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The fish populations of the River Avon, Hampshire, downstream of Salisbury, in 1987

by

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CONTENTS

SUMMARY

1. A survey of the coarse fish populations in the River Avon, Hampshire, between Salisbury and Sopley was made by FBA personnel in September and October, 1987. Twelve river sites, mean length 236 metres, were electrofished using a multi-anode apparatus mounted on a boat. Three weir pools were examined using conventional single-anode electrofishing gear.

2. The fish species of particular interest were dace, roach, chub and pike, but data were collected for other species, notably barbel. Information was obtained on fish species distribution, age and growth, population densities (numbers and biomass), and variations in recruitment success in previous years as indicated by the age-structure of each species. Comparisons were made with available data from other rivers in England.

3. Dace, roach and chub grew faster than in other English rivers, but pike growth was the same as in the R. Frome and R. Stour, Dorset.

4. Juvenile dace grew progressively faster with increase in distance downstream of Salisbury, but juvenile roach grew best in the upstream sites where many were reared under protected conditions. The uneven distribution of juvenile fish along the river suggests that spawning and nursery areas are limited.

5. The strengths of different year-classes varied greatly and, though similar variations are found in other rivers in England, the data suggested that fish aged 6 years or more are under-represented in the populations. Of older year-classes, only that from 1976 was prominent; this is especially evident for chub.

6. Mean biomass data indicate that the Avon compares well with other UK coarse fish rivers for which data are available. The wide variations in stock levels between the 12 survey sites can be explained, in part, by the

shoaling habit of many species of coarse fish. However, the low numbers of roach in the downstream sections, which appeared to be suitable habitats for the species, could not be explained.

7. There were few obvious signs of diseased or parasitised fish, and no barbel were found with abnormal barbel formations.

1. INTRODUCTION

The objective of this study is to describe the present status of the coarse fish populations of the River Avon, Hampshire. The agreement with the Department of the Environment and Wessex Water Authority was to examine the populations of coarse fish at 12 river sites as well as selected weir pools between Salisbury and Sopley, with particular reference to dace, roach, chub and pike. The study was to include age and growth determinations, estimates of population numbers and biomasses, and examination of variation in recruitment success as indicated by the age composition of each species.

The study arose from a widespread concern among anglers and riparian owners that fish numbers had decreased since the early 1970's, and from a scarcity of accurate information on population densities on which to assess this complaint. It was realised at the outset that, without such information from earlier years, the survey would not reveal the extent of any decline in the fisheries. Further, the survey was not designed to establish the impact of potential perturbations (e.g. weed-cutting, trout farms, water abstraction, loss of water meadows, increased predation) on fish numbers, though some independent newspaper articles suggested this to be so.

The results of the survey are compared with available data from other rivers, chiefly the nearby R. Frome and R. Stour. They may be used to assess any future changes in population densities and growth rates, and to indicate promising areas for future research.

The data were collected from a quantitative survey of twelve river sections along the fifty kilometres of river between Salisbury and Sopley, and a qualitative survey of three weir pools within the same area from 14 September to 9 October, 1987.

2. STUDY SITES

The twelve river survey sites (Figure 1) were selected after consultation with local riparian owners and fishery keepers, and in accordance with a number of pre-determined criteria:

- that the sites were representative of the R. Avon below Salisbury,
- that the sites had vehicular access to facilitate the transport of heavy electrofishing equipment, boat and nets to the river bank,
- that the river depth was suitable for the electrofishing boat (i.e. not less than 0.5 m deep),
- that permission for access and electrofishing was available from riparian owners (none was refused at any site).

Details of the site numbers, site names, grid references and areas sampled are provided in Table 1. The exact length of each section was constrained by the ease of vehicle access, the position of suitable places to set the upstream and downstream stop-nets, and by the time estimated to carry out four successive electrofishings.

A sketch map was made of each site, showing general features (bridges, trees etc.) and the stop-net positions.

The weir pools at Wild Weirs (double pool system), Breamore and Ibsley (lower pool only) were selected for qualitative sampling because such pools often hold large numbers of fish. The samples provided additional data on species distribution, age and growth, but were not used in population estimates.

3. METHODS

3.1 Sampling Procedure

The Avon is a fast-flowing, occasionally deep river, of high conductivity (c. 550 micro-siemens) and contains extensive areas of aquatic macrophytes, chiefly Ranunculus. These are all factors that make

electrofishing difficult and preliminary trials, in conjunction with the Wessex Water Authority, were designed to find an effective system. The method selected was a multi-anode, boom boat demonstrated by the Severn-Trent Water Authority. The equipment for the survey was built at the FBA River Laboratory to a design provided by the S-TWA. Figure 2 shows the general arrangement of the equipment; the pulsed d.c. output at the anodes was c. 18 amps, 230 volts at 100 pulses sec^{-1}. This system was not suitable for sampling the weir pools, where a 0.5 amp, 200 volt, pulsed d.c. machine powered by a 0.8 kW generator was used, with a single-anode operator working from an inflatable rubber boat. Staffing levels for the boom-boat electrofishing are shown in Table 2.

The primary target species were dace, roach, chub, barbel and pike, but all species encountered were captured except eels, bullheads, stone-loach, minnows and lampreys (Table 3). The lengths of all fish were pricked onto 'Permatrace' tracing plastic to provide a permanent record of the numbers and lengths of fish caught in each fishing at each site. Scales were taken from most fish to determine their age. Fish were retained in floating keep-nets and returned to the river at the end of each day's electrofishing operation.

At each of the twelve river sections, stop nets (mesh sizes 20 and 25 mm knot to knot) were set at the upstream and downstream limits in order to prevent the gain or loss of fish in the area during sampling operations. The nets had extra weights and floats to enable them to hold position in the fast-flowing river. In the preliminary trials, the nets were set in shallow water but experience during the survey showed that deeper, slower-flowing areas were more suitable. No nets were used at the weir pools.

At each survey site, four successive electrofishings were carried out, each comprising two runs downstream each covering approximately half the

width of the river. Fish were caught by hand-nets from the boom boat, and from two inflatable rubber boats just behind the boom boat. All operations were overseen by a safety officer walking on the river bank, who could warn the boat personnel of operating difficulties.

At sites 3 and 7, additional fish were caught outside the study area after the fourth fishing. At site 6 a fifth fishing was carried out down the centre of the study reach. Data from these extra fishings were not used in the population estimates, but only to supplement the records for age and growth material.

3.2 Analysis of Catch Data

Population densities for each species at each site were estimated from the 4-catch data using the maximum-likelihood method of Zippin (1956, 1958). The Zippin method is based on the principle that the percentage number of a particular species caught at a particular site remains constant at each successive catch. This percentage represents the catch efficiency of that species at that site, and it can vary between species and between sites.

For example, assuming a particular site contains 400 roach and the capture efficiency for each catch is 50 per cent, the four successive catches would be 200, 100, 50, 25.

Catch 1. 50% of 400 roach = 200

Catch 2. 400 minus 200 = 200 roach remain in the section

50% of 200 = 100

Catch 3. 200 minus 100 = 100 roach remain in the section

50% of 100 = 50

Catch 4. 100 minus 50 = 50 roach remain in the section

50% of 50 = 25

The Zippin method computes the rate of decrease of successive catches, even when catch efficiencies vary between successive fishings, provided

that the variation is not too great. It also computes the total numbers of fish that will have been caught when the catch falls to zero. This total represents the population estimate. Confidence limits attached to this estimate are smaller with high and constant efficiencies, and are higher when catch efficiencies are low and variable (see Table 4 and Tables 7-11).

Computations were performed on a BBC microcomputer using the program described by Higgins (1985). In addition, the numbers of fish actually caught at each site were used as minimum estimates. They provided information on population density for samples in which the catch data were too variable for Zippin estimates. Such occasions were usually associated with low catch numbers and hence low population densities.

The estimates do not include 0 and 1 group fish because they were caught with low and variable efficiencies compared with older fish. Catch efficiencies for the five target species, based on combined data for all sites, ranged from 34 per cent (roach) to 52 per cent (barbel) (Table 4). Thus the mean capture efficiency for the five species was 42 per cent per catch, so that four successive catches took on average c. 88 per cent of the fish present.

Population estimates were converted to biomass estimates using data on the length-frequency distribution of each species at each site, and published length:weight relationships (Table 5). It was impractical to weigh fish during the survey because of the large number of fish caught and the time necessary to measure them and take scale samples. There was also a resistance by most fishery keepers to killing fish for further examination at the River Laboratory.

3.3 Age-Determination

Scales were collected from over 85 per cent of the dace, roach, chub, barbel and pike caught during the survey (Table 6). They were cleaned in

a 4 per cent solution of sodium hydroxide, washed and mounted dry between glass slides for examination under a 'Projectina' projection microscope. Exceptions were scales from younger fish in which annuli were clearly visible on unprepared scales.

For each species, ages were determined by one person and checked independently by another. There was very close agreement for all samples except for roach and chub of 12 or more years. Annuli on the edges of scales from these fish were difficult to separate (Mann 1973, 1976b), but corroborative information was obtained from opercular bone samples from Bisterne and Britford. As fish have to be killed to obtain the opercular bones, age-determinations by this method were very few.

4. RESULTS AND INTERPRETATION

4.1 Species Composition

The total numbers of the fourteen species caught during the survey (including extra sections and weir pools) are set out in Table 6. The list does not include the five species (Table 3) that were ignored during the survey. Trout include both brown and sea trout forms, whose juveniles cannot be distinguished from one another. The salmon catch was mostly of juveniles, but a few adults were also recorded. The adult catch at site 7 (Bickton) was high, but no record of numbers or lengths was kept; emphasis was placed on returning the fish quickly to the river away from the electrofishing area.

Only dace, chub, pike, gudgeon, and grayling were present at all 12 survey sites, although roach were only absent at one location. Barbel were nearly all found at sites downstream of Fordingbridge (one was caught just upstream) although there are records of them being caught by anglers further upstream. Bream, which are not native to the Avon, occurred in appreciable numbers only at site 2 (Longford Castle). Only

one rainbow trout was caught (site 7, Bickton), although there is concern among anglers that escapees from commercial trout farms may be major predators of juvenile coarse fish.

4.2 Population Estimation

The catch data and estimates of numbers and biomass of dace, roach, chub, barbel and pike at the twelve survey sites are shown in Tables 7-11 inclusive. There are few data from other English rivers with which to compare the Avon results, and the rivers included for comparison in Tables 7-11 show varying differences with the Avon in their geology, flow regime, water chemistry and fish species composition. The Frome is a chalk river and is the most similar to the Avon, but it contains fewer fish species. The main drainage of the Stour is off the Oxford Clay in Blackmore Vale, but its coarse fish community is similar to the Avon. The Eden is a small, hard-water, fast-flowing tributary of the River Medway in Kent. The Nene is a turbid, slow-flowing lowland river in Northamptonshire, which is subject to dredging. The Thames at Reading is a slow-flowing lowland river.

