FLIGHT-MUSCLE DEGENERATION IN SPRUCE BEETLES, *DENDROCTONUS RUFIPENNIS* (COLEOPTERA:SCOLYTIDAE)

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ABSTRACT

Changes in width of an indirect flight muscle, the lateralis medius, were measured at various stages of adult life of **D. rufipennis.** This muscle degenerated in both female and male spruce beetles after flight and attack on the host. Flight muscles of young adults that emerged in late summer to enter hibernation were smaller than those of beetles taken in spring flight. Young beetles entering hibernation did not disperse by flying, but dropped or crawled to the bases of trees, in which they had developed, and burrowed into the bark.

INTRODUCTION

Spruce beetles, *Dendroctonus rufipennis* Kirby, like other *Dendroctonus*, accomplish flight to new hosts, attack and egg-laying during one summer. Sometimes there is a second attack by parent adults during this season. Unlike most *Dendroctonus*, spruce beetles usually take two years to develop, overwintering the first year as larvae, pupating in June and becoming young adults in July. However, these beetles differ from all other *Dendroctonus* in that many young adults abandon the galleries in which they develop and fall or crawl to the tree base, where they re-enter the bark to hibernate (Massey and Wygant, 1954). Knowledge of flight-muscle change and flight capability is important in interpreting what beetles do after emergence from the host.

Flight-muscle changes during brood establishment have been observed in the Scolytidae (Chapman, 1956; Reid, 1958) and gross flight-muscle changes have been reported in *Dendroctonus* (Chapman, 1957; Reid, 1958; Atkins and Farris, 1958; McCambridge and Mata, 1969). Detailed studies of these changes were made by Atkins and Farris (1962) on *Dendroctonus pseudotsugae* Hopkins and on *Ips confusus* Le Conte by Bhakthan, Borden and Nair (1970) and Bhakthan, Nair and Borden (1971). Chapman (1956) suggested that atrophy and regeneration of flight muscles influence Scolytid behavior because beetles cannot fly from their galleries during brood production. The present studies were conducted to measure flight-muscle change in spruce beetles after host attack and to determine whether young beetles, emerging for the first time in August and September, were capable of flight.

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METHODS AND MATERIALS

Adults were collected in two widely separated regions of British Columbia; Lodgepole Creek, near Fernie and the Naver forest, near Prince George. These beetles had overwintered and were capable of flight. Some were allowed to infest freshly cut billets and were later excavated in the boring, egg-laying or post egg-laying stages. Young adults, emerging in late summer from infested spruce trees, *Picea engelmannii* Parry and *P. glauca* (Moench) Voss, were captured by screen enclosures (Massey and Wygant, 1954). After collection, beetles were fixed and retained in alcoholic Bouin's until dissection.

The left and right lateralis medii muscles were removed and placed in 70 ethanol for measuring. Measurements were made to the nearest micron, using a dissecting microscope with ocular micrometer. The width (Fig. 1) was recorded at ¼, ½ and ¾ of the muscle length. To compensate for the effect of body size on muscle size, comparisons were made, using a median size index calculated by dividing the average of the three widths by the width of the beetle's pronotum and taking the average for the left and right muscles (McCambridge and Mata, 1969).

RESULTS AND DISCUSSION

The lateralis medii are indirect flight muscles, attaching on the metacoxa and inserting on the prescutal and scutal lobes (Fig. 1). These dorsoventral muscles, rather than the longitudinal extensor muscles, were chosen as indicators of flight-muscle degeneration because the former exhibited greater change in size. The muscle's width was more indicative of atrophy than thickness because the lateralis

