Trout diet in small mountain streams

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In July 1947 work began on the River Research and Development Centre of the Game Department of the Kenya colony which was built on the banks of the Sangana stream and in February 1948 the biologist who was to conduct research, Vernon van Someron, started work.

The centre, which was a combined research station and experimental hatchery, was designed to study the biology of the introduced trout in the Kenya colony which were first stocked in 1905. Specific attention was focused on the Sangana but trout, rainbow and brown, were also studied on 15 other streams and rivers.

I transcribed the chapter on trout diet for the Cape Piscatorial Society because it provides an invaluable guide to trout diet on the streams near Cape Town.

My article, *Trout Diet in the Fynbos Biome'* which is also featured on this website, relates more specifically to trout diet in our own streams such as the Smalblaar and the Elandspad.

Van Someron's three year study, which earned him a doctorate, highlighted the important role of the blackfly in the diet of trout in mountain streams and two articles which focus on this insect in our situation can be found on Tom Sutcliffe's *'Spirit of Flyfishing* website.

The majority of insects on which trout live in the streams near Cape Town are small, about the size of a matchhead or smaller. For further information read *What stream trout eat* by Tom Sutcliffe on his website.

Also on this website is an article I wrote, *Why fish hoppers in autumn?* which focuses on the two main sources of food for trout on our streams in April and May, grasshoppers and the Dobsonfly or hellgrammite – what we call 'toebiters. *Trout and Wasps* and *Surveys on insects available as trout food and how to sample the stomach contents of trout* also provide useful information on the diet of trout in South African streams.

None are, however, as comprehensive as Vernon van Someron's doctoral thesis which makes an obvious point - trout eat what is available and most vulnerable to their predation and on the Sangana as on the Smalblaar, Elandspad, Holsloot and other South African streams that means *Baetis* nymphs and, just as important and sometimes more so, those little, black sausages that festoon the rocks at the top and bottom of every riffle and rapid, the larvae of the blackly.

Read *Blackfly – the challenge* and *The blackfly challenge – a postscript.*

Extract: ***The Biology of Trout in Kenya Colony*** by Dr V D van Someren, M.B.E. – Biologist River Research and Development Centre

PART III - THE FOOD OF TROUT

(a) **Rainbow Trout, Sagana River**

(1) QUALITATIVE

Coincident with the bottom sampling of fish foods available, regular routine analyses have been made of the stomach contents of rod-caught fish in the Sagana river at various places. In all 489 fish have been examined, the samples made up as follows: -

1945–46–89 (mainly Lower Sagana, with a few from the research Centre stretch).

1948–294 (all from the one mile of river immediately adjacent to the Research Centre sampling area).

1949–106 (Kabaru sampling area 50, Research Centre area 38, Lower Sagana 18).

Stomachs were cut open as soon as possible after capture, the contents preserved in a 5 per cent formalin and sorted later. Results are expressed in three different ways; each organism as a percentage of the total number of organisms present in all stomachs; the percentage “bulk value” of each organism as assessed by the 1-2-3 “points” method of Swynnerton and Worthington (1940); and finally as a percentage frequency of occurrence in all stomachs. All these three ways have been used by various workers, either singly or combined, and it may be stated now that these present results, as has already been found by Hynes and Jones (*in litt*) in their work on sticklebacks, show that the final assessments are almost identical from all three methods; providing the sample of fish is large enough.

It may be remarked also that rod-caught fish appear to show identical results to those which have been examined when caught by other methods (trapping and electrical shocking). There has been no conclusive evidence of vomiting of food on capture by rod and line. Furthermore, nearly all rainbow trout stomachs are full when caught and empty stomachs form a very small percentage of the whole (Tables 8 and 9).

*As a general statement applied to forest fish up to 1½ lb. in weight I agree. Should however a larger sample of brown trout from two to nine pounds be taken from the South Mathioya crab will be found much more dominant in the diet. My own impression is that crab in the diet is seasonal and this factor will come out when the Research Station takes up the study of the life history of the Freshwater crab. H.C.

