Arthropod Capture Technique Comparison and Analysis

Rachel Mohr
Rachel Mohr
Texas A&M Study Abroad Program
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Dr. R. Wharton

Abstract:

Due to the sparse arthropod distribution in the Check Hall River, different capture techniques are necessary to capitalize on each microhabitat. This study investigates the effectiveness of five different techniques in four microhabitats. It also analyzes the different microhabitat preference of different captured specimens.

Introduction:

Over all their history, arthropods have displayed one trait that has enabled them to exploit nearly every microhabitat: adaptability. Their chitinous exoskeleton's versatility allows them to survive in an astounding variety of ecosystems, and is arguably the single greatest factor in arthropods' success as a phylum. However, this same high level of adaptation presents difficulties for researchers seeking to capture and study them. In the case of aquatic arthropods, they hide under rocks, in loose sediments, amongst plant roots, or build their own shelters. To further complicate matters, arthropods display different behaviors in different niches of a general habitat. This tendency is shown more specifically by the arthropods of the Check Hall River. In overall appearance, the Check Hall is a shallow, clear, cold, fast-flowing river in the wet forest of the island of Dominica. The river displays four distinct sub-habitats: deep, fast flowing riffles; shallow, fast-flowing riffles; deep, slow moving pools, and shallow slow-moving pools. Evidence from two previous studies (Swick 2001, Roberts 2001) showed that prawns, the largest of the resident arthropods, showed no definite response to either stream velocity or to pool volume. Extrapolation from this data would seem to indicate that the prawns (and probably the other arthropods) have a fairly even distribution throughout the different sub-habitats. Given this assumption, the researcher's challenge then becomes selecting the correct technique for each area. This survey thusly addresses the difficulties of implementing various capture techniques within each area, and the success of each technique among the four sub-habitats.

Materials and Methods:

The equipment for collecting insects needs to fulfill two basic qualities: portable and sturdy. Equipment must be portable to reach the area of study, and often must be hand carried to the site. It must be study to handle the rigors of use and travel, but also needs to stand up to the accidents that routinely happen in the field. Each piece of equipment used in this study was built with these qualities in mind.

Aquatic net- The aquatic net is a very common, very simple piece of equipment – a fine mesh net attached to a long pole. This survey used a net with a trapezoidal opening, 8” at the widest, on a 6’, two-segmented steel pole. With the net portion removed, the net handle can be used in conjunction with the kick net, to disturb the substrate. In operation, the net is swept from downstream to upstream along the streambed, but it can also be used to skim along the surface of the water to capture surface dwelling insects. This is the most diverse tool, as it can be used at any depth, at any time.

Kick net – The kick net is a variation of the aquatic net – a length of mesh stretched between two poles. In this survey, a strip of mesh 2’x4’ was duct taped to two 3’ poles. The poles protruded about 3” beyond the lower margin of the mesh, to allow them to sink into the creek substrate without damaging the mesh. In practice, one stretches the kick net taut between the two poles downstream of the area of interest. Once the net is in position, the substrate is roughly disturbed; and the current carries dislodged specimens into the net. This technique works best with two people: one to hold the poles steady, and one to disturb the sediments. Furthermore, this trap method is limited by depth, as it is ineffective in water deeper than the mesh.

Light trap- This trap works on the assumption that aquatic insects are attracted to light. It is the most complex piece of equipment used in this study. A 3.5’ piece of 4” PVC was fitted with a foil-lined, funnel shaped reflector about 8” from one end. An underwater flashlight fits into the hole in the funnel, oriented towards the distal end of the pipe. On this distal end, a conical stiff mesh cap covers the opening, and is held in place by a metal retaining ring on the inside of the pipe, and large rubber bands on the outside. A hole 2.5” in diameter is cut into the mesh to allow arthropods ingress, but the conical shape of the cap prevents easy egress. To complete the trap, two eyebolts were screwed into the pipe as attachment points for light rope, which keeps the trap from being accidentally swept away by the current. To deploy the trap, the flashlight is switched on, and the whole device is submerged and braced on the bottom of the site with available rocks. (In the absence of a rocky bottom, lead weights could be attached to the eyebolts.) This is a passive trapping method, and should just be left in position for a set period of time; however, it is night and depth dependent.

