*Annals of Tropical Research* 24(2):102-110


# Life history of yam scale, *Gonaspidiotus hartii* Cockerell (Hemiptera:Diaspididae)

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## ABSTRACT

Vasquez, E. A. and Melecio A. Buyser. 2002. Life history of yam scale, *Gonaspidiotus hartii* Cockerell (Hemiptera: Diaspididae). *Ann. Trop. Res.* 24(2):102-110.

Yam scale, *Gonaspidiotus hartii* Cockerell, is one of the most important insect pests attacking stored yam in the Philippines. In this study, *G. hartii* was investigated on greater yam *Dioscorea alata* (var Kinampay). The insect underwent three developmental stages: egg, nymph and adult. The total developmental period from egg to adult stage lasted 53-62 (58.77) days for the male and 58-66 (61.74) days for the female. Each female laid 9-196 (89.85) eggs during its entire oviposition period of 3-7 days with 95-100 percent hatchability. A male to female ratio of 1:4.43 was recorded. Adult male lived shorter (1-4 days) than the female (14-22) days.

Keywords: yam scale insect, *Gonaspidiotus hartii* Cockerell, life history

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## INTRODUCTION

One of the major insect pests of stored yam is the scale insect. This pest forms a thick colony on the surface of the tuber and obtains nourishment by sucking its sap. Scale insect reduces the viability of yam tubers when used as setts especially when infestation is heavy and storage period is prolonged (Lancaster and Coursey, 1984).

The scale insect may attack the yam plant in the field but only less frequently reducing plant vigor (Onwueme, 1978).Likewise, Kay (1973) reported that scale insect mainly attacks stored tubers.In the West Indies, the pest attacks principally the vines and destroys the seedlings completely.

The species of scale insect attacking yam tubers in the Philippines is *Gonaspidiotus hartii* Cockerell. Research shows that this scale insect has a wide distribution. First recorded in Guam attacking *Dioscorea spp.*, *G. hartii* is also found in the British West Indies (Trinidad), Micronesia, India, New Guinea, Ghana, Mauritius, Mali and Fiji Islands (Kay, 1973).

The problem of scale insect infestation in yam is perpetuated by the use of infested tubers as planting materials. When it attacks, germination rate of scale-infested sett is reduced. Studying the biology of *G. hartii* is the first step towards formulation of an effective control strategy.

## MATERIALS AND METHOD

### *Collection and Mass Rearing of Scale Insect*

Scale-infested yam tubers (var Kinampay) (Fig. 1) collected from yam growing areas in Leyte and Bohol, Philippines were brought to the laboratory as stock culture for the biological studies. The collected scale-infested yam tubers were placed in wire-screened cages (77 cm H x 35 cm L x 3 cm W). Uninfested mature yam tubers were provided to serve as host substrates for the emerging crawlers from scales on the field collected yam tubers.