Since the 1945-46 Sagana stomachs were collected only casually and not related to bottom samples, they will not be discussed in detail. Table 6 and Figs. 12 and 13 give the results. They bear a close resemblance in general to the 1949 Lower Sagana results (Table 9 and Figs. 10 and 11), except that they show a greater percentage of *Simulium* larvae, and *Acentrella* nymphs; the 1949 stomachs show a higher proportion of *Octhopetina*, *Goerodes and Hydrocampid* larvae. This is probably a reflection of the fact that the 1945-46 stomachs were nearly all collected from the Nairobi river junction up to the forest edge, while the 1949 stomachs were spinner-caught below the Nairobi junction.

In general, all the stomach results show features previously noted in trout feeding surveys elsewhere in the world. Firstly, that nearly all the trouts' food is taken underwater, and that only a small proportion (usually less than 10 per cent) is of terrestrial origin, or the aerial stages of insects of aquatic origin. Secondly, that among this greater percentage of aquatic food, the organisms which contribute the bulk of this underwater food are those which are also commonest on the river bottom and most readily available to the trout. Special selection of particular food animals in preference to others is only rarely shown, and selectivity is of less importance than availability. Crass (1947 and 1947-48) has pointed this out with reference to the feeding habits of rainbow and brown trout in South Africa, and his results are very similar to the present ones, within the limits of the two different river faunal compositions in the two areas of the continent.

Thus in Table 8 and Figs. 8 and 9, in the results for the whole year 1948, the percentage of food species eaten by the trout, and the percentage occurrence of the food species on the river bottom gravel are almost mirror images of the one another (Fig. 9). Individual trout indeed may show evidence of having fed in other areas of the river, but it is certain that most of the trout food is derived from such gravel areas, in the forest stretches. Allen (1942) has discussed the question of availability of food organisms, and suggested as a measure of this availability the ratio between the percentage occurrence of an organism in a sample of stomach contents and in samples of the corresponding bottom fauna; this varies not only with the species of food organism, but also with the size and species of fish concerned. He gives a table (*loc. Cit.* p. 278) of different availabilities for different groups of organisms with different size groups of fish. No figures are given separately for rainbow trout, but Table 11A is a comparison of Allen's 25-40 cms. brown trout, with Sagana rainbow of equivalent size, and with brown trout from three Kenya rivers. There is only a very general resemblance, except in the case of Chironomidae and other Diptera (including *Simulium* larvae) which are a good bit higher in the case of the Kenya trout, but true comparisons are difficult since widely different species of food organisms are concerned.

The availability factors will be discussed in more detail in the following paragraphs for each food species concerned.

Simulium larvae are eaten in the greatest percentage, form the greatest bulk of the aquatic food taken, and are found in the greatest percentage of stomachs. *Simulium* pupae on the other hand form only a fraction of one per cent of the total food, and are found in only a small percentage of the fish (Fig. 8). Although as noticed previously they are not common in the river in spite of the abundance of larvae, they are also not easy for the trout to scrape off the stones. Considering the abundance of *Simulium* larvae in the river as a whole, and the fact that they live mostly on the upper sides of stones in an exposed position, their availability is surprisingly low. From many observations of wild feeding trout, I am convinced that the bulk of a river trout's food is obtained from the "living drift" of organisms brought by the current past the trout in its particular "lie", and that there is little active searching for food on the part of the trout. In Part II, the composition of this "living drift" was discussed, and it was shown that *Simulium* larvae are found in less percentages in this drift than in bottom samples, because they do not become detached so readily as *Baetis* nymphs for example. Thus in spite of their abundance and exposed position in the river, they are in fact not so available to the trout feeding on such drift only; and it would be better when calculating availability factors to take into consideration, not only the size of the trout, but their feeding habits. In other words, a more true availability figure is given by using "drift" percentages rather than bottom sample percentages: in this particular case the availability figure would therefore be 1.9 instead 0.7.

