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During the years 1950, 1951 and 1952, collections with a pond-net were made almost every month at five or six stations in a small stony stream, Ford Wood Beck. No marked fluctuations in the numbers of any species were found during the three years, and it was felt that the descriptive survey stage of the work had come to an end (GLEDHILL 1960, MACAN 1957, 1963, p. 16, MACKERETH 1957, 1960). In 1952 an emergence trap that had been used on a fishpond was installed near the mouth of the stream (st. 1), and visited about twice a week when catches were large and about once a week at other times. It was hoped that the project, which was regarded more as a spare-time activity than as a full-dress piece of research, would indicate, without demanding much expenditure of time and effort, whether the populations continued to remain constant, and would make it possible to name species of Trichoptera and Chironomidae, which are not identifiable in the aquatic stage. After a year or two the catches indicated that the population was changing. In consequence collections in the water were resumed and have been continuous since 1956, apart from a gap in 1957 caused by an accident.

March was selected as the most suitable month for one collection, as few adults have appeared by then but most species are near emergence and therefore of large size. Sometimes a second collection was made in June to discover the numbers of the summer species.

(*) With 3 figures and 5 tables in the test.

TABLE I

YEARS IN WHICH COLLECTIONS WERE MADE

		1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
St. 1	Standard	X	X	X	X	X	X	X	X	X	X	X
	Mundie cone					X						
	Mundie pyramid						X	X	X			
Og	Standard			X	X	X	X	X	X	X	X	X
Collections in the water with a net	March	X				X		X	X	X	X	X
	June	X							X		X	

The purpose of the present paper is to compare the results of these two methods of collecting in order to discover how the picture of the fauna of the stream given by one collection in the water in spring differs from that given by regular catches in an emergence trap throughout the season.

Other comparisons are made. Dr. J. H. MUNDIE devised two traps, one of them specially for work in running water (MUNDIE 1956) and these were set, first one then the other, close to the original trap at station 1 near the mouth of the stream. The catches in the different designs of trap are compared. Another comparison is between the catch at st. 1 and the catch in Outgate Beck (Og) near the head of the stream, where a trap was installed in 1954. The years when the various types were in operation and the places where they were set are shown in Table I.

Maps showing the stream and the positions of the stations are given by MACAN (1957, 1962), the latter being diagrammatic, the former more accurate.

THE TRAPS

It is convenient to refer to the trap installed originally as the standard trap, because it has been used continuously since the beginning in order that results for different years may be comparable. Briefly it is a box that sits in a wooden frame to which floats are attached. The framework of the box is of wood, the top and some sides are of celluloid and the remaining side or sides of gauze. I have named Dr. MUNDIE's two traps from their shape. Sketches of them may be seen in Fig. 1 and accurate diagrams or photographs in the works referred to in Table II. The MUNDIE cone consists of a duralumin framework supporting a nylon fabric. Three floats keep this light

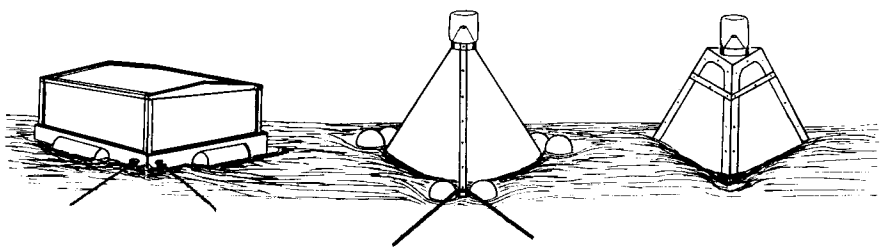

Fig. 1 — From left to right: standard; cone pyramid.

TABLE II

Name	Area	Situation	Fate of an insect that dies	Illustrated
Standard	.33 m^2	generally resting on bottom but floats when water high	falls into the water	MACAN 1949, pl. 9
Mundie cone	.25 m^2	lighter than preceding and more often afloat	retained by an inverted cone	MUNDIE 1956, fig. 2
Mundie pyramid	.15 m^2	always on bottom	ditto	MUNDIE 1956, fig. 3

structure sitting on the surface. At the top of the trap is an inverted jar entered through a vertical translucent cone intended to make ingress easy and egress difficult. The MUNDIE pyramid, in contrast, is of strong robust construction and it rests permanently on the bottom. The framework is of angle–iron, two sides are of perspex and the third is of copper gauze. It is surmounted by a jar with a cone–entrance as is the other trap. Further details are set out in Table II. The traps were visited twice a week at the time of year when catches were large, and there was a loss of unknown size in the standard trap of insects which, emerging after one emptying, had died before the next. There was possibly some loss in the other two also, as specimens were occasionally seen sitting on the sloping walls and making no effort to climb up through the cone into the jar.