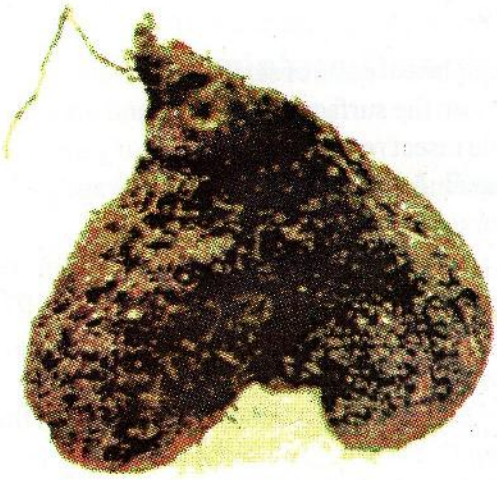

Fig. 1. Yam tuber covered with scale insects

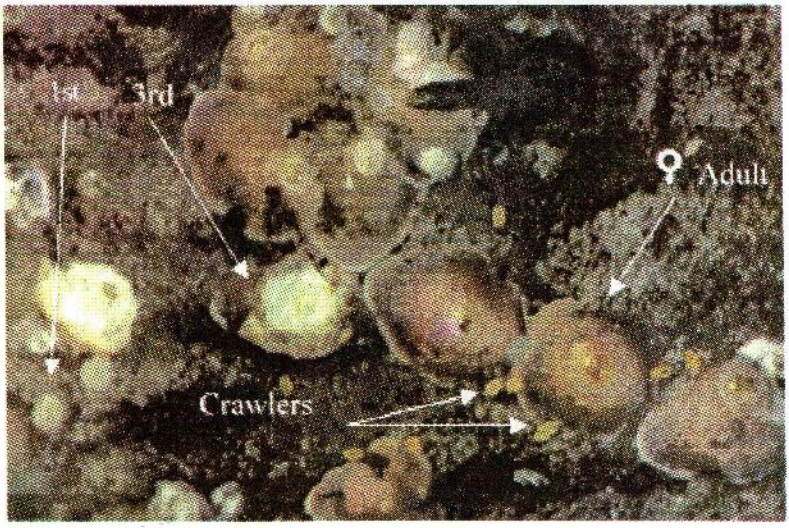


Fig. 2. Close up of the different developmental stages of scale insect.

## *Life History Studies*

The life cycle of *Gonaspidiotus hartii* was studied for two generations with 100 reared individuals per generation on yam tubers (var. Kinampay). Healthy and mature, uninfested yam tubers were trimmed of fibrous roots. Newly-hatched nymphs or crawlers were introduced into the tubers with the use of a fine brush. The crawlers were allowed to wander about the tuber until they were settled on certain location where they could obtain nourishment and developed into adult stage.Each distantly settled nymph was marked with a pen and labeled with a corresponding culture number. A total of 100 settled crawlers randomly selected were studied per generation. Excess crawlers were brushed off and settled ones were scraped off of the surface of the tubers.

The cultures were observed daily under a stereoscopic microscope. The change in insect size (diameter and length) was used as indicator of change of developmental stages. The duration of each stadium and total developmental period was noted. After reaching the adult stage,other biological parameters such as mortality of immatures, longevity of adults, sex ratio, fecundity, and feeding habits were likewise recorded.

The fecundity study was done by carefully detaching the edges of the waxy scale of female adults and flipping it out to expose the eggs for counting. The number of eggs laid was recorded by counting the total number of eggs examined minus the total number of eggs laid on previous day. After examination, the waxy scale was carefully laid back on top of the insect. Observation of fecundity started from adult female emergence until cessation of egg laying.

Crawlers produced from the first generation females were allowed to settle to uninfested yam tubers and 100 selected settled crawlers were once again studied for the next generation. Excess settled crawlers were scraped off to have room for the numbering of individual cultures. The data obtained from the two generations were incorporated and analyzed.

## RESULTS AND DISCUSSION

### *Life History and Behavior*

#### *Development Period*

The duration of the different developmental stages of yam scale, *Gonaspidiotus hartii*, is shown in Table 1. The insect had three main developmental stages - egg, nymph, and adult. The incubation period lasted up to 10 days.The active crawlers from the newly-hatched eggs became fixed unto the surface of the yam tubers after few hours to one day of searching for suitable substrate.The duration of nymphal development lasted 6-8 weeks for both sexes. The total life cycle differs between sexes, with that of the male shorter (53-62) than that of the female (58-66). The adult males lived less than a week while the females lived up to three weeks after emergence. The shorter developmental period and longevity of male than female is a usual pattern exhibited by most insect species.

With a period of two months required by yam scale to complete its development, there will be two overlapping generation of yam scale produced within 3-4 months, the usual dormancy of yam tubers before they could be planted in the field. The effect of yam infestation during the dormancy period where yam tubers are being stored could be great depending on the level of infestation. Scale infestation contributes to weight loss of yam tubers in storage. It also causes significant reduction in germination of yam setts due to long exposure of developing buds just beneath the skin surface to long feeding duration of scale insects during its entire life cycle.

#### *Fecundity and Egg Hatchability*

The female scale insect started to lay eggs a day after mating. The eggs were deposited under the abdomen of the female adult such that inorder for the eggs to be seen, the female had to be detached from the sustrate to where it attaches.Oviposition period lasted 3-6 (3.7) days with more eggs laid during the first day. Each female adult laid 9 to 196 (89.85) eggs with hatchability of 95-100% (98.62%). The female may or may not move even if the eggs have already hatched.

