 1966 to 1969

The relatively mild effects on the dissolved oxygen which, in consideration of the high B.O.D. levels, might have been expected to be much greater, appear to be due to the rapid reaeration rates produced by river flow characteristics which operate in most cases. Rapidity of reaeration also appears to be responsible for reducing the magnitude of diurnal variation in the dissolved oxygen in the rivers.

Very marked changes in the dissolved oxygen content of rivers may occur between day and night due to photosynthesis of algae and weeds. During daylight, the production of oxygen by these organisms may greatly exceed the uptake of the gas for respiratory purposes by both plants and animals leading to supersaturated conditions with respect to dissolved oxygen (as high as 200% in some rivers). During the hours of darkness, when photosynthesis ceases, a steady loss of dissolved oxygen occurs, partly to the atmosphere if conditions of supersaturation have been reached in daylight and partly to the respiration of plants and animals. Where the latter is large (e.g. where dense weed beds occur) and particularly in polluted streams where extra demand on dissolved oxygen are made by organic matter in solution and by mud and sewage fungus on the substratum, very low concentrations may be reached before daylight returns. The minimum concentrations are usually found to occur just before sunrise. The magnitude of diurnal variation in dissolved oxygen is partly dependent on the rate of reaeration, the degree of supersaturation during daylight and that of depletion during darkness being smaller where the rate is relatively rapid.

Measurements showed that in one stretch (Funcheon R. below its confluence with the Gradoge) lethally low concentrations of dissolved oxygen would remain undetected if monitoring was confined to daylight hours. Round the clock continuous sampling is necessary to judge the extent of depletion in the dissolved oxygen by pollution. It has also been shown that the use of the standard theoretical formula to predict variation in dissolved oxygen in the rivers would in most cases be rendered invalid by the presence of mud and sewage fungus. The dissolved oxygen uptake by these agents would have to be taken into account in addition to B.O.D. and reaeration rates.

Suspended solids were usually found in high concentrations wherever the B.O.D. was also high and especially so immediately below outfalls. Rapid settling out of suspended material seems to occur in both rivers, as pools alternate quite regularly with the faster flowing stretches. While the concentrations recorded are not high enough to be directly injurious to fish, the tendency of suspended solids to form sludge deposits is potentially harmful since this creates a continual drain on the dissolved oxygen which is greatly aggravated during floods when the solids are dispersed in a septic condition. Such material also causes impairment of the animal and plant communities on the substratum and, by increasing turbidity, reduces photosynthesis.

The concentrations of ammonia in all stretches investigated were much lower than those which would be directly toxic to fish. Ammonia is much less toxic in the slightly acid waters of these rivers than in alkaline conditions.

Situations in which pollution caused adverse changes in pH (acidity or alkalinity) were not encountered during the survey.

tributary streams which cause a rapid improvement in water quality. Elsewhere, trout and salmon were present in polluted water, though at Rathmore the latter were much less numerous in polluted water compared to unpolluted.

Non-salmonid fish such as eel, dace, roach, gudgeon, minnow and lamprey were found to be relatively unaffected by pollution and at Rathmore were much more numerous in polluted conditions than in unpolluted. On the other hand, stoneloach appeared to be as susceptible as trout and salmon to pollution.

A marked feature of trout, at Rathmore especially, was the faster growth rate and higher fat content of fish in polluted water compared to those in unpolluted water. The difference is probably due to a greater food supply in polluted reaches where the invertibrate fauna, though restricted in species, was usually found to be much more abundant than in unpolluted reaches. However, further deterioration in water quality in these stretches would lead to conditions incapable of supporting salmonid and, ultimately, coarse fish. There is no doubt that the several effects on fish stocks encountered in this survey, ranging from mild to severe, may be expected to follow each other in time at each location, if pollution increases.

Since assessment of the fish populations was undertaken on the basis of localised surveys it is not feasible to make an estimation of the effects of pollution on the general fish productivity of the rivers. With the information available it would appear that a stage has not yet been reached where significant decline in productivity is detectable. Certainly, in so far as the salmon catches on the Blackwater are concerned, there appears to have been no reduction in these in recent years which could clearly be attributed to the effects of pollution. However, this survey has shown that the beginnings of a serious decline in trout stocks are present in some parts of the rivers, particularly the Funcheon below Mitchelstown.

Investigations of the flora of the rivers were made in June in both 1967 and 1968 covering flowering plants, mosses and algae, and in the period October, 1968 to January, 1969 in relation to sewage fungus (a growth which develops where organic matter is discharged into a river). The most notable effects of pollution on the flora are the replacement of water-crawfoot (Ranunculus spp), the most commonly occuring flowering plant in the unpolluted riffles (fast flowing, shallow reaches) by pond weed (Potamogeton spp.) and the stimulation of the growths of sewage fungus and of algae belonging to the genus Stigeoclonium. Sewage fungus was a marked feature below all outfalls, especially at Mitchelstown in summer and Mallow in winter. In the case of Mallow the infestation stretches for up to fifteen miles below the beet factory during the campaign in winter though the intensity of the growth is reduced by periodic floods. Sewage fungus, like the sludge deposits mentioned earlier, may have serious effects on dissolved oxygen when it decays and is dispersed by floods.

The larger invertebrate fauna of unpolluted and polluted riffles in each area was examined in two surveys, the first in 1966/67 and the second in 1968/69. Various degreex of impairment of the normal fauna were noted in polluted riffles but in these the basic change is always of the same type i.e. a reduction in the numbers or complete elimination of the non-burrowing forms such as most

catchment area, since all of the major effluents have a relatively high ...
However, under the normal conditions of river flow encountered during the survey, the capacity (i.e. dilution and natural purification) of the rivers to deal with the waste material without serious and widespread deterioration in water quality or reduction in productivity appeared to be adequate.

Although the survey was mainly concerned with freshwater reaches short investigations of the estuary of the Blackwater were carried out in August, 1967 and 1968. Those of 1967 showed that an appreciable depletion in dissolved oxygen was present, a minimum saturation of 70% being recorded about 9 miles above the mouth. However, in the 1968 investigation marked depletion in dissolved oxygen was not recorded at any point.

AN ROINN TALMHAÍOCHTA AGUS IASCAI[GH]
(Department of Agriculture and Fisheries),
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3 SRÁID CHATHAL BRUGHA
(3 Cathal Brugha Street),
BAILE ÁTHA CLIATH 1.
(Dublin 1.)

12 Márta, 1970.

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B.Sc.) will be published in the Irish
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Misc, le meas,

E. O'KELLY.

Telephone :- 41121.
Telegrams :- Fisheries, Dublin.

Seol aon fhreagra chun :-
(Address any reply to :-)
An Rúnaí
(The Secretary)
faoin uimhir seo :-
(quoting :-)

AN ROINN TALMHAÍOCHTA AGUS IASCAIGH
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River Blackwater:

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Le Deiġ-méinn an Rúnaí Conntae

(With the County Secretary's Compliments).

COURTHOUSE,
CORK.

Mr. Whelan.
Enclosed literature for Meeting at Zoology Dept U.C.C. on 31/10/'67 at 4.30 p.m.

1. Areas of Investiga

(a) Rathmore,
some 10 miles

Sources of pol

(i)

percolating fi

(ii) Untreated milk washings and cooling water from a small creamery entering main river via tributary.

(iii) Effluent from Chocolate Crumb factory. pretreated on a modern disposal plant including double alternating filtration.

(b) Mallow, Co. Cork. Location: On main river, about 30 miles downstream of Rathmore. Population 5,600.

Sources of pollution:

(i) Untreated domestic sewage from approx. 4,000 persons.

(ii) Effluents from Sugar Beet/food processing factory, discharged to river via lagoons.

(iii) Effluents from Creamery/Chocolate Crumb factory - sprayed on surrounding land in summer, directly discharged in winter.

(c) Fermoy, Co. Cork. Location: On main river some 25 miles downstream of Mallow. Population 4,000.

... sewage disposal works, which is discharged to a small stream, the Gradogue; this stream enters the Funcheon half a mile downstream of the outfall. The sewage works takes the domestic sewage of the town and in addition the effluent from a large cheese factory; the daily liquid load from the latter can rise to 700,000 gals. from an average of 500,000 gals. in summer months. At this period the capacity of the works is greatly overtaxed.

2. Methods of Investigation

(a) Chemical: From Mid May, to September, 1967, weekly measurements of the factors listed below, were carried out on samples of the river water in each of the above mentioned areas. Several samples were taken at increasing distances below the major outfalls and one or two were taken above the pollution zones as controls. In addition, samples of the major effluents were also taken at these times. The measurements made were of (i) Temperature (°C) (ii), pH; (iii) Dissolved Oxygen. (iv) Biochemical Oxygen Demand; (v) Free Ammonia; (vi) Nitrate Nitrogen. (vii) Suspended Solids.

(b) Biological: (i) Samples of the bottom fauna from riffle sections were taken in September and November, 1966 and again in April, 1967, in each area under investigation and at the same stations used in the chemical sampling programme. (ii) In August, 1967, samples of the fish populations were taken in each area; stretches above and below the major outfalls were worked, to correspond with the points of sampling used in the other programmes. (iii) The macrophytic vegetation was sampled qualitatively in the same places in June, 1967.

3. Other Investigations:

(ii) During the summer of 1967, measurements of depth and velocity were made on the river in each area, in order to gain some idea of the reaeration capacity of the river at these points.

Summary of work from July, 1966 to September, 1967.

The river is a tributary of the R. Lee. It rises half-way between Mallow and Cork, and falls through 300 ft in its 10 mile length. At its widest, near Blarney, it measures 25 ft. across. Blarney is the only population centre situated on the river, and the water is used for domestic supply to the town.

Work to date falls into three main sections:-

1. BIOLOGICAL

1.1. Zoological.

An estimate of the fish population of the river, is the first recommendation of the consultants. In September, 8 thirty yard stretches, 4 near Rathduff and 4 near Blarney, were fished electrically. The population of these stretches can be calculated from the catch and from this an estimate can be made of the total stocks.

Scales from the fish have been taken so that the age composition and growth rate of the fish stocks can be learned. Stomachs from a sample of the catch have been preserved, so that the food of the fish can be studied.

The fish caught are salmon, trout, eel, stone-loach, minnow, stickleback and lamprey.

The invertebrate fauna has been sampled at 12 points along the river, and the species present have been recorded, together with the numbers taken in each sample. A unit of effort was used throughout, and all sampling was done in areas with the same type of substrate.

1.2. Botanical.

The area of the riverbed covered by plants has been measured

3. PHYSICAL

The water flow is being measured, and for this purpose two staff guages have been set up, one at Rathduff, and one at Blarney. These are being read daily.

Measurements of depth and velocity have been made over a number of regular sections so that the reaeration coefficient of the river can be calculated.

There is pollution of the River Martin at Rathduff and at Blarney, from piggery, creamery and woollen mill effluents. All sampling points, chemical and biological, are located, so that the effects of these on the river can be measured, and the ability of the river to purify itself can be observed.

The effluent from the woollen mills at Blarney is being metered.

Future Work.

Regular chemical sampling will be continued, though some changes will be made in the number of samples taken, particularly during the winter months when conditions are not as variable as in Summer. In addition to this a number of 24 hour sampling programmes are planned for Summer, 1968.

Fauna sampling will be resumed, but the technique will be changed to a basis of unit area, and it is thought that those results will be more easily related to the other measurements being taken.

Fish census work will be continued as an annual excercise.

Investigations commenced early in June 1966 on return from a short training course in Britain at the Water Pollution Research Laboratory in Stevenage and at other research establishments. Initially, the work was carried out from the laboratory of the Irish Sugar Company in Mallow; later, when more space became available there, headquarters were set up in the Zoology Department at University College, Cork. The first month was occupied mainly with a general tour of the rivers so as to become familiar with the catchment areas, generally, and to pick suitable sampling points. While field work was carried out together, in the laboratory the investigation has been divided, so that the Martin River is being dealt with by Miss O'Connell, and the Blackwater River by the writer. This report deals only with the investigations on the Blackwater.

THE RIVER

The Blackwater R. (Fig.A) is over 80 miles in length; some 18 miles of this distance comprise the tidal part of the estuary, which runs almost directly south from Cappoquin to Youghal at the mouth of the river. The river rises in hilly country in east County Kerry, at an altitude of some 1,400 feet. It flows almost due south for 10 miles to Rathmore, where it turns and flows more or less in an easterly direction to the top of the estuary. Most of the initial elevation is lost in the first 10 miles of the river's course, so that for most of its length it meanders through a broad valley. There are several larger tributaries, the more notable being the Allua, Awbeg, and Funcheon rivers entering from the north, and the Awnaskirtawn and Glen rivers which come in from the south. The Finisk and Bride Rivers flow into the estuary. The catchment area is relatively large and accounts for the great variation in flow in the main river. There is a guaging station maintained by the Irish Sugar Company near their factory at Mallow, and here an overnight rise of 3' - 6' is not unusual. The volume of flow ranges from a summer low of some 20 million gallons per day, to nearly 500 M.G.D. in winter.

industries, most of which receive some form of pretreatment. These wastes are relatively small in volume, or else, where they are large, they receive a high dilution e.g. the wastes from the sugar beet factory. The effects on the water quality are noticeable only in very localised areas, and are not a constant feature for the most part.

THE AREAS OF INVESTIGATION.

During a visit which he made to Cork as consultant to the project, the late Mr. Pentelow selected three areas on the Blackwater as being worthy of investigation in so far as they were giving rise to waste material of relatively large volume. These were the towns of Rathmore, Mallow and Fermoy. During a preliminary survey of the river in July, 1966, it was decided to add to the former the town of Mitchelstown, which discharges wastes into a tributary system of the Blackwater, the Gradoge and Funcheon rivers. Since the amount of waste material entering the Gradoge stream is relatively large, the stream when examined was grossly polluted, and, as no other area on the main river is as seriously affected by wastes, it was decided to study the situation in Mitchelstown as representative of heavy pollution on the Blackwater system.

Rathmore (Fig.B). The town is situated near the west bank of the river, some 10 miles downstream of the source. The population of the town is around 300, and the domestic sewage is treated on a small percolating filter and settlement tank on the bank of the river. A few yards upstream of the outfall, a small stream enters the river. This stream carries the untreated wastes from a creamery in the town (10,000 gallons wash water per day at peak period of May-August). However, the main effluent here comes from the chocolate crumb factory of Messrs. Fry-Cadbury situated about ½ mile downstream of the sewage works. This is a relatively large concern and the wastes are treated on a very modern disposal system which includes double-alternating filtration, settlement tanks etc. The receiving stream at this point is still small.

via a small stream which runs adjacent to the premises. Recently the wastes have been sprayed on surrounding land, and the small stream which until then was grossly polluted, is now relatively clean. The effect on the main river has yet to be estimated. The Sugar Company's plant is situated on the south bank of the river about 3 miles upstream of the town. The wastes from the sugar beet processing section (which during the campaign uses 3,000 tons beet per day) are pumped to lagoons, where the net standing period is some 4 days, and then passed out to the river. The pretreated wastes from the beet washing have a B.O.D. of between 300-400 ppm and there is a reduction of over 50% in this on standing. The average dilution available during the campaign is around 100 : 1.

During the beet campaign there is a heavy growth of sewage fungus below the outfall, and unless this is periodically scoured by floods, the growth is stimulated over a considerable length of the river; in the 1966-67 campaign, the sewage fungus extended for some 15 miles downstream of the factory. The wastes from the food processing section (peas, cabbage, turnips) which operates in the late summer months, are also pumped to lagoons. These, however, are of much smaller volume than those of the beet campaign, and the effects on the river bed and on the water quality are small. During summer months, when the factory is either completely idle, or the food processing section alone in operation, the effect of the town sewage becomes more noticable both through a change in the water quality and in the growth of sewage fungus and algae for a short distance downstream of the sewage inlet.

Fermoy The greater part of the waste entering the river from the town, which has a population of some 5, 000, is of domestic origin. The waste passes into the river untreated but do not give rise to any marked changes in the chemical or biological qualities of the river at this point.

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There is a very heavy growth of sewage fungus in the Gradoge below the sewage works outfall, at this time. About ½ mile downstream of the sewage works outlet, the Gradoge meets the larger Funcheon River, a very clean stream. For a distance of at least one mile beyond the confluence, this latter stream also supports a growth of sewage fungus; 2 miles further on, it has disappeared. Last summer, however, fish were killed over a distance of some 4 miles downstream of the confluence, presumably due to low O_2 cones caused by the organic load on the Gradoge stream from the sewage works.

INVESTIGATIONS - (1) GENERAL PROCEDURE

The major share of the work of the first 9 months of the project has been devoted to a study of the macro-invertebrate fauna. Since the first year's work is necessarily exploratory it was decided to start with an investigation of an aspect - the river fauna - of which the writer had had some experience. In addition it was felt that the fauna would indicate the overall position as regards pollution, more accurately than would a chemical sampling programme; as Hynes (1960) says .... "they (fauna) provide a more or less static record of prevailing conditions, and are not affected by a temporary amelioration nor, usually, by a transient deterioration of the effluent". In addition, as Gaufin and Tarzwell (1956) point out, the macro-invertebrates usually have longer life cycles than the smaller animals and plants, and are thus better fitted to reflect changes, due to pollution, on the biological scale.

In July - August, 1966 a quick survey of the main river and major tributaries was undertaken in which radical changes in the macro-invertebrate fauna below towns and villages as compared with upstream fauna, were looked for, using these changes as rough indicators of sizeable pollution. This survey confirmed the choice Mr. Pentelow had made, i.e. Rathmore, Mallow and to a lesser extent, Fermoy; as already mentioned, the Mitchelstown tributaries were added then, two quantitative surveys have been undertaken. The sampling procedure is based on a yield per unit effort. The collection is made over 10 mins. (5 mins. where sewage fungus is heavy) with a coarse hand net (20 meshes/inch) and material swept into the net by agitating the substratum upstream of the opening, with the feet. Movements are made as standardised as practical and as much as possible of the area being sampled is worked. This method is preferred to taking material from a small defined area of the substratum e.g. by the Surber sampler, since using the former, all microhabitats are likely to be sampled, and thus specimens of all species present are likely to be present. This would not necessarily be the case in using the area density methods because of the non-random distribution of the bottom fauna. There is, of course, no indication of absolute numbers of organisms present in the area, to be derived from these samples; however, since the effort at each station is approximately similar, the differences in returns are likely to reflect the scale of differences in the river. The organismo collected were later identified as far as possible in the time available; specimens of those which could not be identified to species level are being preserved until an opportunity of so doing arises. The first series of quantitative samples of the fauna was carried out in the August - September period; the second was undertaken in November. Several extra samples were taken in the Mallow area during, and just after, the beet campaign there.

A small number of chemical and physical measurements were made on the river during the period under review. The acquisition of a dissolved O_2 meter allowed quick surveys of the river to be carried out in regard to oxygen conc. and temperature. Mr. T. Quill, chemist at the Sugar Company's laboratory in Mallow, made available records of his investigations of the river above and below Mallow during the year under review. These records include estimations of B.O.D., dissolved O_2, suspended solids, pH and temperature, both on the river water and on the effluents from the factory.

(2) THE FAUNA OF THE BLACKWATER - THE UNPOLLUTED STRETCHES

review, these groups account for approximately 50% of the total numbers of animals taken; there is one exception to this at Mitchelstown in September, when very high numbers of larvae of the Simuliidae reduced the relative proportions of the above four groups. Of the four groups, three, the amphipod, the Ephemeroptera and the chironomids are important as fish food organisms. The helmid beetles which are very small and heavily chitinised, are probably of little value as food to the fish. G. duebeni especially in the adult stage is among the larger members of the fauna and is probably one of the most important of food organisms when it is numerous. This also applies to the baetid nymphs and there is the further point that both of these organisms are active swimmers at times and more likely to be taken by fish such as trout. There is a tendency for the relative proportions of these two animals to become reversed the further downstream the sample is taken. At Rathmore B.rhodani has much greater representation than G.duebeni: At Mallow the proportional differences are much smaller, while at Fermoy they are reversed. The increase in G.duebeni is probably due to increasing hardness of the water (see 6) and greater amounts of weed at the banks, while B.rhodani is probably reduced in abundence by the increasing tendency to flood conditions downstream (Hynes, 1960). Several seasonal variations show up. In most of the earlier samples the bulk of the fauna is made up of the Chironomidae and Simuliidae; at Fermoy, however, G. duebeni is the main feature. The Plecoptera, the Ecdyonuridae and the larvae of the Trichoptera are rather sparsely represented. The Ephemeroptera, however, show a larger variety than in later samples, since in addition to B. rhodani, Ephemerella ignita a quick growing summer form, is present and also two other species of the Baetis genus, B. pumilus and B. scambus. In the November samples the most notable changes are the increases in the Ecdyonuridae Trichoptera, and, to some extent, the Plecoptera, and the great reduction in abundance of the Chironomidae and Simuliidae. The Ecdyonuridae are represented by three species Ecdyonurus venosus, Rhithrogena semicolorata and Heptagenia sulphurea. The latter two become more numerous downstream, E. venosus becoming families, though this is not the case at Mitchelstown. The cased forms are rather scarce, though the genus Agapetus was taken in fair numbers at times, as also were the members of the sub-family Lepidostomatinae. The chironomid larvae become very much reduced in importance particularly at Rathmore where they drop in % by a factor of 10. The Simuliidae show a similar decrease at Mitchelstown. Among the other groups, the mites tend to disappear in winter months while the other small groups, the leeches, worms, and molluscs remain more or less stable.