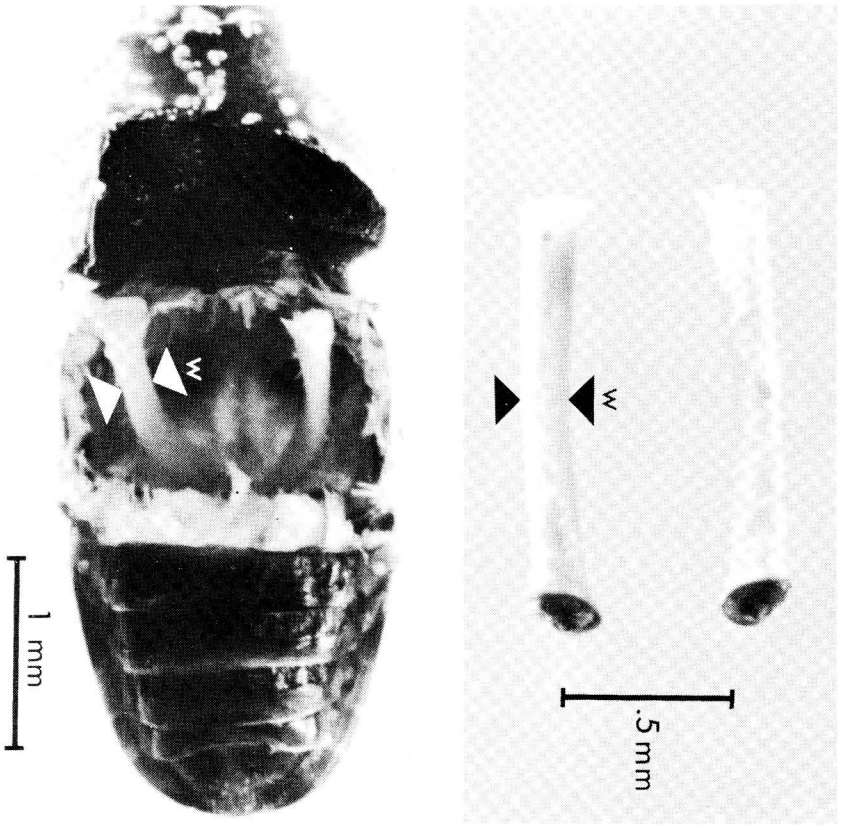

Fig. 1. Indirect flight muscles lateralis medius in adult **Dendroctonus rufipennis.** Arrows denote width (w).

medius became compressed transversely into ribbon-like tissue during egg-laying.

The muscle median size indices for female beetles (Table 1) show a progressive reduction in width from the flight-capable condition through initial boring under the bark to egg-laying. This change occurred in beetles from both areas. The gradual reduction in muscle size is similar to that reported by McCambridge and Mata (1969) for laboratory-reared *D. ponderosae*.

Male spruce beetles, from the same galleries as the females, revealed a similar pattern of muscle change, but more degeneration. However, variation in muscle size was greater in males and fewer of them were collected at the various stages. Atkins (1959) found that, during brood establishment, the sex ratio of parent *D. pseudotsugae* changed in favor of females because some males remained flight-positive and left the galleries early.

The young spruce beetle adults emerging to hibernate had underdeveloped wing muscles, apparently incapable of sustaining flight (Table 1). Approximately one-third of the beetles were flight tested prior to measurement and when tossed, none flew or opened their elytra, as do those capable of flight. Beetles were classified as emerging-to-hibernate because, at that time, beetles from unscreened parts of the same trees were crawling down and re-entering the bark near ground level. Others taken under similar conditions in previous years, hibernated and would not establish brood galleries in freshly cut billets, a behavior reported by Massey and Wygant (1954).

Because young beetles emerging to hibernate have underdeveloped wing muscles, they are unable to disperse by flight or reach new hosts. They crawl or fall to the tree base to re-enter and pass the winter. Emergence without flight capability may have advantages

TABLE I. The median size index of the lateralis medius of female spruce beetles collected from two areas of British Columbia.

Stage of adult beetle life	Median Size Index					
	Lodgepole			Naver		
	No. of beetles	Mean	S.D.	No. of beetles	Mean	S.D.
Pre-flight	13	0.157	0.007	9	0.153	0.014
Flight	22	0.155	0.019	11	0.160	0.013
Boring	6	0.113[a]	0.003	25	0.117[a]	0.036
Egg-laying	11	0.069[a]	0.022	26	0.072[a]	0.038
Post egg-laying	11	0.067[a]	0.025	-	-	-
Emerging to hibernate	24	0.087[a]	0.025	-	-	-

[a] Means within columns differed significantly (t .01) from the flight condition.

for survival. Beetles that cannot fly to hibernate in autumn do not undergo the risks inherent in an extra flight or use energy needed for hibernation and flight the next spring. The tree-base hibernating site has the advantage of being in the thickest bark and being covered with snow most of the winter. This provides protection from extreme cold, and from winter woodpecker predation which occurs on the tree bole but not at the base.

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