Together with *Simulium*, *Baetis* nymphs constitute a major portion of the aquatic food eaten, and the remarks above concerning their availability apply also. The figure calculated on bottom sample composition is 0.7 that for drift composition 0.3; perhaps a more true expression of their relative value compared with *Simulium* larvae.

Hydropsyche larvae are next in order taken, their availability factor calculated on bottom samples being high, 2.4, and for drift samples even higher, 3.9. As will be seen from Table 11A, the availability factors for all *Trichoptera* are high, except in the case of the more cryptic *Chimarrha* larvae, and it has been mentioned in Part II that Trichoptera appear to be grazed out faster than other organisms when a river is first stocked; this is obviously connected with their large size and ready availability.

Afronurus and *Acentrella* nymphs form the next most common food taken, and it is interesting to note that the latter, a free-swimming type, has a higher availability than the former, a flattened crawler, even when calculated on drift percentages (3.5 and 3.0).

In this connection, however, it is surprising to note the very high availability factor for 1949 for the Ephemerid *sp. Nov.* (7.2), which is a very flatted crawler of the Caenid type, very difficult indeed to detach from stones.

Chironomidae and Coleoptera larvae in the Research Centre area form only a small percentage of the food, although their availability is apparently as great as that of *Baetis* and *Simulium* larvae; except that for the former the figure is less for drift samples (0.5) than for bottom samples.

Contrary to popular opinion in Kenya, the river crab *Potamon* forms a fractional percentage of the food taken, either as a total percentage, bulk percentage or frequency percentage; nor is their availability factor high (0.5). It is not an important item of the diet in any river yet studied.*

The method of calculating the percentage frequency of occurrence in stomachs however enables one to see more readily the relative value of those food animals, which constitute a fractional percentage of the total taken, and the larvae of *Goerodes* are a case in point (Fig. 8). They occur in over 60 per cent of stomachs examined, although in small total numbers. As they are more frequent in fringing vegetation and among vegetable débris than in gravel bottom samples, they are an indication that such gravel beds are not the sole source of trout foods. Hence also, the availability figure given for them in Table 11A is too high, since these are calculated on gravel samples only and not for all river habitats (Allen 1942) as they should be; although the figure would undoubtedly still be a high one with full quantitative sampling of all habitats.

Miscellaneous aquatic organisms eaten are merely casuals, such as Ancylid snails and tadpoles, but these are of little consequence in affecting the staple diet.

No support has been found for the theory commonly held that trout feed mainly at night. Stomachs are equally full of fresh undigested food at any hour of the day or night; though there is a tendency for rainbow to drop back to the shallow tails of pools in the evening, and feed on the drift there. This may be connected with light intensity, but does not argue a different feeding habit.

It will be noted also from Table 8 and Fig. 8 that the rainbow trout is a very indiscriminate feeder, and that no less than 35 per cent of the 1948 stomachs contained inedible items such as sticks, stones up to ¼ inch diameter, plant seeds and feathers. There is no suggestion that these things, such as stones, are taken for gizzard purposes, though these must be picked up either accidently or deliberately off the bottom; but the other items such as plant seeds and feathers are undoubtedly snapped up while floating past, as being possible edible. So much for the “exact fly imitations” on Kenya rivers!

Although food of terrestrial origin forms only a small percentage of the total food taken, and of the bulk, nevertheless it is found in 70 per cent of the stomachs for the year, and it is interesting to note the analysis of such terrestrial food as separate items (Table 8 and Fig. 8).

All these items are insects, except for some unimportant exceptions, and there is little point in classifying them further than the order to which they belong. The composition of such terrestrial foods is clearly a reflection of the wooded bank environments of the river in this Research Centre area.