The standard trap and the MUNDIE cone were not designed for use in streams. They were held in place by bridles which had to be of such strength that they broke in big floods; otherwise they might have collected a dam of dead leaves and branches sufficient to divert the stream. In most seasons they were washed away only occasionally and rarely damaged. The MUNDIE pyramid was secured by a single rope which ran round a big stone between the attachments to the bank and to the trap. It was not affected by floods and, from this point of view, was easily the most satisfactory of the three.

COMPARISON OF NUMBER OF ADULTS CAUGHT IN THE TRAPS WITH NUMBER OF NYMPHS CAUGHT IN A NET

Comparison being the main object, the results are expressed as ratios in Table III, the catches at st. 1 being set out in columns 3 and 4, and those at st. Og in columns 5 and 6. The lower total has always been made unity. In order that a conversion from ratio to number may be made if desired, the actual catches of adults are shown in the first (st. 1) and last (st. Og) columns.

The net catch is the fruit of 5 minutes collecting with a pond-net in March, the trap catch of a season's captures in the way already described. The figures against Ephemeroptera at st. 1 are the ratios of the total number of numphs caught in 7 years to all the adults caught in the same years. At Og the trap was installed later (Table I) and there are only six years in which collections were made by means of both methods. The numbers of Plecoptera at both stations are those caught in 5 years. Four summer-species, *Baetis scambus, Habrophlebia fusca, Ephemerella ignita* and *Leuctra fusca,* are not found in March, being in the egg stage then, and their totals are based on collections made in June, of which only three were made in years when traps were in action.

Certain groupings can be detected:

1. *Baetis rhodani, B. pumilus, Rhithrogena semicolorata,* and *Leuctra hippopus.* More adults were taken at station 1 than at Outgate, and the disparity between the number of nymphs at the two places is not as great, from which it is deduced that nymphs of these species move downstream before emergence.

2. The first 10 species in Table III (two of them are also in the first group). Adults were more numerous than nymphs at st. 1. *Baetis pumilus* is known to inhabit the interstices between smaller stones, and, therefore, a net collection which is obtained mainly by lifting up the large stones at the surface will fail to catch a certain proportion of the population in the area covered. The two species of *Chloroperla* and four species of *Leuctra* are all slender elongate Plecoptera nymphs, whose form suggests that they too inhabit the interstices between small stones. The remaining two species belong to the Leptophlebiidae, a family which PLESKOT (1953) has shown to live in this kind of place. *Paraleptophlebia submarginata,* however, crawls in the small spaces between the leaves of plants rather than between stones. *Baetis scambus* was a rare species and all 34 adults in Table III were taken in one

TABLE III

COMPARISON OF CATCHES OF LARVAE AND ADULTS

The columns at the extreme right and left show the total number of adults caught in the traps over a period of years; the exact number is described in the text. The other figures show the ratio of these figures to those of the number of larvae taken in a net.

F.W.B. St. 1	Species	F.W.B. St. 1		St. Og.		St. Og.
Total caught in trap		Trap (adults)	Net (larvae)	Trap (adults)	Net (larvae)	Total caught in trap
34	*Baetis scambus*	34	0	—	—	—
30	*Habrophlebia fusca*	30	0	4	1	110
13	*Chloroperla tripunctata*	13	0	2	0	2
4	*Leuctra nigra*	4	0	1	1	7
482	*Baetis pumilus*	6	1	1	6	6

158	*Chloroperla torrentium*	5	1	4	1	89
18	*Paraleptophlebia submarginata*	2	1	3	1	141
113	*Leuctra hippopus*	1.5	1	1	3	28
370	*Baetis rhodani*	34	1	1	15	11
1	*Perlodes microcephala*	1	2	—	—	—
1	*Isoperla grammatica*	1	2	1	3	1
99	*Rhithrogena semicolorata*	1	2	1	10	3
6	*Protonemura meyeri*	1	2	—	—	—
8	*Ecdynovus torrentis*	1	3	0	4	0
60	*Ephemerella ignita*	1	4	3	1	3
6	*Heptagenia lateralis*	1	4	9	1	26
9	*Amphinemura sulcicollis*	1	4	1	1	7
1	*Perla bipunctata*	1	4	—	—	—
14	*Nemoura cambrica*	1	13	1	6	25
—	*Nemurella picteti*	—	—	1	1	2

Station 1 is near the mouth, station Og near a source of the stream.

year ; they could have been derived from nymphs that spent all but the last portion of their lives higher up the stream than station 1.

