

**DIEL EMERGENCE PATTERNS OF
TRICORYTHODES STYGIATUS
(EPHEMEROPTERA: LEPTOHYPHIDAE)
ON THE LITTLE LEHIGH CREEK
NEAR ALLENTOWN, PENNSYLVANIA¹**

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ABSTRACT: *Tricorythodes stygiatus* subimagos and adults show a diel periodicity in drift rates. Most of their activity is centered around the hours of sunrise and sunset. There is a differential emergence of male and female subimagos, males emerge after sunset and females emerge after sunrise. Light periodicity is the primary influence in the timing of *T. stygiatus* emergence, molting, and oviposition. This species is univoltine at this study site.

Tricorythodes stygiatus McDunnough (Ephemeroptera: Leptohiphidae) is a common species in the limestone streams of southeastern Pennsylvania. The species emerges throughout the summer. *Tricorythodes* species have been described as univoltine (Newell and Minshall 1978), bivoltine (Hall 1975), or multivoltine (Newell and Minshall 1978) depending on geographic location and water temperatures.

Tricorythodes species are atypical of most mayflies in that the subimago emerges from the larval shuck underwater and swims/floats/crawls to the surface, with males emerging after dark and females emerging early the next morning (Hall 1975; Edmunds and McCafferty 1988).

In Hall's (1975) study of *T. allectus* Needham, the surface drifting of male subimagos took place from sunset until the early hours of the morning, while female subimagos showed a peak in surface drift rate around sunrise. The emergence of male subimagos of *T. allectus* was correlated with low light intensity in the evening, while female subimago emergence is correlated with increasing light intensity in the morning (Hall 1975). However, in a study by Newell and Minshall (1978) *T. minutus* always emerged at the water surface, usually in the afternoon. *T. minutus* seems to be little influenced by photoperiod.

T. allectus male subimagos molt to adults before dawn, so the length of the male subimago stage is 5-7 hours. The female's subimago stage is very short. Some female subimagos molt immediately after emergence, others may wait up to 2 hours (Hall 1975). The male alate life of *T. allectus* lasts about 9-10 hours, beginning after dusk until the sun is well above the horizon. The female's alate stage spans a few short hours after dawn (Hall, Berner and Cook 1975).

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In *T. minutus*, the subimago stage usually lasts less than 30 minutes and the alate forms live less than 6 hours (Newell and Minshall 1978).

The purpose of this study is to determine if there is a differential emergence of male and female subimagos of *T. stygiatus* in the Little Lehigh Creek in Allentown, PA., and to determine if this differential emergence can be correlated with water temperature or time of day.

METHODS

This study took place on the Little Lehigh Creek, a 4th order stream in Salisbury Township, Lehigh County, Pennsylvania. The study site was at the end of a riffle in the main channel of the stream. It is a limestone spring creek with a typical riffle-pool complex, with a substrate composed mainly of marl and silt.

Sampling was done using a Munro style drift net with a 250 micron mesh size and a net opening measuring 39cm x 39cm and a length of approximately one meter. A removable (250 cm) catch basket, composed of 3 inch PVC pipe and mesh screen was attached to the end of the drift net. The frame, made of 0.5 inch PVC pipe, was slid over steel reinforcing rods that were hammered into the stream bottom. When in place, the Munro drift net extended from the stream bottom through the water's surface (anywhere from 5 cm to 15 cm above the surface depending on water levels).

The net was placed in the selected riffle of the study area for 24 hours at a time. Samples were removed and the net replaced every hour during the study period. At this time, the stream temperature was also taken and recorded. These 24 hour study periods were conducted three times, about one month apart, on July 13, August 11, and September 8 of 1995.

The samples were rinsed from the net into a pan, concentrated with an aquarium net and preserved in 70% ethanol. Using a 20x Swift dissecting microscope, these insects were counted, aged (as subimagos or adults) and the subimagos sexed. To determine the life stage of the alate *T. stygiatus*, the methods described by Edmunds and McCafferty (1988) were used. Subimagos had translucent wings with cilia along the hind edge. Adults had transparent wings without cilia on the hind edge of the wing. Subimagos and adults were sexed as males if claspers were present at the end of the abdomen, and as females if claspers were absent. Voucher specimens are deposited at the Department of Biological Sciences, East Stroudsburg University, East Stroudsburg, Pa.

RESULTS

The largest numbers of alate *T. stygiatus* were caught in the July 1995 sample with 891 organisms collected, including 73 subimagos and 818 adults. During the July 13th sample period, the water temperatures ranged from 16° C. in the early morning hours to 21° C. in the late afternoon. Sunrise was at

0542 and sunset was 2033 so the day length was 14 hours 51 minutes. The peak drift time for male subimagos occurred between 2200 and 2400; for female subimagos this peak occurred between the hours of 0600 and 0900 (Table 1, Figure 1). Adults showed a peak drift rate between the hours of 0800 and 1100 (Table 1, Figure 2).

