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Free-Swimming Invertebrate Communities of Vernal Pools in Eastern Washington

Abstract

Free-swimming invertebrates which consisted mostly of crustaceans and insects were collected weekly from five vernal pools in eastern Washington from 20 February through 18 June 1982. By use of activity traps and a modified Wilding sampler, the planktonic or benthic habit of these taxa were determined. Community composition is compared to a nearby permanent lake and a model of the habit and trophic relationships in the pools is proposed.

Introducton

Vernal pools are temporary bodies of water that form in late winter or early spring from rain and melting snow (Wiggins 1973). Duration of the wet phase varies, but these pools usually dry up in summer (Hartland-Rowe 1972).

Typical invertebrate communities found in vernal pools include phyllopods, copepods, cladocerans, rotifers and dipterans (Hartland-Rowe 1966, Stout 1964, Kenk 1949, Wiggins *et al.* 1980, Simpson 1967, Donald 1971, Fairbanks 1950). Certain taxonomic groups such as Anostraca, Conchostraca, and Notostraca are found primarily in temporary waters (Pennak 1978, Wiggins *et al.* 1980).

The objective of this study was to document the free swimming invertebrate community of five vernal pools and to describe habits and trophic relationships.

Study Area Description

The study site is located 2.5 km south of Cheney, Washington on the Turnbull Pine Research Natural Area (Fig. 1). The site is 81 hectares in area and is part of the Turnbull National Wildlife Refuge, Spokane County, Washington (Franklin *et al.* 1972). The refuge is part of the "channeled scablands" first described by Bretz (1923). Prior to the formation of the scablands, the region was comprised of Columbia River basalt overlain with thick deposits of loess. The scablands are the result of scouring by glacial rivers which left a series of coulees, lakes and marshes which are oriented in a northeast-southeast direction.

The natural area is characterized by various ponderosa pine (*Pinus ponderosa* Douglas) habitat types (Daubenmire 1968). Snowberry (*Symphoricarpos albis* (L.) Blake) is a common understory species. Various grassland communities are also found on the study site (Franklin *et al.* 1972).

All pools studied were surrounded by stands of ponderosa pine and contain quaking