The preponderance of all but the last of these species in the trap catches would seem to be due to a net–technique which collects a smaller proportion of their nymphs relative to those of other species.

3. *Nemoura cambrica* was one of the commoner species in the net collections but comparatively few adults were taken in the traps. Presumably this is caused by some habit at or near the time of emergence.

The numbers of the remaining species are too small to justify much deduction from them, but it is perhaps worth pointing out that the ratios of *Heptagenia lateralis*, which preponderates as a nymph at station 1 and as an adult at Outgate could be brought about by upstream migration. Since this species cannot tolerate high temperatures (MACAN 1960 a), such an upstream migration seems not unlikely.

The conclusion to be drawn from this first comparison is that emergence traps do not give a reliable picture of the relative abundance of the species inhabiting a stream. Distortion is caused by migration, and one species, at least, has habits at or near the time of emergence which take it away from the trap. On the other hand it does disclose deficiencies in the net technique employed, which evidently leads to the capture of an unduly small proportion of species that inhabitat the gravel beneath the larger stones at the surface. Indeed one species, *Chloroperla tripunctata*, was never recorded at all as a nymph. At present an emergence trap is essential to any worker who wishes to obtain a correct list of the species of Trichoptera and Chironomidae, and it is revealed in this analysis as an indispensable adjunct to quantitative work on other groups.

NOTES ON COLLECTING WITH A NET

In view of the conclusion that the net did not capture a representative sample of the population, it is important to know exactly how it was wielded. After working on the taxonomy of Ephemeroptera nymphs for some years, I started the survey of Ford Wood Beck with particular interest in the life history and distribution of species in this group. A good technique for collecting them is to lift the stones at the surface one by one, and to slip the net beneath each so that any specimen that is exposed to the current by the raising of the stone is

swept into it. Specimens that cling to the stone are dislodged by swilling it in the mouth of the net. A different technique is used by HYNES (1961), who describes it thus : « The net was held vertically against the stream bed and the area immediately upstream of it was vigorously stirred with a foot ». I have no doubt that this method, which disturbs a greater depth of substratum, is a better one for collecting Plecoptera, a group on the taxonomy of whose nymphs HYNES worked for many years, but it is possibly less efficient for Ephemeroptera. Fast swimmers, such as *Baetis* that dart away when disturbed, might be more likely to evade a net held still in one position, and the clinging nymphs of Ecdyonuridae might not all be dislodged. Thus apparent differences in the fauna of two places may be caused by different collecting techniques and it is important to allow for this when comparison is being made.

COMPARISON OF THE TRAPS

The catches in the standard trap and in the MUNDIE cone are shown in Table IV. The standard caught more of both species of *Baetis*, which, perhaps, find that the vertical wooden walls of the former provide a pre-emergence resting place that the cone does not. All the other Ephemeroptera are in nearly equal numbers in the two traps.

Since Plecoptera crawl out of the water to emerge, it might be expected that the walls of the standard trap would provide a vantage point as postulated for *Baetis* and that more would be caught in it than in the cone. No explanation is offered of why this expectation is not realized.

Eleven species of Trichoptera were taken in the cone compared with seven in the standard. Moreover, numbers of all but one were greater in the cone. Possibly the pupae of Trichoptera being carried downstream are more likely to be swept under the cone because there is a bigger space between its edge and the bottom. Whatever the explanation, the cone is the more efficient of the two traps at catching Trichoptera.

Table V compares the standard and the MUNDIE pyramid in the same way. The three-year totals for the first three abundant Ephemeroptera are remarkably similar. Those for the rest and for the Plecoptera show less close agreement. Nine species of Trichoptera were caught in the standard and 11 in the pyramid, and the totals were not greatly different. It is not possible to explain any of the main diffe-

