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OBSERVATIONS ON THE FOOD OF FRESHWATER FISH FROM THE COAL AND JORDAN RIVERS, TASMANIA

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(with five tables)

ABSTRACT

The Coal and the Jordan Rivers are two slow-flowing rivers in south-eastern Tasmania. Details are given of the stomach contents of brown trout *Salmo trutta* Linnaeus, English perch *Perca fluviatilis* Linnaeus, short-finned eels *Anguilla australis occidentalis* Schmidt and Tasmanian smelt *Retropinna tasmanica* McCulloch collected from the Coal River and of the stomach contents of brown trout, English perch, tench, short-finned eels, freshwater flathead *Pseudaphritis urvilli* (Cuvier and Valenciennes) and galaxiids *Galaxias maculatus* (Jenyns) collected from the Jordan River.

INTRODUCTION

The food of trout in Australia has been studied by McKeown (1934a, 1934b, 1936, 1937, 1955), Evans (1942), Butcher (1945, 1946), Wilson (1966) and Knott (1973). However, there are few published data on the food of native freshwater fish or even of non-salmonid introduced fish. Butcher (1945, 1946) examined the food of Macquarie perch, *Macquaria australasica* (Cuvier & Valenciennes), English perch, *Perca fluviatilis* Linnaeus, blackfish, *Gadopsis marmoratus* (Richardson) and *Galaxias maculatus* (Jenyns). McKeown (1934a) recorded the food of six Macquarie perch and brief non-quantitative descriptions of the food of some native and introduced freshwater fish of New South Wales are given by Lake (1959). Recently Pollard (1973) has provided a detailed account of the diet of land-locked *Galaxias maculatus* in Lake Modewarre, Victoria. In Tasmania the food of tench *Tinca tinca* (Linnaeus) has been studied by Weatherley (1962) and the food of a few specimens of the Tasmanian blackfish (*G. marmoratus*) has been recorded by Knott (1973).

There are no published accounts of the food of freshwater eels in Australia, despite the fact that eels, mainly short finned eels *Anguilla australis occidentalis* Schmidt, are common in coastal streams of south-eastern Australia and Tasmania and are considered by many anglers to damage the trout fisheries. Such a situation contrasts with the situation in New Zealand where there has been a number of studies of the food of freshwater eels mainly of the long finned eel *Anguilla dieffenbachi* Gray (e.g. Cairns 1942, Allen 1951, Burnet 1952, 1969, Hopkins 1965, 1970, Cadwallader 1975). Cairns (1942) and Burnet (1952) have shown that the diets of the long finned eel and the short finned eel are rather similar.

The present study is of a preliminary nature only and provides some data on the food of introduced brown trout *Salmo trutta* Linnaeus, English perch and tench and of the native short finned eel, freshwater flathead *Pseudaphritis urvilli* (Cuvier & Valenciennes), Tasmanian smelt *Retropinna tasmanica* McCulloch and *Galaxias maculatus*.

THE RIVERS OF INTEREST

The Coal River rises near Tunnack, flows westward for about 24 km to pass close to Lake Tiberias, then flows southward for about 56 km to enter the sea at Pittwater, near

Richmond.

The Jordan River is the outflow of Lake Tiberias and flows in a north-westerly direction to Jericho where it then flows in a southerly direction for about 80 km through Melton Mowbray, Broadmarsh and Brighton to enter the Derwent estuary near Bridgewater.

Data on the water chemistry of the five sampling sites on the Coal River where fish were collected are presented in table 1.

Data on the water chemistry of four localities on the Jordan River are given in table 2.

The Jordan River is both more alkaline and more saline than the Coal River. Both rivers may be regarded as "hard" with respect to calcium concentrations (Williams 1964).

MATERIALS AND METHODS

Fish were collected with an electro-fishing machine, which was constructed from a design by Dr R.H.K. Mann of the Freshwater Biological Association, U.K. (pers. comm.). The design of the control switch circuitry was modified from that in the original plan. Power was provided by a Honda E800 U generator and the A.C. current was rectified to either a 50 P.P.S. or 100 P.P.S. pulsed D.C. current.

