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DRIFT PERIODICITY AND UPSTREAM DISPERSION OF STREAM INSECTS[1]

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ABSTRACT

Drift periodicity and upstream dispersion by larval and nymphal insects from two north Idaho streams were investigated. Drift was determined with drift nets sampling at 2-hour intervals over 24-hour periods. Upstream dispersion was evaluated using a marking-release-recapture technique. Mayflies demonstrated nocturnal drift as did the corixid **Sigara (Vermicorixa) grossolineata** Hungerford and dipteran **Simulium** sp.; chironomids showed continuous drift as opposed to behavioral drift for most of the other insects studied. Both nocturnal and diurnal drift occurred with species in the order Trichoptera. Stonefies showed little tendency to drift. Mid-summer upstream dispersion by mature nymphs and larvae of selected species was found to be insignificant as a means of recolonizing insect-decimated riffle habitats and offsetting downstream displacement by drift.

INTRODUCTION

Knowledge of recolonization processes of insect-decimated streams is a matter of increasing importance in understanding stream ecology. The presence or absence of certain species of insects often reflects the quality of a stream. Insects also constitute an important trophic link in food chains and play an important role in secondary production. Maintenance of unpolluted, high-quality streams and rehabilitation of those that have been rendered unproductive are vital considerations in stream management.

Population dynamics of stream insects, particularly dispersion by drift, has been investigated by Anderson (1967), Elliot (1967), Müller (1954), Pearson (1968), Waters (1962, 1968) and others. Upstream dispersion of benthic invertebrates has been studied to a much lesser extent. Neave (1930) reported nymphs of the mayfly *Blasturus cupidus* Say to annually move up newly formed tributaries. Studying energy flow in a stream, Ball *et al.* (1963) detected upstream dispersion of radiophosphorus and suggested it was possibly transported by invertebrates. Bishop and Bishop (1968) reported no upstream movement of nymphs labeled with P^{32}. Studying dispersal patterns of the mayfly nymph, *Baetis* sp. and a crustacean, *Gammarus* sp., Waters (1965) concluded that major movements in an experimental enclosure occurred in a downstream direction and at night, but did not exclude the possibility of some upstream movement. Roos (1967) reported the flight of egg-bearing, adult insects was principally upstream.

MATERIALS AND METHODS

Downstream dispersion by drift was studied

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during 1966 and 1967 in Merry Creek and Gold Center Creek respectively. Both creeks are principal tributaries of the St. Maries River in northern Idaho and are physically similar, having bottom types of cobble. They course through mountains of moderate relief and carry a light to moderate sediment load during spring run-off as a result of logging and road construction. The flow for Merry Creek was 14.32 and 10.35 ft^3/sec during June and July respectively and 27.82 and 15.33 ft^3/sec during the same months for Gold Center Creek. A single riffle from each creek was selected for study. The Merry Creek riffle, more appropriately classified a riffle-run, encompasses approximately 7.5 yards by 43 yards. The larger Gold Center Creek riffle has dimensions of 11 by 86 yards.

Drift insects were collected in two, square-foot drift nets, placed approximately 1 foot apart, in mid-channel. The collecting bags were 3-feet long and made of fine nylon (32 x 32threads inch). Samples were taken at 2-hour intervals over 24-hour periods during June 27 and July 29, 1966 from Merry Creek and June 29 and July 26, 1967 from Gold Center Creek. August samples were taken from each stream, but data were not summarized because of extremely low numbers of insects during that period.

The standing crop was measured with a 1-square-foot, cylindrical-bottom sampler similar to that described by Waters and Knapp (1961). The collecting bag was made of nylon, similar to that of the drift nets. Samples were taken along each side and through the middle of the riffle in order to reflect spatial distribution. Samples were taken above the position of the drift nets and subsequent to drift collections. Drift and bottom samples were stored in 70% alcohol. Insects were sorted by hand, identified and counted. Quantitative enumerations for drift and standing crop are given as numbers per unit time and per unit area respectively.

Determination of upstream dispersion by insects in water was made through use of a marking-release-recapture technique. Fluorescent pigments described by Brusven (1970) were used for markir insects. Two channelettes (Streams I and II) off the St. Maries River and Gold Center Creek were used for the study. They ranged from 4-7 feet wide and supported a 3-6 inch water column during most of the summer; bottom types were pebble and cobble. Insects were collected 20 feet above and 40 feet below the release zone by turning and scraping the bottom materials to simulate a relatively insect-free area that might occur as a result of extreme scouring. Insects used for marking were captured with a standard 3-foot aquatic screen from the channelettes and augmented with insects from the larger adjoining streams. To facilitate handling and recovery, only larger specimens of immature Ephemeroptera, Trichoptera and Plecoptera were used for marking. The latter was emphasized because the large size of several species of stoneflies made them excellent subjects for release and recapture. Marked releases were made on the basis of availability, so no attempt was made to unify release numbers during each of the release periods of June, July and August.