The total numbers of organisms taken in each 10 min. sample show a considerable decline in the winter months. This is especially so at Mallow though at this location the high water level in November made sampling more difficult and probably less efficient. The decline in numbers is probably exaggerated. The real drop is mainly due to the reduced abundancy of two groups, the Chironomide and the Simuliidae. In the case of the latter, this may be due in part to a diminution in the amount of plant growth in winter; in both cases the life cycle probably plays a part. Generally the variation in composition compares well with that quoted by Hynes (1960) in his data on monthly faunal composition on the Welsh Afon Hirnant.

(3) The Fauna of the Blackwater - the polluted stretches.

In compiling Table II which summarises the macro-invertibrate fauna of the polluted stretches of the river, the four areas under investigation had to be approached differently. Since a clean tributary enters the Blackwater within ½ mile below the last effluent (chocolate crumb factory) at Rathmore, it was decided to confine the representation of pollution affected fauna to samples taken within this ½ mile stretch; there is a definite improvement as regards the faunal composition after the confluence. In the case of Mallow, in August, the faunal composition in Table II is based on samples as set out in Table II is based on samples taken in the 2 mile stretch below the confluence; in this way the Gradoge stream is treated as an effluent with respect to the Funcheon River. Two samples were, however, taken in the Gradoge stream below the sewage works outfall, and these samples are summarised in Table III.

The most obvious effect on the fauna, disregarding the situation at Fermoy, where there appears to be little change below the town, is the great reduction in three of the four major groups present above the effluents. These, G. duebeni, B. rhodani and the helmid beetles have a considerably lower representation in these polluted zones, whereas the chironomids have become the outstanding feature of the fauna. These changes are most obvious at Rathmore, where the samples in the polluted zone were taken within a small distance of the effluent outfall. In August and November nearly 90% of the fauna is comprised of chironomids and annelids. The drop in importance of the chironomid larvae in November is compensated by a great increase in the leeches, most of these being represented by the form Helobdella stagnalis. There is an apparent improvement in November as regards the other groups, but this is mainly due to a drop in total numbers taken in each sample because of the decline in abundance of the chironomid larvae.

In Mallow, the changes in faunal composition show much the same pattern, though the magnitudes of these are not as great. This is mainly due to the great reduction in total numbers below the effluents as compared to the unpolluted stretches. Again, the oligochaetes and Hirudinea become major features of the fauna and, in addition, the isopod Asellus aquaticus has appeared in numbers. This species is typical of slow flowing, more muddy stretches, and only becomes numerous in riffles where there is organic pollution. Another point of note here is the apparently greater tolerance of the Hydropsychidae to pollution than the other families of the Trichoptera; this type of difference also seems to apply between the ephemeropteran B. rhodani and the related species B. pumilus better here. The other groups which were present in relatively large numbers, are mostly burrowing types and are thus not affected to the same extent by changes of the above nature in the substratum.

The samples below Fermoy were spread over a fairly long stretch - over 4 miles - and as a result there is not much change in composition of the fauna compared with above town samples, nor, indeed, in total numbers. There is one notable difference, however, the decline in numbers of G. duebeni, which is abundant in the stretches above the town. It is not certain that this is due to the effluents from the town (which are relatively small, and cause no apparent growth on the substratum) and it is probably partly accounted for by the decrease in weed under the banks as compared with areas sampled upstream.

The changes at Mitchelstown are of the same order as those at Mallow and Rathmore, with the exception of the leeches, which do not show any increase in importance due to pollution, in this area. Otherwise, the main changes are the increases in numbers of the oligochaetes and the chironomid larvae from 3.5 - 4.0% of the total numbers in the clean stretches to nearly 50% in the polluted zones. The Simuliidae are rather erratic in their distribution at this point, perhaps due to changes in the vegetation as mentioned previously. Whereas in summer, they were more numerous above the effluents, in November the position is reversed. These fluctuations are responsible for the variation in total numbers of organisms in the above-and-below-effluent samples. All the typical clean water forms are much reduced in representation, the stonefly nymphs and the ecdyonurids being severely affected.

The samples taken in the Gradoge stream below the Mitchelstown sewage works and which are set out in Table III show the effects of gross pollution. The stream, at this point, is heavily coated with sewage fungus, and, especially in summer, the O_2 levels approach the lethal conc. for trout. In September, the sample was taken in an area of no weed, and the numbers of animals collected are much in both cases; there is one main difference however. G. duebeni is, apparently, absent from the Awnaskirtawn, but present in relatively large numbers in the Sheep River. This is probably accounted for by the fact that the Sheep river is relatively enriched, as evidenced by its good crop of weed. Weed growth in the Awnaskirtawn is rather sparse. This difference is alone responsible, no doubt, for the smaller total number of animals in the latter river.

Table III is given to show the maximum difference so far encountered in the project, between clean water and polluted water fauna. It demonstrates that the main effect of organic pollution is to lock up the biomass, so far as the mecro-invertebrate element is concerned, in 2 or 3 groups. From these samples, it is also calculated that the average wet weight per organism in the clean ater zone is around 7.0 mg. In the polluted stretch it is in the region of 2.0 mg. The effect of this on fish feeding will be considered later.

(4) The Fauna of the Blackwater - the variation in total Nos.

In Figs. 1-12, the total numbers of individuals in several groups, collected at different points in each area, are set out diagramatically. The base line shows the position of the samples taken with respect to the point of entry of the major effluent in each area. Stations upstream of these points (zero miles) are marked negatively, points downstream positively. The positions of other outfalls, and of the confluences with clean tributaries are also indicated. The diagrams show that while there are large variations in abundance in the clean zones, these are not of the same magnitude as those exhibited in the polluted stretches.

Rathmore (Figs. 1-4). The main feature here is the marked reduction in numbers of B.rhodani, and especially the Plecoptera below the outfall from the chocolate crumb factory, and the huge upsurge, especially in August, of the chironomids and the annelids (Mainly leeches). Also of note is the temporary increase below above the factory (see Sect.5). Five groups are depicted in the diagrams. The Hydropsychidae and other Trichoptera (Fig.5) show the expected drop off in numbers below the effluents, though this is delayed in summer, until below the creamery and town sewage outfalls. Indeed, the hydropsychid show a rise in numbers just below the factory. This may be due to a temporary rise in the amount of suspended matter just below the outfall; the hydropsychids feed by trapping such matter in nets which they construct, and may be favoured by conditions at this point. Such a rise in the numbers of larvae is often noted below lakes on the course of a river. The Simuliidae (Fig.8) show a similar peak; these animals feed in a manner basically similar to the Hydropsychidae. Beyond the last effluent the hydropsychids show a much quicker recovery than the other caddis families, and, indeed, reach a relatively large number compared to above effluent densities, before they return to clean water levels. A similar situation was noted by Woodiwiss (1964).

<u>G. duebeni</u> is very badly affected by the pollution at Mallow, especially in winter, and is very much reduced in numbers for over 12 miles below the town. It shows good recovery after this, however, and near Fermoy reaches very high densities. The Annelida (Oligochaeta and Hirudinea) show the usual increase below the effluents, this increase being very much more marked in summer, especially in the case of the chironomids, which were present in very high numbers just below the sugar beet factory at this time. The station just beyond the factory could not be sampled in the November-January period due to high water levels, so that it was not possible to ascertain whether the numbers of larvae here had declined on the same scale as they had at the next station (+ 1.5 mls). The apparent drop in the numbers of chironomid larvae immediately below the outfall from the town sewage is unexpected (cf.Rathmore).

<u>Mitchelstown (Figs 9-12)</u>. Two levels of pollution are apparent here. In the Gradoge the effect is very much more drastic than that seen in the Funcheon below the confluence. The latter river is

the turbulence of these zones would ensure complete oxygenation at all times irrespective of the amount of organic matter in the moving body of water. However, whether this was the case among sewage fungus covered stones on the substratum is not certain. Indeed in the Gradoge stream below the sewage works at Mitchelstown, the material beneath the layer stones was black, in places, suggesting anaerobic conditions. This was not seen anywhere else, however. If the oxygen levels remain adequate the effects on the fauna would seem to be due either to (a) toxic substances, or, (b) physical impairment of the environment - (a) seems unlikely since there were always small numbers of each group present. The great bulk of the wastes are organic in nature and adequate oxygenation would prevent the formation of toxins suvh as sulphide and ammonia. The latter may, however, have been produced in the slow moving stretches, and, especially at Mitchelstown might have been partly responsible for some of the faunal changes. Longwell and Pentelow (1935) point out the danger of poisoning from the above substances in the case of discharges of poor quality from sewage works. In addition the study of Ellis (1937) showed that increased levels of ammonia were always associated with outfalls from sewage works. It is proposed, however, that the second factor (b) is the main reason for the changes in the fauna below the effluents. In all cases, the substrata in these areas was covered with a slimy film of algae, and sometimes sewage fungus - e.g. at Mallow. The bulk of the clean water fauna lives in and among stones relying on their claws to grip the stone surfaces. Any impairment of this ability, as would surely happen where the stones were slime covered, is likely to prevent the animals maintaining themselves in these reaches. The organisms which seem to thrive, the chironomid, leeches, and worms, are all elongate and better adapted to burrowing, which overcomes the encumberance offered by the slime. In addition, as Hynes (1960) points out, sewage fungus does not seem to grow on chironomids larvae, as it does on other aquatic insects.

The investigations on the fauna are expected to give less efficient, though it may be compensated partly by the increased abundance of the surviving groups in the polluted zones. The question should be settled when a fish sampling programme is undertaken.

(6) The Blackwater River - Physical and Chemical Measurements.

Work on this aspect of the project has been limited so far. Two surveys of the River were carried out in the winter months in which recordings of the dissolved oxygen (% sat.) and temperatures were taken, using an E.I.L. dissolved O_2 meter (Model 15A). In addition Mr. T. Quill, Chemist at the Sugar Company's Laboratory in Mallow, provided records of measurements he had carried out on the main river between January and December, 1966, in the stretch from Mallow to Fermoy. Recently (April, 1967), samples of the river were taken for inorganic analysis. Three locations were sampled, Ballydesmond near the source; above Mallow, which is nearly halfway along the course; and at Ballyduff about 6 miles above the tidal limits of the estuary. The results of these tests, which were carried out in the State Laboratory, are given below:

Location	pH 0 19°c	As p.p.m. $CuCO_3$ Tot. Alk.	Tot. Hard	Ca	Mg	Tot. PO_4 p.p.m.	Silicon p.p.l. SiO_2	Tot. diss Solids p.p.m.	Chloride p.p.l.
Ballydesmond	7.45	24.0	24.0	14.0	10.0	0.04	3.0	97.0	19.0
Mallow	7.6	71.0	82.0	62.0	20.0	0.04	1.5	136.0	20.0
Ballyduff	8.3	132.0	140.0	62.0	78.0	0.04	1.5	209.0	20.0

The above figures demonstrate the typical tendency for a river to become more alkaline in downstream reaches, with increasing additions of such dissolved solids as Mg and Ca., from tributaries and general run-off from load. The river at source is soft, but above Mallow has become rather hard; there appears to be no further increase in Ca content after this point, so that, pollutants entering the river system, especially domestic sewage, are rather small when the dilution of the river is taken into consideration. However, the fact that the river passes almost entirely through cultivated land, over much of which it floods periodically, might have led to the presumption that phosphates, originating from fertilisers, would tend to increase the levels of this substance downstream. Such is not the case, it would appear. Again the dilution is probably too great for detectable differences to arise.

Early in November, a survey of the river above and below the chocolate crumb factory outfall at Rathmore was carried out, and measurements of diss.O_2, temperature, and suspended solids recorded. The results are given below, with the positions of the sampling stations indicated by their distances above or below the outfall as before:

Miles:	-1.3	-0.8	-0.7	0.0	+0.05	+0.35	+3.5
Temp. °C	5.7	6.1	6.25	6.5	7.0	6.5	6.5
O_2% saturation	87.6	91.0	92.0	91.0	92.0	89.0	88.0
Sus.solids p.p.m.	4.0	4.0	3.5	5.5	5.5	4.0	3.5

These measurements seem to indicate that the effluents at Rathmore have little effect on the three factors in question at least in winter months. The river at time of sampling was near winter normal. The low temperature of the water tends to bring the O_2 levels towards saturation and it cannot be safely forecast from the above whether the effluents would have the same small effects during summer when flows are lower and water temperature higher. The position 0.0. miles is directly above the outfall from the chocolate crumb factory. The rise in temperature of the water immediately below this point appears to be due to the effluent. The rise in temperature over the first two points is probably due to an error in measurement. The suspended solids content appears to be unaffected by the effluent from the chocolate crumb factory.

readily detectable in the changes in magnitude of the B.O.D., dissolved O_2, and suspended solids. Temperature appears to be little if at all affected, though there is a tendency for a rise to occur below the town. This may be due to a greater occurrence of slow flowing stretches below the town. It is obvious that the greatest changes in B.O.D., dissolved O_2 and suspended solids occur during low river flow (B) and in the case of high river flow (A) the effect is very much smaller, allowing for the fact that the receiving waters have an initial B.O.D. of 3.0-3.6 ppm, due probably to the flood conditions. There appears to be in most cases a definite improvement in water quality before the river reaches the creamery and town. This is very marked in the case of the suspended solids, less so of the B.O.D. The dissolved O_2 is only restored to above effluent levels in the case of A; at the other two periods under consideration it continues to diminish before stablising at a level some way below that of above effluent points. Effluents from the creamery, and especially the town (mainly domestic sewage) cause the B.O.D. and suspended solids content of the water to rise again, and continue to deplete the dissolved O_2. The town effluents appear to have a considerable effect here, e.g. the suspended solids (B) and the B.O.D.(A). The situation is, of course, not exactly comparable with that above and below the sugar beet plant, since the water flowing past the creamery and town is already polluted. Nonetheless, the B.O.D. loading from the creamery and town appears to be as great as that from the sugar beet plant, while at times (B) it contributes more suspended solids than the latter. The wastes from the creamery are discharged by spraying on land and it is claimed that there is no resulting effect on the river. From the data described above this claim would seem to be unwarranted.

The B.O.D. returns to above Mallow levels after some 15 miles. However, in the case of A, the satisfaction of the B.O.D. appeared to be more protracted than in the case of B or C.

plant, 4.2 p.p.m. below the creamery, and 9.0 p.p.m. below the town. The flow on this day was 175 M.G.D. No operation was being carried out at the sugar beet plant at this time.

The food processing section attached to the sugar beet plant appears to have little effect through its effluents; e.g. on 19th August, 1966, during the pea campaign (24 tons/day) and the flow at 24 M.G.D., the above and below outfall records of B.O.D. were 1.7 p.p.m., and 1.2 p.p.m. respectively. Below the town sewage outfall the B.O.D. was over 7.0 p.p.m. on this day. On 30th September, 1966, however, during the turnip processing period, with the flow at 34 M.G.D., a rise in the B.O.D. from 2.8 p.p.m. above to 6.0 p.p.m. below the factory outfall was recorded.

The dissolved O_2 is not seriously threatened by any of these effluents and the saturation values remain safely above the danger zones for fish and other organisms. The lowest value recorded was around 75% saturation; the greatest B.O.D. loading in the river was 9.8 p.p.m. This may imply that the Blackwater has a relatively high capacity for reaeration.

Records of dissolved O_2 measurements made at Mitchelstown in December, 1966 are shown in diagram form in Fig (iii). The water temperature at this time was constant around 5.5°C, and percentage [illegible] values for O_2 are relatively high. Nevertheless, a sag in the O_2 content of the Gradoge below the sewage works outfall is marked, and near the confluence with the clean, highly oxygenated Funcheon, the % saturation has dipped below 100%. After the confluence, the O_2 of the Funcheon is also lowered, and the reduced level persists for over 4 miles before a rise to the above pollution level is recorded. The creameries in the town were not working at summer capacity at the time of measurement and the latter probably reflect the period of least harmful effects from the sewage works effluent. Certainly, fish have been killed in the Gradoge, and in the Funcheon for more hazardous levels of dissolved O_2. An exception to this must be the river below the sugar beet plant where the wastes from this process, which is confined to late autumn and winter, causes the growth of sewage fungus in the river. In this case, chemical sampling will have to continue throughout most of the year. With regard to the changes in the invertebrate fauna below effluents, and a relationship with chemical and physical variations in water quality, it would appear, as already mentioned, that such changes are unlikely to be due directly to a deterioration in water quality, but rather to a disturbance of the environment. The latter, however, is more likely to be a function of change in the chemical composition of the water. Further elucidation of this point may emerge from future work on chemical factors.

The Proposed Future Programme of Research.

1. Chemical and Physical Investigations. The coming summer months will be spent mainly on the periodic (weekly if necessary and practical) measurements of chemical factors such as diss.O_2, B.O.D., ammonia and nitrate levels, and physical such as water temperature and suspended solids. Two of these tests, NH_3 and NO_3, will be carried out in Mr. Quill's laboratory in the Sugar Company at Mallow. It is hoped to show from these measurements the relationship between values of these factors in the River water, and variables such as river flow volumes and strength of wastes, and reaeration constants. On at least one occasion, the above named factors will be monitored over a 24 hour period in each area to determine the extent of diurnal variation. The assistance of the Engineers Branch of the Fisheries Division has been obtained in setting up river flow gauging stations at points of interest. The work of constructing discharge curves will, of course, be lengthy but height gauges will be erected immediately, and water levels read during the taking of samples will be recorded for later calibration with flow volumes. In addition, information is being sought from the industrial under-

(b) Macro-invertebrates: It is proposed to carry on the investigations of the bottom fauna at least throughout one more year. Area density methods may be employed later so as to have some basis for comparison with other workers in this field. Several small areas (up to one-tenth sq. metre) may be sampled at each station. This would probably mean taking less material than under present methods of sampling for 10 mins, and the taking of several such samples (3 or 4) would allow an average figure to be arrived at.

(c) Higher plants: It is proposed to list the species, and obtain some estimate of the abundance of the Macrophytes in each area of study, early in summer, both for record purposes, and to determine if the effluents have an effect on the water plants.

(d) Algae, sewage fungus: Since work on algae is time consuming, and especially so for non-specialists, it is not proposed to devote much time to a study of these organisms. It may be possible, however, to carry out some quantitative investigations on the algae, either by letting them grow on artificial substrata, or by collecting them from small comparable areas of stones, in order to establish what, if any, response they show to effluents. The question of sewage fungus will have to receive some attention since it is a major feature of the pollution from the sugar beet plant at Mallow, and to a lesser extent from the other effluents. This will entail some measure of abundance at successive sites below the effluents, the species complex, and the relationship with water quality factors.

3. Other Investigations: Some time during summer this year, it is proposed to carry out a quick survey of the estuary of the Blackwater river for dissolved O_2 content. In addition salinity measurements will also be made on water samples from various depths at each station, to detect any stratification that may exist in the estuarine reaches.

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M.Whelan, Esq.,
TO/ C.A.C.E. (Sanitary)

CORK COUNTY COUNCIL
COUNTY HALL CORK
TELEPHONE 26891

Please Address Reply to Room No. 1101

25th October, 1968

RE/ Water Purity Project - Rivers Blackwater and Martin

I refer to my letter of 24th instant in connection with above.

I now wish to inform you that the venue for the meeting has been changed to Court Room No. 3, Courthouse, Washington Street, Cork. The time and date remain the same, that is 11.00 a.m. on 29th instant.

I would also like to bring to your notice the fact that Dr. B.A. Southgate is giving a lecture on Water Polution at the Metropole Hotel on Monday night, 28th instant at 8.00 p.m.

D Kavanagh
County Engineer
(D. Kavanagh)

DK/ML

CORK COUNTY COUNCIL
COUNTY HALL CORK
TELEPHONE 26891
Please Address Reply to Room No. 1407

County Engineer.

HS/N

18th. October, 1968.

Water Purity Project.
Rivers Blackwater and Martin.

Herewith copy of letter from the Department of Agriculture and Fisheries regarding a meeting to be held at the Zoology Department, University College, Cork, on Tuesday, 29th. October, 1968, at 11 a.m. in connection with the above.

A similar meeting was held on the 31st. October, 1967 which was attended by Messrs. M.W. Whelan and M. Barry. It occurs to me that Mr. Mullins would be interested in attending this meeting. He was, in fact, recommended by Mr. Geraghty a year ago but it appears that the Department only anticipated two representatives. You might indeed be interested in attending yourself. Please let me know, as soon as you can, who will be attending so that I can inform the Department.

J.K. O'HARE.
COUNTY SECRETARY.