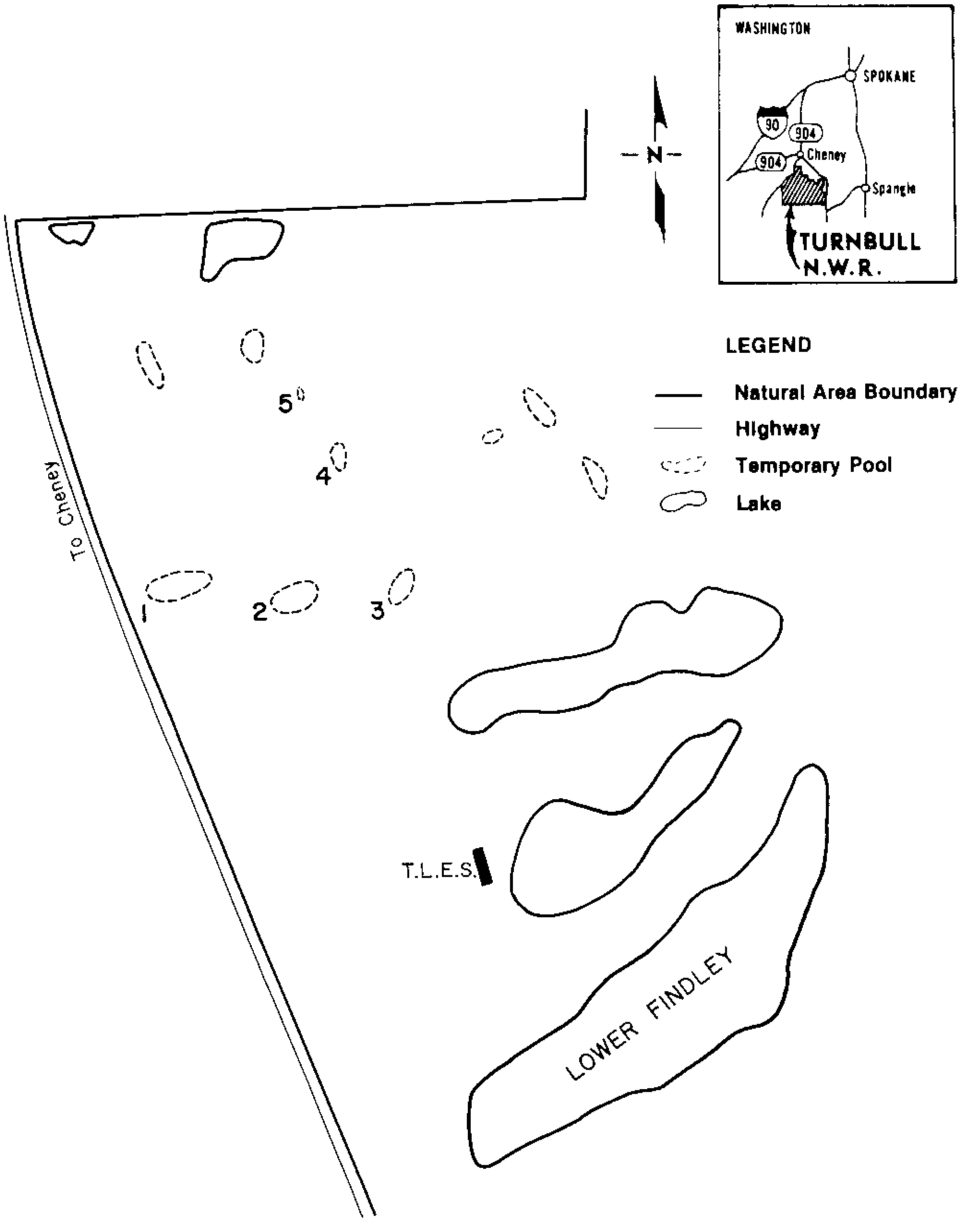

Figure 1. Location map of study area in eastern Washington. T.L.E.S. represents the Turnbull Laboratory for Ecological Studies.

aspen (*Populus tremuloides* Michaux) in their basins. The substrate is composed of needles of ponderosa pine and dead leaves and branches of aspen. In addition, some areas of most pools contain various grasses.

Methods

Sampling began on 20 February 1982, which was the first day water was found in the pools. Six days earlier, only snow existed in the basins and surrounding watershed. Rain and warming weather resulted in initial filling of pools. Sampling was continued each week until the pools dried up.

Six sampling stations were established in each of five pools during the fall of 1981. Two types of sampling stations were marked in each pool based on the presence or absence of dead limbs and branches of quaking aspen. Each type was paired together about 4 m apart to minimize differences caused by location within a pool. In addition, stations were selected so that depths would be uniform.

Quantitative samples of invertebrates were taken with a modification of the Wilding sampler (Wilding 1940). The sampler consists of a 1.25 m section of 10 cm plastic pipe with a closable aluminum valve on one end. The outer portion is made of two joints of 12.7 cm galvanized stovepipe. One side was marked in centimeters to facilitate measurement of the depth of each sample taken.

Samples were collected by quickly placing the stovepipe in the station area. The inner portion was then lowered into the stovepipe and the valve closed. The entire water column together with organisms inhabiting the surface of the bottom substrate was removed and filtered through a Wisconsin plankton net with 80 μm Nitex netting. It was assumed that all organisms isolated by the stovepipe were removed by the inner tube.

Invertebrates were separated from detritus by allowing the detritus to settle and then pouring the supernatant through a Wisconsin net. This process was repeated twice. The remaining detritus was placed in a coarse mesh net and washed into a Wisconsin net to remove any remaining invertebrates. This made it possible to count the taxa more easily. Samples were then preserved in formalin, stained with Eosin Y, and volumes were adjusted to 50 ml.

Density of organisms was estimated in the lab by taking two 5 ml subsamples with a Stenson-Hempel pipette (Edmondson 1971) and counting under a dissecting microscope at 24x magnification using a modification of the rotary counting chamber designed by Ward (1955).

The activity trap consists of a 4 l jar with a large funnel attached to the opening (Whitman 1974). Organisms swim into the traps and accumulate over a period of time. Two of these samplers were suspended in the water column in each of pools 1-3. After 24 hours, samples were removed, filtered through a Wisconsin net, and preserved in formalin.