Table 1. Duration (days) of the development stages of *Gonaspidiotus hartii* Cockerell reared on yam tubers (var. Kinampay) for two generations.*

| Development Period | Male (52) Range | Male (52) Mean | Female (95) Range | Female (95) Mean |
|---|---|---|---|---|
| Incubation Period | 7-10 | 8.00±2.82 | 7-10 | 8.36±2.93 |
| Nymphal Period | | | | |
| First Instar | 17-25 | 22.48±3.06 | 20-25 | 23.67±1.90 |
| Second Instar | 12-15 | 13.83±0.86 | 13-19 | 15.08±0.72 |
| Third Instar | 12-16 | 15.13±0.67 | 12-19 | 16.72±0.95 |
| Total Nymphal Period | 44-53 | 51.56±3.41 | 51-57 | 54.94±4.03 |
| Total Dev't. Period | 53-62 | 58.7±3.35 | 58-66 | 61.74±3.86 |
| Longevity of Adults | 2-6 | 3.54±1.87 | 14-22 | 18.02±1.54 |

* Data based on 147 individuals.

The fecundity data showed that yam scale insects had reproductive rate. It will only require few highly fecund female to infest the entire surface of the yam within the usual storage period.

*Nymphal Development*

Several hours after hatching, the crawlers (1st nymphal instar) started to search for suitable site as substrate on the surface of the yam tuber. Once the crawlers were settled, they seldom moved around because they were glued to the spot until they reached the adult stage.

Molting occurred three times before the nymphs reached the adult stage. Upon molting, the edges of the scale started to crack and gradually detached the body of the scale insect. The newly molted nymph was soft and tender and became sclerotized after few hours.

*Adult Emergence and Sex Ratio*

The adult emerged from the last molting of the nymph. The zonation line, where the integument started to break during molting, became prominent, indicating that the insect reached the adult stage. After sclerotization some adults moved about the yam tuber to locate a permanent feeding spot.

Of the 200 immatures reared individually, 147 or 73.50% reached the

adult stage, 52 of them males and 95 females giving a male to female ratio of 1:1:83.

*Mortality of Immatures*

Table 2 presents the mortality observed in the different nymphal instars of yam scale. A total of 26.50% mortality was observed during the nymphal stages of the insect. The highest of which occurred in the first instar, the stage of insect development most vulnerable to handling and susceptible to stresses.

## *Description of Life Stages*

*Egg*

The egg was ovoid with peach top pale yellow when newly laid and turning golden yellow when about to hatch; soft and delicate;length was 0.225-0.50 mm; width, 0.20-0.35 mm.

*Nymph*

First Instar. The body of the first instar was cream-colored to peach; devoid of any markings; mite-like when viewed with the naked eye; highly mobile; legs visible when viewed dorsally; body had white tinge when about to molt; it was round with a diameter of about 0.3-0.5 mm.

Second Instar. The body of the second instar was white to pale yellow. The female was elongated with a length of 0.4-0.5 mm and a width of 0.25-0.35mm. The female was round with a diameter of 0.5-1.0 mm.

Third Instar. The body of the male is pale yellow, elongated, about 1.0-1.5 mm long and 0.35 mm wide.

*Adult*

The male was winged and had developed legs and antennae; length was

Table 2. Mortality of the immatures of Gonaspidiotus hartii Cockerell reared on yam tubers (var. Kinampay) for two generations.*

| Stage of Development | Mortality |
|---|---|
| Nymph | |
| First Instar | 19.09 |
| Second Instar | 6.31 |
| Third Instar | 1.10 |
| Total | 26.50 |

* Data based on 200 individually-reared insects.

1.25-1.75 mm and the width was 0.35-0.50 mm. The female (Fig. 2) looked similar to the third nymphal instar with prominent zonation line in the dorsal side; it was 1.5-2.5 mm diameter, round with median lobes without strongly developed marginal fringe plates in the anterior up to the third lobe.

### *Natural Enemies*

There were no natural enemies observed attacking scale insect in newly harvested scale-infested tubers as well as those in storage in Bohol and Leyte.

## CONCLUSION AND RECOMMENDATION

With a total of 7-8 weeks required for a scale insect to complete its development, an overlapping of 2 generations would be expected during the usual yam dormancy period of 3-4 months if no control measures are being applied on infested tubers before storage. Scale infestation continues to spread when infested tubers are mixed with healthy ones during storage. Significant losses due to scale infestation can be translated to poor quality of planting materials resulting to low germination efficiency.

To avoid scale infestation of yam during storage, only healthy and uninfested tubers should be stored. Pretreatment of tubers with contact systemic insecticides prior to storage is further recommended especially that early infestation of scale insect is hardly noticed.

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