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STUDIES ON SOME RIVERINE INSECT EMERGENCE TRAPS: EFFECTS OF SAMPLING FREQUENCY AND TRAP DESIGN

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ABSTRACT

Flannagan, J.F., and D.G. Cobb. 1994. Studies on some riverine insect emergence traps: effects of sampling frequency and trap design. Can. Tech Rep. Fish. Aquat. Sci. 1995: iv + 10 p.

Comparisons of the effect of sampling frequency on the catch of insects by Box Emergence traps indicated little difference in frequencies from 2 hours to 3 days. The exceptions were those animals with aquatic adult stages or animals which are known to re-enter the water when disturbed.

In comparisons of Box traps with three other emergence traps and with the the Mundie Drift Emergence trap over two substrates in the Assiniboine River in 1990 and 1991, Box traps collected 2 to 4 times as many individuals, and the highest number of taxa of the various traps tested. Each of the traps tested in 1991 collected at least some species not collected by the other traps. In general, the efficiency of traps appeared to be in the following order: Box, New Mesh, Mundie, Dome, Townsend, although this varied somewhat by insect Order. Since Box traps are usable only in shallow water, the New Mesh trap is recommended for use in large deep rivers.

Key words: emergence traps; comparisons; efficiency; sampling frequency; aquatic insects; rivers.

RÉSUMÉ

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À la comparaison, on observe peu de différence quant aux effets de fréquences d'échantillonnage comprises entre deux heures et trois jours sur la capture d'insectes au moyen de boîtes à piquet. Les exceptions sont observées dans le cas d'insectes dont le stade adulte se passe dans l'eau ou de ceux dont le comportement est de replonger sous l'eau lorsqu'ils sont dérangés.

On a comparé les boîtes à piquet à trois autres types de pièges ainsi qu'au piège à émergence de Mundie en les employant sur deux substrats dans la rivière Assiniboine en 1990 et 1991. Les boîtes à piquet ont permis de capturer deux à quatre fois plus de spécimens que les autres ainsi que le plus grand nombre de taxons. Tous les pièges testés en 1991 ont permis de capturer au moins certaines espèces qui ne l'étaient pas par les autres. En général, l'efficacité des pièges semble suivre l'ordre suivant: boîte à piquet, New Mesh, piège à émergence de Mundie, Dome, et piège de Townsend, malgré des variations selon l'ordre auquel appartiennent les insectes. Puisque les boîtes à piquet ne sont utilisables qu'en eau peu profonde, il est recommandé d'avoir recours au piège New Mesh dans les cours d'eau profonds.

Mots-clés: pièges à émergence; comparaisons; efficacité; fréquence d'échantillonnage; insectes aquatiques; cours d'eau.

INTRODUCTION

Davies (1984), in his review of the literature dealing with the design and use of emergence traps in standing and running waters, pointed out the paucity of data available to evaluate the efficiency of the traps used in streams. This report results from a continuing project to evaluate the efficiency and, if possible, recommend and/or develop suitable sampling devices for sampling freshwater invertebrates (e.g. Flannagan 1970; Hamilton et al. 1970; Burton and Flannagan 1973, 1976; Burton et al. 1985). It describes the results of a series of experiments designed to test the effect of sampling frequency on catch of emerging insects in a Box Emergence trap (Flannagan 1978), and compares its efficiency with some representative designs, especially designs suitable for use in sampling insects emerging from large rivers.

MATERIALS AND METHODS

DESCRIPTION OF NEW TRAPS

The Dome trap was constructed of 1 mm cellulose acetate, heat moulded to the streamline shape shown in Fig. 1b and mounted on a Handy Angle frame to sample an area of 0.28 m^2. The metal loop on the front of the trap allowed the trap to slide down a 3 cm steel pole which had been driven into the bottom of the river.

The New Mesh trap shown in Fig. 1c was similar in general shape to the Dome trap, but was constructed from a Handy Angle frame covered in 0.4 mm mesh nylon. It, too, was designed to slide down a pole driven into the substrate of the river. This trap was larger, sampling an area of 0.49 m^2.

