

AUSTRALIAN MUSEUM SCIENTIFIC PUBLICATIONS

McKeown, Keith C., 1934. Notes on the food of trout and Macquarie Perch in Australia. *Records of the Australian Museum* 19(2): 141–152, plate xvii. [26 March 1934].

doi:10.3853/j.0067-1975.19.1934.694

ISSN 0067-1975

Published by the Australian Museum, Sydney

nature culture **discover**

Australian Museum science is freely accessible online at
<http://publications.australianmuseum.net.au>
6 College Street, Sydney NSW 2010, Australia



NOTES ON THE FOOD OF TROUT AND MACQUARIE PERCH IN AUSTRALIA.

By

KEITH C. McKEOWN.

(Assistant Entomologist, The Australian Museum, Sydney.)

(Plate xvii.)

Introduction.

ALTHOUGH of considerable economic value to those engaged in establishing trout in our rivers, and of the greatest interest to anglers, no information appears to have been published regarding the food of trout in Australia. It has been with the intention, therefore, of securing data on this subject that fish stomachs have been procured from time to time, as opportunity permitted, and their contents examined and listed.

Sufficient information has now been secured to warrant the publication of a preliminary paper, and it is hoped that additional material will come to hand to enable further work to be carried out. A very much larger series of stomachs is required, from as many localities as possible and secured over an extended period, before any definite conclusions can be drawn from the results.

Realizing the diversity of tastes of the trout, and that they will feed upon practically any small animals which may come within their reach, and that the presence or absence of any organism is dependent upon climatic and other conditions, I have refrained, as far as possible, from expressing opinions, other than tentatively, simply setting out the results obtained in the hope that future work will enable a fairly exact estimate to be arrived at as to the constitution of trout-foods in Australia.

Although no work has been carried out in Australia to date, much valuable research has been achieved in New Zealand, notably by G. V. Hudson, J. S. Phillips, E. Percival, W. J. Phillipps, and A. W. Parrott.

The question of the decline of trout-fishing, and the depletion of aquatic life in trout-streams has not, as yet, arisen in Australia, but this aspect of the question has given a great impetus to research in fish-foods in New Zealand.

Considerable interest attaches to the composition of trout-food from a purely biological point of view, since the trout is an exotic species introduced into a strange environment, with consequent reaction upon the native fauna and disturbance of the balance of nature which has been so marked in the case of certain terrestrial animals imported into Australia. We have, as yet, no knowledge of a definite nature of the effect upon the aquatic fauna of those streams in which trout have been liberated.

An examination of the contents of trout stomachs from several localities in New South Wales indicates that by far the greater proportion of the insects are terrestrial species which have fallen or been blown into the water from the surrounding vegetation and have been snapped up as they struggled on the surface. On examining the list of genera eaten it would appear that nothing really comes amiss as food. Size of the prey seems to play but a small part in the choice of insects taken by the trout, since small insects, as the Rutherglen Bug (*Nysius vinitor*), are taken with quite as much readiness as large ones.

The New Zealand data show that by far the most important trout-food in the Dominion is provided by the aquatic Neuropteroid insects, but, with the exception of the caddis-flies (Trichoptera), these insects form but a very small proportion of the food of the Australian fish, the most important component in which is undoubtedly the terrestrial insects, chiefly Hymenoptera, Orthoptera, and Coleoptera. This is strongly brought out by the following table, adapted from Phillips¹, showing the food of trout taken in the Wellington Province, N.Z.

Summary of Trout Stomachs.

—	1927-28.	1928-29.	Mr. G. V. Hudson (1899-1902) for Comparison.
Number of stomachs: ...	48	42	60
Trichoptera	6,217	6,847	4,804
Ephemeroptera	661	832	529
Plecoptera	21	27	16
Sialoidea	58	69	18
Diptera	65	111	42
Coleoptera	54	23	590*
Hemiptera	16	11	23
Hymenoptera	4	3	4
Lepidoptera	1	...	...
Orthoptera .....	...	2	3
Arachnida	1	7	4
Crustacea	4	43	1
Mollusca	740	921	21
Oligochæta	2	15	0

* Due to one special case of 500 *Hydora*.

For comparison the total numbers of insects of the same Orders from the stomachs of Rainbow Trout taken in Australian rivers are summarized hereunder:—

Stomach Contents of Rainbow Trout, N.S.W.

Number of stomachs ...	...	...	...	...	...	...	38
Trichoptera ...	...	...	...	...	...	...	170
Ephemeroptera ...	...	...	...	...	...	...	7
Plecoptera ...	...	...	...	...	...	...	3
Sialoidea ...	...	...	...	...	...	...	—
Diptera ...	...	...	...	...	...	...	23
Coleoptera ...	...	...	...	...	...	...	130
Hemiptera ...	...	...	...	...	...	...	81
Hymenoptera ...	...	...	...	...	...	...	695
Lepidoptera ...	...	...	...	...	...	...	8
Orthoptera ...	...	...	...	...	...	...	401
Arachnida ...	...	...	...	...	...	...	12
Crustacea ...	...	...	...	...	...	...	42
Mollusca ...	...	...	...	...	...	...	26
Oligochaeta ...	...	...	...	...	...	...	4

¹ Phillips, J. S.—A Report on the Food of Trout and other Conditions Affecting their Well-being in the Wellington District. Fisheries Bull. No. 2, N.Z. Marine Dept. Wellington, N.Z., 1929, p. 24.

Altogether the stomach contents of forty-four trout have been examined and the preferences of individual fish for certain orders is summarised as follows:— Of 37 stomachs of Rainbow Trout examined, 24 contained Coleoptera, 16 Hemiptera, 24 Hymenoptera, 7 Neuroptera, 14 Orthoptera, 23 Trichoptera, 6 Lepidoptera, 18 Odonata, 1 Sialoidæ, 5 Ephemeroptera, 11 Diptera, 1 Thysanoptera, 1 Perlaria, 8 Araneidæ, 2 Vermes, 3 Crustacea.

