addition, we found at both study sites that the first and second instars of *Urania boisduvalii* display a gregarious behavior. Perhaps this behavior was facilitated by gregarious oviposition, as suggested by Sillén-Tullberg (1988) for many species of butterflies.

We cannot explain why *Urania boisduvalii* displays such a large range in egg clutch size. Although we have not been able to demonstrate that this species presents gregarious oviposition, finding clutches with more than 2000 eggs in an uraniid moth, supports the idea that in the Lepidoptera this phenomenon is common, as suggested by Reed (2005).

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EGG VIABILITY AND LARVAL CONTRIBUTION TO FECUNDITY OF *PARNASSIUS SMINTHEUS* DOUBLEDAY (PAPILLIONIDAE)

Additional key words: life history, reproduction, Rocky Mountain Apollo

Fecundity and egg viability are important components of life history affecting population dynamics and persistence as well as being a central factor in evolution. Despite its basic nature, estimates of fecundity for Lepidoptera are not common (Hunter 1995). Here we briefly present estimates of egg viability and fecundity primarily due to larval resources for the Rocky Mountain Apollo butterfly *Parnassius smintheus* Doubleday, 1847.

We collected 146 female butterflies from two large meadows (sub populations P & Q, see Matter *et al.* 2000) along Jumping Pound Ridge, Kannanskis, Alberta, Canada (51°57'N, 114°54'W, ~2100 m). All *P. smintheus* encountered were removed on six occasions (July 20, 23, 30, 31 and August 11, 19) during the adult flight season of 2005 (~18 July–24 August). We collected ten additional females from nearby Powderface Ridge (Matter and Roland 2002) on August 6th 2005. The removals on Jumping Pound Ridge are part of a larger experiment examining spatial population dynamics. Upon capture, we placed individual butterflies in a glassine envelope and took them to The University of Calgary's Barrier Lake Field Station (~1400 m) where they were kept in the envelopes at ambient conditions. After the female's death, we counted the number of eggs laid by each butterfly. Because butterflies were removed from meadows frequently, each was captured fairly shortly (1–10 d) after its emergence. *Parnassius smintheus* continues to develop eggs in the adult stage (C. Guppy, personal communication). Thus, the number of eggs produced here should largely represent fecundity based on larval resources, rather than total fecundity including additional eggs produced from nectar resources during the adult stage. Additionally, the mating status of females was assessed by the presence or absence of a sphragis which males affix to females during copulation to prevent additional mating by other males (Bird *et al.*

1995).

We examined egg viability for a subset of females and compared viability among mated and unmated females. Eggs from all females were kept at ambient temperature until September 4. After that they were refrigerated in a humid relaxing chamber at ~5 ˚C until use in mid December. Between 3 and 28 eggs (X = 12.2) from 32 females (25 mated and 7 virgin) were placed on wetted filter paper in individual Petri dishes and kept at room temperature (~25 ˚C). Although some larvae began to eclose immediately upon the addition of water, most hatched after 4–5 days. To ensure that hatching was complete, we kept the filter paper moist and waited 3 weeks to examine number of larvae that eclosed.

We compared egg production among the three populations and between mated and unmated females using one-way analysis of variance. To assess any effect of the time between captures on the number of eggs produced we used linear regression.

Populations differed in the number of eggs produced by females ($F_{2,153}$ = 5.52, P = 0.01). Likely due to differences in phenology and our frequent removals, the mean numbers of eggs produced by females from the two Jumping Pound Ridge sub-populations (19.3 ± 2.1 (Std. Error, here and throughout) and 10.8 ± 2.3) were much greater than butterflies from Powderface Ridge (1.1 ± 0.7). All further analyses exclude the Powderface Ridge butterflies. There was no difference in the mean number of eggs laid by mated (18.0 ± 2.1) or unmated females (15.2 ± 2.8; $F_{1,144}$ = 0.52, P = 0.47), indicating that male-donated nutrients likely play little or no role in female fecundity for this species (Boggs 1990, 1997). The number of eggs laid by butterflies collected on different dates showed significant variation ($F_{5,140}$ = 4.93, P < 0.01). The greatest numbers of eggs were produced by females collected on July 30 and 31. Surprisingly, the number of eggs laid increased with the number of days between butterfly removals ($F_{1,141}$ = 16.16, P < 0.01). Thus, the observed number of eggs produced by females did not decrease due to prior oviposition by older females collected after longer intervals. In contrast, this result suggests that longer access to adult nectar resources may increase egg production (see below).

Across all butterflies from the two Jumping Pound Ridge populations, the mean number of eggs produced was 17.1 ± 1.7 (Figure 1). The distribution was highly skewed, ranging from 35 butterflies that produced no eggs to one female that produced 95 eggs. If the data are limited to mated females the mean number of eggs produced increases slightly to 18.0 ± 2.1. The number of eggs produced by *P. smintheus* was much lower than estimates for *Euphydryas editha* and *Melitaea cinxia* (Boggs and Nieminen 2004). Watanabe and Nozato (1986) reported a similar mean of 17.8 ± 4.9 mature eggs from dissections of 17 newly emerged spring generation *Papillio xuthus*. Newly emerged butterflies from later generations and from *P. machaon* showed over twice as many mature eggs. The low reproductive output seen for *P. smintheus* relative to other Papillionids is likely a function of the lack of adult nutrition (nectar) provided in our study combined with continued egg maturation by adults. Lack of adult nectar resources may limit both lifespan and egg maturation (Boggs 1997). Thus, the reproductive output seen here largely represents the contribution due to larval resources, and is not an estimate of total potential fecundity. This result further emphasizes the importance of adult nectar resources for population processes (Matter and Roland 2002).