Both traps contained a removable 1 L Mason jar partly filled with water, with an air pocket as a reservoir to collect emerging insects. In the 1991 series of experiments, a small piece of styrofoam was inserted into the Mason jar to provide a resting place for adult insects.

The Townsend trap was a wooden, boat-shaped, floating apparatus, with a plexiglass surface containing a flap which opened to allow removal of the catch. The trap was assumed to sample an area of 0.23 m^2 (the size of the bottom opening).

The Box traps sampled an area of 1 m^2 and the Mundie drift emergence traps, which are not open at the bottom and which sample drifting, emerging insects from upstream, were assumed to sample an area equal to the bottom area of the trap, i.e. 0.18 m^2 in the model we used.

SAMPLING SCHEDULES

On May 28, 1989, 12 pre-numbered, 1 m^3 Box Emergence traps (Flannagan 1978) were randomly installed in an relatively uniform cobble riffle, downstream of the Hwy 271 bridge over the North Pine River, in the Duck Mountain Provincial Forest, Manitoba and sampled over the next six days. Traps numbered 1, 2 and 3 were sampled every two hours for three days (each day's catch was pooled to make one sample); then left for three days and sampled on day six; traps 4, 5 and 6 were sampled daily for six days; traps 7, 8 and 9 were sampled every second day for six days; and traps 10, 11 and 12 were sampled every third day for six days.

This schedule allowed the following comparisons, each with an n = 9: 3 x 3 samples where traps were emptied two hourly; two sets of 3 x 3 samples where traps had been emptied daily (first three days and last three days); this sampling schedule allowed us to ascertain if there had been a change in emergence pattern over the sampling period; 3 x 3 samples where traps had been emptied every second day; and 3 x 3 samples where traps had been emptied every third day.

Samples were sorted, identified, counted, and catch converted to number$\cdot m^{-2} \cdot d^{-1}$ to allow direct comparison of the results. Sample variances were approximately equal to and correlated with means, so the data were log transformed [n = log (n+1)] to remove the dependency of the variances on the means. Sets of samples were then compared using t-tests. Data presented in tables are untransformed, t-test results shown are from analyses on transformed data.

To find and test an emergence trap that would work effectively in large rivers, four replicates each of Box traps, Townsend Floating traps (Fig. 1a), a new submersed Dome trap (Fig 1b) and Mundie traps (Mundie 1964) were set over both sand and cobble substrates (except Mundie Traps, which were set over sand only) in the Assiniboine River at Lido Plage, Manitoba from July 23-27, 1990. The traps were emptied daily for 5 days. As described above, samples were sorted, identified and counted, converted to number$\cdot$ $m^{-2}\cdot$ d^{-1} and results compared using t-tests on transformed data.

On June 10-17, 1991 an improved version of the Dome trap, the New Mesh trap (Fig. 1c) was compared to Dome traps and Box traps set over cobble substrates and to Box traps over sand substrate. Three traps of each kind were set over the substrates listed above and sampled daily for seven days. Traps were sampled, sorted, identified, counted, converted to number$\cdot$ $m^{-2}\cdot$ d^{-1} and compared as before, using t-tests.

RESULTS AND DISCUSSION

The North Pine River experiments showed no significant difference in emergence of any taxon or "total Insecta" between the first three days and the last three days (Table 1). Thus, comparisons within the period are assumed to be valid. In general, there were few differences among the various treatments and except for "two hourly" versus "every third day", Plecoptera and some differences among the "Other Insecta" results (Table 1), frequency of sampling did not appear to affect the number of insects collected. The Plecoptera involved were almost exclusively Pteronarcys dorsata (Say), which is a large, robust, long-lived insect, with a tendency to re-enter the water when disturbed. Similarly, the "Other Insecta" collected were almost all adult Hemiptera and Coleoptera. The members of the latter two Orders involved in these tests live, as adults, immersed in the water. Thus, all of the insects in which significantly fewer captures were recorded are able to swim or crawl down into the water and out of the traps. However, significantly lower numbers of these insects generally occurred only when the traps were not emptied for the longer sampling periods.