Hymenoptera Formicoidea (ants) are taken in far greater quantities than other terrestrial foods, and nearly all these are of the well-known “siafu” or “safari” types (Dorylines).

These are common in forestland, and much addicted to forming living bridges over small stretches of water, and climbing trees overhanging the river in order to cross – from whence they are easily dislodged into the water. Tree-haunting ants of other species are not uncommon in stomachs. Ants of all types are greedily eaten by rainbow trout, even the large soldier forms; these latter have been the cause of death of many fry in the rearing ponds, their jaws paralysing the mouth of the fry with their bite.

Next in importance amongst terrestrial foods are beetles of various kinds, again common inhabitants of the forest floor and readily falling the water.

The only aerial foods of aquatic origin which are eaten in significant quantities by trout are Trichoptera, nearly always *Chimarrha* sp.; most of these appear to be taken while emerging from the pupal stage, and should really be classed as aquatic foods; their availability factor obviously increases with the later stages of their life history.

Hemiptera of various species, again common inhabitants of trees and bushes overhanging the river, are also taken by a high percentage of trout, as are various Diptera adults (often Simuliidae and Chironomidae, again of aquatic origin). Mayfly imagos form a negligible percentage of food, unlike temperate regions, even when emerging nymphs; this is rather curious considering their abundance in the river, but their “penny number” hatching habits have been described in Part II, and at any one time there is no great abundance of emerging adults.

Other insects, such as grasshoppers, caterpillars, bees*, wasps and termites (worker forms) form a very small percentage of the food eaten, but spiders are not uncommon articles of diet.

Miscellaneous terrestrial animals such as frogs, small rodents, millipedes, etc., form a negligible percentage of the food in such forested areas.

*In the Gura open waters bees are often taken. The bee comes down to drink and often sits on a stone to do this. A wavelet comes and washes the bee off and it is carried downstream. The bee seems unable to get off the water and is held by the water skin. H.C.

(2) SEASONAL VARIATIONS:

Stomachs were collected as regularly as was possible in the Research Centre area throughout the year 1948, but since the numbers per month varied considerably, these have been grouped into quarterly intervals in order to determine any seasonal variations (Table 8 and Fig. 9).

It has been pointed out in Part II that the bottom fauna shows little or no seasonal variation in the composition of its constituent organisms, only the total numbers varying with the flood season. Hence it would be expected that, unless the trout change their feeding habits during the year, their diet will also show no seasonal variation. Fig. 9 shows that this is indeed the case, and there is no season when the trout concentrate mainly on surface food, or vice versa as in temperate regions; nor any one season when they concentrate on any particular type of aquatic food. Their diet is monotonous throughout the year.

It will be noted however, that when the quarterly bottom sample percentages are compared with the quarterly trout foods (Fig. 9), the gradually increasing percentage of *Simulium* on the bottom throughout the year is also reflected in the diet of the trout, as is the conversely decreasing *Baetis* percentage. The trout are opportunists, and feed on what is commonest at any time.

Table 11B shows the seasonal variation in availability factors of the trout foods during the year, and there appears to be little consistency in these. *Baetis* is increasingly available throughout the year in spite of decreasing bottom percentages, as also is *Afronurus*, and *Acentrella*, *Hydropsyche* and *Simulium* are more available in the low-water season of January – March, Coleoptera larvae and Chironomids in the flood season of April – September. The reasons for the differences are obscure, but the variations are not apparently significant. Otherwise, as with the average diet for the whole year, each quarterly diet is almost a mirror image of the bottom fauna.

With regard to terrestrial foods, however, there is an indication this is present in trout stomachs in slightly greater percentages in April – June and July – September than in the other two quarters; this is probably due to the fact during the season of rain and floods, terrestrial food is more easily dislodged off the banks and trees, and is thus more available to the fish. Further, since most of the terrestrial food consists of ants, it is interesting to note that in the rainy season, ants of the “safari” type are most active above ground and thus most easily dislodged into the river.