Insects collected for marking were segregated, counted and placed in partially submerged 3 x 3 x 5 inch screened cages. The cages were momentarily lifted from the water; insects were uniformly fogged with fluorescent powder, then submerged several times to remove excess powder. Marked insects were introduced into a 3-foot release zone in each stream. A screen was placed immediately below the release zone to catch insects that did not become established with the bottom; the screen was not removed until all insects had become established. Recaptures were again made with a standard aquatic collecting screen by turning and scraping the bottom sediments after a 48-hour period, thus encompassing two dark-light periods. A complete sampling of an area 18 feet above and 42 feet below the release zone was made.

RESULTS

Drift Periodicity

Drift was determined for the principal riffle insects occurring in Merry and Gold Center Creeks (Fig. 1-4). Standing crop and daily drift are given in Tables 1 and 2 for the principal species in the orders Ephemeroptera, Plecoptera, Hemiptera, Trichoptera and Diptera. With the exception of riffle beetles (Elmidae), coleopterans were poorly represented in the study.

Ephemeroptera

Mayflies were the most abundant insects from the two streams studied. Nine genera and 18 species were collected in drift and/or bottom samples during the study with *Baetis* and *Ephemerella* the principal genera. As a group, mayflies demonstrated nocturnal drift (Fig. 1a,c). June drift was appreciably higher than July drift and is consistent with a decrease in standing crop between the two months. *Baetis bicaudatus* Dodds, *Ephemerella edmundsi* Allen, *E. inermis* Eaton, *E. tibialis* McDunnough and *E. flavilinea* McDunnough each demonstrated a single drift peak between 10 p.m. to 2 a.m. (Fig. 1b,d; 2c-f). *Baetis tricaudatus* Dodds, reflected a bimodal drift pattern with two peaks occurring during the dark hours (Fig. 2a,b). It is significant to note that the pattern exhibited by this species occurred during July from two different streams, during two different years.