The mean density and standard deviation of the taxa collected during the trap comparison studies of 1990 and 1991 are presented numerically in Table 2 and graphically in Fig. 2. Generally, except for the few comparisons outlined in Table 3, the efficiency of the traps, as measured by mean number of the various taxa, were in the following order: Box traps > Townsend traps > Dome traps in cobble and Box traps > Mundie traps > Dome Traps > Townsend traps in sand, in 1990. In 1991, the order was Box traps > New Mesh traps > Dome traps in cobble and Box traps > New Mesh traps in sand. In 1990, although the Box traps caught two to four times as many animals in total as the next best trap (largely because of the large sample variance), virtually all of the kinds of traps used had at least some comparisons which were not significantly different (Table 3). Note that because the Mundie trap samples drifting, emerging insects from upstream we have included it in both the sand and cobble comparisons (Table 3).

In 1991, although the Box traps still produced three to four times as many total animals as the other traps, the New Mesh traps were not significantly different from them in three out of the five comparisons on the sand substrate. This improvement may result from the insertion of styrofoam resting blocks into the collecting jars, which prevent drowning and subsequent loss of those adult insects which are susceptible.

A comparison of the species collected by the various traps in 1991 indicated that while most species were collected by the Box and New Mesh traps, all three trap types collected some species not collected by other two (Table 4). Thus, to sample all the species collected during the comparisons in the Assiniboine River, one would need to use all three trap types. Comparing only the two more effective traps, we see that the Box traps can be used only in water less than about 60 cm deep, while the New Mesh trap depth is limited only by the length of pole that can be driven into the substrate. The New Mesh trap catches fewer animals, and perhaps slightly fewer species, but because it can be used over a much wider range of depths, it could provide a more reliable comparison of the effect of depth on the composition of animals on any particular substrate type in large deep rivers. Conversely, the Box trap, because of its larger size, can be used over a much wider range of substrates than the New Mesh trap. Thus, in studies of relationships between substrate and animals where a large substrate is included, and the water is relatively shallow, the Box trap might be the sampler of choice.

CONCLUSIONS

Frequency of sampling, at least up to three days, seemed to have little or no effect on the number of insects caught in Box traps. The only exception to this were those insects which either live as adults in the water, or escape into the water to avoid collection.

Comparisons of the five different traps in 1990 and 1991 indicated that they varied in efficiency in the following order: Box, New Mesh, Dome, Mundie, Townsend, although the numbers of species and individuals varied slightly by substrate. All but the Box traps can be used to sample most depths found in rivers. If only shallow water is to be sampled, the Box traps will collect both the highest densities and the largest numbers of species, however, the New Mesh trap is recommended for whole stream surveys because it will collect most of the species, and most of the animals, at least over some substrates, and will work effectively at all depths.

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Table 1. Mean number (±1 s.d., n = 9) of adult insects collected$\cdot d^{-1}$ while varying the sample frequency of Box traps in the North Pine River, Manitoba.

Sampling frequency	Two hourly	Daily (first 3 days)	Daily (last 3 days)	Every second day	Every third day
Chironomidae	68.0 (64.2)	34.6 (40.7)	50.0 (39.2)	28.7 (19.1)	67.8 (66.7)
Ephemeroptera	0.56 (0.73)	0.9 (1.3)	0.3 (0.7)	1.0 (1.4)	0.9 (0.9)
Trichoptera	0.2 (0.4)	0.4 (0.5)	1.4 (1.6)	0.7 (0.7)	0.6 (0.5)
Plecoptera	1.2 (1.4)[a]	0.1 (0.3)	0.2 (0.4)	0.1 (0.3)	0.1 (0.3)[a]
Other Insecta	4.3 (3.3)[b,c]	1.7 (3.2)	1.0 (1.4)[b]	1.1 (1.5)[c]	1.3 (1.7)
Total Insecta	75.2 (67.9)	37.6 (41.3)	53.0 (40.8)	31.6 (20.2)	71.6 (67.6)

[a,b,c] Samples with the same letter are significantly different from each other. a, c = $p<0.03$; b = $p<0.02$.