TABLE IV

TOTAL CATCH DURING 1956 IN STANDARD EMERGENCE TRAP AND MUNDIE CONE

Order	Family	Genus & Species	Standard	Cone	Ratio*
Ephemeroptera	*Baetidae*	*Baetis rhodani*	77	23	2 : 1
		pumilus	103	10	8 : 1
	Ecdyonuridae	*Rhithrogena semicolorata*	31	35	1 : 1.5
		Ecdyonurus torrentis	5	5	1 : 1
		venosus		1	—
		dispar	1		—
		Heptagenia lateralis		1	—
	Leptophlebiidae	*Paraleptophlebia submarginata*	1		—
		Habrophlebia fusca	1	1	1 : 1
	Ephemerellidae	*Ephemerella ignita*	19	13	1 : 1
Plecoptera	*Chloroperlidae*	*Chloroperla tripunctata*	2	7	1 : 4.5
		torrentium	15	7	1.5 : 1
	Leuctridae	*Leuctra hippopus*	34	6	4 : 1
		fusca	11	48	1 : 6

		nigra	1	2	1 : 3
		inermis	7	14	1 : 1.5
	Nemouridae	*Nemoura cambrica*		1	—
		cinerea		1	—
Trichoptera	*Hydropsychidae*	*Hydropsyche* sp.		7	—
		instabilis		4	—
	Philopotamidae	*Wormaldia occipitalis*	1	6	1 : 8
		subnigra	2	7	1 : 4.5
	Rhyacophilidae	*Rhyacophila dorsalis*		1	—
		Agapetus fuscipes	9	21	1 : 3
	Sericostomatidae	*Silo nigricornis*	2		—
		pallipes	12	13	1 : 1.5
	Limnophilidae	*Potamophylax latipennis*	2	7	1 : 4.5
		stellatus		1	—
		Drusus annulatus	6	26	1 : 5.5
		Chaetopteryx villosa		2	—

* The ratio has been calculated after the number caught in the cone has been multiplied by a factor that makes its area the same as that of the standard.

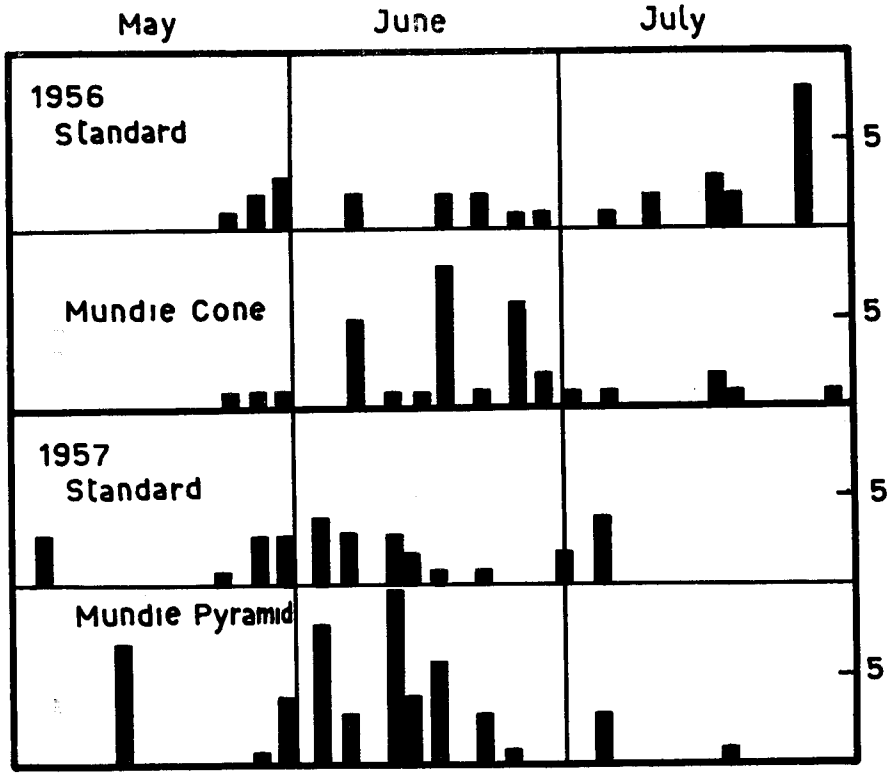

Fig. 2 — Comparison of daily catches of *Rhithrogena semicolorata* in standard emergence trap and Mundie cone and pyramid (1956, 1957 Ford Wood Beck st. 1).