Plecoptera

Stoneflies, although abundant benthic in-

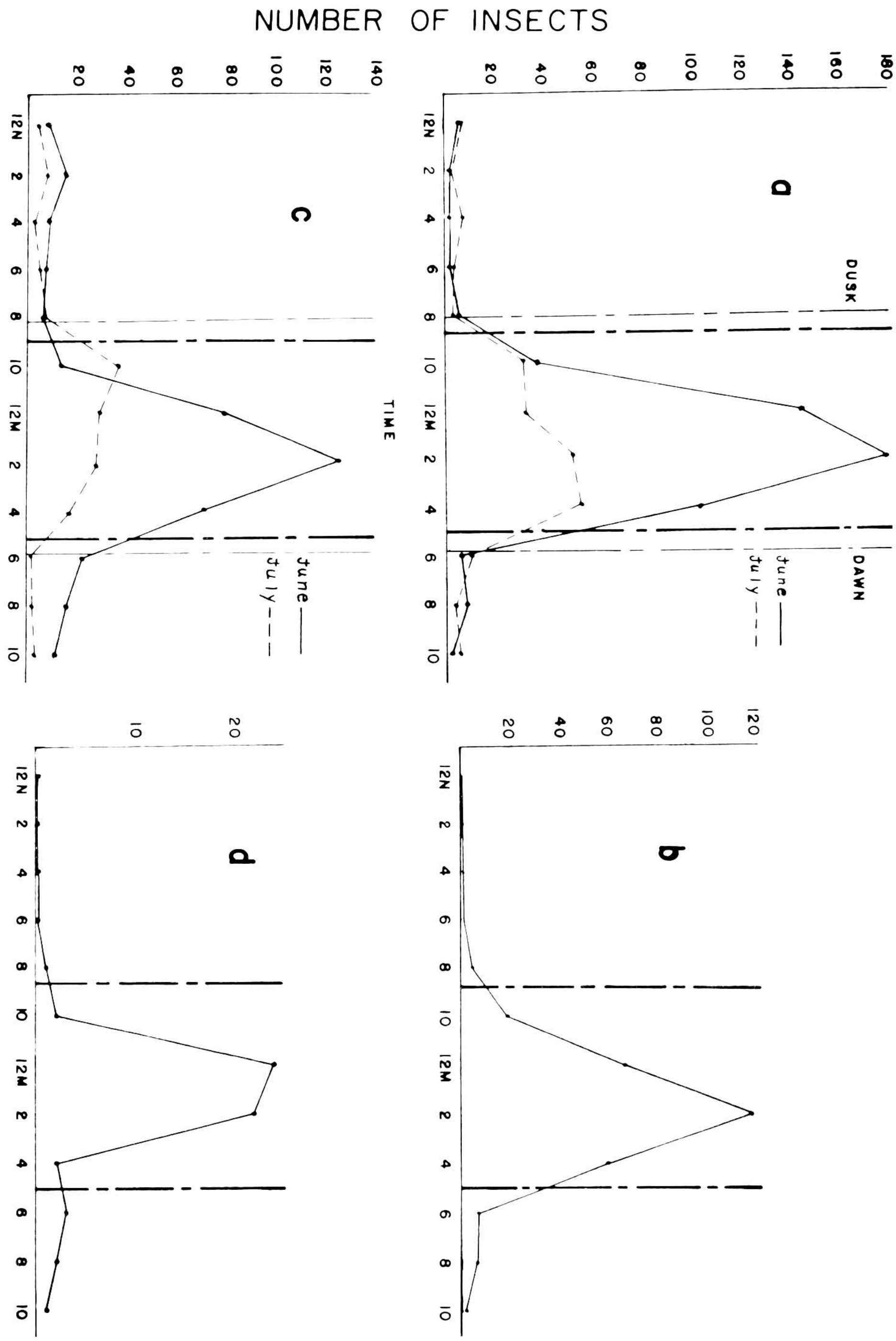

Fig. 1. Drift rate/2 nets/2-hour intervals for: a. Ephemeroptera (total drift), Merry Creek, 1966; b. **Ephemerella tibialis** McDunnough, Merry Creek, June 27, 1966; c. Ephemeroptera (total drift), Gold Center Creek, 1967; d. **E. flavilinea** McDunnough, June 29, 1967.

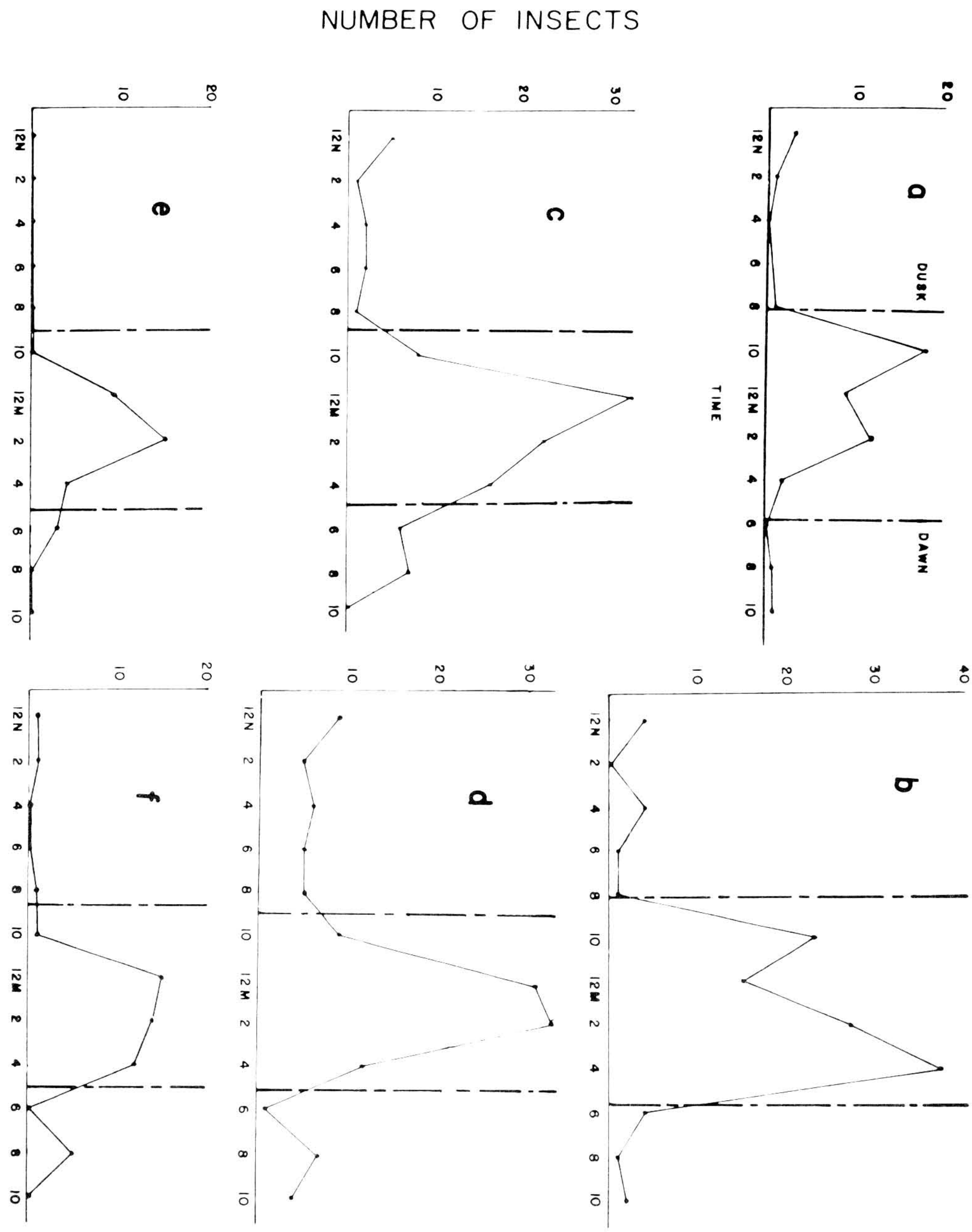

Fig. 2. Drift rate/2 nets/2-hour intervals for: a. **Baetis tricaudatus** Dodds, Gold Center Creek, July 26, 1967; b. **B. tricaudatus** Dodds, Merry Creek, July 29, 1966; c. **B. bicaudatus** Dodds, Merry Creek, June 27, 1966; d. **B. bicaudatus** Dodds, Gold Center Creek, June 29, 1967; e. **Ephemerella edmundsi** Allen, Gold Center Creek, June 29, 1967; f. **E. inermis** Eaton, Gold Center Creek, June 29, 1967.

vertebrates, were poorly represented in drift (Tables 1 and 2). With the exception of *Alloperla* sp. which showed a slight increase in drift at night, no drift trends were evident. Anderson and Lehmkuhl (1968) reported small stoneflies *Capnia* sp. and *Nemoura* sp. as important drift components after the first freshet in November. With the exception of *Alloperla* sp. which is relatively small, the stoneflies *Isogenus*, *Acroneuria* and *Pteronarcys* occurring in this study are medium to large size as mature nymphs and exhibit extreme mobility. It is believed their physical strength and swimming abilities better enable them to counteract the effects of current and are not easily displaced.