There was a large variation between sites in the population densities of the five species in the Avon, but overall dace were the most numerous fish (mean: 1.99 fish 100 m^{-2}), followed by roach (0.90), chub (0.72) and pike (0.60). The biomass data occurred in approximately the reverse sequence: pike (721 g 100m^{-2}), chub (710), dace (288) and roach (241). Barbel occurred only in the eight sites furthest downstream, and estimates are available only for sites 8-12. Mean values for these five sites were 0.30 fish 100 m^{-2} and 751 g 100 m^{-2}.

Compared with the River Eden, Kent (Hickley & Bailey 1982), the numbers of chub and dace were low but their biomasses were similar. This reflects the faster growth rate and larger average weight of chub and dace in the Avon. The mean numbers and biomass of pike were in the

range found in the River Frome and River Stour, Dorset (Mann 1980). Roach densities and biomass were much lower than recorded for the River Thames at Reading (Mann, 1964), and higher densities were also recorded in some sections of the River Nene (Hart & Pitcher, 1973).

The Anglian Water Authority classify their rivers according to fish biomass levels as determined in electrofishing and netting surveys. Their categories are: A. >2000 g 100 m^{-2}, B. 1000-2000, C. 500-1000, D. 0-500. On this basis, even without 0 and 1 group fish and species other than dace, roach, chub, barbel and pike, the Avon would rank in category A. The mean biomass over the 12 sites was 2272 g 100 m^{-2} with a range from 873 at site 5 to 5092 at site 7 (Table 12). Confidence limits, based on mean minimum and mean maximum population estimates, were 1842 to 3896 g 100 m^{-2}.

The highest biomass of dace and chub occurred at site 7 (Bickton), just downstream of a commercial trout farm. Figures 3 and 5 show the presence of substantial numbers of large fish at this site. In contrast, roach biomass was highest at sites 2-4, in an area where the local estate rears juvenile roach from native stocks and releases them back into the river (Table 12).

4.3 Age Structure

The age-compositions of dace, roach, chub and pike in the R. Avon are shown in Table 13 and indices of relative year-class strength (Mann 1973) from the Frome and Stour appear in Table 14. Data for roach at Woodgreen are not included in these analyses as large numbers were stocked in the summer of 1987 during the preliminary electrofishing trials. These roach came from a nearby lake and their age and growth pattern were not typical of Avon roach. Many of the introduced roach could be identified from their scale pattern, but there was a danger that some would be overlooked. Hence, no roach from Woodgreen were used in age

and growth analyses.

The dace, roach and chub in the Avon show evidence of irregular recruitment, with the 1976, 1982 and 1984 year-classes being well represented. The same strong year-classes were manifest in a synchronous set of data for dace in the Frome. Synchronous data are not available for roach and chub but indices of relative year-class strength, based on catches over several years, show the presence of strong and weak year-classes (Mann 1973, 1976b), with recruitment being exceptionally high in 1959 and 1964.

In the Avon, as for dace in the Frome, low recruitment is evident for the years before 1982, as can be seen from the relatively small numbers of fish older than age-group 5 except in the case of chub (Table 13). Only the 1976 year-class shows evidence of above average recruitment, and possibly 1977 for chub. Mills & Mann (1985) reported major variations in year-class strength for coarse fish in several European rivers, although the degree of variability for a particular species was not the same in all rivers.

4.4 Growth Rate

The length-frequency distributions of dace, roach, chub, barbel, pike and grayling at the twelve survey sites are shown in Figures 3-8. Juvenile dace (0 and 1 groups) increased in mean length from site 1 to site 12. This trend was still apparent in age-group 3 but not in age-group 5 (Table 15). Grayling also increased in mean length (Figure 8), but it is noteworthy that in the Avon at Upper Woodford, sixteen kilometres upstream of Salisbury, their mean length was similar to that below Ringwood (Mann, unpublished data).

Mean growth curves for dace, roach, chub and pike (Figures 9-12) were derived from the aged sub-samples. In general, growth rates were higher than in the R. Frome or R. Stour, except for pike which had a

similar growth pattern in all three rivers (Mann 1973, 1974, 1976a,b). Data for dace in the Avon at Upper Woodford showed that they grew faster than in the sites below Salisbury (Mann, unpublished data). On average, the lengths for age of dace, roach and chub were similar to those reported for the Avon at Britford, Alderbury Meadows and Trafalgar (Frake 1978).

4.5 General Condition of Fish

Although relative condition factors were not calculated, the team measuring fish and taking scale samples made general observations on the health of the fish. They found very few fish in an emaciated condition or with obvious symptoms of disease. None of the 132 barbel caught had an abnormal barbel formation, though photographic evidence from anglers shows that some fish with an extra barbel occur in the river.

5. DISCUSSION

5.1 Aims and Limits of the Survey

The aims of the survey, as outlined in the Introduction, were largely fulfilled and the use of electrofishing to survey a large river proved successful. The calculation of relative condition was not possible as it was impractical to weigh fish during sampling operations and only a small number of fish were killed for further examination. However, the loss of information is not great because the condition factor of a species changes markedly through the year and differs in male, female and immature fish (Mann 1973, 1974, 1976a,b). Hence, a single measure of condition has limited value, especially without internal examination of gonads.

The timing of the survey (late September/early October) meant that the location of spawning grounds was not possible, though some information on the distribution of 0 group fish was obtained. An autumn survey had the advantage that most fish had completed their growth for

the year and, therefore, length:age data collected at the start and end of the survey were compatible. In addition, many 0 group fish were large enough to be caught by electrofishing and, though the catches were too low and variable for use for population estimates, useful information on age and growth was acquired.

References are made in this Discussion to minutes of a meeting organised by the Department of the Environment at the Wessex Water Authority offices in Poole on 24 September 1987, at which parties interested in the welfare of the Avon fish populations could discuss river management problems. Some of the questions raised at the meeting are discussed also in the 1987 report by Wessex Water Authority on the status of the river.

5.2 Population Densities and Biomass

The shoaling habits of dace, roach and young age-groups of chub are reflected in the variation in their numbers in different sites. It is often a matter of chance whether a shoal that is moving up and down the river is in a study section at the time of sampling (Mann & Penczak 1986). The stocking of desired fish species is a feature of several of the R. Avon fisheries, but the dispersal of stocked fish among the native populations makes the impact of this management practice difficult to assess. However, based on scale characteristics, it seems likely that the high densities of roach at sites 2, 3 and 4 result from a supplementation of stocks by the local estate. Eggs that have been spawned naturally in the river are hatched under protected conditions and the young roach reared in ponds before being released into the river. This procedure will increase substantially the survival rate of 0 group roach during their vulnerable early months of life. The high growth rate during the first year could be seen on the scales of many older roach.

Lower densities of roach occurred in the downstream sections of river

whereas the reverse was true for barbel. In contrast, the dace, chub and pike occurred along the whole length of the river, and many pike (n = 31) were caught in the weir pools.

In general, biomass estimates were similar to those found in other rivers but estimates of population densities were lower. Exceptions were the pike, which occurred in similar numbers to those in, apparently, unperturbed rivers, and the large population numbers and biomass of roach in the Thames (Mann, 1964). The data on pike suggest that pike predation is no greater in the Avon than in other rivers, and this is supported by knowledge that pike numbers are controlled homeostatically (Mann 1982a,b). Pike are cannibals and, if the number of large pike in a population increases, then the number of juvenile pike eaten increases also. Thus, the potential number of large pike in future generations is reduced. This, in turn, leads to an increased survival of juvenile pike. Such a self-regulatory mechanism means that the predation by pike on other species is never excessive.

Predation on juvenile coarse fish by escapees from commercial trout farms was suggested at the Poole meeting, September 1987, as contributing to a decrease in fish stocks. However, only one rainbow trout was caught during the survey, which indicates that predation by this species is low, especially when compared with pike and chub.

5.3 Age and Growth

Many non-salmonid species of fish exhibit pronounced variations in year-class strength, which are often associated with changes in the environment, especially water temperature (Mills & Mann 1985). It is no surprise, therefore, that coarse fish populations in the Avon have an irregular recruitment pattern. Similarities in the age-composition of Avon and Frome dace suggest that any factors influencing population densities have not completely removed the effects of natural phenomena on

recruitment. At the Poole meeting, September 1987, it was suggested that the younger age-groups of fish were scarce. The length-frequency and age-composition data do not support this idea, but point to a numerous but uneven distribution of 0 and 1 group fish. However, age-groups hatching before 1982 appear to be under-represented, except for the 1976 year-class. In a single survey it is not possible to determine if fish aged 6 years or more have a poor survival rate, or that recruitment success before 1982 was less than in subsequent years.

The length-frequency data, supported by individual age-determinations, show that most 0 and 1 group fish were caught in the lower sections of the river. Moreover, growth conditions in the lower sections appeared to be more favourable, especially for juvenile fish. Older fish (e.g. 5 group dace) showed little intraspecific change in mean length at each age along the river, which may reflect their widespread movements up and down the river.

The mean growth rates of dace, roach and chub, for all the sections combined, were higher than those recorded previously in other British rivers, although dace in the upper reaches of the Avon grew even faster. It is also noteworthy that many of the largest and oldest fish of each species were caught at Bickton, just downstream of an effluent from a commercial trout farm.

6. CONCLUSIONS

The coarse fish populations of the River Avon below Salisbury showed a wide variation in population densities at the twelve sites examined. Juvenile fish were more abundant at the downstream sites; exceptions were pike at site 1 (Britford) and roach at site 2 (Longford Castle). Dace, roach and chub densities were lower than have been recorded in the rivers Nene and Eden but biomass levels were similar. Density and biomass

values for pike were in the range encountered in the Dorset Frome and Stour. The populations of some species may have been influenced by stocking, but an assessment of this practice was beyond the scope of this study.

Successful recruitment of 0 group dace, roach, chub and barbel has varied greatly between years, which is a common feature of these species in other rivers. The strong and weak year-classes of dace closely paralleled those observed in a synchronous set of data from the Dorset Frome. However, there was some evidence that the numbers of fish aged 6 and over were less than expected from the number of younger fish in the river. An exception was the large number of chub from the 1976 year-class.

The absence of comparable information on population density, biomass and recruitment from previous years makes it impossible to indicate if fish numbers have changed in recent years. However, the data do indicate that any factors that have affected population densities have not been sufficient to swamp natural variations in annual recruitment success.

