Methods of Biological Sampling
A Colonization Sampler for Collecting Macro-invertebrate Indicators of Water Quality in Lowland Rivers 1983

Methods for the Examination of Waters and Associated Materials

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The compilers of this booklet have given information on suppliers of suitable materials for the construction of apparatus. This in no way endorses these suppliers. Equivalent materials are acceptable.

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Warning to users

The analytical procedures given in this booklet should only be carried out by competent trained persons, with adequate supervision when necessary. Local Safety Regulations must be observed. Laboratory procedures should be carried out only in properly equipped laboratories. Field operations should be conducted with due regard to possible local hazards, and portable safety equipment should be carried. Care should be taken against creating hazards whether for one's self, one's colleagues in the laboratory, outsiders or subsequently for maintenance workers. Lone working, whether in the laboratory or field, should be discouraged. Reagents of adequate purity must be used, along with properly maintained apparatus and equipment of correct specifications. Specifications for reagents, apparatus and equipment are given in manufacturers' catalogues and various published standards. If contamination is suspected, reagent purity should be checked before use.

There are numerous handbooks on first aid and laboratory safety. Among such publications are: 'Code of Practice for Chemical Laboratories' and 'Hazards in the Chemial Laboratory' issued by the Royal Society of Chemistry, London; 'Safety in Biological Laboratories' (Editors Hartree and Booth), Biochemical Society Special Publication No 5, The Biochemical Society, London, which incudes biological hazards; and 'The Prevention of Laboratory Acquired Infection, 'Public Health Laboratory Service Monograph 6, HMSO, London.

Where the Committee have considered that a special unusual hazard exists, attention has been drawn to this in the text so that additional care must be taken beyond that which should be exercised at all times when carrying out analytical procedures. It cannot be too strongly emphasized that prompt first aid, decontamination, or administration of the correct antidote can save life; but that incorrect treatment can make matters worse. It is suggested that both supervisors and operators be familiar with emergency procedures before starting even a slightly hazardous operation, and that doctors consulted after any accident involving chemical contamination, ingestion, or inhalation be made familiar with the chemical nature of the inquiry, as some chemical injuries require specialist treatment not normally encountered by most doctors. Similar warning should be given if a biological or radio-chemical injury is suspected. Some very unusual parasites, viruses and other micro-organisms are occasionally encountered in samples and when sampling in the field. In the latter case, all equipment including footwear should be disinfected by appropriate methods if contamination is suspected.

The best safeguard is a thorough consideration of hazards and the consequent safety precautions and remedies well in advance. Without intending to give a complete checklist, points that experience has shown are often forgotten include: laboratory tidiness, stray radiation leaks (including ultra violet), use of correct protective clothing and goggles, removal of toxic fumes and wastes, containment in the event of breakage, access to taps, escape routes, and the accessibility of the correct and properly maintained first-aid, fire-fighting, and rescue equipment. Hazardous reagents and solutions should always be stored in plain sight and below face level. Attention should also be given to potential vapour and fire risks. If in doubt, it is safer to assume that the hazard may exist and take reasonable precautions, rather than to assume that no hazard exists until proved otherwise.

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About this series

This booklet is part of a series intended to provide both recommended methods for the determination of water quality, and in addition, short reviews of the more important analytical techniques of interest to the water and sewage industries. In the past, the Department of the Environment and its predecessors, in collaboration with various learned societies, have issued volumes of methods for the analysis of water and sewage culminating in 'Analysis of Raw, Potable and Waste Waters'. These volumes inevitably took some years to prepare, so that they were often partially out of date before they appeared in print. The present series will be published as individual methods, thus allowing for the replacement or addition of methods as quickly as possible without need for waiting for the next edition. The rate of publication will also be related to the urgency of requirement for that particular method, tentative methods being issued when necessary. The aim is to provide as complete and up to date a collection of methods and reviews as is practicable, which will, as far as possible, taken into account the analytical facilities available in different parts of the United Kingdom, and the quality criteria of interest to those responsible for the various aspects of the water cycle. Because both needs and equipment vary widely, where necessary, a selection of methods may be recommended for a single determinand. It will be the responsibility of the users — the senior analytical chemist, biologist, bacteriologist etc. to decide which of these methods to use for the determination in hand. Whilst the attention of the user is drawn to any special known hazards which may occur with the use of any particular method, responsibility for proper supervision and the provision of safe working conditions must remain with the user.

The preparation of this series and its continuous revision is the responsibility of the Standing Committee of Analysts (to review Standard Methods for Quality Control of the Water Cycle). The Standing Committee of Analysts is a committee of the Department of the Environment set up in 1972. Currently it has seven Working Groups, each responsible for one section or aspect of water cycle quality analysis. They are as follows:

1.0 General principles for sampling and accuracy of results
3.0 Empirical and physical methods
4.0 Metals and metalloids
5.0 General nonmetallic substances
6.0 Organic impurities
7.0 Biological methods
9.0 Radiochemical methods.

The actual methods and reviews are produced by smaller panels of experts in the appropriate field, under the overall supervision of the appropriate working group and the main committee. The names of those associated with this method are listed inside the back cover. Publication of new or revised methods will be notified to the technical press, whilst a list of Methods in Print is given in the current HMSO Sectional Publication List No 5.

Whilst an effort is made to prevent errors from occurring in the published text, a few errors have been found in booklets in this series. Correction notes and minor additions to published booklets not warranting a new booklet in this series will be issued periodically as the need arises. Should an error be found affecting the operation of a method, the true sense not being obvious, or an error in the printed text be discovered prior to sale, a separate correction note will be issued for inclusion in that booklet.

L R PITTWELL
Secretary

31 October 1983

A Colonization Sampler for Collecting Macro-invertebrate Indicators of Water Quality in Lowland Rivers 1983

1. Performance Characteristics of Colonization Samplers

1.1	Biota sampled		Benthic macro-invertebrates
1.2	Habitats sampled		Bottoms of rivers > 0.5 m deep
1.3	Types of sampler		Bags of stones/slag; Standard Colonization Unit
1.4	Basis of Operation		Manually located and retrieved from river bank; a boat may be required at difficult sites
1.5	Form of data		Qualitative and/or quantitative
1.6	Advantages of method	(i)	The effect of differences in natural substrata is reduced
		(ii)	Simple; easy to construct, convenient to handle easy to secure in position and usable by persons having various degrees of experience and training
		(iii)	Inexpensive and disposable, readily reusable
		(iv)	Virtually indestructible, durable and corrosion resistant
		(v)	Unlikely to accumulate excessive quantities of extraneous material, especially sediment or larger debris during normal flow conditions
		(vi)	Inconspicuous in position, yet easily recovered
		(vii)	Allows quick laboratory sorting and processing
		(viii)	Quantitative comparable data can be obtained from rivers which are virtually impossible to sample by conventional methods
		(ix)	A higher level of precision is obtained than with other sampling devices at difficult sites
1.7	Limitations of method	(i)	Colonization may be prevented or reduced by the accumulation of benthic or abiotic debris in or around the sampler during high flow
		(ii)	Destruction by floods or exposure in drought
		(iii)	Samplers subject to vandalism or interference
		(iv)	Floats and samplers are sometimes difficult to anchor in place
		(v)	The type of colonization sampler used is selected for the type of organism which will settle on it
		(vi)	Samplers only record the community that develops during the sampling period and are therefore not indicators of prior conditions
1.8	Efficiency of method		Closely dependent on immersion period and the number of sample replicates
1.9	Logistics of sampling		Samplers are light and require only one operator to locate and retrieve them. Require two people for safe operation from a boat.