Of 6 stomachs of Brown Trout examined, 5 contained Coleoptera, 5 Hemiptera, 5 Hymenoptera, 4 Orthoptera, 4 Trichoptera, 1 Lepidoptera, 6 Odonata, 4 Diptera, 4 Araneidæ, 1 Vermes, 3 Crustacea.

Of 6 stomachs of Perch examined, 2 contained Coleoptera, 3 Hemiptera, 2 Hymenoptera, 1 Neuroptera, 1 Orthoptera, 4 Trichoptera, 2 Lepidoptera, 2 Ephemeroptera, 2 Vermes.

I have as far as possible presented a summary of the stomach contents in tabular form for ease of reference to meet the needs of those consulting the paper, but I have also given the contents of each stomach in full detail, since they form a basis showing the food of individual fish, which can be added to from time to time as the work proceeds. Before the food of any particular species of fish can be rightly assessed a large number of individuals must be examined in detail, and to enable the results of previous workers to be added to those of later investigators the full data as regards individual fish must be available, since a summary of the food of a species will not necessarily indicate the proclivity of individuals of that species to feed upon a particular food.

The calculation of percentages by number of any insect food of fish appears to be of but little value in assessing its importance, since one large insect, as a grasshopper, is equal in bulk to many individuals of a small insect—for example, Caddis flies.

On account of the importance of the environment as a factor in any consideration of the food of fish, I include field notes of considerable value in this regard, relating to the Tuross River, supplied by Dr. A. J. Spiller Brandon:—

“The Tuross River, in which these fish were caught, rises near Nimmitabel on the eastern side of the Divide, and for many miles is shallow and overgrown with tea tree. Its first fishable portion runs through fairly open country 9 miles S.E. of Countegany. This portion is bordered with tea trees and gums, and the banks are covered with tussocky grass. It was along a 3-mile stretch of this portion that the fish were caught. The altitude was 3,700 feet. The river is slow running and wide stretches of weed grow along the sides, and the bottom is also heavily weeded.

“Just before my arrival there had been a freshet in the river, but the water was quite clear. The weather was warm with westerly winds for the first few days, April 8th to 10th, but from then until the 15th it was bitterly cold with high south-west gales. The 16th and 17th were warm still days.

“*Insects.*—Grasshoppers were very few until the last two days. Before the 10th a few Mayflies were seen floating on the water, and were taken readily by the fish. On the evening of the 8th and 9th fish were rising everywhere, the water being covered with a small black insect.

“As the Rainbow and Brown Trout were caught in the same stretch of water it would be interesting to note whether the stomachs of the Brown Trout contain more surface insects than those of the Rainbow.”

In addition to data on the food of both Rainbow and Brown Trout, I have included details of the stomach contents of six Macquarie Perch (*Macquaria australasica*) from the Goodradigbee River, which indicate that its feeding habits are very similar to those of the trout.

I am indebted to Dr. C. Anderson, M.A., Director, Australian Museum, Sydney, Dr. A. J. Spiller Brandon, and Mr. A. C. Ebsworth, of Sydney, for considerable trouble taken by them in collecting the stomachs for examination, and for supplying me with much valuable information. My thanks are also due to my colleagues, Messrs. G. P. Whitley and T. Iredale, for identifying material and for much valuable assistance in the preparation of this paper.

Food of Trout.

Hymenoptera.

Ants formed by far the predominating item of trout food in the stomachs examined, and in the case of the fish from the Tuross and Big Badja Rivers the ants were apparently engaged in their nuptial flights, since the greater percentage were winged males and females, which had fallen or been blown into the water where they had been eaten by the fish. In addition to the winged ants, however, there were many workers and soldiers, which had apparently dropped from the overhanging vegetation. In the case of one large specimen of the Bull-dog ant (*Myrmecia gulosa*) it had been swallowed while living, and its mandibles were deeply buried in the stomach wall of the trout and required considerable force to disengage them. As this ant is possessed of an extremely potent sting, it may have made its presence felt in an unexpected manner. The principal genera represented were the Sugar Ants (*Camponotus*), the Bull-dog Ants (*Myrmecia*), and the Meat Ant (*Iridomyrmex detectus*), together with other species of the genus.

The Thynnid wasps found in the stomach contents were, for the most part, apparently taken *in cop.*, for in most cases the males and females in each stomach were in equal numbers. The female Thynnid wasp is wingless and is carried about by the male while pairing.

Several specimens of a Paper-nest Wasp (*Polistes* sp.) were found. The most prevalent Ichneumon was the common *Paniscus productus*, a large reddish species widely distributed throughout Australia. Bees of several species occurred in small numbers, while other members of the order were negligible.

Orthoptera.

Locusts or Short-horned Grasshoppers (*Acridiidae*), both mature and immature, form a very large proportion of the stomach contents, and on the evidence available appear to be the most important item of trout food in those seasons when they are available in the larval and nymphal stages. The insects are fairly bulky and would appear to have a high food value, since they are preyed upon by birds almost exclusively when they are available. A total of 267 grasshoppers, all practically intact, together with a quantity of broken remains, was taken from the stomach of one Rainbow Trout captured in the Big Badja River, New South Wales. The strongly muscular walls of the stomach of this fish were distended with food to such an extent that the membrane was almost transparent and little thicker than paper. Other fish had fed largely upon grasshoppers.

Trichoptera.

The next food of importance, disclosed by an examination of the stomach contents, was the Caddis-flies, which proved to be the only aquatic Neuropteroid insects preyed upon in sufficient numbers to be considered of economic importance. This is quite contrary to the New Zealand data, which prove them to be the staple food of trout in the Dominion. The majority of the Caddis cases found were constructed of sand grains (Sericosmatidæ), while those formed by tunnelling in twigs and portions of the stems of aquatic plants (Leptoceridæ) were much less numerous.

Coleoptera.

