

DEVELOPMENT OF THREE *IPS* BARK BEETLES ON A PHLOEM-BASED REARING MEDIUM^{1, 2}

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A phloem-based, semi-artificial rearing medium for three southeastern *Ips* bark beetles, *Ips avulsus* (Eichh.), *Ips calligraphus* (Germ.), and *Ips grandicollis* (Eichh.), was reported by Yearian and Wilkinson (1965). This paper presents larval and pupal developmental rates for the three bark beetles on the medium.

The medium was prepared as described by Yearian and Wilkinson (op. cit.) and dispensed into 20 x 90 mm petri dishes at approximately 30 ml per dish. A disc of blotting paper the same diameter as the dish was pressed to the surface of the hot medium.

Eggs of the three *Ips* species were obtained from naturally infested host material. The eggs were teased from their oviposition niches with a flattened dissecting needle and surface-sterilized for 5 minutes in the sterilizing solution used by Yearian and Wilkinson (1963). After a 3-minute rinse in sterile water, the eggs were transferred to a petri dish lined with moist filter paper and incubated at 30°C.

Five newly-hatched larvae were implanted per rearing dish. A small slit was cut in the paper covering the medium, and a hole was punched through the medium to the bottom of the dish with a dissecting needle. Each larva was placed at the bottom of the hole with the head oriented downward. The hole and slit were carefully filled and sealed with medium so that larvae contacted the medium on all sides. The dishes were held at 30°C and 40-50% relative humidity.

The larvae were observed daily through the bottom of the rearing dish and the stage of development recorded. When a larva was not visible through the bottom of the dish, it was dissected from the medium, examined, and transferred to a new dish. Head capsule width was used as the criterion for differentiating the larval instars (Wilkinson 1963). Pupal weight and survival were also recorded.

Ips avulsus, *Ips calligraphus*, and *Ips grandicollis* larval and pupal developmental rates on the phloem-based rearing medium were similar at 30°C (Table 1). The mean length of the larval period was 8.4 days for *Ips avulsus*, 8.9 days for *Ips calligraphus*, and 9.2 days for *Ips grandicollis*. Larval stadia within a given *Ips* species were not entirely comparable, since only the third stadium included a non-feeding (prepupal) time of approximately 1 day. The duration of the pupal period for *Ips avulsus*, *Ips calligraphus*, and *Ips grandicollis* averaged 2.8, 3.3, and 3.0 days, respectively.

Observations on newly deposited surface-sterilized eggs showed the

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TABLE 1.—MEAN LARVAL AND PUPAL DEVELOPMENT OF *Ips avulsus*, *Ips calligraphus*, AND *Ips grandicollis* ON A PHLOEM-BASED, SEMI-ARTIFICIAL REARING MEDIUM AT 30°C.

Stage of Development	<i>Ips avulsus</i>			<i>Ips calligraphus</i>			<i>Ips grandicollis</i>		
	Mean* (days)	No. Observed	Mean* (days)	No. Observed	Mean* (days)	No. Observed	Mean* (days)	No. Observed	
Larva (total)	8.4 ± 0.51	11	8.9 ± 0.27	45	9.2 ± 0.20	51			
1st instar	2.5 ± 0.22	15	2.7 ± 0.13	86	2.6 ± 0.10	87			
2nd instar	3.2 ± 0.29	15	3.0 ± 0.10	64	2.8 ± 0.12	81			
3rd instar**	2.8 ± 0.30	13	3.7 ± 0.22	49	3.6 ± 0.18	71			
Pupa	2.8 ± 0.36	9	3.3 ± 0.10	45	3.0 ± 0.18	43			

* Includes 95% confidence limits.

** Includes non-feeding (prepupal) period of approximately 1 day.

incubation period to average 2.3, 2.7, and 2.8 days for *Ips avulsus*, *Ips calligraphus*, and *Ips grandicollis*, respectively. With the mean incubation period added to the mean larval and pupal developmental times, the average time required from egg to callow adult was 13.5 days for *Ips avulsus*, 14.9 days for *Ips calligraphus*, and 15.0 days for *Ips grandicollis*. After 7 days, adults reared on the medium were capable of infesting pine bolts and establishing broods. Thus, allowing a day for attack, mating, and initiation of oviposition, a complete life cycle, from egg to egg, would average 21.5, 22.9, and 23.0 days for *Ips avulsus*, *Ips calligraphus*, and *Ips grandicollis*, respectively. These rates are comparable to generalized life cycles for the three species given by Thatcher (1960).

Larval mortality on the medium was high. In a group of 100 newly hatched larvae of each species only 13 *Ips avulsus*, 50 *Ips calligraphus*, and 49 *Ips grandicollis* larvae reached the pupal stage. Much of the mortality was attributed to handling as it was necessary to remove many of the larvae from the medium daily to determine the stage of development. Additional observations on several hundred larvae, handled only when initially implanted in the medium, showed larval survival to be 56.7% for *Ips avulsus*, 80.6% for *Ips calligraphus*, and 68.3% for *Ips grandicollis*.

Based on pupal weight, the medium was most satisfactory for rearing *Ips calligraphus* and *Ips grandicollis*. *Ips calligraphus* and *Ips grandicollis* pupae reared on the medium averaged 10.77 and 5.17 mg and were significantly heavier ($p = .05$) than wild pupae. The increased weight of medium-reared *Ips calligraphus* and *Ips grandicollis* pupae was attributed in part to reduced pressure from parasites. The pupae were reared from surface-sterilized eggs, and the larvae were apparently free of internal parasites found in wild populations, particularly nematodes. *Ips avulsus* pupae reared on the medium weighed significantly less ($p = .05$) than wild pupae: 1.66 and 2.20 mg respectively. Possible reasons for this difference will be discussed by the authors in a separate paper.

The medium proved unsatisfactory as an oviposition site for the adult beetles. Although pairs of adults and mated females were maintained on the medium for extended periods, no egg deposition occurred. *Ips* species similarly did not oviposit on an artificial medium developed by Clark (1965).

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