OPTIMAL LENGTH OF *COCCUS HESPERIDUM* L. (HOMOPTERA: COCCIDAE) FOR PARASITISM BY *COCCOPHAGUS LYCIMNIA* (WALKER) (HYMENOPTERA: APHELINIDAE)

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ABSTRACT

Coccophagus lycimnia (Walker), a primary parasitoid of *Coccus hesperidum* L., most frequently parasitized hosts in the 1100 to 1500 μm size range. Scale insect hosts continued to develop after being parasitized but eventually died before maturity. Some 71% of the parasites successfully emerged from hosts 1400 to 1700 μm long. The most common oviposition site was the filter chamber. Females most frequently deposited a single egg within the filter chamber of the host, although two or three eggs were occasionally found. However, only one parasitoid developed to maturity per host.

Key Words: Optimal length, parasitism, brown soft scale, *Coccus hesperidum*, *Coccophagus lycimnia*, Hymenoptera, Aphelinidae, Homoptera, Coccidae.

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INTRODUCTION

Coccophagus lycimnia (Walker) is a cosmopolitan hymenopterous parasitoid with over 47 scale insect host species in the families Coccidae and Diaspididae (Gordh 1979). This species is a primary parasitoid of the brown soft scale, *Coccus hesperidum* L., and is a potential biocontrol agent of this citrus and ornamental pest. Knowledge of optimal host length for parasitism is essential for successful use of this parasitoid in biocontrol programs and other biological studies.

Cendana (1937) reported the optimal stage of *Saissetia coffeae* (Walker) for parasitism by *C. ochraceus* Howard to be late first to early second instars. Flanders (1952) stated that the second instar of the black scale, *S. oleae* (Bernard), was the preferred stage for oviposition by four species of *Coccophagus* including *C. lycimnia*. Later, Flanders et al. (1961) reported the optimal length of *C. hesperidum,* for parasitism by *C. basalis* (Compere) to be 0.8 to 1.1 mm. Reed et al. (1968) found the optimal age of the brown soft scale for parasitism to be 25 to 31 days old. Because of host - plant interactions, species development is dependent on its host plant (Miller and Kosztarab 1979). Our objective was to determine the optimal length of *C. hesperidum* for parasitism by mated females of *C. lycimnia.*

MATERIALS AND METHODS

Five potted bird's nest ferns, *Asplenium nidus* L., were maintained in a controlled environmental room at 27 ± 2°C. 60 ± 10% RH and a photoperiod of L:D 16:8. Each plant was infested with a cohort (1000 - 2000) of 24 hours old brown soft scale crawlers by placing the fronds against a reservoir colony maintained on watermelon. When first, second, and third instars were present (after 4 weeks), one frond was removed from a bird's nest fern and sectioned into five squares, each ca. 2.5 cm. Each frond square was placed in a plastic petri dish (100 × 15 mm) with the bottom lined with 9 cm filter paper. The frond square was braced to the bottom at a 45° angle with modeling clay (Stewart Clay Co.) to allow scale insects on both sides to be exposed to parasitoids.

A mixture of 25-50 *C. lycimnia* adult males and females of varying ages (> 24 hours old) was introduced into each of the five petri dishes. These treatments were then placed in a different room maintained at the same environment parameters. After 24 hours, parasitoids and scales were removed. Each scale was measured using a light microscope equipped with an ocular micrometer and then was dissected in Ringer's saline under a dissecting microscope. Scale length and the number of parasitoid eggs per scale were recorded.

Emergence tests were conducted by placing a bird's nest fern infested with 24 hours old *C. hesperidum* (1000 - 2000) into a 20 × 20 cm plexiglass chamber, covered on one side by nylon mesh, in a controlled environmental room. When first, second, and third instars were present, adult males and females of *C. lycimnia* of varying ages (> 24 hours old) were placed into the plexiglass chamber. Upon emergence of *C. lycimnia* from their hosts, two infested fronds were removed from the bird's nest fern, and only scales with emergence holes were measured and recorded.

All measurements of *C. hesperidum* were grouped into 100 μm size ranges for comparison. Parasitism, emergence, and available hosts were calculated as a percentage of the total number of parasitized hosts in each size range, the total number of hosts with emergence holes, and the total number of available hosts, respectively.

RESULTS AND DISCUSSION

The length of *C. hesperidum* offered for parasitism ranged from 550 to 3150 μm (n = 380) (Fig. 1). Parasitism occurred in scales that ranged from 650 to 2850 μm long (Fig. 2). Parasitism increased gradually up to 50% at 1350 μm, then fluctuated from 36 to 60% up to 2050 μm. The erratic parasitism obtained from scales longer than 2050 μm was possibly due to the low number of scales offered in these ranges. Parasitism in scales 550 μm to 1150 μm long was 19.4% (0 - 32) and increased to 44.0% (33 - 60) in scales 1250 μm to 2050 μm long. These results indicate that the parasite will oviposit in late first and third instars, but oviposit more frequently in second instars.

