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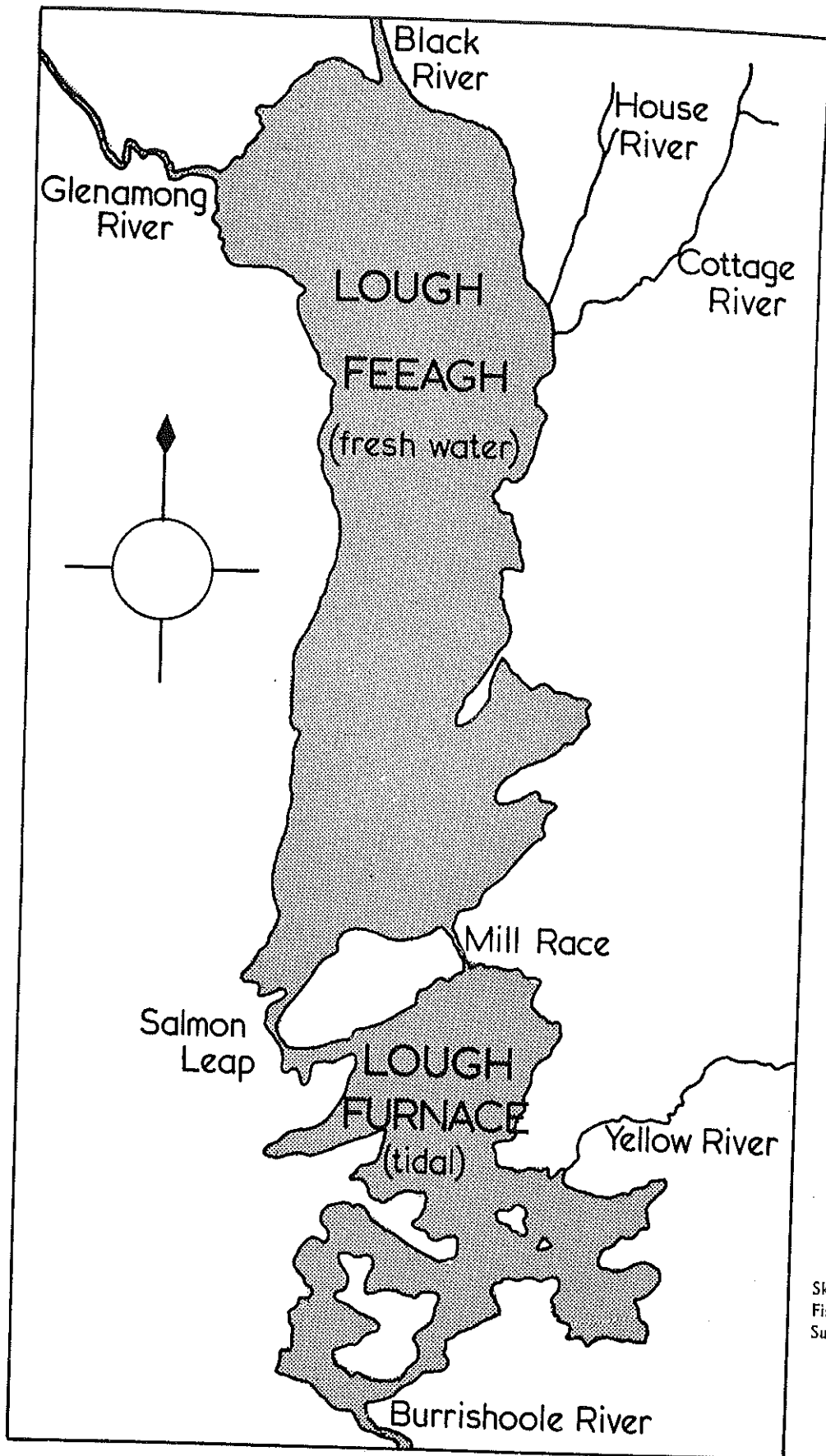
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**REPORT
AND
STATEMENT OF ACCOUNTS**

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FOR THE YEAR ENDED 31st DECEMBER 1965



Sketch map of the Burrishoole Fishery. Based on the Ordnance Survey by permission of the Government (229/2).

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**ANNUAL REPORT
FOR THE YEAR ENDED
31st DECEMBER 1965**

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IONTAOBHAS TAIGHDE BRADAN na h-EIREANN IONCORPORTH
(THE SALMON RESEARCH TRUST OF IRELAND INCORPORATED)

REPORT FOR THE YEAR ENDED 31st DECEMBER 1965

The Report is set out in the following Sections :—

- (1) STAFF
- (2) INSTALLATIONS
- (3) RAINFALL AND WATER TEMPERATURE
- (4) REARING OF SALMON OF KNOWN ANCESTRY
- (5) SALMON × SEA TROUT HYBRIDS
- (6) FEEDING AND REARING EXPERIMENTS
- (7) FISH MOVEMENTS
- (8) SMOLT TAGGING AND MARKING
- (9) PREDATORS
- (10) RECOVERIES OF ADULT SALMON OF KNOWN PARENTAGE
- (11) BIOLOGICAL SURVEY WORK
- (12) COTTAGE RIVER EXPERIMENT
- (13) PEAT SILT RESEARCH
- (14) GENERAL
- (15) ACKNOWLEDGEMENTS

APPENDICES

- (I) PEAT SILT RESEARCH GROUP
- (II) PEAT SILT RESEARCH GROUP : BIOLOGIST'S REPORT
- (III) COTTAGE RIVER EXPERIMENT
- (IV) SPECIFIC CHARACTERISTICS OF YOUNG SALMON AND TROUT

The nominated Members of the Committee of Management in 1965 were the same as in previous years and Major C. W. Roberts was re-elected to the Committee.

(1) STAFF

The permanent staff has remained unchanged in 1965.

Mr. J. A. Spence and Mr. A. B. West (Trinity College, Dublin) were again employed during university vacations on some final aspects of the Cottage River experiment.

Miss Mary Crichton, B.A., was employed from 1st May to 31st July on studies of the specific characteristics of young salmon and trout. This work was continued by Mrs. Eileen Rogers, B.Sc., from 1st September to 31st December 1965.

(2) INSTALLATIONS

The new 22' diameter rearing pond was completed at Furnace in 1965, and was used to rear a further 2,000 yearling salmon to the 2+ years smolt stage.

Two concrete tanks (6' x 3' x 3') were built alongside the holding pens at Furnace and were used during stripping operations for the hatchery. It has been found easier to transport fertilised eggs to the hatchery than to move the parent fish to the old stripping tanks in the hatchery, which have now been converted to pellet food storage lockers.

Demolition of the disused plankton ponds at Furnace was begun and it is intended to use the site for early-feeding tanks.

Three more automatic feeders were purchased and installed on the two metre tanks at Furnace and a further seven feeders await installation on the larger rearing ponds for underyearlings.

At Treanlaur a new and larger settling tank was built into the rearing pond water supply, thus eliminating blockages due to gravel and silt. The pipeline was repaired, new gate valves were fitted to the circular ponds, and the timber walkways renovated. A gate valve was fitted in the 4" pipe supply to the square rearing tanks, allowing for more precise regulation of the water supply during abnormal flow conditions in the river.

Further modifications were made to the screens of the smolt trap on the Cottage River as a result of poor fishing performance during the 1965 smolt run.

Notice boards were erected at both Furnace and Treanlaur, giving details of the aims, activities and sponsors of the Trust, together with a map of the Furnace installations.

In addition to completing several site improvements the field assistants also reconstructed a smashed 16' boat which is now used for netting operations on Ballinlough, the experimental lake.

(3) RAINFALL AND WATER TEMPERATURE

Daily rainfall records have been kept at Furnace over the past six years and at Shrahmore (at the north end of Lough Feeagh, 2½ miles north of Furnace) from 1958 to 1961.

Rainfall during 1965 was the highest recorded over the past six years, totalling 1,738 mm. (68.4 inches), when the wettest months were January and December, respectively. In both of these months rainfall was greater than in any month over the preceding six years. The following table gives monthly rainfall amounts in mm. from 1960 to 1965 inclusive:—

MONTHLY RAINFALL AMOUNTS FOR THE YEARS 1960 - 65

	1960	1961	1962	1963	1964	1965
January ...	127.9	195.7	212.8	26.0	88.5	256.5
February ...	106.1	134.7	125.8	47.0	39.4	21.5
March ...	53.9	51.1	128.7	156.4	90.5	119.9
April ...	126.8	96.2	120.4	99.1	81.4	161.5
May ...	57.3	64.1	72.9	123.9	117.3	91.6
June ...	121.7	91.4	88.9	95.5	87.1	152.8
July ...	143.2	177.8	77.4	100.8	106.5	73.8
August ...	114.7	110.5	163.6	119.5	138.3	119.6

MONTHLY RAINFALL AMOUNTS FOR THE YEARS 1960 - 65—Continued

	1960	1961	1962	1963	1964	1965
September ...	116.7	171.3	172.2	134.7	207.6	155.2
October ...	72.1	207.4	94.7	156.7	185.8	165.1
November ...	225.3	138.3	154.6	227.3	155.5	184.6
December ...	212.1	142.8	183.1	53.7	206.6	235.9
TOTAL (mm.)	1,477.8	1,631.3	1,595.1	1,340.6	1,504.5	1,738.0
TOTAL (in.)	58.18	64.22	62.8	52.8	59.2	68.4

Water temperatures ranged between a minimum of 2.5°C. (36.5°F.) in February and a maximum of 17°C. (63°F.) in July. The water was slow to warm up in the spring, due to cold, rainless conditions in February and was at 3°C. in mid-March but maintained temperatures of over 10°C. (50°F.) until the onset of frost and snow in early November.

(4) REARING OF SALMON OF KNOWN ANCESTRY

(a) **Spring fish and grilse ova hatched in 1963.** The sustained period of cold dry weather in February and early March inhibited growth of all fish in the rearing ponds and the two-year-old fish which had reached an average length of 148 mm. by 31/12/64 had only increased their length to 155 mm. when released in late April 1965. Total survival of 9,600 fish reared from the yearling stage in April 1964 to the 2+ smolt in April was 80%. This was less than usual and a major contributory cause was the retention of 1+ smolts in fresh water for a further year's rearing. As stated in the Annual Report for 1964, a considerable proportion of these fish died and the practice of retaining them was discontinued in 1965. A large number of fish in this group at Treanlaur were killed as a result of blockage of the water supply by gravel and silt. This has now been remedied by effective settlement of suspended material.

A total of 7,700 2+ smolts was released in 1965, comprising:—

Spring fish parentage: 3,520
Grilse " : 4,180

(b) (Spring fish × grilse) and grilse ova hatched in 1964

On 1/1/65 these underyearlings were made up of:—

Spring fish × grilse: 9,000 Average length: 67 mm.
Grilse × grilse : 6,800

When graded on 30/4/65, the total survival over the preceding four months was found to be 93%, with the following totals remaining:—

Spring fish × grilse: 8,400 Average length: 86 mm.
Grilse × grilse : 6,300 Average length: 84 mm.

At this stage 1,980, 1+ smolts averaging 133 mm. in length, were released, representing almost 14% of the population, which is judged satisfactory in view of the poor winter growing season. As stated above, 1+ smolts were marked and released in 1965 since it was felt that only a small return as adult fish would be preferable to having a large proportion of them die if retained for further rearing.

Some 12,700 yearling fish remained after grading out 1+ smolts and of these a total of 10,900 of the best-grown fish were retained, comprising:—

Spring fish × grilse: 5,600 (Furnace)
Grilse × grilse : 5,300 (Treanlaur)

The remaining smaller yearling parr were released at selected points in the fishery.

From an average length of 99 mm. in early July both groups of fish had grown to an average length of 131 mm. by 31st December 1965. The growth rate decreased in late autumn when difficulties were experienced with pellet food

supplies, and an inferior type substituted resulting in a decreased growth rate. However, survival was satisfactory, at 94.6% at Furnace and 92.7% at Treanlaur —(Overall : 93.6%).

(c) **Spring fish and grilse ova hatched in 1965.** Spring fish ova numbering 26,800 and grilse ova (40,200) were incubated in the hatchery during 1965, and losses from mid-December 1964 to the end of hatching in early April were 3.5%. The incubation period averaged 100 days, which was 14 days more than in 1964.

A further 7.5% of the alevins and early feeding fry died in the period 1st April to mid-June, but no extensive mortality was experienced, as in 1964, following the substitution of inert paint for anti-fouling paint in the hatchery flumes.

The price of condemned liver from local suppliers has risen by 300% since 1960 and an attempted economy measure in the feeding of spleen instead of liver resulted in unsatisfactory growth and survival of the early feeding fry.

Continuous trouble was experienced with the fish in the rearing flumes, involving blue-slime disease, fin-rot and tail-rot, with the result that the fry were not moved out to the rearing ponds until 14th to 29th July, almost a month later than usual. Survival from the fertilised egg to the October under-yearling was only 52.5%.

Lacking a good start, the fish have not yet made up the ground lost, and the average length after grading in mid-October was only 57 mm., increasing to 59 mm. by 31st December. After grading, 9,000 fish of grilse parentage and 7,400 fish of spring fish parentage were retained for further rearing and the remaining small grade fish were released in the upper reaches of the river. Losses (1.2%) since grading have been very slight.

(d) **Hatchery operations in 1965.** As a result of the extremely poor spring fish run in 1965 no fish of this category was available for hatchery operations. Accordingly the opportunity was taken of continuing and expanding earlier work on inter-specific hybridisation. However, the programme of rearing fish of known parentage was also continued, but only with grilse stocks.

(i) Nine grilse females (whose parents were known also to be grilse) were stripped, giving 189 fluid ounces ova at 160 ova/fluid ounce, making a total of 30,330 ova. These ova were fertilised with milt from six male grilse, four of which were adults derived from grilse parentage smolts. Mortality among these ova until 31/12/65 was 1.6%.

(ii) Two grilse females were stripped to give 9,400 ova which were fertilised with milt from two male sea trout. Losses at fertilisation were 1.2% and had not increased by 31/12/65.

(iii) Four sea trout females were stripped to give 3,620 ova, fertilised by milt from three male grilse and losses to 31/12/65 were only 1.1%. The small losses at fertilisation in this group were considerably less than those reported in similar Swedish experiments by Alm (1955) and tend to discount the theory that in fertilising sea trout ova with grilse milt, the micropyle of the ovum is too small to admit the head of the salmon sperm, giving rise to a large proportion of infertile eggs. However, considerable losses may yet be experienced prior to, and during, hatching.

(iv) Eleven female F. 1 hybrids (5+ years of age) produced 94 fluid ounces ova, estimated at 19,960 in number, fertilised by milt from male hybrids of the same age. Mortality amongst these ova was 1.7% at 31/12/65.

The females in this group have shown a steady increase in ovum size and numbers over the past four years.

(v) Three F. 2 hybrid females (average size 12", 14 oz.) from the Ballinlough population were stripped, giving 1,200 ova, fertilised by milt from three male hybrids. Losses here have been higher than among the preceding groups, at 17%, up to 31/12/65.

(5) SALMON × SEA TROUT HYBRIDS

(a) F. 1. A.