The fish from the five sampling sites of table 1 were collected on 10 October and 24 October 1974. Two other fish samples from the Coal River were collected on 3 October 1975 and 26 March 1976. Both of these samples were collected about three km upstream from Campania near the Brown Mountain Road station of table 1. Fish were collected from the Jordan River on 2 April 1976 near the property of "Cliftonvale" where the road from Elderslie crosses the river.

After capture the fish were individually labelled with a metal tag and preserved in five per cent neutral formalin. Fish longer than about 100 mm were slit along the ventral surface to allow formalin to enter the body cavity. Stomachs were later removed from the fish and the stomach contents identified and recorded using the numerical method (Windell 1971).

RESULTS

Details of the stomach contents of the fish collected in the Coal River on the three separate occasions, October 1974, October 1975 and March 1976, are given in table 3. At the times of sampling in October 1974 and March 1976 the river was clear and at the normal low summer level, while in October 1975 the Coal River was turbid and fast flowing after a heavy spate.

Although the collection dates differed and the conditions of the river at the times of the three collections differed, to give an overall indication of the diets of the various fish species collected from the Coal River, the data of the three collections are combined in table 4.

The porportion of empty stomachs of each fish species captured from the Coal River varied considerably. The incidence of empty stomachs was low in trout, perch and smelt whereas in tench and eels the incidence was much higher.

In the Coal River, amphipods (*Austrochiltonia australis* (Sayce) and *Paracalliope fluviatilis* (Thomson)) formed the main part of the diets of the three most abundant fish, namely trout, eels and perch. Trichopteran larvae, mostly of the family Leptoceridae, constituted an important part of the diet of trout and eels, while Ephemeroptera were prominent in the diets of perch and eels. Their habit of feeding in the still parts of the river is reflected in the diet of tench, with gastropods and ostracods, both found in still, weedy stretches of the river, being important in the diet. Although only a few smelt were collected, the data suggest that chironomid larvae are an important food for this species.

Details of the stomach contents of fish collected from the Jordan River are given in table 5. As in the Coal River samples, eels and tench from the Jordan River had a relatively high incidence of empty stomachs compared with fish such as trout and perch.

There were some notable differences between the food of fish from the Jordan and

Coal Rivers. In the Jordan River aquatic dipteran larvae, mostly chironomids, are important in the diets of trout, eels and galaxiids, although trichopteran larvae form an important part of the diet of trout, eels and tench in both rivers.

DISCUSSION

In the following discussion the conclusions can only be of a tentative nature since the numbers of fish examined, especially of *Retropinna tasmanica*, *Pseudaphritis urvilli* and *Galaxias maculatus*, were relatively low. All fish were collected in early- to mid-afternoon. The tench and eels were notable for the relatively high proportion of fish with empty stomachs which may be due to nocturnal feeding habits. In New Zealand streams, eels have been reported to be more active and to feed at night (Cairns 1942, Cadwallader 1975) and Burnet (1952) also suggested that eels, especially large eels, are spasmodic feeders. Tench may also be largely nocturnal feeders since Weatherley (1962) observed that at night tench schools disperse and individuals swim "in apparent independence of each other". This activity may be related to nocturnal feeding.

In both rivers the basic food of trout consisted of trichopteran larvae (especially the cased eruciform larvae), decapod shrimps (*Paratya tasmaniensis* Riek) and amphipods (*Austrochiltonia australis* and *Paracalliope fluviatilis*). In the Jordan River aquatic dipteran larvae (mostly Chironomidae) were the dominant food.

Eels appear to be opportunistic in their choice of food. In the Coal River amphipods and trichopteran larvae were the most important food items, whereas in the Jordan River trichopteran larvae and dipteran larvae were the most important food items. In both rivers, eels closely resemble trout in the major food items eaten. Whether interspecific competition is severe between the two species is difficult to say from such a preliminary study. In both rivers, trout and eels occupy different habitats; trout prefer areas where there is some current, whereas eels prefer weedy areas and areas with sunken logs and plant debris. Thus, although they may eat similar food items, they may largely avoid competition by inhabiting and feeding in different habitats in the same river, as suggested by Burnet (1969).