Beetles form a considerable portion of the food of trout in New South Wales, especially members of the Scarabæidæ. The small species of the genera *Phyllotocus* and *Heteronyx* frequently occur in summer on the flowers of the tea-trees, from which they fall into the water and are eaten by the fish. Dung beetles (*Onthophagus* spp.) occurred in small numbers, apparently meeting with disaster in the water while flying. Dryopidæ and their larvæ, in spite of their small size, appear to be relished by both trout and perch. Carab beetles (Carabidæ), weevils (Curculionidæ), and Chrysomelidæ were present somewhat rarely, and Water beetles (Dytiscidæ and Gyridæ) were found only in small numbers and are not nearly as numerous as one would expect.

Hemiptera.

Aquatic bugs were found in the stomachs fairly frequently, especially the Water-striders (Gerridæ), small dark slate-grey insects, which run rapidly over the surface of the water, but in spite of the swiftness of their movement fall a prey to the fish. Water-boatmen (Notonectidæ) and Back-swimmers (Corixiidæ) were present in several instances. The terrestrial plant bug (Pentatomidæ, etc.) and tree-hoppers (Jassidæ), were found but rarely, and their occurrence is probably more or less accidental, they having been picked up from the surface of the water together with other insects.

Diptera.

The order Diptera includes a number of families which contain species with aquatic larvæ, such as the mosquitoes (Culicidæ) and the Chironomid midges (Chironomidæ), both of which are possibly of value as fish food, especially in the case of young fish, although they were present but rarely in the stomachs examined.

A remarkable feature of the trout stomachs from the Tuross River was the number of the curious Stratiomyid fly (*Boreoides subulatus*) present. The females of this fly are wingless, but the males are furnished with well-developed wings; they occur in the higher elevations of New South Wales. Nothing seems to have been recorded with reference to their life history, but from their presence in the fish stomachs it would appear probable that their larvæ are aquatic, as in certain other members of the genus, and that the flies fall a prey to the fish when emerging.

Odonata.

The larvæ and nymphs of both Anisopterid and Zygopterid dragon-flies occur constantly, but in small numbers, in the stomach contents of trout, together with a few of the adult insects, but they do not appear to constitute an important item of their food. Tillyard² states that in certain parts of New Zealand he found dragon-fly larvæ to be the principal food of trout.

² Tillyard, R. J.—Report on Neuropteroid Insects of the Hot Springs Region, N.Z., in relation to the Problem of Trout Food. Proc. Linn. Soc., N.S.W., XIV, 1920, pp. 205-213.

Crustacea.

Small fresh-water shrimps (*Paratya australiensis*) were found in some of the stomachs examined, and are apparently an excellent food for trout. Of the fresh-water crayfish or "Yabbie" (*Parachærops bicarinatus*), two examples only were found in the stomach of a 5-lb. Brown Trout from the Tuross River.

Mollusca.

Several stomachs contained a considerable number of snails of the genus *Bullinus*, apparently gathered from aquatic weed or the bottom of the stream.

The Stomach Contents of the Rainbow Trout.

(*Salmo irideus*.)

Stomach contents of Rainbow Trout taken by Dr. C. Anderson, Australian Museum, Sydney. Goodradigbee River, New South Wales, January, 1931.

- No. 1.—Coleoptera: 3 Scarabæid beetles, 2 Click beetles (Elateridæ), 7 beetles (Chrysomelidæ). Hemiptera: 3 plant bugs (Pentatomidæ), 2 plant bugs (Coreidæ), 1 tree hopper (*Eurymeloides* sp.), 1 Corixiid. Hymenoptera: 9 ants (*Camponotus* sp.), 3 ants (unidentifiable), 1 bee (? *Hylæus* sp.), 1 Ichneumon wasp (*Paniscus* sp.). Neuroptera: Remains of a Neuropteroid insect. Vegetable matter: A quantity of vegetable matter.
- No. 2.—Coleoptera: 6 Scarabæid beetles (*Phyllotocus* sp.), 1 weevil (Curculionidæ). Hemiptera: 1 water strider (*Gerris* sp.). Hymenoptera: 2 bees (? gen.). Diptera: Unidentifiable remains.
- No. 3.—Coleoptera: 5 Dryopid beetle larvæ. Hymenoptera: 5 ants (*Camponotus* sp.), 2 ants (unidentifiable), 1 Ichneumon wasp (*Paniscus* sp.). Orthoptera: 1 grasshopper (Acridiidæ, immature) and a quantity of broken remains. Trichoptera: 1 skin of a caddis larva and remains of caddis cases. Araneidæ: 1 spider.
- No. 4.—Coleoptera: 1 Scarabæid beetle (*Diphucephala* sp.), 1 weevil (Curculionidæ), 6 beetles (Dryopidæ). Lepidoptera: 3 Lepidopterous larvæ.
- No. 5.—Hemiptera: 2 water striders (*Gerris* sp.). Trichoptera: 1 caddis case. Neuroptera: 1 Neuropteroid larva. Miscellaneous: Sand and gravel.
- No. 6.—Coleoptera: 12 Scarabæid beetles (*Phyllotocus* sp.). Hemiptera: 3 plant bugs (unidentifiable). Hymenoptera: 1 Ichneumon wasp, (? gen.). Odonata: 2 Zygopterid dragon-flies. Araneidæ: 1 spider.
- No. 7.—Coleoptera: Unidentifiable remains, mostly Scarabæidæ. Hymenoptera: 1 small wasp. Odonata: 1 Zygopterid dragon-fly. Sialidæ: Unidentifiable remains of Alder flies. Vegetable matter: A quantity of vegetable matter.
- No. 8.—Coleoptera: 5 Dryopid beetle larvæ. Hemiptera: 3 jassids (immature). Hymenoptera: 3 Ichneumonoid wasps, 1 ant. Trichoptera: 2 caddis flies (mature) and 4 caddis cases. Ephemeroptera: 1 May-fly larva. Odonata: 1 Zygopterid dragon-fly. Miscellaneous Insects: 3 aquatic larvæ (? group). Araneidæ: 1 spider.
- No. 9.—Hemiptera: 1 plant bug (immature). Hymenoptera: 3 ants (unidentifiable). Odonata: 1 Anisopterid dragon-fly nymph, 1 Zygopterid dragon-fly nymph. Orthoptera: 1 grasshopper (Acridiidæ). Diptera: 2 Chironomid pupæ. Neuroptera: 9 Neuropterous larvæ.

