PRESIDENTIAL ADDRESS

The Entomology of Fly Fishing

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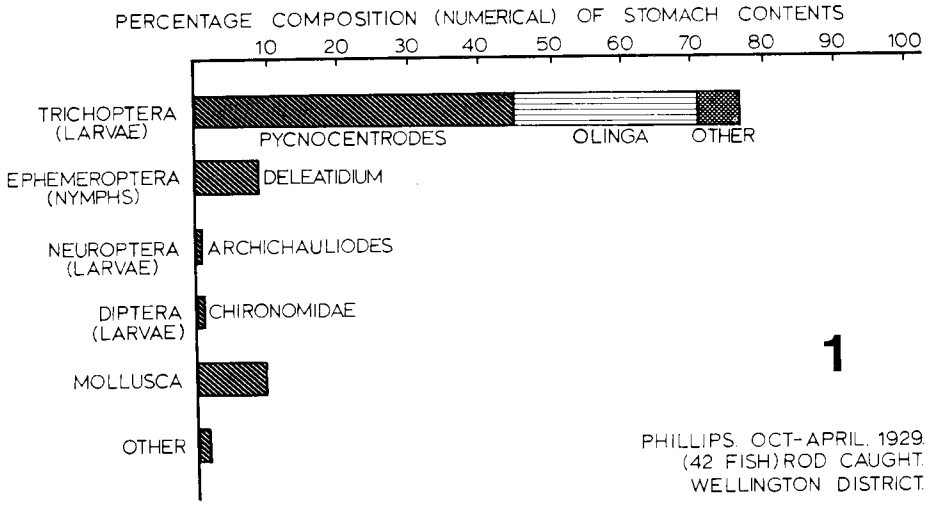
It is first necessary to define what I mean by " fly fishing ", because surprisingly there is no universal agreement on a definition. The average fisherman would probably say something like " the art of angling for fish, using lures constructed from feathers and other similar materials." Such a definition however would include the use of large sunken lures, which are meant primarily to simulate small fish. We must qualify this definition so that it reads " the art of angling for fish using lures constructed from feathers and other similar materials *to simulate some form of insect life* ". This qualification limits one to a consideration of insects (aquatic in origin or otherwise) as fish food and enables one to refer without hesitation to the entomology of the subject. It also reflects what I believe to be the true origin of the art as it was originally conceived.

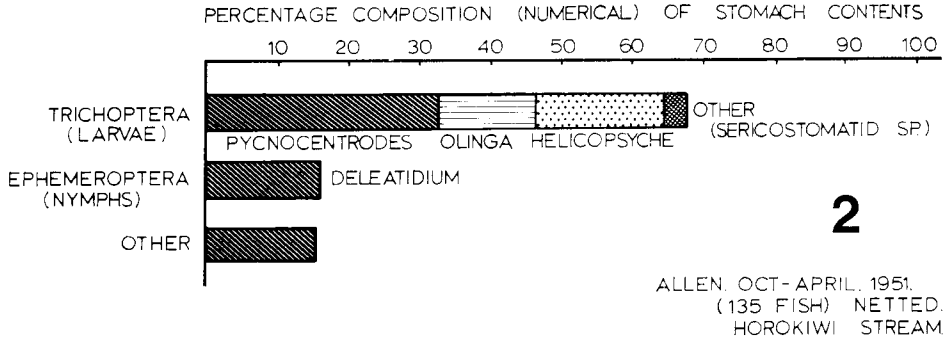
It is possible in theory and to a considerable extent in practice, to catch with an artificial fly any species of fish that feeds on insects at least occasionally. However for many such fish, insects form only a minor constituent of a mixed diet. But in the group of Salmonidae referred to as trout, insects form the main, and in some instances virtually the sole component of their diet and they are therefore the most susceptible group to the fly fisher's art. As far as New Zealand is concerned, the all important species are Brown Trout *(Salmo trutta)* and Rainbow Trout *(Salmo gairdnerii)*. It is with the former that I will be almost entirely concerned.