The 1945-46 Sagana and Thego fish (Table 7. Fig. 13) are very similar in such seasonal aspects.

(3) VARIATION OF FEEDING INTENSITY WITH SIZE AND BREEDING CONDITION:

In order to determine the possible effects of size of fish and their breeding condition on their intake of food, all fish caught in the Research Centre area from April, 1948 to April, 1949 have been divided into immature fish, or ripe, spawning and spent fish of size groups 20-24.9 mm. and 25-30 cm. respectively (the two dominant size groups in the river).

As has been noted above, practically all rainbows, when caught at any time of the day or year, have full or nearly full stomachs, and there is no season when the trout undergo a fasting period, as in temperate regions with other species of fish (Hartley, 1947). Therefore, the feeding intensity has been calculated by totaling the number of food organisms found in each monthly sample of stomachs, since it is impossible to estimate “mean fullness” on a basis of full, half-full, or empty stomachs. The results are shown in Table 10 and Fig. 17.

Although the monthly numbers of fish are small when thus subdivided into four groups, the figures indicate that there is no constant significant difference in feeding intensity between small and large fish, or between immature and breeding fish of the size limits examined. There is an indication, however, when all the figures are graphed together as in Fig. 17, that the trout tend to have more food organisms in their stomach at time of capture during the flood months of November and April than at other times. The April 1949 figures are indeed high, and these fish were mostly caught during subsiding floods. This is natural, since during such floods bottom food is more readily dislodged by the force of the current, and thus is totally more readily available for fish.

These samples, however, have not included the occasional much larger fish of 2lb. and over, which are caught in the lower reaches of the rivers. Several of these have been examined from several rivers, and while they also always contain the usual assortment of smaller food animals such as *Simulium* and *Baetis*, they nearly always contain in addition much larger food organisms such as frogs, large grasshoppers, lizards, big dragonfly nymphs, large crabs and occasionally small rodents. There are not yet sufficient data of such from the Sagana River to construct a comparative table.

The selection is certainly a mechanical one, since such larger fish can more easily cope with such large items when available, than smaller fish, but they do not on the other hand, completely ignore the smaller staple items of diet.

In this connection, although very occasional authentic records of true cannibalism (that is to say trout eating trout) have been reported in Kenya, I have never come across a single case in several hundred stomach examinations, and it must be rare, as indeed can be deduced from the general size distribution of trout in Kenya rivers (*see* Parts V, VI, VII) which precludes any opportunity of cannibalism as a rule.

It may be remarked in passing, that the large, ugly fish which are occasionally caught by anglers and immediately dubbed as "cannibals, better out of the river" and bashed on the head "without mercy", have been in all cases examined (and probably all not examined also) nothing but old cock fish, with the kyped lower jaw and big teeth characteristic of old fish of this sex. Their stomach contents were perfectly normal, and they are no more potential cannibals than the beautiful, small-headed, silvery hens of equivalent weight.

(4) ALTITUDE VARIATION

The 1949 stomach results from Kabaru, the Research Centre, and Lower Sagana fish are shown in Table 9 and Figs. 10 and 11. As has been pointed out in Part II, there are qualitative differences in the bottom fauna at these three altitudes, and as expected, the food of the trout also reflects these qualitative differences.

In all three places, the trout appear to have selected *Baetis* nymphs as against the more common *Simulium* larvae; the availability factor of the former certainly appears to have been higher in general, and of the latter, lower than in 1949, and it may be a question of drift availability rather than selection (Table 11B).

Actually in the Lower Sagana (where the sample of fish is relatively small), the diet apparently differs considerably from the bottom fauna, *Simulium* being scarcely present in the trout food, while Odonata and Hydrocampidae occur in the stomach in fair percentages, while not present in the sampled fauna at all. The comparison is hardly a fair one, however, since the 1949 Lower Sagana fish were all caught below the Nairobi junction by spinning in deep pools - i.e. the very places where *Simulium* does not occur in abundance, and Odonata and Hydrocampidae are fairly common in the stiller water and fringing vegetation. Probably the 1945-46 Lower Sagana fish are a better comparison with the bottom samples (Fig. 12), since these were nearly all caught on fly, just above the Nairobi junction.