Summary of Stomach Contents of Rainbow Trout (*Salmo irideus*).

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38			
Coleoptera	Scarabaeidae	3	6		1		12	*						4	13		5				1				1	21		3		3		1					17	2				
	Elateridae	2																																								
	Chrysomelidae	7																																								
	Curculionidae		1		1												1										3		1													
	Dryopidae			5	6					5				17		3			8	7		26			1		1															
	Carabidae														2	2																										
	Lampyridae														2	1																										
	Tenebrionidae																																									
	Dytiscidae																												8													
	Buprestidae																							1																		
	Mordellidae																																									
	Gyrinidae																																									
	Cerambycidae																																									
	Unidentifiable								*									*		*																						
	Hemiptera	Pentatomidae	3					3																1				1												1	14	
		Coreidae	2																																						2	
		Jassidae	1								3																															8
Corixidae		1																																						7		
Notonectidae																																								3		
Gerridae			1				2																																	5		
Lygaeidae																																								3		
Cydnidae																																								3		
Unidentifiable											1	1																													3	
Hymenoptera		Formicidae	12		7					1	3					4	8	1	5		5	4						2		2	2	104	3	96		1			3	2	660	
		Apidae	1	2												2	2	1	1									1		2										10		
		Ichneumonidae	1		1			1		3						2	1																							13		
		Vespidae						1											2																					3		
	Braconidae																																						6			
	Thynnidae																																						1			
	Chalcididae																																						1			
	Unidentifiable																																						25			
Orthoptera	Acridiidae	1		1						9																			2	267		79	27		7		6	4	399			
	Gryllidae													2		8	7	3	3		4	1		2	9	4	4	2	1		2	3	5		1		1	2				
Trichoptera			1		1			6																															170			
Lepidoptera	Noctuidae														1	1																							6			
	Unidentifiable					3																																	2			
Odonata	Anisoptera																																						36			
	Zygoptera						2	1	1	1	1				*	*	1																						10			
Sialidae																																							7			
Ephemeroptera																																							2			
Diptera	Chironomidae																																						1			
	Syrphidae																																						1			
	Culicidae																																						3			
	Muscidae																																						1			
	Tipulidae																																						12			
Thysanoptera	Mycetophyllidae																																						3			
	Unidentifiable	*																																					1			
	Perlaria																																						3			
Miscellaneous Insects	Fragments																																						16			
	? Group			1			1		1				12																										12			
Araneidae																																							4			
Vermes	Crustacea																																						42			
																																							26			
Mollusca																																										
Miscellaneous	Sand and gravel					*																																				
	Algae																																									
	Bark and twigs																																									
	Unidentified veg. matter	*						*																																		
Feathers, etc.																																										
																																							1,759			

- No. 10.—Hemiptera : 1 small Hemipteron. Odonata : 1 Anisopterid dragon-fly nymph, 1 Zygopterid dragon-fly nymph. Ephemeroptera : 1 May-fly nymph. Miscellaneous insects : 1 aquatic larva ?
- No. 11.—Miscellaneous : Sand and gravel only.
- No. 12.—Coleoptera : 17 Dryopid beetle larvæ. Trichoptera : 2 caddis cases. Odonata : 1 Anisopterid dragon-fly nymph. Miscellaneous insects : 12 aquatic larvæ ?
- Stomach contents of Rainbow Trout taken by Dr. C. Anderson, Australian Museum, Sydney. Goodradigbee River, New South Wales, 6 miles above Wee Jasper, December, 1931.
- No. 13.—Coleoptera : 4 Scarabæid beetles (*Phyllotocus navicularis*), 2 Carab beetles (*Clivinia* sp.), 2 soldier beetles (*Telephorus* sp.), 1 Caraboid beetle larva. Hymenoptera : 2 Ichneumon wasps (*Paniscus productus*), 3 ants (*Camponotus nigriceps*), 1 ant (*Iridomyrmex detectus*). Lepidoptera : 1 Bugong moth (*Agrotis infusa*). Perlaria : 3 stone flies and a large quantity of wing remains. Odonata : A large quantity of wings of Zygopterid dragon-flies. Diptera : Wing remains. Ephemeroptera : Wings. Miscellaneous insects : A quantity of unidentifiable insect remains. Vegetable matter : Algæ.
- No. 14.—Coleoptera : 1 beetle and 2 larvæ (Dryopidæ), 1 soldier beetle (*Telephorus* sp.), 1 beetle (*Chalcopterus* sp.), 10 Scarabæid beetles (*Phyllotocus navicularis*), 3 Scarabæid beetles (*Heteronyx* sp.), 2 Carab beetles (*Clivinia* sp.), and a quantity of unidentifiable beetle remains. Hemiptera : 2 unidentifiable bugs (Pentatomidæ), 2 plant bugs (*Echalia schellenbergii*), 1 *Dictyophora* sp., 1 tree hopper (*Eurymela* sp.), 1 jassid, 2 water striders (*Gerris* sp.). Hymenoptera : 2 bees (*Halictus* sp.), 8 ants (unidentifiable), 1 Ichneumon wasp (unidentifiable). Lepidoptera : 1 Noctuid moth. Diptera : 1 Syrphid fly, and a quantity of Dipterous remains. Trichoptera : 8 caddis cases. Odonata : Wings of Zygopterid dragon-flies. Araneidæ : 1 Salticid spider.
- No. 15.—Coleoptera : 1 *Rhantus pulverosus*. Hymenoptera : 1 ant (*Camponotus nigriceps*). Trichoptera : 73 caddis cases. Odonata : 1 Zygopterid dragon-fly. Diptera : Quantity of unidentifiable insect remains.
- No. 16.—Coleoptera : 5 Scarabæid beetles (*Phyllotocus navicularis*), and unidentifiable beetle remains. Hymenoptera : 2 wasps (*Polistes variabilis*), 4 ants (*Camponotus nigriceps*), 1 ant (*Amblyopone* sp.), 1 bee (*Halictus* sp.). Orthoptera : 1 grasshopper (immature). Trichoptera : 3 caddis cases. Ephemeroptera : Remains of May-flies. Vegetable matter : Algæ.
- No. 17.—Coleoptera : 8 Dryopid beetle larvæ. Trichoptera : 3 caddis cases. Miscellaneous : Quantity of sand and gravel.
- No. 18.—Coleoptera : 5 beetles and 2 larvæ (Dryopidæ), 1 Caraboid larva. Hymenoptera : 4 ants (*Iridomyrmex detectus*), 1 ant (*Ectatomma metallicum*). Orthoptera : 1 grasshopper (immature). Lepidoptera : 1 moth (unidentifiable). Miscellaneous insects : A small quantity of unidentifiable insect remains.
- No. 19.—Hymenoptera : 3 ants (*Camponotus nigriceps*), 1 ant (unidentifiable). Diptera : 1 crane fly (Tipulidæ). Trichoptera : 4 caddis cases. Neuroptera : 1 lacewing (*Chrysopa* sp.). Miscellaneous insects : A small quantity of unidentifiable insect remains. Miscellaneous : Small quantity of sand and gravel.