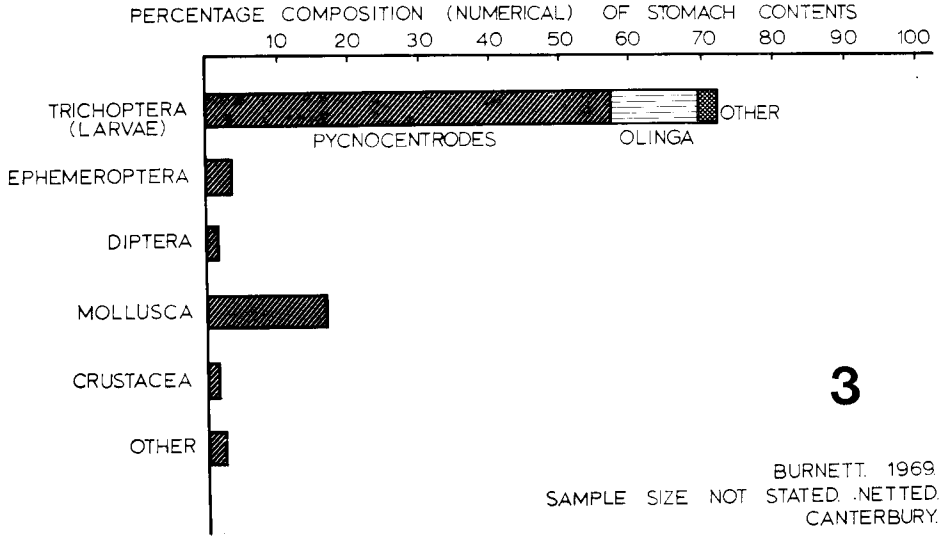
The establishment of these species in New Zealand waters in itself presents an extremely interesting ecological situation, because we are here concerned with *introduced* species that depend entirely for their food on *indigenous* components of the fauna. This interaction has been quite inadequately studied. There were some moves in the early years to introduce some species of may flies from the Northern Hemisphere, in fact Tillyard (1921) recommended the introduction of *Ephemera danica* from England, and Phillips (1929) made a similar recommendation for the introduction of " a number of the larger herbivorous May-flies (unspecified) such as occur in swarms on rivers at Home." To the best of my knowledge no such introductions were ever attempted.

The object, in fly fishing for trout (as defined), is to present to the fish an artificial representation of its natural insect prey in such a way that the fish will take it into its mouth as it would natural food. A detailed knowledge of the insect life on which trout predominantly feed should provide the key to successful angling, and indeed one finds that the more successful fishermen are usually very keen observers. However, for the most part they are only interested in ascertaining what fish are likely to be feeding on at a certain place and at a certain time, and much information that could be gathered is never documented, in fact, the scientific literature concerning the nature of trout food is rather sparse.

The most direct way of course to obtain data on the food eaten by trout is to examine the stomach contents of samples of fish, and this has been the usual approach. There are however two main limitations in interpretation of the data. Firstly, the sample of fish may be biased according to the method of capture (this applies particularly to angling compared to netting of samples); and secondly there is inadequate data on the relative rates of digestion of food organisms in the trout stomach, to know whether composition truly reflects intake over a period of time.