Hemiptera

The corixid bug, *Sigara (Vermicorixa) grossolineata* Hungerford, was an unexpected drift invertebrate. It occurred from both Merry Creek and Gold Center Creek and reflected a precipitous increase in drift after dark (Fig. 3a-c). No specimens were taken in drift during the daylight hours from Merry Creek and only an occasional specimen from Gold Center Creek. Waters (1962) reported essentially similar results for the corixid *Hesperocorixa* sp.

All corixids recovered in drift were adults. It is probable their occurrence in drift was the result of an evening flight originating from some other point along the stream since they were not recovered in bottom samples from the two riffles investigated.

Diptera

Diptera larvae were well represented in bottom samples, but with the exception of chironomids and simuliids, showed little tendency to drift (Tables 1 and 2). Collectively, chironomids showed continuous drift during the day (Fig. 3e). Although there were detectable differences among 2-hour sampling periods, there was no indication of a day- or night-active period. The standing crop decreased by a factor of 2 between June and July while there was a 17-fold increase in drift. This increase occurred commensurate with a decrease in stream discharge. Anderson and Lehmkuhl (1968), however, reported an increase in chironomid drift as stream discharge increased.

Simulium sp. drift from Merry Creek during July indicated a night-active period (Fig. 3d), reaching highest proportions at midnight. A direct relationship appears to exist between standing crop and drift (Table 1). No larvae were collected in bottom samples in June and only four individuals were collected in drift. During July, there was a noticeable increase in bottom density to 6.41 larvae per sq. yd. and a daily drift of 86 individuals.

Trichoptera

As a group, caddisflies demonstrated highly variable drift patterns (Fig. 4). The brachycentrid genera of *Micrasema* and *Brachycentrus* reflected a precipitous increase in drift after sunset, reaching highest levels at midnight; a much smaller, secondary drift period occurred during early morning (Fig. 4a,d). Because of the diminutive nature of the secondary peak, particularly by *Brachycentrus*, it might be questioned whether this was indeed a "bigeminus" drift pattern, i.e. the major peak occurs first and shortly after sunset, followed by a secondary peak, as discussed by Müller (1965).

Drift by the limnephilid *Dicosmoecus gilvipes* (?) (Hagen) reflected a day active or more appropriately an afternoon-active period, occurring between 10 a.m. to 8 p.m. (Fig. 4b). Drift decreased after sunset and remained low until 10 a.m. the following morning. Continued low drift during the daylight hours of the subsequent morning suggests this species was both light and temperature sensitive. The daily temperature range for June 29, 1967 was seven degrees F., being highest at 4 p.m. and lowest at 4 a.m. Most of the larvae taken in drift were caseless, indicating they were perhaps in the process of reconstructing new cases. It is interesting to note that the *Dicosmoecus* sp. population from Merry Creek did not show similar drift tendencies, although the bottom density was higher than Gold Center Creek. The bottom density of *Dicosmoecus gilvipes* (?) in Gold Center Creek was not appreciably different between June and July, however, considerable differences in daily drift were recorded (Table 2). This is probably the result of age-behavioral changes or age-distributional changes as suggested by Anderson (1967).

The lepidostomatid trichopteran, *Lepidostoma* sp., demonstrated a relatively high tendency to drift as reflected by the relationship of bottom density to daily drift during June from Gold Center Creek (Table 2). Slightly higher drift occurred during the daylight hours, decreasing to lowest levels at 2 a.m. (Fig. 4c). Anderson (1967) reported *L. unicolor* (Banks) having no discernible daily drift periodicity.

Arctopsyche grandis (Banks), a net-spinning trichopteran, drifted most actively at night from Gold Center Creek. *Hydropsyche* sp. from Merry Creek, another member of the hydropsychid family, showed little tendency to drift, although its density was approximately twice that of *Arctopsyche* from Gold Center Creek (Tables 1 and 2). Few members of either genus were taken by drift or bottom samples from either creek during July and is probably the result of pupation and emergence as indicated by adult collection records.

