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J. E. McPherson
Southern Illinois University

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McPherson: Sensitivity of Immature <i>Thyanta Calceata</i> (Hemiptera: Penta

SENSITIVITY OF IMMATURE *THYANTA CALCEATA* (HEMIPTERA: PENTATOMIDAE) TO PHOTOPERIOD AS REFLECTED BY ADULT COLOR AND PUBESCENCE[1]

J. E. McPherson[2]

ABSTRACT

Dimorphism in color and pubescence of adult *Thyanta calceata*, in response to 8L:16D and 16L:8D photoperiods, resulted from an accumulation of photoperiod effects on two or more immature stages. More immature stages were receptive to 8L:16D than to 16L:8D photoperiod influence.

Thyanta calceata (Say) occurs from New England south to Florida and west to Illinois (Blatchley, 1926) and Missouri (Oetting and Yonke, 1971). Ruckes (1957) felt it was seasonally dimorphic, with brown "autumnal-vernal" adults clothed in long seta-like hairs and "summer" adults in short hairs (less than diameter of tibiae). Recently, McPherson (1977a) confirmed Ruckes' belief that *calceata* is seasonally dimorphic and demonstrated that the "autumnal-vernal" and "summer" adults can be produced in the laboratory by rearing immatures under 8L (light hours):16D (dark hours) and 16L:8D photoperiods, respectively (McPherson, 1977b). McPherson (1977b) also reported the ability of adults to change color when switched to the reciprocal photoperiod (16L:8D or 8L:16D). Not determined was whether adult dimorphism resulted from the effects of photoperiod on one (sensitive stage) or more (accumulative effect) immature stages. Results bearing on this question are presented here.

MATERIALS AND METHODS

Adults and 3rd-5th instars were collected July-September, 1976, in the La Rue-Pine Hills Ecological Area, Union County, Illinois, and placed in incubators (23.9 ± 1.1°C) under a 16L:8D photoperiod (ca. 130 ft-c, 15W Daylight F15T8/D). They were kept in mason jars and fed green snap beans, *Phaseolus vulgaris* L., as described by McPherson (1971).

Parents for experiments were selected from field-collected nymphs as they reached adulthood, or from the offspring of field-collected adults. All parents and their offspring were kept under essentially the same conditions as field-collected individuals, with the only variable being photoperiod. Fifteen males and 15 females were selected for the "sensitive stage" experiments, and an identical number for the "accumulative effect" experiments (five of each sex/mason jar for both experiments). Half the resulting egg clusters were placed in a 16L:8D photoperiod, half in an 8L:16D photoperiod. The rearing technique was described by McPherson (1971).

To determine if adult dimorphism results from photoperiod effects on a single developmental stage (sensitive stage), immatures were reared through one stadium in the 8L:16D or 16L:8D photoperiod (Original and Reciprocal Experiments, respectively), through the remaining stadia in the other (e.g., egg-2nd in 16L:8D, 3rd in 8L:16D, 4th-adult in 16L:8D). All combinations of instars and photoperiods were tested. If a "sensitive stage" exists, the resulting adults should be identical to controls reared in the same photoperiod.

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[2]Department of Zoology, Southern Illinois University, Carbondale 62901.

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To determine if adult dimorphism results from photoperiod effects on several developmental stages (accumulative effect), immatures were allowed to begin development in the 8L:16D or 16L:8D photoperiod (Original and Reciprocal Experiments, respectively), but complete it in the other (e.g., egg-1st in 16L:8D, 2nd-adult in 8L:16D). All combinations of instars and photoperiods were tested. If more than one immature stage is receptive to photoperiod influence, the resulting adults should most closely resemble controls reared under the same photoperiod as these immatures.

Controls consisted of animals reared from egg to adult in either the 8L:16D or 16L:8D photoperiod.

Adult characters compared were color and length of pubescence. Differences between experimental groups were tested with the 2 X 2 χ^2 test for independent samples unless expected cell values were less than 3.0, thus affecting the validity of the test, or an observed cell value was 0; in both cases, the Fisher exact probability test was used. The 0.05 level of significance was used for all tests. All intermediate individuals (those with greenish patches or tinge) were scored as green.