Butcher (1945) and Lake (1959) in Victoria and New South Wales respectively, found that the food of perch *P. fluviatilis* consisted mainly of Crustacea and insect larvae, mainly Trichoptera. In the Coal River, amphipods were the major food of perch while in the Jordan River trichopteran larvae were the most important food. Perch were mainly caught in still and slow-flowing parts of the rivers, often in weedy stretches.

Tench were only collected in weedy, still sections of the rivers; a habitat they prefer (Weatherley 1962). In the Coal River gastropods were their major food, while trichopteran larvae were their major food in the Jordan River. The food of tench from the two rivers is similar to that recorded by Weatherley (1959).

The food of the small number of Tasmanian smelt examined consisted predominantly of dipteran (Chironomidae) and trichopteran larvae. Lake (1971) reported that mainland Australian species of *Retropinna* feed on algae and plankton. In New Zealand Allen (1951) found that the food of a small sample of the smelt *Retropinna osmeroides* Hector was dominated by chironomid larvae and pupae. He concluded that the food of smelt in rivers is similar to that of young trout and that food competition may occur between the two species.

Pseudaphritis urvilli was only collected in the Jordan River from sections with a gravel substrate and a moderate current flow. Although only a few fish were examined it appears that *P. urvilli* is carnivorous with trichopteran larvae, *Paratya tasmaniensis*, amphipods and gastropods forming the major part of the diet.

The sample of *Galaxias maculatus* from the Jordan River fed on Cladocera, aquatic dipteran larvae (mainly Chironomidae), Hymenoptera (Formicidae) and Amphipoda in decreasing order of importance. Pollard (1973) investigated the diet of a land-locked population of *G. maculatus* inhabiting Lake Modewarre in south-western Victoria and found that the diet consisted mainly of amphipods, chironomid larvae and small crustaceans (copepods, cladocerans, ostracods). Butcher (1946), Allen (1951) and McDowall (1968) found that the diet of stream-dwelling *G. maculatus* was dominated by dipterans (mainly chironomid larvae and pupae).

This preliminary study indicates that the different fish species in the Coal and Jordan Rivers share a common food resource. For example, in the Coal River amphipods form an important part of the diets of trout, perch and eels, whereas in the Jordan River trichopteran larvae (eruciform) form an important part of the diets of trout, perch, eels, tench and freshwater flathead. It is conceivable that interspecific competition for food is occurring in the rivers, for example between trout and smelt, perch and trout.

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TABLE 1

Results of chemical analyses of Coal River water in October 1974

Locality	A	B	pH	Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	HCO_3^-	SO_4^-	Alkalinity mg/l
						μeq/l					
Baden	20	185	7.9	1,350	40	880	270	920	850	320	47.5
Brandy Bottom	34	247	8.6	1,430	50	1,900	430	1,400	1,110	310	67.5
Craigbourne Rd	46	270	8.5	1,520	51	1,900	510	1,610	1,230	230	85.0
Brown Mountain Road	58	306	8.6	1,570	54	1,880	530	1,780	1,280	270	100.0
Laburnum Park	67	298	8.0	1,630	49	1,380	530	1,720	1,310	270	100.0

A kilometres downstream from source

B $K_{18}\ \mu S\ cm^{-1}$

TABLE 2

Results of the analyses of some chemical features of Jordan River water

Locality	Total dissolved solids p.p.m.	pH	Na^+	K^+	Ca^{++}	Mg^{++}	Cl^+	HCO_3^-	Alkalinity p.p.m.
					μeq/l				
Lake Tiberias[1]	463.6	7.6	4350	1024	130	2166	7360	2160	
Jordan River[2] (Jericho)	744-1345	7.4-8.1	-	-	-	-	-	-	194-396.5
Jordan River[2] (Pontville)	644	8.0	-	-	-	-	-	-	222
Jordan River[2] (Brighton)	622-1072	7.8-8.0	-	-	-	-	-	-	85.4-322.0

(1) Buckney and Tyler (1973)

(2) Williams (1964)

TABLE 3

Stomach contents of fish collected from the Coal River in October 1974, October 1975 and March 1976