Upstream Dispersion

Upstream dispersion by larval and nymphal insects was investigated to determine if it occurred in

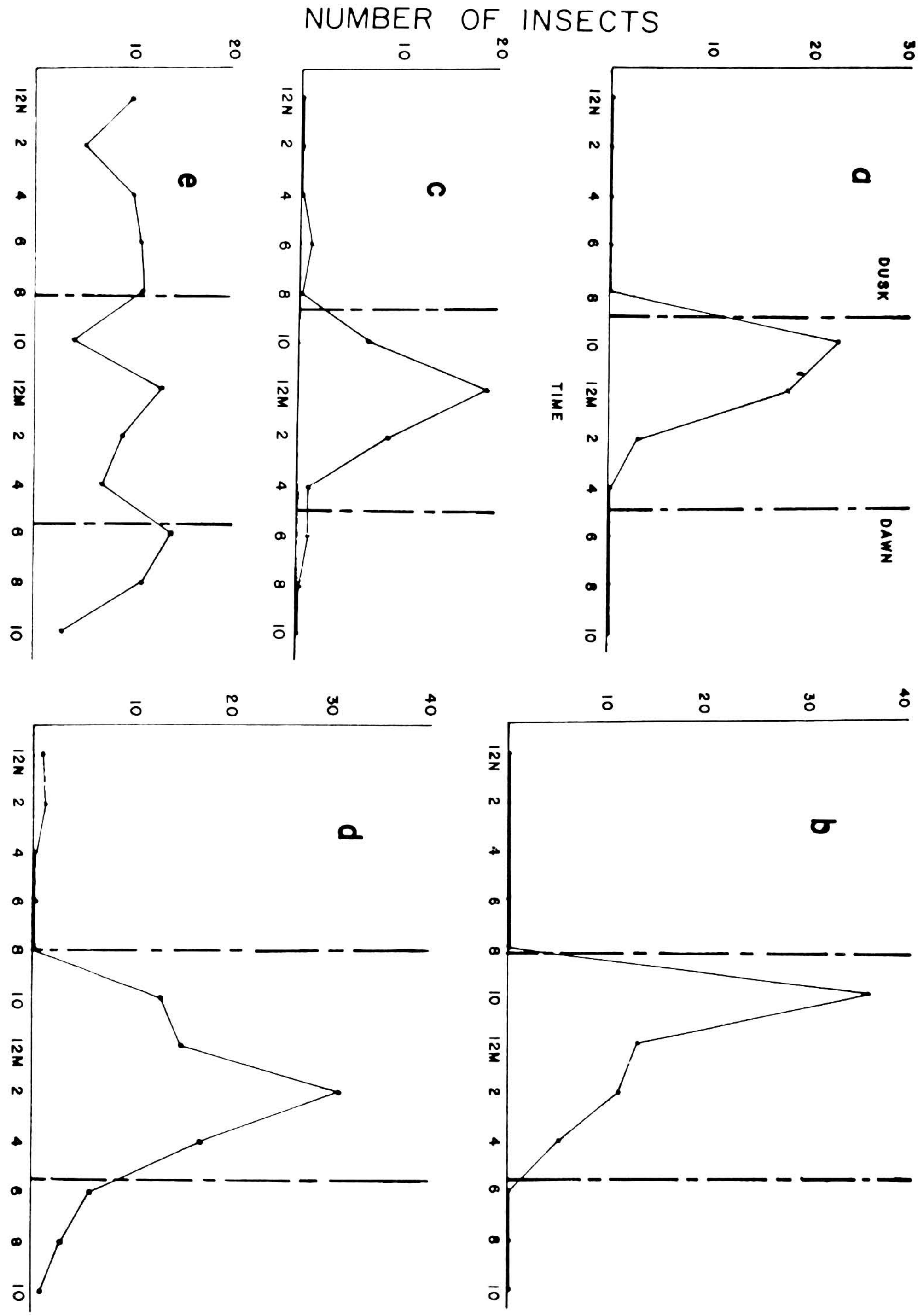

Fig. 3. Drift rate/2 nets/2-hour intervals for: a. **Sigara grossolineata** Hungerford, Merry Creek, June 27, 1966; b. **S. grossolineata** Hungerford, Merry Creek, July 29, 1966; c. **S. grossolineata** Hungerford, Gold Center Creek, June 29, 1967; d. **Simulium** sp., Merry Creek, July 29, 1966; e. Chironomidae, Merry Creek, July 29, 1966.

streams and what role it played in offsetting downstream displacement by drift. The number and kinds of insects marked and released are given in Table 2. Marked releases were made in June, July and August in Stream II, but only during June and July in Stream I because of low flow during August. Streams were sampled 48 hours after the insects were released in order to determine distribution of marked insects in relation to their point of release (Tables 4 and 5).

No marked insects were recovered above the release area in Stream I; only two insects, representing 4.9% of the total recovered insects in Stream II, were collected above the release zone. The latter were taken in the first 3-foot region above the point of release. Highest recovery of marked insects was from the release zone, although the area was small in relation to the collective upstream and downstream areas sampled (Tables 4 and 5). Recovery of marked insects from Stream I during June and July was 13.3 and 7.2% respectively; recovery from Stream II was 6.7, 8.6 and 33.7% for the months of June, July and August respectively. The current volocities for these same periods were 0.8 and 0.5 ft sec in Stream I and 1.1, 0.9 and 0.5 ft sec for Stream II.