Coccophagus lycimnia primarily oviposited in the filter chamber of the host (Fig. 3). Eggs deposited in the haemolymph of the host were always encapsulated. Although up to three eggs were discovered in a few specimens, only one parasite developed to maturity. Upon eclosion, larvae moved to the pericardial cavity to complete development. Because of the oviposition site, *C. lycimnia* may have difficulty ovipositing successfully in the mesenteron of hosts greater than 2050 μm long. These results correspond to those of Flanders et al. (1961) who reported that very few brown soft scales parasitized by *C. basalis* were greater than 2000 μm long. They concluded that the ovipositor of the parasitoid was too short to reach the ovipositional site in the subesophageal ganglion of scales greater than 2000 μm long.

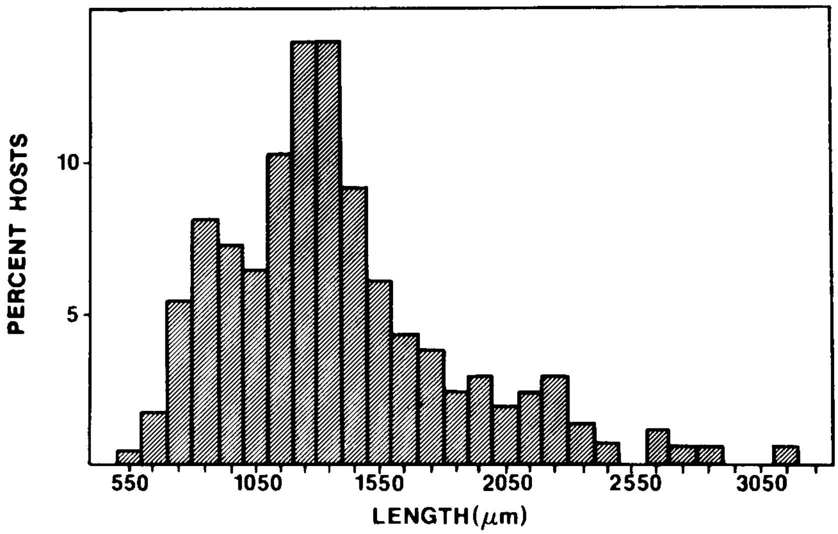

Fig. 1. Percent hosts available for parasitism by *Coccophagus lycimnia.*

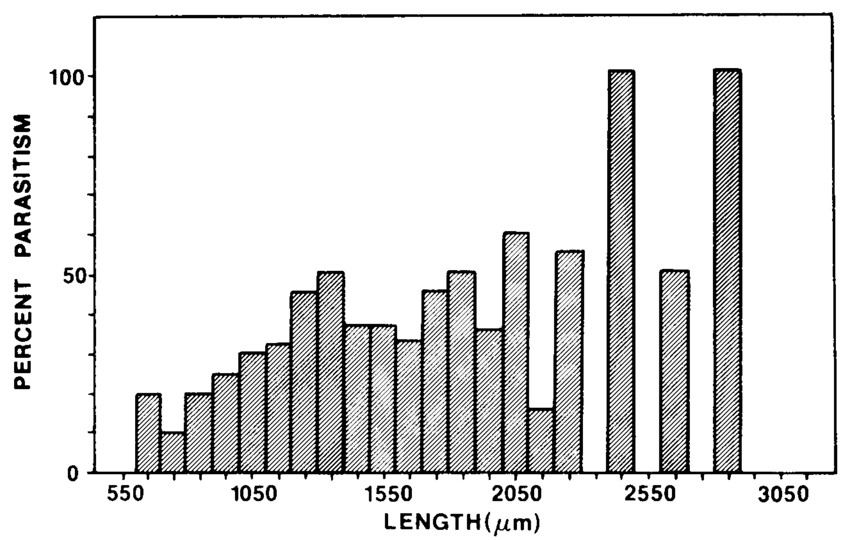

Fig. 2. Parasitism of various sizes of *Coccus hesperidum* by *Coccophagus lycimnia.*