The growth rates of dace, roach and chub were higher than in other UK rivers, but a higher growth rate of dace has been observed in the Avon above Salisbury. Pike growth was similar to that in the Dorset Frome and Stour.

Mean lengths of 0, 1 and 3 group dace increased in successive sites below Salisbury, but this trend was absent from older dace. 0 group grayling showed a similar pattern but 0 group pike did not. From scale readings of older roach, 0 group roach had a higher growth in sites 2-4, possibly because many were reared under protected conditions.

In terms of the mean biomass of fish available to anglers, the Avon compares well with other coarse fisheries in UK rivers. However, though dace and chub appear to be relatively evenly distributed along the river,

roach and barbel do not. It is of some concern to anglers that there are low densities of roach in the downstream sections where, from anecdotal information, large numbers once occurred. In addition, the distribution data for 0 group fish indicate that most species spawn only in selected areas of the river, even though there are apparently suitable sites elsewhere.

7. RECOMMENDATIONS

Many questions have been raised by the results of the survey, and the following points indicate areas that require further study:

a) In view of the observed progressive increase in growth (especially of dace) below Salisbury, it is recommended that sites upstream of the city should be examined in the near future. These sites should include the lower reaches of the two tributaries, the R. Nadder and R. Wylye.

b) Growth rates in fish are often determined largely by the water temperature regime during the growing period (late spring to early autumn). Thermograph records at intervals along the Avon would provide the data necessary to show the relative importance of temperature in creating the observed variation in growth patterns.

c) The absence of quantitative data prior to the survey makes it essential to repeat the survey, at about 3-4 year intervals, in order to determine if there are any trends in population densities, recruitment or growth.

d) It is not clear why most 0 and 1 group fish were found in the more downstream reaches, though there were some exceptions. The location of major spawning sites and nursery areas is necessary to explain this distribution pattern. Nursery areas are often associated with aquatic macrophytes; hence, a survey of aquatic plants in the river would be extremely useful.

e) The recruitment of 0 group fish is a major factor in determining the population density and age-composition of any coarse fish species. Various perturbations have been suggested as reducing recruitment success and specific studies are required to examine their influence. The potential perturbations, some of which are discussed in a WWA report (1988) are:

(i) Weed-cutting

(ii) Pollution - domestic, industrial, agricultural (including effluents from trout farms)

(iii) Entrapment of juvenile fish in trout farm intakes

(iv) Loss of nursery areas for juvenile fish through the loss of water meadows and other back-water areas

(v) Predation by pike, rainbow trout, herons, cormorants

(vi) Reduction in discharge through water abstraction

(vii) Increase in current speed through loss of weirs and hatches and to increased land drainage works

(viii) Changes in land use and farming practices throughout the catchment.

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Table 1

Details of the sites on the River Avon that were sampled for fish in September/October 1987
[Sites 1-12 are river sections, sites A-C are weir pools]

Site No.	Site Name	NGR	Length (m)	Area (m^2)	Sampling Date
* 1	Britford	SU 155257	175	1750	14 September
2	Longford Castle	SU 172265	225	4590	18 "
3	Standlynch	SU 182238	240	3360	17 "
4	Wild Weirs	SU 176221	235	3290	16 "
5	Woodgreen	SU 171181	265	5830	21 "
6	Burgate	SU 160164	225	4950	22 "
7	Bickton	SU 147123	110	1870	1 October
8	Ibsley	SU 143092	275	4950	23 September
9	Somerley	SU 142072	290	8120	24 "
10	Watton's Ford	SU 136013	220	4400	25 "
11	Bisterne	SZ 140997	260	6500	28 "
12	Sopley	SZ 148975	310	6400	30 "
A	Wild Weirs	SU 177218			9 October
B	Breamore	SU 163175			8 "
C	Ibsley	SZ 148095			5 "

*Manor ditch sampled, not main river
Sites 1-12 sampled quantitatively, sites A-C sampled qualitatively

Table 2

Outline of staff requirements for
main electrofishing survey

	Operation	No. of personnel
1. Multi-anode boat		
	Outboard	1
	Boom operator	1
	Hand nets	2
2. Two inflatable rubber boats		
	Oars	2
	Hand nets	2
3. Bank personnel		
	Fish processing	4
	Safety	1

[Additional assistance obtained at most sites from local fishery keepers]

Table 3

Fish species caught in the River Avon
in September/October 1987

Common Name	Scientific Name
Roach	Rutilus rutilus (L.)
Dace	Leuciscus leuciscus (L.)
Chub	Leuciscus cephalus (L.)
Barbel	Barbus barbus (L.)
Bream	Abramis brama (L.)
Gudgeon	Gobio gobio (L.)
Tench	Tinca tinca (L.)
Carp (Common & Mirror)	Cyprinus carpio (L.)
Pike	Esox lucius L.
Perch	Perca fluviatilis L.
Salmon	Salmo salar L.
Trout (Brown & Sea)	Salmo trutta L.
Rainbow Trout	Salmo gairdneri Richardson
Grayling	Thymallus thymallus (L.)

Species encountered but not caught: eel Anguilla anguilla (L.) bullhead Cottus gobio L., stone loach Noemacheilus barbatulus (L.), minnow Phoxinus phoxinus (L.), lamprey Lampetra sp.

Table 4

Catch efficiencies for 2 group and older dace, roach, chub, barbel and all age groups of pike

Site No.	Dace	Roach	Chub	Barbel	Pike
1	0.52	-	0.34	-	0.42
2	0.31	0.23	0.39	-	0.37
3	0.64	0.36	0.37	-	0.52
4	0.44	0.35	0.46	-	0.39
5	0.58	0.43	0.64	-	0.31
6	0.55	-	0.48	-	0.34
7	0.22	0.17	0.27	-	0.58
8	0.62	0.43	0.14	0.46	0.09
9	0.12	-	0.54	0.42	0.34
10	0.56	0.43	0.21	0.82	0.23
11	0.25	0.34	0.57	0.43	0.12
12	0.62	0.59	0.27	0.72	0.34
Overall (based on combined catches for all sites)	0.44	0.34	0.41	0.52	0.37

Table 5

Length:weight relationships used in converting population density estimates to biomass estimates [log Weight (g) = log a + b log Length (mm)]

Species	Length:Weight coefficient log a	b	River	Reference
Dace	-5.30	3.20	Frome	Mann, 1974
Roach	-5.46	3.30	Frome	Mann, 1973
Chub	-4.97	3.06	Stour	Mann, 1976b
Pike	-5.41	3.11	Frome	Mann, 1976a
Barbel	-4.57	2.86	Severn	Hunt & Jones, 1975

Table 6

Total numbers of fish caught in the River Avon survey during September/October 1987 and number of scale samples taken for each species

Site No.	Dace	Roach	Chub	Pike	Barbel	Gudgeon	Grayling	Bream	Carp	Perch	Tench	Salmon	Brown Trout	Rainbow Trout
1	81	1	9	39	0	4	33	0	0	0	6	0	0	0
2	99	101	11	32	0	40	3	30	6	1	0	0	1	0
3	89	158	8	26	0	33	2	3	4	6	1	0	7	0
4	43	67	24	14	0	33	1	0	0	0	0	1	2	0
5	116	39	12	19	0	12	14	2	0	2	0	1	10	0
6	36	29	38	9	1	10	14	0	0	5	0	2	0	0
7	66	12	54	21	4	5	1	0	1	19	0	6	1	1
8	98	13	41	8	15	18	3	0	4	4	9	25	0	0
9	94	0	36	4	16	3	5	0	0	2	0	13	1	0
10	93	15	5	6	23	10	10	0	0	0	0	15	1	0
11	176	14	28	6	70	13	14	0	0	0	0	36	6	0
12	282	56	51	21	20	60	2	1	0	2	0	26	5	0
Weir Pools	12	2	12	31	4	0	1	0	0	3	1	0	1	0
Total	1285	507	339	236	153	241	103	36	15	44	11	125	35	1 = 3131
No. Scales	1064	465	304	198	132	16	77	36	11	40	10	0	8	0 = 2361

Table 7

Estimates of population density and biomass of 2 group and older dace in the River Avon, September/October 1987

Site No.	Catch 1	2	3	4	Total Catch	No. 100m^{-2}	95% C.L.	Biomass g 100m^{-2}	Total catch as No. 100m^{-2}
1	48	14	10	6	78	4.69	0.37	451	4.46
2	34	34	18	10	96	2.70	6.67	391	2.09
3	36	6	3	4	49	1.48	0.07	178	1.46
4	9	4	4	1	18	0.61	0.16	69	0.55
5	70	20	9	8	107	1.89	0.09	340	1.84
6	24	3	5	3	35	0.73	0.07	112	0.71
7	14	18	12	5	49	3.93	2.18	856	2.62
8	17	2	2	2	23	0.47	0.04	54	0.46
9	18	26	12	15	71	2.18	2.83	271	0.87
10	15	7	3	1	26	0.61	0.06	81	0.59
11	42	26	28	14	110	2.42	0.78	375	1.69
12	91	27	11	8	137	2.19	0.07	273	2.14
R. Nene (Hart & Pitcher, 1973)						0.03-2.2		-	
R. Eden (Hickley & Bailey, 1982)						9.68		169	
R. Thames (Mann, 1965)						10.3		257	

Table 8

Estimates of population density and biomass of 2 group and older roach in the River Avon, September/October 1987

Site No.	Catch 1	2	3	4	Total Catch	No. 100m^{-2}	95% C.L.	Biomass g 100m^{-2}	Total catch as No. 100m^{-2}
1	1	0	0	0	1	-	-	(49)	0.06
2	16	9	7	8	40	1.34	0.89	648	0.87
3	59	21	20	18	118	4.28	0.07	761	3.51
4	25	15	18	3	61	2.26	0.54	612	1.85
5	20	8	2	6	36	0.69	0.12	110	0.62
6	4	10	8	5	27	-	-	(203)	0.55
7	3	1	3	1	8	0.78	1.70	336	0.45
8	2	3	1	0	6	0.13	0.06	35	0.12
9	0	0	0	0	0	0	-	0	0
10	2	3	1	0	6	0.15	0.07	7	0.14
11	4	4	2	1	11	0.21	0.13	61	0.17
12	15	2	2	2	21	0.34	0.03	70	0.33
R. Nene (Hart & Pitcher, 1973)						1.3-16.0		-	
R. Thames (Mann, 1965)						69		2017	

Table 9

Estimates of population density and biomass of 2 group and older chub in the River Avon, September/October 1987