DISCUSSION

Drift

Insect drift, manifesting distinct periodicities, was a common phenomenon in both streams studied. These periodicities suggested a circadian rhythm entrained by exogenous factors as light and to a lesser degree temperature. The periodicity of drift varied considerably both between and within insects orders (Fig. 1-4). Most insects showed behavioral drift, a notable exception was chironomids which demonstrated relatively constant drift (Fig. 3e). Mayflies as a group reflected nocturnal drift, as did the hemipteran *Sigara (Vermicorixa) grossolineata* Hungerford, dipteran *Simulium* sp., and trichopterans *Micrasema bactro* Ross, *Brachycentrus* sp. and *Arctopsyche grandis* (Banks) (Fig. 1-4). The limnephilid trichopteran *Dicosmoecus gilvipes* (?) (Hagen) differed from other insects studied in that an afternoon-active drift period (Fig. 4b) was indicated, which was probably the result of sensitivity to both light and temperature. The trichopteran, *Lepidostoma* sp. reflected a weak day-active drift period (Fig. 4a). Stoneflies were not a significant component of drift although their density was comparable to several other drift insects.

Because of the open-ended nature of lotic habitats and the possibility of long-distance displacement of stream insects, it is difficult to unequivocally relate benthic density to drift. Temporal and interstream comparisons are further complicated by differing physical and biotic parameters. The physical conditions of riffle or stream size, substrate type and current velocity are undoubtedly important factors influencing the magnitude of drift. Drift in this study is expressed as a rate, i.e. number of organisms drifting per unit stream width per unit time. Elliott (1967) partially overcame the difficulty of expressing drift under different flow regimes by expressing it as density units, i.e. number of organisms per unit volume of water.

Age-distribution and age-behavioral differences are important biotic factors influencing drift (Anderson, 1967). The latter was indicated by the trichopteran *Dicosmoecus gilvipes* (?) in this study (Table 2). Density may also be a factor in changing the propensity of drift as indicated by Pearson and Franklin (1968). The generally low population densities from Merry Creek and Gold Center Creek, however, did not permit a critical evaluation of this factor.

That drift indeed exists for many stream insects, often in a large an spectacular way, was borne out in this study (Fig. 1-4; Tables 1-2). However, neither distances of displacement nor the physical hazards experienced by drifting insects are well established. A complete understanding of the implications of drift on the stream community cannot be fully assessed until such information becomes available.

Upstream Dispersion

Upstream dispersion, as a means of offsetting displacement by drift, was determined to be insignificant for late-instar nymphs and larvae of species studied (Tables 4 and 5). Although a nearly insect-free region was created above the release zone by removing insects prior to releasing marked insects, there was no indication of significant upstream movement into available niches. Use of blocking devices in the test channelettes were avoided in order to refrain from interference with normal flow characteristics of the stream, thus, marked and unmarked insects were free to enter and depart from test areas. Recovery data are reflective on a relative basis since complete recovery of marked insects was not obtained nor expected (Table 3-5). A significant part of the marked population undoubtedly became a product of drift and was displaced to lower reaches of the stream.

The stoneflies, *Pteronarcys californica* Newport and *Acroneuria* sp., being large in size and mobile, were emphasized in this study and proved to be effective test insects. Larger mayflies *Ephemerella hecuba* (Eaton), *E. grandis* Eaton and *E. doddsi* Needham were nearly as effective but occurred in low numbers in the study area. The caddisflies, *Arctopsyche grandis* (Banks) and *Hydropsyche* sp.