Invertebrates were identified as to species when possible with the aid of Brooks (1957), Edmondson (1959), Pennak (1978), and Usinger (1963).

Results and Discussion

Approximately 30-45 cm of snow covered the study area prior to the first week in which water was observed in the pools. This condition persisted until 14 February at which time temperatures increased and precipitation began. Water accumulated in all pools by 20 February (Fig. 1). Maximum depth reached a peak on 6 March, decreased, and peaked again on 17 April. Depths decreased until pools 4 and 5 dried up shortly after 1 May (week 11). The last date that water was recorded in pool 1 was 5 June.

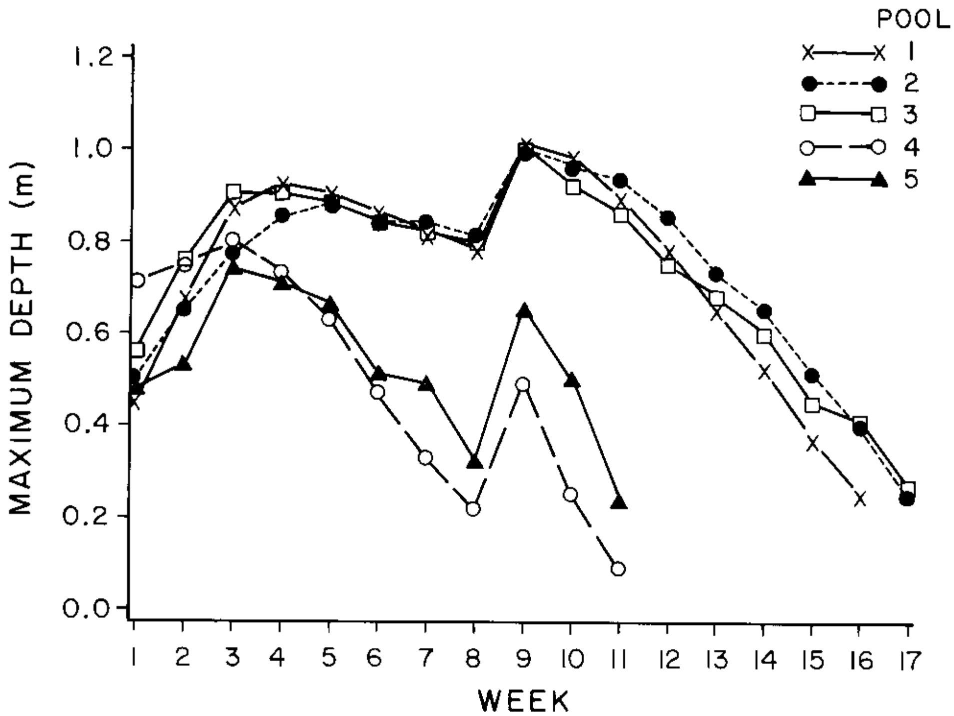

Figure 2. Weekly fluctuation in maximum depth.

The last date for pools 2 and 3 was 12 June. Small puddles of water existed in pools 2 and 3 as of 18 June. The maximum surface area ranged from approximately 250 m^2 for pool 5 to about 1400 m^2 for pools 1 and 2.

Maximum depth for pools 4 and 5, which was approximately 80 cm and 74 cm respectively, occurred during 6 March. Maximum depth for pools 1-3 was about 100 cm on 17 April.

Eight species of crustaceans were found in the pools (Table 1). These included four species of copepods (Copepoda), and one species each of seed shrimps (Ostracoda), water fleas (Cladocera), clam shrimps (Conchostraca), and fairy shrimps (Anostraca). Seven insects were also observed (Table 2). These represented two species of mosquitoes (Culicidae), four species of diving beetles (Dytiscidae), and one species of water strider (Gerridae). In addition, rotifers (Rotifera) and water mites (Acarina) were collected.

There were representatives of 17 taxa in pools 2 and 3, and 8 taxa in pool 5. With some exceptions, most species were found in all pools. Pool 5 did not contain the two

TABLE 1. Distribution of crustaceans found in five vernal pools.