2. Introduction

a. Requirement

Although the biological surveillance of rivers should cover the full community of organisms, this is rarely possible and in practice a restricted group of organisms is often used. Macro-invertebrates are the most commonly used group for such studies (Hellawell, 1978).

The benthic macro-invertebrates of riffles are sensitive and often more exposed to pollution and are readily sampled. Methods of sampling benthic macro-invertebrates in riffles, both qualitatively and quantitatively, have been described in previous publications of this series (HMSO 1979, 1982).

A major problem in using benthic macro-invertebrate communities as indicators of water quality in rivers arises from the natural differences in community structure, caused by factors other than water quality eg current velocity and the nature of substratum. In upland rivers riffles provide suitable comparable sampling sites where differences in water quality can be detected biologically. However in lowland rivers suitably located riffles may not be available and in the larger, deeper rivers, may be totally absent. Additionally, in deeper rivers (>1 m deep) sampling methods suitable for shallow waters are not practicable and other alternative methods have to be used (HMSO 1983). Therefore, although desirable for purposes of comparison, it is not possible to adopt a standard method of sampling for the benthos of all rivers.

In lowland rivers also, not only are riffles not always available as sampling sites but a corresponding standard benthic biotope for comparison of water quality in lowland rivers themselves is not always available. Although the smaller, slow-flowing lowland rivers, with a depositing substratum and rooted plants, support a characteristic rich macro-invertebrate fauna, such biotopes are not always available in the lower stretches of larger rivers. In such rivers the benthic macro-invertebrate fauna may be severely restricted by the adverse physical conditions such as a strong current flowing over a substratum of bed-rock, or an unstable substratum of deposited silt which is subject to frequent scour at high flows. Therefore, for the purposes of biologically monitoring water quality in lowland rivers there is a need to provide an alternative biotype independent of the natural substratum.

b. Rationale

In lowland rivers, in the absence of riffles and rooted vegetation, it is commonly experienced that the most readily collected macro-invertebrates are to be found on submerged hard surfaces. The possibility of using standardized colonization samplers (artificial substrata) to provide such invertebrate collections has been investigated (Girton, 1980; Watton, 1982; Murray-Bligh 1984). Colonization samplers have been used previously by several workers for surveillance as reviewed by Hellawell (1978) and Girton (1980).

c. Performance Characteristics

It is emphasized that, in the present context, the objective of using colonization samplers is to provide a collection of macro-invertebrates indicative of the water quality at the sites and **not** to sample the natural invertebrate fauna, which may be restricted by physical conditions unrelated to water quality.

The following criteria are important in providing a suitable habitat for colonization by macro-invertebrates:—

a. The total surface area available for colonization in relation to size of samplers.

b. The provision of interstices of sufficient size and variety for colonization.

c. The presence of different current regimes within and around the samplers to meet the different requirements of the colonizing species.

The following factors influence the performance of colonization samplers:—

a. Size of samplers

b. Methods of positioning

c. Duration of immersion

d. Method of retrieval

e. Replication.

Several of these aspects were studied in the above mentioned investigations and validated in the literature (Watton & Hawkes 1984) and these form the basis of the recommendations in this publication.

d. Development

After considering many colonization methods which have been examined and reviewed in the literature, different types of natural mineral material such as gravel, slag and certain varieties of artificial plastics used in biological sewage filters were tested. These were compared in riffles and pools of different water quality (Girton, 1980).

The selection of a standard sampling technique was made on the basis of both practicability in the field and performance as determined by the criteria described in Section C. In riffles the largest numbers of species were recorded by active sampling (handnet and cylinder), which is also a practicable method of sampling this biotype. In shallow riffles problems of fouling with drifting algal mats and vandalism were experienced with colonization samplers. In pools, however, some colonization samplers performed better than active sampling in terms of the number of species collected. It was therefore concluded that for pool reaches and deeper rivers, difficult to sample directly, the use of colonization samplers should be considered. Further tests in a wide range of rivers of different water quality verified these earlier conclusions.

The following samplers were therefore recommended:—

a. A mineral medium sampler consisting of 40 pieces of non-toxic slag or similar material of nominal size 40–50 mm contained in a wide-mesh plastic bag (Figure 1).

b. A cylindrical unit consisting of 14 pieces of biological sewage filter plastic medium "Actifil 50" (Figure 2).

e. Period of Submersion

The optimal period of submersion is determined by the following considerations:—

the need to collect as large a number of species as possible which will reflect the water quality of the study area;

the need to avoid fouling the sampler with drifting debris or silt and to prevent loss by being washed away at times of high flow or by vandalism, the chances of all of which increase with time.

Sequential studies over periods of up to ten weeks gave different results at different times of the year presumably because of changes of flow conditions and the seasonal behaviour of the species involved. Although in some cases the number of species increased over the whole period, generally the number peaked at about 3–4 weeks both in pools in smaller rivers (Girton, 1980) and in the deep zones of the large rivers (Watton, 1982; Murray-Bligh, 1984). This is similar to information from other studies.

f. Replication

The number of sample replicates required at each sampling site is determined by the need to collect sufficient taxa to estimate water quality

In a series of trials in different rivers, on different occasions throughout the year, ten sample replicates were used. Using the mean of ten randomly selected sequences of the samples, the accumulative number of taxa was plotted against the number of sample replicates (Figure 3). From the graphs the numbers of taxa derived from three samples compared with those from ten were expressed as percentages. These percentages ranged from 67 to 88.

3. Equipment

a. Standard Colonization Bag

Each bag consists of 40 pieces of a biological filter medium such as "slag", placed inside a nylon mesh plastic bag. Although the size and type of "slag" will vary on a regional basis, including the surface area to volume ratio, it is recommended that slag of a nominal size 40–50 mm be used to reduce the overall weight of the sampler and prevent complete submersion and fouling in a mud substratum.

b. Standard Colonization Unit

Each unit consists of 14 pieces of a biological sewage filter medium such "Actifil 50E" obtained from Hydronyl-Norton Process Plants Limited, assembled into a cylindrical shape (Figure 2). Using "Actifil 50E" two layers each of a single central piece surrounded by six peripheral ones are joined together using straps or appropriate material to form the unit. Alternatively the individual units may be bonded together by applying heat where contact is to be made and pressing together. Further options would include the use of large rubber bands for holding the units in place. To minimize the loss of animals whilst retrieving the sampler, the lower quarter (bottom 30 mm) including the base is covered with a nylon gauze of 10 meshes cm^{-1} . Fabricated units are available from:

G.B. Nets, 50 Henshaw Road, Small Heath, Birmingham B10 0TB

Although "Actifil 50E" is recommended for use, other plastic material may also be used to construct a standard unit.

Both the colonization samplers described above have proved useful and practicable and perform equally well in the field. However, the need for a standard sampler for national survey purposes would best be met by the **Standard Colonization Unit**.

4. Methods of use

4.1 Placement or Installment of the Samplers (Figure 4)

The method of installing the samplers in deep lowland rivers is important to avoid problems with vandalism, the samplers becoming exposed following a fall in river level and fouling with extraneous material.

In relatively shallow water (0.5 m) the samplers can be pinned on to the bottom using a 8 mm dia. steel rod (Figure 4a).

In deep waters, where it is impossible to peg colonization samplers on to the substratum, it is recommended that the samplers are weighted to the bottom as follows. Nylon cord (4 mm dia.) is tied to a suitable weight such as a house brick and passed vertically through the centre of the sampler. The sampler 'sits' on the weight and is then lowered carefully into position on to the substratum. When using plastic filter media, a knot or rubber bung should be fixed above the sampler to prevent any upward movement (Figure 4b).