A similar remark probably applies also to the percentage of *Goerodes* larvae, though the availability factor increases with increasing altitude.

It is curios, however, that at Kabaru, the Chironomids are represented only poorly in the diet, although abundant in the bottom fauna, while exactly the reverse is true of the Research Centre fish. Different species availability is clearly involved, the figures being 0.2 and 1.9 respectively.

The availability of *Baetis* increases with decreasing altitude, that for *Afronurus* is greatest at the Research Centre in spite of their greater abundance in the Lower Sagana, while *Acentrella* is more available with increasing altitude, *Octhopetina* the reverse, and *Hydropsyche* similar to *Octhopetina. Simulium* availability increases slightly with increasing altitude as do Coleoptera larvae.

The presence of ephemerid *sp. nov.* at the Research Centre only and not elsewhere is reflected in the trout diet; and these have a surprisingly high availability considering their clinging habits as noted before.

The percentage frequency of occurrence diagrams (Fig. 10) demonstrate the qualitative differences even more clearly, and it is easily seen that: -

a) The gradually increasing frequency of occurrence of *Hydropscyche* in the river as it gets lower is faithfully reflected in the trout stomachs from Kabaru down, and as noted above it becomes more readily available.
b) *Octhopetina* shows a similar trend in abundance and availability.
c) *Afronurus* is similar, but the availability varies.
d) Odonata show a similar trend.
e) The aquatic Coleoptera larvae and *Acentrella* nymphs occur in increasing percentages of trout stomachs from the Lower Sagana up to Kabaru, as they do in the corresponding bottom samples, while their availability also increases as noted above.

Other minor correspondences can also be found, and these facts demonstrate even more clearly the point that in general the trout diet is a good reflection of the bottom fauna present and available, and there is little preference for a particular food throughout the river, though the question of selection is a complex one (Allen 1942) and should not be confused with availability.

These results also show that the method of recording trout food by percentage frequency of occurrence in stomachs is probably a better way of indicating their diet than either total percentage of bulk, especially when only small numbers of individual food organisms are concerned.

Turning to terrestrial foods, it is noteworthy that in the two forested areas of Kabaru and the Research Centre, ants again form the main items taken, with Coleoptera second. In the Lower Sagana, however, this position is reversed, Coleoptera being the chief terrestrial food taken, as also in 1945-46 (Fig. 12), and ants second. This is again a reflection of the bank vegetation communities.

Of interest also is the gradually increasing percentage of occurrence of white ants, the further down the river. They are indeed almost absent in the forest at the Kabaru altitude, and common in the open Native Reserve area.

For some reason, Trichoptera imagos are more readily taken in the Research Centre area than elsewhere.

The frequency of occurrence of sticks, stones, feathers, etc, in trout stomachs in all three areas is remarkably alike; and obviously altitude has no effect on this particular feeding habit.

(b) **Rainbow Trout in other Rivers**

The food of rainbow trout in the Thiba and Kiringa rivers has already been described by van Someren (1946), and in this paper a comparison was made between trout food in the forest Thiba and Lower Thiba. Although quantitative bottom surveys of the Thiba have not yet been made, it is now clear that some of the differences found then were due to the same altitudinal variation of fauna as found in the Sagana. Thus *Afronurus* (provisionally called *"Rithrogena*" in the paper quoted) was found to be more common in Lower Thiba stomachs, as it is in Lower Sagana stomachs and bottom samples.

No attempt has yet been made intensively to survey food supplies and food of trout in other Kenya rivers, nor is it expected that such would show much significant difference to the Sagana, since aquatic fauna appears to be so uniform over Kenya generally.