GROUPS	RATHMORE Aug	RATHMORE Nov	MALLOW Aug	MALLOW Nov-Jan	FERMOY Sept	FERMOY Nov	MITCHELSTOWN Sept	MITCHELSTOWN Nov
Annelida								
Oligochaeta	+	1·8	+	0·4	0·6	3·2	0·3	1·0
Hirudinea	0·9	+	0·3	1·9	0·4	0·6	–	0·2
Crustacea								
Gammarus duebeni	3·4	6·0	7·3	20·1	50·2	25·5	4·3	28·3
Asellus aquaticus	–	–	0·3	0·1	0·2	0·3	–	–
Ephemeroptera								
Baetis rhodani	16·7	13·9	14·3	17·4	5·6	11·8	5·8	19·2
Other Baetidae	9·7	+	0·4	4·1	+	+	0·5	+
Ecdyonuridae	0·9	17·9	4·9	23·7	0·9	16·9	0·2	7·4
Ephemerella ignita	1·0	+	3·2	+	4·7	+	1·4	0·3
Plecoptera								
All species	1·6	8·2	3·4	3·0	0·1	0·5	0·2	3·0
Trichoptera								
Hydropsychidae	4·8	12·3	1·5	4·9	3·6	3·8	0·1	1·9
Other families	2·4	7·1	2·2	2·2	1·6	3·3	0·3	7·9
Coleoptera								
Helmidae	9·1	22·5	3·8	6·8	11·4	7·8	4·5	15·3
Diptera								
Chironomidae	34·0	3·4	25·7	5·6	0·6	8·2	3·6	2·5
Simuliidae	7·7	0·9	28·0	3·3	12·7	14·7	77·6	9·2
Tipulidae	+	0·4	+	1·5	0·1	0·2	0·2	0·9
Hydracarina								
All species	3·8	+	0·3	–	0·3	–	0·7	1·0
Mollusca								
Ancylastrum fluviatile	2·8	1·9	2·6	0·7	1·5	1·6	+	0·7
Other species	+	0·9	1·0	3·4	5·0	1·2	+	0·3
Average total numbers in samples	1351	954	3520	670	2687	2124	8087	2268

TABLE I Composition of macro-invertebrate fauna of eroding zones of

GROUPS	RATHMORE Aug	RATHMORE Nov	MALLOW Aug	MALLOW Nov-Jan	FERMOY Sept.	FERMOY Nov	MITCHELSTOWN Sept	MITCHELSTOWN Nov
Annelida								
Oligochaeta	3.8	2.9	7.9	9.0	9.6	6.0	18.2	10.1
Hirudinea	1.3	21.5	18.2	10.8	1.0	0.8	0.1	+
Crustacea								
Gammarus duebeni	+	+	2.5	14.6	6.3	12.7	1.4	0.9
Asellus aquaticus	-	-	3.1	3.5	0.2	0.3	1.5	3.4
Ephemeroptera								
Baetis rhodani	1.1	7.9	9.1	11.8	17.8	11.4	5.1	11.7
Other Baetidae	0.3	-	-	+	2.8	+	0.7	+
Ecdyonuridae	-	0.1	0.5	1.5	2.3	2.1	+	0.2
Ephemerella ignita	+	+	9.0	+	5.6	+	0.8	+
Plecoptera								
All species	+	+	1.6	0.5	1.6	0.7	0.2	+
Trichoptera								
Hydropsychidae	0.2	1.4	4.0	3.0	5.9	3.2	+	-
Other families	+	3.7	1.1	2.1	2.3	3.8	0.3	0.6
Coleoptera								
Helmidae	+	0.8	2.2	5.1	12.0	9.9	2.1	0.5
Diptera								
Chironomidae	84.3	51.0	23.3	16.6	9.7	7.5	35.7	35.0
Simuliidae	7.3	0.8	2.4	9.9	19.5	32.3	30.9	36.7
Tipulidae	-	-	0.4	1.6	0.1	0.4	+	-
Hydracarina								
All species	+	0.4	1.4	0.2	0.2	-	1.7	0.2
Mollusca								
Ancylastrum fluviatile	0.9	4.0	3.2	1.8	0.7	4.6	0.4	0.2
Other species	0.1	1.2	8.0	6.7	1.6	3.0	0.2	0.1
Average total numbers in samples	4672	1197	850	210	2136	3012	2921	4369

TABLE II Composition of macro-invertebrate fauna of eroding zones

GROUP	AWNASKIRTAWN	SHEEP	GRADOGE SEPT.	GRADOGE NOV.
Annelida				
Oligochaeta	0·3	2·3	42·0	32·9
Hirudinea	0·9	–	–	–
Crustacea				
Gammarus duebeni	–	11·2	–	–
Asellus aquaticus	–	–	–	–
Ephemeroptera				
Baetis rhodani	12·2	15·0	0·5	0·4
Other Baetidae	9·5	3·2	–	–
Ecdyonuridae	2·7	2·5	–	–
Ephemerella ignita	0·2	0·4	–	–
Plecoptera				
All species	7·4	10·4	–	+
Trichoptera				
Hydropsychidae	1·6	2·1	–	–
Other families	7·4	4·3	–	+
Coleoptera				
Helmidae	5·4	6·7	–	+
Diptera				
Chironomidae	41·0	34·7	56·0	62·9
Simuliidae	1·0	3·9	0·5	2·7
Tipulidae	1·2	0·3	–	+
Hydracarina				
All species	5·9	–	–	–
Mollusca				
Ancylastrum fluviatile	0·4	1·5	–	–
Other species	0·5	0·1	0·9	–
Total no. organisms in sample	556	1971	428	5650

ANNELIDA - OLIGOCHAETA

Enchytraeidae R,M,F,MiT.
Lumbriculidae R,M,F,MiT.
Naididae R, MiT.
Limnodrilus hoffmeisteri R,M,MiT.
Tubifex tubifex R,M,F,MiT.
Rhyacodrilus coccineus M.
Psammoryctes barbatus M,F.
Peloscolex ferox MiT.
Tubifex ignotus M,MiT.
Limnodrilus udekemianus MiT.
Eiseniella tetraedra R,M,F,MiT.

HIRUDINEA

Erpobdella octoculata R,M,F,MiT.
Glossiphonia complanata R,M,F,MiT.
Helobdella stagnalis R,M,F,MiT.
Piscicola geometra R,M,MiT.
Hemiclepsis marginata M,MiT.
Theromyzon tessulatum M.

CRUSTACEA

Gammarus duebeni R,M,F,MiT.
Asellus aquaticus M,F,MiT.

EPHEMEROPTERA

Paraleptophlebia tumida R.
Baetis rhodani R,M,F,MiT.
Baetis pumilus R,M,F,MiT.

PLECOPTERA

Leuctra hippopus R,M,F,MiT.
Leuctra fusca R,M,F,MiT.
Protonemoura meyeri R,M,F,MiT.
Amphinemoura sulcicollis M,MiT.
Chloroperla torrentium R,M,MiT.
Capnia bifrons M
Isoperla grammatica R,M,F,MiT.
Perla bipunctata R,M,F,MiT.
Brachyptera risi M.

TRICHOPTERA

Rhyacophilinae R,M,F,MiT.
Glossosoma R,M,F,MiT.
Agapetus R,M,F,MiT.
Hydroptilidae R,M,F,MiT.
Hydropsychidae R,M,F,MiT.
Polycentropidae R,M,F,MiT.
Philopotamidae M,F.
Limnephilidae R,M,F,MiT.
Leptoceridae M,F.
Beraeinae R.
Lepidostomatinae R,M,F.
Silo R,M,F,MiT.
Sericostoma personatum R,M,F,MiT.
Odontocerum albicorne F,MiT.
Goera R.

COLEOPTERA

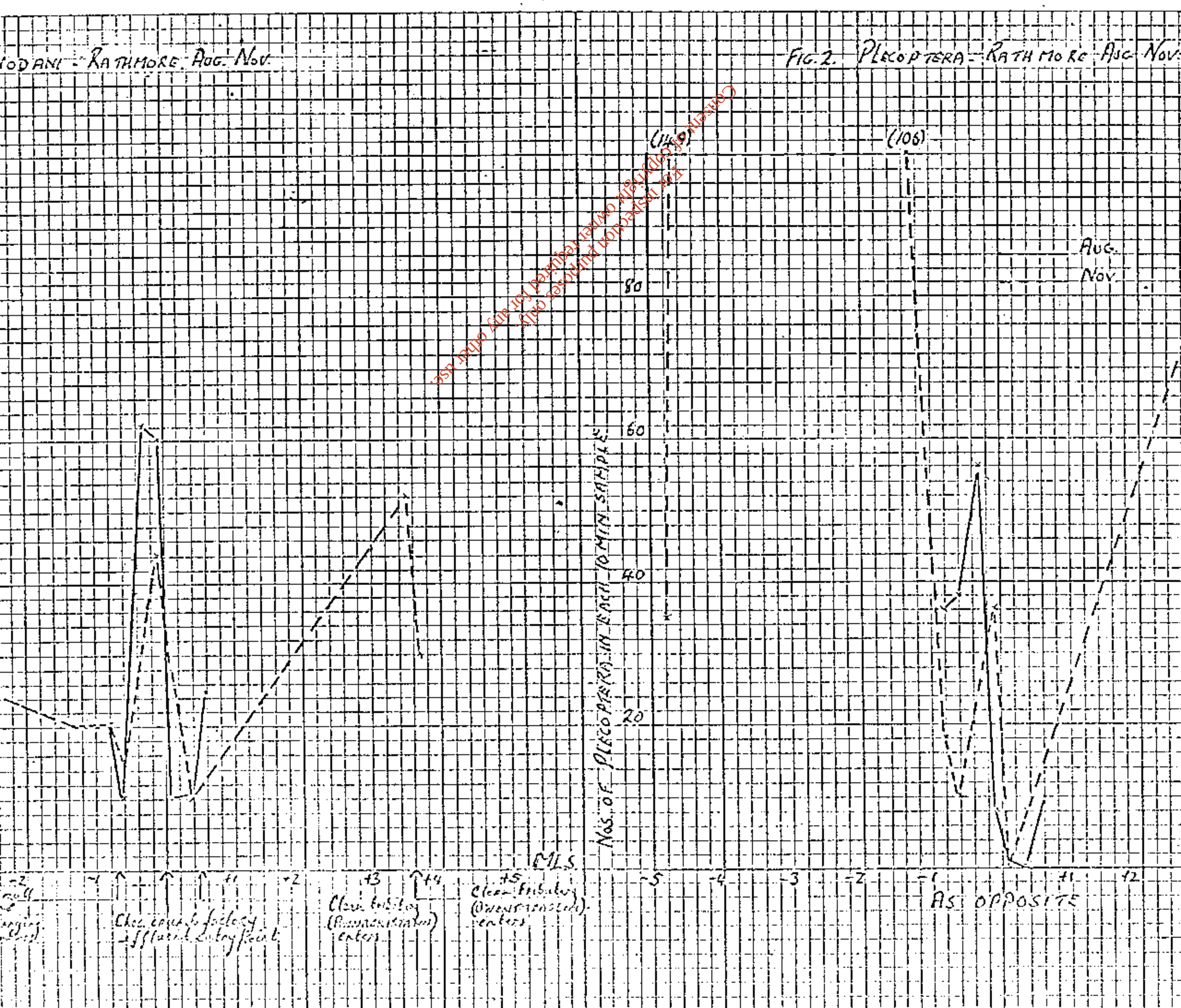
Latelmis volkmari R,M,F,MiT.
Limnius tuberculatus R,M,F,MiT.
Esolus parallelopipedus R,M,F,MiT.

Chironomus plumosus M.T.
Tipula R, M, M.T.
Pedicia R, M.
Dicranota R, M, F, M.T.
Ceratopogonidae R, M, F.
Anthomyidde R, M, F, M.T.
Simuliidae R, M, F, M.T.
Chaoborinae M.
Psychodidae R, M, M.T.
Eristalis M

HYDRACARINA
Hygrobates R, M, F, M.T.
Lebertia R, M, M.T.
Megapus R, M, F.
Sphercon R, M
Aturus M, F.
Atractides F.

Physa fontinalis M, F, M.T.
Pisidium R, M, F, M.T.
Planorbis contortus M, F, M.T.
Planorbis albus M.F.
Planorbis laevis M.F.
Sabanea aloae M.F.
Segmentina nitida M.
Sphaerium R, M, F.
Theodoxus fluviatilis F.
Valvata piscinalis M, F.
Valvata cristata M.
Zonitoides R.

PLATYHELMINTHES - TRICLADIDA
Polycelis M, M.T.
Dugesia M, F.


...ODANI - RATHMORE AUG. NOV.
FIG. 2. PLECOPTERA - RATHMORE AUG. NOV.
(140)
(106)
AUG.
NOV.
80
60
40
20
NOS. OF PLECOPTERA IN EACH 10 MIN SAMPLE
MLS
-2
-1
+1
+2
+3
+4
+5
-5
-4
-3
-2
-1
+1
+2
Clear, course to factory effluent entry point
Clear tributary (Ramanstown) enters
Clear tributary (Owenstown) enters
AS OPPOSITE

onomidae larvae Rathmore, AUG, Nov.
AUG
NOV
-3
-2
-1
+1
+2
+3
+4
+5
effluent from small sewage wks & small stream carrying milk wastes enters
Choc crumb factory effluent enters
Clean trib. (AWNASKAWN) enters
ML-S Clean trib. (ONENTAINGLAS) enters

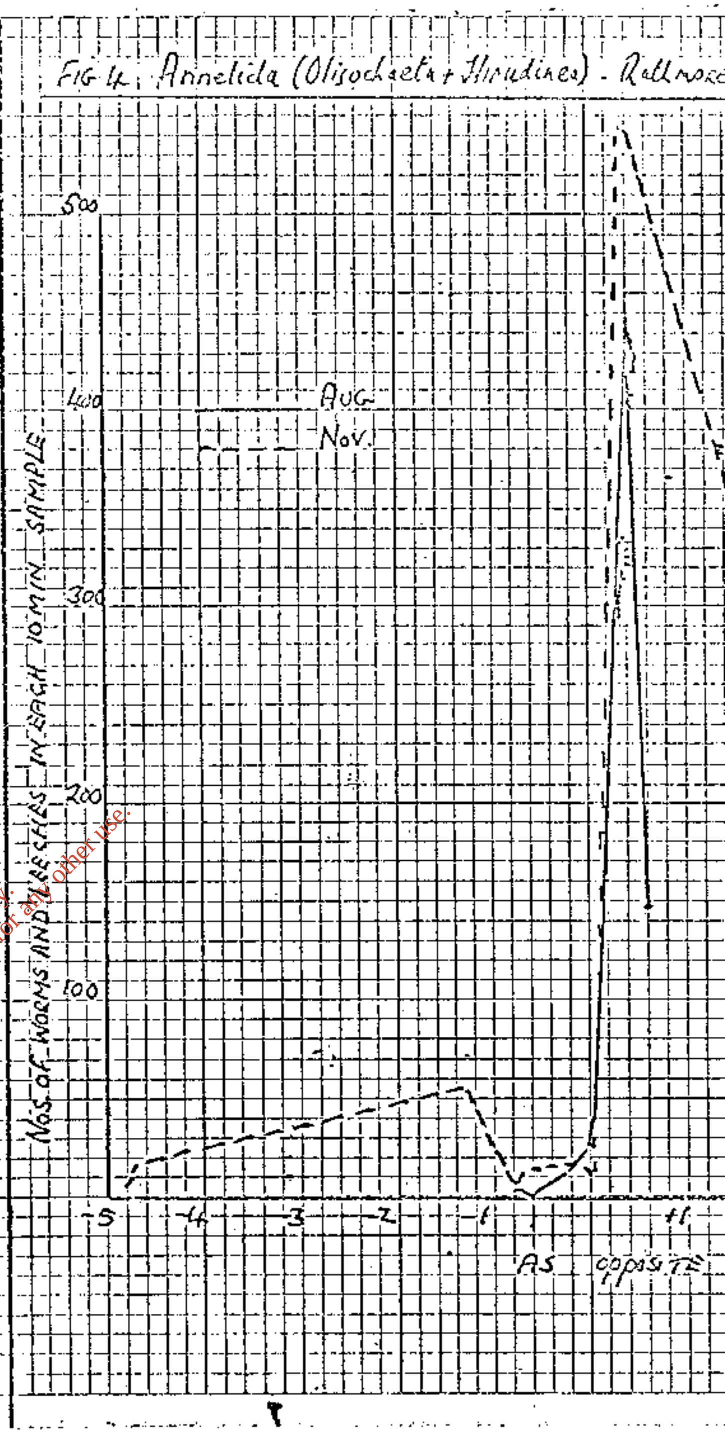


FIG 4. Annelida (Oligochaeta + Hirudinea) - Rathmore
500
400
300
200
100
AUG
Nov.
Nos. of WORMS AND LEECHES IN EACH 10 MIN. SAMPLE
-5
-4
-3
-2
-1
+1
AS
OPPOSITE

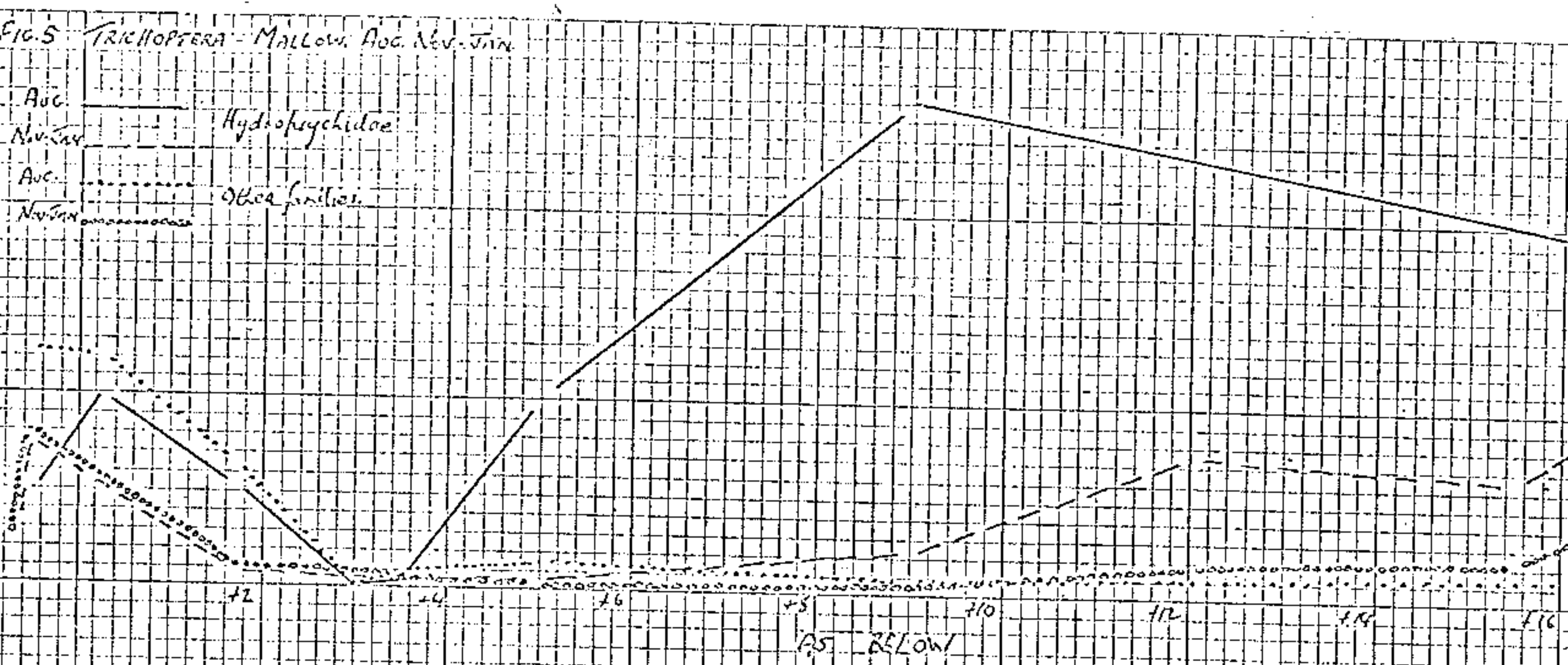
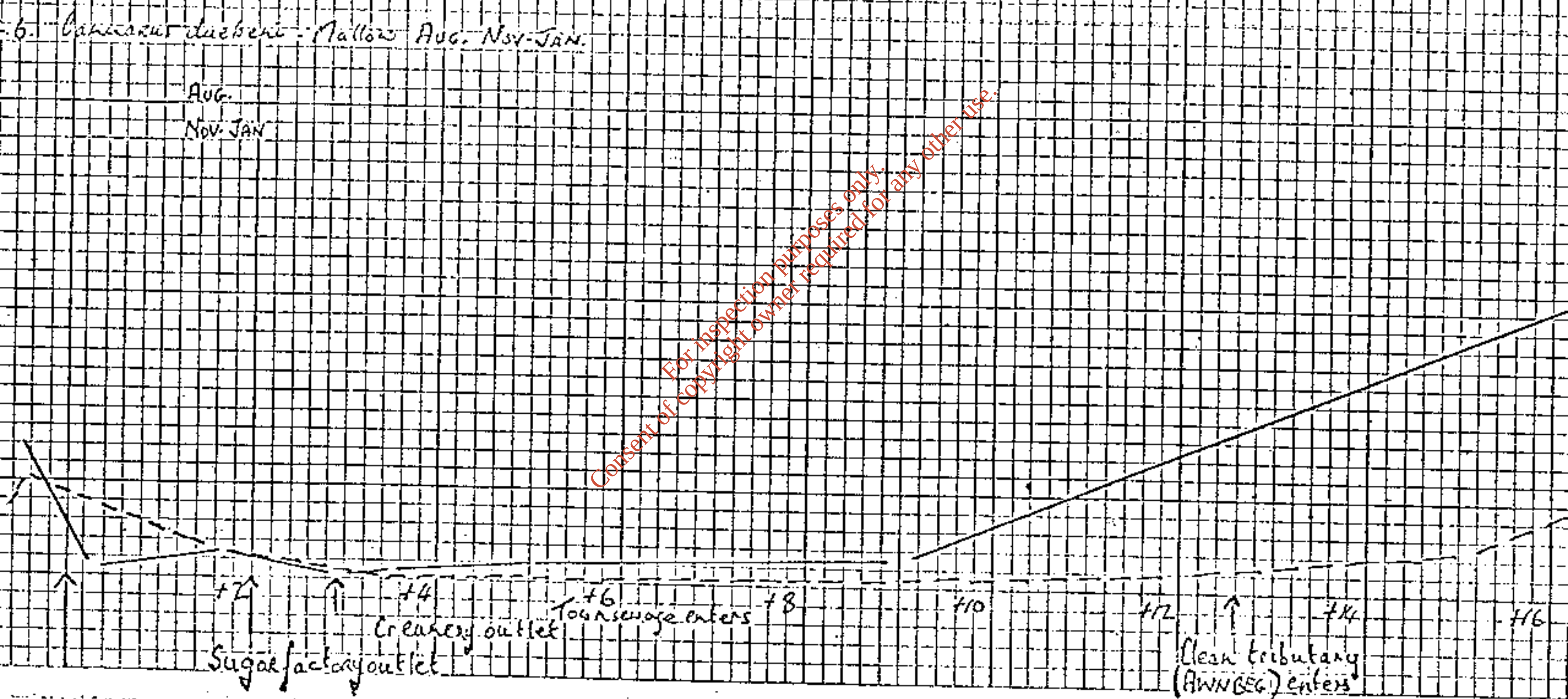