To measure the water quality of the river, care must be taken to place the colonization sampler in the main flow of the river and not in any "back waters" or "static areas" unless information on the quality of these areas is specifically required.

In a depositing zone the weight should penetrate into the surface mud until the colonization sampler is resting on the surface substratum. The nylon cord is attached securely to the river bank, preferably in a concealed position, above the high water mark. If the sampler is placed in the river during the high flow, provision must of course be allowed for a drop in the water level. To assess water quality colonization samplers should be left in situ for 4 weeks. If practical problems are encountered with this immersion period, a feasibility study should be conducted to determine optimum colonization times at difficult sites. Bearing in mind the limited amount of time available for routine surveillance work, three replicates (minimum) should be taken at each sampling site, with the number of taxa pooled for data analysis and interpretation.

4.2 Retrieval

After 4 weeks immersion, the samplers are carefully removed from the river, care being taken to prevent loss of organisms. This is facilitated by using a hand net and placing it immediately downstream of the sampler and moving it under the sampler as it is lifted off the river bed. The sampler is then retrieved in the net.

In deeper water the mesh base prevents initial loss of organisms during lifting, but the hand net then facilitates retrieval over the last few metres or so. The whole sampler (excluding the weight) together with any animals in the net is placed in a strong plastic container with a small quantity of water and sealed for transportation back to the laboratory. If for any reason there is a delay in returning to the laboratory, the sample should be preserved in the field.

4.3 Laboratory Sorting

The contents of the container and the colonization sampler are placed in a 4 mm sieve and washed through into a 250 μm fine retaining sieve to trap any organisms dislodged from the sampler. The Standard Colonization Unit is best placed upside down on the sieve and the contents washed out of the unit with water. Macro-invertebrates which spin nets or threads *Hydropsyche* spp., *Simulium* spp.) or build macilaginous tubes *(Corophium curvispinum*, Chironomidae) are best removed by spraying the unit with a jet of water. Cased caddis (particularly Limnephilidae, Phrygeneidae and Leptoceridae), molluscs (particularly Lynmaeidae, Physidae, Viviparidae, Hydrobiidae and Ancylidae) and Odonata, which often become trapped within the unit are usually removed by mechanical shaking or tapping.

Attached leeches are the most difficult to remove, but placing the unit in a dilute solution of formalin (about 1% strength) or warm water quickly dislodges the animals without damaging them. Flatworms, which are easily damaged by heel-kick sampling are normally found on colonization samplers and in the sorting process they should be removed first.

5. A Cautionary Note on the Application of Results in Water Quality Assessment

It is necessary to consider the data from pool-riffle type rivers and from larger potamon zones separately.

5.1 Pool-riffle type rivers

A study of the methods of colonization of samplers suggests that they are colonized both from the natural nearby substratum by migration and by drift from upstream riffles and possibly from nearby hard surfaces including vegetation. The species found on the samples are influenced by the proximity of the nearest upstream riffle. Nevertheless the data provided by colonization sampling in pools are comparable with those from associated riffles and should be processed to produce indexes in the same way. A list of taxa found on the Standard Colonization Unit is shown in Table 1 (Appendix A). A comparison of Biological Monitoring Working Party* scores derived from the Standard Colonization Sampler data from pools and from direct sampling of associated riffles is given in Figure 5. Typical colonization data from rivers of different qualities are given in Table 2 (Appendix A).

5.2 Lowland Rivers

Although in large lowland rivers, without riffle zones, the use of colonization samplers provides a larger number of taxa than by direct sampling of the natural substratum, fewer species are recorded than would be expected in riffle samples of similar water quality. As a result, water quality indexes, derived by using methods applicable to riffle sample data, are depressed. As more information becomes available of the faunas of colonization samplers in deeper rivers of different water qualities, it is anticipated that a score comparable with that for riffle samples will need to be developed. In the meantime as some guidance, a list of taxa found on colonization samplers in deep rivers is provided in Table 3 (Appendix A). Typical colonization data from large downland rivers of different water quality are given in Table 4 (Appendix A).

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Girton, C (1980) Ecological studies on benthic invertebrates communities in relation to their use in river water quality surveillance. PhD Thesis University of Aston in Birmingham.

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*The Biological Working Party (BMWP) Biological Score System is reproduced in Appendix B together with the Department of the Environment quality classification system. These apply at the time of going to press but may one day be revised.

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a. The use of colonisation samplers in relation to biological surveillance of river water quality.

b. The requirements of freshwater Gastropoda. PhD Thesis, University of Aston in Birmingham.

Watton A J and Hawkes H A (1984). The performance of an invertebrate colonization sampler (SAufU) in biological surveillance of lowland rivers. In Freshater Biological Monitoring. Eds D Pascoe and R W Edwards. 5–24 Pergamon Press, Oxford.

Construction of the Standard Colonization

Unit List of Suppliers

1. **Actifil 50E**

   Hydronyl
   Norton Process Plants Ltd
   King Street
   Fenton
   Stoke-on-Trent
   Staffs
   0782-45561

2. **Nylon Straps** (medium size)

   Schuco Scientific Ltd
   Halliwick Court Place
   Woodhouse Road
   London
   01-368-1642

3. **'St Martin' Nylon mesh**

   Henry Simon Ltd
   Cheadle Heath
   Stockport
   Cheshire
   061-428-3621

4. **Nylon Rope**

   Yacro Ltd
   Twickenham Industrial Estate
   Rugby Road
   Twickenham
   Middlesex

5. **Fabricated Units**

   G.B. Nets
   50 Henshaw Road
   Small Heath
   Birmingham B10 0TB
   021-773-5664

Appendix A

Performance Characteristics of the Standard Colonization Unit Sampler lowland rivers

(Tables 1–4)

Table 1. Dominant benthic macro-invertebrates collected on Standard Colonization Units in a wide range of river types and water qualities. (After Girton, 1980)

Taxa	Occasions recorded (max. 235)	Stations recorded (max. 33)	Taxa	Occasions recorded (max. 235)	Stations recorded (max. 33)
A.aquaticus	210	32	*P.flavomaculatus*	45	13
E.octoculata	159	30	*S.lutaria*	43	13
Orthocladiinae	150	33	*C.moesta*	42	12
Chirononomini	148	31	Dytiscidae	38	19
G.pulex	148	27	*M.nigra*	38	11
Tanypodinae	109	24	*Pisidium* spp.	37	16
L.peregra	108	27	*C.puella*	36	17
G.complanata	106	30	*D.lugubris*	34	19
B.tentaculata	104	20	*A.splendens*	34	11
Hydracarina	98	21	*B.rhodani*	30	13
T.tubifex	91	20	*V.macrostoma*	29	11
P.jenkinsi	75	20	*P.geometra*	28	11
H.stagnalis	73	20	*A.fluviatilis*	28	11
S.corneum	67	21	*Nais* spp.	27	15
L.hoffmeisteri	63	19	*P.barbatus*	26	9
Haliplus spp.	62	22	*P.pennipes*	25	13
P.maculatus	59	18	*L.variegatus*	24	10
Ceratopogonidae	58	23	*G.heteroclita*	23	13
P.tenuis	58	22	*P.grandis*	23	10
D.lacteum	56	17	*P.carinatus*	23	9
H.angustipennis	53	17	*V.viviparus*	23	5
P.fontinalis	51	19	*C.curvispinum*	23	3
N.elinguis	49	21	*H.marginata*	22	8
Tanytarsini	47	14	*T.fluviatilis*	22	5