Taxa	Pool 1	2	3	4	5
Class Branchiopoda					
Order Anostraca					
Eubranchipus serratus Forbes	X	X	X	X	X
Order Diplostraca					
Suborder Conchostraca					
Lynceus brachyurus Muller		X	X		
Suborder Cladocera					
Daphnia sp.*	X	X	X		
Class Ostracoda					
Order Podocopa					
Family Cypridae	X	X	X	X	X
Class Copepoda					
Order Calanoida					
Diaptomous novemdecimus Wilson	X	X	X	X	
Diaptomus hirsutus Wilson	X	X	X	X	
Order Cyclopoida					
Cyclops vernalis Fischer	X	X	X	X	X
Order Harpacticoida	X	X	X	X	X

*The **Daphnia** species present is either **D. pulex** Leydig or **D. middenforffiana** Fischer or a possible hybrid as discussed by Brook (1957).

TABLE 2. Distribution of insects found in five vernal pools.

Taxa	Pool 1	2	3	4	5
Class Insecta					
Order Hemiptera					
Family Gerridae					
Gerris buenoi Kirkaldy	X	X	X	X	
Order Coleoptera					
Family Dytiscidae					
Acilius semisulcatus LeConte	X	X	X	X	
Agabus sp. Leach	X	X	X	X	
Colymbetes sp. Clairville	X	X	X	X	
Rhantus sp. Dejean	X	X	X	X	
Order Diptera					
Family Culicidae					
Aedes cataphylla Dyar	X	X	X	X	X
Toxorhynchites sp. Theobald	X	X	X	X	X

Diaptomus species, and *Daphnia* species was only found in pools 1-3. *Lynceus brachyurus* was observed only in Pools 2 and 3.

Crustaceans observed in the vernal pools were compared with those collected in a permanent wetland approximately one km from the nearest pool (Table 3). Anostraca and Conchostraca were found in the pools but were not observed in the lake (Rabe and Gibson 1982). Cladocera and Calanoida occurred in both systems but were different species. Ostracoda and Cyclopoida had representative species in both habitats. Harpacticoids could not be distinguished because of taxonomic difficulties.

Free swimming insects that occurred in the pools consisted of Culicidae, Gerridae, and Dytiscidae (Table 2). No Culicidae were recognized in samples from Lower Findley Lake (Gibson, pers. comm.) and Gerridae were comprised of different genera from the two waters. Dytiscidae samples were not collected on a regular basis from the lake, so comparisons were not attempted.

TABLE 3. Comparison of number of species of crustaceans found in vernal pools and a permanent shallow lake.

Taxa	Pools	Lower Findley Lake
Anostraca	1	0
Conchostraca	1	0
Cladocera	1*	7
Ostracoda	1	1
Calanoida	2*	1
Cyclopoida	1	2
Harpacticoida	1	1

*Species different from those in lake.

In addition, 23 macroinvertebrates were collected in the lake (Rabe and Gibson 1982) but not the pools. Of these, species of *Hyallela, Gammarus, Chaoborus, Enallagma, Libellulidae,* Aeshnidae, *Hesperocorixa, Cenocorixa,* Hydrophilidae, Nepidae, *Callibaetis, Caenis,* Mesoveliidae, and Phryganeidae were observed during the period that the pools had water in them.

Apparently there is a significant difference in invertebrate community composition between temporary and permanent lentic systems. The lower number of taxa present in the vernal pools is probably caused by a lower diversity of microhabitats in the pools which are primarily lacking aquatic macrophytes. Secondly, organisms inhibiting vernal pools must cope with the dry phase or avoid it (Hartland-Rowe 1972). As one would expect, not all aquatic taxa are adapted to such an existence. Many species present in the vernal pools come under the classification of overwintering residents (Wiggins *et al.* 1980). These remain in the pool basin as encysted juveniles or as drought resistant eggs. All crustaceans and rotifers collected fit into this category.