ADULT COLOR AND PUBESCENCE, SENSITIVE STAGE

Animals were compared in sequential pairs of tested stages from egg through 5th instar (Table 1). For example, adults from 1st instars reared in the 8L:16D photoperiod were compared with both adults from eggs, and adults from 2nd instars, reared in the same photoperiod (Table 1, Orig. Exp.). Rearing eggs, 1st, 2nd, or 3rd instars in 8L:16D did not affect dorsal or ventral coloration of males (i.e., adults were green) (Table 1, Orig. Exp.). Rearing 4th instar males in 8L:16D produced significantly more brown adults than did earlier instars, and 5th instar males more brown adults than 4ths. Fifth instar sensitivity was strong enough to produce 95% brown adults, not significantly different from the 8L:16D controls. Fourth and 5th instar males reared in 8L:16D produced more adults with long pubescence than did earlier instars, but not enough to equal the 8L:16D controls (Table 1, Orig. Exp.).

Sensitivity of female dorsal and ventral coloration to the 8L:16D photoperiod was most evident in the 5th instars, with 50% of the resulting adults being brown. This was intermediate between the two controls (Table 1, Orig. Exp.). Fourth and 5th instar females reared in 8L:16D produced more adults with long pubescence (20%) than did earlier instars, but not enough to equal the 8L:16D controls (Table 1, Orig. Exp.).

Males reared in the 16L:8D photoperiod for one instar showed no significant effect; the resulting adults were brown with long pubescence as were the 8L:16D controls (Table 1, Recip. Exp.).

Rearing 5th instar females in 16L:8D produced more green adults (60%) than did earlier instars, the number intermediate between the two controls. There was no difference in hair length between sequential pairs of adult females (i.e., the immatures

Table 1. Comparison of color and pubescence between *Thyanta calceata* adults tested for single instar sensitivity to 8L:16D or 16L:8D photoperiod influence.

		Color								
		Dorsal			Ventral			Pubescence		
Stage Tested	Sex	Green and Intermediate	Brown	Test[a]	Green and Intermediate	Brown	Test[a]	Long	Short	Test[a]
ORIGINAL EXPERIMENT										
16L:8D Control	M	20	0		20	0		0	20	
Egg=8L:16D[d]	M	20	0	1.00[b]	20	0	1.00[b]	0	20	1.00[b]
Egg=8L:16D[d]	M	20	0		20	0		0	20	
1st=8L:16D	M	20	0	1.00[b]	20	0	1.00[b]	0	20	1.00[b]
1st=8L:16D[d]	M	20	0		20	0		0	20	
2nd=8L:16D	M	14	0	1.00[b]	14	0	1.00[b]	0	14	1.00[b]
2nd=8L:16D[d]	M	14	0		14	0		0	14	
3rd=8L:16D	M	18	2	0.34[b]	19	1	0.59[b]	5	15	0.06[b]
3rd=8L:16D[d]	M	18	2		19	1		5	15	
4th=8L:16D	M	7	13	10.67*[c]	9	11	9.64*[c]	14	6	6.42*[c]
4th=8L:16D[d]	M	7	13		9	11		14	6	

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Table 1 (Continued)