Bait trap- The bait trap can take a number of forms; for the purposes of this experiment, the light trap apparatus was reused for the body of the trap, though the flashlight was not switched on. (It was left in place to prevent small arthropods from escaping through the reflector funnel.) Previous research indicated that native coconut and mangos were effective baits (Roberts, 2001); so both products were cut into 4” pieces and placed in the trap. The trap was then submerged and braced in the same fashion as the light trap. This technique primarily targets detritivores – obviously, arthropods not attracted by fruit would not be captured. This trap should be deployed at night during times of maximum arthropod feeding activity.

Rolling Rocks – This technique seeks out arthropods that cling to the undersides of rocks and similar sheltered crevices. No equipment is necessary, as one simple removes submerged rocks and examines them for arthropods. This technique is best performed during the daylight (or under strong area illumination) to better select likely rocks, and to see the specimens.

This study utilized a simple procedure. A 200’ section of the Check Hall River contained typical examples of all four sub-habitats. Four test sites were selected, one typical of each sub-habitat. During daylight hours at each site, ten passes of the aquatic net were performed, four passes with the kick net, and examination of 20 submerged rocks. During the nighttime, 10 more aquatic net sweeps were performed at each site, and the light trap and bait traps were deployed for 12-hour periods. To minimize variation due to foraging habits, the traps were deployed at 8:30 pm. Since the flashlight batteries were only good for six hours, it can be assumed that the daylight period before trap retrieval played no part in the trap’s action.

Specimens from each trap method at each site were preserved in sample vials containing 70% ethanol. These vials were later examined under a dissecting microscope to identify the specimens. For the larger, and legally protected, prawns, identification and counts were made at the site; the prawns were then released back into their native habitat.

Results:

See Tables 1-11, and Figure 1 for detailed breakdown of collected data.

Table 1 illustrates the species found, and where they were most commonly captured. Tables 2-5 show the average effectiveness of each capture technique at each of the different sites, but the breakdown of species captured by each technique is provided in Tables 6,7,8,9, and 11. Table 10 deals with the specimen density at each site as documented by the Rolling Rocks technique. The data array tracks the data in two groups: differences between sites in the number of specimens and differences in the techniques by number of specimens in each species.

In terms of the number of species collected, the kick net seemed the most effective tool. By measure of straight efficiency, the light trap was more effective. (See Table 12) However, neither showed a strong dominance of the field – no single technique did. Some techniques were highly successful for specific species, shown in Table 13.

Discussion:

The first major division of data deals with the differences between the sites. Site 1, the deep, slow moving water, was most likely to yield prawns and water skaters. This result is unsurprising, as the Roberts (2001) study showed that prawns were more common in larger volumes of water. Water skaters are more likely to prefer slow water because their locomotion depends on water tension. Disturbed, fast moving water is likely to disrupt their ability to walk. Since these two species are very different in habit, different capture techniques were required. The submerged bait and light traps lured in the larger, completely aquatic prawns fairly efficiently. Aquatic sweep netting was the technique of choice for catching the fast moving Veliidae.

Site 2, the deep, fast moving water, was most likely to yield Elmidae, commonly called Riffle Beetles, and Simuliidae larvae. This result is unsurprising because Elmidae are known to live in riffle areas, and Simuliidae depend on the fast flowing water to oxygenate their poorly developed posterior gill plate. However, the fast moving water has worn down many rocks, making protective cover hard to find, discouraging larger species, like the Zygoptera naiads. The kick net was the most effective technique, since it dislodged the Simuliidae from the rocks, and also captured the Elmids on the surface of the water.

Damselflies seemed to prefer the slower moving, shallow waters of site 4. With well-developed gills and predatory habits, they do not need the water movement to oxygenate them; and they can use the more common cover as a refuge from which to ambush prey. This site showed an even split between the kick net and the rolling rocks method for capturing the sub aquatic species. However, there were also a good number of water skaters taken, as before, with the aquatic net. In addition, the aquatic net captured two prawns, unsurprising since sites 1 and 4 are at distal ends of a large pool. The last site, site 3, was home to Ephemeroptera and free-living Trichoptera. Both species need fast flowing water to keep them oxygenated. The predacious Trichopterans need cover from which to ambush their prey; likewise the Ephemeropterans need cover to protect them from predators. The rocks in the shallow water provide plenty of cover, so it is not surprising that the rolling rocks method was the most effective at capturing specimens.