As a result of seasonal variability in duration of vernal pools, organisms with r-selected characteristics are at an advantage over other organisms. Extending the number of generations in favorable years is also important. Taxa capable of parthenogenetic reproduction are suitable for these temporary environments (Wiggins *et al.* 1980). *Daphnia* species exhibited parthenogenesis until late in the season at which time drought resistant ephippia began to appear. Many other crustaceans are also capable of parthenogenesis (Pennak 1978).

The remaining taxa come under one of three additional classifications: overwintering spring recruits, overwintering summer recruits, and nonwintering spring migrants Taxa in these groups are capable of active dispersal (Wiggins *et al.* 1980).

Overwintering summer recruits, including mosquitoes of the genus *Aedes*, oviposit in the dry pool basin. Dytiscid beetles have been reported under both of the two remaining classifications, but Gerridae are classified as nonwintering spring migrants. Water mites fall into the same classifications as the dytiscid beetles (Wiggins *et al.* 1980).

The habit or mode of existence of invertebrates was determined by the use of activity traps and the modified Wilding sampler. The Wilding sampler collects forms from the water column and bottom surface whereas activity traps collect organisms only in the water column. Thus it was possible to compare the percentage occurrence in these two methods and subsequently classify all taxa according to their general habit.

Harpacticoids and nauplii are primarily benthic which is indicated by the higher percentage occurrence in the Wilding sampler (Table 4). In contrast, *Diaptomus* spp.,

TABLE 4. Weekly occurrence (expressed as a percentage of total samples for pools 1-3) of crustaceans collected by two sampling methods. A = Activity trap . W = Wilding sampler.

Week	Species															
	Diaptomus		Cyclops		Ostracods		Eubranchipus		Daphnia		Lynceus		Harpacticoids		Nauplii	
	A	W	A	W	A	W	A	W	A	W	A	W	A	W	A	W
1	—	0	—	100	—	100	—	58	—	42	—	0	—	92	—	100
2	0	0	88	100	100	100	38	81	0	0	0	0	50	75	75	100
3	13	22	88	100	75	100	38	72	17	0	0	0	50	89	100	100
4	100	89	100	83	75	100	50	89	50	0	0	0	13	89	63	100
5	100	94	88	78	50	89	38	78	17	6	25	42	0	83	75	100
6	100	94	83	72	83	83	67	83	0	0	0	25	0	83	17	100
7	100	78	50	61	50	100	67	78	17	11	0	25	0	89	17	94
8	100	83	33	72	50	78	33	56	17	0	0	0	17	78	0	89
9	100	94	50	56	33	72	17	22	33	22	0	8	0	61	17	94
10	100	94	50	72	100	83	17	50	33	39	0	17	0	83	0	100
11	100	78	50	83	100	78	67	33	67	72	0	0	17	94	33	100
12	100	78	33	89	100	89	33	28	100	50	0	0	0	89	0	100
13	100	81	67	100	67	100	67	50	33	75	50	0	17	88	17	94
14	100	80	50	93	100	100	33	7	50	80	100	0	17	73	0	100
15	100	83	0	100	100	92	0	0	50	83	100	25	0	50	0	100

Cyclops vernalis, Eubranchipus serratus, Daphnia sp., and Ostracoda are mostly planktonic as a result of similar occurrences in both samplers. *Lynceus brachyurus* shows a higher percentage in the Wilding sampler early in the study indicating a benthic existence. However, later there was a higher percentage in the activity traps, thus indicating a planktonic existence.

Similar results for rotifers and water mites are presented in Table 5. Both organisms

TABLE 5. Weekly occurrence (expressed as a percentage of total samples for pools 1-3) of rotifers, water mites, and insects collected by two sampling methods. A = activity trap. W = Wilding sampler. L = larvae. Ad = adults.

Week	Rotifera	Acarina		Culicidae		Dytiscidae	
	W	A	W	A	W	A	
						L	Ad
1	8	—	50	—	0	—	—
2	100	13	88	13	19	0	0
3	67	13	56	50	33	0	25
4	78	0	67	75	39	0	13
5	67	0	44	63	22	0	63
6	67	0	39	83	17	0	83
7	72	0	61	67	22	0	67
8	39	0	28	100	28	0	33
9	61	17	56	33	6	0	33
10	78	17	67	100	6	0	67
11	72	0	50	83	0	0	100
12	67	17	44	100	11	67	83
13	56	17	50	100	6	67	100
14	33	0	27	67	0	67	83
15	25	17	8	83	17	50	67

demonstrated a benthic existence since rotifers were not collected in the activity traps and water mites had a higher occurrence in the Wilding sampler.