These fish were 5+ years of age at 31/12/65 and they have exhibited a

declining growth rate during the past year, when their average length has increased only to 45.7 cm. (18") from 44.0 cm. (17.3"). Since these fish have now reached the stage at which they are of very little use to future research work it is proposed to release them in Ballinlough during the spring of 1966.

(b) F. 2. A. (1)

Some 700 of these fish were reared with negligible losses at Treanlaur until late March when they had increased their length over the winter from 183 mm. to 198 mm. The fish had their adipose fins removed and were also tagged, using two small pieces of blue and white telcothene sleeving attached under the dorsal fin by a double wire, as in the Swedish technique.

When transferred to the release pond some left immediately but others were slow to leave and then stayed close to the pond outlet for two to three weeks.

In the nine months following release there have been 28 recaptures of these fish (4.0%) of which 18 were migratory forms and 10 were non-migratory.

The migratory forms were mostly rod-caught fish and none were observed in the upstream trap on the Mill Race. They were silvery in appearance, measuring from 8.0 to 12.0 inches in length and with sea growth on the margins of their scales. They were outwardly indistinguishable from small sea trout or "finnock" and were described as such by those people who caught them. Recaptures were not confined to this fishery, two being caught in the neighbouring Newport River, whilst two others were caught in the Owenduff and Owenmore Rivers respectively, which must have involved a migration in the sea of at least 40 miles.

Of the 10 hybrids recaptured as non-migratory forms (i.e. showing no signs of silvering or sea growth), three were caught in the upstream trap having ascended the Mill Race, three were caught in the downstream trap and four were rod-caught specimens from Lough Furnace, where they were released.

It remains to be seen whether further examples will be recaptured in 1966, after staying away at sea for more than 12 months.

The following table gives details of recaptures for 1965:—

MIGRATORY FORMS

Date	Where recaptured	How caught	Length (in.)	Weight (oz.)
9/ 7/65	L. Furnace	Rod	11.2	8
9/ 7/65	Mill Race (mouth)	Rod	11.1	8
12/ 7/65	L. Furnace	Rod	11.1	8
13/ 7/65	L. Furnace	Rod	9.7	5
13/ 7/65	Newport River	Rod	10.9	7
23/ 7/65	L. Furnace	Rod	10.7	6
25/ 7/65	Owenmore River	Rod	10.5	7
26/ 7/65	Newport River	Rod	11.5	8
29/ 7/65	L. Furnace	Rod	11.5	8
30/ 7/65	L. Furnace	Rod	12.0	12
5/ 8/65	L. Furnace	Rod	10.5	7
11/ 8/65	L. Furnace	Rod	10.8	7
22/ 8/65	Owenduff River	Rod	9.5	4
25/ 8/65	L. Furnace	Rod	11.0	8
30/ 8/65	L. Furnace	Rod	10.5	7
21/ 9/65	L. Furnace	Rod	10.2	6
8/12/65	Mill Race	Down trap	8.0	—

NON-MIGRATORY FORMS

Date	Where recaptured	How caught	Length (ins.)
21/ 6/65	L. Furnace	Rod	7.5
23/ 6/65	L. Furnace	Rod	8.0
3/ 7/65	L. Furnace	Rod	8.0
4/ 7/65	L. Furnace	Rod	7.0
23/ 7/65	Mill Race	Up trap	7.3
4/ 8/65	Mill Race	Up trap	7.1
4/ 8/65	Mill Race	Up trap	7.4
15/11/65	Mill Race	Down trap	7.7
15/11/65	Mill Race	Down trap	9.5
30/12/65	Mill Race	Down trap	8.7

The F. 2. A. (1) hybrids released in Ballinlough as unfed fry in April 1963 had reached an average size of 11.0" and 12 oz. by 1st May 1965. The fishing on the lake was opened free of charge to local angling clubs on that date, with limitations as to methods of fishing and size of bag.

In all, over 600 fish were taken during the season which closed prematurely on 31st August, due to a green algal bloom which developed at that time. The fish taken averaged $\frac{3}{4}$ -lb. whilst the best fish weighed 1 $\frac{1}{2}$ lb. at 2+ years of age.

Netting operations for hatchery parent stock in early December were disappointing and only five females and four males were caught, of which two females and one male were barren or spawned out. It is possible that the majority of the fish had moved out into deeper water with the advent of cold weather and thus could not be netted. There are no spawning streams flowing into the lake and the outflow is an underground channel.

F. 2. A. (2)

The 1,000 surviving underyearlings of this group were used in comparative feeding experiments described later and also for demonstration purposes at the Royal Dublin Society's Spring and Horse Shows. Some 600 fish were transferred to Treanlaur in late July 1965, where they have been reared with 6% losses to an average length of 197 mm. which is somewhat larger than the comparable group (F. 2. A. (1)) in 1964, at 182 mm.

(6) FEEDING AND REARING EXPERIMENTS

(a) **Smooth and corrugated surfaces for early rearing.** Recent work by Marr (1965) suggested that the average size of early-feeding fry might be increased if hatchery flumes had a corrugated floor rather than a smooth floor, in that the alevins would expend less energy in maintaining position in the water flow and, therefore, from the limited food supply available in the yolk sac more food would be available for growth requirements.

As a preliminary experiment in 1965 one hatchery flume at Furnace was fitted with wooden mouldings 1" wide and $\frac{1}{2}$ " high, whose cross-section was an arc of a circle. The mouldings were spaced at $1\frac{1}{4}$ " centres, giving a gently corrugated floor. A normal hatchery flume with a smooth painted floor was used as a control and each flume contained 3,300 alevins at the beginning of the experiment in early April, 1965.

When samples of fry were measured on 1st July 1965 no significant difference was found in the average length of both samples although those from the corrugated flume tended to be slightly larger at 28.8 mm. c.f. 27.7 mm. Mortalities were slightly less among fry from the smooth flume. It was very noticeable, however, that fry in the corrugated flume were much more evenly dispersed over the floor of the flume than over the smooth surface where typical "packing" in corners was observed.

The effect on growth might have been more noticeable if the experiment had been confined to the period between hatching and early feeding. (Marr, D. H. A., 1965. *Rep. Challenger Soc. 3. No. XVII.*)

(b) **The effect of P.M.A. on early-feeding fry.** The use of P.M.A. (pyridyl-mercuric-acetate) has been recommended by several workers for the treatment of bacterial gill disease of salmonids. Previous experience of this chemical has shown it to be very toxic at the recommended dosage level (1 ppm. for 1 hour) in the hatchery at Furnace.

In a suspected outbreak of gill disease during June, PMA was employed at half the recommended dose for half the time (i.e. 0.5 ppm. for 30 minutes). At the same time other fry were treated with salt (1%) for 30 minutes and others merely had the water drawn down to the same level as those undergoing treatment. Mortality among fish treated with P.M.A. was 95%, whilst in the salt-treatment and control groups it was negligible.

It would appear, therefore, that the toxicity of P.M.A. to 2 months old salmon fry in this hatchery is such as to make its use inadvisable.

(c) **Automatic feeding.** The experiment reported in progress in the *Annual Report* of 1964 was continued until 22nd March 1965. The fish and feeding techniques were as described earlier.

From 11th October 1964 to 22nd March 1965 growth in the two groups was as follows:—

Controls :	From 76 mm. to 89 mm. (13 mm.)
Experimentals :	„ 76 mm. to 110 mm. (34 mm.)

Mortalities amounted to 8% in the controls and 3.2% in the experimental fish.

On the results of this experiment, automatic feeding was considerably more efficient than hand feeding.

(d) **Automatic feeding of different grades of pellets.** Three batches of F. 2. A. (2) hybrids, 200 to 220 in number and 12 months old, were maintained in three two-metre diameter ponds from 22nd March to 5th July 1965. Each batch was fed with equivalent weights of three different types of pellets from automatic feeders during the hours from 9 a.m. to 5.30 p.m. daily.

The constitution and price of the pellets were as follows:—

- (1) Pellet A: 47% protein, 29.7% carbohydrate, 4.9% fat
Price: £200 per ton, delivered
- (2) Pellet B: 36% protein, carbohydrate unknown, 3.75% fat
Price: £100 per ton, delivered
- (3) Pellet C: 41% protein, 35% carbohydrate, 5% fat
Price: £60 per ton, delivered

Growth made by the three groups during the experimental period was:—

- (1) Pellet A: From 99.6 mm. to 140.7 mm. (41.3%)
- (2) Pellet B: From 99.6 mm. to 138.8 mm. (35.3%)
- (3) Pellet C: From 99.6 mm. to 127.4 mm. (27.9%)

Survival during the same period was:—

- (1) Pellet A: 94%
- (2) Pellet B: 79%
- (3) Pellet C: 73%

Although the actual survival with *Pellet B* was 79%, at the close of the experiment over 50% of the fish in this group were suffering from dietary cataract. This takes the form of a bluish-white discoloration of the pupil of the eye, with no demonstrable causative organism and results in the fish becoming blind and black in colour. It may have been due to degradation of vitamin content of the pellets with age, although the other two types of pellets were of a comparable age.

It would appear that if first quality fish are required for experimental purposes *Pellet A* (the most expensive) is to be preferred, although the price of

this pellet is inflated by the cost of carriage from Sweden. For commercial purposes, there would be little to choose between *Pellets B and C*, provided that both were fed with liver or meat supplements.

(e) **The effect of population density on growth.** The experiment began on 22nd September when four batches of underyearling salmon, i.e. 500 weighing 1 lb., were transferred to four two-metre tanks. The batches were composed of 500, 1,000, 1,500 and 2,000 fish respectively. Each group was fed with pellets from automatic feeders, in weighed amounts representing 1 oz. per lb. of fish. The ration was increased by 50% after 25 days. Results obtained up to 31/12/65 were as follows:—

	500 fish	1,000 fish	1,500 fish	2,000 fish
Growth	18.5%	24.1%	13.5%	13.3%
Mortality	13.6%	13.5%	14.2%	11.4%

The experiment will be continued in 1966.

(7) FISH MOVEMENTS

(a) Upstream

(i) **Salmon and grilse.** The spring salmon escapement through the upstream trap was the lowest yet recorded when only one fish (a male) was released upstream on 8th May 1965.

The first grilse was seen on 7th June and was followed by a rather better than average run for June. The July total was less than usual, due probably to low water conditions, whilst the major portion of the grilse run occurred in August, a tendency towards later-running grilse which has been noticeable both in the Burrishoole River system and elsewhere over the past few years.

Month	PERCENTAGE OF SALMON RUN RETURNING EACH MONTH						
	1959	1960	1961	1962	1963	1964	1965
January ...	—	—	—	—	—	—	—
February ...	—	—	—	—	—	—	—
March ...	—	0.4	—	—	—	—	—
April ...	0.5	1.7	1.9	—	0.4	0.8	—
May ...	3.2	3.9	3.8	6.2	0.8	2.2	0.3
June ...	21.7	23.2	10.6	11.4	7.9	8.6	16.0
July ...	30.6	26.4	16.2	41.0	12.2	25.0	26.5
August ...	23.6	17.5	48.1	28.6	47.2	30.5	37.4
September ...	16.2	9.7	13.9	4.7	17.5	23.4	14.4
October ...	3.7	3.9	3.2	1.9	4.5	3.2	1.9
November ...	0.5	6.6	1.4	4.3	7.1	1.6	1.9
December ...	—	6.6	0.9	1.9	2.4	4.7	1.6

The total escapement was only slightly less than that of 1964 and reflects a continuing trend towards improved grilse runs over the past three years compared with the years 1959 to 1962.

If the 1959 total for grilse be taken as 100 and the 1960 total for spring fish similarly, the percentage annual escapements through the upstream trap are as follows:—

Year	Spring fish	Grilse
1959	No records	100%
1960	100%	105%
1961	79%	107%
1962	79%	101%
1963	36%	263%
1964	71%	196%
1965	3%	173%

As in other years considerable numbers of grilse were seen at the base of the falls of the Salmon Leap during floods in late July and August.

(ii) **Sea trout.** After rising steadily for the past four years the run of sea trout in 1965 showed a marked decline, the total of 1,466 being only 61% of that in 1964. This decline appeared to be general along the west coast of Ireland and was reflected in the figures for rod-caught sea trout of neighbouring fisheries. The unknown escapement of sea trout to Lough Feeagh via the Salmon Leap was probably small, due to low water conditions during most of July, when sea trout were forced to ascend the Mill Race.

As discussed in a later section of this Report, the major cause of this decline is thought to be due to kelt loss and delay during the cold, dry weather of late winter.

For comparison purposes, the sea trout totals counted through the upstream trap over the past seven years are given in the following table:—

Year	Total count through upstream trap
1959	1,210
1960	1,431
1961	1,372
1962	1,739
1963	1,988
1964	2,393
1965	1,466

As in 1964, almost the entire sea trout run occurred during June and July, although the kelts were relatively late in leaving fresh water in the spring. This may account in part for the generally poor condition of fresh sea trout in west coast rivers this year, since they spent some 21 days less in the sea than in a normal year, when the absence period averages about 100 days.

Month	PERCENTAGE OF SEA TROUT RETURNING EACH MONTH							
	1959	1960	1961	1962	1963	1964	1965	
January ...	—	—	—	—	—	—	—	
February ...	—	—	—	—	—	—	—	
March ...	—	—	—	—	—	—	—	
April ...	—	—	—	—	—	—	—	
May ...	0.1	0.3	0.1	0.1	—	—	—	
June ...	35.4	31.2	27.1	9.4	5.0	0.1	—	
July ...	46.2	59.5	64.7	81.6	69.5	45.5	30.4	
August ...	8.5	3.2	3.6	6.3	19.3	43.9	57.7	
September ...	6.8	0.6	1.0	0.7	1.8	4.6	4.7	
October ...	1.5	1.6	1.5	0.2	1.8	2.1	3.2	
November ...	1.2	3.2	1.8	1.1	2.5	2.1	3.0	
December ...	0.3	0.4	0.2	0.6	0.1	1.5	0.8	
						0.2	0.2	

(b) **Downstream**

(i) **Salmon and sea trout smolts.** The salmon smolt run was very prolonged in 1965, beginning on 9th April and ending on 1st June. The major peak of the run occurred from 2nd to 12th May but almost 1,000 were counted in April and a further 1,000 between 12th to 31st May.

The trap caught total of 4,507 probably reflects a satisfactory total smolt run, since water levels at the Salmon Leap ranged from normal to flood conditions over the period of the run with no periods of low water. Details of salmon smolt counts through the downstream trap on the Mill Race over the past seven years are given in the following table:—

Year	Total	First Smolt	Peak of Run
1959	3,229	—	23rd April — 30th April
1960	7,435	31st March	27th April — 10th May
1961	3,552	27th March	14th April — 23rd April
1962	6,389	11th April	29th April — 3rd May
1963	2,113	21st April	5th May — 17th May
1964	3,159	4th April	24th April — 17th May
1965	4,507	9th April	2nd May — 12th May

The sea trout smolt run was similarly prolonged but began earlier than the salmon, on 24th March. The daily totals of sea trout smolts did not exceed 55 and as in 1964 there was a steady run throughout the entire period to give a total of 897, very similar to those of most preceding years :—

Year	Sea Trout Smolts	Salmon Smolts
1959	567	3,229
1960	795	7,435
1961	788	3,552
1962	1,384	6,389
1963	788	2,113
1964	758	3,159
1965	897	4,507

(ii) Kelts

1964 to 1965 spawning season

Salmon. The proportion of kelts tagged at the downstream trap in 1965 from the spawning escapement of 1964 was 27% compared with 35% in the previous year. A total of 96 kelts was tagged, of which 22 were males; occasional male kelts were seen as late as mid-April though most left fresh water in the early part of the run. A further 27 kelts used in hatchery operations were also tagged and released. Scale samples were taken again in 1965, for use in confirmation of possible long-absence habit in grilse kelts.

