Further Notes on Rates of Development of the Naiads of *Neotetrum pulchellum* (Drury) (Odonata: Libelluidae)[1]

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We have reported previously (Montgomery and Macklin, 1962) of the effect of photoperiod and temperature upon the length of the time from collection of final instar naiads to emergence of adults of *Neotetrum pulchellum* (Drury). This period was found to average 40.5 days for naiads collected November 8, and almost 32 days for those collected December 24, at approximately 80° F., in a 16 hour photoperiod. This time was approximately the same for a photoperiod of 24 hours (continuous light) and for three periods of three hours each equally spaced throughout the 24 hour period. With a photoperiod of 11 hours at both 70° and 80°, this period was considerably longer (90.7 and 77.7 days, respectively, for the November collection and 52.2 days at 70° for the December collection).

Another collection was made from the same population April 10, 1962, and reared to emergence in ten lots. Of 60 ultimate instar naiads collected, 58 survived to emergence. Ten lots of six naiads each were subjected to different conditions of photoperiod or light quality (wave length), all at an approximately constant temperature of 80° F. There were four photoperiods of 24 (continuous), 16, 12, and nine hours of light in each 24 hour period and two with nine hours of light divided into three periods of three hours each and six periods of one and one-half hours each, equally spaced in the 24 hour period. Four colored lights—red, green, blue and "black"—with a 16 hour photoperiod were also included.

Rearing conditions were the same as previously described (Montgomery and Macklin, 1962). The naiads were maintained in pint "wide-mouth tapering can or freeze jars" with approximately 200 ml. of water and fed "white worms" (Enchytraeidae). The rearing cabinets consist of

TABLE 1. Characteristics of energy emitted by colored lamps.

	Peak	Percentage of energy emitted		
		Middle Ultra-violet 2800-3200A	Near Ultra-violet 3200-4000A	Visible 4000-7600A
Red	6000-7600A	0.0	0.0	100
Green	5000-6000A	0.28	1.43	98.3
Blue	4000-5000A	0.5	11.1	88.4
"Black"	3400-3800A	2.68	86.8	10.05

1. Purdue University Agricultural Experiment Station Journal Paper No. 2027.
2. Research from the Entomology Environment Laboratory.

TABLE 2. Numbers of naiads of *Neotetrum pulchellum* (Drury) collected April 10 completing developments at intervals during continuous exposure to different photoperiod and light quality. Lafayette, Indiana, 1962.

Photoperiod[a] and light quality	Days										Ave.	Earlier Collections[d] Range and Average (days)	
	16	17	18	19	20	21	22	23	25	30		Nov. 8	Dec. 24
24		2	2		2						18.66	31—37 33.3	33—37 35.0
16		4	1								17.20	37—44 40.5	30—35 31.8
16 Black		1	5								17.87		
16 Red	1	4	1								17.0		
16 Green	3	2			1						17.0		
16 Blue	3	2									16.40		
12					4	1	1				20.50		
9			2		2			1		1	21.50	51—75 65.8	
3—3[b]	1	2	2	1							17.50		35—48 41.8
6—1½[c]				4			1		1		20.50		

[a] Numbers indicate the hours of light within each 24 hour period; unless indicated otherwise white light was used.
[b] Three equally spaced 3 hour periods in each 24 hours.
[c] Six equally spaced 1½ hour periods in each 24 hours.
[d] Summary of comparable data from previously published report (Montgomery & Macklin 1962).

wood-chambers, approximately 2x2x3 feet, in triple units (with one separate unit). Light is provided by a 15-watt fluorescent lamp in each chamber with an independent photoperiod control clock. White light was supplied with ordinary 18-inch lamps ("Champion F 15 T 8/W"). The colored light was furnished by lamps (all 18 inch, 15-watt, fluorescent), producing energy (in percentages) in several ranges as shown in Table 1.

The results of the rearings of the April 10 collection are given in Table 2. The statistical analysis of these results indicate highly significant differences among the treatments. (The F ratio is 5.26723, with 2.9 required for significant difference at the 1% level. The differences required for significance between any two treatments are 2.2 at 5% and 2.69 at 1% level.)

From this analysis there appears to be no significant differences due to colored light, nor any among the 24, 16 and 3-3 hour photoperiods. The 12, 9 and 6-1.5 hour photoperiods differ significantly from the former treatments, but not from each other. It is of interest that nine hours of light divided into three periods produces results almost identical with a 16 hour photoperiod, but that further division (six periods of one and one-half hours each) produces results identical with a 12 hour period and not significantly different from nine hours.

Comparison with the results of experiments with earlier collections indicate that some development occurred "in nature" between November 8 and December 24 and a considerable amount (equivalent to approximately half of the remaining time required to complete naiadal development) between December 24 and April 10.

In all tests to date (except the 24 hour period of the November collection) any departure from a 16 hour photoperiod induces a longer average period from development. While there is some overlap, almost all individuals require a somewhat longer period, but the major portion of the longer average time is due to a few individuals. At 16 hours the development is almost constant, while at other periods there are considerable differences in the rates of development of individuals.

Literature Cited

MONTGOMERY, B. ELWOOD and JERRY M. MACKLIN. 1962. Rates of development of the later instars of *Neotetrum pulchellum* (Drury) (Odonata, Libellulidae). Proc. n. Cent. Br., Ent. Soc. Am., **17**:21-23.