A few collections were made from other rivers in 1945-46. These comprise 19 rainbow from the Gura, 84 from the Thego, and 26 from the Ndarugu. The results are shown in Table 6 and Fig 12.

Since, as has been shown above, there is little seasonal variation in quality of food taken, these isolated surveys probably show the standard diet of the fish throughout the year.

The Thego fish were sufficiently numerous to split up into quarterly samples, as in Table 7 and Fig. 13 (based on bulk percentages). As in the Sagana, there is not noteworhty seasonal variation.

Fig. 12 shows that for these 1945-46 samples, in the Gura, Thego, Sagana and Ndarugu rivers the sub-aquatic diet of the trout is very similar, *Baetis* being the chief food, then *Simulium,* then *Hydropsyche* and *Afronurus* in all four rivers. The slight differences apparent are due tot the different altitudes at which the fish were caught, and are purely local.

The Gura and Ndarugu rivers are mainly open-banked in the public fishing reaches from which these samples were taken, and not forested like the Sagana and Thego. Although no bottom samples have been taken, the Gura food supplies must be very similar qualitatively (though not necessarily quantitatively) to that of the Sagana and Thego.

The Ndarugu differs from the previous three in being a very much smaller river, scarcely 6 ft. wide, with several canal-like stretches. To this greater length of stiller water is almost certainly due the greater abundance of Odonata nymphs in the diet, since these prefer such quiet water conditions.

The greatest local differences are noted with regard to the types of terrestrial food taken. As in the Sagana, however, this forms in all rivers less than 10 per cent of the total food eaten, although between 50 and 70 per cent of the stomachs contain such terrestrial food. Thus on the Gura, although an open river, ants form the chief item of land-derived food, and on the Thego, beetles and ants are almost equally important. White ants (termites) also bulk large in the Thego diet, less so on the Gura.

Caterpillars and miscellaneous flies occur in both in small quantities, but on the Ndarugu caterpillars and grasshoppers are by far the most abundant terrestrial food, and beetles are surprisingly absent.

These variations in terrestrial foods taken are a reflection only of local conditions prevailing at the time of capture and are not necessarily indicative of yearly averages. Terrestrial insects show much more seasonal variation in abundance and quality than do aquatic fauna.

All the Ndarugu fish were caught in one day, and samples over a whole year would show a different terrestrial food picture; caterpillars are very seasonal insect stages.

Again stomachs from all these rivers show a high (30 - 40 per cent) percentage of inedible trash such as sticks and stones; the Ndarugu fish show such matter in over 60 per cent of stomachs. It appears a widespread habit among rainbow trout.

(c) **Brown Trout**

Brown trout are found exclusively in the North and South Mathioyas and Maragua River on the eastern Aberdares, and in one or two rivers elsewhere recently stocked but not yet open to fishing. They are also found exclusively in the upper reaches of the Gura, Thika Chania and Thika, in whose lower waters they mix with the much more numerous rainbow.

Brown trout stomachs from the North Mathioya have been examined in 1946 (31 fish), 1948 (36 fish) and 1949 (4 fish); from the South Mathioya 1945 (7 fish), 1949 (27 fish); and from the Maragua in 1949 (27 fish).

These samples are sufficiently large to form an estimate of the diet of this different species, and the results are shown in Table 11 and Figs. 14 and 15.

Bottom samples from the North and South Mathioya and Maragua were collected in January-February, 1949, when they might be expected to be richest (Part II), and are shown in Table 3 and Fig. 15. Altitudinal differences in these rivers, in the qualitative composition of the bottom fauna, are evident as in the Sagana, but the samples of trout were not sufficiently well distributed over these altitudes to make a stomach comparison worth while for each altitude. Hence Fig. 15 shows the stomach contents compared with the average percentage fauna composition for the whole of each river.