The main downstream migration occurred during the period 7th to 16th April and scarcely any kelts were seen during February or March.

From a total of 123 tagged kelts, five have been recaptured as short-absence, previously spawned, grilse in 1965; the recapture rate of 4% was low by comparison with 10.1% for 1964, and tends further to confirm that survival of salmon kelts in the sea is better following a mild winter in fresh water.

Of the five recaptures, three were taken in the upstream trap, one was rod-caught in Lough Feeagh (having ascended the Salmon Leap), and one was caught in drift nets off Arranmore Lighthouse, Co. Donegal. No recaptures were reported in 1965 from the Greenland fishery.

Sea trout. There have been 98 recaptures of sea trout in 1965, from a total of 333 tagged, giving a recovery rate of 29.0%. This was very similar to results from previous years :—

Year	First Year % Recapture	Final % Recapture
1960	25.5	31.5
1961	15.4	20.1
1962	30.5	36.1
1963	29.0	34.8
1964	32.5	35.5
1965	29.0	—

Although this figure will be increased by further recaptures as kelts or fresh fish in 1966 from the Salmon Leap escapement of 1965 it would tend to confirm that survival of sea trout in the sea during 1965 was normal and that kelt loss

B. 442:	tagged 29/4/62, 12.9"	recaptured:	(i) 8/7/62, 14.3"
			(ii) 8/8/63, 15.5"
			(iii) 7/7/64, 17.2"
			(iv) 29/6/65, 17.6"
B. 482:	tagged 2/5/62, 16.2"	recaptured:	(i) 19/7/62, 17.7"
			(ii) 15/7/63, 18.7"
			(iii) 7/7/64, 19.4"
			(iv) 21/7/65, 19.6"
801:	tagged 20/3/61, 14.5"	recaptured:	(i) 13/7/61, 16.4"
			(ii) 21/7/62, 18.3"
			(iii) 26/6/63, 19.3"
			(iv) 15/6/65, 21.0"

These fish had ascended the Mill Race to Lough Feeagh each year and left as kelts via the Salmon Leap each year after being tagged. No. 801 was unseen in either trap in 1964.

(v) Silver eels

There was no improvement in the run of silver eels during 1965 and the total of 967 was somewhat less than that of 1964. When samples of the runs of the past two years have been analysed into year-classes it may throw some light on this decline in numbers.

Silver eel runs:	1959 — 2,245
	1960 — 1,928
	1961 — 1,901
	1962 — 2,055
	1963 — 2,333
	1964 — 1,054
	1965 — 967

(vi) Autumn-migrating trout

Smolt screens were in position on the fish fence from 1st September to 31st November 1965 in order to catch migrating silver eels in the downstream trap. During this period 1,035 small trout migrating downstream were counted and released which, together with a further 112 in December when only 1¼" screens were in place, constituted a total of 1,147 of these fish.

It has been demonstrated that a proportion of these autumn-migrating trout are potential sea trout (*Annual Report* 1964, p. 11) and two further recaptures of trout fin-clipped in the autumn of 1962 were recaptured as adult sea trout in 1965.

- (i) 1/7/65 15.3" ♀ Adipose + Dorsal 2 sea winters Up trap
- (ii) 6/8/65 16.9" ♀ Adipose + Dorsal 2 sea winters Up trap

One small brown trout was caught in the downstream trap on 10/4/65, 9.5" long, clipped adipose and dorsal. This was a further example of the component of the autumn migrating trout which do not go to sea.

(8) SMOLT TAGGING AND MARKING

A total of 700 2+ hybrids were tagged with blue and white telcothene sleeving, with double wire attachment. All reared salmon smolts were fin-clipped as follows:—

1+ grilse parentage	:	Adipose and Dorsal	:	898
1+ spring fish × grilse	:	Adipose + Left pelvic	:	1,082
2+ grilse parentage	:	Adipose + Dorsal	:	4,180
2+ spring fish parentage	:	Adipose + Right pelvic	:	3,514

Total : 9,674

All smolts were fin-clipped in February and transferred to the release ponds in early April.

(9) PREDATORS

Five tags attached to sea trout in 1964 and 1965 were found either inside cormorants or on a cormorant nesting island in Clew Bay. Three tags were found in two mergansers. One further smolt tag, used in 1962, was found on the now deserted cormorant island in Ballinlough.

Both wild and fin-clipped smolts were found in the stomachs of slob trout (<1 to 2 lbs. in weight) and pollack in Lough Furnace. Pollack reappeared in small numbers in 1965 and about 30 were caught in the draft net operating on Lough Furnace. A pair of dippers were observed at infrequent intervals, diving into two rearing ponds containing 2" salmon fry during October and November 1965. When the pond populations were checked at the end of the year over 1,000 fry were missing. This is a considerably larger unaccountable loss than is usual, and it is presumed that the major part of the loss was due to the predatory activities of the dippers. The birds have now been driven away and the ponds covered.

(10) RECOVERIES OF ADULT SALMON OF KNOWN PARENTAGE

There have been 33 further recaptures of adult salmon derived from reared smolts during 1965. Details are given in the following table :

No.	Mark	Date of return	Length	Parentage	Returned as	Fate
1.	Adipose + 2 pelvics	10/ 4/65	24.5"	Spring fish	Grilse kelt	Tagged and Released
2.	Scotch tag	31/ 5/65	30.5"	Grilse	Long-absence grilse	Market
3.	Adipose + left pelvic	11/ 6/65	31.0"	Grilse	Long-absence grilse	Market
4.	Adipose + right pelvic	28/ 6/65	22.7"	Grilse	Grilse	Market
5.	Adipose + dorsal	23/ 7/65	22.3"	Spring fish	Grilse	Holding pen
6.	Adipose + dorsal	26/ 7/65	22.5"	Spring fish	Grilse	Rod- caught
7.	Adipose + right pelvic	29/ 7/65	22.6"	Grilse	Grilse	Holding pen
8.	Adipose + right pelvic	29/ 7/65	25.4"	Grilse	Grilse	Holding pen
9.	Adipose + right pelvic	5/ 8/65	20.5"	Grilse	Grilse	Holding pen
10.	Adipose + dorsal	5/ 8/65	21.8"	Spring fish	Grilse	Holding pen
11.	Adipose + dorsal	5/ 8/65	23.9"	Spring fish	Grilse	Holding pen
12.	Adipose + right pelvic	5/ 8/65	24.6"	Grilse	Grilse	Holding pen
13.	Adipose + right pelvic	6/ 8/65	21.7"	Grilse	Grilse	Holding pen
14.	Adipose + dorsal	25/ 8/65	28.2"	Spring fish	Small summer fish	Holding pen
15.	Adipose + right pelvic	25/ 8/65	20.5"	Grilse	Grilse	Holding pen
16.	Adipose + dorsal	25/ 8/65	27.2"	Spring fish	Small summer fish	Holding pen

No.	Mark	Date of return	Length	Parentage	Returned as	Fate
17.	Adipose + right pelvic	10/ 9/65	23.2"	Grilse	Grilse	Holding pen
18.	Adipose + right pectoral + tag	11/ 9/65	25.6"	Grilse	P.S. Grilse	Holding pen
19.	Adipose + right pelvic	11/ 9/65	22.4"	Grilse	Grilse	Holding pen
20.	Adipose + right pelvic	17/ 9/65	24.1"	Grilse	Grilse	Holding pen
21.	Adipose + right pelvic	18/ 9/65	22.2"	Grilse	Grilse	Holding pen
22.	Adipose + right pelvic	18/ 9/65	22.0"	Grilse	Grilse	Holding pen
23.	Adipose + right pelvic	18/ 9/65	22.7"	Grilse	Grilse	Holding pen
24.	Adipose + dorsal	18/ 9/65	22.2"	Spring fish	Grilse	Holding pen
25.	Adipose + right pelvic	9/10/65	21.9"	Grilse	Grilse	Holding pen
26.	Adipose + right pelvic	9/10/65	22.5"	Grilse	Grilse	Holding pen
27.	Adipose + 2 pelvics	3/11/65	28.0"	Spring	P.S. Grilse	Holding pen
28.	Adipose + right pelvic	4/11/65	23.2"	Grilse	Grilse	Holding pen
29.	Adipose + right pelvic	5/11/65	24.6"	Grilse	Grilse	Holding pen
30.	Adipose + right pelvic	29/11/65	23.3"	Grilse	Grilse	Holding pen
31.	Adipose + dorsal	9/12/65	24.7"	Spring fish	Grilse	Holding pen
32.	Adipose + dorsal	10/12/65	24.4"	Spring fish	Grilse	Holding pen
33.	Adipose + dorsal	19/12/65	23.7"	Spring fish	Grilse	Holding pen

There have been 19 examples of grilse parentage smolts returning as maiden grilse and two examples of their returning as long-absence previously spawned grilse.

Nos. 5, 6, 10, 11, 24, 31, 32 and 33 were further examples of the phenomenon first noted in 1964 of spring fish parentage smolts returning as grilse. Two small summer fish (i.e. two sea-winter fish) were derived from 1+ smolts of spring fish parentage. One previously spawned grilse (No. 27) was also derived from a spring fish smolt fin-clipped in 1963 and a further fish (No. 1) was derived from the same batch, being recaptured as a grilse kelt.

The total of recaptures from reared smolts now stands at 116, which can be divided into the following categories (excluding previously spawned fish) :—

7	two sea-winter salmon	from spring-fish smolts
15	grilse	from " "
75	grilse	from grilse smolts
4	two sea-winter salmon	from " "

The tendency for smolts of spring fish parentage to return as grilse appears to be increasing, and it has been noted recently in Scotland and Sweden that hatchery reared smolts tend to return as grilse irrespective of their parentage. Fish culturists endeavour to produce large smolts, in the belief that their chances of survival in

the sea are better, but the rapid growth rate of the smolt may superimpose or reinforce a short absence habit on its hereditary traits.

Survival to 1965 of reared smolts released in 1964 was as follows:—

19 grilse from 3,290 grilse smolts	=	0.58%
8 grilse from 3,340 spring fish smolts	=	0.24%

Swedish sea trout

There have been five recaptures in all from 485 Swedish sea trout smolts, released in 1964:—

1. 11/7/64 10.7" Finnock (0+ years in the sea)
2. 17/4/65 11.0" Finnock kelt (0+ years in the sea)
3. 12/6/65 14.6" Sea trout (1+ years in the sea)
4. 20/6/65 13.6" Sea trout (1+ years in the sea)
5. 27/7/65 14.0" Sea trout (1+ years in the sea)

The fast growth in the sea exhibited by Swedish sea trout in their native habitat appears not to be an heritable factor, as the above examples are typical of sea trout in the Burrishoole River system.

(11) BIOLOGICAL SURVEY WORK

In February 1965 an investigation was begun on the Black River with the object of determining the degree of competition between the three species of fish present in the Burrishoole River system, i.e. salmon (*S. salar*), trout (*S. trutta*) and eels (*A. anguilla*).

Samples of the three fish species were taken each month as closely together in time and place as possible during the year. A comparison of the food eaten with the environmental fauna was made, and a quantitative faunal survey was undertaken at the site of the electrical fishing operations at approximately the same time, together with determination of pH and temperature.

The eels taken in this investigation were used also in a comparative study of the age and growth of eels from the three main rivers flowing into Lough Feeagh, namely the Black River, the Cottage River and the Glenamong River. The results of the age and growth analyses of eels of the Cottage River appear in Appendix III to this report. Eels were also taken from the Glenamong River by electrical fishing operations on two occasions during the year. This investigation will be completed in 1966.

(12) COTTAGE RIVER EXPERIMENT

There was a disappointing total of only 107 2+ smolts counted through the trap on the Cottage River in 1965. However, there are grounds for believing that the trap was not fishing efficiently, following modifications carried out in 1964. This suspicion has been reinforced by a count of 350 3+ parr remaining in the river, during electro-fishing operations in the summer. It is most unlikely that 3+ smolts would outnumber 2+ smolts by so much, particularly when the total of 164 1+ smolts is taken into account.

Messrs. Spence and West completed their work on the age, growth and feeding of the brown trout of the Cottage River and in conjunction with Mr. Rogers, present their results in Appendix III of this report.

(13) PEAT SILT RESEARCH

This aspect of the Trust's work is being carried out under the direction of a sub-committee called the Peat Silt Research Group, composed of Sir Richard V. H. Levinge, Bart., member of the Committee of Management; Mr. T. J. Lee, Bord na Mona; Mr. S. O Mealláin, Inspector and Engineer, Fisheries Division, Department of Agriculture and Fisheries, and Dr. A. E. J. Went, Director of Research. The report of this Group to the Committee of Management appears as Appendix I.

(14) GENERAL

An account of the progress of the Trust's research during the ten years since its inception has been prepared and will be issued in 1966.

Dr. Went, Dr. Piggins and Mr. Rogers attended the Second British Coarse Fish Conference at Liverpool University in April. Dr. Went and Dr. Piggins attended meetings of the Salmon Research Group at Pitlochry, Perthshire in April and at London in November, as well as the Tenth London Conference of the Salmon and Trout Association in November.

Dr. Piggins attended the meetings of the Salmon and Trout Committee of the International Council for the Exploration of the Sea held in Rome from 6th to 9th October. Mr. Rogers made a short study tour of fishery installations and laboratories in Scotland during May, with the kind co-operation of Mr. K. A. Pyefinch, Officer in Charge, Freshwater Fisheries Laboratory of the Ministry of Agriculture, Scotland.

(15) ACKNOWLEDGEMENTS

The Committee expressed its appreciation to the Minister for Agriculture and Fisheries, and to the Staff of the Fisheries Division of the Department of Agriculture and Fisheries, in particular, Mr. C. J. McGrath, Engineer, for their valuable assistance during 1965.

IONTAOBHAS TAIGHDE BRADAN na h-EIREANN IONCORPORTH
(THE SALMON RESEARCH TRUST OF IRELAND INCORPORATED)

APPENDIX I

PEAT SILT RESEARCH GROUP

The Peat Silt Research Group has the honour to present its report for the year 1965 to the Committee of Management of the Salmon Research Trust of Ireland.

Mr. J. O. Browne, B.Sc., continued his scientific work on the biological aspects of the peat silt research during the year on the River Boyne with a view to ascertaining the effects of the discharge of water from certain bog workings in the Boyne catchment area.

Mr. Browne's report on the work carried out by him during the year is included in this report as Appendix II.