The second major division of data deals with the differences between capture techniques on the number of each species taken. The kick net was most effective at taking different number of species. This result is due in large part to the trap's design, as it occupies the entire height of the water column to capture arthropods at the surface, at midwater, and one the substrate. Upstream agitation of the streambed helps to increase the number of specimens, giving this technique many of the strong points of both the aquatic net and the rolling rocks method. However, the kick net has the draw back of being too general, at time. The rolling rocks method was effective at obtaining the Zygoptera, Trichoptera, and Ephemeroptera because it provided direct access to the concealed habitats in which they reside. The light and bait traps only seemed to be effective at luring in prawns; all other arthropods stayed away. The light trap result is unusual, as they are effective in lentic environments to capture Culicidae, Dytiscidae, Belostomatidae, and Haliplidae. Since all the other captured species besides the prawns are predators, it is unsurprising that they were not attracted to the mangos.

One immediately noticeable characteristic of the whole data set is it's small size. The vast majority of subsamples, regardless of technique, were devoid of specimens; there does not seem to be a great deal of arthropod activity in the Check Hall River. A possible explanation for this lack is the shortage of aquatic plant material. As noted, the Check Hall is clear, fast, and very rocky. No plants seem to have been able to establish themselves anywhere on the streambed. All vegetable matter comes from the canopy, in the form of falling fruit and deciduous leaves. This dearth of green stuff means that the ordinary pyramid of plants->herbivores->small predators -> big predators -> detritivores is an impossibility. Instead, there are handfuls of small predators and handfuls of detritivores. The detritivores (prawns and crabs) are too large for the predators (insects) to eat, so the predators must hunt other insects. This cycle is self-limiting, as all the insect species are trying to eat all the other insect species, and are keeping their own populations low. The prawns and crabs seem to form a separate loop of the food chain. They are present in the river in quite large numbers, as evidenced by the large amount of eye shine seen at night. There does not seem to be enough biomass in the river to support such a population; they must be either eating one another, or eating a very large amount of the vegetable matter that falls from the canopy. The dynamics of these populations are fascinating, but outside the scope of this study.

The ultimate result for the researcher is that there is a small population of targets in a small river. To capture them for study, the most effective method for that species in their sub-habitat ought to be used to maximize the potential for study.

References:

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Tables and Figures:

Table 1: Overall Species Breakdown by Sub-Habitat: 1- Deep, slow pool; 2- Deep, fast riffles; 3-Shallow, fast riffles, 4-Shallow, slow riffles.

Overall Species Breakdown		
	Found at:	Most Common:
Zygoptera Naiads:	1,3,4	4
Ephemeroptera Naiads:	3,4	3
Trichoptera Larvae:	2,3,4	3
Simuliidae Larvae:	2,3	2
Elmidae	2	2
Gerridae	1,4	1
Macrobranchium crenulatum	1,2	1
Xiphocaris elongata	1,2,4	1

Table 2: Technique Effectiveness at Site 1: Deep, Slow Pool

Site 1:			
Trap Type	# Tests	# Specimens	Avg. Response
Aquatic Net Day:	10	10	1
Aquatic Net Night:	10	0	0
Rolling Rocks:	20	3	0.15
Kick Net:	0	0	0
Light Trap:	1	7	7
Bait Trap:	1	4	4

Table 3: Technique Effectiveness at Site 2: Deep, Fast Riffles

Site 2:			
Trap Type	# Tests	# Specimens	Avg. Response
Aquatic Net Day:	10	0	0
Aquatic Net Night:	10	0	0
Rolling Rocks:	20	1	0.05
Kick Net:	4	12	3
Light Trap:	1	0	0
Bait Trap:	1	1	1

Table 4: Technique Effectiveness at Site 3: Shallow, Fast Riffles

Site 3:			
Trap Type	# Tests	# Specimens	Avg. Response
Aquatic Net Day:	10	0	0
Aquatic Net Night:	10	0	0
Rolling Rocks:	20	12	0.6
Kick Net:	4	1	0.25
Light Trap:	1	0	0
Bait Trap:	1	0	0