All insects exhibited avoidance behavior (Table 5). Mosquitoes occurred in higher percentage in the activity traps, but the diving beetles were collected in activity traps only. Water striders were only collected with dip nets. Our data appears to support what has been reported in the literature regarding the habit of these invertebrates (Edmondson 1959, Pennak 1978).

Barlocher *et al.* (1978) observed that the dry phase of temporary pools results in higher protein levels in the detritus than would occur in permanent lentic systems. This may account for the large number of detritivores and filter feeders as shown in Figure 3. Taxa under this category include rotifers, harpacticoids, and nauplii which are primarily benthic as well as *Aedes cataphylla*, ostracods, and the branchiopods *Eubranchipus serratus, Daphnia* sp., and *Lynceus brachyurus*, all of which are mostly planktonic (Edmondson 1959, Pennak 1978). Some primary production was evident in the pools because of the observation of filamentous algae in the gut of *Diaptomus novemdecimus*.

A large number of predators were also present in this community (Fig. 3). The insects had the largest number of representatives. The planktonic *Toxorhynchites* species is known to feed on other mosquitoe larvae. *Gerris buenoi* is a surface dwelling predator and scavenger, whereas the Dytiscidae are swimming and diving forms (Merritt and Cummins 1978). Adult dytiscids were observed to prey upon adult *Eubranchipus serratus* in the lab and larvae have been reported to prey upon mosquitoe larvae (James 1969). Insects have the capability of actively leaving the system.

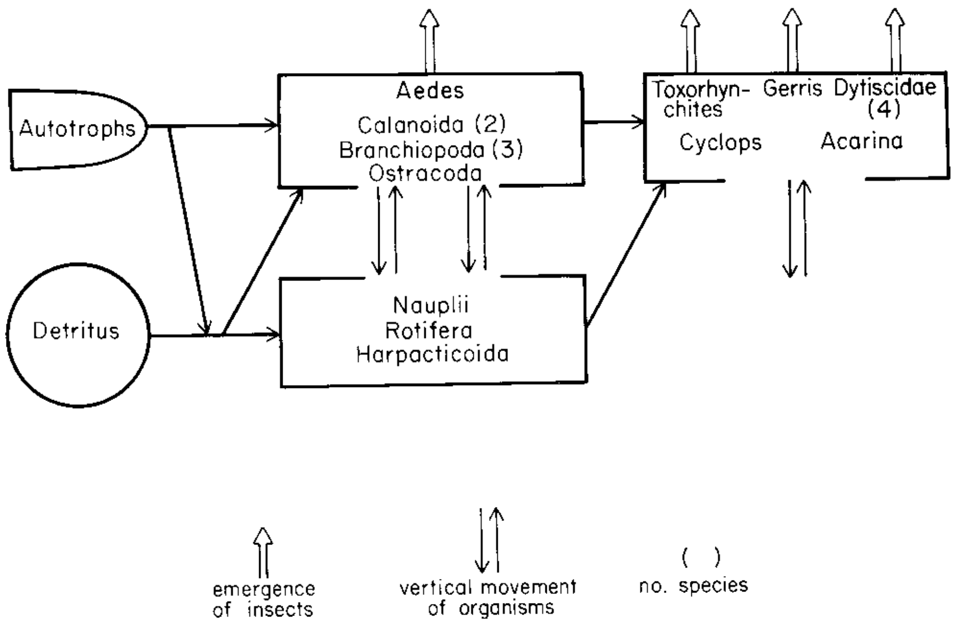

Figure 3. Mode of existence and trophic model for free-swimming invertebrates in vernal pools of eastern Washington.

Water mite larvae are parasitic upon insects such as the Culicidae, Gerridae, and Dytiscidae (Pennak 1978). However, nymphs and adults are predators which have been reported to prey upon ostracods (Wiggins *et al.* 1980). *Cyclops vernalis* is considered to be a predator among the species of crustaceans (Pennak 1978).

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