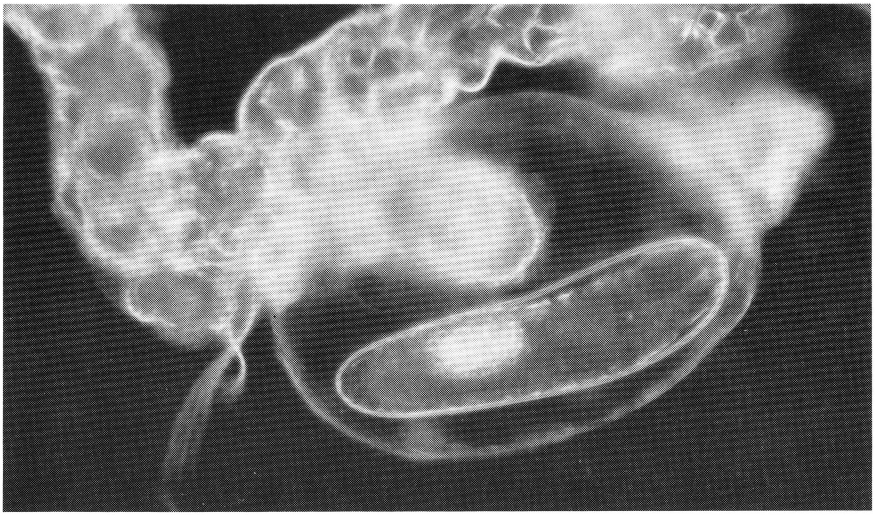

Fig. 3 *Coccophagus lycimnia* egg in the filter chamber of *Coccus hesperidum.*

All pupae observed were positioned with their head directed to the posterior of the host. Upon eclosion, the adult turned upside down and chewed a subcircular hole in the dorsoposterior portion of the host's exoskeleton to emerge. Emergence of *C. lycimnia* occurred most frequently in *C. hesperidum* hosts that were 1450 - 1750 μm in length (Fig. 4). Although parasitism occurred in scales greater than 2050 μm in length, less than 6% emerged from hosts in this length range.

Because of the variability in size exhibited by the different instars, it is difficult to identify developmental stages of the potential host without first mounting the specimens on slides for microscopic examination. A more convenient and efficient method to identify susceptible hosts may be by size rather than stage for use in mass rearing programs.

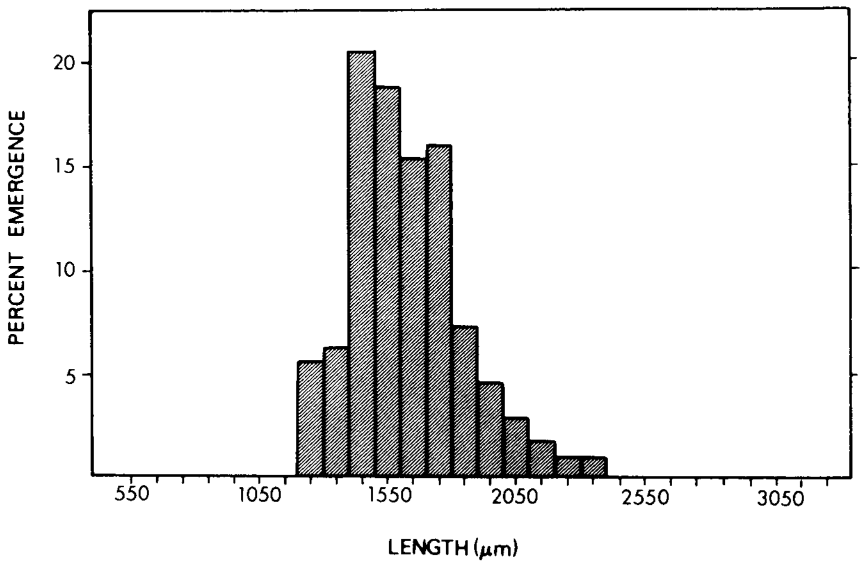

Fig. 4 Emergence of *Coccophagus lycimnia* from various sizes of *Coccus hesperidum.*

LITERATURE CITED

Cendana, S. M. 1937. Studies on the biology of *Coccophagus* [Hymenoptera]. A genus parasitic on nondiaspidine Coccidae. Univ. Calif. Publ. Entomol. 6: 337-400.

Flanders, S. E. 1952. Biological observations on parasites of the black scale. Ann. Entomol. Soc. Am. 45: 543-49.

Flanders, S. E., B. R. Bartlett, and T. W. Fisher. 1961. *Coccophagus basalis* (Hymenoptera: Aphelinidae): Its introduction into California with studies of its biology. Ann. Entomol. Soc. Am. 54: 227-36.

Gordh, G. 1979. Family Encyrtidae. 890-967. In: Krombein, K. V., Hurd, P. D., Smith, D. R. and B. D. Burks. eds. Catalog of Hymenoptera in America North of Mexico. Smithsonian Inst. Press. Wash., D. C. 2188 pp.

Miller, D. R., and M. Kosztarab. 1979. Recent advances in the study of scale insects. Ann. Rev. Entomol. 24: 1-27.

Reed, D. K., W. G. Hart, and S. J. Ingle. 1968. Laboratory rearing of brown soft scale and its hymenopterous parasites. Ann. Entomol. Soc. Am. 61: 1443-46.