Table 2. Number of animals· m^{-2}· d^{-1} in Box (BT), Townsend (TT), Dome (DT), Mundie (MT), and New Mesh (NMT) traps in 1990 and 1991 over cobble and sand substrates of the Assiniboine River (= standard deviation).

	Cobble			Sand			
Taxon (number· m^{-2}· d^{-1})	BT	TT	DT	BT	TT	DT	MT
1990 (n = 20)							
Ephemeroptera	72.4 (70)	47.8 (43)	12.1 (14.3)	204.6 (276.7)	3.1 (4.1)	7.9 (6.7)	35.1 (28.8)
Trichoptera	19.5 (13.4)	7.2 (7.6)	6.8 (5.9)	1.5 (1.2)	2.0 (6.0)	0.8 (1.6)	5.9 (7.1)
Chironomidae	15.2 (8.0)	2.9 (4.5)	3.3 (3.9)	22.7 (12.4)	0.5 (1.2)	9.0 (12.5)	8.5 (9.1)
Others	5.8 (4.4)	10.7 (11.3)	0.6 (1.5)	2.3 (2.4)	2.2 (2.5)	0.2 (0.9)	0.8 (1.8)
Total	112.9	68.6	22.7	231.7	7.7	17.9	50.1
	BT	DT	NMT	BT	NMT		
1991 (n = 21)							
Ephemeroptera	29.8 (18.9)	7.4 (8.1)	9.9 (4.9)	63.3 (50.1)	10.8 (8.1)		
Trichoptera	51.7 (23.6)	13.5 (12.8)	16.6 (14.9)	0.3 (0.6)	0.7 (1.0)		
Plecoptera	3.9 (3.5)	0	0.7 (1.3)	1.2 (0.8)	1.2 (1.2)		
Chironomidae	71.9 (58.5)	22.5 (24.2)	20.8 (16.9)	232.3 (132.9)	55.4 (44.9)		
Others	33.1 (31.8)	8.6 (7.6)	12.0 (7.0)	1.9 (2.0)	1.3 (2.0)		
Total	190.1	52.1	60.2	299.1	69.4		

Table 3. Lists of comparisons, using t-tests, of log transformation of results presented in Table 2 which were <u>not</u> significantly different.

1990		
Ephemeroptera	MT v's TT (cobble)	BT v's TT (cobble)
Trichoptera	DT v's TT (sand, cobble)	DT v's MT (cobble)
	TT v's MT (cobble)	
Chironomidae	MT v's BT (sand, cobble)	
Others	TT v's BT (sand, cobble)	MT v's DT (sand, cobble)
1991		
Trichoptera	NMT v's BT (sand)	NMT v's DT (cobble)
Plecoptera	NMT v's BT (sand)	
Chironomidae	NMT v's DT (cobble)	
Others	NMT v's BT (sand)	

Table 4. Species collected by the various traps during the 1991 trials.

Species	BTC	NMTC	DTC	BTS	NMTS
	Cobble			Sand	
Potamyia flava	p	p	p	p	p
Hydropsyche bidens	p	p	p	-	-
H. bifida	p	p	-	-	-
H. spp females	p	p	p	-	-
Cheumatopsyche campyla	p	p	-	-	-
C. speciosa	p	p	-	-	-
Cheumatopsyche females	p	p	p	-	-
Hydroptila angusta	p	p	-	-	-
Oecetis avara	p	p	-	-	-
Ochrotrichia tarsalis	p	p	-	-	-
Leptocella candida	p*	-	-	p*	-
Ceraclea spp.	p*	-	-	r*	-
Helicopsyche borealis	p*	-	-	-	-
Protoptila maculata	-	p*	r	-	-
Neureclipsis crepuscularis	-	p*	-	-	p*
Ithytrichia clavata	-	-	-	r*	-
Total Trichoptera	13(+3)**	12(+2)	5	4(+3)	2(+1)
Trichorythodes stygiatus	p	p	p	p	p
T. sp	p	p	p	p	p
Baetis propinquus	p	p	p	p	p
B. sp	p	p	p	p	p
Stenonema terminatum	p	p	p	p	p
S. luteum	p	p	p	p	p
Stenonema females	p	p	-	p	p