FIG. 5 TRICHOPTERA - MALLOW AUG. NOV-JAN
AUG.
NOV-JAN
Hydropsychidae
AUG.
NOV-JAN
Other families
+2
+4
+6
+8
+10
+12
+14
+16
AS BELOW


6. Gammarus duebeni - Mallow AUG. NOV-JAN.
AUG.
NOV-JAN
+2
+4
+6
+8
+10
+12
+14
+16
Sugar factory outlet
Creamery outlet
Town sewage enters
Clean tributary (AWNBEG) enters

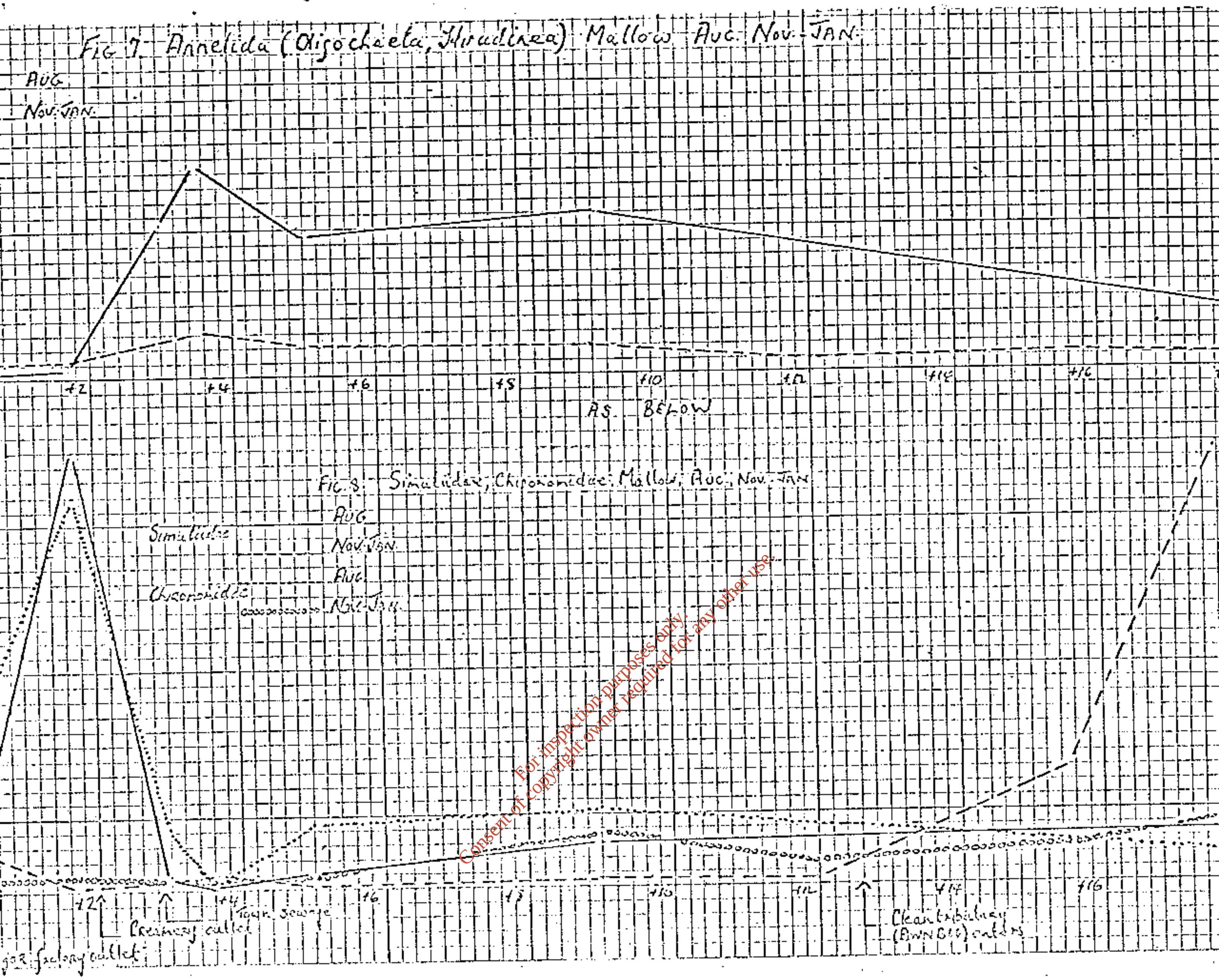
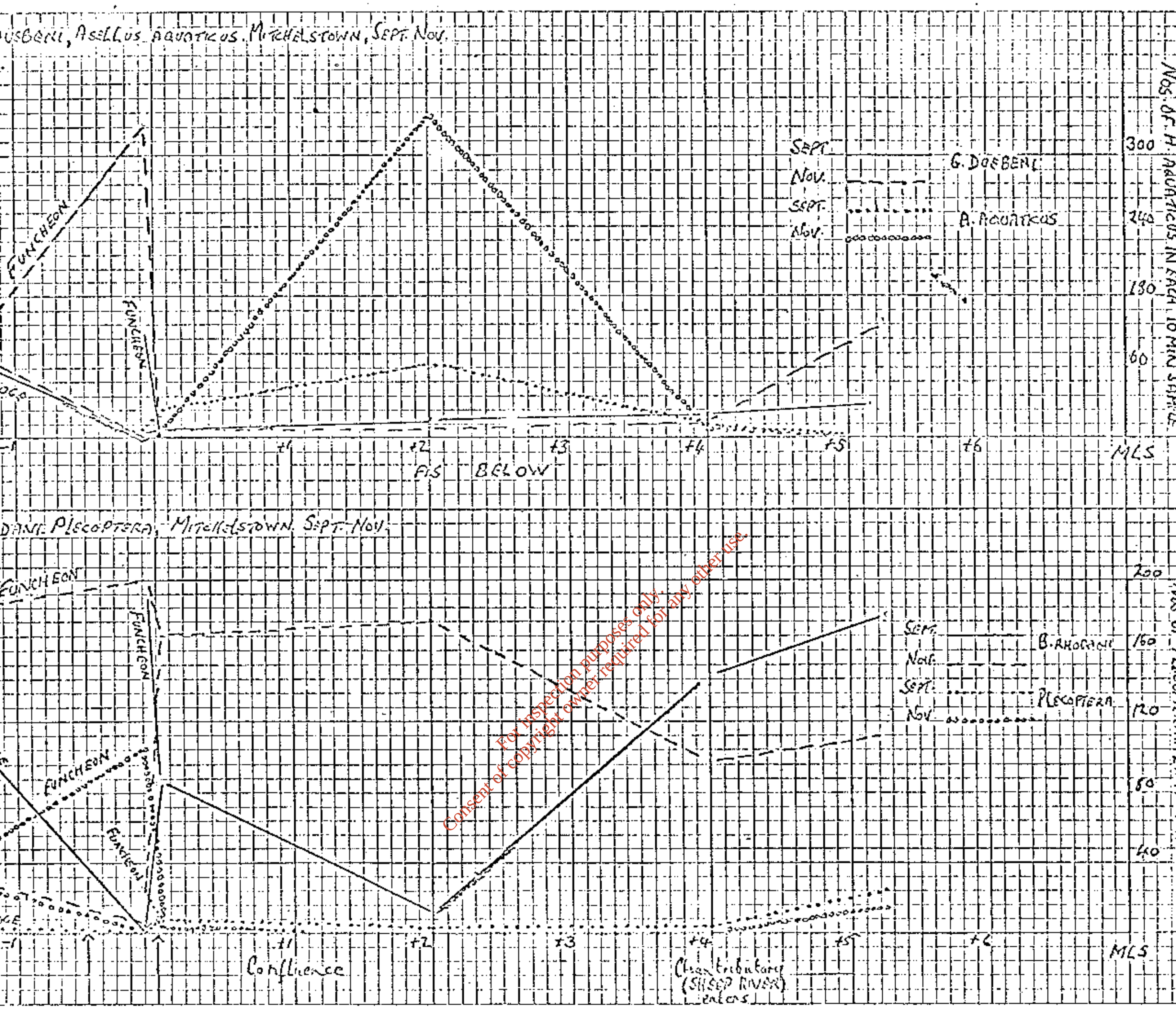
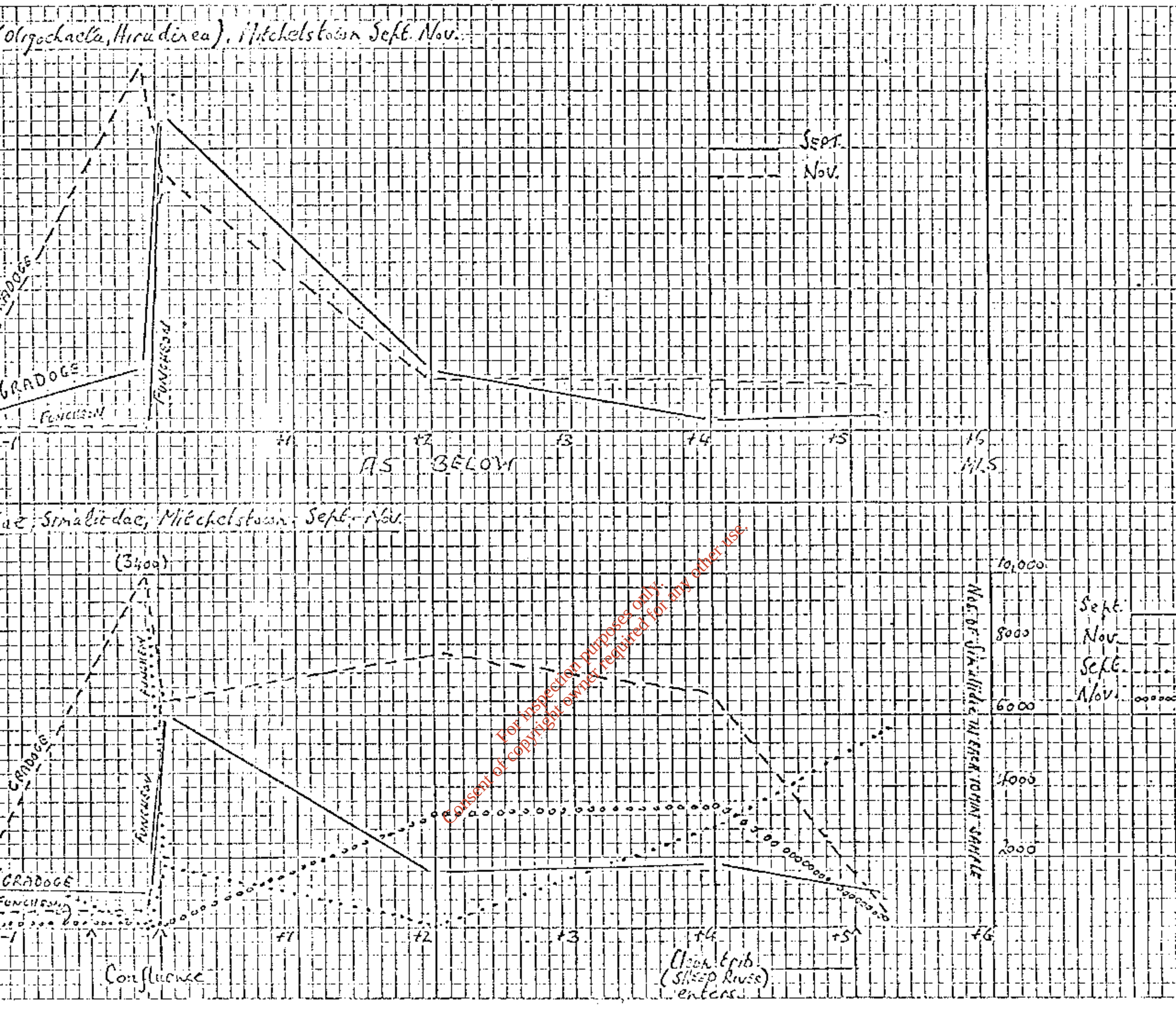


Fig 7 Annelida (Oligochaeta, Hirudinea) Mallow Aug. Nov-Jan.
Aug
Nov-Jan
+2
+4
+6
+8
+10
+12
+14
+16
As below
Fig 8 Simuliidae, Chironomidae Mallow Aug, Nov-Jan
Simuliidae
Aug
Nov-Jan
Chironomidae
Aug
Nov-Jan
+2
+4
+6
+8
+10
+12
+14
+16
Creamery outlet
Town sewage
Clean tributary (Awnbeg) enters

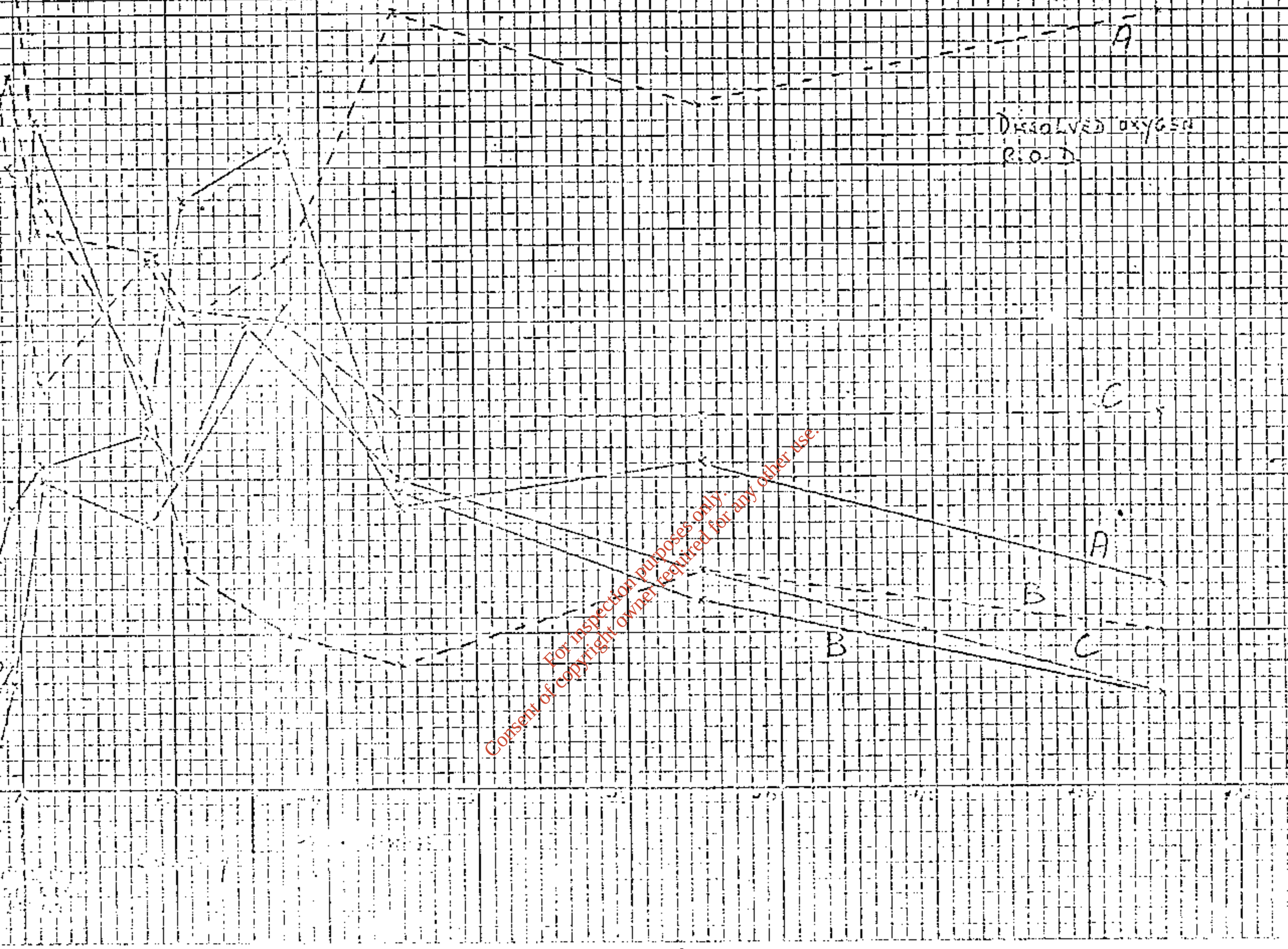

...USBENI, ASELLUS AQUATICUS, MITCHELSTOWN, SEPT. NOV.
FUNCHEON
FUNCHEON
SEPT.
NOV.
G. DOEBENI
SEPT.
NOV.
A. AQUATICUS
NOS. OF A. AQUATICUS IN EACH 10 MIN SAMPLE
300
240
180
60
+1
+2
+3
+4
+5
+6
MLS
F/S BELOW
...DANI PLECOPTERA, MITCHELSTOWN, SEPT-NOV.
FUNCHEON
FUNCHEON
FUNCHEON
FUNCHEON
SEPT.
NOV.
B. RHODANI
SEPT.
NOV.
PLECOPTERA
200
160
120
80
40
-1
+1
+2
+3
+4
+5
+6
MLS
Confluence
Clean tributary
(SHEEP RIVER)
enters

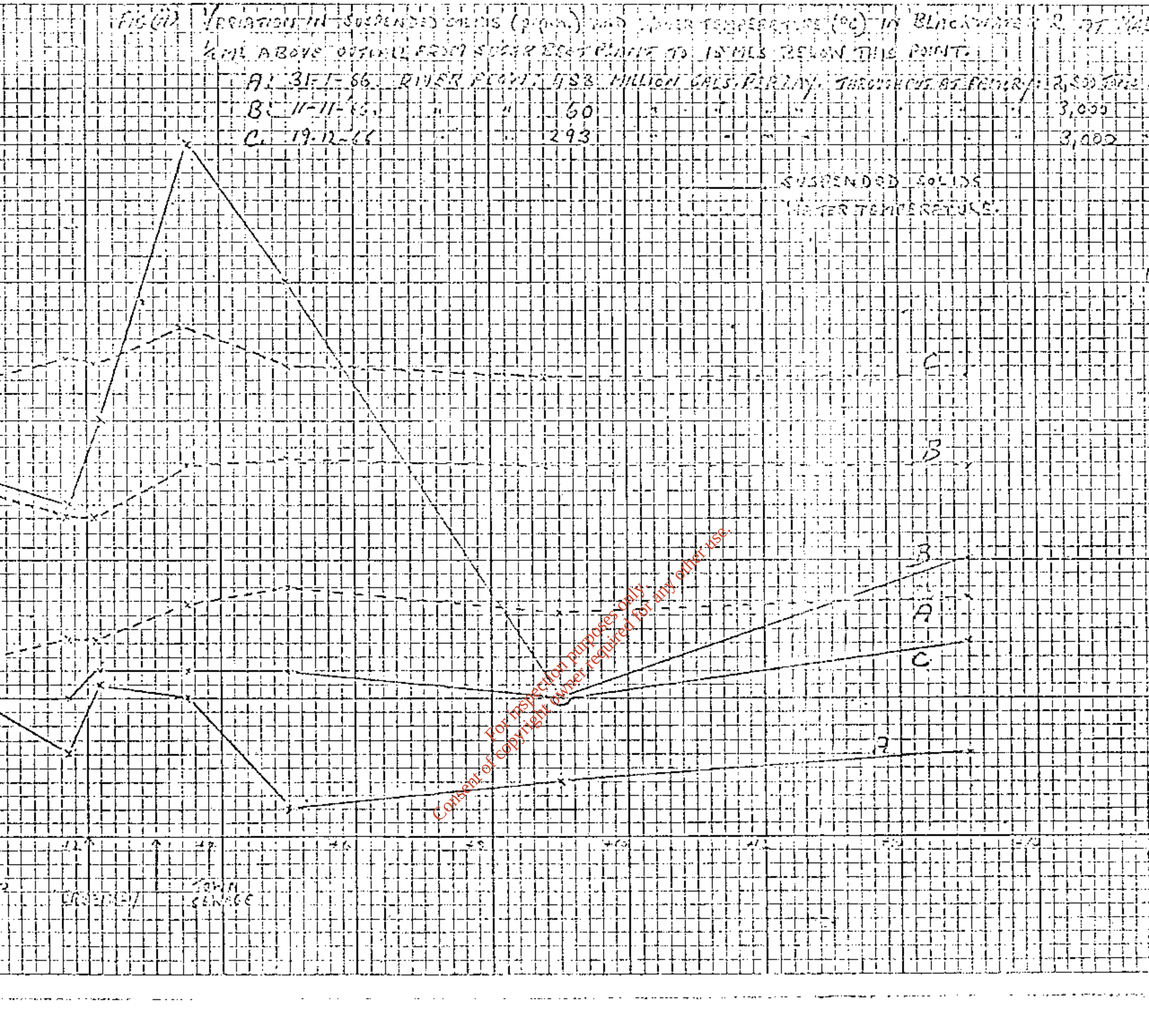
GUIDEX
Ref.
133/25 GRAPH



GUIDEX Ref. 139/25 GRAPH

FIG. (1) VARIATION IN DISS. O_2 (% SATURATION) AND B.O.D. (p.p.m) IN BLACKWATER RIVER AT MALL[OW]
OUTFALL FROM SUGAR BEET PLANT TO 15 MLS BELOW THIS POINT.
A: 31-1-66 RIVER FLOW: 458 MILLION GALS. PER DAY THROUGHPUT AT FACTORY
B. 11-11-66 " " 60 " "
C. 19-12-66 " " 273 " "




SUSPENDED SOLIDS
WATER TEMPERATURE
60
293
3,000
A
B
C

DEC. 1966
-1000
-500
+200

Telephone:- ~~XXXX~~ 779471
Telegrams:- Fisheries, Dublin.