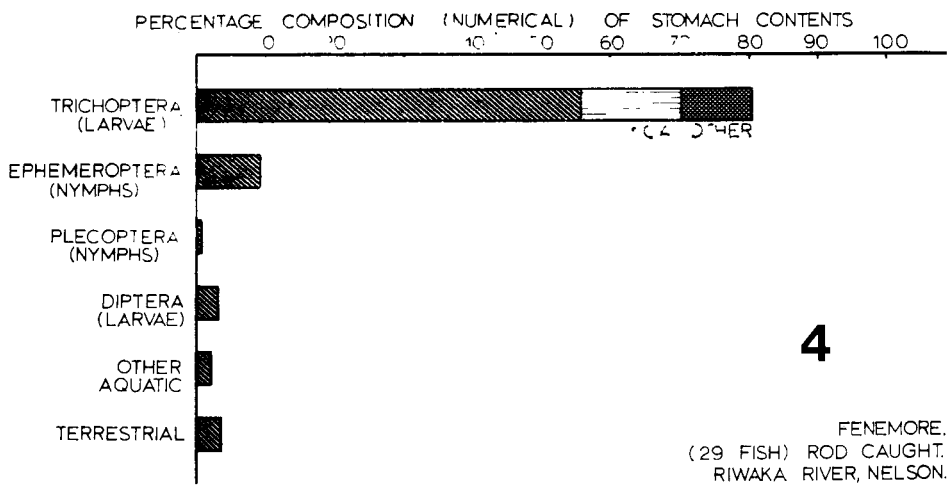

PERCENTAGE COMPOSITION (NUMERICAL) OF STOMACH CONTENTS
10 20 30 40 50 60 70 80 90 100
TRICHOPTERA (LARVAE)
PYCNOCENTRODES
OLINGA
OTHER
EPHEMEROPTERA (NYMPHS)
DELEATIDIUM
NEUROPTERA (LARVAE)
ARCHICHAULIODES
DIPTERA (LARVAE)
CHIRONOMIDAE
MOLLUSCA
OTHER
1
PHILLIPS. OCT-APRIL. 1929.
(42 FISH) ROD CAUGHT.
WELLINGTON DISTRICT.

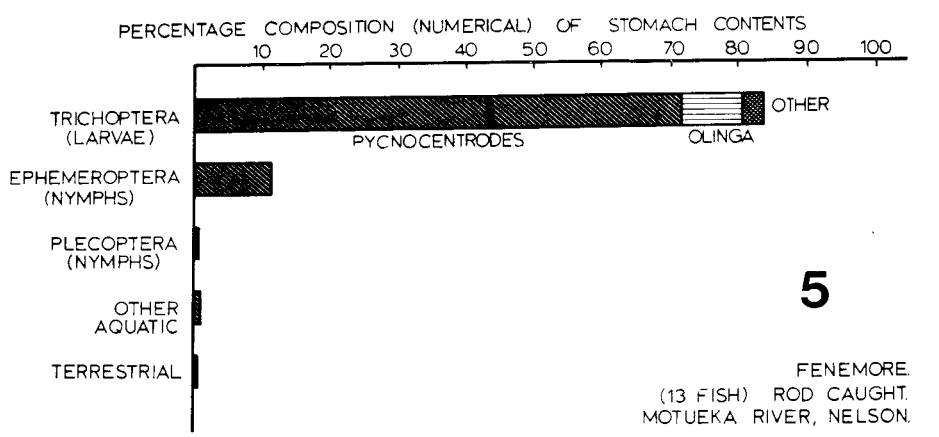

PERCENTAGE COMPOSITION (NUMERICAL) OF STOMACH CONTENTS
10 20 30 40 50 60 70 80 90 100
TRICHOPTERA (LARVAE)
PYCNOCENTRODES
OLINGA
HELICOPSYCHE
OTHER (SERICOSTOMATID SP.)
EPHEMEROPTERA (NYMPHS)
DELEATIDIUM
OTHER
2
ALLEN. OCT-APRIL. 1951.
(135 FISH) NETTED.
HOROKIWI STREAM.


PERCENTAGE COMPOSITION (NUMERICAL) OF STOMACH CONTENTS
10 20 30 40 50 60 70 80 90 100
TRICHOPTERA (LARVAE)
PYCNOCENTRODES
OLINGA
OTHER
EPHEMEROPTERA
DIPTERA
MOLLUSCA
CRUSTACEA
OTHER
3
BURNETT. 1969.
SAMPLE SIZE NOT STATED. NETTED.
CANTERBURY.

In the following trout stomach analyses, all the data presented are for Brown Trout. Figure 1 summarizes some data of Phillips (1929) covering a sample of 42 fish from the "Wellington district" for October to April. The dominant feature is the overwhelming importance of larval Trichoptera with larval Ephemeroptera and aquatic Mollusca coming very poor seconds.