Species	BTC	NMTC	DTC	BTS	NMTS
		Cobble		Sand	
Heptagenia flavescens	p	p	-	p	p
Baetis ellioti	p	p	-	p	p
B. intercalaris	p	p	p	-	p*
B. dardanus	-	p*	-	p	p
Centroptilum sp	-	-	p*	p	p
Baetis flavistriga	p	p	-	-	-
Centroptilum bifurcatum	-	-	-	p	p
Ephemera simulans	r*	-	-	-	-
Stenonema interpunctatum	r*	-	-	-	-
Procloeon rufostrigatum	-	-	-	p*	-
Centroptilum walshi	-	-	-	p*	-
Hexagenia limbata	-	-	-	r*	-
Total Ephemeroptera	13(+2)	12(+1)	8(+1)	15(+3)	13(+1)
Acroneuria abnormis	p	p	-	p	p
Isoperla bilineata	p	p	-	p	p
I. patricia	p*	-	-	-	p*
I. sp	-	p*	-	-	-
A. lycorias	p*	-	-	-	-
Total Plecoptera	4(+2)	3(+1)	-	2	3(+1)
TOTAL NUMBER OF TAXA	30(+7)	27(+4)	13(+1)	21(+6)	18(+3)

* indicates species not present in other traps on same substrate
** () indicates # species unique to this trap on this substrate