The study of the behaviour of sediment produced by the discharge of peat silt into rivers is one which requires trained personnel and special laboratory facilities not available in Ireland. During the year, therefore, the Committee entered into negotiations with the Laboratoire Central d'Hydraulique de France with a view to their investigating the physical properties of the sediment produced by the discharge of peat silt and its behaviour under various hydrodynamic conditions. This important laboratory has been carrying out investigations on similar topics in many parts of Europe and, therefore, is well qualified to deal with this aspect of the problem of the discharge of peat silt laden waters into rivers.

Professor J. C. I. Dooge, M.E., M.Sc., A.M.I.C.E., A.M.ASCE., continued to act as Consultant Hydrologist to the Trust during the year.

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APPENDIX II

By J. O. BROWNE, B.Sc.

The bulk of the work during 1965 was concerned with the effect of peat silt on fauna and flora and also the direct effect of silt on fish. The river investigated, as in 1964, was the Stoneyford, a tributary of the Boyne. The stations sampled were the same as in 1964 and are shown in Fig. 1. Limited fauna sampling was also carried out on the Mongagh River, which is affected by milled peat workings and the Athboy River, which is unpolluted throughout its length. Both these rivers are tributaries of the Boyne.

FAUNAL INVESTIGATIONS

During the year 1965 fauna samples were taken from the three stations of the Stoneyford River shown in Fig 1. Because of high water it was not possible to sample the stations regularly each month as was intended. The results are therefore presented bi-monthly (Table 1). The figures in the longitudinal columns in this Table represent the average for a number of samples taken during each bi-monthly period.

As in 1964 the total number of individuals present at Station 1 was higher than at Station 3, which in turn was higher than at Station 2, Fig. 1. The difference over the year 1965, however, is not as striking as in 1964. The numbers of families represented at each Station did not vary to a great extent throughout the year.

Station	Total number of families
1	36
2	29
3	31

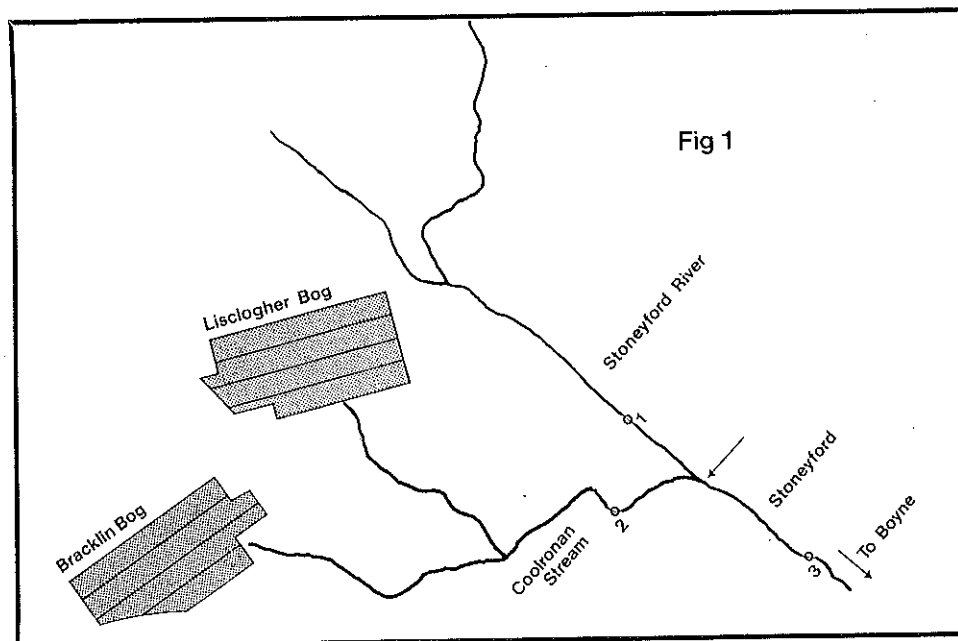


Fig. 1—Sketch map of the Stoneyford River and Coolronan Stream. (The numbers indicated are those of the Stations used.)

Usually the lower reaches of a river are more productive than the upper reaches. Station 3 then should be more productive than Station 2 but the reverse is the case.

Peat silt in the Stoneyford River affects the resident fauna to some extent. It is not clear whether this damaging effect is brought about by a change in the natural habitat by peat silt impregnation or by a reduction in light penetration caused by peat silt in suspension.

The fauna in the Mongagh River is apparently quite healthy. It is well represented and far more plentiful than a comparable stretch of the Stoneyford River. The fauna compares favourably with the unpolluted and productive Athboy River (Table 2). No samples were taken after June.

FLORAL INVESTIGATIONS

Observations over the summer period on the aquatic flora of the various parts of the Stoneyford River were made during the year. Above the point of entry of Coolronan Stream the Stoneyford River supports an abundant flora, consisting mainly of species of *Potamogeton*, *Rorippa* and *Ranunculus*. None of these species are in evidence in the Coolronan Stream.

From the junction the waters of the two rivers flow side by side without much intermingling for a distance of over 30 yards. That part of the Stoneyford River which carries the discharge from the Coolronan Stream in the area above-mentioned is also devoid of the aquatic plants mentioned above but on the other side, which carries the normal waters of the Stoneyford River, these species, although reduced in number, are fairly well represented. As soon as admixture is complete the flora seems to recover but is nowhere as abundant as above the junction.

It is not possible to state whether the reduction or absence of flora is caused by interference with light penetration or alteration of the substratum by peat silt. The local and dramatic effect at the junction of the two rivers would suggest, however, that light penetration may be a big factor in producing these phenomena.

TANK EXPERIMENTS

In an effort to find out if suspended particles of peat silt caused mortalities among alevins, two lots of a hundred alevins were kept in

- (a) a concentration of approximately 20 g per gallon
- (b) a concentration of approximately 40 g per gallon

Four tanks were used for the experiment. Mechanical stirrers and aerators kept the water in each tank in continuous motion. Tanks 1 and 2 contained 100 alevins each and were used as controls. Tank 3 contained 100 alevins and 20 g of peat silt (wet weight) per gallon of water. Tank 4 contained 100 alevins and 40 g of peat silt (wet weight) per gallon of water.

The mechanical stirrers were switched on in the tanks on the 19th January and the silt added to Tanks 3 and 4 that day. The number of survivors in each tank over the 17-day period of the experiment are shown in Table 3.

Under the conditions of the experiment the alevins appeared to suffer no ill effects from concentrations of suspended peat silt. The alevins in the silt in fact had a higher survival rate than those in the control tanks. A possible explanation for this is that alevins survive better when reared on a dark background, and the tanks were light blue in colour. The suspended peat silt would have provided a dark background for the alevins in the test tanks.

TABLE 1

Average numbers of individuals of each family present at the different stations on the Stoneyford River

	Station 1 Rathkenna Br.					Station 3 Earls Br.					Station 2 Coolronan				
	January February	March April	May June	July August	September October	January February	March April	May June	July August	September October	January February	March April	May June	July August	September October
ANNELIDA															
Lumbricidae	+	2	1	1		+		3	1		8		1	5	3
Naididae		6	13	5	5	2	3	5	2	9	6	9	2	10	15
ARACHNIDA															
Hydrachnellae	12	8	4	6	43	3	9	+	10	2	2	3	+	6	
CRUSTACEA															
Asellidae	+		2			1	+	4	2	3		2	5	1	9
Gammaridae	49	30	43	35	23	6	39	6	40	7	8	10	3	5	8
Cyprididae	1			1		1									
Others			1				+		+	+		1		3	
COLEOPTERA															
Helmidae (A)	14	6		2	15	+	1		13	1		1			
Helmidae (L)	52	34	13	18	96	19	16	9	19	17	10	4		12	
Others			+												
DIPTERA															
Chironomidae (L)	46	35	20	26	35	14	51	22	53	14	5	4	11	15	5
Simuliidae	+	12	28		2	3			30	12			+		
Pupae			1	8	2		+			+	+	+		3	
Others		+		+	+	+			1	+					+
EPHEMEROPTERA															
Ephemeridae	+	+	+	3				+	+					4	
Caenidae	53	49	10	5	84	7	39	15	18	29	15	21	3	+	
Ecdyonuridae	1	13	1	6	1	1			2	12			1		
Baetidae	6	+	9	19	2	2	10	12	3	13	1	1		+	4
Ephemerellidae					1					1					
Others				9						+				2	
HEMPITERA															
All			+		+										1
MOLLUSCA															
Limnaeidae		+	+						+		1				+
Ancylidae		19	26	1		12	9	+	3	+	6		4	2	
Sphaeriidae	+	3	2	5	1	+	4	+	+	+				1	
Planorbiiidae		+		2	+				+						+
Others	+		3	1											+
PLATHYHELMINTHES															
PLECOPTERA															
Nemouridae	+	3		1		+	2		+						
Others	+		+			+			+						

TABLE 1—Continued

Average numbers of individuals of each family present at the different stations on the Stoneyford River

	Station 1 Rathkenna Br.					Station 3 Earls Br.					Station 2 Coolronan				
	January February	March April	May June	July August	September October	January February	March April	May June	July August	September October	January February	March April	May June	July August	September October
TRICHOPTERA															
Sericostomatidae		1		2						1					
Polycentrophidae		2		1	4	1	12	6	10						
Rhyacophilidae		4	3			+			1	+				+	+
Hydropsychidae	5		1	12	11	2		1	7	5	2				+
Limnophilidae															
Hydroptilidae	1	3	1	1	3	+	9	+		+	+	+			
Others			+		+					+					
COELENTERATA			+	1							+				
COLLEMBOLA				2							+			+	

+ = present but less than 6

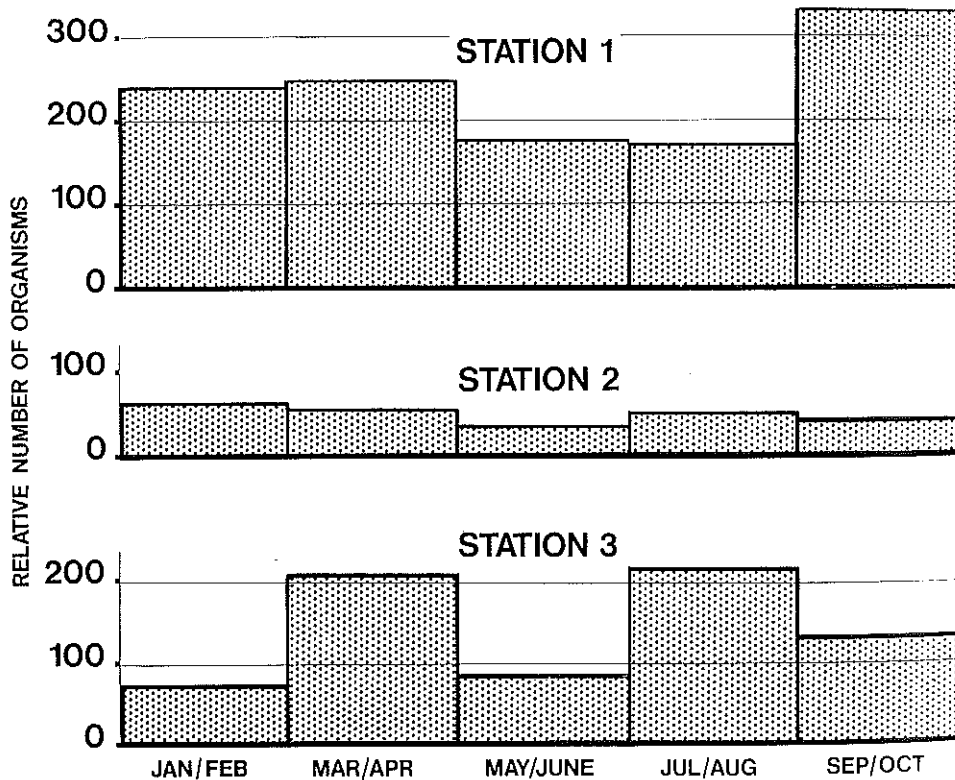


Fig. 2—Relative numbers of organisms present at the three Stations of the Stoneyford River during each bi-monthly period.

TABLE 2

Average numbers of individuals of each family present at stations on the Stoneyford, Mongagh and Athboy Rivers

	Stoneyford Station 3		Mongagh River		Athboy River	
	Mar./ Apr.	May/ June	Mar./ Apr.	May/ June	May/ June	July/ Aug.
ANNELIDA						
Lumbricidae		3	+			
Naididae	3	5	20	10		
ARACHNIDA						
Hydrachnellae	9	+	6	3	12	19
CRUSTACEA						
Asellidae	+	4		1		3
Gammaridae	39	6	26	12	140	226
Cyprididae						
Others	+		+		5	26
COLEOPTERA						
Helmidae (A)	1			3	30	16
Helmidae (L)	16	9	15	18	212	317
Others					+	5
DIPTERA						
Chironomidae	51	22	213	94	300	285
Simuliidae			56	15	+	
Pupae	+		2			89
Others			+	+		+
EPHEMEROPTERA						
Ephemeridae			1			
Caenidae	39	15	36	45	9	4
Ecdyonuridae			+		+	
Baetidae	10	12	54	60		
Ephemerellidae						
Others			+			+
HEMPTERA						
All						
MOLLUSCA						
Limnaeidae			4	+		
Ancylidae	9	+			6	12
Sphaeriidae	4	+	+	3		2
Others						
PLATHYHELMINTHES						
Turbellaria			+			2
PLECOPTERA						
Nemouridae	2					
Others						
TRICHOPTERA						
Sericostomatidae						
Polycentropidae	12	6			12	6

TABLE 2—Continued
Average numbers of individuals of each family present at stations on the Stonyford, Mongagh and Athboy Rivers

	Stoneyford Station 3		Mongagh River		Athboy River	
	Mar./Apl.	May/June	Mar./Apl.	May/June	May/June	July/Aug.
Rhyacophilidae		1		+	4	3
Hydropsychidae						
Limnophilidae					22	4
Hydroptilidae	9	+		1		
Pupae and others			2			
COLEENTERATA				+		
COLEMBOLA						

+ = present but less than 6

TABLE 3
Showing number of survivors from 100 alevins in the tank used in these experiments

Date	Number of alevins				Amount of silt in g.	
	Tank 1	Tank 2	Tank 3	Tank 4	Tank 3	Tank 4
19/1/65	—	100	100	100	20.0	40.0
20/1/65	—	100	99	100	"	"
21/1/65	—	97	99	100	"	"
22/1/65	—	88	98	97	"	"
25/1/65	100	80	98	96	"	"
26/1/65	98	77	90	95	"	"
27/1/65	98	77	90	95	"	"
28/1/65	81	74	86	94	"	"
29/1/65	80	70	86	90	"	"
1/2/65	80	69	85	90	"	"
2/2/65	80	68	85	86	"	"
3/2/65	75	68	85	86	"	"
4/2/65	75	66	85	84	"	"
5/2/65	74	66	84	83	"	"

26

APPENDIX III

THE COTTAGE RIVER EXPERIMENT

By A. ROGERS, B.Sc., J. A. SPENCE, B.A. and A. B. West, B.A.