Stage Tested	Sex	Color: Dorsal Green and Intermediate	Dorsal Brown	Dorsal Test[a]	Ventral Green and Intermediate	Ventral Brown	Ventral Test[a]	Pubescence Long	Pubescence Short	Pubescence Test[a]
5th=8L:16D	M	1	19	3.91*[c]	2	18	4.51*[c]	9	11	1.64[c]
5th=8L:16D[d]	M	1	19		2	18		9	11	
8L:16D Control	M	0	20	0.50[b]	0	20	0.24[b]	20	0	0.00*[b]
5th=8L:16D[d]	M	-	-		-	-		9	11	
16L:8D Control	M	-	-		-	-		0	20	0.00*[b]
16L:8D Control	M	20	0		20	0		0	20	
8L:16D Control	M	0	20	0.00*[b]	0	20	0.00*[b]	20	0	0.00*[b]
16L:8D Control	F	20	0		20	0		0	20	
Egg=8L:16D[d]	F	20	0	1.00[b]	20	0	1.00[b]	0	20	1.00[b]
Egg=8L:16D[d]	F	20	0		20	0		0	20	
1st=8L:16D	F	17	0	1.00[b]	17	0	1.00[b]	0	17	1.00[b]
1st=8L:16D[d]	F	17	0		17	0		0	17	
2nd=8L:16D	F	16	1	0.50[b]	17	0	1.00[b]	0	17	1.00[b]
2nd=8L:16D[d]	F	16	1		17	0		0	17	
3rd=8L:16D	F	19	1	0.80[b]	20	0	1.00[b]	0	20	1.00[b]
3rd=8L:16D[d]	F	19	1		20	0		0	20	
4th=8L:16D	F	18	2	0.50[b]	19	1	0.50[b]	4	16	0.05*[b]
4th=8L:16D[d]	F	18	2		19	1		4	16	
5th=8L:16D	F	10	10	5.83*[c]	12	8	5.16*[c]	4	16	0.00[c]
5th=8L:16D[d]	F	10	10		12	8		4	16	
8L:16D Control	F	0	20	0.00*[b]	0	20	0.00*[b]	20	0	0.00*[b]
5th=8L:16D[d]	F	10	10		12	8		4	16	
16L:8D Control	F	20	0	0.00*[b]	20	0	0.00*[b]	0	20	0.05*[b]
16L:8D Control	F	20	0		20	0		0	20	
8L:16D Control	F	0	20	0.00*[b]	0	20	0.00*[b]	20	0	0.00*[b]
RECIPROCAL EXPERIMENT										
8L:16D Control	M	0	20		0	20		20	0	
Egg=16L:8D[e]	M	0	18	1.00[b]	0	18	1.00[b]	18	0	1.00[b]
Egg=16L:8D[e]	M	0	18		0	18		18	0	
1st=16L:8D	M	0	12	1.00[b]	0	12	1.00[b]	12	0	1.00[b]
1st=16L:8D[e]	M	0	12		0	12		12	0	
2nd=16L:8D	M	0	20	1.00[b]	0	20	1.00[b]	20	0	1.00[b]
2nd=16L:8D[e]	M	0	20		0	20		20	0	
3rd=16L:8D	M	0	20	1.00[b]	0	20	1.00[b]	19	1	0.50[b]
3rd=16L:8D[e]	M	0	20		0	20		19	1	
4th=16L:8D	M	0	10	1.00[b]	1	9	0.33[b]	9	1	0.56[b]
4th=16L:8D[e]	M	0	10		1	9		9	1	
5th=16L:8D	M	2	18	0.44[b]	2	18	0.75[b]	19	1	0.56[b]
5th=16L:8D[e]	M	2	18		2	18		19	1	
16L:8D Control	M	20	0	0.00*[b]	20	0	0.00*[b]	0	20	0.00*[b]
5th=16L:8D[e]	M	2	18		2	18		19	1	
8L:16D Control	M	0	20	0.24[b]	0	20	0.24[b]	20	0	0.50[b]
8L:16D Control	M	0	20		0	20		20	0	
16L:8D Control	M	20	0	0.00*[b]	20	0	0.00*[b]	0	20	0.00*[b]
8L:16D Control	F	0	20		0	20		20	0	
Egg=16L:8D[e]	F	0	20	1.00[b]	0	20	1.00[b]	20	0	1.00[b]
Egg=16L:8D[e]	F	0	20		0	20		20	0	
1st=16L:8D	F	0	12	1.00[b]	0	12	1.00[b]	12	0	1.00[b]
1st=16L:8D[e]	F	0	12		0	12		12	0	
2nd=16L:8D	F	0	12	1.00[b]	0	12	1.00[b]	12	0	1.00[b]
2nd=16L:8D[e]	F	0	12		0	12		12	0	
3rd=16L:8D	F	1	19	0.63[b]	2	18	0.38[b]	16	4	0.14[b]
3rd=16L:8D[e]	F	1	19		2	18		16	4	
4th=16L:8D	F	2	11	0.29[b]	2	11	0.36[b]	10	3	0.58[b]
4th=16L:8D[e]	F	2	11		2	11		10	3	
5th=16L:8D	F	12	8	4.72*[c]	13	7	5.95*[c]	15	5	0.02[c]
5th=16L:8D[e]	F	12	8		13	7		15	5	
16L:8D Control	F	20	0	0.00*[b]	20	0	0.00*[b]	0	20	0.00*[b]
5th=16L:8D[e]	F	12	8		13	7		15	5	
8L:16D Control	F	0	20	0.00*[b]	0	20	0.00*[b]	20	0	0.02*[b]
8L:16D Control	F	0	20		0	20		20	0	
16L:8D Control	F	20	0	0.00*[b]	20	0	0.00*[b]	0	20	0.00*[b]