Fifty- four alate *T. stygiatus* were collected in the August drift samples, including 8 subimagos and 46 adults. During the August 11th sample period, the water temperatures ranged from 15° C. in the early morning hours to 19° C. in the late afternoon. Sunrise was at 0608 and sunset was 2006, so the day length was 13 hours and 58 minutes. The peak drift time for male subimagos occurred between 2100 and 2300, for female subimagos this peak occurred between 0900 and 1000 (Table 1, Figure 1). Adults showed a peak drift rate between the hours of 0900 and 1000 (Table 1, Figure 2).

Table 1. Hourly drift rates of *Tricorythodes stygiatus* subimagos and adults taken over a 24 hour period in the Little Lehigh Creek.

Time	Subimago Male			Subimago Female			Adults		
	7/13/95	8/11/95	9/08/95	7/13/95	8/11/95	9/08/95	7/13/95	8/11/95	9/08/95
0100	1	0	0	1	0	0	0	0	0
0200	1	0	0	0	0	0	0	2	0
0300	0	0	0	0	0	0	0	0	0
0400	0	0	0	0	0	0	0	0	0
0500	1	0	0	0	0	0	0	0	0
0600	0	0	0	20	0	0	1	1	0
0700	1	0	0	4	0	1	1	1	6
0800	0	0	0	4	0	0	59	1	16
0900	1	0	0	15	1	1	349	11	7
1000	0	0	0	1	1	0	335	22	16
1100	0	0	0	0	0	0	63	3	4
1200	0	0	0	0	0	0	2	1	1
1300	0	0	0	0	0	0	1	0	0
1400	0	0	0	0	0	0	0	1	0
1500	0	0	0	0	0	0	2	0	1
1600	0	0	0	0	0	0	0	1	0
1700	0	0	0	0	0	0	0	1	0
1800	0	0	1	0	0	0	0	0	0
1900	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0
2100	0	5	1	0	0	0	0	0	0
2200	8	0	0	0	0	0	1	0	0
2300	4	1	0	0	0	0	1	1	0
2400	11	0	0	0	0	0	3	0	0
Total	28	6	2	45	2	2	818	46	52

Fifty-five alate *T. stygiatus* were collected in the September drift samples, including 4 subimagos and 51 adults. During the September 8th sample period, the water temperatures ranged between 15° C. and 16° C. Sunrise was at 0636 and sunset was 1921, so the day length was 12 hours 45 minutes. The peaks in drift time for male subimagos were at 1800 and 2100, for female subimagos these peaks were at 0700 to 0900 (Table 1, Figure 1). Adults showed a peak in drift rate from 0700 to 1100 (Table 1, Figure 2).

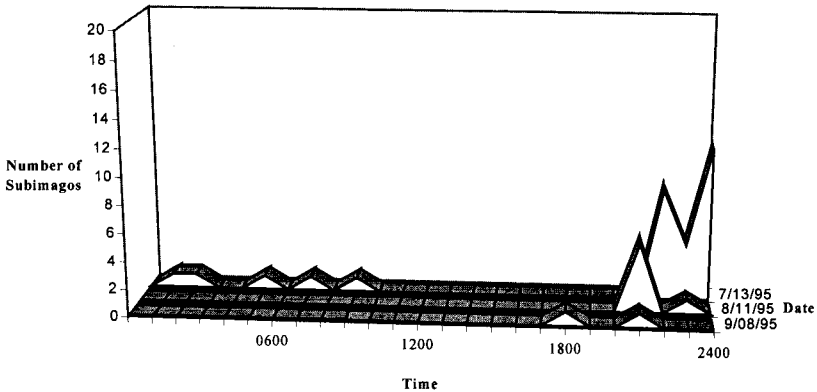


Figure 1A. Hourly drift rate of *Tricorythodes stygiatus* male subimagos in the Little Lehigh Creek.

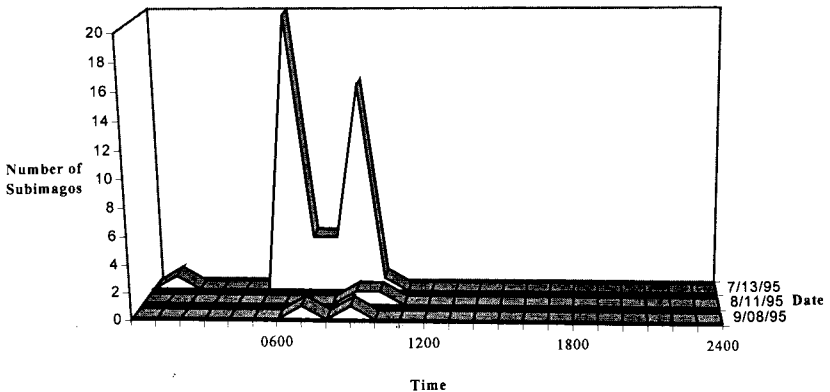


Figure 1B. Hourly drift rate of *Tricorythodes stygiatus* female subimagos in the Little Lehigh Creek.