Species of fish		*Salmo trutta*			*Anguilla australis*			*Perca fluviatilis*			*Tinca tinca*			*Retropinna tasmanica*
Date		October 1974 n = 20; e = ?	October 1975 n = 6; e = 0	March 1976 n = 5; e = 0	October 1974 n = 5; e = ?	October 1975 n = 13; e = 9	March 1976 n = 50; e = 21	October 1974 n = 7; e = ?	October 1975 n = 13; e = 4	March 1976 n = 6; e = 1	October 1974 n = 6; e = ?	October 1975 n = 18; e = 15	March 1976 n = 1; e = 1	October 1974 n = 6; e = ?
Food item														
Annelida:	Oligochaeta (aquatic)	53	-	-	41	-	-	-	-	-	2	-	-	-
	Oligochaeta (terrestrial)	-	1	-	-	4	-	-	1	-	-	-	-	-
Crustacea:	Cladocera	-	-	-	10	-	-	-	-	-	-	-	-	-
	Ostracoda	-	-	-	-	-	3	-	-	-	156	-	-	-
	Amphipoda	672	20	258	92	33	113	850	215	291	8	14	-	7
	Isopoda (Phreatoicidea)	5	-	-	-	-	7	-	-	-	-	-	-	-
	Decapoda *(Paratya tasmaniensis)*	533	1	10	-	3	10	7	59	17	-	-	-	-
Insecta:	Ephemeroptera (nymphs)	4	-	-	46	-	3	214	12	-	22	-	-	-
	Plecoptera (nymphs)	80	-	-	22	1	-	29	2	-	3	-	-	-
	Odonata: Zygoptera (nymphs)	-	2	-	-	-	1	1	-	3	8	-	-	-
	Anisoptera (nymphs)	7	2	-	4	-	-	-	-	-	3	-	-	-
	Dermaptera	-	2	-	-	-	-	-	-	-	-	-	-	-
	Orthoptera	-	-	1	-	-	1	-	-	-	-	-	-	-
	Hemiptera (aquatic)	55	5	5	1	-	-	1	9	4	4	-	-	1
	Coleoptera (aquatic) larvae	26	-	-	1	-	-	1	-	-	9	-	-	5
	Coleoptera (terrestrial) adults	-	1	-	-	-	-	-	-	-	-	-	-	-
	Coleoptera (aquatic) adults	-	4	1	1	-	-	-	-	-	-	-	-	-
	Lepidoptera (aquatic) larvae	-	-	-	-	-	5	-	-	-	-	-	-	-
	Trichoptera larvae	500	321	-	58	-	3	7	3	5	129	2	-	20
	Hymenoptera, Formicidae	2	-	-	-	-	-	1	-	-	-	-	-	-
	Diptera (aquatic) larvae	15	2	6	18	-	11	52	5	3	26	-	-	23
	Diptera (adults)	25	-	-	-	-	-	-	-	-	-	-	-	6
Arachnida:	Hydracarina	2	-	-	2	-	-	-	-	-	-	-	-	-
Mollusca::	Bivalvia	-	-	-	-	-	1	-	-	-	-	-	-	-
Chordata :	Anura	2	-	-	-	-	-	-	-	-	-	-	-	-
Total number of food items:		2,273	363	282	299	41	162	1,164	306	323	870	16	-	62

n = number of fish examined e = number of fish with empty stomachs

TABLE 4

Summary of stomach contents of fish captured from Coal River in October 1974, October 1975 & March 1976

