Weights of *Polia Grandis* Pupae Reared at Two Constant Temperatures (Lepidoptera: Noctuidae)

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ABSTRACT

Sibling *Polia grandis* (Boisduval) larvae were reared at two constant temperatures on fresh foliage of quaking aspen (*Populus tremuloides* Michx.). Female pupae developing at 25°C were 24% heavier than those developing at 30°C and corresponding males were 32% heavier. Duration of the larval period averaged 51 days at the former temperature and 41 days at the latter. Based on other Lepidoptera, a 24% change in pupal weight affects fecundity by 28 to 130 eggs per female. Fluctuations in larval temperature regime might induce size and fecundity variation in natural populations of *grandis* and other Lepidoptera.

INTRODUCTION

While examining foliage of 45-year-old quaking aspen (*Populus tremuloides* Michx.) near International Falls, Minnesota, I found an unfamiliar lepidopteran egg mass on a leaf. Reared in the laboratory, the eggs produced adults of *Polia grandis* (Boisduval), a noctuid occurring transcontinentally through southern Canada and northern U.S. (Godfrey, 1972). In nature, the larva of *grandis* has been most often recorded feeding on woody plants (Godfrey, 1972; Ferguson, 1975; and others) but in one instance was reported on a herb (Thaxter, 1883). The date of the egg find, June 19, was within the period adults had previously been collected in Minnesota, May 15 to August 16 (Knutson, 1944). In the laboratory, the insect did not pupate until August. Previous authors likewise did not obtain pupae in their rearings until late July and August (Fletcher and Gibson, 1907; Lintner, 1889; Thaxter, 1883). *Polia grandis* probably overwinters as a pupa and is univoltine in Minnesota.

Larvae hatching from the one egg mass were reared at different temperatures to learn whether size of the insect would be affected. Pupal weight was taken as the indicator of size because it is strongly correlated with fecundity in Lepidoptera (Danthanarayana, 1975; Jennings, 1974; Miller, 1957; Morris and Fulton, 1970; Rudelt, 1935; and Williams, 1963).

METHODS

The eggs were held at room temperature until late June when all but two hatched. Newly hatched larvae were divided into two equal sized groups and reared at constant 25° and 30°C respectively. These temperatures were selected arbitrarily and were warmer than the 15.5° and 18.7°C monthly means at International Falls for June and July (Kuehnast, 1972). Refrigerator type incubators maintained rearing temperatures to within 1°. Light was provided 14 hours/day by 20-w daylight flourescent lamps. Each group of larvae was held in a transparent plastic box measuring 7370 cm^3, about 4.5 cm^3/newly hatched larva, and ventilated by muslin-covered openings on two sides and the top. Fresh quaking aspen foliage on branchlets 10-20 cm long was provided as food and changed at 2- to 3-day-intervals. Cut ends of branchlets were held in vials of distilled water. Humidity in rearing boxes was not regulated as larvae were in constant contact with turgid, transpiring foliage. Containers were checked once daily for pupae and each new

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pupa was sexed (Muggli, 1974) and weighed to the nearest 1 mg. Sex was verified by checking adult genitalia. Pupae were chilled for 5 months beginning in September. Incubator temperature was lowered gradually over 5 weeks to -4°C and held near 0°C. The temperature was then raised gradually over 5 weeks to 25°C while the pupae were occasionally moistened with water. Adults emerged in March. Identification was by E. L. Todd, USDA Systematic Entomology Laboratory, Beltsville, Maryland.

RESULTS AND DISCUSSION

The egg mass consisted of 166 contiguous eggs uniformly arranged in one layer on the upper surface of the aspen leaf. Based on nine eggs, means ± standard deviations for two diagnostic characters were as follows: egg diameter, 0.75 ± 0.02 mm, and number of egg ridges, 28.5 ± 0.9. Eggs resembled those of other *Polia* (Peterson, 1964).

Early instar larvae had reduced prolegs on the third and fourth abdominal segments and walked in a semi-looping manner. Later instars often hid beneath leaves when lights were on. Survival from egg to pupa was the same at each temperature, 14%. Although unaccountably low, this value is probably similar to what occurs in nature. Mean duration of the larval period was 51 days at 25°C and 41 days at 30°C. Female pupae were 8-15% heavier than males [(319-295)/295 = .08; (257-223)/223 = .15 (Table 1)].