Table 2. Examples of data collected from Standard Colonization Units from pools in riffle-pool rivers of different water quality

(I) R. Weaver — Hankelow Mill
Chem Class I. (15.IX — 11.X)

Taxa	Replicates 1	2	3
Dendrocoelum lacteum		1	
Nais elinguis	1		
Erpobdella octoculata	7		2
Glossiphonia complanta	1	2	1
Helobdella stagnalis	1		1
Hydracarina	185	36	58
Gammarus pulex	59	48	45
Asellus aquaticus	22	11	5
Baetis rhodani		1	1
Hydropsyche anguistipennis (I)	17	30	20
Mystacides nigra (L)	5	1	1
Platambus maculatus (A)			1
Haliplus sp. (L)		1	
Gyrinus sp. (L)	3		4
Sialis lutaria	2		1
Agrion spendens	1		
Simulium sp. (L)			1
Brillia longifurca	1		
Orthocladiinae	4	12	16
Tanytarsini		1	4
Chironomidae (P)	2	3	18
Dicranota sp.	1		
Potamopyrgus jenkinsi	2	2	7
Lymnaea peregra	1	1	1
Sphaerium corneum			1

(II) R. Weaver — Church Minshull
Chem. Class II. (15.IX — 11.X)

Taxa	Replicates 1	2	3
Polycelis Tenuis	10	8	7
Dendrocoelum lacteum	42	31	6
Dugesia lugubris/polychora		2	
Lumbriculus variegatus	1		
Eropobdella octoculata	5	7	9
Helobdella Stagnalis	1		1
Gammarus pulex	1	6	4
Asellus aquaticus	1014	1600	1474
Platambus maculatus (A)	1		
Haliplus sp. (L)			1
Ischnura elegans			1
Platycnemis pennipes			2

(III) R. Churnet-Cheddleton Mill
Chem Class III (4.VIII — 2.IX)

Taxa	Replicates 1	2	3
Tubifex tubifex	26	86	416
Erpobdella octoculata	12	24	17
Helobdella stagnalis	1	2	1
Gammarus pulex	2	17	
Asellus aquaticus	232	193	289
Dytiscidae (L)			1
Procladius sp.	17	13	22
Chironomidae (P)	1		1
Lymnaea peregra	1		
Sphaerium corneum	1		

(IV) R. Tame-Elford
Chem. Class IV (20.IX — 17.X)

Taxa	Replicates 1	2	3
Polycelis tenuis			1
Tubifex tubifex	11		
Erpobdella octoculata	14	20	44
Haemopis sanguisuga	1		
Asellus aquaticus	2366	1504	1856
Haliplus sp. (A)		1	
Coenagrion puella			1
Lymnaea peregra	1		
Glossiphonia complanta	1		

Table 3. Dominant macro-invertebrates collected on Standard Colonization Units in Potamon Zones

Taxon	Stations Recorded (n = 24)		Class I Sites Recorded (n = 7)		Proportional Occurrence in Class I Sites
	n	%	n	%	%
Asellus aquaticus	22	92	7	100	32
Orthocladiinae (L)	21	88	7	100	33
Chironomini (L)	20	83	6	86	30
Oligochaeta	18	75	6	86	33
Erpobdella octoculata	18	75	4	57	22
Bithynia tentaculata	18	75	6	86	33
**Lymnaea peregra*	17	71	7	100	41
Dugesia polychroa	15	63	5	71	33
Physa fontinalis	15	63	5	71	33
**Crongonyx pseudogracilis*	15	63	6	86	40
**Potamopyrgus jenkinsi*	14	58	6	86	43
Tanypodinae (L)	13	54	4	57	31
Glossiphonia complanata	12	50	3	43	25
Gammarus spp.	12	50	4	57	33
**Pisidium spp.*	11	46	5	71	45
*Tanytarsini (L)	11	46	5	71	45
Polycelis spp.	10	42	3	43	30
Planorbis spp.	10	42	3	43	30
Helobdella stagnalis	9	38	2	29	22
**Valvata spp.*	9	38	5	71	56
Corophium curvispinum	9	38	3	43	33
Haliplus spp.	9	38	2	29	22
Baetidae	8	33	1	14	13
*Polycentropidae	8	33	4	57	50
Polycelis tenuis	7	29	3	43	43
Piscicola geometra	7	29	3	43	43
Planorbis albus	7	29	2	29	29
**Valvata piscinalis*	7	29	4	57	57
Sphaerium spp.	7	29	2	29	29
Gammarus pulex	7	29	2	29	29
Coenagrion spp.	7	29	2	29	29
**Plectrocnemia geniculata*	7	29	3	43	43
Dendrocoelum lacteum	6	25	0	0	0
Batrocobdella paludosa	6	25	2	29	33
**Gammarus tigrinus*	6	25	3	43	50
Caenis moesta	6	25	2	29	33
*Dytiscidae	6	25	3	43	50

*Species having highest proportion of occurrences in unpolluted rivers.

Table 4. Examples of data collected from Standard Colonization Units from large lowland rivers of different water quality.

Yorkshire Ouse-Naborn
Chem Class 1B (7VIII — 4.IX)

Taxa	Replicate 1	2	3
Dugesia plychroa			2
Polycelis tennis	5	1	4
Oligochaeta	5	4	26
Hemiclepsis marginata			1
Asellus aquaticus	1	1	4
Crangonyx pseudogracilis	25	27	5
Procloeon pseudoruflum	24	8	2
Plectrocnemia geniculata	19	19	17
Dytiscidae	1	1	1
Chironomini (L)	1	5	1
Tanytarsini (L)			1
Diamesinae (L)	1		
Orthocladiinae (L)	4	4	3
Tanypodinae (L)	2		1
Chironomidae (P)	1	1	1
Lymnaea peregra	8	5	5
Physa fontinalis			1
Bithynia tentaculata		4	8
Potamopyrgus jenkinsi	3	1	
Valvata piscinalis	18	10	7
V. cristata	3	2	5
Pisidium sp.	1	1	3

R. Severn-Saxon Lode
Chem Class 1B (28 — VIII — 25.IX)

Taxa	Replicate 1	2	3
Dugesia polychroa		1	
Polycelis tennis	1		1
Oligochaeta	5		36
Piscicola geometra	1	3	
Asellus aquaticus	1		
Corophium curvispinum	380	184	296
Gammarus tigrinus	7	14	11
Plectrocnemia geniculata	2	1	
Agrion splendens		1	
Chironomini (L)	4	7	24
Orthodadiinae (L)	1		15
Tanypodinae (L)	1	1	1
Chironomidae (P)	1		
Lymnaea peregra	25	15	25
Physa fontinalis	9	6	1
Bithynia tentaculata	6	7	8
Potamopyrgus jenkinsi	37	7	8
Theodoxus fluviatilis	3	6	10
Valvata piscinalis	3		1
Viviparus viviparus		2	5
Pisidum sp.	6		1

Trent, Nottingham
Chem Class 2 (25–VIII — 22–VIII)