Site No.	Catch 1	2	3	4	Total Catch	No. 100m^{-2}	95% C.L.	Biomass g 100m^{-2}	Total catch as No. 100m^{-2}
1	3	4	1	1	9	0.64	0.42	630	0.51
2	5	3	2	1	11	0.28	0.12	354	0.24
3	6	6	3	1	16	0.59	0.22	643	0.48
4	10	9	5	0	24	0.80	0.16	793	0.73
5	8	2	2	0	12	0.21	0.02	248	0.21
6	21	7	6	3	37	0.81	0.11	933	0.75
7	10	9	10	1	30	2.11	0.99	2915	1.60
8	8	9	7	5	29	1.29	2.13	679	0.59
9	21	9	2	3	35	0.45	0.04	454	0.43
10	1	2	2	0	5	0.19	0.40	184	0.11
11	15	6	4	1	26	0.42	0.05	311	0.40
12	17	11	8	6	42	0.88	0.37	372	0.66
R.Nene (Hart & Pitcher, 1973)						0.8-11.0		-	
R.Eden (Hickley & Bailey, 1982)						13.05		538	

Table 10

Estimates of population density and biomass of 2 group and older barbel in the River Avon, September/October 1987

Site No.	Catch 1	2	3	4	Total Catch	No. 100m^{-2}	95% C.L.	Biomass g 100m^{-2}	Total catch as No. 100m^{-2}
6	1	0	0	0	1	-	-	-	0.02
7	0	0	0	0	0	0	-	0	-
8	8	3	3	1	15	0.33	0.08	669	0.30
9	8	4	2	2	16	0.22	0.07	582	0.20
10	11	3	0	0	14	0.32	0.01	886	0.32
11	14	8	2	4	28	0.49	0.11	1336	0.43
12	5	3	0	0	8	0.13	0.01	282	0.13

Table 11

Estimates of population density and biomass of 0 group and older pike in the River Avon, September/October 1987

Site No.	Catch 1	2	3	4	Total Catch	No. 100m^{-2}	95% C.L.	Biomass g 100m^{-2}	Total catch as No. 100m^{-2}
1	17	15	3	4	39	2.49	0.46	2418	2.23
2	15	7	7	3	32	0.82	0.23	1016	0.70
3	11	6	3	1	21	0.66	0.10	769	0.63
4	6	3	3	1	13	0.46	0.20	437	0.40
5	8	6	1	4	19	0.42	0.23	175	0.33
6	5	0	3	1	9	0.22	0.15	335	0.18
7	7	3	2	0	12	0.66	0.09	985	0.64
8	3	0	4	1	8	0.51	2.87	914	0.16
9	2	0	2	0	4	0.06	0.06	69	0.05
10	3	1	0	2	6	0.21	0.36	651	0.14
11	2	1	2	1	6	0.23	1.03	700	0.09
12	9	5	5	2	21	0.41	0.18	177	0.33
R. Nene (Hart & Pitcher, 1973)						<0.1-2.0		115	
R. Frome (Mann, 1980)						1.59		686	
R. Stour (Mann, 1980)						0.61		458	

Table 12

Estimates of biomass (g 100m-²) for five coarse fish species of angling importance in the River Avon

Site No.	g 100 m-² Dace	Roach	Chub	Barbel	Pike	Total Biomass
1	451	49	630	-	2418	3548
2	391	648	354	-	1016	2409
3	178	761	643	-	769	2351
4	69	612	793	-	437	1911
5	340	110	248	-	175	873
6	112	203	933	-	335	1583
7	856	336	2915	-	985	5092
8	54	35	679	669	914	2351
9	271	0	454	582	69	1376
10	81	7	184	886	651	1809
11	375	61	311	1336	700	2783
12	273	70	372	282	177	1174

Table 13

Age-distribution of dace, roach, chub and pike in the River Avon and dace in the River Frome

Age Group	Year Class	No. of fish				
		Dace	Roach	Chub	Pike	Dace (Frome)
0	1987	234	26	25	63	-
1	86	201	90	3	36	-
2	85	76	44	6	32	36
3	84	280	92	33	38	472
4	83	145	47	33	26	195
5	82	193	77	18	22	205
6	81	15	11	5	5	89
7	80	13	3	4	0	4
8	79	1	5	3	3	6
9	78	4	3	12	2	1
10	77	4	4	50	1	0
11	76	10	7	95		5
12	75	1	2	18		
13	74			4		
14	73			4		

Table 14

Relative year-class strengths of roach and chub in the River Frome and River Stour
[Data from Mann 1973, 1976b]

Year Class	Roach (Frome)	Roach (Stour)	Chub (Stour)
1970	-	-	56
69	-	-	186
68	-	115	138
67	-	134	52
66	-	49	45
65	-	97	81
64	-	148	132
63	-	79	75
62	22	114	61
61	60	62	28
60	29	86	73
59	223	143	309
58	99	103	18
57	53	245	55
56	86	-	55
55	97	-	172
54	107	-	24
53	37	-	34
52	124	-	94
51	141	-	63
50	33	-	-

[Note: Indices can be compared only within species and within rivers]

Table 15

Mean lengths (mm) ± 95% C.L. of dace in the River Avon
in September/October 1987
Numbers in parentheses = numbers of fish

Age-group:	0	1	3	5
Site No.				
1	-	84 ± 12 (3)	167 ± 8 (15)	236 ± 9 (9)
2	-	85 ± 29 (3)	179 ± 6 (19)	218 ± 4 (43)
3	-	90 ± 6 (13)	169 ± 5 (30)	237 ± 6 (12)
4	53 ± 2 (10)	91 ± 5 (14)	179 ± 11 (10)	219 ± 9 (3)
5	56 (1)	97 ± 6 (8)	208 ± 5 (21)	248 ± 3 (41)
6	-	-	199 ± 7 (18)	246 ± 9 (9)
7	65 ± 3 (6)	107 (2)	211 ± 6 (17)	256 ± 9 (11)
8	60 ± 1 (59)	111 ± 5 (15)	184 ± 11 (8)	221 ± 8 (5)
9	65 ± 2 (14)	111 ± 7 (9)	193 ± 5 (25)	224 ± 5 (13)
10	68 ± 2 (46)	116 ± 5 (21)	199 ± 10 (12)	229 (2)
11	70 ± 2 (36)	118 ± 4 (30)	205 ± 3 (43)	238 ± 3 (26)
12	69 ± 2 (65)	121 ± 2 (79)	206 ± 3 (61)	236 ± 6 (10)

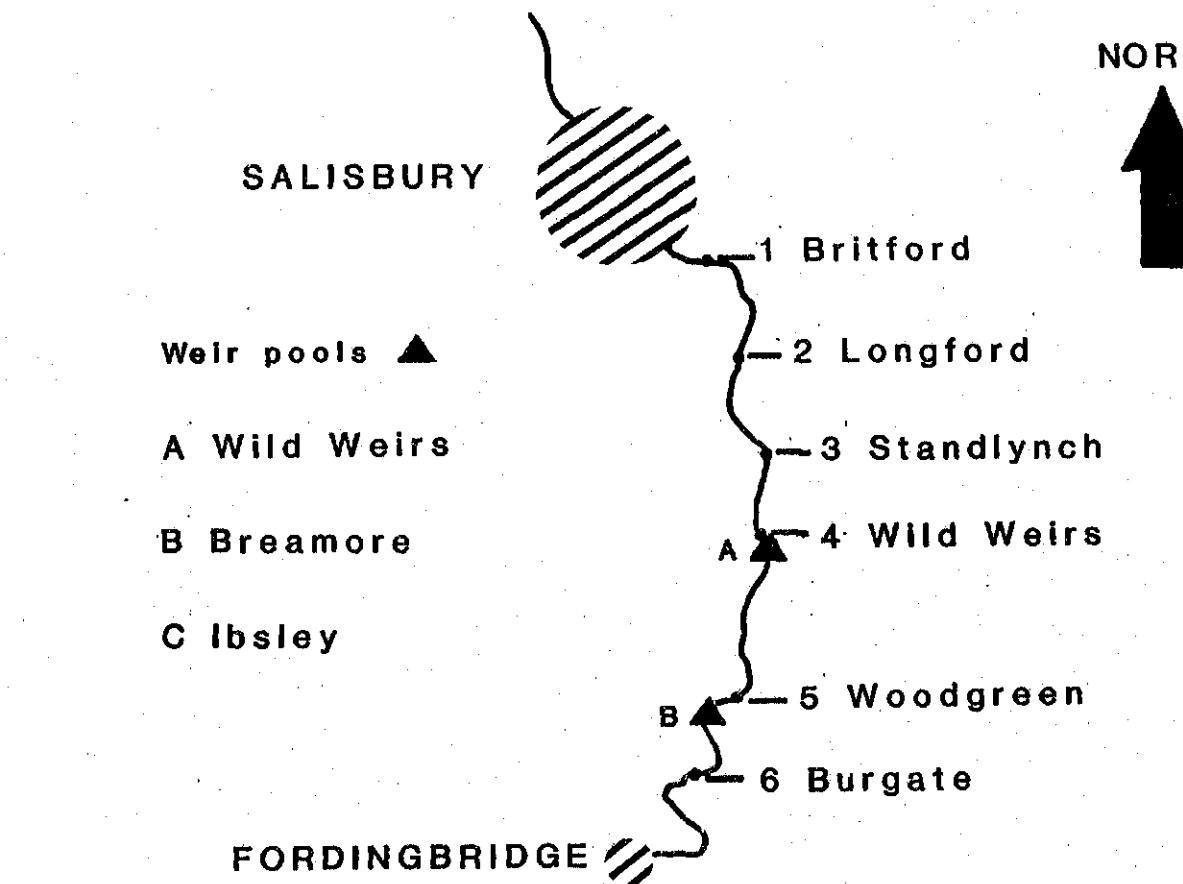

Fig. 1. Map of the River Avon below Salisbury showing the locations of the 12 survey reaches and 3 weir pool sites.