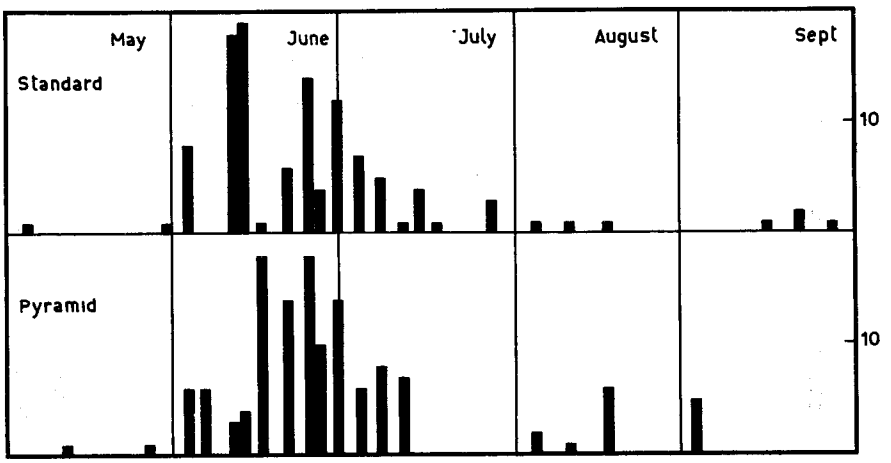

Fig. 3 — Comparison of daily catches of *Baetis pumilus* in standard emergence trap and Mundie pyramid (1957, Ford Wood Beck st. 1).

rences on present knowledge, but none is great enough to make the picture of the fauna revealed by one trap substantially different from that revealed by the other. The pyramid covers less than half the area covered by the standard trap, and is, therefore, much the more efficient instrument of the two.

In Figs. 2 and 3 individual catches by two different kinds of traps are compared. On the whole the pattern is similar. The catch in the standard trap was used by MACAN (1960 b) to compare the emergence of *Rhithrogena semicolorata* in successive years. The year 1956, with the greatest number at the end of the season, was unlike the rest. The pattern of the contemporaneous catch in the pyramid is more like that of other years but it does not alter the general picture and shows 1956 to have been a year in which emergence was late just as the standard catch did.

Some of the chironomids emerging from the stream are small enough to pass through the meshes unless material of fine texture is used for the walls of the traps. Dr. MUNDIE hopes to deal with this aspect of the work in a forthcoming publication on the Chironomidae of small streams in the district.

In conclusion it is evident that, under the conditions described, the standard trap was less efficient than the other two. Whether this is true if it is visited more frequently so that captured insects have a shorter time in which to die and fall into the water was not ascertained. Of the other two, the cone appeared to be more efficient at catching Trichoptera. However, the difference was not great and there is no doubt that the MUNDIE pyramid, designed for the purpose, is the most satisfactory instrument in stony streams.

Dr. J. H. MUNDIE has kindly criticized the typescript.

SUMMARY

1. Collections in a small stony stream were made with a net at stations near the source and near the mouth in March. Emergence traps at the same places were visited regularly throughout the season. Comparison of the results (Table III) shows that.

— Nymphs of *Baetis rhodani*, *B. pumilus*, *R. semicolorata* and *Leuctra hippopus* move downstream before emergence. Nymphs of *Heptagenia lateralis* may move upstream.

— The net gives an inaccurate picture of the numbers of nymphs

TABLE V

TOTAL CATCH DURING THREE YEARS IN STANDARD EMERGENCE TRAP AND MUNDIE PYRAMID

The ratio has been calculated after the number caught in the pyramid has been multiplied by a factor that makes its area the same as that of the standard.

		1957		1958		1959		Total		Ratio
		st	py	st	py	st	py	st	py	
Ephem.	*Baetis rhodani*	30	41	15	18	36	19	81	78	1 : 2
	pumilus	127	129	7	4	4	9	138	142	1 : 2
	scambus	.	.	1	.	.	.	1	.	—
	Rhithrogena semicolorata	30	51	19	4	4	.	53	55	1 : 2
	Ecdyonurus torrentis	16	3	1	.	.	1	17	4	2 : 1
	dispar	1	.	.	.	.	.	1	.	—
	Heptagenia lateralis	2	.	.	.	.	.	2	.	—
	Paraleptophlebia submarginata	17	7	.	.	.	.	17	7	1 : 1
	Habrophlebia fusca	13	.	.	.	.	.	13	.	—
	Ephemerella ignita	7	7	2	22	9	12	18	41	1 : 4
Plecopt.	*Perla bipunctata*	1	.	.	.	.	.	1	.	—
	Isoperla grammatica	.	1	.	1	.	.	.	2	—
	Chloroperla tripunctata	8	.	4	.	.	.	12	.	—
	torrentium	34	15	20	19	37	25	91	59	1 : 1.3