INTRODUCTION

Various topics arising from the Cottage Experiment have been dealt with by Reynolds, Spence and West (1963) and Spence and West (1964) and in this, the concluding section, the study of the food of trout, begun in the 1963 report, has been finalised, as has the study on the feeding habits of the eels, begun in the 1964 report. In addition, the length/weight relationship of eels has been examined more closely and their growth rate determined. This concludes the studies on the fish population removed from the river in 1962 and 1963, by electrical fishing.

Electrical fishing techniques are not fully efficient, and a small number of fish remained after 1963 of which the brown trout constituted a breeding population. A further electrical fishing of the river was carried out in July and August 1965, in order to discover differences in growth-rate under the new conditions of reduced brown trout and eel populations and to ascertain how many of the 40,000 salmon fry planted in 1963 remained as 3+ years old parr.

MATERIALS AND METHODS

1. The trout and eel population removed in 1962 and 1963

(a) The feeding habits of trout and eels

The analysis of the stomach contents of brown trout and eels was continued on the same lines as in 1963 and 1964. This involved identification of individual items of the diet down to species level, the summation of the numbers of each species in the diet for the trout and eels of a particular reach of the stream and for the total population of the stream, and finally the expression of these totals as percentages of the numerical total of food species.

(b) Age and growth of eels

The age of eels was estimated from examination of the otoliths only and no scale reading was attempted. Otoliths are readily extracted by longitudinal sagittal sections of the cranium to expose the auditory bullae. It was found necessary to grind the convex surfaces of the otoliths on a fine carborundum stone moistened with dilute hydrochloric acid (Sinha, 1965). The otoliths were then dried and cleared in oil of cresote for at least 24 hours, generally longer. It was found that fresh oil of cresote cleared otoliths quicker than that which had been used several times.

Sinha's (1965) interpretation was used in the estimation of age, by counting the number of summer rings in fresh water, rather than by ascribing an arbitrary date of entry into fresh water for the eels, from which the age is calculated.

The length/weight relationship of yellow eels was calculated from the formula: $w = al^3$ (w = weight in g. and l = length in cm.) where conversion to logarithmic values gives the "straightline" formula: $\log w = \log a + 3 \log l$. To carry out this part of the study, the eels were arranged into length groups of four cm., and the average length, weight, and standard deviation of the weight for these groups were calculated and converted to logarithmic values.

27

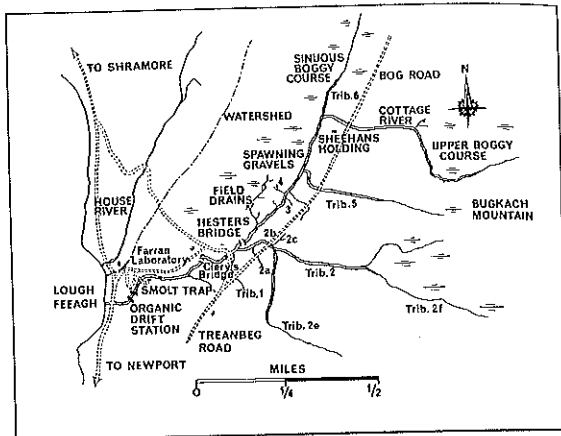


Fig. 3—Map of Cottage River. Based on the Ordnance Survey by permission of the Government (229/2).

2. The fish population in 1965

As indicated already, the entire Cottage River above the smolt trap (Fig. 3) was electro-fished in July and August, 1965. On this occasion, the larger machine (400 volt pulsed D.C.) was used for the entire stream. Salmon parr and trout were anaesthetised in M.S. 222, measured and returned to the stream, but scale samples were taken from every tenth parr in order to confirm that only 3+ salmon parr remained in the stream. Eels were counted and returned. The numbers of each species caught in each reach were noted and the length frequencies of salmon and trout in each reach were calculated.

RESULTS

1. (a) The feeding habits of trout and eels

Table 1 shows total food in the stomachs of 987 trout and 691 eels. From this, in the case of trout, it was calculated that the ten most important items in the diet were:—

1. Adult terrestrial insects: 30.7% (mainly Diptera and Hymenoptera)
2. Chironomidae: 16.8%
3. Aquatic Oligochaetes: 10.7%
4. *Baetis rhadani*: 9.1%
5. *Simulium* spp.: 5.6%
6. *Philopotamus* spp.: 4.5%
7. *Gammarus duebeni*: 2.9%
8. *Ephemera ignita*: 2.6%
9. Dipteran pupae: 2.6%
10. Polycentropidae spp.: 1.9%

To determine the distribution of groups of trout food organisms in the stream, the numbers of a given group from each reach were expressed as a percentage

28

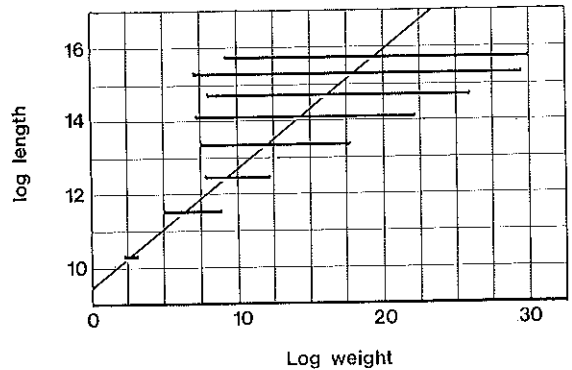


Fig. 4—Length/weight relationship of eels in the Cottage River. (Horizontal lines represent two standard deviations.)

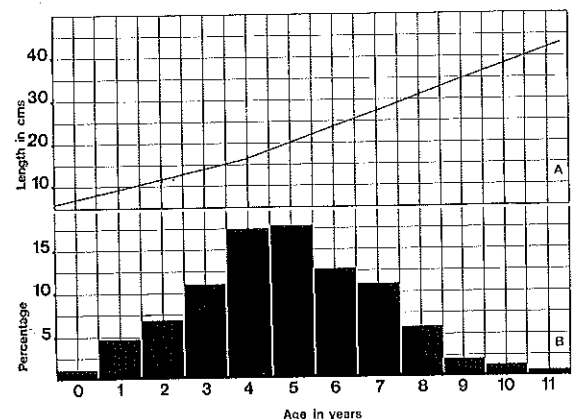


Fig. 5—A = Length for age curve. (Horizontal lines represent two standard deviations.)
B = Percentage age frequency distribution histogram of eels.

29

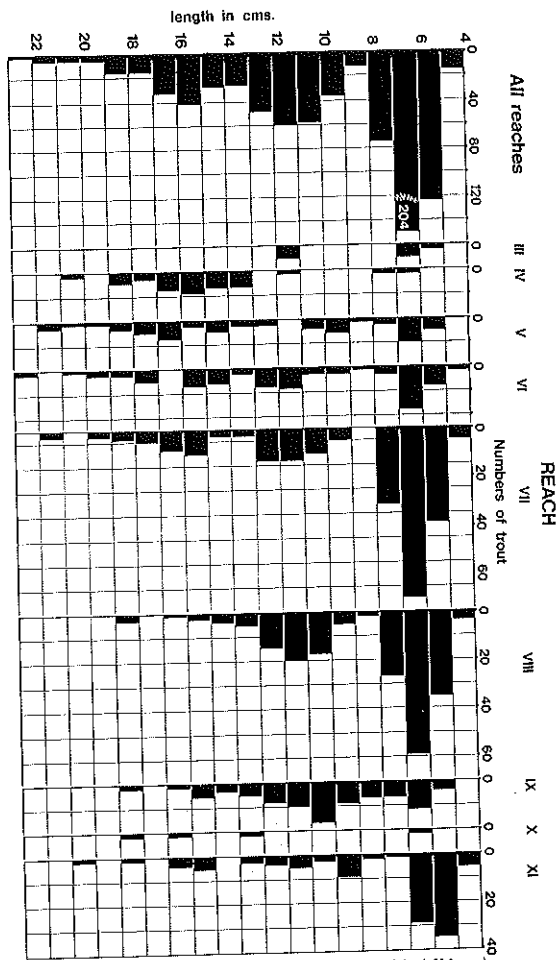


Fig. 6—Length distributions of trout in each Reach (excluding one fish of 25.0 cms.).

30

DISCUSSION

1. (a) The feeding habits of trout and eels in 1962 and 1963

In previous years, the food consumed was related to the stream fauna by use of "availability factors" (Reynolds, Spence and West (1963) and Spence and West (1964)). The practice of comparing the food present in fish stomachs with faunal surveys taken at different times has been discarded as unreliable in common faunal surveys (Maitland, 1965) since annual and seasonal variations in fauna with other workers (Morgan and Waddell, 1961; Hynes, 1941; Egglislaw, 1964; Morgan and Egglislaw, 1965).

Table 1 can be taken to show the main items in the diet of trout and eels, but without accurate knowledge of the status of the various food species in the stream only limited conclusions can be drawn as to the extent of competition among the fish species for the available food.

The food of trout is similar to that found in other investigations (e.g. Thomas, 1962; Maitland, 1965; Nilson, 1957; Rozanska, 1961; Southern, 1932; Frost, 1945 (c)). Terrestrial insects (adults and pupae) taken at the water surface are the most important, together constituting one-third of the total food consumed. A portion of trout diet was generally made up of Chironomids, Baetis, Gammarus and Simulium as in this study. Small aquatic oligochaetes were important in Reaches IX and XI (especially in IX) where a high proportion of the trout were obviously selecting these annelids. Of the remaining organisms *Ephemera* is limited almost entirely to the lower reaches of the stream, whilst *Philopotanus*, *Polycentropid* spp. and the Tipulidae are of little importance, their main contribution to the diet occurring in the upper reaches. Possible reasons for this may be:—

- That this reflects the abundance of those species in the fauna of the different reaches.
- The availability of the species may alter due to competition for a species varying with the location in the stream, or
- The amount of preferred food may be smaller in e.g. the higher reaches, so that the fish turns to species in lesser demand in the lower reaches (vice-versa).

It should be noted that (a) implies little or no preference on the part of the trout and (c) implies distinct preferences as to the constitution of the diet. In considering (b), it is necessary to compare the numbers of the different fish species found in different reaches of the stream. These are given in the table below, where figures in parentheses are the percentage proportions per reach for each fish species:—

Reach No.	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Total
Salmon	49 (69.0)	1 (1.4)	20 (28.2)	1 (1.4)	—	—	—	—	—	—	—	71
Trout	25 (2.4)	24 (2.3)	101 (9.6)	79 (7.5)	179 (17.0)	114 (10.8)	145 (13.7)	120 (11.4)	106 (10.0)	12 (1.1)	96 (9.0)	691
Eels	38 (5.5)	50 (7.2)	273 (39.5)	98 (14.2)	170 (24.6)	35 (5.1)	13 (1.8)	6 (0.9)	3 (0.4)	—	—	691

Salmon were confined exclusively to Reaches I, II, III and IV; eels occurred in Reaches I to VI in fair numbers but with the greatest density in Reaches III, IV and V; trout, although occurring throughout the stream, reached their highest numbers in Reaches V to IX. The salmon was the most abundant species in Reach I, eels were dominant in II, III and IV; trout and eels shared Reach V in equal numbers but in the higher reaches and the tributaries, trout were dominant. Thus if Reach I is disregarded, the remaining reaches, ascending the stream, were dominated first by eels and then by trout.

In considering the degree of competition for food between trout and eels, it will be remembered that in the eel diet, *Ephemera ignita* was first in importance, followed closely by Chironomids. The fact that *E. ignita* is important to both trout and eels in the lower stretches tends to support the idea that

32

of the total of that group in the entire stream (Table 2). Table 3 shows each group expressed as a percentage of the total food consumed per reach.

The most important food items in the eel stomachs were:—

- Ephemera ignita* : 19.7%
- Chironomidae : 15.3%
- Gammarus duebenii* : 12.9%
- Baetis rhodani* : 11.7%
- Rhyacophila* spp. : 11.4%
- Polycentropidae* spp. : 5.8%
- Tipulidae : 3.4%
- Simulium* spp. : 2.9%
- Dytiscidae : 2.0%
- Eiseniella tetraedra* : 2.0%

1. (b) The age and growth of eels

Table 4 gives the lengths of eels, their corresponding average weights and the standard deviations of these weights, together with the number of individuals in each group. Logarithmic values for length and weight are also given. Fig. 4 is the curve derived from these points, which takes the form of a straight regression line, fitted by the method of least squares, of the formula: $y = 2.93x + 2.73$. In this formula, "n" of the equation $\log w = \log a + n \log l$ is seen to be very close to 3, as might have been expected.

Table 5 gives the average length and standard deviation for each age group as well as the numerical and percentage frequency of the eels in each age group. Fig. 5 A represents the length for age curve, which shows a slow growth rate for the first four or five years, then a faster growth rate up to the age of descent as silver eels. Fig. 5 B is the percentage age frequency distribution histogram.

2. The fish population in 1965

The numbers of each species of fish caught in the different reaches of the stream were as follows:—

Reach No.	III	IV	V	VI	VII	VIII	IX	X	XI	Totals
Salmon	69	31	75	73	27	2	1	0	7	285
Trout	19	45	63	90	206	196	89	4	104	816
Eels	46	57	24	23	24	5	11	2	9	201

There is a pronounced trend towards the reduction in numbers of salmon in the higher reaches whilst the reverse is true of trout. In particular, trout were markedly preponderant in Reach XI, which is a small tributary stream (Fig. 3). Eels also show reduced numbers in the higher reaches, the greatest numbers being found in the lowest reaches (III and IV). The length distributions of trout in each reach are shown in Fig. 6 and those for salmon in Fig. 7.

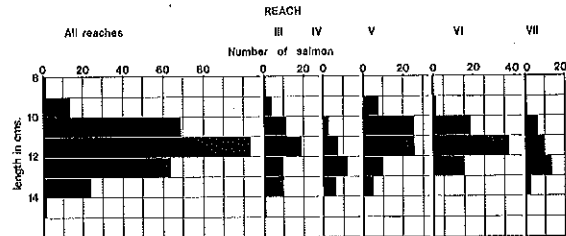


Fig. 7—Length distributions of salmon in each Reach.

31

diet is closely related to the abundance of food species in any particular locale (see (a) above). This tends to discount the reason (b) above, concerning competition.

Chironomidae, *Gammarus*, *Baetis*, *Simulium* and *Polycentropidae* were all represented in both the diet of the trout and of the eel. The *Polycentropidae* in the trout diet occurred mainly in the upper reaches and Chironomidae were probably superabundant (Frost, 1945, c.). The position concerning the other three genera (*Gammarus*, *Baetis* and *Simulium*) is uncertain, since in the absence of faunal surveys carried out at the same time as the fish were removed from the stream, competition between trout and eels for these species cannot be ascertained. A similar situation obtains for Tipulidae, Dytiscidae and *Eiseniella*. Again, as noted in an earlier paper (Rogers, 1964), the fact that a food species occurs in one fish species and not in another to any extent, does not rule out the possibility of competition.

It is safe to say, however, that there is little or no competition between eels and trout for surface food.