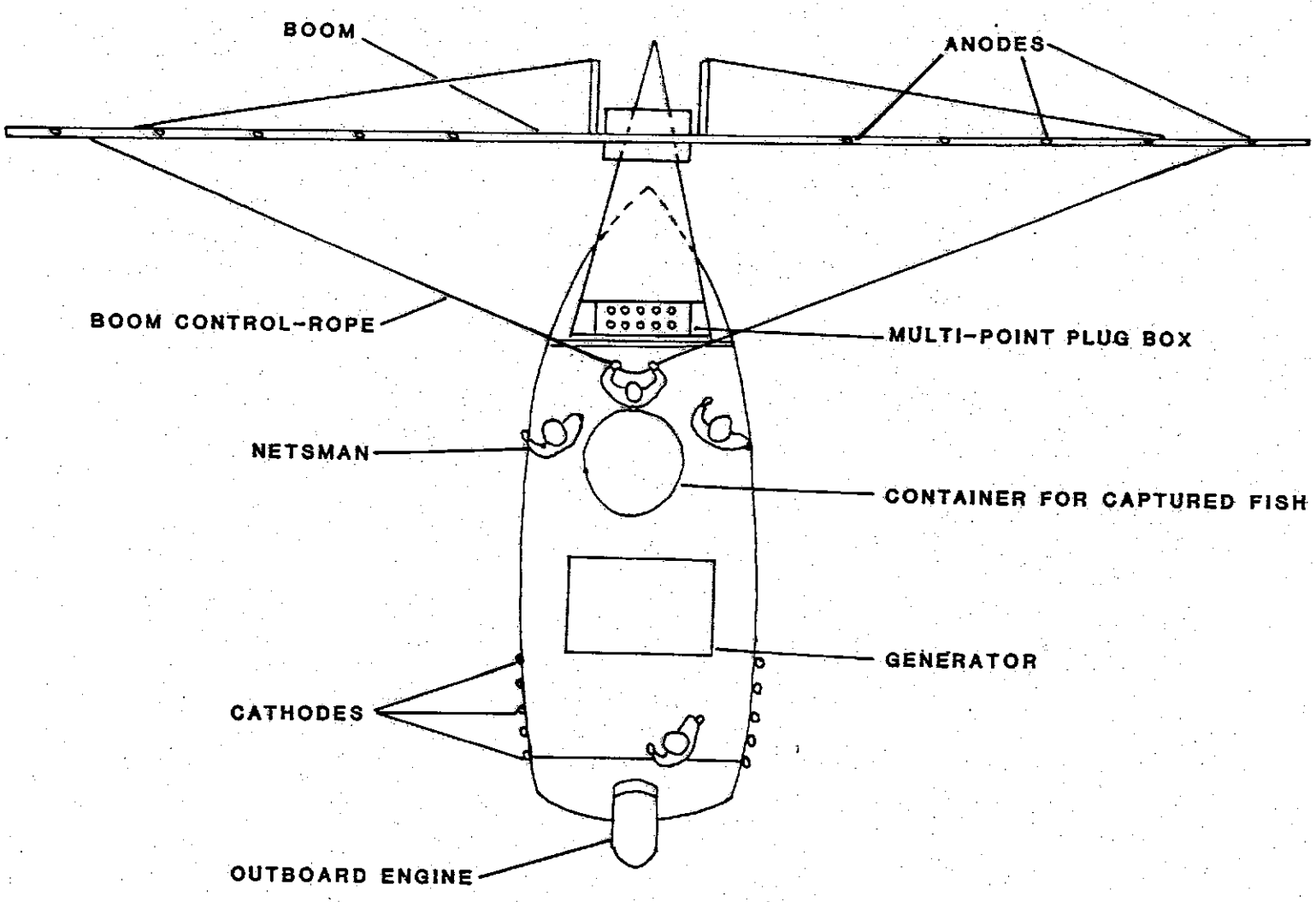

Fig. 2. Plan of the electrofishing 'Boom-boat'.

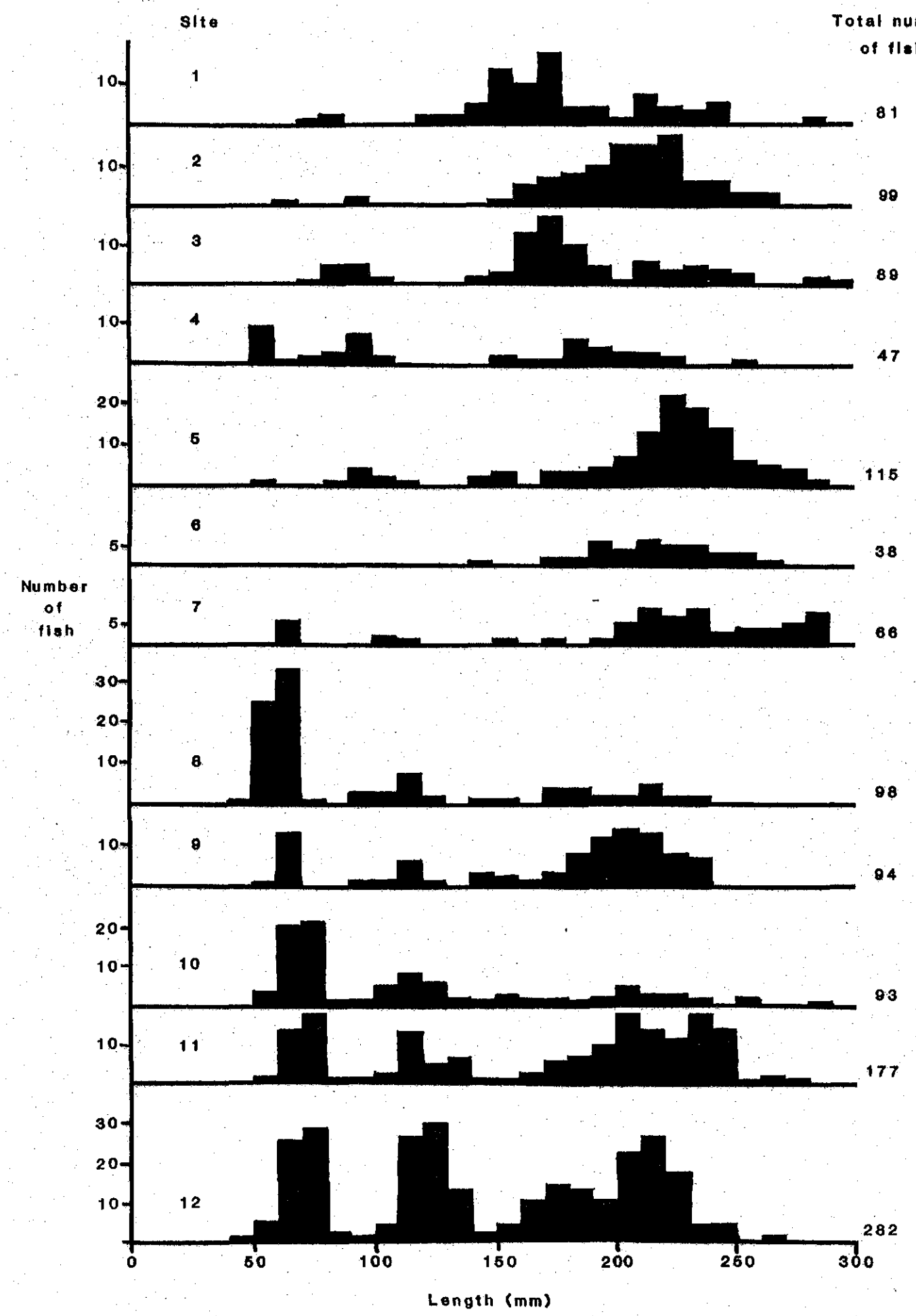

Fig. 3. Length-frequency distributions of Dace at 12 sites on the River Avon.

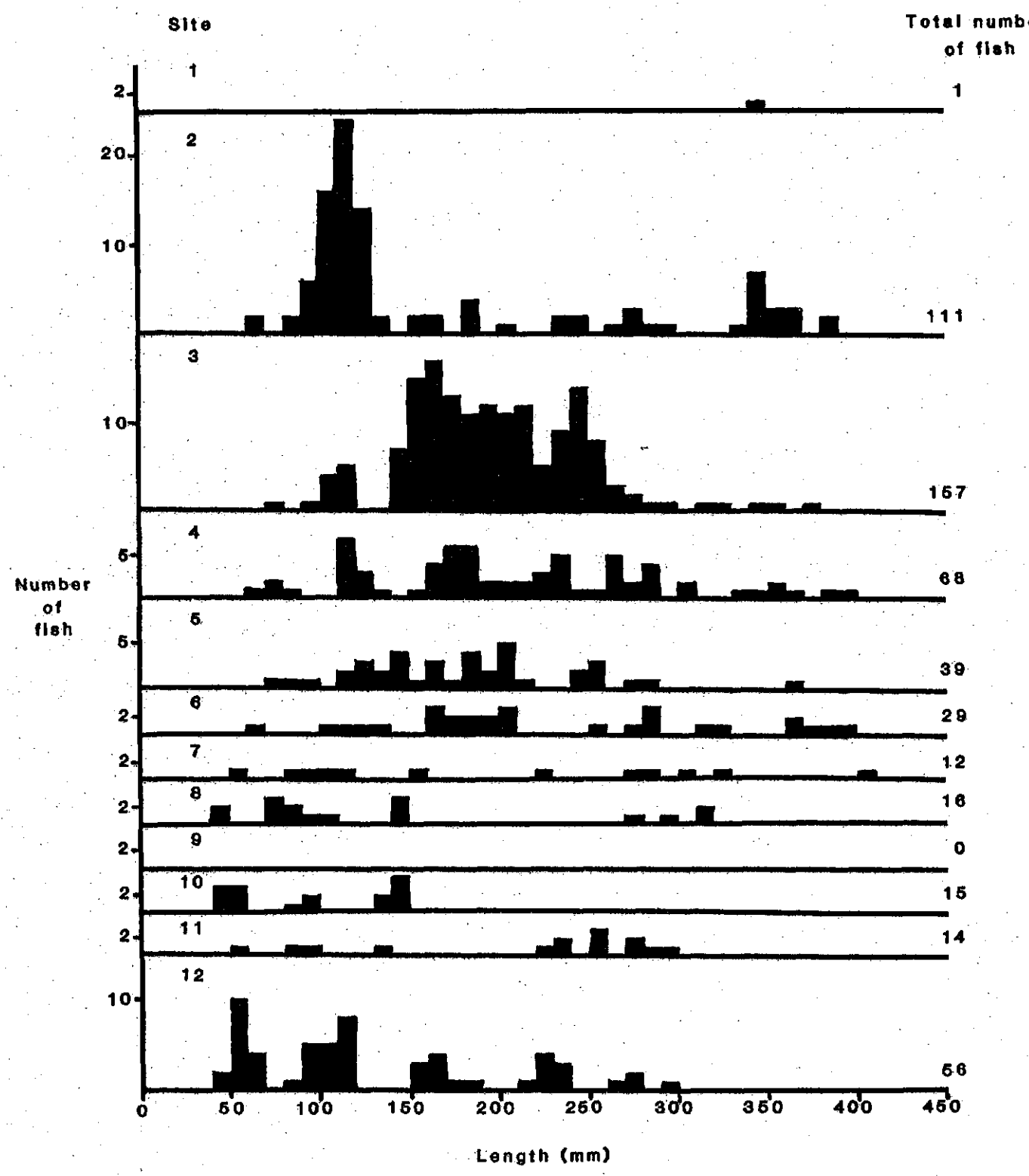

Fig. 4. Length-frequency distributions of Roach at 12 sites on the River Avon.