- No. 20.—Coleoptera : 26 Dryopid beetle larvæ, 1 Scarabæid beetle (*Phyllotocus* sp.). Odonata : 1 Anisopterid dragon-fly larva and the mask of another. Trichoptera : 1 caddis case. Neuroptera : 5 Neuropterous larvæ.
- No. 21.—Vermes : 2 Gordian worms. Miscellaneous : A small quantity of unrecognizable animal and vegetable matter.
- No. 22.—Coleoptera : 1 water beetle. Hemiptera : 1 plant bug. Hymenoptera : 1 Braconid wasp. Trichoptera : 2 caddis cases. Diptera : 1 mosquito (*Megarrhinus* sp.), 1 Dipterous larva (Muscid). Neuroptera : 6 Neuropterous larvæ. Miscellaneous : Hairs from Lepidopterous larvæ ?
- No. 23.—Coleoptera : 1 Dryopid beetle larva. Trichoptera : 9 caddis cases. Vegetable matter : A large fragment of bark $\frac{3}{4}$ in. x $\frac{1}{4}$ in.
- No. 24.—Coleoptera : 1 Scarabæid beetle (*Phyllotocus* sp.). Trichoptera : 4 caddis cases. Vegetable matter : 8 slender twigs measuring up to $4\frac{1}{2}$ inches in length. A quantity of large pieces of bark, and a large quantity of Algæ.
- No. 25.—Coleoptera : 16 Scarabæid beetles (*Phyllotocus navicularis*), 3 Scarabæid beetles (*Heteronyx* sp.), 1 beetle (*Cisseis* sp.), 1 beetle (Dryopidæ), 1 weevil (Curculionidæ), 2 dung beetles (*Onthophagus* sp.), 8 water beetles, 2 Carab beetles, 3 beetles (*Tomyrus* sp.), 1 Mordellid beetle. Hemiptera : 33 Rutherglen bugs (*Nysius vinitor*), 2 jassids, 1 plant bug (Pentatomidæ). Hymenoptera : 1 Ichneumon wasp, 2 ants (unidentifiable), 1 bee (*Halictus* sp.), 1 Braconid wasp, 1 Thynnid wasp. Orthoptera : 1 grasshopper (immature). Trichoptera : 4 caddis cases. Lepidoptera : 1 moth (unidentifiable). Neuroptera : 3 Neuropterous larvæ. Diptera : 1 fly (Muscid). Vermes : 1 Gordian worm. Araneidæ : 4 spiders. Miscellaneous insects : A large quantity of insect remains.

Contents of stomachs of Rainbow Trout taken by Mr. A. C. Ebsworth, Sydney, in the Big Badja River, New South Wales, between 1st and 16th April, 1933. Weight of fish between $1\frac{1}{2}$ and $2\frac{1}{2}$ lb. River in flood and about 18 inches above normal level.

- No. 26.—1st to 8th April, 1933.—Coleoptera : 1 Gyrinid beetle. Orthoptera : 2 grasshoppers. Trichoptera : 2 large stick caddis cases and larvæ. Crustacea : 38 shrimps (*Paratya australiensis*).
- No. 27.—1st-8th April, 1933.—Coleoptera : 1 elephant beetle (*Orthorrhinus cylindrirostris*), 3 Scarabæid beetles. Hymenoptera : 1 winged ant (? gen.), 1 winged ant (*Myrmecia* sp.), 2 bees (*Apis mellifica*). Hemiptera : 1 *Corixa* sp. Orthoptera : 267 grasshoppers, mature and nymph (Aceridiidæ, ? gen. et spp.), together with a large quantity of grasshopper remains in an advanced stage of digestion and 2 crickets (immature). Trichoptera : 1 caddis case. Odonata : 5 Anisopterid dragon-fly larvæ. Diptera : 1 Dipterous larva.
- No. 28.—1st-8th April, 1933.—Mollusca : 1 snail (*Bullinus* sp.). Vegetable matter : Stomach completely filled with unidentifiable green vegetable matter.
- No. 29.—1st-8th April, 1933.—Hymenoptera : 3 ants (? gen. et sp.). Orthoptera : 79 grasshoppers. Trichoptera : 2 caddis cases. Odonata : 1 Anisopterid dragon-fly nymph. Diptera : 1 blowfly (*Calliphora* sp.), 3 flies (unidentifiable).