[a]Significant at the 0.05 level.
[b]Fisher exact probability.
[c]Chi^2.
[d]Other immature stages reared in 16L:8D photoperiod.
[e]Other immature stages reared in 8L:16D photoperiod.

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were apparently unaffected by 16L:8D). However, the sample size of adults from 2nd instars reared in 16L:8D was only 12, which possibly explains the lack of significance between the 2nd and 3rd instar comparison when individuals (3rds) with short pubescence first appeared (Table 1, Recip. Exp.). Also, 5th instar females reared in 16L:8D resulted in 25% adults with short hairs; this was significantly different from both controls, and thus showed they had been mildly sensitive in this instar to 16L:8D.

ADULT COLOR AND PUBESCENCE, ACCUMULATIVE EFFECT

There was no significant difference in adult dorsal and ventral coloration between sequential pairs of males or females reared for increasing lengths of time in the 8L:16D photoperiod (i.e., most were green) until the 4th instar, but the percentage of brown adults increased progressively (Table 2, Orig. Exp.). Rearing male and female immatures through the 4th instar in 8L:16D resulted in enough brown adults to be nonsignificantly different from the 8L:16D controls. Rearing immatures in 8L:16D through the 3rd instar in males and 2nd instar in females, produced significant numbers of adults with long pubescence (male = 75%, female = 25%) with these numbers increasing progressively through the remaining instars (Table 2, Orig. Exp.). Rearing both males and females in 8L:16D through the 4th instar produced only adults with long pubescence, as in the 8L:16D controls.

Rearing males and females in 16L:8D through the 4th instar produced more green adults than did earlier instars, but not enough to equal the 16L:8D controls (Table 2, Recip. Exp.). Rearing males in 16L:8D through the 4th instar produced 95% adults with short pubescence, similar to the 16L:8D controls, and significantly different from earlier instars. In females, an increase in the number of adults with short pubescence was significant when immatures were reared through the 2nd and 4th instars in 16L:8D; with the 4th instar, the number was similar to the 16L:8D controls (Table 2, Recip. Exp.).

DISCUSSION

The 4th and 5th instars were most sensitive to 8L:16D photoperiod influence in both males and females, causing brown adults and long pubescence. However, the "accumulative effect" experiment (Table 2, Orig. Exp.) indicated that adult pubescence was also partially determined by the sum total effect of 8L:16D on younger instars (male = egg-3rd, female = egg-2nd).

The 16L:8D photoperiod influence was weaker than that of 8L:16D as evidenced by the "sensitive stage" experiment (Table 1, Recip. Exp.). No male instar was sensitive enough to produce a significant number of green adults and short pubescence. The 5th instar females were receptive to 16L:8D influence on color (i.e., most adults were green) but no immature stage individually produced a significant number of adults with short pubescence. However, the "accumulative effect" experiment (Table 2, Recip. Exp.) showed that the sum total effect of 16L:8D on egg-4th instar in both males and females did result in significant numbers of green adults with short hairs and in addition, on egg-2nd instar females, a smaller, but significant, number of adults with short hairs.