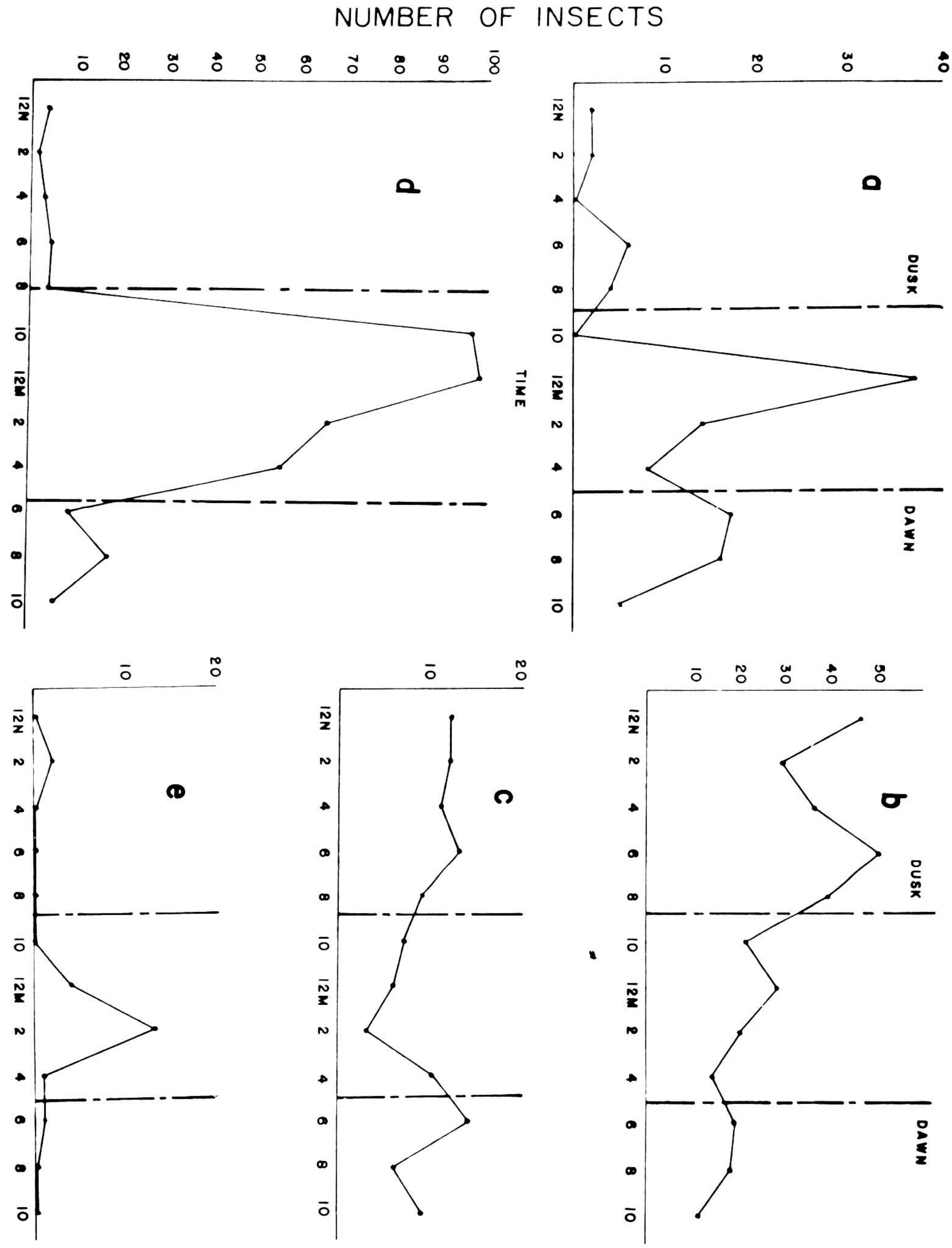

Fig. 4. Drift rate/2 nets/2-hour intervals for: a. **Micrasema bactro** Ross, Merry Creek, June 27, 1966; b. **Dicosmoecus gilvipes** (?) (Hagen), Gold Center Creek, June 29, 1967; c. **Lepidostoma** sp., Gold Center Creek, June 29, 1967; d. **Brachycentrus** sp., Merry Creek, July 29, 1966; e. **Arctopsyche grandis** (Banks), Gold Center Creek, June 29, 1967.

Table 1. Standing crop and daily drift of principal insects from Merry Creek during June and July, 1966.

INSECTS	June 27		July 29	
	No. per sq. yd.	Daily Drift per 2 nets	No. per sq. yd.	Daily Drift per 2 nets
Diptera				
Chironomidae	30.30	7	15.38	118
Rhagionidae (Atherix sp.)	4.54	4	15.38	1
Tipulidae	4.54	2	25.64	0
Simuliidae (Simulium sp.)	0	4	6.41	86
Ephemeroptera				
Baetis bicaudatus Dodds	9.09	102	11.54	1
Baetis tricaudatus Dodds	18.18	14	39.74	125
Epeorus longimanus (Eaton)	51.52	8	1.28	0
Ephemerella flavilinea McDunnough	40.91	28	0	0
Ephemerella inermis Eaton	53.03	2	0	0
Ephemerella tibialis McDunnough	2.08	285	141.02	35
Rhithrogena sp.	87.87	11	0	0
Plecoptera				
Alloperla sp.	7.58	11	2.56	6
Isogenus sp.	7.58	5	0	1
Pteronarcys californica Newport	1.52	0	0	6
Trichoptera				
Brachycentrus sp.	13.64	17	19.23	363
Dicosmoecus sp.	19.70	13	5.13	0
Hydropsyche sp.	6.06	3	0	0
Micrasema bactro Ross	3.03	111	14.10	3
Rhyacophila sp.	3.03	0	3.85	0

occurred abundantly but were difficult to sample. Highest recovery of marked insects was obtained for stoneflies as would be expected on the basis of numbers released (Tables 3-5). A reasonably high recovery of *Ephemerella grandis* was obtained in the release zone or slightly below, although the number marked and released was small in comparison with the stoneflies *P. californica* and *Acroneuria* sp. An interesting recovery trend was observed in Stream II; the percentage recovery of marked insects increased progressively from 6.7% to 33.7% between June and August commensurate with a decrease in stream velocity from 1.1 to 0.5 ft sec during the same period. The lower velocity of 0.5 ft sec probably better enabled the insects to maintain contact with the cobble substrate. Similar recovery trends in Stream I were not evident although there was a decrease in flow between June and July; the channel was nearly dry in August. The bottom was pebble in Stream I as opposed to cobble in Stream II and was generally a less favorable habitat for stoneflies and caddisflies. Stoneflies generally reflected reasonably high fidelity for the site or slightly below the site in which they were released. This was dramatically in evidence during August in Stream II when 34% of the stoneflies marked and released were recovered in the 3-foot release zone (Table 5). Caddisfly recovery, particularly hydropsychid caddisflies, was generally low during all test periods from both streams. This was probably the result of their net-spinning habits, making them less vulnerable to recapture or they were rapidly displaced as drift. In general, the incidence of recovery of marked insects per unit area became less as the distance from the release zone increased.