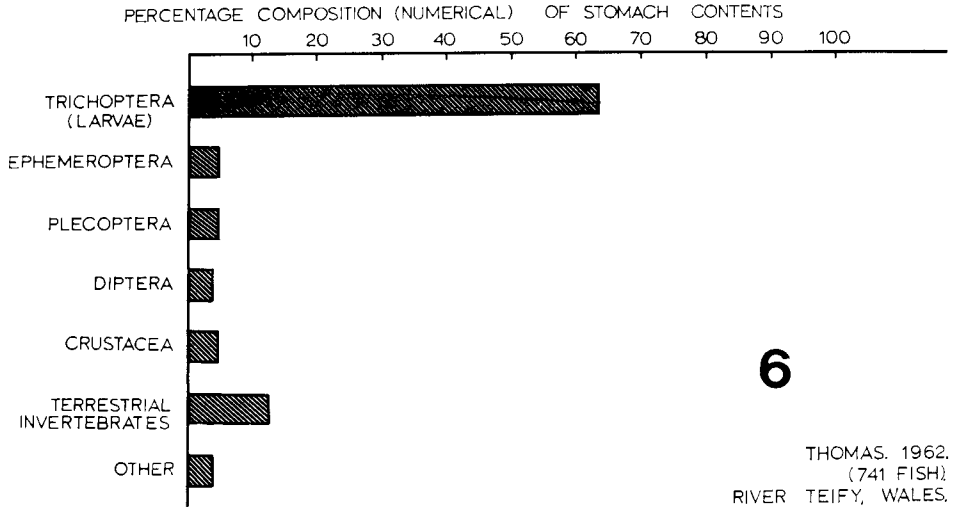
Some 10 years later Radway Allen (1951) made a detailed study of the Horokiwi trout stream in the Wellington district, and found a very similar picture (Fig. 2). Data are also available from Canterbury (Burnett 1969) and again the same pattern is present except that the Ephemeroptera occupy an even smaller place (Fig. 3). My data from the Riwaka (Fig. 4) and Motueka rivers (Fig. 5) in Nelson province again show an almost identical pattern except that Mollusca are virtually absent.

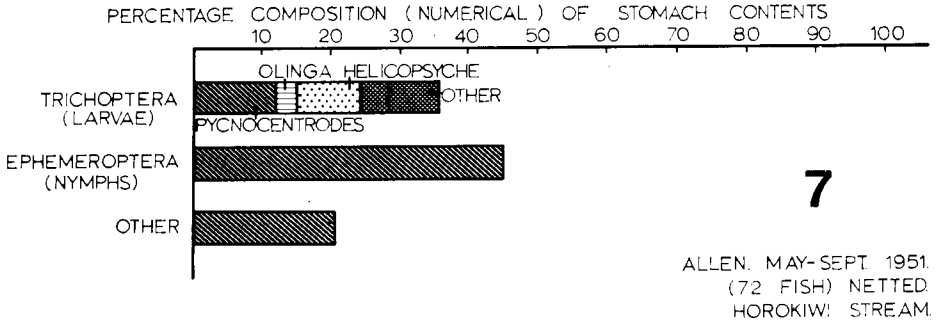




Let us compare these findings with some data from Great Britain. Fig. 6 gives information for Brown trout from the River Teify in Wales (Thomas 1962). This again shows the dominant importance of larval Trichoptera with other aquatic invertebrates of much less frequent occurrence.

These data are limited in time (all refer to summer-caught fish as opposed to winter) and the type of stream concerned. It is possible to expand on them a little. Allen (1951) for instance sampled the Horokiwi at monthly intervals