Seol aon fhreagra chun:-
(Address any reply to:-)

An Rúnaí
(The Secretary)

faoin uimhir seo:-
(quoting:-) B2/230(4)

AN ROINN TALMHAÍOCHTA AGUS IASCAIGH
(Department of Agriculture and Fisheries).

FO-ROINN IASCAIGH
(Fisheries Division),

3 SRAID CHATHAL BRUGHA
(3 Cathal Brugha Street).

BAILE ATHA CLIATH 1.
(Dublin 1.)

10 Deire Fómhair, 1968.

Rivers Blackwater and Martin

Water Purity Project

A Chara,

With reference to the meeting held at University College, Cork, on 31st October, 1967 in the above matter I am to inform you that a further meeting has been arranged for 11a.m. on Tuesday, 29th October at the Zoology Department, University College, Cork. The purpose of the meeting is to inform representatives of local authorities and other interested persons of the progress made in the water purity research project, which is being carried out on the rivers Blackwater and Martin, and to enlist their co-operation, where possible, in contributing towards the successful completion of the work.

A summary of a report on work carried out in the period September 1967 - March, 1968 is enclosed for your information.

It would be appreciated if you would be good enough to confirm that your Co. Council will be represented, as requested, at the meeting.

Mise le meas,

[signature]

The Secretary,
Cork Co. Council,
Cork.

c.c. Co. Engineer.

Water Purity Project - Rivers Blackwater and Martin, Co. Cork.

Report for period September, 1967 - March, 1968.

(Fish Stocks)

SUMMARY

Using "Onan" and "Pulsator" fishing sets, samples of the fish stocks in clean and polluted water at each of the locations under study on the two rivers were obtained in August, 1967 and March, 1968. The samples taken in the former month were of a quantitative nature since the complete stock was removed from measured areas of the river; in March 1968 smaller samples were obtained.

The food, density, growth rates and age structure of the stocks of brown trout and salmon from polluted and non-polluted zones in each area are compared. Additional information, on the occurrences of other species, is also given, though in this case the data is less detailed. Mention is also made of the occurrence of gut parasites. A description and discussion of the methods employed to obtain quantitative samples in August, 1967, is included.

In regard to the results of the investigations on brown trout, it would seem that where they occur in polluted zones these fish make better growth than the same species in clean water. However, the numbers per unit area are smaller, and the mean age of the stock greater in polluted water. Parr and smolts of the salmon appear to be more severely affected by pollution than are trout, and were taken in very reduced numbers or not at all in polluted water. In their case also, the average age of fish in polluted water was greater than in upstream clean water reaches. In regard to other species, eels were found to be much more numerous in polluted than in non-polluted zones, while the opposite seemed to hold in the case of stone loach. In some cases differences in fish populations between polluted and non-polluted zones are not clearly attributable to water quality effects, since the physical nature of the stream changes between the areas.

Descriptions of the nature of the stretches fished in each area together with a summary of chemical and physical data on water quality have been recorded.

RIVER MARTIN

Description

The River Martin is a tributary of the Blarney River which is itself a tributary of the River Lee. It rises in marshy land near Lyradane Mountain (754',1228.5m), at an altitude of 600ft (181.8m), about half way between Cork and Mallow, and runs almost due South to Blarney. At Blarney town the river bends to the South-West for approximately one mile before it joins the Blarney River. The total length of the river is about the miles (16.1Km). It's width near the source at the first collecting station is in the region of one metre, while at the bridge at Blarney it is about four metres wide.

The river falls through 300'(100m.) over it's ten mile length. The flow appears uniformly rapid throughout 6-8m.p.h., and the course of the river in it's upper reaches is fairly straight, as it runs through clay and shingle. Below Rathduff however the river bed has been eroded down to rock.not very far belos the surface, and winds sharply for several miles. Below Putlands Bridge, at Waterloo village, down river to the confluence with the Blarney R. is another relatively straight stretch. Finally there is a right angled bend in the river as it flows through Blarney.

The Martin River drains rich pastoral land in a

South of Rathduff the banks are wooded on each side; there are large plantations south of Wises Bridge on the right bank, and between Putlands Bridge and Blarney town on the left and right banks.

The upper part of the river, between the source and Rathduff was dredged in 1965, in conjunction with a land drainage scheme. The river bed is now clean and stony, with little aquatic macrophytic vegetation. Isolated areas with a growth of algae moss or other plants do occur, but these have not yet been recorded systematically. Some notes on the occurrence of these plants have been made in association with the fauna collecting stations. The river bed between Rathduff and Waterloo has not been altered, as far as is known. The flora here is of mosses and algae, such as Chara sp., in the rocky areas and other macrophytes in the few stony stretches.

About 1 mile (1·4km.) above Blarney town the river has been dammed to form a roughly triangular shaped pond, nearly ¾mile long. This supplys a mill race for the town. The bed of this mill pond is silted near the dam, where it's greatest depth is about 8ft. Below Blarney the bed of the river is stony with patches of shingle and sand. There is a large growth of algae just below the town. The distribution of the other plants appears scattered.

It is planned to identify and map the distribution of the aquatic macrophytes present during the Summer

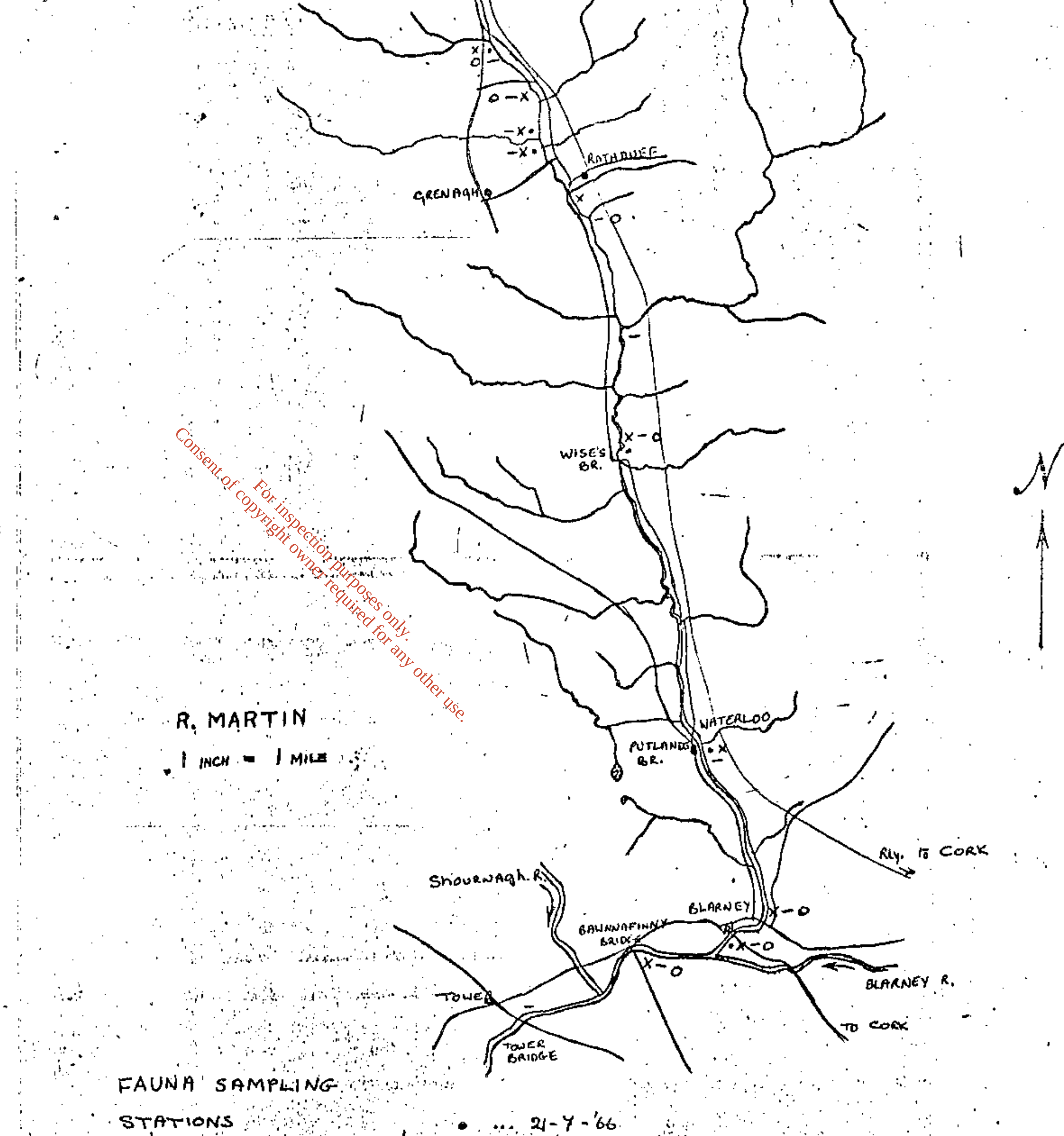
It is possible, though at the moment it appears unlikely, that there will be variation in the plant communities which could be associated with the pollution of the river.

The effect of vegetation on the oxygen content of water is well known. From observations so far, of the quantity of vegetation in the River Martin, and the velocity of the water, it seems unlikely that the plants will influence the O_2 content of the water in a significant amount, even in the polluted areas.

There is one population centre in the area, Blarney town, with about 500 inhabitants. The villages of Rathduff and Waterloo have about 100 and 50 inhabitants respectively. These figures can only be used as a very rough guide to the size of the population. In addition there is a scattered population in farms in the drainage area of perhaps another 100 people. Domestic eswage from these places is discharged untreated into the river.

That the river drains a dairying area has been already mentioned. One of the industries which use the river water water is a cheese factory at Rathduff. This factory utilises most of the milk produced in the area. Associated with the factory is a pig farm where the whey produced in the cheese making is used for feeding the animals. Pig manure in the form of a slurry is used as a fertiliser on a number of nearby farms. The cheese factory does not put any large effluent into the river, nor does it extract water for it's processes.

The only other industry in the area, that affects the river is the Martin Mahony & Co. Woollen Mills at Blarney. This is a large establishment producing woollen yarn from the fleece. The factory has, upon occasion, run foul of the Fishery Conservators who claim that the effluent caused fish mortalities in the area.


R. MARTIN
1 INCH = 1 MILE
GRENAGH
RATHDUFF
WISE'S BR.
WATERLOO
PUTLANDS BR.
RLY. TO CORK
SHOURNAGH R.
BLARNEY
BAWNNAFINNY BRIDGE
BLARNEY R.
TO CORK
TOWER
TOWER BRIDGE
FAUNA SAMPLING STATIONS • ... 21-7-'66

Sampling.

Method. From the information and advice given by many workers in the field of freshwater research it was decided that the fauna collections should be made using a standard of time. A pond net was used to sweep through weeds, and the s... stones of the river bed are kicked to dislodge the animals so that these are swept into the net by the current. It is now considered that the collections so made are not sufficient for the requirements of the project, and it is proposed to take some samples using a Surber Sampler, or one of its modifications, for comparison. It is hoped that estimates of numbers per unit area will be achieved. Such results would be more read readily comparable with the results of the fish census work when this is done, and with the survey of the flora, as both of these will be dealt with as density per unit area.

Sites Because the greatest number of species is found in shallow broken water, on a stony substrate, all the collecting was done at riffles, or some similar area, as in the River Blackwater. Some collecting from plants in each area was done in an attempt to get a comprehensive collection, should there be any difference between the fauna of a weedy and a stony area.

Time With one exception all the fauna collections were of ten minutes duration. A five minute collection was made in t the most polluted part of the river where the meshes of the net became rapidly choked with sewage fungus. The fact that it is unpleasant to work in the area also influenced the decision to reduce the sampling time. If the Surber Sampler is used in future collections the time involved will be reduced in all the samples.

Preservation. All samples were killed and fixed in formalin as were sorted and stored in alcohol for identification when the series of colledtions was completed. Storing as soon as possible was essential as the number of sampling stations increased.

Identification. With the aid of the F.B.A. keys identification to species level was possible in most cases. In some instances the lack of a key, the rough treatment during collection or the method of preservation caused considerable damage to the specimens and identification was not possible. The Ecdyonurids are particularly susceptible to damaging by rough treatment.

Subsamples. These became necessary in some cases, e.g. in the Blarney area where the numbers of Hydrobia jenkinsi rise to over 300,000. Subsampàes were taken as 1/10 of the weight or of the volume of the total. The results are not satisfactory as they seem to yeild a much higher number than a direct count would give. It is felt that the figures obtained from the subsamples could only be used to indicate the magnitude of the population in the sampling area and that they should not be considered as an accurate asessment of quantity.

Collecting Stations. The number suggested by Mr. Pentelow was four, above and below Rathduff and Blarney as it is in these places that any pollution or enrichment of the river occurs. These limits were taken very generally, so that in the July series 10 collecting points were utilised, and in November 12. The increase in the number of stations was felt necessary as there was nothing known of the fauna of the river. In the last series taken on March 16th tha number of stations was reduced to seven and these will be used in all future collections. The stations are numbered from the source to the confluence

Natural Var

relation to the previous collections. The map (1) and Table 1 , show the positions of the stations. Some of those are close together and are grouped for use in the graphs and fauna lists.

Natural Variation. It was thought that some knowledge of the natural changes in the invertebrate fauna population was necessary before any alteration caused by pollution were considered. For this reason a number of collecting points were used above Rathduff, the first polluted area. These cover stony rocky and weedy areas separately andshould yeild useful information of the variation of the fauna with the substrarum, and any annual variation that may occur.in the cleanest part of the river.

Table I

Alignment of Sampling Stations. (see Map I.)

Station numbers used in collections					
	1	1	-	-	
	-	-	1	1	
	-	2	2	2	
	2	3	3	-	Just above polluting stream
	3	4	4	-	" below " "
	-	5	-	-	
	-	-	5	3	
	-	-	6	-	
	-	6	7	4	
	4	-	-	-	
	5	7	-	-	Waterloo (Putlands Brådge)
	-	-	8	-	
	-	8	9	5	
	6	9	10	6	Blarney Bridge
	-	10	11	7	Bawnafinny Bridge
	-	-	12	-	Tower Bridge
Map Symbol	•	x	-	o	

• 21-7-66
x 14-9-66
- 29-11-66
o 16-3-67

Blarney 17-9-66 Dull cool showery, water low Nos. 7 - 10

Rathduff 14-9-66 Weather cloudy, cool, some showers.

No.	Substrste	Vegetation	Current, Depth	Remarks
1	Small stones gravel	Good weed, moss & algae growth	Fast clear Very shallow	Near No.1 21-7-66 10yds downstream
2	Med-large stones	more weed than No. 1	Fast clear Shallow	New station 1ml downstream of No.1
3	As No.2 slimy	little weed	Fast clear Shallow	Near No.2 21-7-66 Not as much sewage fungus on stones
4	Stones bedded in gravel	Mosses, little weed	Fast Shallow Clouded	As No.3 July. Not as much sewage fungus on the stones
5	Large stones gravel slime	Good weed, moss growth fungus	Fastdeeper clouded	New stat. at bridge belos factory. 5min.only. Substitute for No.4 July
6	Large-med stones	Some weed, moss leaf debris	Fast Shallow clear	About ½ml. above No.4 21-7-66.
7	As July	As July	Fast shallow clear	As No.5 July
8	Med-large stones	Some moss weed	Water fast shallow clean	New stat. about ½ml. above Blarney
9	As July	Less algae than in July	Fast clear	As No.6 July
10	Large stones	Good growth of weed & moss Much algae		New stat. about ½ml. below Blarney Bawnnafinny Bridge

..otes on the Collecting Stations

Rathduff 29-11-66

Fine, sunny and cool, becoming dull later. Some rain during the previous night. Water level normal.

No.	Substrate	Vegetation	Current. Depth	Remarks
1	Large stones loose in gravel some small rocks clean	Fair amount of weed, moss some leaf debris clean	Mostly shallow fast. Some deep deeper slower. Water clear	About 15yds below No.1(14-9-66) 1 mile above poll.
2	Relatively small stones in gravel somewhat slimy	Good amount of weed. Several spp., moss clean	Fast shallow Water clear	Same as No.2 14-9-66, about1/3 mile above effl.
3	Medium small sized stones loose gravel clean	Little weed or moss, Clean	Relatively fast & shallow. Water clear	As No.3 14-9-66 about 50yds. above pollution
4	Large & small stones, gravel Sewage fungus on stones, slimy	Very little weed or moss	Fast, shallow suspended matter in water inc. S.F.	As No. 4 about 20 yds below pollution
5	Med. large stones S.F. blanket slimy	No weed. Some moss	Fairly fast shallow. Susp. of S.F in water	About 30yds below No.5 14-9-66
6	Large med. stones slimy	No weed little moss	Fast, shallow S.F. in water	New stat. about ½ way between 5 & 6 14-9-66. 1½ml below pollution
7	Large stones in gravel, mud & sand. Slimy	Small amount of weed, moss	Fast shallow tho' deep in places	As No.6 14-9-66 about 2½ml below pollution

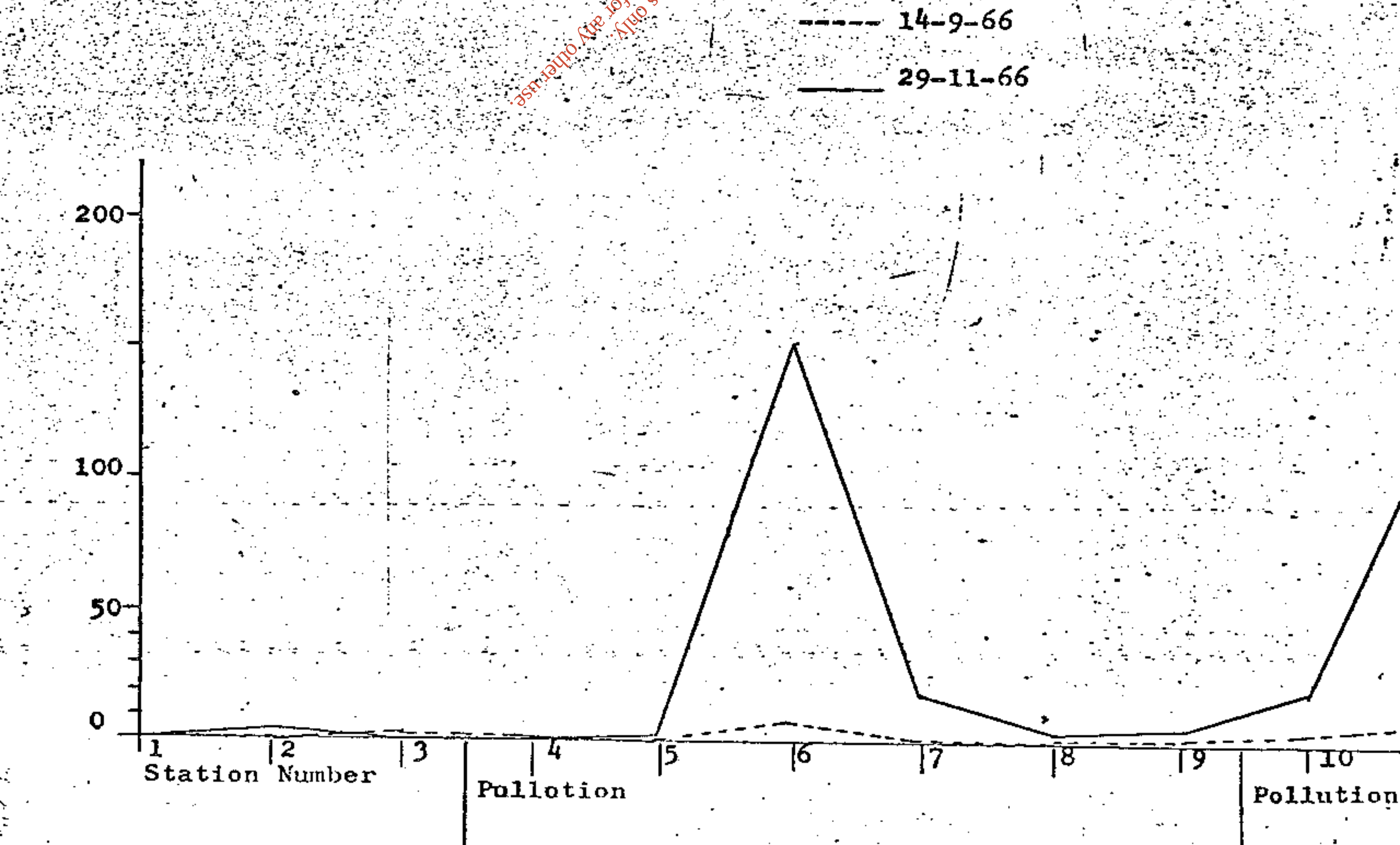
Blarney 29-11-66

Weather dull and cool, sunny later heavy rain during the previous night and day. Water level above normal.