Female pupae reared at 25°C were 24% heavier than their female siblings reared at 30°C [(319-257)/257 = .24] and males were 32% heavier [(295-223)/223 = .32 (Table 1)]. Most Lepidoptera probably have bell-shaped size/temperature curves such as shown for *Hyphantria cunea* (Morris and Fulton, 1970). Data reported here probably reflect the high-temperature limb of such a curve for *grandis*.

In fecundity/female pupal weight regressions for other Lepidoptera, change in pupal weight at mid-range equal to that induced by temperature in *grandis* affects fecundity by 28 to 130 eggs per female (Danthanarayana, 1975; Miller, 1957; Morris and Fulton, 1970; Rudelt, 1935; Williams, 1963). Annual variation in larval temperature regimes of univoltine insects amounting to 5°C, the difference between the above rearing temperatures, are fairly common. Weather records for International Falls show that mean June temperature differed 4.5°C or more between successive years three times during the past 25 years.

The implication is that small temperature variations may influence reproductive potential in natural populations of *grandis* and other Lepidoptera, thereby triggering changes in population density.

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Table 1. Mean pupal weight by sex at two rearing temperatures. Means based on 4-7 pupae.

Rearing temperature (C)	Sex	Pupal weight (mg)	
		Mean[1]	Standard deviation
25	Female	319	17
	Male	295	45
30	Female	257	59
	Male	223	35

[1]All possible comparisons except female-male at 25°C were statistically significant at the .05 level based on Student t-testing.

LITERATURE CITED

Danthanarayana, W. 1975. The bionomics, distribution, and host range of the light brown apple moth, *Epiphyas postvittana* (Walk.) (Tortricidae). Austral. J. Zool. 23:419-437.

Ferguson, D. C. 1975. Host records for Lepidoptera reared in eastern North America. USDA Tech. Bull. 1521, 49 p.

Fletcher, J., and A. Gibson 1907. Notes on the preparatory stages of some species of Canadian Lepidoptera. Trans. Roy. Soc. Can. 3rd ser., 1 (sec. 4):57-70.

Godfrey, G. L. 1972. A review and reclassification of larvae of the subfamily Hadeninae (Lepidoptera, Noctuidae) of America north of Mexico. USDA Tech. Bull. 1450, 265 p.

Jennings, D. T. 1974. Potential fecundity of *Rhyacionia neomexicana* (Dyar) (Olethreutidae) related to pupal size. J. Lepidop. Soc. 28:131-136.

Knutson, H. 1944. Minnesota Phalaenidae (Noctuidae). Minn. Agric. Exp. Stn., Tech. Bull. 165, 128 p.

Kuehnast, E. L. 1972. Climate of Minnesota. USDC climatography of the United States 60-21, 20 p.

Lintner, J. A. 1889. Fifth report on the injurious and other insects of the State of New York. 202 p. *in:* 42nd Rep. N.Y. State Mus. Nat. Hist. 496 p.

Miller, C. A. 1957. A technique for estimating the fecundity of natural populations of the spruce budworm. Can. J. Zool. 35:1-13.

Morris, R. F., and W. C. Fulton. 1970. Models for the development and survival of *Hyphantria cunea* in relation to temperature and humidity. Mem. Entomol. Soc. Can. 70, 60 p.

Muggli, J. M. 1974. Sex identification of *Malacosoma disstria* pupae (Lepidoptera: Lasiocampidae). Ann. Entomol. Soc. Amer. 67:521-522.

Peterson, A. 1964. Egg types among moths of the Noctuidae (Lepidoptera). Fl. Entomol. 47:71-91.

Rudelt, J. 1935. Über die Beziehungen zwischen Puppengewicht und Eiproducktion beim Kiefernspinner (*Dendrolimus pini* L.). Anz. Schädlingsk. 11:1-6.

Thaxter, R. 1883. Descriptions of noctuid larvae found on Cutts' Island, Maine. Papilio 3:10-19.

Williams, J. R. 1963. The reproduction and fecundity of the sugar cane stalk borer, *Proceras sacchariphagus* Bojer (Lep., Crambidae). p. 611-625, in: 11th. Congr. Int. Soc. Sugar Cane Tech. Proc., 1962.