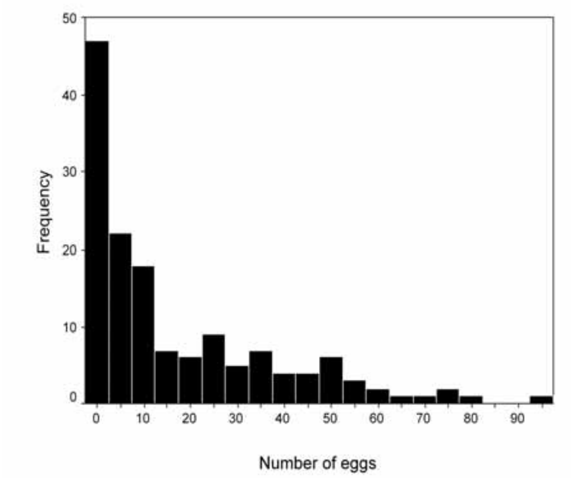

FIG 1. Frequency distribution of the number of eggs laid by female *Parnassius smintheus* from two populations along Jumping Pound Ridge.

A mean of 46.3 ± 8.2 % of the eggs from mated females produced larvae (range 0–100%). No larvae were reared from eggs from females without a sphragis. This result confirms that the sphragis generally is not lost, and the presence of a sphragis can be used to confirm mating status. Dissection of 5 eggs from one mated female revealed 3 live pharate first instar larvae and 2 incompletely developed larvae. As these butterflies overwinter as pharate first instars (Guppy and Shepard 2001) the fate of the incompletely developed eggs is unclear. These eggs, presumably produced later in the season, either die or overwinter. The incomplete development may have been due to some eggs being subjected prematurely to a cold environment. It is unclear to what degree this incomplete development occurs under natural conditions.

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SOURWOOD DEFOLIATION BY LETTERED SPHINX (*DEIDAMIA INSCRIPTA*) IN GREAT SMOKY MOUNTAINS NATIONAL PARK (LEPIDOPTERA: SPHINGIDAE)

Additional key words: Black bear, grape.

The Lettered Sphinx, *Deidamia inscripta* (Harris), is a familiar, widespread moth that occurs from South Dakota, extreme southern Quebec, and Massachusetts to northern Florida and Mississippi (Hodges 1971, Covell 1984). It is a univoltine, early season sphingid, flying from late April through mid May over much of its range (Hodges 1971). Reported hosts include grape (*Vitis*), ampelopsis (*Ampelopsis*), and Virginia creeper (*Parthenocissus*), all members of the Vitaceae (Forbes 1948, Hodges 1971, Covell 1984). Here we report widespread use and defoliation of a heath, sourwood (*Oxydendrum arboreum* (L.) DC) (Family Ericaceae), in the Appalachians.

DLW first noticed the presence of *Deidamia* on sourwood in West Virginia in 1995 near Parsons, Tucker County, West Virginia. More than a dozen larvae were collected on a small 2 m high tree, but the caterpillars soon consumed all the foliage that had been gathered for them, and as a result the identification of both foodplant and sphingid remained unknown. In 2000 when DLW started visiting Great Smoky Mountains National Park as part of the Park's "All Taxa Biodiversity Inventory," the sphinx was again encountered in large numbers—this time both the host and moth were identified to species. May visits to the Park in 2001–2003 yielded enormous numbers of the caterpillar from sourwood, especially from drier, open woodlands where Virginia pine (*Pinus virginiana* P. Mill.) was a dominant tree. During the third week of May in 2003, Eric Hossler and DLW observed numbers commonly in excess of 20–30 late instar *Deidamia inscripta* per shrub along the Foothills Parkway East, above Cosby, Cocke County, Tennessee—many smaller plants were defoliated by the larvae. KL first noted *Deidamia* in the Park more than a decade earlier. The following are two excerpts from the Park's "Observations Database."

1988-May-28 Location: Chilhowee Mt. along Foothills Parkway and west end of the Park. Observation: About half of the smaller trees of this species [*Oxydendrum*] are significantly or entirely defoliated. Examined several, found only 1 large sphinx-type larva, green. This defoliation was not observed in 1986 or 1987. K. Langdon.

1990-May-20 Location: Foothills Parkway Walland to Look Rock Observation: Most Sourwoods at least partially defoliated. On some, defoliation is 100%, only leaf mid-veins left. Collected green sphinx larvae for rearing, but they died. K. Langdon.

We report here an instance of large-scale defoliation in the spring of 2004, again along the Foothills Parkway East. The pictures shown here (figs. 1–3) were taken below the summit of the Parkway (N35°49.227' and W83°13.032'). Most of the smaller, 2–4m shrubs growing along the road had been stripped or were soon to be defoliated by the caterpillars. Road surfaces near