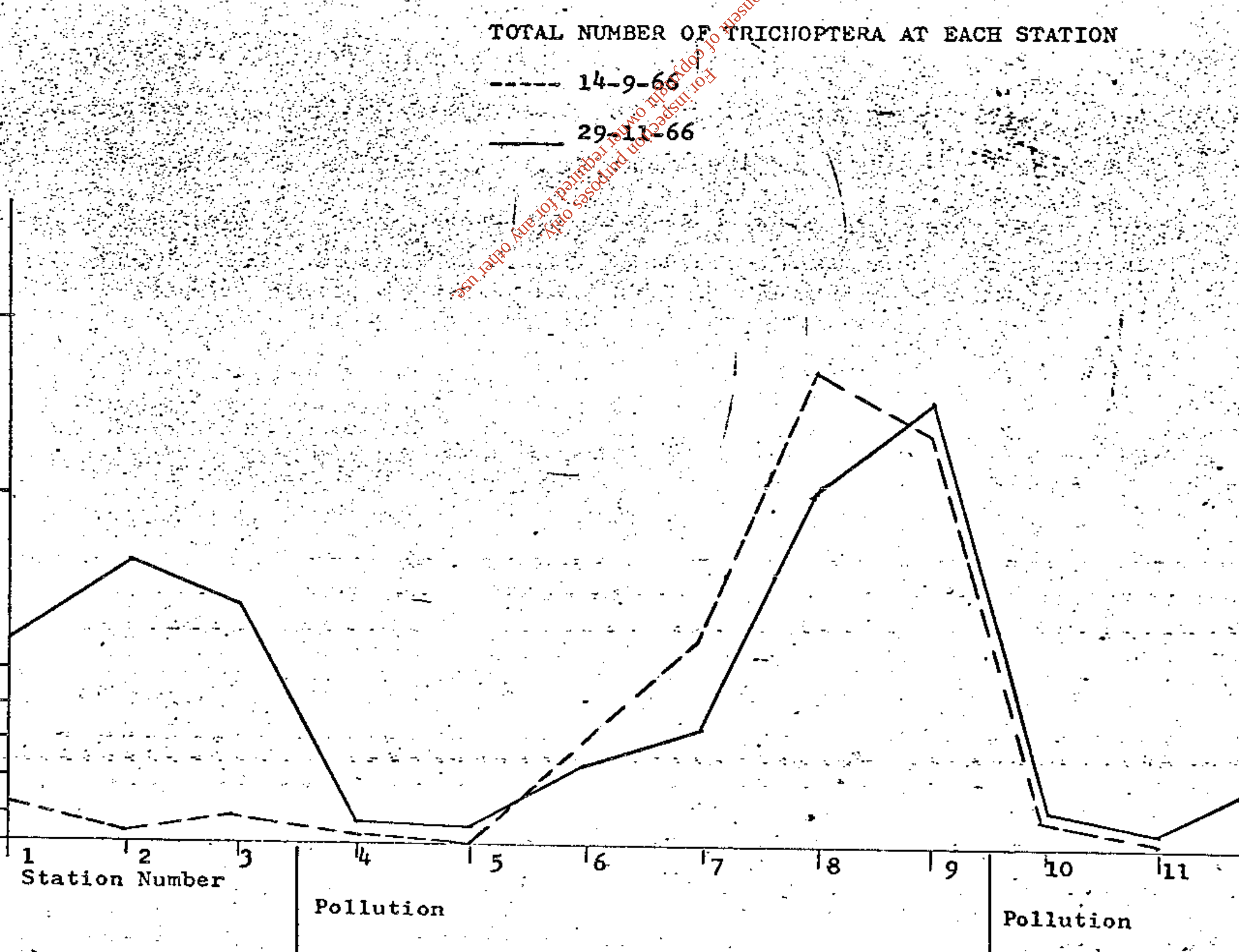
No.	Substrate	Vegetation	Current. Depth	Remarks
1 (8)	Stones all sizes gravel & sand Some slime	Good amount of weed & moss. Leaf debris Refuse. Slimy	Fast-V.fast Wide flat shallow. Water clear	30yds. below Waterloo Br. & B.1. of 17-9-66 About 1½ml. abov mills 5¼ml. belo Rathduff.
2 (9)	Med. large stones gravel. Clean	Little weed or moss. Leaf debris	Fairly fast shallow clear	As No.2 17-9-66 About ½ml. above mills & 6½mls. below Rathduff.
3 (10)	Med. small stones gravel, slime	Small amount of weed on deep side. Some moss clean	Fairly fast not V. shallow clear	As No.3 17-9-66 200 yds., below woolen mills & town
4 (11)	Small-med. stones gravel, sand clean	Small amount of weed & moss. Leaf debris	Fairly fast deep clear	As No.4 17-9-66 Bawnafinny Br. on Blarney Rd., 1ml., below mill
5 (12)	Small stones in gravel on shallow side, larger on deep side	Fair amount weed 'specially on deep side clean	Shallow, fast V.fast on deep side, clear	New stat. 100 y upstream of Tower Br. 2mls. below mills Below Shournagh

GRAPH

NUMBER OF HIRUDINEA AT EACH STATION

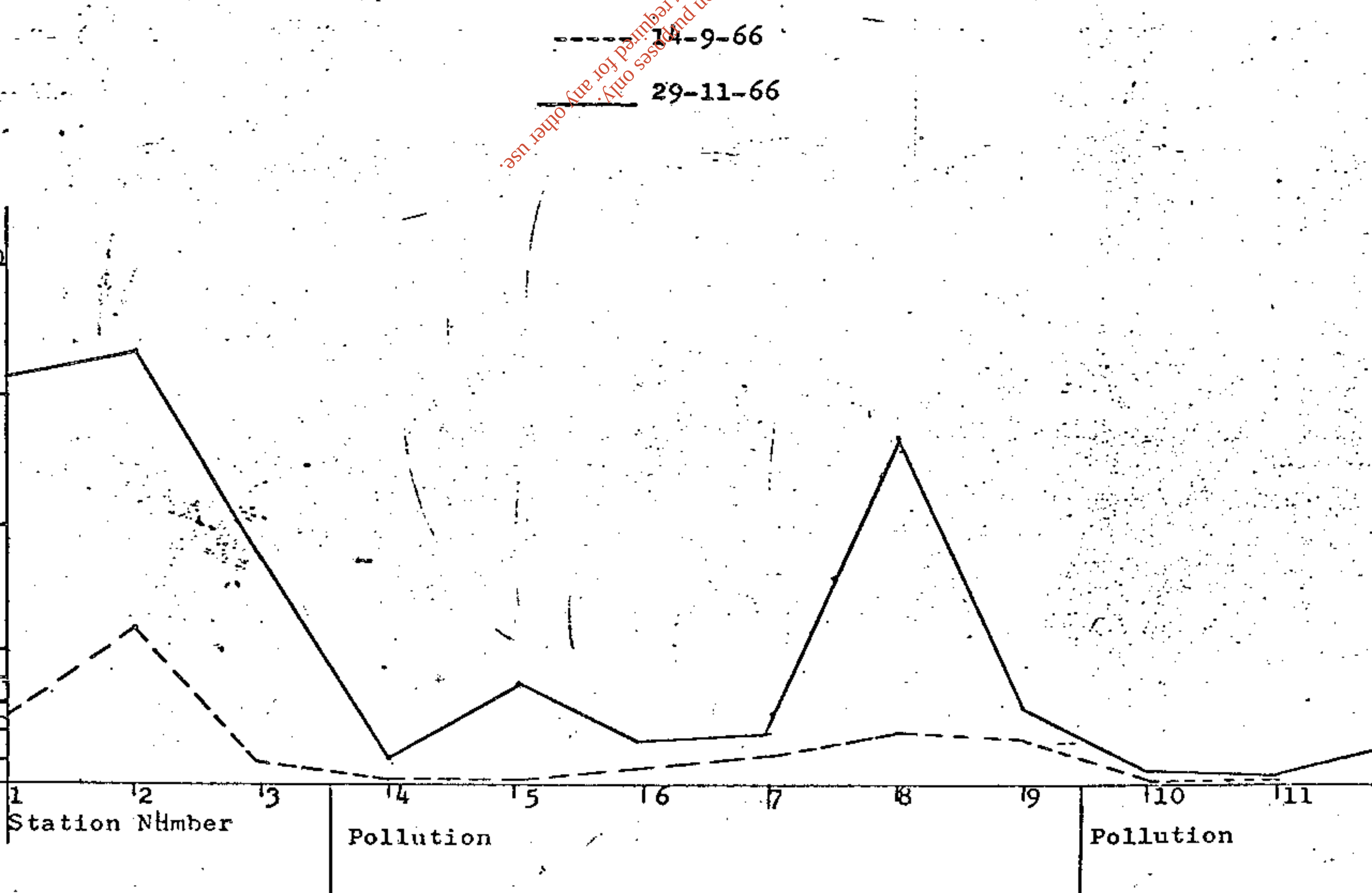


GRAPH 2

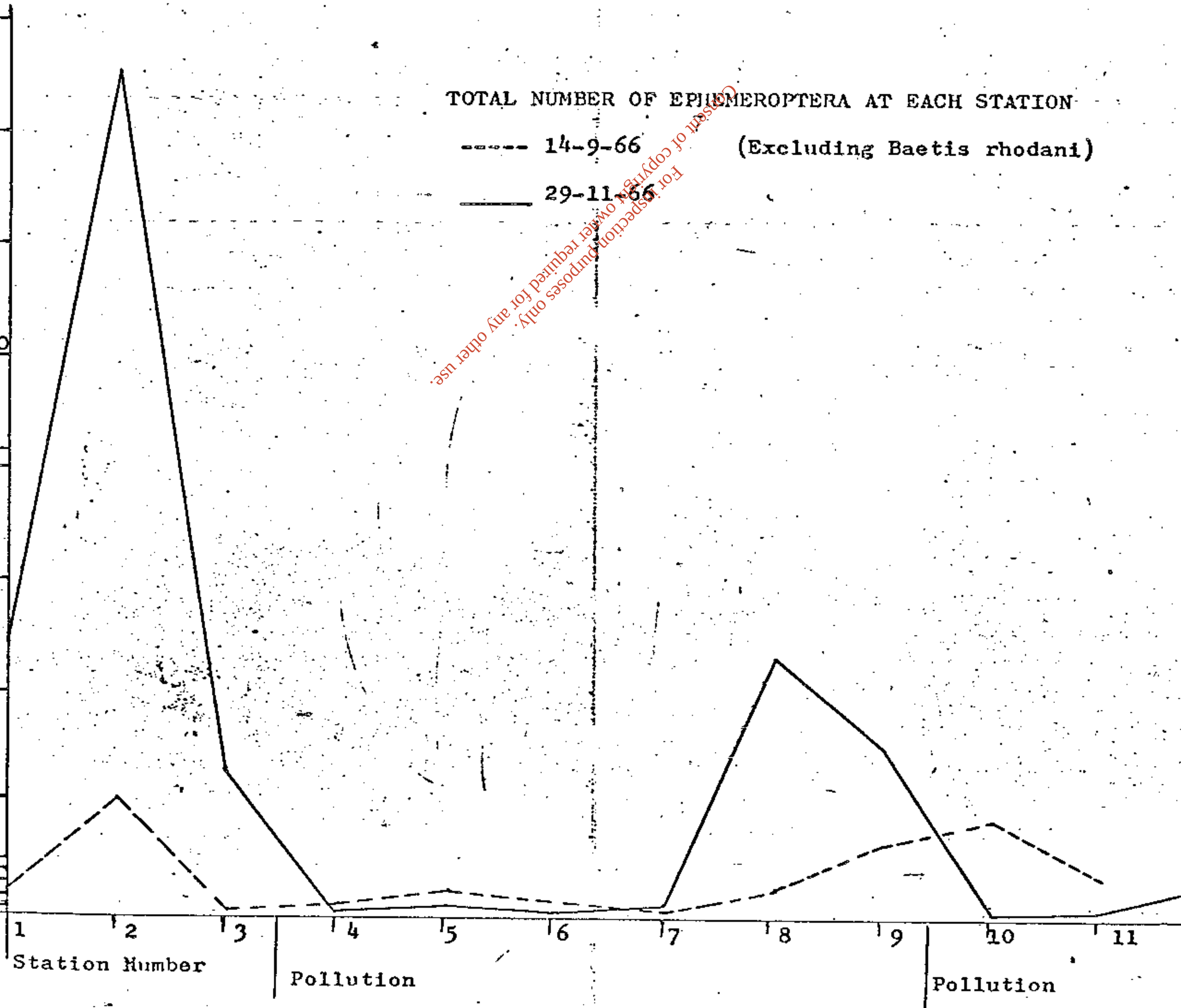

TOTAL NUMBER OF TRICHOPTERA AT EACH STATION
14-9-66
29-11-66
1
2
3
4
5
6
7
8
9
10
11
Station Number
Pollution
Pollution

GRAPH 3

TOTAL NUMBER OF PLECOPTERA AT EACH STATION



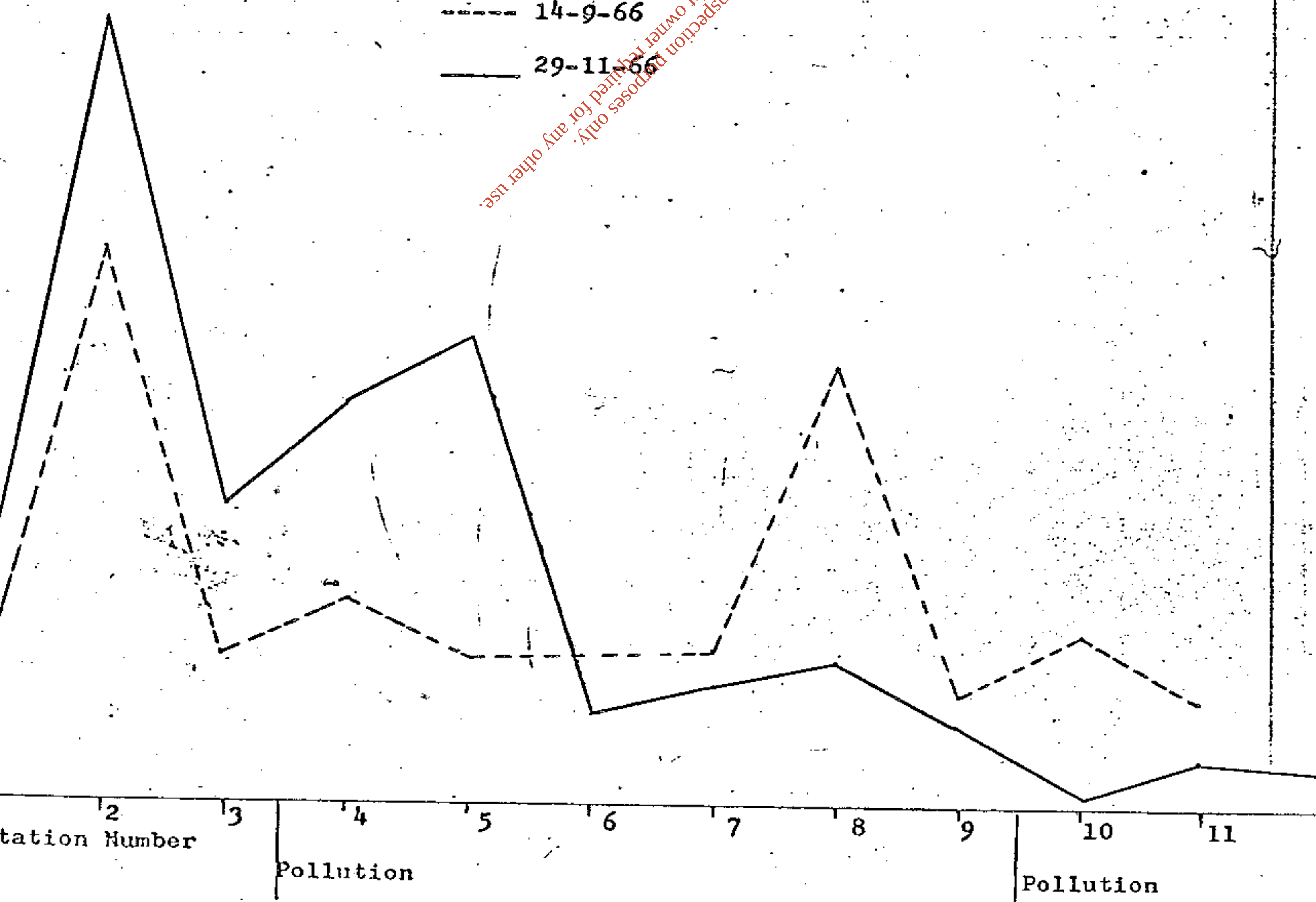
GRAPH 4



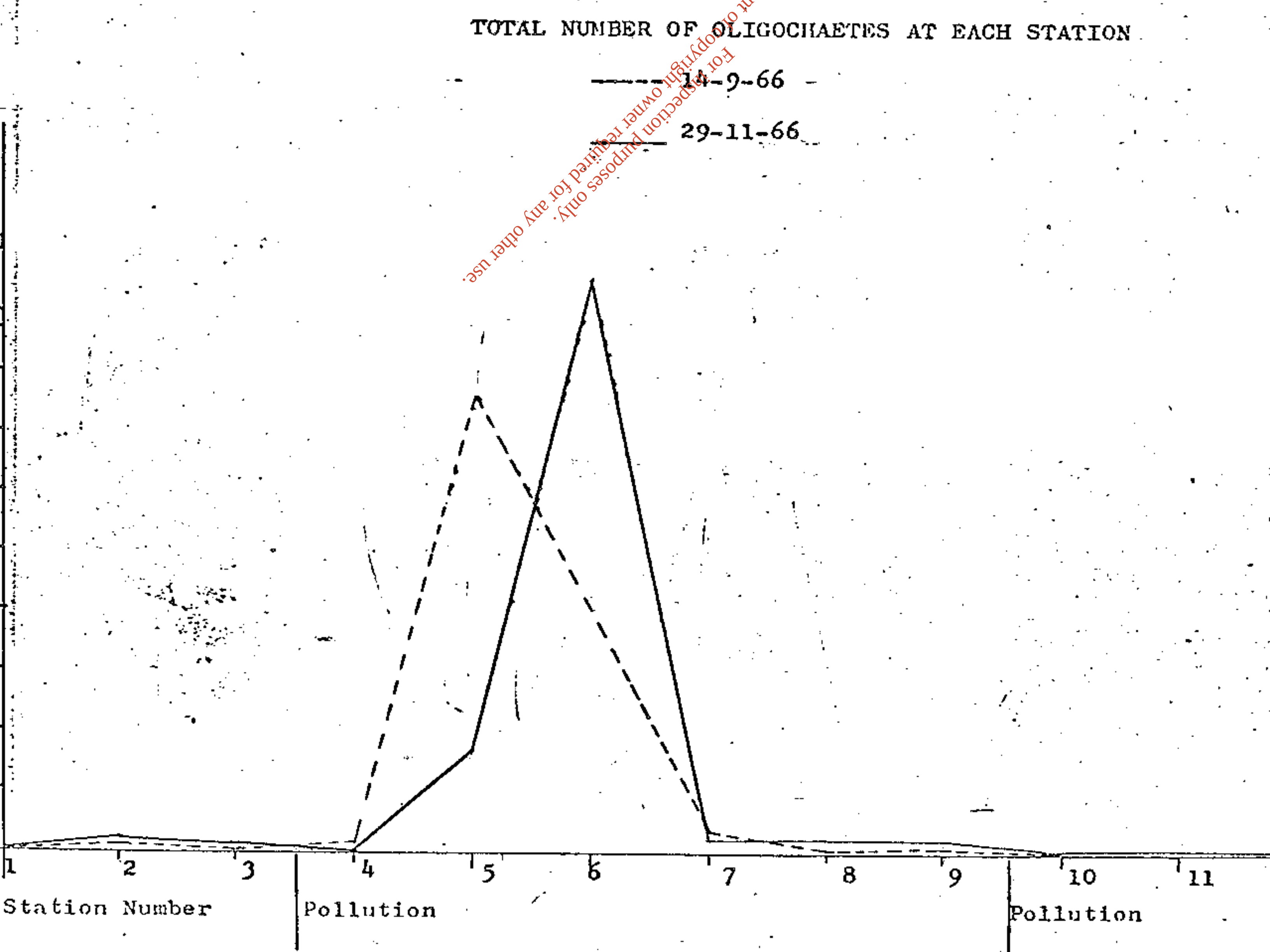
TOTAL NUMBER OF EPHEMEROPTERA AT EACH STATION
------ 14-9-66 (Excluding Baetis rhodani)
29-11-66
1
2
3
4
5
6
7
8
9
10
11
Station Number
Pollution
Pollution