Thus, the seasonal dimorphism exhibited by *calceata* adults (green with short pubescence in summer, brown with long pubescence in fall) (McPherson, 1977a) results from photoperiod influence on the immatures over most of the developmental period, with older instars being most receptive.

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Table 2. Comparison of color and pubescence between *Thyanta calceata* adults reared from immatures kept for increasing lengths of time (accumulative effect) in 8L:16D or 16L:8D photoperiod.

		Color								
		Dorsal			Ventral			Pubescence		
Instar	Sex	Green and Intermediate	Brown	Test[a]	Green and Intermediate	Brown	Test[a]	Long	Short	Test[a]
ORIGINAL EXPERIMENT										
16L:8D Control	M	20	0		20	0		0	20	
Egg=8L:16D[d]	M	11	1	0.38[b]	11	1	0.38[b]	2	10	0.13[b]
Egg=8L:16D[d]	M	11	1		11	1		2	10	
Egg-1st=8L:16D	M	19	1	0.87[b]	19	1	0.87[b]	0	20	0.13[b]
Egg-1st=8L:16D[d]	M	19	1		19	1		0	20	
Egg-2nd=8L:16D	M	14	5	0.08[b]	15	4	0.16[b]	3	16	0.11[b]
Egg-2nd=8L:16D[d]	M	14	5		15	4		3	16	
Egg-3rd=8L:16D	M	8	4	0.18[c]	9	3	0.76[b]	9	3	8.52*[c]
Egg-3rd=8L:16D[d]	M	8	4		9	3		9	3	
Egg-4th=8L:16D	M	1	19	11.22*[c]	1	19	14.00*[c]	20	0	0.04*[b]
Egg-4th=8L:16D[d]	M	1	19		1	19		20	0	
Egg-5th=8L:16D (=8L:16D Control)	M	0	20	0.50[b]	0	20	0.50[b]	20	0	1.00[b]
16L:8D Control	M	20	0		20	0		0	20	
8L:16D Control	M	0	20	0.00*[b]	0	20	0.00*[b]	20	0	0.00*[b]
16L:8D Control	F	20	0		20	0		0	20	
Egg=8L:16D[d]	F	13	0	1.00[b]	13	0	1.00[b]	1	12	0.39[b]
Egg=8L:16D[d]	F	13	0		13	0		1	12	
Egg-1st=8L:16D	F	18	2	0.36[b]	20	0	1.00[b]	0	20	0.39[b]
Egg-1st=8L:16D[d]	F	18	2		20	0		0	20	
Egg-2nd=8L:16D	F	18	2	0.70[b]	18	2	0.24[b]	5	15	0.02*[b]
Egg-2nd=8L:16D[d]	F	18	2		18	2		5	15	
Egg-3rd=8L:16D	F	10	3	0.29[b]	11	2	0.52[b]	9	4	4.63*[c]
Egg-3rd=8L:16D[d]	F	10	3		11	2		9	4	
Egg-4th=8L:16D	F	1	16	13.10*[c]	1	16	15.89*[c]	17	0	0.03*[b]
Egg-4th=8L:16D[d]	F	1	16		1	16		17	0	
Egg-5th=8L:16D (=8L:16D Control)	F	0	20	0.46[b]	0	20	0.46[b]	20	0	1.00[b]
16L:8D Control	F	20	0		20	0		0	20	
8L:16D Control	F	0	20	0.00*[b]	0	20	0.00*[b]	20	0	0.00*[b]
RECIPROCAL EXPERIMENT										
8L:16D Control	M	0	20		0	20		20	0	
Egg=16L:8D[e]	M	0	20	1.00[b]	0	20	1.00[b]	20	0	1.00[b]
Egg=16L:8D[e]	M	0	20		0	20		20	0	
Egg-1st=16L:8D	M	1	16	0.46[b]	2	15	0.20[b]	17	0	1.00[b]
Egg-1st=16L:8D[e]	M	1	16		2	15		17	0	
Egg-2nd=16L:8D	M	1	19	0.80[b]	1	19	0.44[b]	18	2	0.29[b]
Egg-2nd=16L:8D[e]	M	1	19		1	19		18	2	
Egg-3rd=16L:8D	M	5	15	1.77[c]	5	15	1.77[c]	13	7	2.29[c]
Egg-3rd=16L:8D[e]	M	5	15		5	15		13	7	
Egg-4th=16L:8D	M	13	7	4.95*[c]	15	5	8.10*[c]	1	19	13.30*[c]
Egg-4th=16L:8D[e]	M	13	7		15	5		1	19	
Egg-5th=16L:8D (=16L:8D Control)	M	20	0	0.00*[b]	20	0	0.02*[b]	0	20	0.50[b]
8L:16D Control	M	0	20		0	20		20	0	
16L:8D Control	M	20	0	0.00*[b]	20	0	0.00*[b]	0	20	0.00*[b]
8L:16D Control	F	0	20		0	20		20	0	
Egg=16L:8D[e]	F	1	19	0.50[b]	1	19	0.50[b]	20	0	1.00[b]
Egg=16L:8D[e]	F	1	19		1	19		20	0	
Egg-1st=16L:8D	F	2	18	0.50[b]	4	16	0.17[b]	20	0	1.00[b]
Egg-1st=16L:8D[e]	F	2	18		4	16		20	0	
Egg-2nd=16L:8D	F	5	15	0.69[c]	4	16	0.00[c]	16	4	0.05*[b]
Egg-2nd=16L:8D[e]	F	5	15		4	16		16	4	
Egg-3rd=16L:8D	F	2	18	0.69[c]	2	18	0.20[c]	18	2	0.20[c]
Egg-3rd=16L:8D[e]	F	2	18		2	18		18	2	
Egg-4th=16L:8D	F	15	5	14.73*[c]	16	4	17.07*[c]	2	18	22.50*[c]
Egg-4th=16L:8D[e]	F	15	5		16	4		2	18	
Egg-5th=16L:8D (=16L:8D Control)	F	20	0	0.02*[b]	20	0	0.05*[b]	0	20	0.24[b]
8L:16D Control	F	0	20		0	20		20	0	
16L:8D Control	F	20	0	0.00*[b]	20	0	0.00*[b]	0	20	0.00*[b]