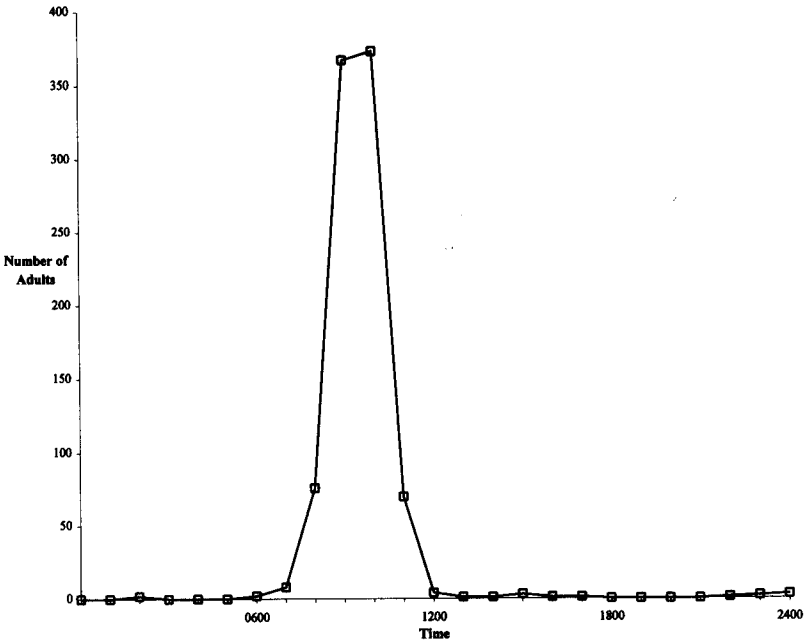


Figure 2. Hourly drift rate of *Tricorythodes stygiatus* adults in the Little Lehigh Creek.

DISCUSSION

Alate forms of *T. stygiatus* adults on the Little Lehigh show a diel periodicity in their drift rates. Water temperature did not appear to trigger the differential emergence of *T. stygiatus* in this study. The temperature of the stream did not fluctuate much ($+ 2^{\circ}\text{C}$.) on a 24 hour basis, or on a seasonal basis (15° - 21°C .) throughout the study period. Instead, the peak for subimago and adult drift revolves around the hours of sunrise and sunset. This can be seen in the data as the season progresses and the day length shortens. It is apparent that light periodicity is the primary influence in the timing of the *T. stygiatus* alate life activities of emergence, molting, mating and oviposition. This agrees with the findings of Hall (1975) and Friesen, Flannagan and Lautersweiler (1980) (*T. allectus*).

There was differential emergence of male and female subimagos of *T. stygiatus* in the Little Lehigh. This is similar to what Hall (1975), Friesen, Flannagan and Lautersweiler (1980) and Edmunds and McCafferty (1988) have found in other parts of North America for other species of *Tricorythodes*. In

found in other parts of North America for other species of *Tricorythodes*. In this study 83% (30 of 36) of the male subimagos emerged in the first 3 hours after sunset, and 93% (43 of 49) of the female subimagos emerged in the first 3 hours after sunrise. About 98% (894 of 915) of the spent adults were collected from 1 to 5 hours after sunrise, so mating and oviposition had occurred prior to this event. Mating and oviposition occur for about 3-4 hours after sunrise based on the first/last appearance of spent wing adults in the drift samples. This is a somewhat longer period than was observed by Hall, Berner and Cook (1975) in *T. allectus*. These findings were similar to R. J. Hall's (1975) study of *T. allectus* except that male subimago emergence did not occur steadily through the night, while the peak emergence of female subimagos occurred after sunrise.

The short life span of *Tricorythodes* species has been well documented (Hall 1975; Hall, Berner and Cook 1975; Edmunds and McCafferty 1988). On the Little Lehigh, alate males live 8-14 hours and alate females live 2-5 hours on average, based on the time from first/last appearance of subimagos and the first/last appearance of adults.

It appears that the *T. stygiatus* on the Little Lehigh Creek are univoltine based on this study. This would agree with Newell and Minshall's (1978) study on *T. minutus*. The drift rate of alate *T. stygiatus* was many times greater in July than in August or September. In this study, 89% (891 of 996) of the total drift is accounted for in the July sample alone.

In a number of the *T. stygiatus* larvae, subimagos and adults, a distinct red coloration on the thorax was noted. In the 0600 hour sample on July 13, 1995, 70% of the female subimagos had a red thorax. The cause of this red coloration is another area for further investigation. A number of causes have been hypothesized from 1) an element of water chemistry (Gary Borger personal communication 1995), 2) parasitic mites (Greg Hoover personal communication 1996, Brittain 1982), to 3) a type of polymorphism (Peters & Peters 1977).

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