- No. 30.—1st-8th April, 1933.—Coleoptera : 1 beetle (*Paropsis* sp.), 1 Longicorn beetle, 3 small Scarabæid beetles, 1 weevil (? gen. et sp.). Hymenoptera : 104 ants (*Iridomyrmex*, *Camponotus*, *Myrmecia*, and *Amblyopone*; mostly winged), 1 Chalcid wasp. Hemiptera : 1 *Corixa* sp., 3 plant bugs (*Cydnius* sp.), 1 plant bug (*Dærlac* sp.), 1 bug (unidentifiable), 2 plant bugs (Pentatomidæ). Orthoptera : 27 grasshoppers (Acridiidae). Trichoptera : 3 caddis cases. Thysanoptera : 1 thrips (*Idolothrips spectrum*). Miscellaneous insects : A large quantity of unidentifiable remains.
- No. 31.—1st-8th April, 1933.—Hymenoptera : 3 winged ants (*Myrmecia gulosa*). Trichoptera : 5 caddis cases. Odonata : 1 Anisopterid dragon-fly nymph.
- No. 32.—1st-8th April, 1933.—Coleoptera : 1 small Scarabæid beetle, 1 small weevil, 1 Click beetle (Elateridæ), 3 Chrysomelid larvæ; 1 water beetle larva. Hymenoptera : 96 ants, mostly winged (*Iridomyrmex*, *Camponotus*, *Myrmecia*, and *Amblyopone*), 1 head of bee (unidentifiable). Orthoptera : 7 grasshoppers. Odonata : 4 Anisopterid dragon-fly nymphs.
- No. 33.—16th April, 1933.—Trichoptera : 1 caddis case and larva. Odonata : 1 Anisopterid dragon-fly larva. Araneidæ : 2 small spiders. Crustacea : 2 shrimps (*Paratya australiensis*).
- No. 34.—16th April, 1933.—Hymenoptera : 1 winged ant (? gen.). Orthoptera : 6 grasshoppers (Acridiidae). Araneidæ : 1 spider (*Epeira* sp.). Vegetable matter : A large quantity of vegetable matter.
- No. 35.—12th April, 1933.—Hemiptera : 1 *Corixa* sp. Odonata : 4 Anisopterid dragon-fly larvæ and nymphs. Mollusca : 25 snails (*Bullinus newcombi*).
- Stomach contents of Rainbow Trout taken by Dr. A. J. Spiller Brandon, Sydney, on the Tuross River, New South Wales, 8 to 16 April, 1933.
- No. 36.—♂, 2½ lb., 11 a.m., 8 April, 1933. Fly : Jungle Cock and Red.—Hymenoptera : 3 ants (*Iridomyrmex detectus*). Trichoptera : 29 caddis cases (27 sand and 2 stick), and one mature caddis fly. Odonata : 18 Anisopterid dragon-fly larvæ and nymphs, and 1 Zygopterid nymph. Lepidoptera : 1 Lepidopterous larva. Miscellaneous insects : A very large quantity of unidentifiable insect remains.
- No. 37.—♀, 3 lb., 11.30 a.m., 9 April, 1933.—Coleoptera : 14 Scarabæid beetles (*Phyllotocus* sp.), 3 Scarabæid beetles (*Heteronyx* sp.), 1 Click beetle (Elateridæ). Hemiptera : 1 *Notonecta* sp. Hymenoptera : 32 ants, winged and workers, including *Myrmecia* sp., 1 Ichneumon wasp, 5 Thynnid wasps (3 ♂ and 2 ♀), together with a quantity of ant remains. Orthoptera : 1 grasshopper. Trichoptera : 1 caddis case and 1 larva. Odonata : 1 Anisopterid dragon-fly nymph. Miscellaneous insects : A quantity of unidentifiable insect remains. Araneidæ : 1 spider. Vegetable matter : Quantity of vegetable matter.
- No. 38.—♀, 1½ lb., 8.30 a.m., 10 April, 1933. Fly : Alder.—Coleoptera : 2 Scarabæid beetles. Hemiptera : 1 Pentatomid bug, 2 Notonectidæ (immature), 1 *Corixa* sp. Hymenoptera : 364 winged ants (several spp.), and remains of ants, 2 Ichneumon wasps. Orthoptera : 1 mature grasshopper (*Calataria terminifera*). Trichoptera : 3 caddis cases. Odonata : 2 Zygopterid dragon-flies. Ephemeroptera : 5 May-flies. Diptera : 12 Mycetophyllid midges. Miscellaneous insects : An exceptionally large quantity of unidentifiable insect remains. Vermes : 3 Gordian worms.

Stomach Contents of Brown Trout (*Salmo fario*).

		1	2	3	4	5	6
Coleoptera	Gyrinidæ.....	...	1	1	...	...	...
	Scarabæidæ .....	...	...	2	3	2	...
	Curculionidæ .....	...	...	...	1	1	...
	Unidentifiable .....	...	...	...	...	...	1
Diptera	Stratiomyidæ	1	...	2	6	6	...
	Tipulidæ .....	...	...	...	...	1	...
	Unidentifiable .....	...	...	...	2	...	...
Hemiptera	Notonectidæ	2	...	...	...	...	...
	Gerridæ .....	...	8	18	...	3	...
	Corixidæ	3	...	...	...	1	...
	Psyllidæ .....	...	2	...	...	...	...
	Jassidæ .....	...	...	...	1	...	...
	Thynnidæ	2	...	2	1	...	...
	Formicidæ .....	...	40	48	6	3	...
Hymenoptera	Ichneumonidæ .....	...	...	1	...	...	...
	Chalcidæ .....	...	...	...	...	1	...
	Vespidæ .....	...	...	...	...	1	...
	Apidæ .....	...	...	...	...	2	...
	Trichoptera	1	10	7	4	...	...
	Odonata.....	...	3	...	...	2	...
	Zygoptera	1	...	...	...	2	2
Orthoptera	Acridiidæ .....	...	3	1	1	4	...
	Gryllidæ .....	...	...	1	...	...	...
Lepidoptera .....	...	...	1	...	...	...
Miscellaneous Insects—Fragments .....	...	*	*	*	*	*
Crustacea	<i>Parachærops</i> sp.	2	...	...	...	...	...
	<i>Paratya</i> sp. ....	...	...	1	2	...	...
Araneidæ .....	...	3	1	2	1	...	
Mollusca .....	...	...	...	...	...	21	
Vermes .....	...	...	...	...	...	1	

* Indicates present but not countable.