As we noted in Part II, the bottom fauna composition of these open Aberdare rivers is somewhat different qualitatively and quantitatively from the Sagana, though *Simulium* and *Baetis* are still dominant forms. Although the former of these are by far the most dominant bottom organisms, yet they form only a small percentage of the food eaten, and their availability factor is the same as for the Sagana rainbow (Table 11A); but *Baetis* nymphs, which are less abundant in these rivers than in the Sagana are grazed upon by brown trout to a greater extend than are *Simulium,* and in fact their availability factor is much higher (Table 11A). Unfortunately drift samples were not taken in these three rivers, and whether this higher percentage of *Baetis* nymphs in brown trout diet represents an actual selectivity, or whether brown trout are greater drift feeders than rainbow is not easy to say. Certainly brown trout do not appear to be such active feeders as rainbow.

Trichoptera again (*Hydropsyche, Goerodes, Leptoceros*) show high availability factors, and are eaten in considerable quantities, but again this does not necessarily imply active selection by the trout in preference to other foods. By comparison with rainbow, although the constituent elements of the diet are much the same, and *Simulium* and *Baetis* still form the chief foods, there appears to be a qualitative difference in the proportion in which all foods are eaten, with reference to the actual quantitative faunal differences; thus for example crabs occur in a far greater percentage of brown trout stomachs. Although these are seldom caught in bottom samples, they may in fact be more common in these three rivers than in the Sagana.

A true comparison of the diets and feeding habits of the two species can only be made when rainbow and brown can by analysed from the same river whose bottom fauna is known. Allen (1942) has pointed out that availability factors do not generally show significant differences between different species of fish, although they change with the size of the fish, and it may well be that the differences noted in Table 11A, particularly with the Ephemeroptera, are influenced by selection, since the size groups of fish are similar.

Although *Simulium* occur in such small total numbers in brown stomachs, nevertheless they occur in almost as great a percentage of stomach as do *Baetis, Hydropsyche, Goerodes, Leptoceros* and *Acentrella.*

As in rainbow, less than 10 per cent of the food taken is terrestrial in origin, and only 50-60 per cent of the stomachs contain such food in each river. There is thus no evidence, as has been claimed, that brown trout take surface food more than rainbow. Their supposed ability to rise more freely to an artificial fly is a different matter, and would be a behavioural feature unconnected with their standard natural diet.

The nature of such terrestrial diet is again an indication of the bank environment and season of capture.

In 1946, grasshoppers formed the main surface diet in the North Mathioya (Fig. 12), and also interestingly enough, there was also in these 1946 stomachs nearly 20 per cent of Ephemerid imagos, taken after a spinner fall. Such quantities have not been found in rainbow.

In 1948, however, grasshoppers and Ephemerids were absent, and the stomachs contained only beetles, flies, bugs and caddis flies. This terrestrial food portion of the diet is clearly a very variable thing, and samples at only one time of the year cannot indicate the general aerial yearly diet, as they do for the greater portion of aquatic food.

In the open Maragua and South Mathioya rivers, beetles again form the bulk of the aerial diet, with ants and caterpillars a close second. Grasshoppers, bugs and caddis' flies (taken as emerging pupae) also occur fairly frequently.

Like rainbow trout (and *pace* to those purists who believe otherwise), the brown trout is also an indiscriminate feeder on inedible trash, from 60-80 per cent of the stomachs containing such. In brown trout, however, small stones up to ¼ inch in diameter are much more frequent than in rainbow, and in one stomach from the North Mathioya no less than 34 of such were found. They are so frequent in brown stomachs in fact that one is tempted to think that they must be taken to deliberately for gizzard purposes as in crocodiles and some birds. In this connection it is surprising how both brown and rainbow trout can quite easily eject a hooked lure as in "short rising", and yet swallow such inedible debris.

Summing up, the brown, like the rainbow, appears mainly an opportunist feeder, taking what the river and surrounding banks offer most commonly available, in the proportions in which such food is offered.