p = more than one specimen collected   r = single occurrence

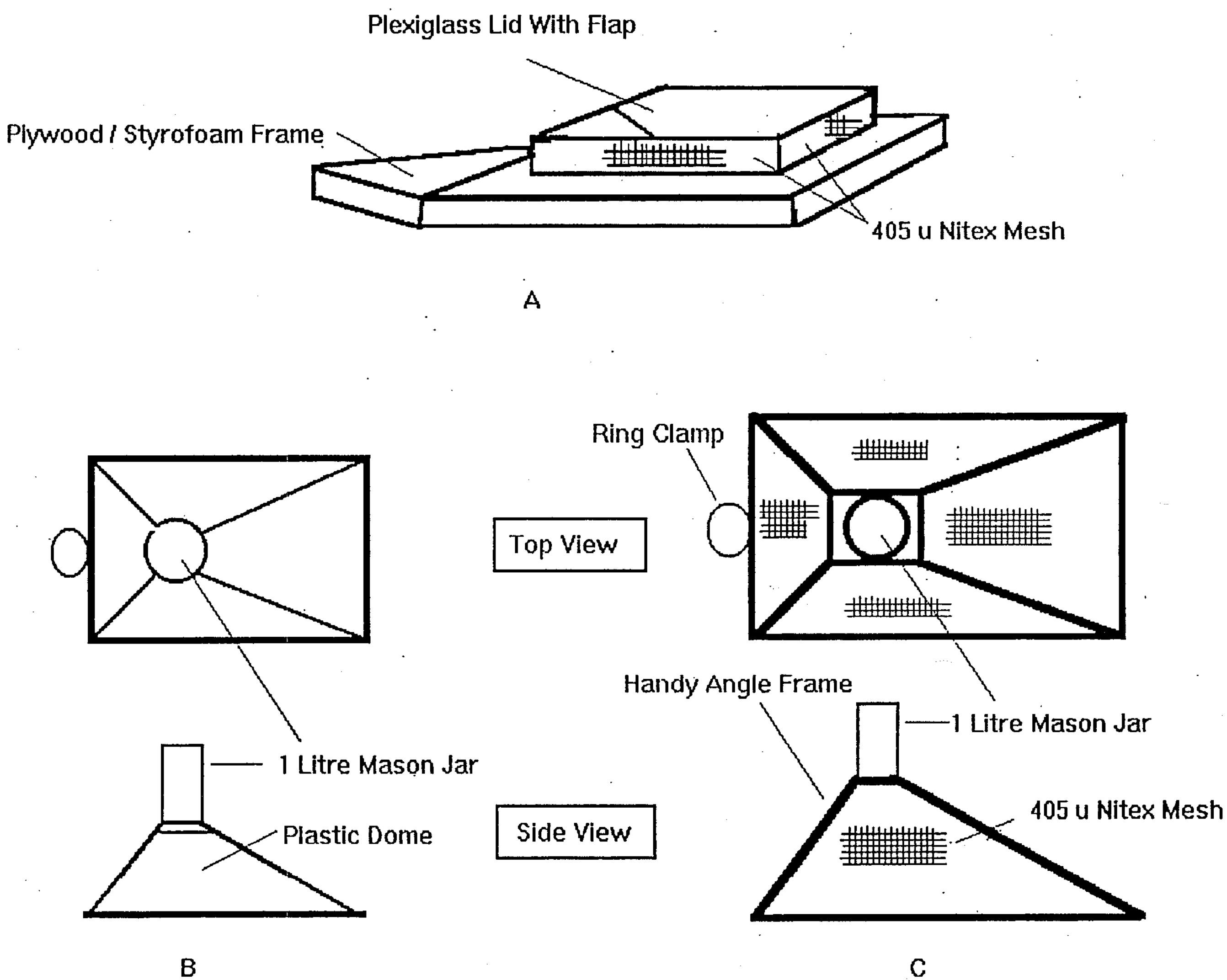

Figure 1. A. Townsend floating trap. B. Dome trap. C. New Mesh trap.

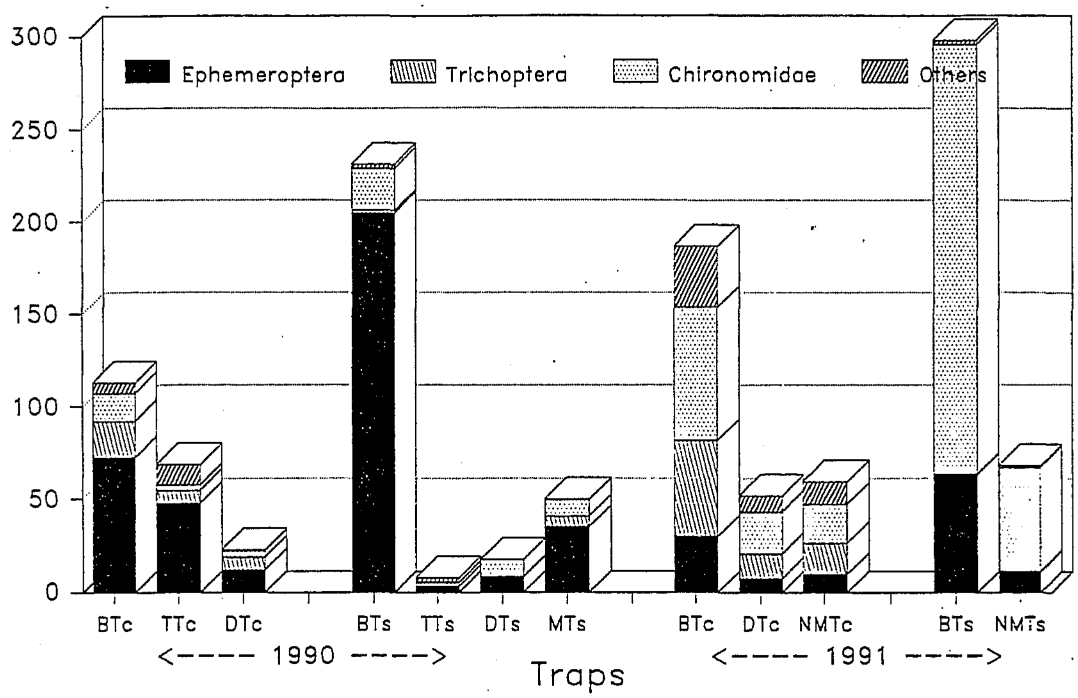

Figure 2. Mean number of animals collected$\cdot m^2 \cdot d^{-1}$ during the 1990 and 1991 comparisons. See Table for explanation of abbreviations.