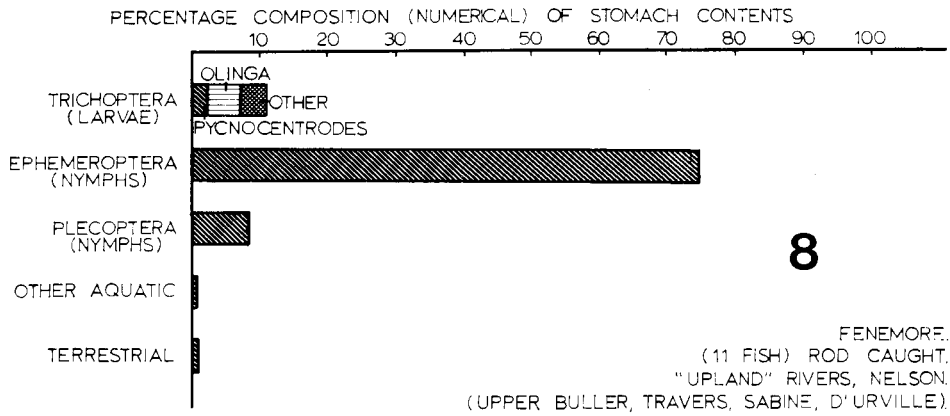


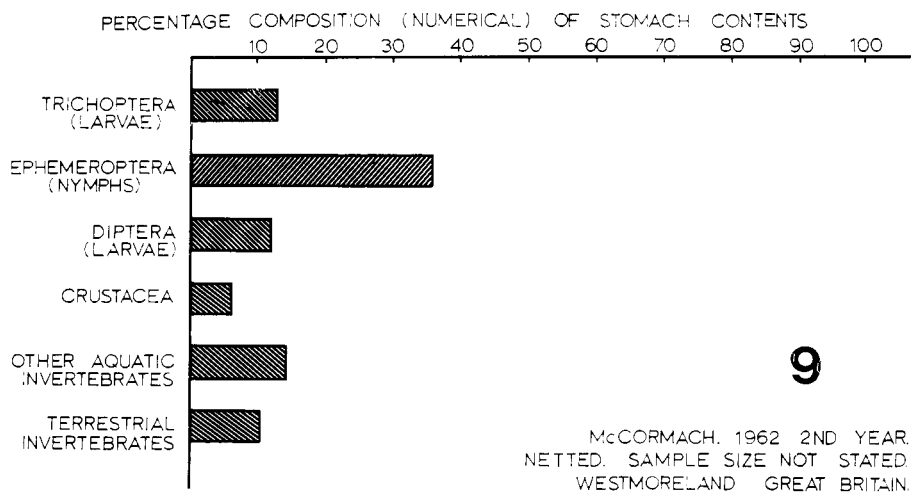
throughout the year and I have grouped his data for May - September (Fig. 7) compared to that for October - April already given. This shows that there is a considerable swing over to Ephemeroptera nymphs during the winter months, this group then assuming dominance.

The type of stream may be of major importance. We can distinguish between lowland streams on the one hand and highland streams on the other. The latter are faster flowing, more turbulent and of lower average temperature than the lowland streams. Different aquatic insects may be expected to predominate and this may be reflected in the trout's diet.

In Fig. 8, I give data for a sample of fish from "upland rivers" in the Nelson Lakes district (all at altitudes of about 500 m or more). The pattern appears quite different from the "lowland" streams. Ephemeroptera nymphs are the dominant food with stonefly nymphs vieing with the Trichoptera for second place. Data of McCormack, 1962 (Fig. 9) for a Westmorland stream in Great Britain shows a somewhat similar pattern though Ephemeroptera are not quite as dominant as in the Nelson samples.

The predominance of caddis larvae in the "lowland" samples is so overwhelming that I have wondered if the figures might not be biased because, with the case bearers (which predominate), the case itself rather than the insect is counted. This could be highly resistant to digestion and thus give a false impression of importance. I examined a random sample of 50 each of the two commonest species of caddis occurring (the Horny-cased Caddis and the Sandy-cased





Caddis) from the Nelson trout and determined how many contained intact caddis bodies. The figure was almost exactly 95 percent in each case so the dominance of caddis in the stomach contents is probably a true indication of intake.

The fish concerned had been feeding almost exclusively on the immature stages of aquatic insects (and to a limited extent other invertebrates) *beneath the water surface.* The adult stages of aquatic insects and terrestrial insects falling into streams, which might be expected to occur *on the water surface,* comprised in most cases less than 5 percent of the diet. This fact may be well known to fisheries scientists but is not always appreciated by the angler, and the dry fly fisherman who fishes exclusively with a floating fly on the surface is thus making things very difficult for himself. Because of the nature of the food organisms concerned, e.g. caddis larvae with comparatively heavy cases, the trout must for the most part actually browse for its food on the bottom rather than feed in mid-water.

May I now turn in rather more detail to the identity of the insect groups concerned. I shall deal largely with my own samples, but this is immaterial as agreement with the other published data from New Zealand is close. In the case of the data from Great Britain the species concerned are obviously different, though the major insect groups making up the diet are closely similar as we have seen.

Trichoptera

The commonest caddis by far is *Pycnocentrodes* sp., the Sandy-cased Caddis, which as its name suggests builds a larval case of fine sandy material. In some instances the stomach contents may consist almost exclusively of this species. Second in importance is the Horn-cased Caddis *(Olinga feredayi)*.