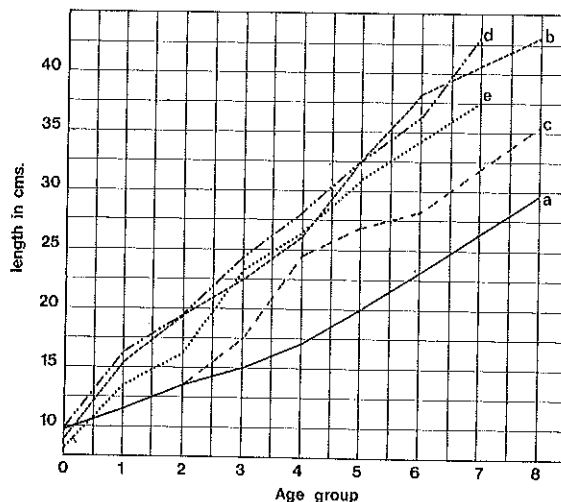


Fig. 8—Growth rate of eels in (a) Cottage River; (b) Windermere (Frost, 1945); (c) Severn (Marcus, 1919); (d) Firaw (Sinha, 1965); (e) Rhyd-hir (Sinha, 1965).

1. (b) The age and growth of eels

Despite its obvious difference in shape from the "conventional" fish, the cube law is fully applicable to eels and is, in fact, more accurate than for many other species (Le Cren, 1951; Maz, 1964).

The age and growth investigations show that the growth rate in the Cottage River is very much lower than in any other British waters for which results have been published. Fig. 8 shows a selection of these. Hornoyd's (1922) study of the growth of eels from a small Worcestershire pond and Marcus's (1919) study on the eels of an Irish river (probably Clare) are not included, due to insufficiency of numbers of eels used in the investigations. Of three rivers studied by Sinha

33

This illustrates very effectively the two major drawbacks of electrical fishing as a means of complete removal of unwanted fish species. These are :

- (i) The "law of diminishing returns", i.e. as the number of fish in a stream is diminished by successive fishings, it becomes increasingly difficult to catch those remaining,

and

- (ii) The efficiency of electrical fishing gear decreases with the decreasing size of fish to be caught. Although fully apparent from the results on trout above, this effect is also noticeable in electro-fishing operations for eels.

It should be noted that in the present study, a small, one-man machine was used in May 1963 for electro-fishing of the upper reaches of the river where the 0+ and 1+ age groups of trout were most numerous, whilst in 1965 a large and more powerful machine was used over the entire river.

Since the trout population was considerably decreased by the electrical fishings of 1962 and 1963 it was anticipated that better growth would result among those trout remaining. Comparison of Fig. 12 of Reynolds, Spence and West (1963) with Fig. 6 of the present paper demonstrates some gain in length. (Both sets of measurements were taken at the same time of the year.)

Length range for modal values of trout of different age-groups were :—

Year	...	0+	1+	2+
1962	...	5.5 — 6.5	9.5 — 10.5	13.5 — 14.5
1965	...	6.0 — 7.0	11.0 — 12.0	15.0 — 16.0

Thus the growth rate is slightly higher in each age-group whilst the annual increments also appear to have increased each year. Frost's work on the River Liffey (1945 c.) showed that the length attained in the first year is important in the future years of a trout's life. This was confirmed by Ball and Jones (1960). The slight difference in length in the first year here is maintained subsequently, in agreement with this.

Fig. 6 shows that 0+ trout are most abundant in Reaches VII and VIII and in 1962/3 (Spence and West, 1964) the numbers of this age-group were shown to be highest in Reaches IV, VIII and IX. In 1965, 1+ trout dominated the latter reach, but were slightly smaller in length than in other mainstream reaches, whilst in the tributaries (Reaches X and XI) the trout were consistently smaller for their age than in the mainstream. Tributary 2 (Reach XI) is of a similar nature to the higher parts of the mainstream (Reach IX) and the fact that both these reaches should show a decrease in average length from that found in the rest of the mainstream is not surprising. The decrease was probably due to food differences, either qualitative or quantitative, and it may be that these reaches are overpopulated. It is also possible that the larger specimens of the size-ranges of the different year-classes have migrated downstream.

In Reach IV there is an obvious congregation of 2+ fish to the virtual exclusion of any other year class (Fig. 6). There are several patches of spawning gravel and a few deeper pools in this reach, but the reason for this large number of 2+ fish is not apparent. It may be a pre-spawning congregation, but in that event it would be expected that similar congregations would have been noted at the other reaches (Reach VIII in particular), with more extensive spawning gravels. As has been noted above, in the 1962 electro-fishing, 0+ fish were the strongest year-class in this reach, whereas they were virtually absent from it in 1965. The present 2+ fish in 1965 were not the survivors of 0+ trout remaining in 1962 (they would have been 3+ fish in 1965).

Little comment is needed on the length frequency results for salmon. Slightly better growth was shown in Reaches IV and VII than in the other reaches (III, V and VI). It was noted earlier that salmon were confined to the lower parts of the river, whilst trout were dominant in the higher reaches. To what extent this reflected antagonism of the two species is not certain, but it has been noted by Maitland (1963), Kalleberg (1958) and Le Cren (1965) that trout in general have the better of any rivalry, except perhaps in the faster-flowing stretches.

Le Cren (op cit.) indicates that there is a tendency for the salmon parr to be pushed downstream to the wider parts of the river, as was found in the present situation.

From 40,000 salmon fry (unfed) planted in the Cottage River after removal of the greater part of the resident population of trout and eels in 1963, 164 smolts and 81 parr of 1+ years of age migrated downstream in 1964. In 1965, only 107 2+ smolts were counted through the trap, together with 23 parr, but there is reason to believe that the trap was not fishing effectively, following modifications carried out in 1964. Since there were 285 3+ years old salmon parr remaining in the stream during the 1965 fishing, the known survival rate is 1.7% compared with 0.25% when a similar number of fry were released in 1959, into a fully populated river.

SUMMARY

1. In this, the third and final report on the Cottage River Experiment, the studies of the feeding habits of the trout and the eel were concluded, and an examination was made of the age and growth of eels. In addition, the strength and distribution of the remaining fish populations were appraised.

2. The food of the trout in the Cottage River was found not to differ appreciably from that of similar trout investigated elsewhere. Terrestrial insects (adult and larval) constituted one-third of the total food consumed.

3. It appears likely that the trout in this particular river exhibit little or no preference for specific food items, where the abundance of a particular food species governs its representation in the diet.

4. Competition between trout and eels appears probable for some food species and less probable for others. In the absence of faunal surveys carried out in conjunction with the fishing operations, no firm conclusions were drawn.

5. The incidence of predation by eels on salmonids was found to be 0.7%, a similar figure to that found by other workers.

6. The cube law has been found to hold good for the length/weight relationship of the eels.

7. The growth rate of the eels is much below that found in studies conducted elsewhere in Great Britain and Ireland. Possible reasons for this are discussed.

8. The limitations of electrical fishing methods are discussed on the basis of the fish populations in 1965, three years after attempted clearance.

9. Following only partial clearance of possible predators and competitors from the river, the survival rate of planted salmon fry increased from 0.25% to 1.7%.

TABLE 1

Total food in the stomachs of 987 trout and 691 eels

Species	Trout	Eels
ANNELIDA		
Lumbricidae	6	35
Other Oligochaetes	1,055	—
Nematoda	10	2
Crustacea		
Gordiaceae	91	—
<i>Gammarus duebeni</i>	558	232
Cladocera and Ostracoda	2,220	—
INSECTA		
Coleoptera		
Hydrophilidae	193	—
Haliplidae	10	—
Helmidae	58	6
Dytiscidae	200	36
Helodidae	—	22
Unidentified	103	17
Diptera		
<i>Simulium spp.</i>	1,065	53
Chironomidae	3,190	274
Tipulidae	205	61
Tabanidae	6	1
Forcipomyia	36	—
Limnophora	14	—
Dixidae	25	—
<i>Chaeoborus spp.</i>	17	—
<i>Eristalis spp.</i>	1	—
Ceratopogonid	1	—
Unidentified	484	7
Ephemeroptera		
<i>Baetis rhodani</i>	1,729	210
Ecdyonuridae	87	23
<i>Ephemerella ignita</i>	502	353
Unidentified	373	1
Lepidoptera		
<i>Nymphula spp.</i>	—	4
Plecoptera		
<i>Leuctra hippopus</i>	124	32
<i>Protonemura meyeri</i>	14	—
<i>Nemoura spp.</i>	4	—
<i>Chloroperla torrentium</i>	7	—
<i>Isoperla grammatica</i>	3	—
<i>Perla bipunctata</i>	1	—
Unidentified	83	1

TABLE 1—Continued
Total food in the stomachs of 987 trout and 691 eels

Species	Trout	Eels
Trichoptera		
<i>Oxyethira</i> spp.	14	3
<i>Hydroptila</i> spp.	16	—
<i>Hydropsyche</i> spp.	65	11
<i>Rhyacophila</i> spp.	80	204
<i>Philopotamus</i> spp.	859	—
Polycentropidae	369	105
<i>Limnophilus</i> spp.	11	2
Leptosomatid	8	—
<i>Silo pallipes</i>	96	9
Sericostomatidae	84	—
<i>Lepidostoma</i> spp.	4	—
Odontoceridae	1	—
Unidentified	126	14
Hemiptera		
<i>Mesovelia furcata</i>	51	—
<i>Microvelia</i> spp.	2	—
<i>Velia</i> spp.	17	—
<i>Gerris</i> spp.	1	—
Unidentified	2	3
Hydracarina	25	—
Terrestrial Arthropoda	5,826	17
Terrestrial Annelidae	30	—
Terrestrial Mollusca	24	—
MOLLUSCA		
<i>Limnaea pereger</i>	193	5
<i>Ancylastrum fluviatile</i>	177	—
<i>Hydrobia jenkinsii</i>	68	—
<i>Planorbis</i> spp.	2	—
<i>Bithynia</i> spp.	2	—
PISCES		
Salmonidae	—	5
Anguillidae	—	2

TABLE 2

Numbers of different food items present in the stomachs of the trout in various reaches

	Reach	No.	I-III	IV	V	VI	VII	VIII	IX	X	XI
Terrestrial insects	...	56.3	0.6	2.2	8.5	9.1	2.0	8.3	0.3	12.7	
Aquatic oligochaetes	...	—	—	—	—	1.2	78.9	—	—	20.8	
<i>Baetis rhodani</i>	...	65.0	6.7	2.4	7.8	4.7	4.8	3.9	2.4	2.2	
Chironomidae	...	64.5	0.8	0.3	0.8	5.1	10.3	13.0	0.5	4.5	
Simuliidae	...	29.0	3.4	6.1	9.5	29.2	12.5	7.0	0.8	2.1	
<i>Philopotamus</i> spp.	...	14.1	—	—	—	—	—	58.3	1.2	25.5	
<i>Gammarus duebeni</i>	...	44.4	2.5	3.0	7.5	11.6	3.9	12.5	0.7	13.2	
<i>Ephemerella ignita</i>	...	74.7	1.2	0.4	11.2	9.0	1.6	0.4	—	1.6	
Dipteran pupae	...	64.9	—	—	0.8	2.9	0.8	26.4	0.6	3.5	
Polycentropid spp.	...	3.0	1.9	0.6	1.9	1.9	1.9	73.2	0.8	15.0	

TABLE 3

The different food items for trout expressed as a percentage of the total food per reach

	Reach No.	I-III	IV	V	VI	VII	VIII	IX	X	XI
Terrestrial insects	...	34.8	13.1	45.6	48.6	36.1	13.9	12.5	13.4	37.2
Aquatic oligochaetes	...	—	—	—	—	—	—	41.2	—	21.4
<i>Baetis rhodani</i>	...	11.9	42.5	14.9	13.3	5.5	10.2	1.8	30.6	1.9
Chironomidae	...	21.9	9.5	3.5	2.8	11.0	40.2	10.7	11.9	7.3
Simuliidae	...	3.3	13.2	22.9	10.2	21.3	16.2	1.9	6.7	1.1
<i>Philopotamus spp.</i>	...	—	—	—	—	—	—	12.9	7.5	11.0
<i>Gammarus duebeni</i>	...	2.6	5.1	6.0	4.2	4.4	1.9	2.7	—	3.8
<i>Ephemerella ignita</i>	...	3.9	—	—	5.5	3.0	—	—	—	—
Dipteran pupae	...	3.3	—	—	—	—	—	3.3	—	—
Polycentropid spp.	...	—	—	—	—	1.4	—	6.9	—	2.3

TABLE 4

The length/weight relationship of the Cottage River eel population

	Length groups	8-11.9	12-15.9	16-19.9	20-23.9	24-27.9	28-31.9	32-35.9	36-39.9
Mean length (cm.)	...	10.42	14.33	17.79	21.79	25.9	29.9	33.7	37.8
Mean Weight (g.)	...	1.78	5.51	10.1	18.58	28.5	47.5	68.3	92.5
Stan. devn.	...	0.6	1.6	1.8	3.4	5.5	8.3	12.8	12.4
No. sample	...	18	39	53	43	21	27	19	10
Log. "l"	...	1.02	1.16	1.25	1.34	1.41	1.48	1.53	1.58
Log. "w"	...	0.25	0.71	1.00	1.27	1.45	1.68	1.83	1.97
Log. "s"	...	0.02	0.20	0.26	0.53	0.74	0.92	1.14	1.09

TABLE 5

Age for length of the eels of the Cottage River

Age in years	Length (cm.)	Stan. devn.	Range (cm.)	n	% frequency
0+	9.7	0.1	8.2-10.6	4	1.1
1+	11.4	0.9	9.4-12.6	18	4.8
2+	13.5	1.0	12.0-15.1	26	6.9
3+	15.1	0.9	13.5-17.3	42	11.2
4+	17.0	2.4	15.0-20.5	67	17.8
5+	20.0	1.3	18.1-22.7	68	18.1
6+	23.1	1.2	20.5-26.0	49	13.0
7+	26.3	1.4	24.0-29.0	42	11.2
8+	29.4	0.8	28.0-31.0	23	6.1
9+	31.4	0.8	30.0-33.0	18	4.8
10+	33.7	1.2	31.0-35.0	12	3.2
11+	37.0	1.0	35.0-38.0	7	1.8

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APPENDIX IV

THE SPECIFIC CHARACTERISTICS OF SMALL
SALMON AND TROUT

By EILEEN ROGERS, B.Sc., MARY CRICHTON, B.A.
and D. J. PIGGINS, Ph.D.

INTRODUCTION

The most recent work in the British Isles on the specific characteristics of small salmon and trout is that of Jones (1947), further elaborated by the same author (1959) and Jones and Tomblason (1964). The differences between the two species set out in these papers are drawn largely from the specific characters noted by Gunther (1864), Day (1887), Regan (1911) and Nall (1930).

In the course of recent work on the meristic characters of salmon-sea trout hybrids (Piggins, 1964) it became apparent that some of the definitions of specific characteristics of the two parent species were unsatisfactory. A number of the diagnostic features were prone to subjective error and in others, the limits of variations within each species and possible changes in these limits with increasing size, were not known. An attempt has been made to overcome some of these defects in the following paper.