Stomach Contents of Brown Trout (*Salmo fario*).

Stomach contents of Brown Trout taken by Dr. A. J. Spiller Brandon on the Tuross River, New South Wales, 8 to 16 April, 1933.

- No. 1.—♂, 5 lb.; midday 8 April, 1933. Fly: Jungle Cock and Red.—Hemiptera: 6 *Notonecta* sp., 3 *Corixa* sp. Hymenoptera: 2 Thynnid wasps (♂ and ♀). Trichoptera: 1 caddis case (stick). Odonata: 1 Zygopterid dragon-fly nymph. Diptera: 1 fly (*Boreoides subulatus*, Fam. Stratiomyidæ. Crustacea: 2 crayfish (*Parachærops bicarinatus*).
- No. 2.—♂, 1 lb., 9 a.m. 10 April, 1933. Fly: Alder.—Coleoptera: 1 small Gyrinid beetle. Hemiptera: 8 *Gerris* sp., 2 Psyllids. Hymenoptera: 40 ants (winged and workers), mainly small *Iridomyrmex* sp. Trichoptera: 10 caddis cases (sand). Orthoptera: 3 grasshoppers, and a quantity of remains. Odonata: 3 Anisopterid dragon-fly nymphs. Miscellaneous insects: Quantity of unidentifiable insect remains. Araneidæ: 3 spiders.
- No. 3.—♂, 2 lb., 3 p.m., 10 April, 1933. Fly: Pennel Black Hackle.—Coleoptera: 2 Scarabæid beetles, 1 Gyrinid beetle. Hemiptera: 18 *Gerris* sp. Hymenoptera: 44 winged ants (several spp.), 4 ants (*Myrmecia gulosa*). [NOTE.—One specimen had the jaws deeply embedded in the stomach-wall of the fish.] 1 Ichneumon wasp, 2 Thynnid wasps (♂ and ♀). Orthoptera: 1 grasshopper,

- 1 cricket (immature). Trichoptera : 7 caddis larvæ. Lepidoptera : 1 large Lepidopterous larva. Diptera : 2 flies (*Boreoides subulatus*) ♀ ♀. Miscellaneous insects : A very large quantity of unidentifiable insect remains. Araneidæ : 1 spider. Crustacea : 1 shrimp (*Paratya australiensis*).
- No. 4.—♀, 3 lb., 11 a.m., 15 April, 1933. Fly: Black Hackle.—Coleoptera : 3 Scarabæid beetles, 1 weevil. Hemiptera : 1 jassid. Hymenoptera : 5 winged ants (*Camponotus* sp.), 1 winged ant (*Myrmecia* sp.), 1 Thynnid wasp, (♀). Trichoptera : 2 caddis cases and 2 caddis flies. Orthoptera : 1 grasshopper. Diptera : 6 flies (*Boreoides subulatus*, Fam. Stratiomyidæ), 3 ♂ and 3 ♀. 2 flies (unidentifiable). Miscellaneous insects : A large quantity of unidentifiable insect remains. Araneidæ : 2 spiders. Crustacea : 2 shrimps (*Paratya australiensis*). Miscellaneous : Quantity of ? insect eggs.
- No. 5.—♂, 1½ lb., 3 p.m., 15 April, 1933. Fly: Black Hackle.—Coleoptera : 1 Scarabæid beetle (*Onthophagus* sp.), 1 Scarabæid beetle (*Phyllotocus* sp.), 1 weevil. Hemiptera : 3 *Gerris* sp., 1 *Corixa* sp. Hymenoptera : 2 winged ants (*Myrmecia* sp.), 1 winged ant (unidentifiable), 1 Chalcid wasp, 1 wasp (*Polistes* sp.), 2 bees (unidentifiable remains). Orthoptera : 4 grasshoppers. Diptera : 1 crane fly (Tipulidæ), 6 flies (*Boreoides subulatus*, Fam. Stratiomyidæ), ♀ ♀. Odonata : 2 Anisopterid dragon-fly nymphs, 2 Zygopterid dragon-fly nymphs, and wings of imagines. Miscellaneous insects : A quantity of finely broken insect remains. Araneidæ : 1 spider (*Epeira* sp.).
- No. 6.—♀, 2½ lb., 11:30 a.m., 16 April, 1933. Fly: Black Hackle.—Coleoptera : 1 small beetle (unidentifiable). Odonata : 2 Zygopterid dragon-fly nymphs. Mollusca : 21 snails (*Bullinus* sp.). Vermes : 1 Gordian worm. Animal matter : A quantity of unidentifiable matter (? snails).

Summary of Stomach Contents of Macquarie Perch (*Macquaria australasica*).

		1	2	3	4	5	6
Coleoptera	Dryopidæ	15	...	...	...	...	...
	Unidentifiable	...	*	...	...	...	...
Hymenoptera	Formicidæ	...	1	...	...	4	...
Lepidoptera		...	1	...	...	1	...
Trichoptera		5	...	1	...	1	2
Odonata		...	...	...	1	...	...
Neuroptera		2	...	...	...	...	...
Ephemeroptera		...	1	...	...	1	...
Hemiptera	Pentatomidæ	...	1	...	1	4	...
	Gerridæ	...	1	...	...	30	...
	Jassidæ	...	1	...	...	...	...
Orthoptera	Acridiidæ	...	1	...	...	...	...
Miscellaneous Insects	Fragments	...	...	*	...	...	...
Vermes		4	...	...	...	...	2

* Indicates present but not countable.