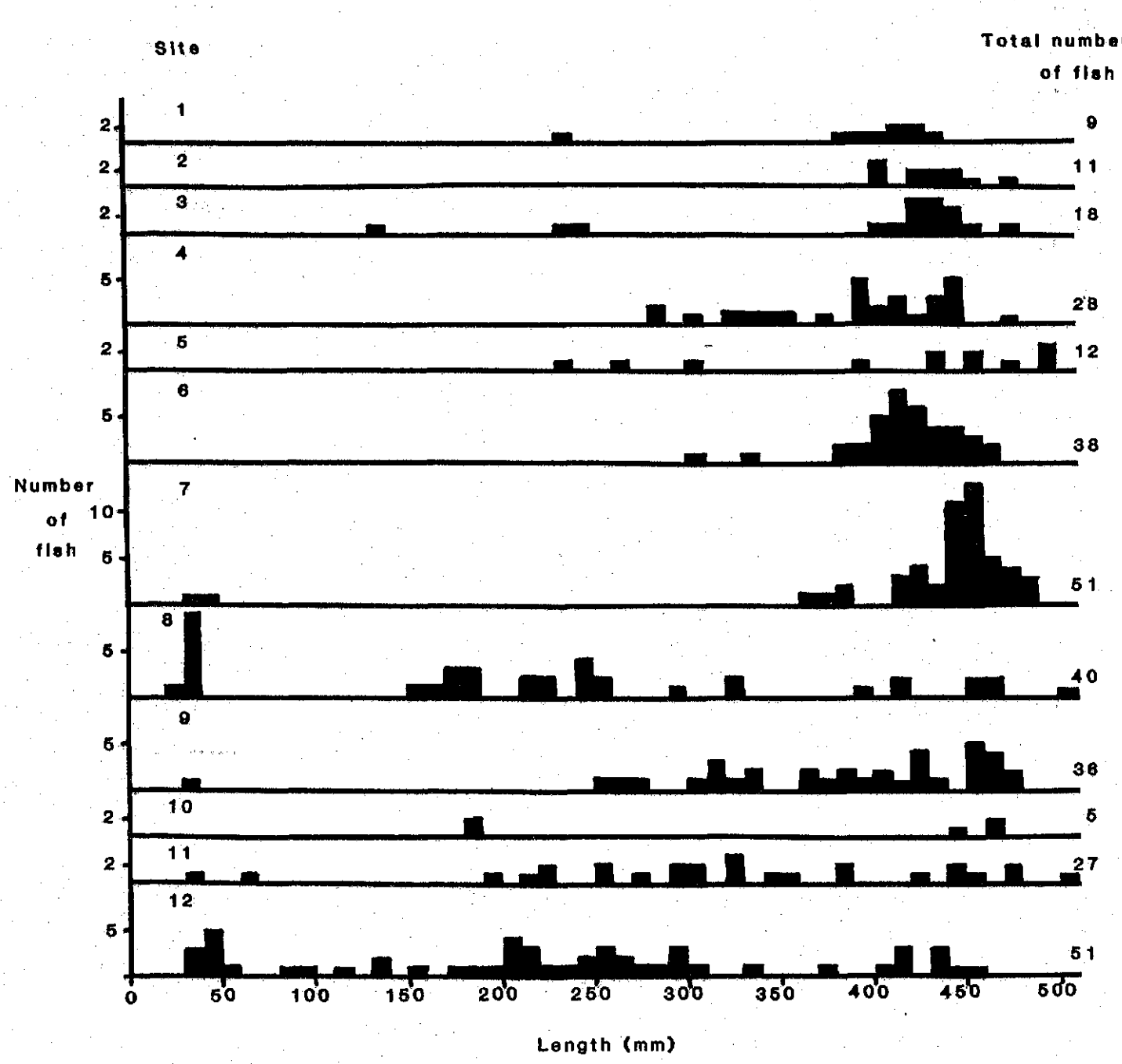

Fig. 5. Length-frequency distributions of Chub at 12 sites on the River Avon.

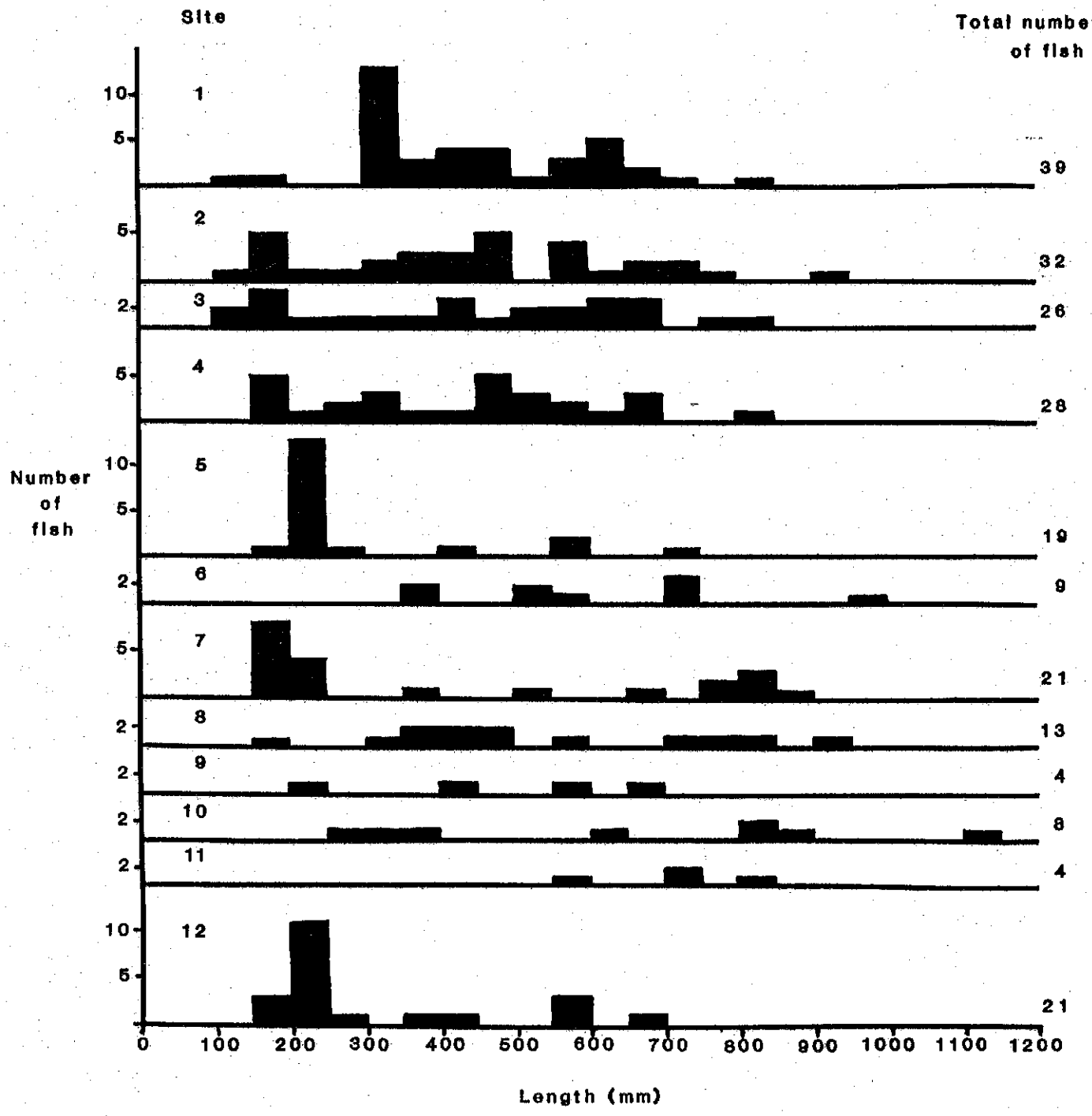

Fig. 6. Length-frequency distributions of Pike at 12 sites on the River Avon.