MATERIAL AND METHODS

Fish used in this study consisted of 476 salmon and 570 trout. The largest proportion of both species was taken during electrical fishing operations in the nursery streams of the Burrishoole river system, but 85 salmon had been artificially reared to the 1+ stage whilst 150 trout were caught during their autumn downstream migration from Lough Feeagh. Most of the larger trout (20.0-24.9 cm.) were rod-caught specimens from Lough Feeagh. Both fresh and preserved (formalin) specimens were used. For comparison purposes, both salmon and trout were divided into length groups, as follows:—

Length group in mm.	No. of salmon	Average length in mm.	No. of trout	Average length in mm.
5.0 - 9.9	290	7.9	135	8.0
10.0 - 14.9	186	11.2	315	12.0
15.0 - 19.9	—	—	75	17.4
20.0 - 24.9	—	—	45	22.2

Analysis of specific characteristics was carried out by two of us as follows:

254 salmon and 345 trout (E. R.)

222 salmon and 225 trout (M. C.)

Results were averaged separately in order to assess the degree of subjective error.

The determination of individual specific characters was as follows:—

(i) **Colouration and parr marks.** Deemed unsatisfactory as specific characters.

(ii) **Spotting of the body.** The number of spots below the lateral line was counted on both sides of the fish and a mean value noted.

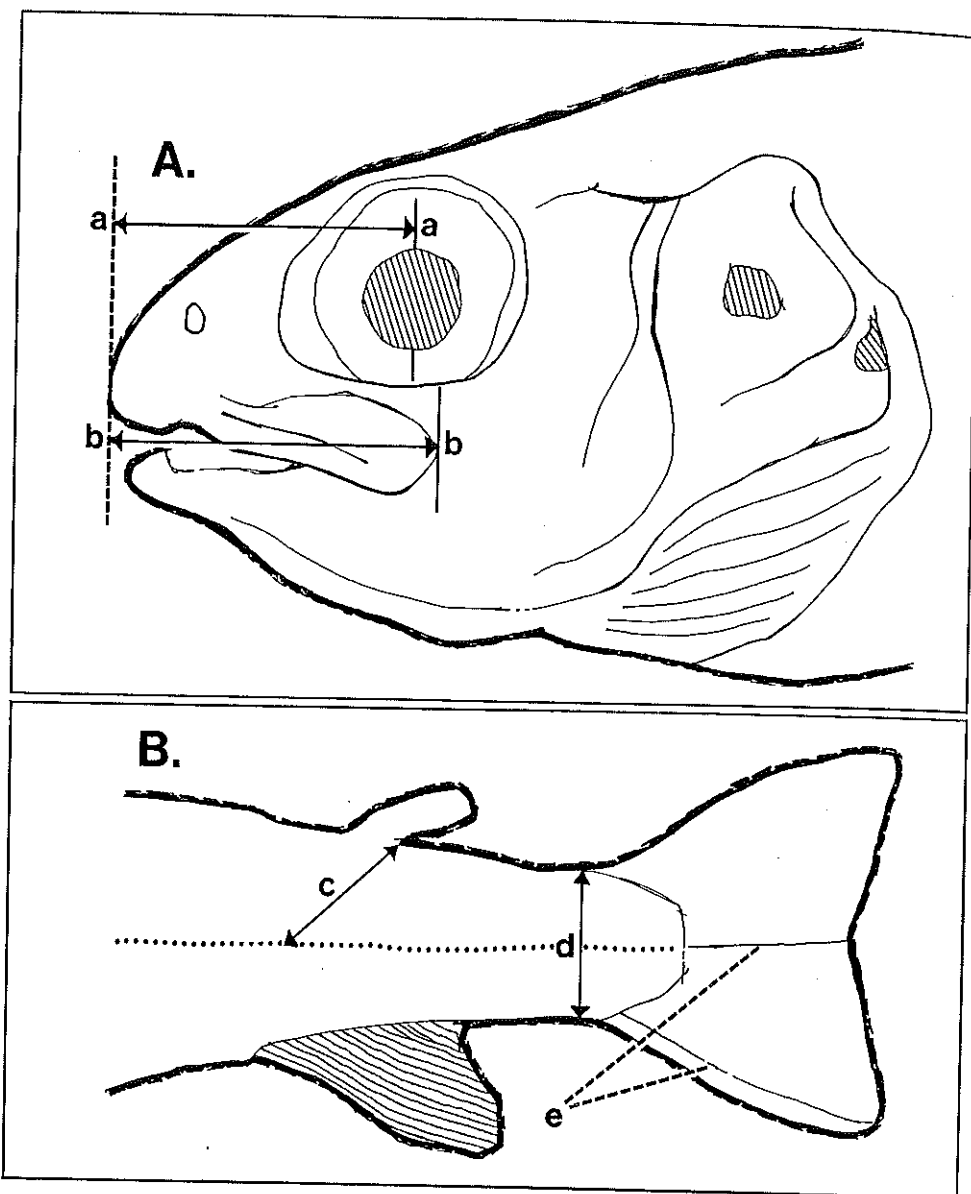


Fig. 9—To show : (i) Measurement of relative length of maxilla (b—b) to centre point of eye (a—a). (ii) Scale count area (c). (iii) Thickness of caudal peduncle (d). (iv) Longest and shortest tail rays (e).

(iii) **Spotting of the operculum.** The number of definitive spots on both operculi was counted and a mean value noted.

(iv) **Spotting of the dorsal fin.** All spots, including those which were only faintly marked, were counted.

(v) **Relative length of maxilla.** The distance between the tip of the snout and the middle of the pupil of the eye was measured to the nearest $\frac{1}{2}$ mm. with a pair of dividers, whilst the mouth was closed. It was compared with the distance from the tip of the snout to the distal point of the maxilla and the results expressed as a ratio, the first distance being unity (Fig. 9 A).

Statistical tests of significance were applied to these ratios, both between the two species and between length groups in each species.

(vi) **Thickness of caudal peduncle.** The thickness (dorsoventrally) of the

caudal peduncle at its narrowest point was measured and expressed as a ratio of the fork length of the fish. The results were tested for statistical significance (Fig. 9 B).

(vii) **Forking of the tail.** With the caudal fin spread in a "natural" position (i.e. neither stretched nor compressed), the lengths of the shortest and longest tail-rays were measured and expressed as a ratio, the shortest ray length being unity (Fig. 9 B). The tail-rays were measured in two ways:—

- (a) From the distal tip inwards to the point where the ray disappeared into the musculature of the caudal peduncle (Technique A).
- (b) From the distal tip inwards to the root of the ray exposed by scraping off the skin (Technique B). The results were tested for statistical significance.

(viii) **Scale count.** The number of scales was counted in an oblique series from the posterior edge of the adipose fin, downwards and forwards to the lateral line (Fig. 9 B). Except in the largest trout, the count was made under low-power magnification, but even then, some difficulty was experienced in detecting the first scale in the series, i.e. that nearest the base of the adipose fin.

(ix) **Branched fin ray count.** The number of branched rays in the dorsal fin was counted, again under low-power magnification, except in the largest fish. The two distal rays of the series were often so close together as to appear like one ray branched at the root but were counted as two rays.

(x) **Pyloric caeca count.** Stomachs were removed from the fish and preserved in 4% formalin for at least 24 hours, before the pyloric caeca were counted. The hardened caeca were considerably easier to detach and count than when fresh. These counts were not related to the size ranges in each species.

RESULTS (See Table 1)

(i) **Colouration and parr marks.** Although it was true that the adipose fin of salmon was rarely tinged with red, some salmon do show red colouration of this fin and some trout have an almost colourless fin. Similarly, the difference in colour between the grey of the pectoral and pelvic fins of salmon and the yellow-grey of trout fins is often slight and susceptible to subjective error. Parr marks disappear in trout of over 5 cm. length in this locality and both parr marks and colouration are affected by preservation in formalin. No serious study of these characters was attempted.

(ii) **Spotting of the body.** There is a distinct difference between trout and salmon in the number of spots present below the lateral line. For salmon, in both length groups the mean value was less than five, whilst the smallest trout averaged over 11. There is a marked tendency for trout to develop more spots as they increase in size.

(iii) **Spotting of the operculum.** Salmon in both length groups average less than three spots on the operculum whilst the smallest trout average over five. As trout increase in size, the number of spots on the operculum increases, although in the largest length group examined, the average value falls slightly.

(iv) **Spotting of the dorsal fin.** Differences in this character are less marked than for the preceding two characters, although in salmon and trout of comparable length groups, trout always exhibited more spots. The difference between the two species is more pronounced if the strength of definition of the spots is considered, when salmon exhibit less well defined spots.

(v) **Relative length of maxilla.** This character shows a clear-cut difference between salmon and trout of each length group. In salmon, the distal point of the maxilla extends only fractionally behind the mid-point of the eye to give a mean ratio of 1.06 : 1 and 1.09 : 1 for the 5.0 to 9.9 cm. and 10.0 to 14.9 cm. length groups respectively. The mean ratios for trout of comparable size are

1.20 : 1 and 1.27 : 1 respectively, indicating a relatively longer maxilla in this species. These ratios are significantly different :—

Salmon 1.06 : 1	Trout 1.20 : 1	(t = 8.4, p > 0.01)
Salmon 1.09 : 1	Trout 1.27 : 1	(t = 19.9, p > 0.01)

The ratio between length of the maxilla and distance to the mid-point of the eye increases in each succeeding length group of trout.

Length group	Ratio	t.	p.
5.0 - 9.9 mm.	1.20 : 1		
10.0 - 14.9	1.27 : 1	8.0	> 0.01
15.0 - 19.9	1.35 : 1	4.7	> 0.01
20.0 - 24.9	1.39 : 1	2.02	> 0.05

Although there is an apparent tendency for this to occur in salmon, the difference between the ratios for the two length groups examined was not statistically significant (t = 0.93, p > 0.3).

The range in values for 285 salmon and 130 trout in both length groups is shown in the table below. Individual values were arranged in groups differing by 0.05 and the number of fish in each group expressed as a percentage of the total :—

Ratio value	Percentage of salmon		Percentage of trout	
	5.0-9.9 cm.	10.0-14.9 cm.	5.0-9.9 cm.	10.0-14.9 cm.
1.00 - 1.04	38	17	2	2
1.05 - 1.09	41	30	10	6
1.10 - 1.14	13	40	23	10
1.15 - 1.19	6	10	8	17
1.20 - 1.24	1	2	19	24
1.25 - 1.29	1	—	30	23
1.30 - 1.34	—	—	6	12
1.35 - 1.39	—	—	2	5

There is an unexplained peak for the trout values in the range 1.10 - 1.14 which does not occur in the 10.0 - 14.9 cm. group, and is therefore ascribed to sampling error.

(vi) **Thickness of the caudal peduncle.** The ratio of the thickness of the caudal peduncle to fork length of the fish was greater than 1 : 10 in both length-groups of salmon. (See Table 1.) The differences between the ratios for salmon and trout of comparable size were statistically significant.

	Salmon	Trout	t	p
5.0 - 9.9 cm.	1 : 11.8	1 : 10.8	6.51	> 0.01
10.0 - 14.9 cm.	1 : 11.9	1 : 11.2	3.32	> 0.01

From Table 1, it is apparent that in trout the ratio of caudal peduncle thickness to total length decreases with increasing length of fish, or in other words, the wrist of the tail becomes progressively slimmer. The ratio amongst the largest trout (1 : 12.2) is less than that of the salmon and differs significantly from trout of the 10.0 - 14.9 mm. size range. (t = 5.14, p > 0.01.)

The range of individual values for salmon and trout of the two comparable length groups is shown in the following table :—

Length group (5.0 - 9.9 cm.)			
Caudal / Total peduncle / length	Percentage of salmon	Percentage of trout	
8.5 - 8.9		1	
9.0 - 9.4		2	
9.5 - 9.9		9	
10.0 - 10.4	1	16	

Caudal peduncle / Total length	Percentage of salmon	Percentage of trout
10.5 - 10.9	7	38
11.0 - 11.4	25	14
11.5 - 11.9	25	13
12.0 - 12.4	24	4
12.5 - 12.9	8	2
13.0 - 13.4	7	1
13.5 - 13.9	1	
14.0 - + +	2	

(Number of salmon = 290)

(Number of trout = 135)

Length group (10.0 - 14.9 cm.)

Caudal peduncle / Total length	Percentage of salmon	Percentage of trout
8.0 - 8.4		0
8.5 - 8.9		0
9.0 - 9.4		1
9.5 - 9.9		1
10.0 - 10.4		11
10.5 - 10.9	8	18
11.0 - 11.4	25	27
11.5 - 11.9	23	24
12.0 - 12.4	17	13
12.5 - 12.9	11	4
13.0 - 13.4	6	1
13.5 - 13.9	4	
14.0 - 14.4	4	
14.5 - + +	2	

(Number of salmon = 185)

(Number of trout = 315)

(vii) **Forking of the tail.** As mentioned in the preceding section, two different techniques were employed in the measurement of the longest and shortest tail rays. This has led to distinct differences in the values of the ratios obtained, but where individual techniques for salmon and trout are compared, the results are significantly different:—

Length group	Salmon	Trout	t.	p.
5.0 - 9.9 cm.				
Technique A	2.22 : 1	1.82 : 1	7.33	> 0.01
Technique B	1.74 : 1	1.58 : 1	6.61	> 0.01

As the trout increase in length, the ratio of the longest to the shortest tail rays increases:—

Trout	Technique A	Technique b
5.0 - 9.9 cm.	1.82 : 1	1.58 : 1
10.0 - 14.9 cm.	2.04 : 1	1.63 : 1
15.0 - 19.9 cm.	2.06 : 1	1.69 : 1
20.0 - 24.9 cm.	2.14 : 1	—

(viii) **Scale count.** The results obtained confirm that a scale count of 11 is the commonest value for salmon and 14 for trout, as shown in the following table. Among salmon of 5.0 to 9.9 cm., 87% of a sample had counts of 11 and 12, whilst 93% of the comparable trout had counts of 13 and 14.

Length group	Scale count	Percentage total salmon	Percentage total trout
5.0 - 9.9 cm.	10	2.4	—
	11	55.2	—
	12	31.7	0.7
	13	9.0	40.8
	14	1.7	51.9
	15	—	5.9
10.0 - 14.9 cm.	16	—	0.7
	10	5.4	—
	11	39.2	—
	12	31.7	1.9
	13	22.6	23.0
	14	1.1	58.9
	15	—	14.3
	16	—	1.9

The complete range found for salmon was from 10 to 14, and 12 to 17 in trout with a common range of 12, 13 and 14. A tendency towards a higher scale count in the largest trout is *not* statistically significant.