Table 5: Technique Effectiveness at Site 4: Shallow, Slow Pool

Site 4:			
Trap Type	# Tests	# Specimens	Avg. Response
Aquatic Net Day:	10	7	0.7
Aquatic Net Night:	10	0	0
Rolling Rocks:	20	8	0.4
Kick Net:	4	2	0.5
Light Trap:	0	0	0
Bait Trap:	0	0	0

Table 6: Aquatic Net Results at all sites

Aquatic Sweeping Results								
Trial	1-Day	2-Day	3-Day	4-Day	1-Night	2-Night	3-Night	4-Night
1	0 (Deep)	0	0	Xiphocaris elongata	0	0	0	0
2	0 (Deep)	0	0	0	0	0	0	0
3	0 (Deep)	0	0	3 Gerridae	0	0	0	0
4	0 (Deep)	0	0	Xiphocaris elongata	0	0	0	0
5	0 (Deep)	0	0	1 Gerridae	0	0	0	0
6	2 Veliidae	0	0	0	0	0	0	0
7	2 Veliidae	0	0	0	0	0	0	0
8	1 Veliidae	0	0	2 Gerridae	0	0	0	0
9	1 Veliidae	0	0	0	0	0	0	0
10	2 Veliidae	0	0	0	0	0	0	0

Table 7: Kick Net Results at all sites

Kick Net Results				
Trial	Site 1	Site 2	Site 3	Site 4
1	N/A	6 Elmidae	1 Simuliidae larva	1 Zygoptera naiad
2	N/A	3 Elmidae	0	1 Ephemeroptera naiad
3	N/A	0	0	0
4	N/A	1 Trichoptera larva 1 Simuliidae larva	0	0

Table 8: Bait Trap Results at all sites

Bait Trap			
Site 1	Site 2	Site 3	Site 4
3 *Macrobranchium crenulatum* 1 *Xiphocaris elongata*	1 *Xiphocaris elongata*	0	N/A

Table 9: Light Trap Results at all sites

Light Trap			
Site 1	Site 2	Site 3	Site 4
3 *Macrobranchium crenulatum* 4 *Xiphocaris elongata*	0	0	N/A

Table 10: Rolling Rocks Effectiveness at all sites

Rolling Rocks							
	Avg. Dimensions	Surface Area	#Tested	#Inhabited	Total Specimens	Overall Density	Inhabited Density
Site 1:	5x5x5	150	20	2	3	0.00100	0.01000
Site 2:	5x4x5	130	20	1	1	0.00038	0.00769
Site 3:	3x4x4	80	20	3	12	0.00750	0.05000
Site 4:	8x4x4	128	20	5	8	0.00313	0.01250

Table 11: Specimen Breakdown for Rolling Rocks at all sites.

Specimen Breakdown: Rolling Rocks			
Site 1:	Site 2:	Site 3:	Site 4:
3 Zygoptera naiads	1 Simuliidae larva	4 Zygoptera naiads 3 Ephemeroptera naiads 5 Trichoptera larvae	4 Zygoptera naiads 4 Trichoptera larva

Table 12: Overall Effectiveness of Techniques for all sites

Overall Technique Effectiveness:				
	#Trials	#Specimens	Average per trial	#Species
Aquatic net	80	16	0.20	2
Kick net	16	14	0.88	5
Rolling Rocks	80	24	0.30	4
Light Trap	3	7	2.33	2
Bait Trap	3	4	1.33	2

Table 13: Comparative Effectiveness of Techniques per Species

Technique Effectiveness as a Percent of Specimens Captured						
	Total	Aquatic Net	Kick Trap	Rolling Rocks	Light Trap	Bait Trap
Zygoptera Naiads:	12	0.00	0.08	0.92	0.00	0.00
Ephemeroptera Naiads:	4	0.00	0.25	0.75	0.00	0.00
Trichoptera Larvae:	10	0.00	0.10	0.90	0.00	0.00
Simuliidae Larvae:	3	0.00	0.67	0.33	0.00	0.00
Elmidae	9	1.00	0.00	0.00	0.00	0.00
Veliidae	16	1.00	0.00	0.00	0.00	0.00
Macrobranchium crenulatum	6	0.00	0.00	0.00	0.50	0.50
Xiphocaris elongata	7	0.29	0.00	0.00	0.57	0.29