	Leuctra hippopus	6	7	2	10	.	13	8	30	1 : 8
	fusca	24	81	5	8	15	38	44	127	1 : 5.5
	nigra	2	2	.	.	2	2	4	4	1 : 2
	inermis	5	8	16	12	10	6	31	26	1 : 1.7
	Nemurella picteti	.	.	.	1	.	.	.	1	—
	Nemoura cambrica	1	1	.	2	.	5	1	8	1 : 16
	erratica	1	.	.	.	.	.	1	.	—
	Amphinemura sulcicollis	.	.	.	1	5	1	5	2	1 : 1
	Protonemura meyeri	.	.	.	.	1	.	1	.	—
Trichopt.	*Hydropsyche* sp.	1	1	.	.	1	.	2	1	1 : 1
	instabilis	2	.	.	.	.	.	2	.	—
	pellucidula	.	.	.	6	.	.	.	6	—
	fulvipes	.	1	.	.	.	.	.	1	—
	Philopotamus montanus	2	.	2	.	.	.	4	.	—
	Wormaldia occipitalis	.	1	.	2	.	.	.	3	—
	subnigra	1	.	2	3	.	.	3	3	1 : 2
	Agapetus fuscipes	22	32	66	57	87	32	175	131	1 : 1.3
	Silo nigricornis	.	.	.	3	.	.	.	3	—
	pallipes	4	5	1	7	.	.	5	12	1 : 5
	Sericostoma personatum	.	1	.	.	.	.	.	1	—
	Potamophylax latipennis	2	3	.	.	.	5	2	8	1 : 8
	Halesus radiatus	.	.	.	.	1	.	1	.	—
	Chaetopteryx villosa	.	1	.	.	1	7	1	8	1 : 16

of *Baetis pumilus*, *Leuctra* and *Chloroperla* presumably because, as they live in the gravel below the larger stones at the surface, it fails to catch many of them.

— *Nemoura cambrica* has some habit at or near the time of emergence that takes it away from the trap.

2. Three types of emergence traps (Fig. 1) were compared (Tables III and IV).

— A box sitting in a frame, designed originally for stagnant water, caught about as much as two other traps although it covered a larger area. Possibly this was because insects dying in it fell into the water, whereas in the other two the catch entered a jar through a vertical cone, which retained specimens that died.

— A light cage that floated higher than the other two caught more species of Trichoptera and more individuals of most of them.

— A heavy cage resting permanently on the bottom, and designed for running water, was found to be the most satisfactory.

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T. T. MACAN

GABBIE DI SFARFALLAMENTO E DI INDAGINE PER LA FAUNA REOFILA

1. Il lavoro si riferisce ad una raccolta eseguita in un piccolo corso d'acqua a fondo ciottoloso dove, nel mese di marzo, sono stati eseguiti campionamenti con un retino in due stazioni : una alla sorgente e l'altra alla foce. Nelle stesse posizioni sono state collocate delle gabbie di schiusura, controllate ad intervalli regolari di tempo nel corso della primavera.

L'esame dei risultati ha portato alle seguenti constatazioni (Tab. III).

— Le ninfe di *Baetis rhodani*, *B. pumilus*, *R. semicolorata* e *Leuctra hippopus* si muovono nella direazione della corrente prima di schiudere. Le ninfe di *Heptagenia lateralis* si possono muovere contro corrente.

— Il retino dà un'idea inesatta del numero delle ninfe di *Baetis pumilus*, *Leuctra* e *Chloroperla*, forse perchè non riesce a catturarle, dato che esse vivono nel fondo sotto grosse pietre.

— *Nemura cambrica*, nel periodo prossimo alla schiusura, diserta la zona delle gabbie.

2. Si confrontano i risultati ottenuti con l'impiego di tre diversi tipi di gabbie (Fig. 1 ; Tab. III–IV).

— Una gabbia con telaio a forma di scatola, costruita originariamente per acque stagnanti, ha catturato circa lo stesso numero di individui delle altre due trappole : una conica e l'altra trapezoidale, sebbene questa ricopra un'area maggiore. Ciò dipende forse dal fatto che gli insetti morendo in essa cadevano dentro l'acqua, mentre nelle altre due trappole gli individui catturati entravano, attraverso un cono, in un barattolo che riusciva a trattenere quelli che morivano.

— Una gabbia leggera che galleggiava più alta delle altre due ha raccolto più individui dell'ordine dei Tricotteri.

— Una gabbia pesante, fissa permanentemente sul fondo e costruita per le acque correnti, è risultata essere la migliore.