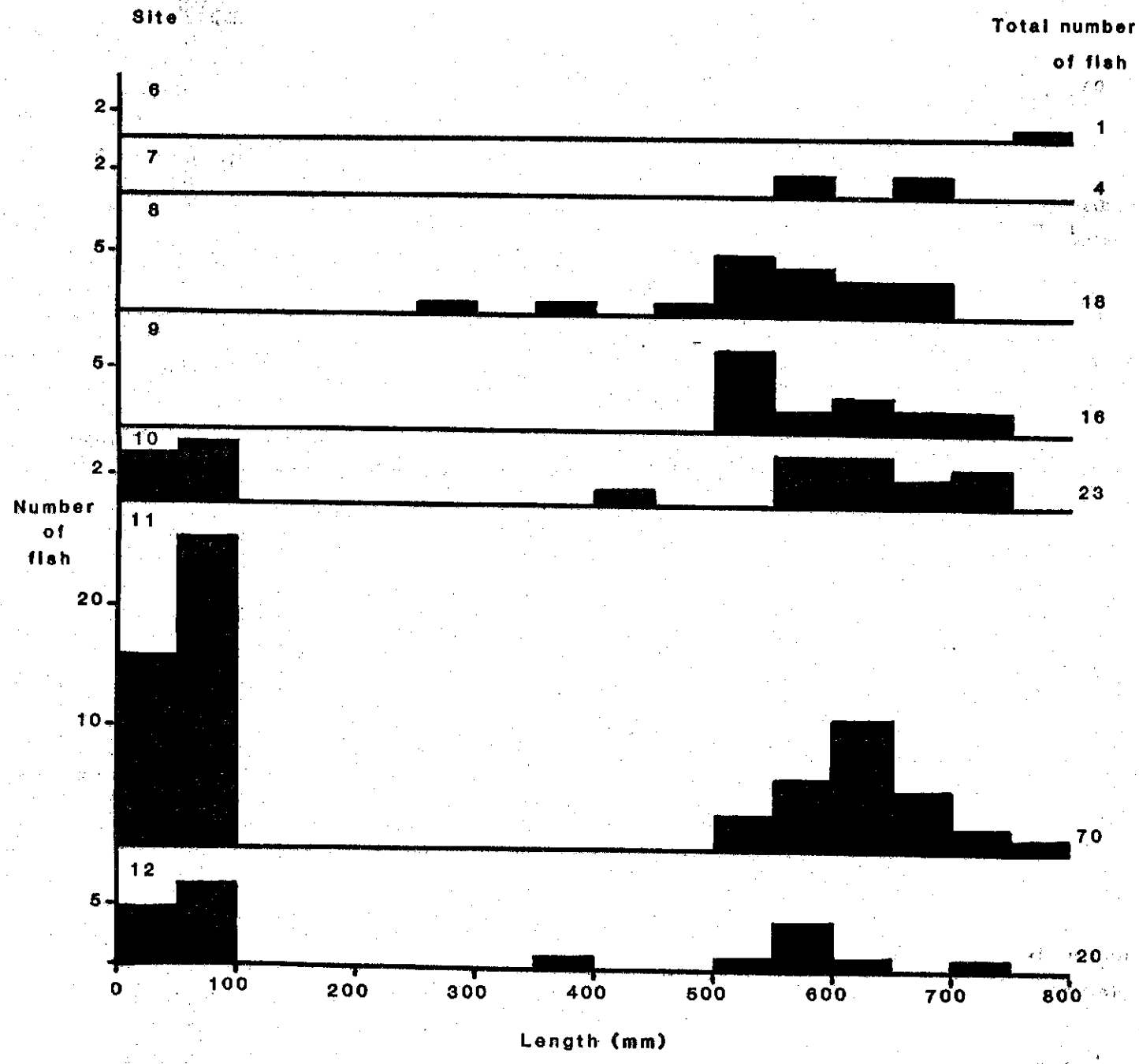

Fig. 7. Length–frequency distributions of Barbel at 7 sites on the River Avon.

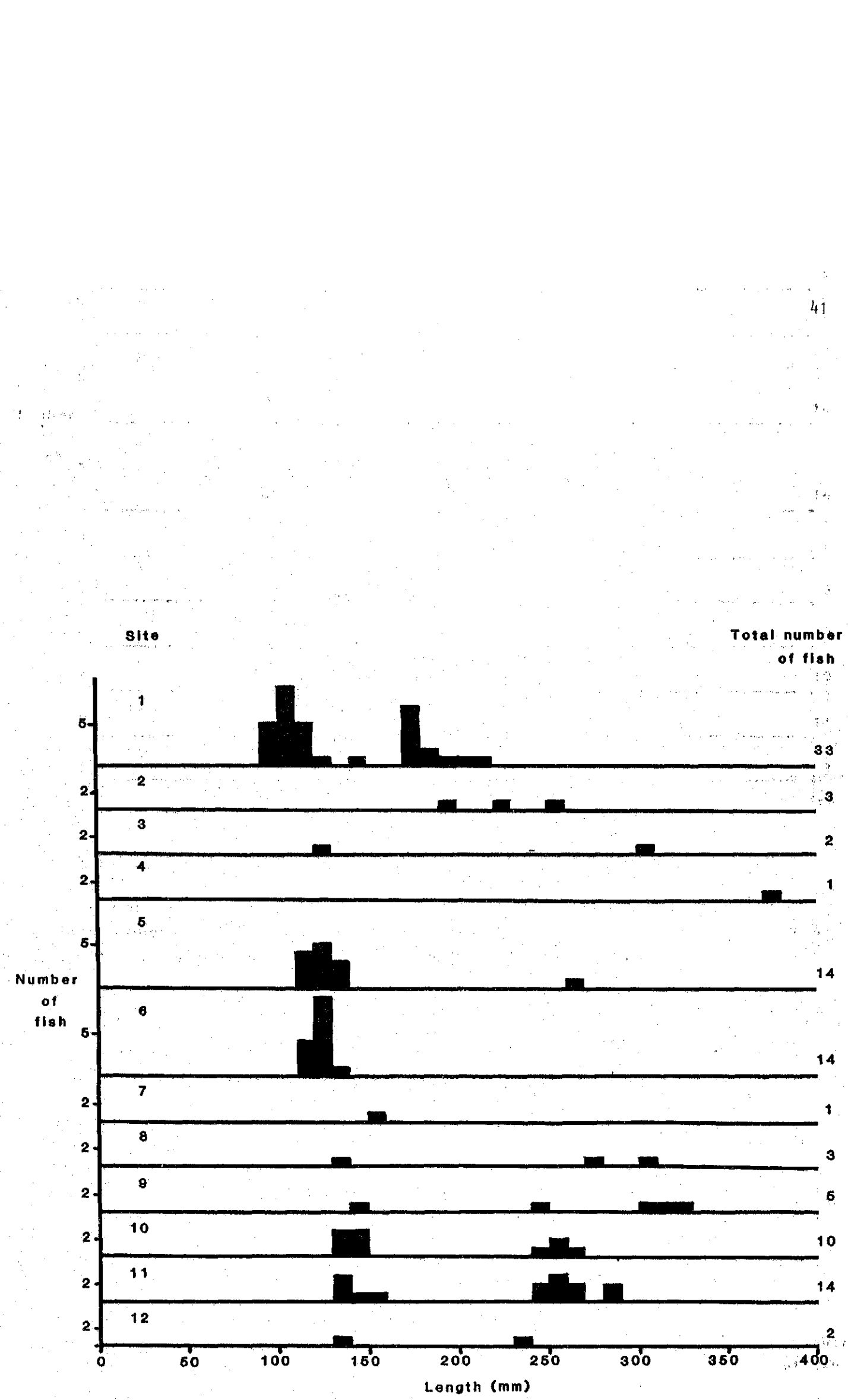

Fig. 8. Length-frequency distributions of Grayling at 12 sites on the River Avon.