Taxa	Replicate 1	2	3
Denrocoelum lacteum	1		
Dugesia polychroa	7	5	
Oligochaeta	99	31	111
Erpobdella octoculata	19	9	11
Glossiphonia complanta	1		1
Helobdella stagnalis	1		
Hemiclepsis marginata	1	1	
Piscicola geometra		1	
Asellus aquaticus	87	125	49
Gammarus tigrinus	179	140	86
Haliplus sp.	1		
Ischnura elegans		1	
Chironomini (L)	2	3	
Orthocladiinae (L)	1		
Tanypodinae (L)	1		
Planorbis alba	1	1	
Bithynia tentaculata	4	27	7
Potamopyrgus jenkinsi	5	11	6

Mersey, Warrington
Chem Class 3 (10.IX. –8 –I)

Taxa	Replicate 1	2	3
Oligochaeta	532	1100	468
Eropobdella octoculata		1	
Asellus aquaticus	1		
Dytiscinae (L)	1		
Chironomus riparius (L)	5	3	3
Chironomini (L)		1	1
Tanytarsini (L)			1
Orthocladiinae (L)	2	2	2
Tanypodinae (L)	3		2
Lymnaea peregra	8	7	5
L. stagnalis		1	
Physa fontinalis	79	97	55
Bithynia tentaculata	1		
Potamopyrgus jenkinsi	1		
Theodoxus fluviatilis	1		

Appendix B

Biological Monitoring Working Party (BMWP) Score System

Department of the Environment River Classification System

1. Biological Score System as recommended by the BIOLOGICAL MONITORING WORKING PARTY (BMWP)

Scores for the assessment of biological quality of rivers were based on the recommendations of the Biological Monitoring Working Party (BMWP) which reported indirectly to the DoE/NWC Standing Technical Advisory Committee on Water Quality, using the following procedure:

a. The BMWP score system shown in Table 5 was used for the survey.

b. This score system was considered appropriate for all sites (including both eroding and depositing zones) for national survey purposes.

c. Sampling sites were selected, where possible, so that they were representative of river reaches rather than being related to the effects of specific pollutant discharges. The need to provide these data had to be balanced against the cost of inclusion of extra sampling sites. Sampling sites were chosen, wherever possible, from eroding zones.

d. Sampling endeavoured to cover all microhabitats and water authorities were recommended to take up to ten replicate samples at a site if necessary. The replicates could be examined separately or bulked in order to derive a 'best possible' site score. Water authorities were asked to use, where possible, the Standing Committee of Analysts' handnet method or Surber or Cylinder samplers for eroding zones. The University of Aston Colonization Sampler (SAufU) was recommended for soft bedded lowland rivers, but, where this was not possible, marginal or pool sampling by handnet was considered to be the only alternative. It was intended that the sampling method used at a site in 1980 should be used in future national surveys.

e. Sampling effort had largely to be determined by existing practice with one sample being acceptable. If more than one sample was included, attempts were made to space sampling evenly through the survey year with a separate data set completed for each sample.

f. The score was intended to be representative of the site for the season sampled. It was also intended that the season(s) should remain the same for future surveys.

g. A minimum frequency of one sampling site per 20 kilometres of river was recommended. In practice the frequency of sampling was dependent on the availability of staff. The existing arrangements within water authorities for biological sampling were regarded as adequate for the purposes of the survey. Where there was a greater density of sampling, water authorities were asked to selected sites at intervals of about 20 km in order to have a reasonably even distribution.

h. Calculation of the score for a site comprised the following steps:

i. All families present at the site were listed,

ii. scores were ascribed to each of these families according to the values indicated in Table 5,

iii. the scores for all families were added to give the total cumulative site score.

Table 5. Allocation of biological scores

Families	Score
Siphlonuridae Heptgeniidae Leptophlebiidae Ephemerellidae Potamanthidae Ephemeridae	
Taeniopterygidae Leuctridae Capniidae Perlodidae Perlidae Chloroperlidae	
Aphelocheiridae	10
Phryganeidae Molannidae Beraeidae Odontoceridae Leptoceridae Goeridae Lepidostomatidae Brachycentridae Sericostomatidae	
Astacidae	
Lestidae Agriidae Gomphidae Cordulegasteridae Aeshnidae Corduliidae Libellulidae	8
Psychomyiidae Philopotamidae	
Caenidae	
Nemouridae	7
Rhyacophilidae Polycentropidae Limnephilidae	
Neritidae Viviparidae Ancylidae	
Hydroptilidae	
Unionidae	6
Corophiidae Gammaridae	
Platycnemididae Coenagriidae	

Families	Score
Mesovelidae Hydrometridae Gerridae Nepidae Notonectidae Pleidae Corixidae	
Haliplidae Hygrobiidae Dytiscidae Gyrinidae Hydrophilidae Clambidae Helodidae Dryopidae Elminthidae Chrysomelidae Curculionidae	5
Hydropsychidae	
Tipulidae Simuliidae	
Planariidae Dendrocoelidae	
Baetidae	
Sialidae	4
Piscicolidae	
Valvatidae Hydrobiidae Lymnaeidae Physidae Planorbidae Sphaeriidae	3
Glossiphoniidae Hirudidae Erpobdellidae	
Asellidae	
Chironomidae	2
Oligochaeta (whole class)	1

2. DOE River Classification system

Details of the system

The river classification system was published by the National Water Council in 'River water quality: the next stage' and is shown in Table 6.

95 percentile values

The classifications are normally based on the values of quality parameters which are expected to be achieved by 95 per cent of samples taken (95 percentile value). The method of calculating the 95 percentile values is the same as is used for other purposes in the individual water authorities.

Limits of survey

The upstream limits of rivers in the survey are normally the same as under the former classification system, a summer flow of 0.05 M^3s^{-1} (1 mgd). The downstream limits of rivers are the same as the upstream limits for the estuary classification (see Clean Rivers (Estuaries and Tidal Waters) Act 1960), or the tidal limit where there is no estuary classification. Canals and other waters of special local interest may be included.

Class X (See Table 6)

Class X watercourses are omitted from the survey as they are by definition insignificant and therefore not appropriate to a national survey.

EIFAC limits

The definition of 'non-toxic to fish in EIFAC terms' is based for the purposes of the survey on *'Water quality criteria for freshwater fish'* edited by J S Alabaster and R Lloyd, published by Butterworths, March 1980.

Table 6. DOE River classification

River Class	Quality criteria	Remarks	Current potential uses
	Class limiting criteria (95 percentile)		
1A	(i) Dissolved oxygen saturation greater than 80%. (ii) Biochemical oxygen demand not greater than 3 mg/l. (iii) Ammonia not greater than 0.4 mg/l. (iv) Where the water is abstracted for drinking water, it complies with requirements for A2** water. (v) Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available).	(i) Average BOD probably not greater than 1.5 mg/l. (ii) Visible evidence of pollution should be absent.	(i) Water of high quality suitable for potable supply abstractions and for all other abstractions. (ii) Game or other high class fisheries. (iii) High amenity value.
1B	(i) DO greater than 60% saturation. (ii) BOD not greater than 5 mg/l. (iii) Ammonia not greater than 0.9 mg/l. (iv) Where water is abstracted for drinking water, it complies with the requirements for A2** water. (v) Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available).	(i) Average BOD probably not greater than 2 mg/l. (ii) Average ammonia probably not greater than 0.5 mg/l. (iii) Visible evidence of pollution should be absent. (iv) Waters of high quality which cannot be placed in Class 1A because of high proportion of high quality effluent present or or because of the effect of physical factors such as canalization, low gradient or eutrophication. (v) Class 1A and Class 1B together are essentially the Class 1 of the River Pollution Survey.	Water of less high quality than Class 1A but usable for substantially the same purposes.
2	(i) DO greater than 40% saturation. (ii) BOD not greater than 9 mg/l. (iii) Where water is abstracted for drinking water, it complies with the requirements for A3** water. (iv) Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available).	(i) Average BOD probably not greater than 5 mg/l. (ii) Similar to Class 2 of RPS. (iii) Water not showing physical signs of pollution other than humic colouration and a little foaming below weirs.	(i) Waters suitable for potable supply after advanced treatment. (ii) Supporting reasonably good coarse fisheries. (iii) Moderate amenity value.
3	(i) DO greater than 10% saturation. (ii) Not likely to be anaerobic. (iii) BOD not greater than 17 mg/l*.	Similar to Class 3 of RPS.	Waters which are polluted to an extent that fish are absent or only sporadically present. May be used for low grade industrial abstraction purposes. Considerable potential for further use if cleaned up.
4	Waters which are inferior to Class 3 in terms of dissolved oxygen and likely to be anaerobic at times.	Similar to Class 4 of RPS.	Waters which are grossly polluted and are likely to cause nuisance.
X	DO greater than 10% saturation.		Insignificant watercourses and ditches not usable, where objective is simply to prevent nuisance developing.