Stomach Contents of Macquarie Perch

(*Macquaria australasica*).

Stomach-contents of Macquarie Perch taken by Dr. C. Anderson, Australian Museum, Sydney. Goodradigbee River, New South Wales, January, 1931.

No. 1.—Coleoptera : 15 beetles (Dryopidæ). Trichoptera : 5 caddis cases. Miscellaneous insects : 2 aquatic larvæ ? Vermes : 2 intestinal worms.

- No. 2.—Coleoptera: Unidentifiable remains. Hemiptera: 1 tree hopper (*Eury-meloides* sp.), 1 plant bug (Pentatomidæ), 1 water strider (*Gerris* sp.). Hymenoptera: 1 ant (unidentifiable). Orthoptera: 1 grasshopper (*Goniæa australasiæ*). Lepidoptera: 1 larva. Ephemeroptera: 1 May-fly nymph.
- No. 3.—Trichoptera: 1 caddis larva. Miscellaneous insects: Unidentifiable fragments.
- No. 4.—Weight about $\frac{1}{4}$ lb. Hemiptera: 1 Pentatomid bug. Odonata: 1 Anisopterid dragon-fly nymph.
- No. 5.—9 January, 1931. Weight about $\frac{1}{2}$ lb.—Hemiptera: 30 water striders, immature (*Gerris* sp.), 4 plant bugs (? spp.). Hymenoptera: 4 ants (? spp.). Trichoptera: 1 caddis fly. Ephemeroptera: 1 May-fly. Lepidoptera: 1 Lepidopterous larva.
- No. 6.—Trichoptera: 2 caddis larvæ. Vermes: 2 intestinal worms.

BIBLIOGRAPHY.

- DONNE, T. E. 1927 Rod Fishing in New Zealand Waters. A description of a Fisherman's Paradise with its teeming Lakes, Rivers, and Seas. The story of the introduction of Game Fish, and full information about sport, equipment, regulations, and camping. London.
- HOPE, D. 1927 Whitebait (*Galaxias attenuatus*). Growth and Value as Trout-food. Trans. N.Z. Inst., vol. 58.
- HUDSON, G. V. 1904 New Zealand Neuroptera. London.
- PARROTT, A. W. 1929 North Canterbury Acclimatization Society, Sixty-fifth Report, 1929. Christchurch.
- PERCIVAL, E. 1932 On the Depreciation of Trout-fishing in the Oreti (or New River), Southland. With Remarks on Conditions in other Parts of New Zealand. N.Z. Marine Dept., Fisheries Bull. No. 5. Wellington.
- PHILLIPS, J. S. 1924 Food-supply and Deterioration of Trout in the Thermal Lakes District, North Island, New Zealand. Trans. N.Z. Inst., vol. 55.
- 1929 A Report on the Food of Trout and other conditions affecting their well-being in the Wellington District. N.Z. Marine Dept., Fisheries Bull. No. 2. Wellington.
- 1931 A further Report on Conditions affecting the Well-being of Trout in New Zealand. N.Z. Marine Dept., Fisheries Bull. No. 3. Wellington.
- TILLYARD, R. J. 1920 Neuropteroid Insects of the Hot Springs Region, New Zealand, in relation to the Problem of Trout-food. Proc. Linn. Soc., N.S.W.

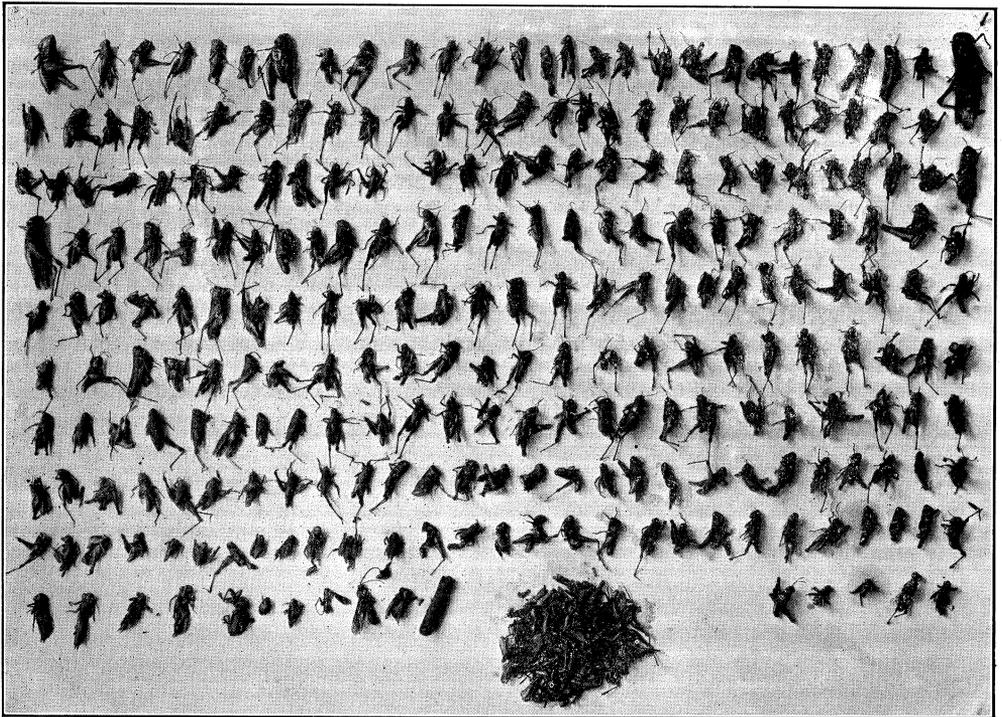
EXPLANATION OF PLATE XVII.

Figure 1.—Stomach of Rainbow Trout (No. 27) (*Salmo irideus*, Gibbons), from Big Badja River, New South Wales.

Figure 2.—Principal contents of the same stomach.



1



2

G. C. CLUTTON, photos.