The other two species of caddis that have commonly occurred are free-living, i.e. the larvae do not build cases. One is *Hydropsyche* sp., the Net-building Caddis, which builds a silken net in flowing water to trap food particles. The other is *Hydrobiosis* sp. — a free-living caddis which can be readily distinguished by its chelate fore-tarsus. Allen (1951) also reported the Spiral-case Caddis *Helicopsyche* sp. of fairly common occurrence in his fish from the Horokiwi stream, but I have not found this species in more than a hundred fish examined.

Ephemeroptera

Amongst the mayfly nymphs, the Sucker-gilled Mayflies, *Deleatidium* species are of overwhelming importance. Almost certainly, more than one species occurs (Phillips, 1931, lists 8 species as occurring in New Zealand) but they are superficially similar and I have not attempted to separate them. Very occasionally specimens of the large and small swimming mayflies occur.

Plecoptera

Turning to the stoneflies, the species of most frequent occurrence is the common Large Green Stonefly, *Stenoperla prasina*. A smaller brown species, the Long Tailed Stonefly *Zealandoperla maculata* may sometimes however be present in considerable numbers.

Megaloptera

The Megaloptera are represented by larvae of the New Zealand Dobson Fly, *Archicauliodes diversus,* popularly referred to by fishermen as the " Black Creeper ". It is a comparatively large insect when fully grown reaching about 3 cm in length.

Table 1. Terrestrial Arthropods Recorded From Trout Stomachs.

GROUP	REMARKS
Coleoptera adults	
Costelytra zealandica	common in spring
Pyronota spp.	occasional
Dictyoptera	
Cockroaches	occasional
Diptera adults	
Tipulidae	occasional
Other	rare
Hemiptera	
Cicadas	occasional
Other	rare
Hymenoptera adults	
Bees, wasps	occasional
Ichneumonoidea	common
Ants	rare
Lepidoptera adults	rare
Orthoptera	
Grasshoppers	occasional
Wetas	occasional
Millipedes	occasional
Spiders	common

Hemiptera

Very occasionally specimens of the New Zealand Water Boatman *(Sigara arguta)* have turned up in stomach contents. These are essentially insects of still water and would thus only appear as food in streams with quiet back-waters.

Diptera

The last group of aquatic insects to be represented are the larval Chironomidae. Identification has not been taken further than family.

When further information is available it will undoubtedly be found that other aquatic insects are significant in the diet of trout from other areas, dragonfly nymphs being reported as important for lake dwellers in some parts of the world.

Some insects which are essentially terrestrial get into fresh water by accident at certain times and hence turn up in trout stomachs. I have listed the most frequent groups that have occurred in Table 1. Precise identification has not been attempted in most cases.

It is clear from this list that Brown Trout are not averse to partaking of almost any insect, or other arthropod of suitable size, that may appear by accident in fresh water, even though these organisms may be quite unfamiliar to the trout in its normal environment.

The main objective of the designer and tier of artificial flies seems to have been to imitate a particular type or even species of natural insect food as closely as possible, and great ingenuity in use of materials and methods of construction has been employed in attempting to achieve this. At best however, the result is some *resemblance* to the natural insect rather than an exact replica. Nevertheless, such artificials catch fish. For many years in New Zealand all the patterns of flis used by anglers were from Europe and were designed to imitate insects that do *not* occur here!

It seems clear to me that the trout, in responding with a feeding behaviour sequence, to an artificial fly, is reacting to some particular characteristic or characteristics of that artificial rather than to its fine detail in resembling a natural insect. Such features could be the distinctly humped thorax of mature Ephemeroptera nymphs, or the plain curved outline of the Sandy-cased Caddis. Colour as well as form may also be important and there is good evidence that trout do in fact have some sort of colour vision.

In this field of behaviour, and its triggering by visual stimuli, it seems that fish biologists may have a lot to learn from students of bird and mammalian behaviour, where such studies have been taken much further. The problems involved in scientific investigation of the fish's behaviour in relation to artificial lures is an extremely difficult one, due to the wellnigh impossible task of conducting controlled experiments. Perhaps we should be grateful for this, so that scope may remain for the application of individual skill and intuition which make angling such a fascinating pastime.

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