Note

(a) Under extreme weather conditions (e.g. flood, drought, freeze-up), or when dominated by plant growth, or by aquatic plant decay, rivers usually in Classes 1, 2 and 3 may have BODs and dissolved oxygen levels, or ammonia content outside the stated levels for those Classes. When this occurs the cause should be stated along with analytical results.

(b) The BOD determinations refer to 5 day carbonaceous BOD (ATU). Ammonia figures are expressed as NH_4.

(c) In most instances the chemical classification given above will be suitable. However the basis of the classification is restricted to a finite number of chemical determinands and there may be a few cases where the presence of a chemical substance other than those used in the classification markedly reduces the quality of the water. In such cases, the quality classification of the water should be downgraded on the basis of the biota actually present, and the reasons stated.

(d) EIFAC (European Inland Fisheries Advisory Commission) limits should be expressed as 95% percentile limits.

* This may not apply if there is a high degree of re-aeration.

** EEC category A2 and A3 requirements are those specified in the EEC Council Directive of 16 June 1975 concerning the Quality fo Surface Water intended for Abstraction of Drinking Water in the Member States.

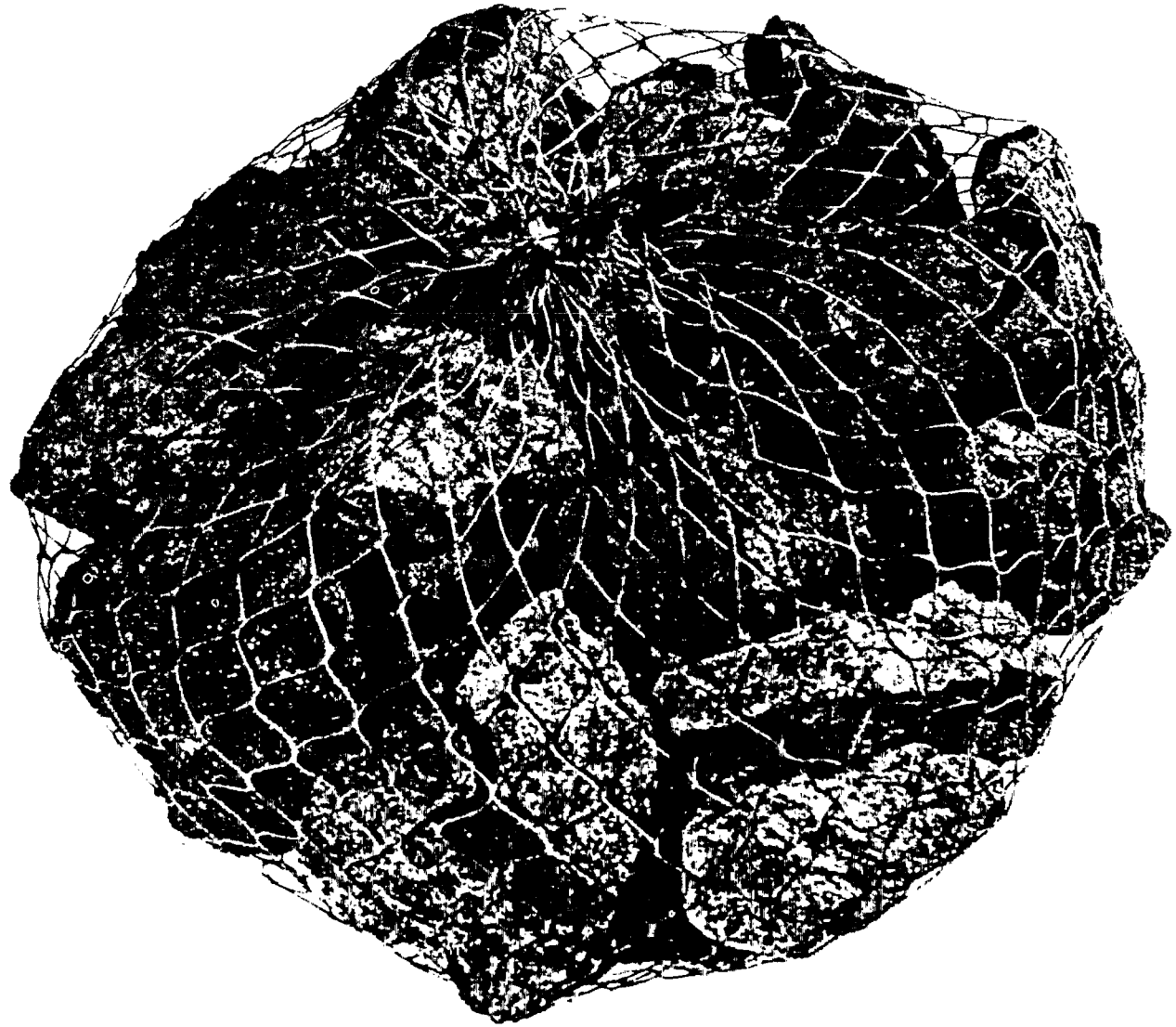


Fig.1 THE STANDARD COLONISATION BAG — SLAG IN PLASTIC NET

Fig. 2 THE STANDARD COLONISATION UNIT FOR MONITORING RIVER WATER QUALITY IN THE DEEP ZONES OF LARGE RIVERS AND THE DEPOSITING ZONE OF LOWLAND RIVERS