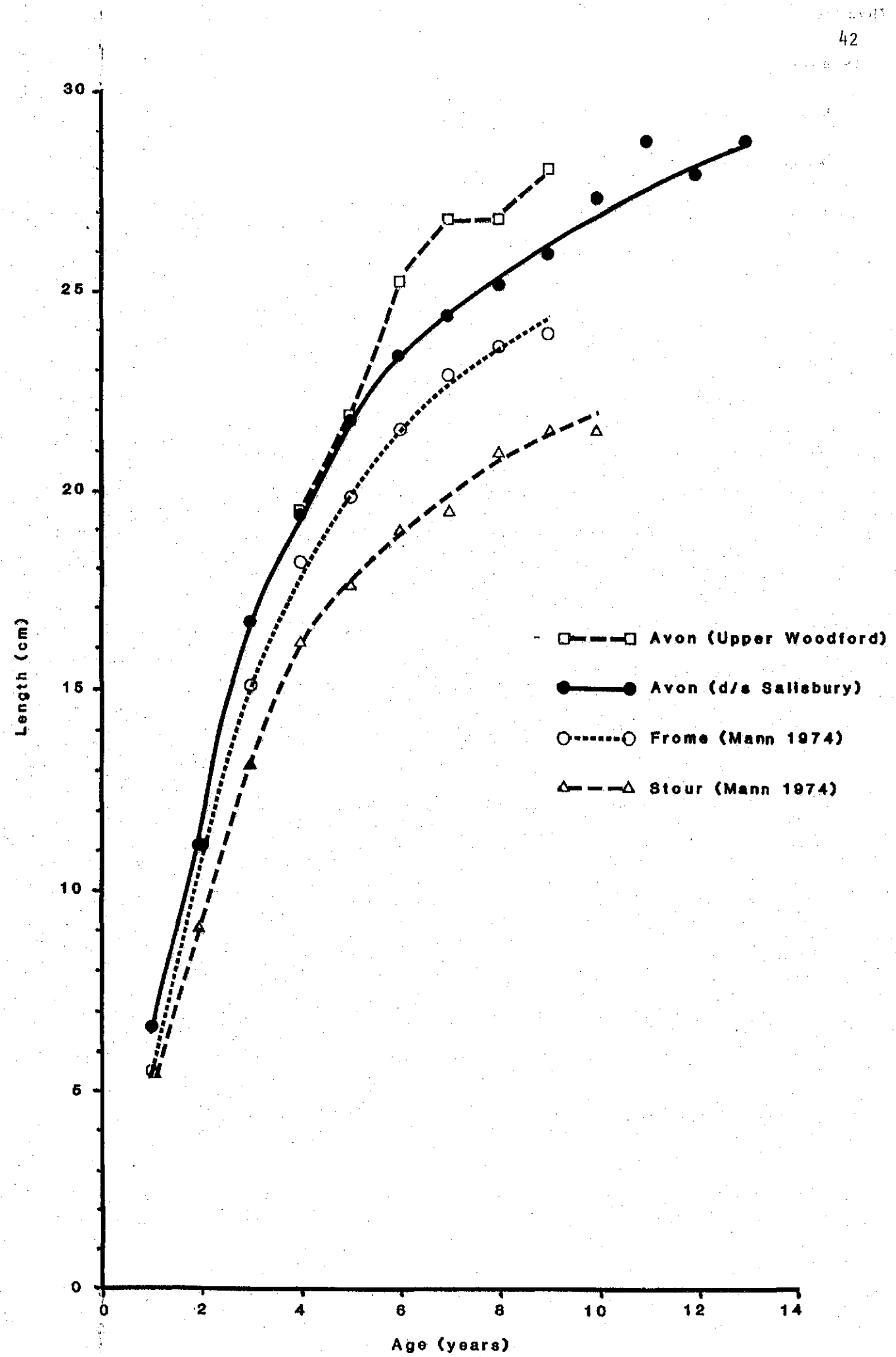

Fig.9. Growth of River Avon Dace compared with other rivers

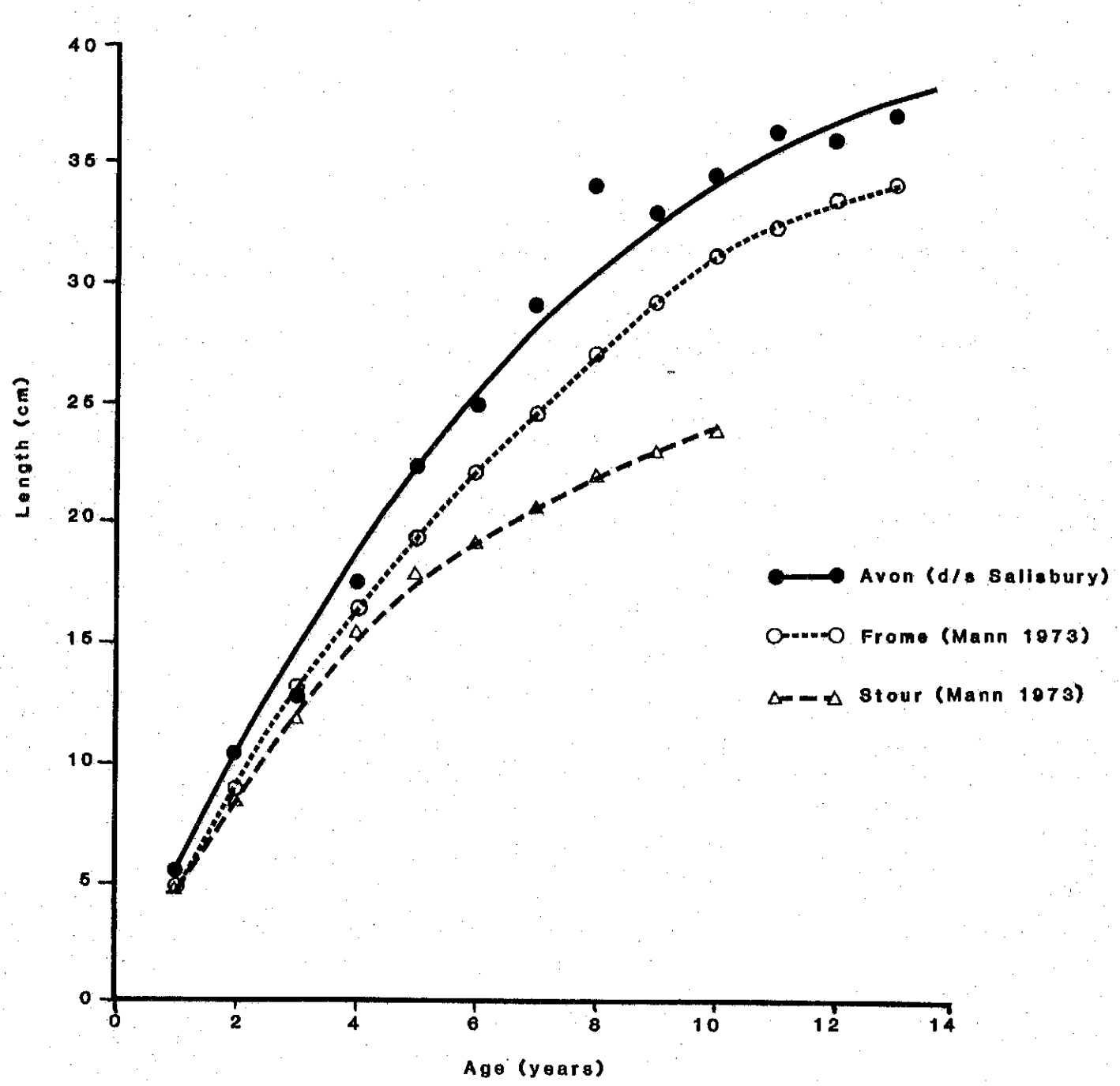

Fig. 10. Growth of River Avon Roach compared with other rivers

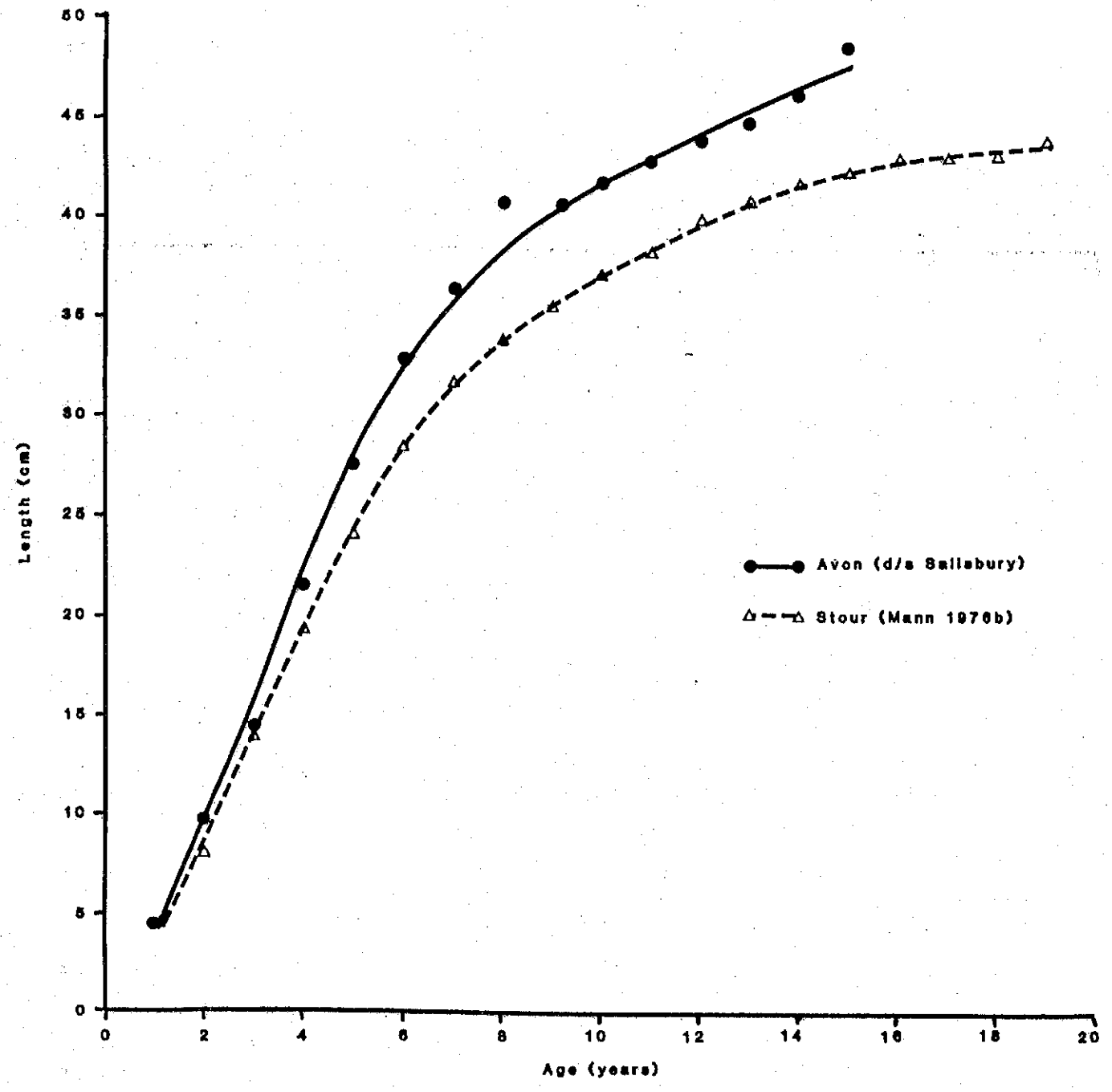

Fig. 11. Growth of River Avon Chub compared with the River Stour.

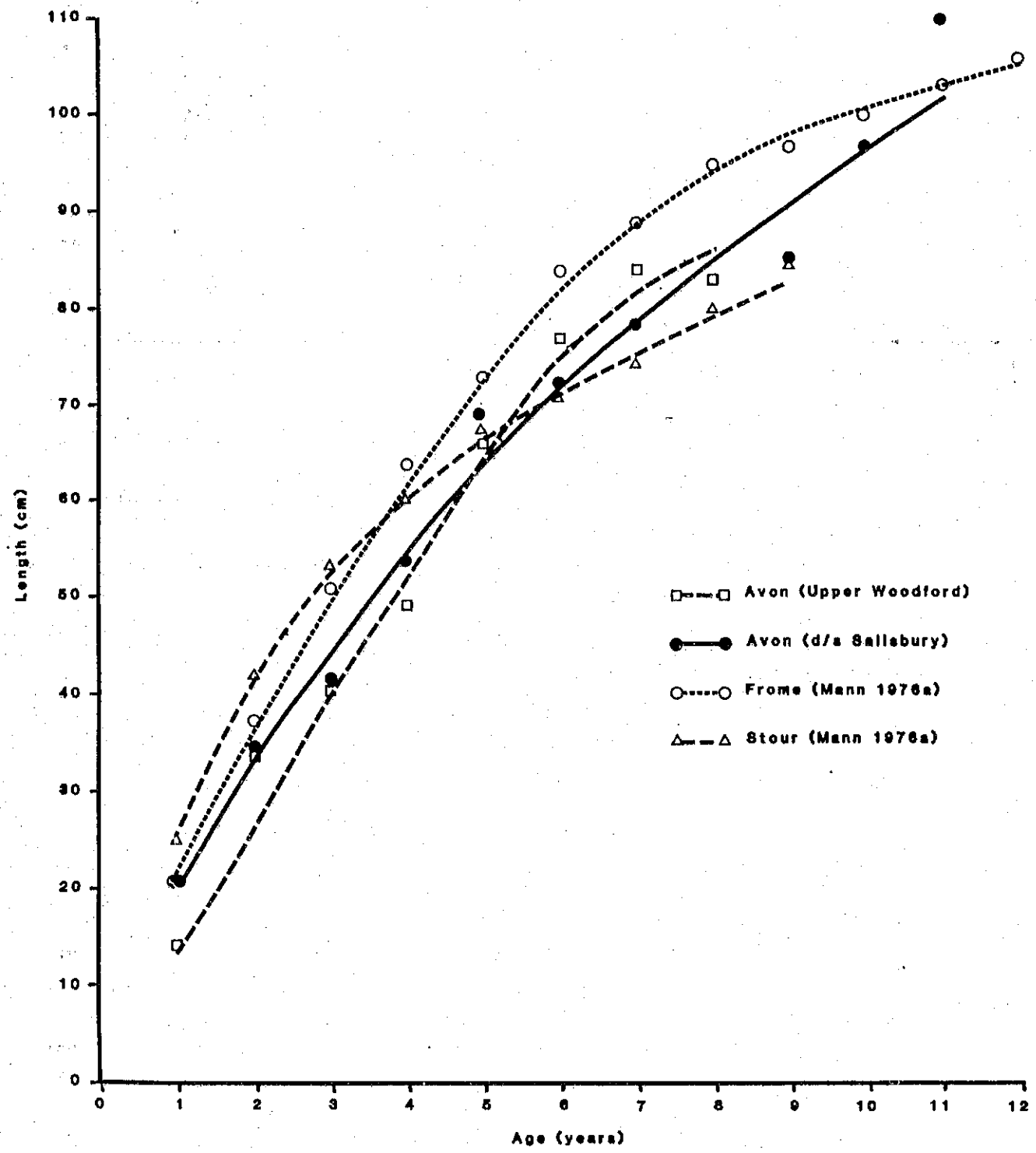

Fig. 12. Growth of River Avon Pike compared with other rivers.