[a]Significant at the 0.05 level.
[b]Fisher exact probability.
[c]Chi^2.
[d]Other immature stages reared in 16L:8D photoperiod.
[e]Other immature stages reared in 8L:16D photoperiod.

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LITERATURE CITED

Blatchley, W. S. 1926. Heteroptera or true bugs of eastern North America with especial reference to the faunas of Indiana and Florida. Nature Publ. Co., Indianapolis.

McPherson, J. E. 1971. Laboratory rearing of *Euschistus tristigmus tristigmus.* J. Econ. Entomol. 64:1339-40.

————. 1977a. Notes on the biology of *Thyanta calceata* (Hemiptera: Pentatomidae) with information on adult seasonal dimorphism. Ann. Entomol. Soc. Amer. 70:370-2.

————. 1977b. Effects of developmental photoperiod on adult color and pubescence in *Thyanta calceata* (Hemiptera: Pentatomidae) with information on ability of adults to change color. Ann. Entomol. Soc. Amer. 70:373-6.

Oetting, R. D. and T. R. Yonke. 1971. Biology of some Missouri stink bugs. J. Kans. Entomol. Soc. 44:446-59.

Ruckes, H. 1957. The taxonomic status and distribution of *Thyanta custator* (Fabricius) and *Thyanta pallido-virens* (Stål) (Heteroptera: Pentatomidae). Amer. Mus. Novitates 1824:1-23.

https://scholar.valpo.edu/tgle/vol11/iss1/10
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