(ix) **Branched fin rays.** In salmon, the number of branched rays in the dorsal fin varied from 9 to 13, usually 11 or 12. In trout, the range was from 8 to 12, with 50% of the sample counting 10, except in the largest trout, where over 50% counted 11. The principal overlap between the two species was present at counts of 10 and 11, where 52.5% of the salmon and 74.1% of the trout of comparable size occur within this range. This overlap and the trend towards higher branched fin ray count with increasing size of fish can be seen in the following table:—

Ray count	Percentage salmon total		Percentage trout total			
	5.0 - 9.9 cm.	10.0 - 14.9 cm.	5.0 - 9.9 cm.	10.0 - 14.9 cm.	15.0 - 19.9 cm.	20.0 - 24.9 cm.
8	—	—	2.2	0.6	1.3	—
9	0.7	—	25.9	20.6	20.0	4.4
10	15.2	10.7	52.6	48.9	48.0	44.4
11	45.2	33.9	17.8	28.9	29.4	51.2
12	36.9	53.2	1.5	1.0	1.3	—
13	2.0	2.2	—	—	—	—

(x) **Pyloric caeca.** The table below gives the range of pyloric caeca counts for 374 salmon and 547 trout, expressed as % fractions of the total for each species within each range of counts. The fish were not divided into length groups for this study.

Number of pyloric caeca	Percentage total salmon	Percentage total trout
26 - 30	—	2.7
31 - 35	0.5	11.3
36 - 40	2.1	24.6
41 - 45	11.2	29.1
46 - 50	23.3	19.2
51 - 55	29.7	9.2
56 - 60	17.6	2.1
61 - 65	11.5	—
66 - 70	3.2	—
71 - 75	0.8	—

The principal overlap occurs at counts of 40 to 55, where 64.2% of the salmon and 57.5% of the trout are contained within this range. The mean values for each species (salmon: 52.2; trout: 42.4) also occur within this range, but these mean values show a statistically significant difference ($t = 11.79$, $p = > 0.01$).

TABLE 1

Length ranges (cm.)	SALMON		TROUT			
	5.0 - 9.9	10.0 - 14.9	5.0 - 9.9	10.0 - 14.9	15.0 - 19.9	20.0 - 24.9
Number of spots below lateral line	4.9	4.8	11.4	13.7	20.5	24.8
Number of spots on operculum	2.5	2.9	5.5	7.1	9.0	7.3
Number of spots on dorsal fin	10.4	14.9	15.9	22.2	23.4	22.4
Length of maxilla/length to med. eye	1.06 : 1	1.09 : 1	1.20 : 1	1.27 : 1	1.35 : 1	1.39 : 1
Caudal peduncle/total length	1 : 11.8	1 : 11.9	1 : 10.8	1 : 11.2	1 : 11.5	1 : 12.2
Longest tail ray/A	2.22 : 1	2.27 : 1	1.82 : 1	2.04 : 1	2.06 : 1	2.14 : 1
Shortest tail ray/B	1.74 : 1	1.94 : 1	1.58 : 1	1.63 : 1	1.69 : 1	—
Scale count ...	11.5	11.7	13.7	13.9	14.1	14.4
Branched ray count	11.3	11.4	9.8	9.9	10.1	10.5
Pyloric caeca count		52.2			42.4	

DISCUSSION

(i) Spotting and colouration of the body

It has been confirmed that spotting of the body is more extensive in young trout than in salmon parr when a large sample of fish was examined, but the range of variation from the norm in both species renders this character, and all those within this section, distinctly unreliable. Small trout have been found with few spots above the lateral line and none beneath, by comparison with salmon parr which were quite heavily spotted (particularly with red spots) below the lateral line.

Spotting of the operculum is a slightly more reliable character in that few salmon were found with more than three spots on each operculum and few trout with three or less. Spotting is not uniform on each operculum however, so that both should be examined. Spots may be overlaid by deposition of guanine during smolt transformation in both salmon and sea trout.

Spotting of the dorsal fin is a thoroughly unreliable character in that it depends largely on a subjective assessment by the observer of the strength of definition of the spots. If faint spots are counted, salmon often exhibit as many spots as an average trout.

The colouration of both species is extremely variable, being dependent on habitat, diet and physiological condition of the fish. In addition, differentiation between, for example, "yellowish" and "yellow-grey" again implies a subjective assessment which could lead to error. Parr marks tend to disappear in quite small trout so that a count of these marks becomes impossible. Indeed, in fish of over 10 cm. length, the presence of parr marks is a better indication of its being a salmon than is a count of these marks.

(ii) Relative size of various parts of the body

The ratio between the lengths from the tip of the snout to the mid-point of the eye and to the distal tip of the maxilla respectively, would appear to be the most reliable character for distinguishing between trout and salmon. The values for "t" obtained in t-tests of the differences between comparable length

groups of the two species were the largest found for any character, indicating a high degree of statistical significance.

The criteria set out by Jones (1947) are valid, and for the lay observer are to be preferred to the meticulous measurements and calculations employed here. The maxilla of the salmon seldom, if ever, extends beyond the pupil of the eye whilst it extends beyond this point in trout of the smallest length group.

The comparison becomes more marked with increasing size in trout, where the ratio increases to a maximum in the largest trout examined and the differences between trout of the four length groups are statistically significant.

Previous criteria relating to the relative thickness of the wrist of the tail in salmon parr have been confirmed, in that all salmon studied had a caudal peduncle thickness which was less than one-tenth the fork length of the fish. However, the ratio for trout was also found to be less than one-tenth the fork length and rarely, if ever, approached the value of 1 : 8 quoted by Jones (1947). The respective ratios found in this study are salmon 1 : 12 and trout 1 : 11 where the difference between the two species, although statistically significant, is not as great as was found in earlier studies.

An unexpected result obtained from a study of trout of different length groups is that the wrist of the tail becomes progressively thinner as the trout become larger. It is generally accepted that the wrist of large trout is so thick as to make it difficult to grasp the fish, whilst that of adult salmon is narrower. No accurate measurements of the wrists of adult salmon were available but Nall (1930) quotes a ratio of 1 : 15 for small grilse. It is probable, therefore, that salmon, like trout, show a reduction in the ratio of caudal peduncle thickness to total length with increasing size, and it is hoped that this will be confirmed in adult salmon and sea trout during 1966.

The degree of forking of the tail expressed as a ratio of the relative lengths of the longest and shortest tail rays conforms to Jones (1947) ratios (salmon $> 1.66 : 1$, trout $< 1.66 : 1$) when the lengths of the rays are measured to their roots. If measured only to the point where the rays disappear into the muscle of the caudal peduncle, the ratio for trout may be more than 1.66 : 1 (i.e. less than three-fifths), and thus gives a false salmon-like character. In the study of this character in trout of increasing size by either technique, it is apparent that the ratio increases, i.e. the forking of the tail should become more marked. Nall (1930, p. 198) states that the centre rays increase in length more rapidly than the outside rays, resulting in the tails of large trout becoming almost square, with little or no apparent forking. This is not confirmed by our techniques of measuring the lengths of the tail rays and our results can only be explained by assuming that the distal prolongation of the caudal peduncle becomes more pronounced with age, having the overall effect of reducing the forking of the tail, even though the centre tail rays are shorter by comparison with the outer rays than they were in the early life of the fish. There is some evidence for this theory from tracings of the tails of individual fish made in this study but considerable confirmatory work is necessary.

On the basis of the anomalous results described above, it is suggested that the measurement of tail rays may be an unsatisfactory technique for determining the degree of forking. A possible alternative would be to spread the tail "naturally" (involving subjective error) and measure the distance in to the fork of the tail from a line joining the two tips. This distance could then be expressed as a ratio of the fork length of the fish.

(iii) Counts of scales, fin rays and pyloric caeca

Although the modal values for the scale counts of salmon and trout have been confirmed to be 11 and 14 respectively, the range of individual values has been extended. Salmon in this study ranged from 10 to 14 (c.f. 10 to 13) and trout from 12 to 17 (c.f. 13 to 16). The overlap between the species in the values for this character is not excessive, occurring mostly at a count of 13. It is suggested that counts of 10, 11 and 12 may be considered a strong salmon character and counts of 14 or more equally strongly trout-like.

By contrast, the overlap between the species in the branched fin ray count is very considerable when over half the salmon and almost three-quarters of the trout had counts of 10 and 11. This means that two out of three fish in a mixed

sample would be likely to fall into this common range and on this basis, the branched ray character is likely to be of very little use in meristic studies. The range for each species has been found to be greater than that given by Jones (ibid) i.e. salmon 9 to 13 (c.f. 10 to 12) and trout 8 to 12 (c.f. 8 to 10). The large percentage of trout with a count of 11 is in contrast to Regan's (1911) results in which only 1% of trout had counts of 11.

A somewhat similar situation obtains in the counts of pyloric caeca in the two species. The range in each species has been found to be greater than that previously cited, viz.

Salmon 30 to 75 (c.f. 50 to 80)

Trout 25 to 60 (c.f. 30 to 60)

A considerable overlap is present, particularly in the range 40 to 55 where the average values for both species occur and it would seem doubtful whether the labour of counting caeca justifies the likely equivocal result.

GENERAL

In this study, two investigators worked independently on random samples of fish, with no counter-checking of results, with a view to determining the degree of subjective error likely for each specific character. Agreement was very good for three characters:—

- (i) Relative length of maxillae.
- (ii) Scale count.
- (iii) Pyloric caeca count.

In two further characters, individual means among the different length groups showed some variance. These were:—

- (a) Relative thickness of caudal peduncle.
- (b) Counts of branched rays in the dorsal fin.

Agreement was least good in the characters concerned with spotting of the body, the operculum and the dorsal fin. This was due to subjective variation in deciding upon what constituted a definitive spot.

Apart from the confirmatory work mentioned in the discussion above, it might be possible to secure further reliable specific characteristics by a study of, for example, the total scale count along the lateral line or the count of gill rakers. The latter character was dismissed as being of doubtful value by Regan (1911).

In the instances reported above where differences exist in the range of specific characteristics with those noted by other workers, it is possible that racial differences exist among the Salmonidae of Great Britain and Ireland. Some confirmation of this is becoming apparent in current physiological studies.

CONCLUSIONS

A survey has been made of accepted specific characteristics of young salmon and trout with special emphasis on degree of overlapping between the species, variation with increasing size of fish and liability to subjective error on the part of the observer. It is concluded that primary identification should be made on the basis of two characters:—

- (i) Relative length of the maxillae (salmon $> 1.10 : 1$; trout $< 1.20 : 1$).
- (ii) Scale count (salmon 12 and less; trout 14 and more).

Further characters are useful for confirmatory evidence but are liable to give false results if used for primary identification. These are:—

- (iii) Relative thickness of caudal peduncle (salmon $1 : 12$; trout $1 : 11$).
- (iv) Degree of forking of the tail (salmon $< 1.66 : 1$; trout $> 1.66 : 1$).

Spotting of body and fins is very variable and together with counts of the

branched fin rays of the dorsal fin and the pyloric caeca should only be used if the other characters listed above give no clear-cut result.

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IONTAOBHAS TAIGHDE BRADY
 (THE SALMON RESEARCH TRUST)
 REVENUE ACCOUNT for

1964	£	548	Traveling Expenses	151	151	311	£
		25	Audit Fee	103	103	25	
		59	Repairs and Maintenance of Property	464	103	464	
		7	Subscriptions	16	16	16	
		148	Miscellaneous Expenses	118	118	118	
		296	Motor Expenses	357	357	357	
		162	Legal Expenses	—	—	—	
		180	Depreciation : Motor Car and Van 20%	65	65	65	
		19	Furniture and Fittings 5%	19	19	19	
1,698							1,629
1,869							
		1,71	Salaries and Wages	2,755	2,755	2,755	
		328	Fish Rearing and Ova	298	298	298	
		347	Laboratory Expenses	235	235	235	
		94	Consumable Stores and Equipment	312	312	312	
		28	Depreciation :				
		415	Plant and Scientific Equipment 5%	94	94	94	
		28	Hatchery and Fish Pond 5%	28	28	28	
		415	Development Works 5%	415	415	415	
3,252							4,137
			Surplus				603
4,950							6,369

PEAT SILT RESEARCH
 FOR THE YEAR END

1964	£	1964	£	153			
		54	Administrative Expenses :				
		99	Traveling Expenses	139	139	1	
		614	Miscellaneous Expenses	1	1		
		20	Salaries, Fees and Wages	1,174	1,174		
		65	Consumable Stores	70	70		
		699	Depreciation :				
		653	Plant and Scientific Equipment	66	66		
			Hydrodynamic Survey on Peat Silt				
			Surplus 1964				
1,505							3,950

na h-EIREANN IONCORPORTHÁ
OF IRELAND (INCORPORATED)

Year ended 31st December, 1965

1,505		3,950
1964		
£		
1,000	Income, under Covenant by Arthur Guinness Son & Co. Ltd.	1,000
189	Contribution from Department of Lands ...	878
284	Contribution from Bord na Mona ...	1,316
32	Deposit Interest ...	66
—	Deficit ...	690

GROUP — REVENUE ACCOUNT
 31st DECEMBER, 1965

4,950		6,369
1964		
£		
3,000	Income under Covenant by Arthur Guinness Son & Co. Ltd.	3,925
1,000	Contribution from Department of Lands ...	1,922
210	Interest on 5% Transport Stock ...	210
21	Deposit Interest ...	39
100	Rent Received ...	100
—	Profit on Sale of Motor Vehicle ...	173
619	Deficit 1964 ...	—

1964 £
The Company is entitled to the income under
Covenants from Arthur Guinness Son & Co. Ltd,
as follows:—
(i) £6,200 per annum for 7 years from 24/8/65
(ii) £1,000 per annum for 7 years from 1/8/60

Fixed Assets:	Cost	Depreciation	Net
Hatchery and Fish Pond	566	256	310
Plant and Scientific Equipment	2,243	939	1,304
Furniture and Fittings	372	199	173
Motor Car and Van	1,167	72	1,095
Development Work	8,302	2,055	6,247
Fishing Rights	30	—	30
9,091	12,680	3,521	9,159

CURRENT ASSETS:							
Due by Department of Lands:	1,000	1,922	878	1,316	8	4,034	110
Salmon Research Trust	1,000	1,922	878	1,316	8	4,034	110
Peat Silt Research	284	1,316	878	1,316	8	4,034	110
British Income Tax recoverable	1,550	1,316	878	1,316	8	4,034	110
Sundry Debtors	8	1,316	878	1,316	8	4,034	110
Investment:	4,034	4,034	—	—	—	—	—
£4,200 5% Transport Stock 1970/75 (Market value £3,550)	4,034	4,034	—	—	—	—	—
Loan Account	110	—	—	—	—	—	—
Cash at Bank:	375	245	—	—	—	—	—
Salmon Research Trust	375	245	—	—	—	—	—
Peat Silt Research	274	245	—	—	—	—	—
Cash on Deposit:	746	2,647	—	—	—	—	—
Salmon Research Trust	746	2,647	—	—	—	—	—
Peat Silt Research	2,292	929	—	—	—	—	—
Cash on Hand	5	2	—	—	—	—	—
19,958	21,353	12,194	21,353	21,353	21,353	21,353	21,353

Signed: A. E. J. WENT }
 C. K. MILL }
 Members of the Committee of Management

counts of the Company and have obtained all the information and explanations
nt have been kept by the Company so far as appears from my examination of those
therewith, give in the manner prescribed by the Companies Act 1963 a true and
the surplus and deficit on the respective Revenue Accounts for the year ended

G. W. O'BRIEN,
Chartered Accountant,
Public Auditor.