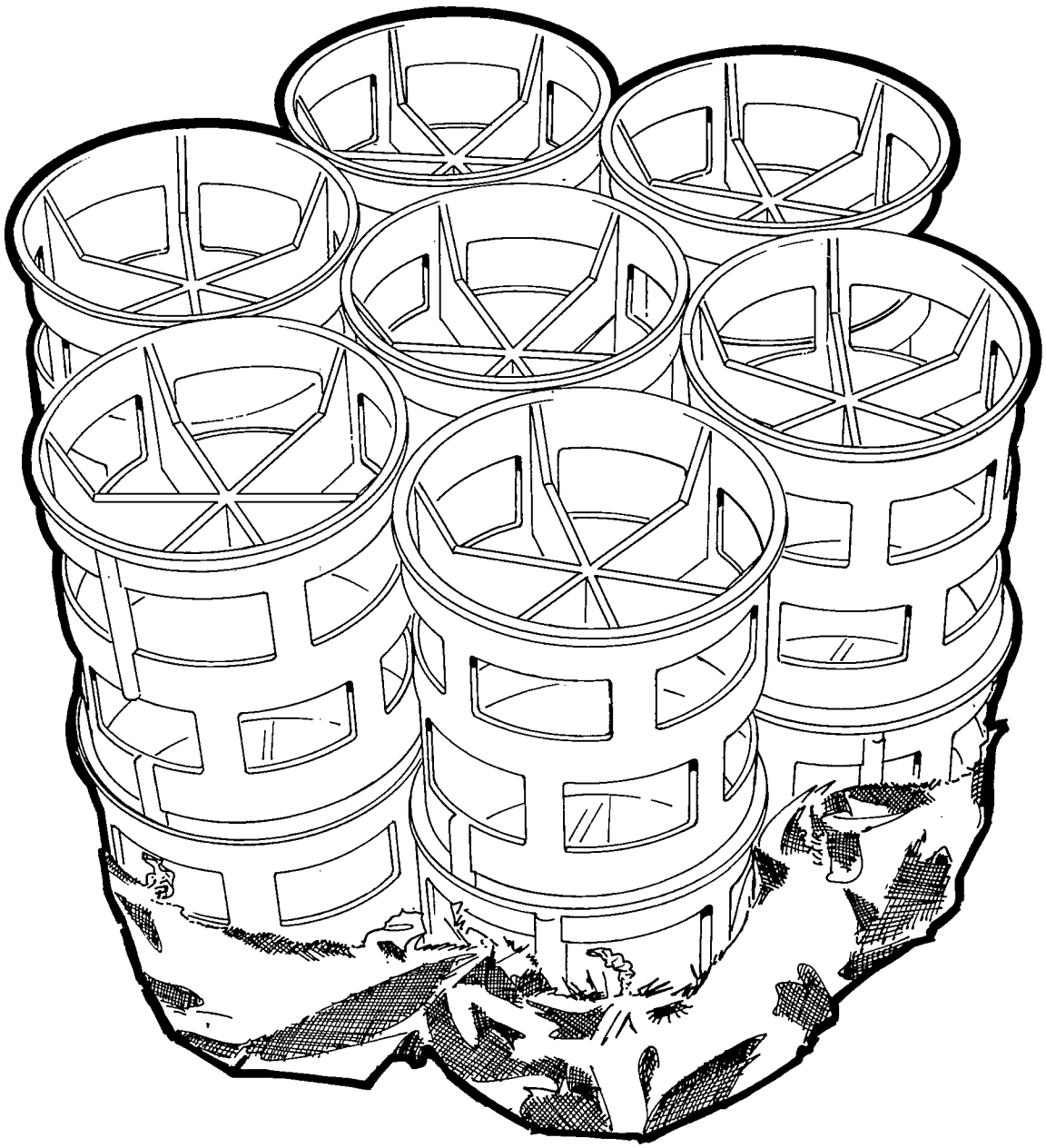


Fig.3 MEAN CUMULATIVE NUMBER OF TAXA TAKEN BY DIFFERENT NUMBERS OF STANDARD COLONISATION UNITS AT DIFFERENT STATIONS

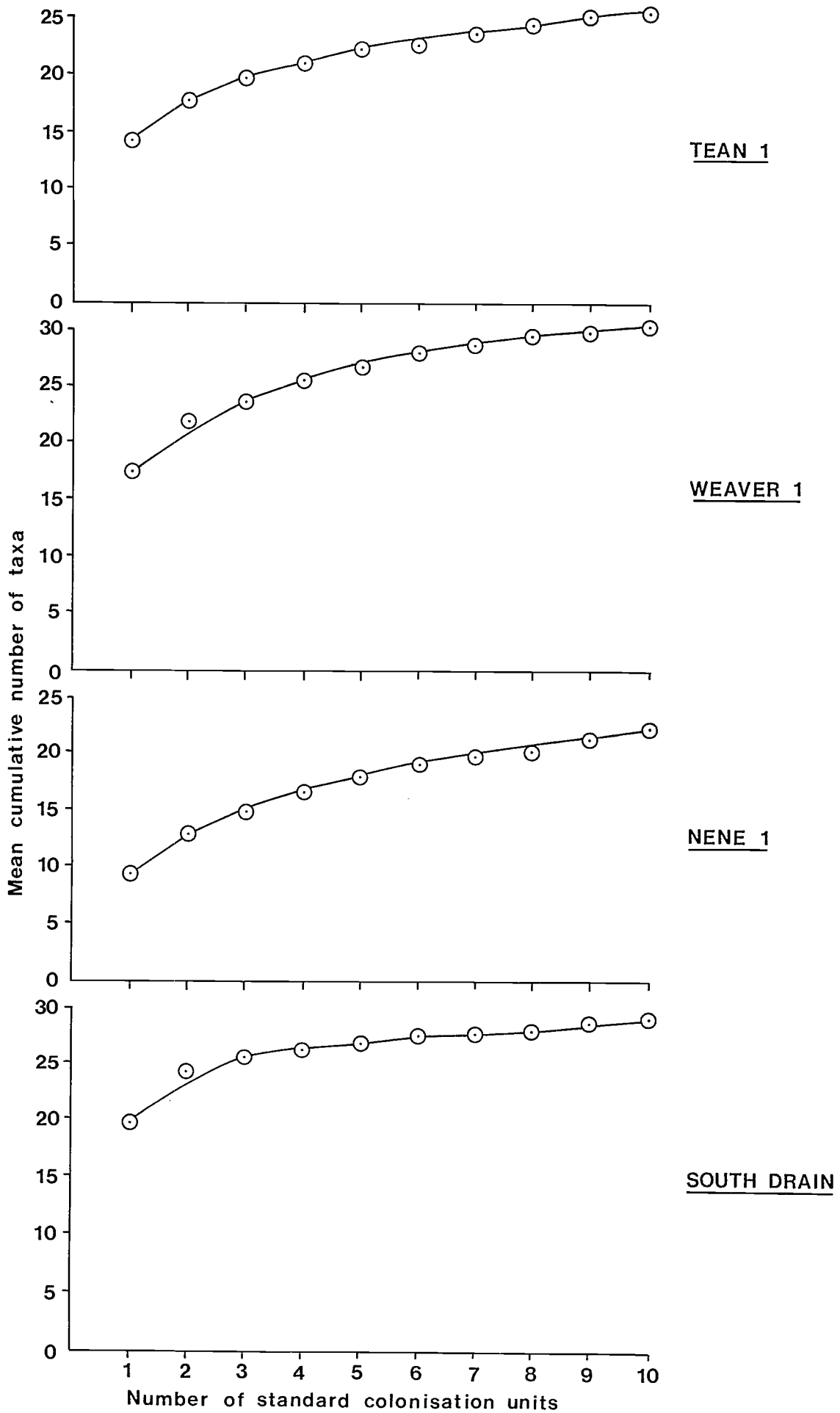
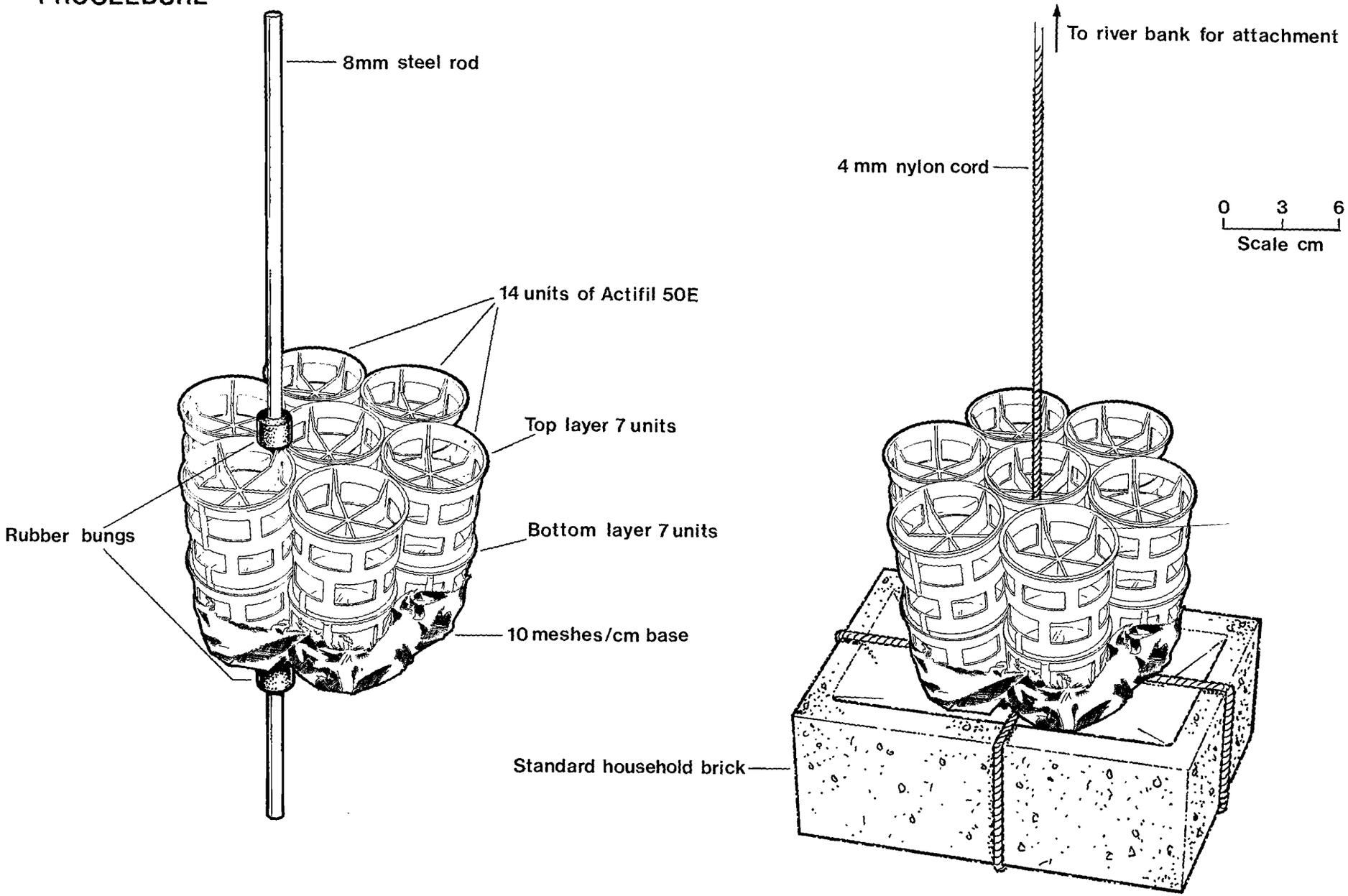