Insect recolonization is a matter of considerable

Table 2. Standing crop and daily drift of principal insects from Gold Center Creek during June and July, 1967.

INSECTS	June 29 No. per sq. yd.	June 29 Daily Drift per 2 nets	July 26 No. per sq. yd.	July 26 Daily Drift per 2 nets
Diptera				
Rhagionidae (*Atherix* sp.)	3.76	3	18.00	5
Tipulidae	2.25	11	2.50	2
Simuliidae (*Simulium* sp.)	0	28	0	4
Ephemeroptera				
Baetis bicaudatus Dodds	7.52	127	1.50	28
Baetis tricaudatus Dodds	.75	20	2.50	48
Cinygmula sp.	12.78	11	6.50	4
Epeorus longimanus (Eaton)	3.00	35	3.50	13
Ephemerella flavilinea McDunnough	9.77	57	1.50	3
Ephemerella inermis Eaton	10.53	50	0	0
Ephemerella tibialis McDunnough	0	16	20.50	49
Rhithrogena hageni Eaton	4.51	17	0	0
Plecoptera				
Acroneuria sp.	3.76	1	2.50	1
Alloperla sp.	3.76	8	29.00	18
Isogenus sp.	5.26	4	1.00	3
Pteronarcys californica Newport	1.50	0	2.00	0
Trichoptera				
Dicosmoecus gilvipes (?)(Hagen)	6.76	331	4.50	8
Hydropsyche sp.	3.75	6	3.00	7
Lepidostoma sp.	1.50	112	0	5
Micrasema bactro Ross	0	9	0.50	0
Arctopsyche grandis (Banks)	3.00	21	0.50	9

Table 3. Number of insects marked and released in Streams I and II in northern Idaho, 1967.

Insect Species	JUNE Stream I	JUNE Stream II	JULY Stream I	JULY Stream II	AUGUST Stream I	AUGUST Stream II
Plecoptera						
Pteronarcys californica Newport	2	1		28		14
Acroneuria sp.	10	14	20	40		53
Trichoptera						
Arctopsyche grandis (Banks)		13	51	20		14
Hydropsyche sp.		7	6	5		
Limnephilidae (spp. unid.)		8	8			
Ephemeroptera						
Ephemerella hecuba (Eaton)						6
Ephemerella grandis Eaton	10	2	8			
Ephemerella doddsi Needham						2
Ephemerella flavilinea McDunnough	6		4			
Rhithrogena sp.	2					
TOTAL	30	45	97	93	0	89

importance in studying the ecology of streams. Downstream displacement by drift is perhaps the most prolific and viable means of colonization. Upstream dispersion by adults is largely conjectural and untested for most stream insects, although Roos (1957) reported this phenomenon for caddisflies. Upstream dispersion by nymphs and larvae was proven insignificant for the species investigated in this study. It is probable, barring catastrophic events, that most reaches of a stream support a residual population of sufficient size to assure perpetuation, irrespective of drift or upstream movements. However, the previously mentioned means of dispersion can function independently or collectively to hasten recolonization of an insect-decimated area or to mitigate extreme population fluctuations of any given stream habitat such as a riffle or pool.

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Table 4. Numbers and species of insects recaptured after 48-hour period from Stream I.

	Distance (Feet)	June 29	July 26
Above Release Zone	12 - 18	0	0
	6 - 12	0	0
	3 - 6	0	0
	0 - 3	0	0
	3-Foot Release Zone	1F	1A, 1B, 1D
Below Release Zone	0 - 3	0	1D
	3 - 6	1C, 1F	1C
	6 - 12	0	0
	12 - 18	0	0
	18 - 24	1F	0
	24 - 30	0	0
	30 - 36	0	0
	36 - 42	0	1E, 1A

Trichoptera
A. *Arctopsyche* sp.
B. *Hydropsyche* sp.
C. Limnephilidae (spp. unid.)

Plecoptera
D. *Acroneuria* sp.

Ephemeroptera
E. *Ephemerella flavilinea* McDunnough
F. *Ephemerella grandis* Eaton

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Table 5. Numbers and species of insects recaptured after 48-hour period from Stream II.

	Distance (Feet)	June 29	July 26	August 25
Above Release Zone	12 - 18	0	0	0
	6 - 12	0	0	0
	3 - 6	0	0	0
	0 - 3	0	1C	1D
	3-Foot Release Zone	2B, 1C	4C	1A, 6C, 17D, 1E
Below Release Zone	0 - 3	0	1C	1C, 1A
	3 - 6	0	0	1D
	6 - 12	0	0	0
	12 - 18	0	1D	0
	18 - 24	0	1C	1C
	24 - 30	0	0	0
	30 - 36	0	0	0
	36 - 42	0	0	0

Ephemeroptera	Plecoptera	Trichoptera
A. *Ephemerella hecuba* (Eaton)	C. *Pteronarcys californica* Newport	E. *Arctopsyche* sp.
B. *Ephemerella grandis* Eaton	D. *Acroneuria* sp.	