GRAPH 5

NUMBER OF BAETIS RHODANI AT EACH STATION



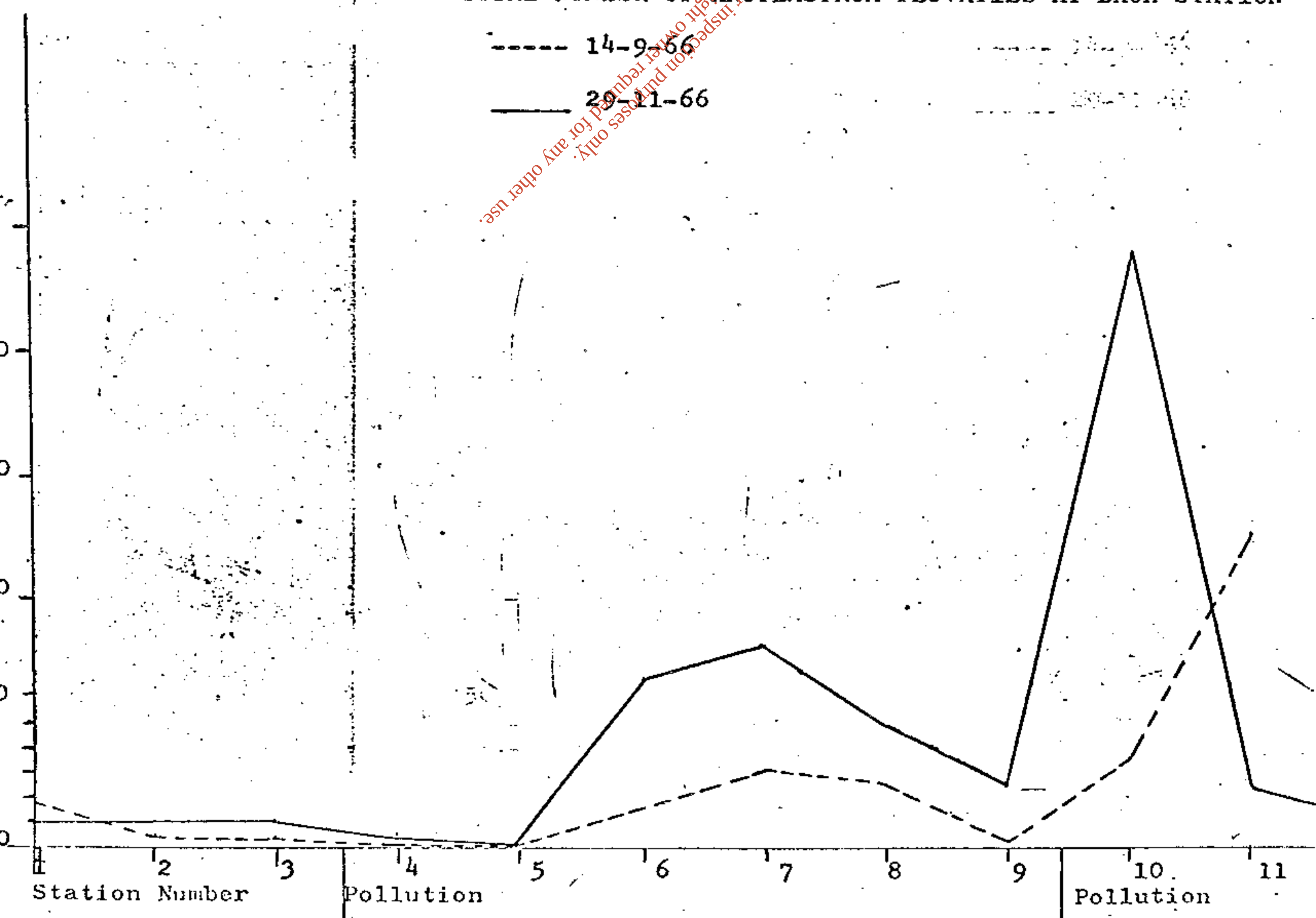
GRAPH 6



TOTAL NUMBER OF OLIGOCHAETES AT EACH STATION
14-9-66
29-11-66
1
2
3
4
5
6
7
8
9
10
11
Station Number
Pollution
Pollution

GRAPH 7

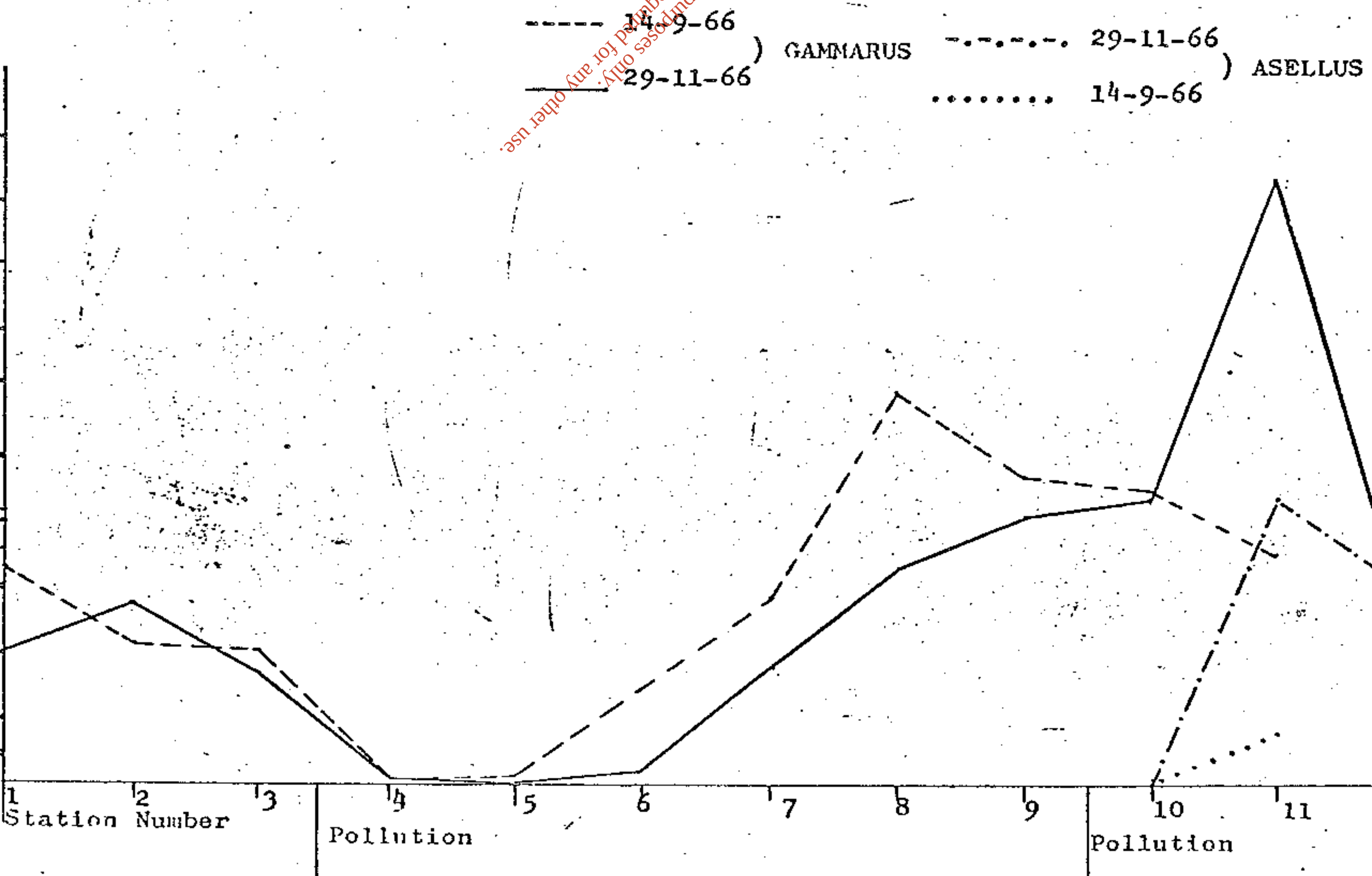
TOTAL NUMBER OF ANCYLASTRUM FLUVATILE AT EACH STATION



GRAPH 8

TOTAL NUMBER OF GAMMARUS DEUBENI AND

ASELLUS AQUATICUS



FAUNA COLLECTIONS AND SPECIES LISTS

River Martin 21-7-66

Qualitative.

x = present
o = absent

Species	Station Number 1	2	3	4	5	6
EPHEMEROPTERA						
Baetis rhodani	x	x	x	x	x	x
Ephemerella ignita	x	x	x	x	x	x
Ecdyonurus venosus	o	o	o	o	x	o
E. dispar	x	o	o	o	x	o
Heptagenia sulphurea	x	o	o	o	o	o
Caenis rivulorum	o	o	o	o	x	o
PLECOPTERA						
Leuctra hippopus	o	x	o	x	x	x
Protonemoura meyeri	x	x	o	x	o	o
Isoperla obscura	o	o	x	o	o	o
TRICHOPTERA						
Hydropsyche sp.1.	x	o	o	o	x	x
Ryacophila sp.1.	x	x	o	x	x	x
Philopotamidae sp.1.	o	o	o	x	o	o
Polycentropidae sp.1.	o	x	o	o	x	o
Agapetus sp.1.	x	x	o	o	x	x
Limnephilidae sp.1.	x	x	o	o	x	o
DIPTERA						
Simulidae sp.1.	x	x	x	x	x	x
" spp.p.	x	x	x	x	x	x
Chironomidae spp.1.	x	x	x	x	x	x
" spp.p.	x	x	x	x	x	x
COLEOPTERA						
Helmidae spp.a.	o	x	x	x	x	x
Limnebius spp.a.	x	x	o	x	x	x
" spp.1.	x	x	x	x	x	x
Dytiscinae spp.	x	o	x	x	x	o

River Martin: 21-7-66 continued.

	1	2	3	4	5	6
HYDRACARINA						
Hygrobates longipalpis	x	x	x	x	x	x
Lebertia porosa	o	o	x	x	o	x
Megapus spinipes	o	o	x	x	o	o
Aturus scaber	o	o	o	o	x	o
Sperchon setiger	o	o	o	o	x	x
S. squamosus	o	o	o	o	o	o
CRUSTACEA						
Gammarus deubeni	x	x	x	x	x	x
OLIGOCHAETA						
Species indet.	x	x	x	x	x	x
HIRUDINEA						
Helobdella stagnalis	x	o	o	o	o	o
Glossiphonia complanata	o	o	o	o	x	x
MOLLUSCA						
Hydrobia jenkinsi	o	o	x	o	o	x
Ancylastrum fluviatile	o	o	o	x	x	x
Limnea pereger	o	o	o	x	o	o
Sphaerium corneum	x	o	x	o	o	x
GORDIACEAE						
Species indet.	xx	x	x	o	o	o

rtin: 14-9-66.

es	Number at each station 1	2	3	4	5	6	7	8	9	10
OPTERA										
s rhodani	461	2200	610	800	590	615	1750	450	676	407
nbus	-	-	1	5	20	2	-	-	80	23
llis	3	7	-	-	-	3	6	25	1	8
erella ignita	-	6	2	2	-	-	8	10	4	2
aurus venosus	19	90	-	-	1	-	12	30	-	-
rogenia semicolorata	1	-	-	-	-	-	-	-	-	-
excluding B. rhodani	23	103	3	7	21	5	20	65	85	33
including B. rhodani	484	2303	613	807	611	620	1770	515	761	440

PTERA										
bipunctata	-	-	-	-	-	-	-	1	-	-
ra hippopus	1	1	-	1	-	-	3	-	-	-
sca	-	-	1	1	-	-	4	7	-	-
nemoura meyeri	20	60	10	-	-	12	13	7	-	-
a bifrons	1	-	-	-	-	-	-	-	-	-
	22	61	11	2	-	12	20	15	-	-

OPTERA										
psyche	-	1	-	-	-	-	100	60	1	-
phila	6	4	8	2	-	54	26	50	-	-
potamidae	4	-	-	-	-	1	-	-	-	-
entropidae	-	-	-	1	-	5	4	6	-	-
sus	1	-	-	-	-	-	-	1	-	-
ocerum albicorne	1	-	-	-	-	-	-	-	-	-
philida	-	-	-	-	-	-	-	-	4	-
	12	5	8	3	-	60	130	117	5	-

. Martin 14-9-66 continued

	1	2	3	4	5	6	7	8	9	10
IPTERA										
imulidae spp.l.	50	700	700	500	410	3200	60	35	13	5
" spp.p.	-	-	-	-	-	-	-	-	-	-
hironomidae spp.l.	45	60	40	850	3600	950	160	80	104	25
" spp.p.	-	-	1	7	212	-	2	4	-	1
cranota spp.l.	10	80	4	3	-	2	64	41	2	-
thomyiidae sp.l.	1	-	-	-	-	-	-	-	-	-
tal	106	840	745	1360	4222	4152	286	100	119	31
OLEOPTERA										
lmidae sp.l. (a)	7	6	2	2	-	4	30	90	88	130
" sp.l. (b)	6	10	-	-	10	5	15	15	63	-
" sp.a.	-	-	-	-	-	-	-	-	25	25
drophilidae sp.a.	-	1	-	-	-	-	8	2	-	-
telmis volkmari	-	2	2	1	-	7	6	9	-	-
mnius tuberculatus	-	-	-	-	-	15	2	7	-	-
olus parallelopipeous	15	-	-	-	-	-	3	22	-	-
tiscinae spp.a.	-	1	-	-	-	-	-	-	-	-
tal	28	20	4	3	10	31	64	145	176	155
DRACARINA										
grobates longipalpis	-	-	-	-	-	-	-	-	17	3
bertia porosa	-	-	-	-	-	-	-	-	2	2
hers	12	30	15	2	5	-	-	30	-	1
tal	12	30	15	2	5	-	-	30	19	6
USTACEA										
mmarus deubeni	320	210	196	8	4	275	600	470	444	356
ellus aquaticus	-	-	-	-	-	-	-	-	-	7

9-66 continued.

	1	2	3	4	5	6	7	8	9	10
GOCHAETA										
al	6	23	10	160	7500	300	73	25	204	5
UDINEA										
cicola geometra	-	-	1	-	-	1	-	-	-	-
ssiphonia complanata	-	-	-	-	-	1	-	-	4	7
obdella stagnalis	-	-	-	2	-	4	1	1	-	-
						6	1			
1	-	-	1	2	-	6	1	1	4	7
LUSCA										
robia jenkinsi	-	-	-	-	-	-	-	27	315400	14200
nea pereger	-	1	1	-	-	-	-	-	8	-
aerium corneum	-	-	-	-	-	-	-	2	2	77
ylastrum fluviatile	15	4	2	-	-	30	26	2	36	125 14325
al	15	5	3	-	-	30	26	31	315444	14325
TYHELMINTHES										
ycelis niger	17	30	-	-	-	-	-	-	-	-
cornuta	-	-	-	-	-	-	-	-	-	-
tal number organisms	1022	3508	1606	1538	12352	4854	3008	4511	317237	15434

Martin: 29-11-66 to 3-12-66

cies	Number at each station 1	2	3	4	5	6	7	8	9	10	11	12
EMEROPTERA												
tis rhodani	760	4154	1186	1620	1860	370	470	529	290	92	180	172
scambus	40	20	-	-	-	-	-	-	-	-	-	-
emerella ignita	-	-	-	-	-	-	-	-	-	1	-	-
yonurus venosus	89	207	62	-	2	-	3	1	10	1	1	19
dispar	8	1	4	-	-	-	-	-	-	-	-	-
throgenia semicolorata	100	508	62	-	-	-	3	259	143	-	-	9
tagenia sulphurea	28	19	-	-	-	-	4	-	-	-	-	-
al excluding B. rhodani	265	755	128	-	2	-	10	260	153	2	1	28
including B. rhodani	1025	4909	1314	1620	1862	370	480	759	443	94	181	200
COPTERA												
la bipunctata	-	-	-	-	-	-	-	-	2	-	-	-
ctra hippopus	91	39	20	2	2	12	91	91	12	4	-	4
inermis	-	12	2	-	-	-	-	-	-	-	-	-
perla obscura	-	17	16	3	-	-	-	1	2	-	-	-
tonemoura meyeri	64	96	52	6	38	2	10	43	12	1	2	13
oroperla torrentium	7	-	-	-	-	-	1	-	-	-	-	-
al	162	164	88	11	40	14	17	135	28	5	2	17
CHOPTERA												
ropsyche sp.l.	-	3	5	-	1	-	4	50	53	6	-	3
cophila sp.l.	-	64	51	3	3	18	26	13	18	1	1	2
petus sp.l.	24	1	1	-	-	-	-	34	40	1	-	10
o sp.l.	1	1	-	-	-	-	-	-	8	-	-	-
ntocerum albicorne	-	-	-	-	-	-	-	-	2	-	-	-
ctronemia sp.l.	-	1	-	-	-	-	-	2	-	-	-	-
toceridae sp.l.	-	-	-	-	-	-	-	2	6	-	-	-
nephilidae sp.l.	24	12	-	-	-	-	-	-	1	-	1	5
lopotamidae sp.l.	4	-	11	-	1	5	3	-	-	-	-	-
idostomatidae sp.l.	4	-	-	-	-	-	-	-	-	-	-	-
al	56	80	68	3	5	23	33	101	128	8	2	20

11-66 to 3-12-66 continued

cies	Number at each station 1	2	3	4	5	6	7	8	9	10	11	12
GOCHAETA												
bytraeidae sp.	2	-	-	-	1400	4700	100	20	-	2	9	2
bricu1idae sp.	5	12	-	15	200	4750	40	48	130	10	30	6
stina longiseta	-	84	-	2	-	-	-	48	5	-	-	-
oscelox sp	-	-	-	-	-	-	1	-	-	-	1	-
tellia arenarius	-	-	-	-	-	-	-	2	-	-	-	-
enella tetrahedra	-	-	-	-	-	2	-	-	-	14	-	-
bricidae spp	-	1	-	-	-	-	-	-	-	-	-	-
lotaxidae spp.	-	-	-	-	1	-	-	-	-	-	-	-
ificidae spp.	4	24	36	-	-	-	20	-	-	-	-	-
al	12	120	36	17	1600	9450	160	118	135	26	40	8
LUSCA												
robia jenkinsi	-	-	-	-	-	-	-	-	23	40528	3084	14
nea pereger	-	-	-	-	2	1	-	-	3	7	-	-
vata piscinalis	-	-	-	-	-	-	-	-	-	-	-	-
norbis contortus	-	-	-	-	-	6	2	-	-	-	-	-
sa fontinalis	-	-	-	-	-	-	-	-	-	-	-	-
aerium corneum	-	-	-	-	-	-	-	-	-	-	-	-
ylastrum fluviatile	10	7	9	3	-	67	80	47	21	230	21	1
al	10	7	9	3	2	74	82	47	47	40765	3105	14
TYHELMINTHES												
ycelis niger	-	-	-	-	-	-	-	-	15	11	-	-
" cornuta	-	-	-	-	-	-	-	-	-	53	34	24
ght of sample	11.55	35.9	24.5	27.3	134.4	124.0	35.0	20.6	23.8	131.6	211.5	3
al number of organisms rganisms	1753	5808	1996	5554	8681	14874	2083	2205	1483	41783	6491	25

9-11- 66 to 3-12-66 continued

cies	Number at each station 1	2	3	4	5	6	7	8	9	10	11	12
TERA												
ulidae spp.l.	71	192	-	791	1721	3199	173	136	46	23	83	12
" spp. p.	-	-	-	-	-	-	-	-	-	-	-	-
ronomidae spp.l.	83	10	276	2253	1432	1296	893	468	110	188	235	211
" spp.p.	8	-	-	843	290	263	93	28	14	46	14	73
ranota spp.l.	14	54	39	4	3	4	7	54	94	8	-	--
ula spp.l.	-	2	1	-	-	-	-	-	1	2	-	4
al	176	258	316	3891	3446	4762	1166	686	265	267	332	300
EOPTERA												
midae sp.a.	3	3	-	1	-	-	2	4	10	62	1459	257
" sp.l.	3	33	22	1	-	2	8	-	-	34	243	21
nebius sp.l.	4	1	2	-	-	-	-	32	4	-	-	-
" sp.a.	-	-	2	-	-	-	-	1	9	3	2	5
iscinae sp.a.	2	-	-	-	-	-	-	-	-	-	-	-
al	12	7	6	2	-	2	10	37	23	126	1704	283
RACARINA												
robates longipalpis	-	-	-	-	-	10	-	-	-	-	1	-
ertia porosa	-	-	-	-	-	-	-	-	-	-	1	-
STACEA												
marus deubeni	199	266	165	9	-	24	170	328	413	436	928	270
llus aquaticus	-	-	-	-	-	-	-	-	-	-	44	30
UDINEA												
cicola geometra	1	3	-	-	-	-	-	-	-	-	2	1
ssiphonia complanata	-	1	-	-	-	3	3	-	3	22	123	11
obdella stagnalis	-	-	-	-	5	137	7	-	5	-	2	1
obdella octoculeata	-	-	-	-	-	7	10	1	1	-	-	3
al	1	4	..	-	5	140	20	1	9	22	127	16

map 2		°C	O_2	solids p.p.m.	
1	11.30	8.5	92	0	At the bridge where the two head-streams meet. Clear water
2	11.40	8.5	102	0	From the bridge. Clear water
3	11.55	8.5	89	9	Road bridge just above the creamery Water murky.
4	12.00	8.7	83	11	Road bridge below the creamery. Water clouded
5	12.05	8.7	80	9	About 300 yards downstream of the last .
6	12.15	8.7	78	7	About 1,000 yds. below the bridge. Water dirty
7	12.25	8.7	82.5	0	1 mile below the bridge, just above the confluence of tributary.
8	12.30	8.7	98.5	0	Another ½ mile downstream. Water cleaner.
9	12.45	8.7	102	0	At Wise's Br., 2½ miles below the factory.
10	12.55	8.7	103	0	Waterloo bridge Clean water.
11	13.10	8.7	104	0	At the 2nd sluice below the dam. Water clean
12	14.20	8.7	108	0	Blarney town bridge below the factory
13	14.30	8.7	104	5	Bridge over Blarney river on the road to Kerry Pike. Clean.
14	14.35	8.7	108	2	Shournagh river at the bridge above the confluence
15	14.50	8.7	104	0.1	Tower bridge over the Blarney river. Clean water
16	15.10	8.4	74		Blarney river at Gothic bridge above confluence with the R. Martin

slight increase in the suspended solids, no alteration of the O_2 saturation and very little other change in the invertebrate fauna apart from a slight decrease in numbers of all other species except the Mollusca.

It is unfortunate that the recovery from this effluent cannot be traced as the Martin joins the Blarney river about ½ mile below the town, and recieves 100% dilution.