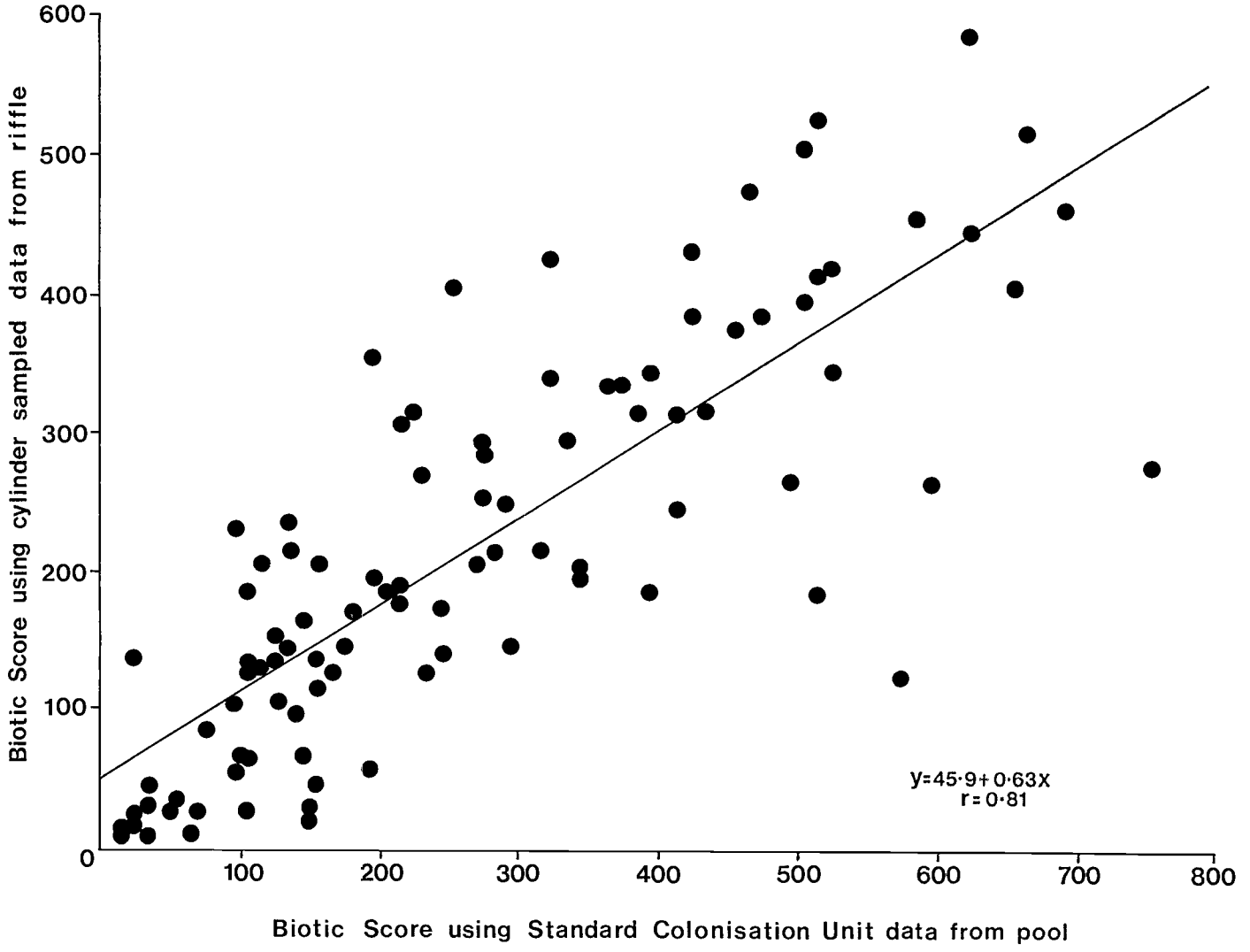
Fig 4. DIAGRAM OF THE STANDARD COLONISATION UNIT DEMONSTRATING TWO TYPES OF ANCORAGE PROCEEDURE



(a) Sampling shallow pools <2m depth

(b) Sampling deep potamon and lowland rivers >2m depth

Fig.5 RELATIONSHIP BETWEEN BIOLOGICAL MONITORING WORKING PARTY SCORES DERIVED FROM CYLINDER RIFFLE SAMPLES AND STANDARD COLONISATION UNIT IN ASSOCIATED POOLS



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