		Salmo trutta % n = 30	*Anguilla australia* % n = 68	*Perca fluviatilis* % n = 36	*Tinca tinca* % n = 25	*Retropinna tasmanica* % n = 6
Annelida:	Oligochaeta (aquatic)	1.82	8.17	-	0.23	-
	Oligochaeta (terrestrial)	.03	.80	.05	-	-
Crustacea:	Cladocera	-	1.99	-	-	-
	Ostracoda	-	.60	-	17.61	-
	Amphipoda	32.55	47.41	75.62	2.48	11.29
	Isopoda (Phreatoicidea)	.17	1.39	-	-	-
	Decapoda *(Paratya tasmaniensis)*	18.64	2.59	4.63	-	-
Insecta:	Ephemeroptera (nymphs)	.14	9.76	12.60	2.48	-
	Plecoptera (nymphs)	2.74	4.58	1.73	.33	-
	Odonata:					
	Zygoptera (nymphs)	.10	.40	.22	.90	-
	Anisoptera (nymphs)	.31	.80	-	.34	-
	Dermaptera	.06	-	-	-	-
	Orthoptera	.03	.20	-	-	-
	Hemiptera (aquatic)	2.23	.20	.78	.45	1.61
	Coleoptera (aquatic) larvae	.89	.20	.05	1.02	8.06
	Coleoptera (terrestrial) adults	.03	-	-	-	-
	Coleoptera (aquatic) adults	.17	.20	-	-	-
	Lepidoptera (aquatic) larvae	-	1.00	-	-	-
	Trichoptera larvae	28.14	12.15	.84	14.79	32.26
	Hymenoptera, Formicidae	.06	-	.05	-	-
	Diptera (aquatic) larvae	.79	5.78	3.35	2.93	37.09
	Diptera (adults)	.86	-	-	-	9.67
Arachnida:	Hydracarina	.06	.40	-	-	-
Mollusca:	Bivalvia	-	.20	-	-	-
	Gastropoda	10.07	1.00	.05	56.43	-
Amphibia:	Anura	.06	-	-	-	-

% = percentage of total number of food items

n = number of fish examined

TABLE 5

Details of the stomach contents of fish collected from the Jordan River on 2 April 1976

	Salmo Strutta n = 58 e = 9		*Anguilla australis* n = 91 e = 59		*Perca fluviatilis* n = 22 e = 5		*Tinca tinca* n = 27 e = 17		*Pseudaphritis urvilli* n = 8 e = 4		*Galaxias maculatus* n = 8 e = 1	
		%		%		%		%		%		%
Annelida: Oligochaeta (aquatic)	1	.22	-	-	-	-	-	-	-	-	-	-
Crustacea:												
Cladocera	2	.43	3	3.37			-	-	-		10	45.45
Ostracoda	-	-	-	-	3	4.28	-	-	-	-	1	4.54
Amphipoda	72	15.65	10	11.23	3	4.28	-	-	7	19.44	2	9.09
Isopoda (Phreatoicidea)	1	.22	1	1.23	2	2.85	-	-	-	-	-	-
Decapoda *(Paratya tasmaniensis)*	36	7.82	11	12.36	13	18.57	-	-	12	33.33	-	-
Insecta: Thysanura	9	1.95	1	1.23	3	4.28	-	-	-	-	-	-
Ephemeroptera (nymphs)	4	.87	-	-	-	-	-	-	1	2.77	-	-
Hemiptera (aquatic)	10	2.17	4	4.49	7	10.00						
Hemiptera (terrestrial)	1	.22	-	-	-	-	-	-	-	-	-	-
Coleoptera larvae (aquatic)	-	-	6	6.74	-	-	1	2.08	-	-	-	-
Coleoptera adults (aquatic)	1	.87	-	-	-	-	-	-	-	-	1	4.54
Coleoptera adults (terrestrial)	3	.65	-	-	-	-	-	-	-	-	-	-
Trichoptera larvae (eruciform)	59	12.83	21	23.59	38	54.29	44	91.66	12	33.33	1	4.54
Trichoptera larvae (campoderiform)	44	9.57	7	7.87	-	-	-	-	2	5.55	-	-
Trichoptera adults	4	.87	-	-	-	-	-	-	-	-	-	-
Hymenoptera Formicidae	14	3.04	-	-	1	1.43	3	6.25	-	-	2	9.09
Diptera larvae (aquatic)	169	36.74	12	13.48	-	-	-	-	-	-	3	13.64
Diptera larvae (terrestrial)	4	.87	12	13.48	-	-	-	-	-	-	-	-
Diptera adults	13	2.83	-	-	-	-	-	-	-	-	1	4.54
Arachnida: Araneae	1	.22	-	-	-	-	-	-	-	-	-	-
Mollusca: Gastropoda	9	1.95	1	1.23	-	-	-	-	2	5.55	-	-
Total number of food items:	460		89		70		48		36		22	

n = number of fish examined e = number of fish with empty stomachs % = percentage of total number of food items