From the tables and the graphs it can be seen that there is a very great variation in the composition of the fauna on the two dates when collections were made. This could be accounted for by the life cycles of the animals involved The prescence of very large numbers of tiny larvae or nymphs might not be reflected in the collections, as many of them would escape the net. Similarly a hatch of Mayfly etc. could considerably alter the proportions found in the collections. The difference in the number of Ephemeroptera caught on the two dates above Rathduff, rising from 65.65% to 84.4% could be attributed to the fact that the larger nymphs are more easily trapped by the net. The percentages

TABLE

		Rathduff		Blarney	
		Above	Below	Above	Below
Ephemeroptera excl. B.rhodani.	19-4-66	2.93	0.17	1.44	0.21
	29-11-66	13.00	0.02	0.09	0.01
Incl. B.rhodani	19-4-66	65.65	4.94	11.44	2.85
	29-11-66	84.52	2.44	34.43	0.22
Plecoptera	19-4-66	1.73	0	0.33	0
	29-11-66	2.82	0.46	6.12	0.01
Trichoptera	19-4-66	1.73	0	0.03	0
	29-11-66	0.14	0.05	4.58	0.01
Diptera	19-4-66	23.95	34.18	3.19	0.19
	29-11-66	4.44	39.69	31.11	0.63
Gammarus deubeni	19-4-66	5.98	0.03	10.41	2.30
	29-11-66	4.58	0	14.87	1.03
Oligochaeta	19-4-66	0.65	60.31	0.55	0
	29-11-66	2.06	18.43	5.35	0.06
Mollusca	19-4-66	0.14	0	0.64	92.81
	29-11-66	0.12	0.02	21.30	97.56
Mean Total		4658.00	10510.50	3358.00 3358.00	28608.50

Number of animals in each group, as a percentage of the total. Above and below the sources of pollution at Rathduff and Blarney.

Suspended Solids

Concurrent with the fall in oxygen saturation, there is a slight rise in the suspended solids in the water. The results of the filtrations th determine these are very unsatisfactory. It is thought that the fault lies with the filter papres used. Future records will be made using glass-fibre filter papers, which are less likely to mask any slight imcrease in weight. With the exception of flooding, however, it is not expected that there will be much variation in the amount of suspended solid present in the water.

Mineral Analysis.

Samples of water were sent to the State Analyst in Dublin on April 17th. Two samples were taken from the Martin one above Rathduff and the second at the town bridge at Blarney. These analyses will be done twice yearly. The results of the first series are as follows.

	Rathduff	Blarney
pH	7.2	7.3
Total alkalinity (ppm as $CaCO_3$)	33	43.0
Total hardness "	40	58
Calcium "	32	43
Magnesium "	8	15
Total Phosphate (ppm as PO_4)	6.04	0.07
Silica (SiO_2 ppm)	3.0	1.5
Total dissolved solids ppm	89	130
Chloride	19	23

Pollution

The two sources of pollution on the River Martin have been mentioned in the introduction. They are of great interest as the two effluents are very different in nature, that at Rathduff being an organic pollution whilst that at Blarney is inorganic.

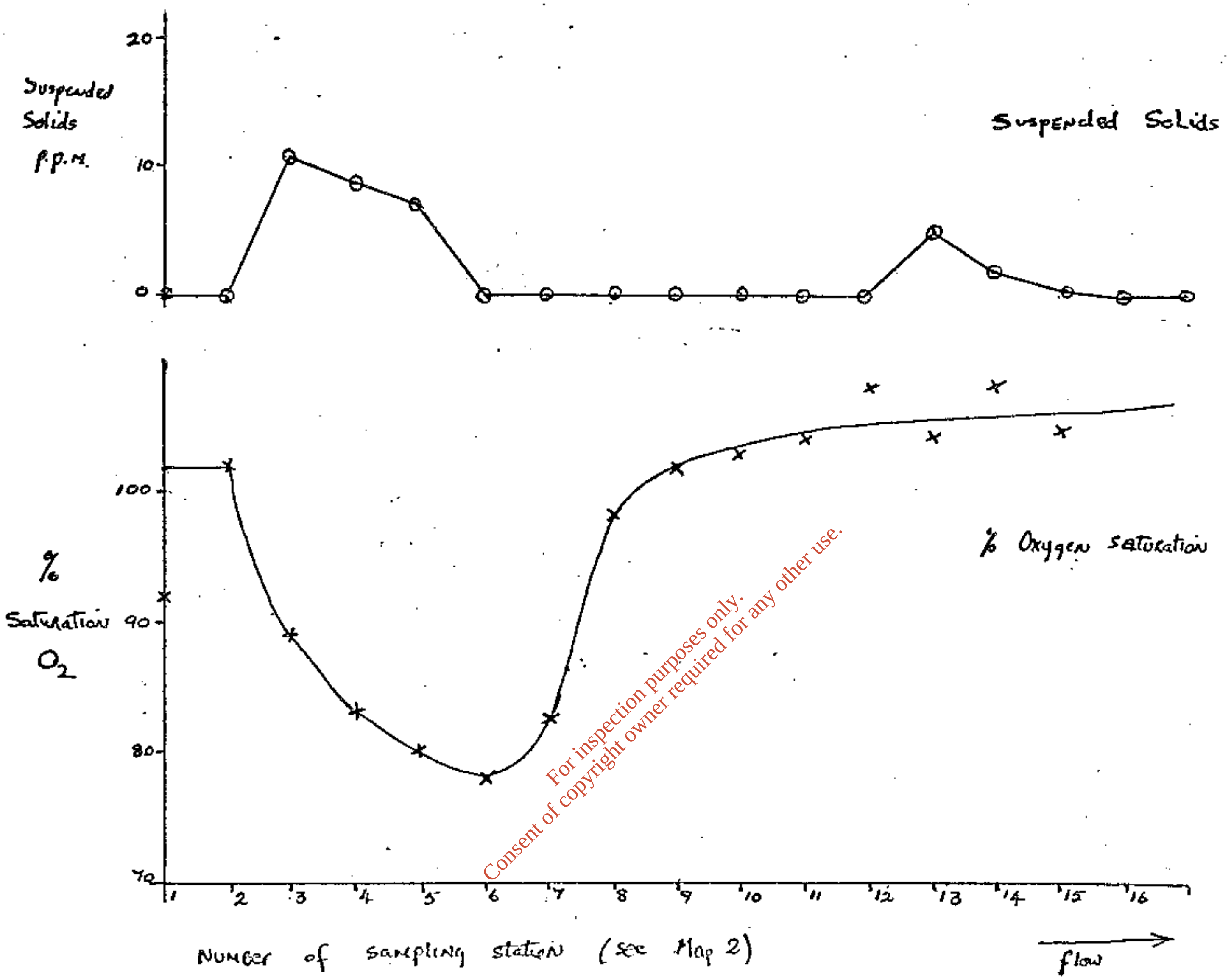
The inorganic pollution at Rathduff gives rise to the well known changes in the river, growth of sewage fungus, deoxygenation, increased B.O.D., (this has not yet been determined for the Martin) increased suspended solids and an alteration in the invertebrate fauna. These changes can easily been seen in the graphs, e.g. the great increase in the numbers of Oligochaetes and Hirudinea is typical of an organically polluted stream. As these species increase in numbers there is a concurrent decrease in the numbers of other species such as Ephemeroptera. There is a gradual return to the proportions found above the source of pollution.

As the information to hand is very slight, it would be presumptious to draw any definite conclusions about the exact effects of the pollution on the river. It does appear that the size of the pollution and its organic nature cause no very great reduction in the quality of the water. Over enrichment, in the restricted area immediately below the effluent causes the effects mentioned above. Moving downstream however , as the dilution is increased by tributaries, and the amount of O_2 present rises so that the semi stagnant conditions are rapidly ameliorated. Several miles downstream of Rathduff then, the extra nutrients present in the water allow for an increase in numbers of species such as Gammarus deubeni, exceeding the population found in the clean waterreaches. This increase is expected in the lower reaches of a river as a result of natural enrichment from land run-off etc., and in the case of the Martin is probably accelerated by the pollution at Rathduff.

The pollution at Blarney is of a different nature. The most noticeable effects here are the increase in the amount of algae and in the numbers of Hydrobia of Diptera fall considerably, but whether this is due to the same reasons, or to a fault in the collection is not certain. The latter seems a more obvious choice, as a comparison of the percentages obtained above Rathduff and above Blarney shows no agreement in these similar areas.

(Signed) CLODAGH O'CONNELL

GRAPH. 9

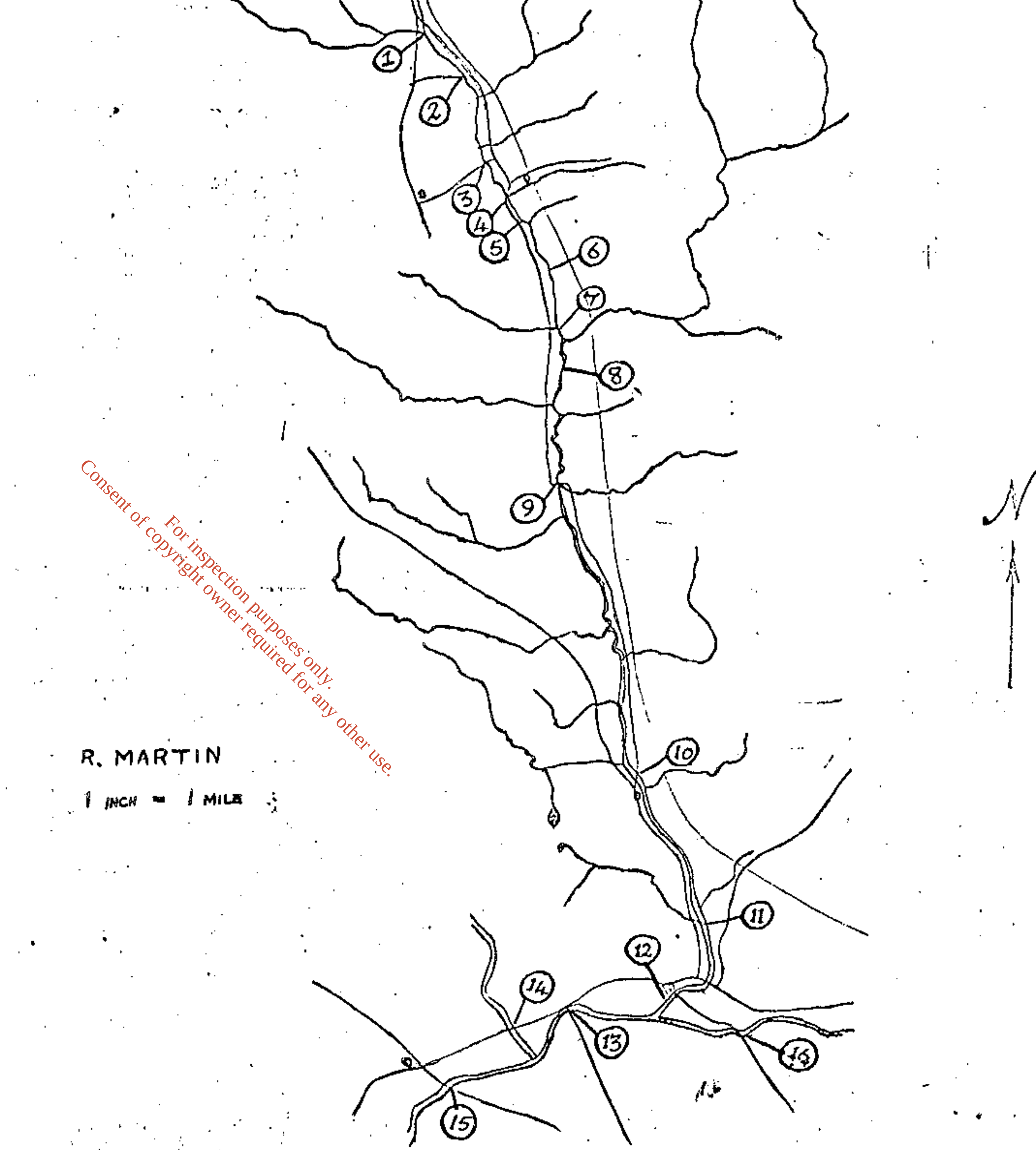


Suspended Solids p.p.m.
20
10
0
Suspended Solids
%
Saturation O2
100
90
80
70
% Oxygen saturation
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Number of sampling station (see Map 2)
flow

Oxygen Saturation.

The oxygen saturation readings taken in December 1966 are the only ones so far taken in the Martin River. The Mackereth electrode was lowered from the bank or from a bridge into the water. As far as possible it was attempted to place the electrode im the middle of the river, but where one side was deeper than the other the deeper channel was used in obtaining the measurements. It can be seen seen from the graph (9) that an almost typical oxygen sag curve is recorded below the effluent from the piggery and creamery at Rathduff. The lowest point of the curve is found about $\frac{3}{4}$ mile below the effluent. It is conjectured that the sharp rise of the line below this point is due to the entry of a tributary, almost as big as the main stream, about 1 mile downstream of the effluent. The recovery could however be due to a high re-aeration rate, as Dr. Southgate suggested is very likely to occur in the Martin.

As data on the flow rates becomes available this re-aeration rate will be calculated using the formulae given to us by Dr. Southgate. As he has said, it will be very interesting to compare the results with those of Streeter and Phelps (1925). From the point of view of calcul-ating the re-aeration coefficient, it is unfortunate that the O_2 sag is not greater, as it would be with increased pollution. However, since these oxygen readings were taken in December in very cold conditions, it is reasonable to expect an increased drop in the O_2 concentrations during warm summer weather, with low water flows and maximum activity at the creamery.



Positions of O_2 and Suspended Solids samples

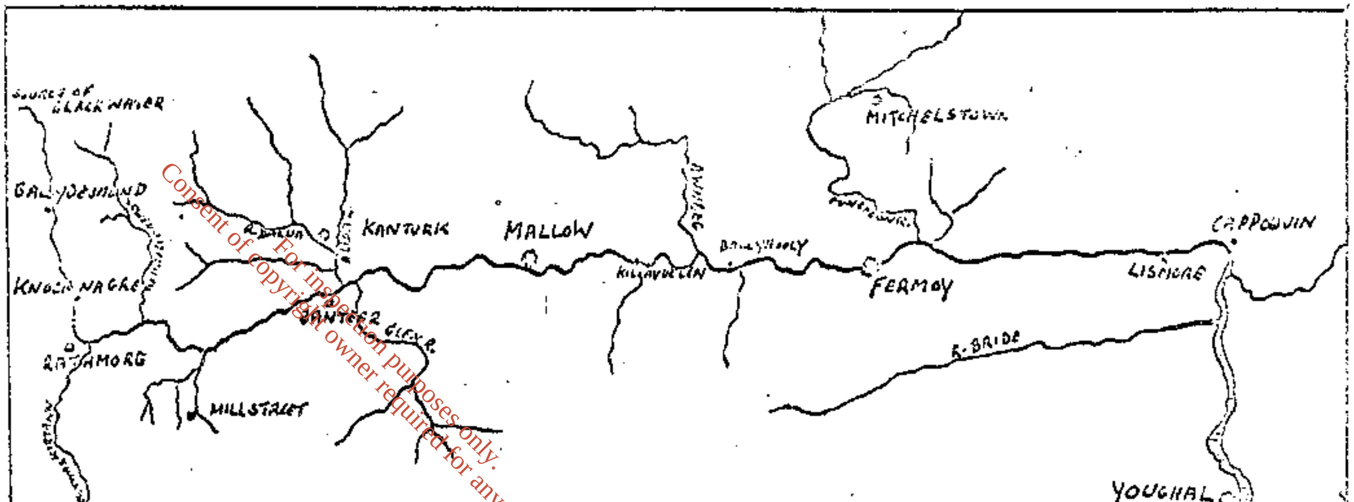


FIG. A BLACKWATER RIVER AND PRINCIPAL TRIBUTARIES

SCALE 10 MLS = 1 INCH

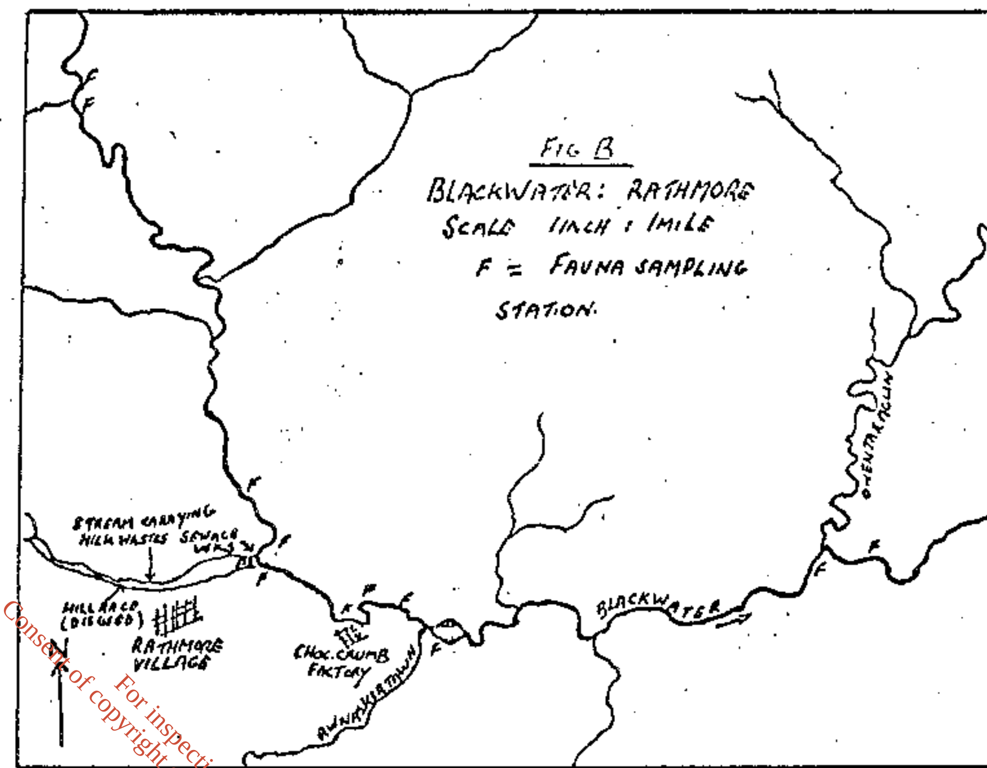


Fig B
BLACKWATER: RATHMORE
SCALE 1INCH : 1MILE
F = FAUNA SAMPLING
STATION.
OWENTARAGLIN
BLACKWATER
STREAM CARRYING
MILK WASTES
SEWAGE WKS
MILL RACE (DISUSED)
RATHMORE VILLAGE
CHOC. CRUMB FACTORY
AWNAKIRTOWN
F

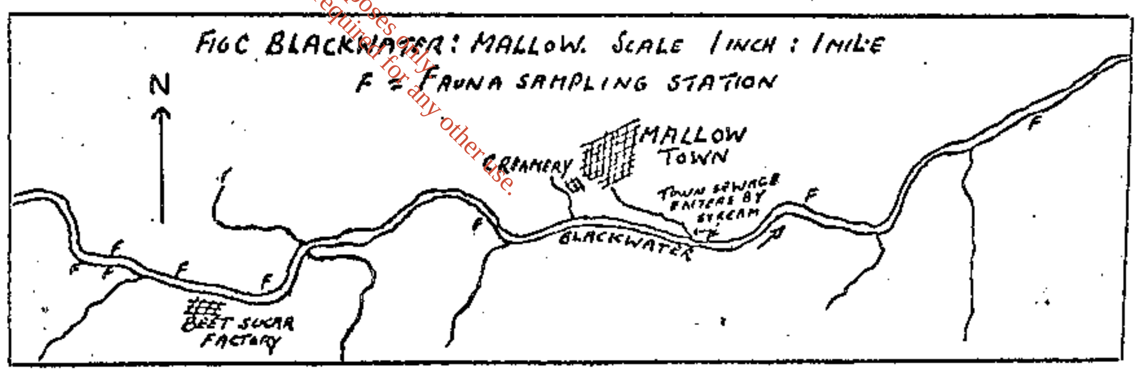


FIG C BLACKWATER: MALLOW. SCALE 1INCH : 1MILE
F = FAUNA SAMPLING STATION
N
MALLOW
TOWN
CREAMERY
TOWN SEWAGE ENTERS BY STREAM
BLACKWATER
BEET SUGAR FACTORY
F

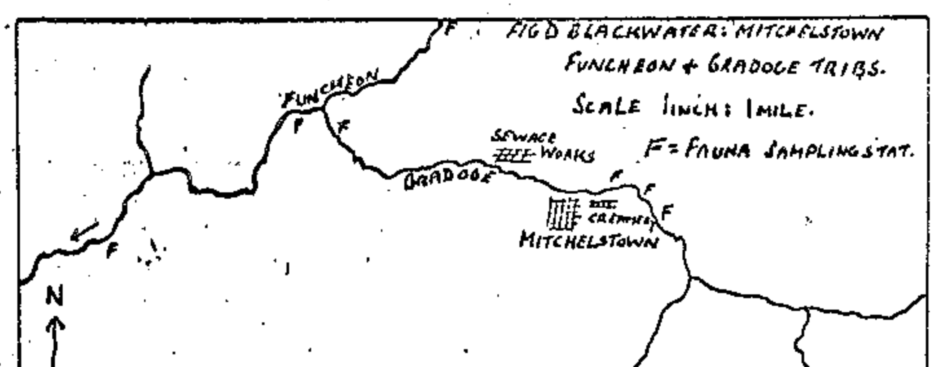


FIG D BLACKWATER: MITCHELSTOWN
FUNCHEON + GRADOGE TRIBS.
SCALE 1INCH : 1MILE.
F = FAUNA SAMPLING STAT.
FUNCHEON
GRADOGE
SEWAGE WORKS
CREAMERY
MITCHELSTOWN
N
F