Bionomics of *Haplaxius crudus* (Homoptera: Cixiidae)[1,2]

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ABSTRACT

Haplaxius crudus nymphs feed and live in the thatch layer and on the roots of St. Augustinegrass, bahiagrass, centipedegrass, bermudagrass, paragrass, yellow nutsedge, broomsedge, foxtail, and other sedges. Secretions from the abdominal wax glands protect the nymphs from wetness, disease, and predators. Average nymph size after each molt at 24°C was 0.80, 1.35, 1.80, and 2.47 mm for 4 respective molts. No differences in size were noted at 30°C. Wingpad development between each molt is a unique characteristic for identifying nymphal age. All nymphal instars developed more rapidly at 30° than at 24°C. Cool temperature (15°C) had an adverse effect on nymph development. Large nymphs survived an extended period without feeding. Eggs were 0.5–0.6 mm in length and 0.15–0.20 mm in width with one blunt end. Parthenogenic reproduction was not observed. The mean life span for adult males on St. Augustinegrass was 7.3 days and 7.8 days for adult females. The mean generation time at 30°C was 52.6 days and 80.8 days at 24°C. The adult *H. crudus* survived 37 and 50 days on coconut and veitchia palms, respectively. Coconut cultivars differed significantly in numbers of *H. crudus* attracted. The numbers of adults attracted to palm differed significantly among seasons. *H. crudus* was found in palms more in the evening hours than in the morning hours.

Research has shown the presence of mycoplasma-like organisms (MLO) in leaves and inflorescences of coconut palms (*Cocos nucifera* L.) affected by the lethal yellowing disease (LY), (Plavsic-Banjac et al. 1972). Most known "yellows" disease organisms are confined to the phloem tissues and are transmitted by leafhoppers and planthoppers (Whitcomb and Davis 1970, and Tsai 1977b). One of the most common insects on coconut palms in subtropical Florida and Jamaica is the planthopper *Haplaxius crudus* Van Duzee (Johnson 1973, Woodiel and Tsai 1978). We studied this insect species in south Florida to help in manipulating and evaluating it as a vector for transmitting the LY causal organism.

Materials and Methods

H. crudus adults were collected in Fort Lauderdale to establish laboratory colonies. Thirty to 40 newly emerged adults were added to a petri dish containing some moist ground coconut husk and a runner of St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze, as described by Tsai et al. (1976) for oviposition testing. Unmated females used in the parthenogenesis test were obtained by placing newly hatched nymphs in individual petri dishes with living grass runners until they became adults.

Nymphal development tests were conducted in 3 light temperature incubators (Freas 815)®[4] which were set at 15°, 24°, and 30°C with a relative humidity of 45–55%. St. Augustinegrass runners ca. 6–7 cm long with roots growing on the internodes were pregrown in a pan of nutrient solution for 3–4 days and then placed on moistened filter paper in individual petri dishes. Dark colored paper was placed over filter paper to facilitate finding early instars and their exuviae.

For longevity, 114 adults *H. crudus* were tested on coconut palms and 159 adults were tested on veitchia palms, *Veitchia merrillii* (Becc) Moore. Groups of 1–5 were caged on the pinnae of each species. Daily observations on the mortality of individuals were recorded throughout the entire period.

A 30×30-m plot planted with 3 cultivars (Gold Malayan, Green Malayan, and Jamaican Tall) of *C. nucifera* and St. Augustinegrass was used for quarterly counts of *H. crudus*. Three 2–3 m tall palms of each cultivar were randomly selected and marked for this experiment. A weekly reading was taken from 2 fully expanded fronds of each palm. For studying the differences in *H. crudus* populations on palms in the morning vs. the evening, 6 Green Malayan palms were randomly selected from the above plot, and counts were made twice on the same day each week for 22 wk. One reading was made in the morning (10:00–11:30 a.m.); another was made in the evening (7:00–8:30 p.m.).

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[4] The use of a trademark name is not an endorsement of one product over another that is equally effective.

Results

Field Collections and Observation

We found nymphs of *H. crudus* in the field in the thatch layer and on the roots of grasses such as St. Augustinegrass, bahiagrass, *Paspalum notatum* Flugge; centipedegrass, *Eremochloa ophiuroides* (Munro) Hack.; bermudagrass, *Cynodon dactylon* (L.) Pers.; paragrass, *Panicum purpurascens* Raddi; *P. bartowense* Scribn. and Merr.; yellow nutsedge, *Cyperus esculentus* L.; broomsedge, *Andropogon virginicus* L.; foxtail, *Setaria* spp.; and *Cyperus* spp. We have also observed *H. crudus* nymphs feeding on the roots of *Verbena scabra* Vahl. Nymphs have not been observed on plant parts exposed to light. It is common to find 20 nymphs/ft^2 on turf, and as many as 49 have been found in 1 ft^2. Despite their abundance, they do not appear to cause visible damage to the grass in field conditions.

H. crudus nymphs produce a cottony wax material both in the field and in laboratory rearing chambers. All the immature instars wave their abdomens back and forth around the nest area until all of the cottony material is brushed off the tip of their abdomens. They then pack the material down on the grass stolons and roots to form a "nest". The nymphs remain in one "nest", usually in groups of 2–10 individuals; however, they can be quite active and are capable of leaping several centimeters.

The adults are very common on the underside of palm fronds, and feed on the phloem of leaves of coconut palms and grasses (Fisher and Tsai 1977, Waters 1976). We have often observed *H. crudus* preyed upon by spiders living in the palm canopy.

Reproduction

Two experiments were conducted to determine the sex ratio of *H. crudus* adults. From the field we randomly collected 83 adults, 42 ♀ and 41 ♂. We reared 54 (25 ♀, 29 ♂) early instars, randomly picked from the laboratory colony, to the adult stage. The χ^2 test indicated that the variation in sex ratio occurred by chance (P=0.80).

A group of 10 unmated females collected from the individual rearing chambers was introduced into the egg laying cage for a parthenogenesis test. No eggs were obtained.

A total of 25 pairs of newly emerged adults was separately tested for fecundity. Only 5 pairs produced nymphs; the numbers ranged from 5–31 with a mean of 13.2 nymphs/♀.

Table 1.—Size of nymphal instars of *Haplaxius crudus*.

Molt no.	No. replicates	Mean length (mm) ± mean deviation
	Reared at 24°C	
1	14	0.80±0.00
2	14	1.35±0.06
3	15	1.80±0.10
4	22	2.47±0.07
	Reared at 30°C	
1	21	0.80±0.00
2	23	1.36±0.05
3	16	1.88±0.11
4	22	2.45±0.10

Table 2.—Life cycle of *Haplaxius crudus* at 24° and 30°C on St. Augustinegrass runner cuttings.

Stage	No. of replicates 24°C	30°C	Duration (days) (± x̄d) 24°C	30°C
Oviposition to eclosion	24	36	19.5± 0.8	11.0± 0.0
Eclosion to 1st molt	13	19	13.1± 0.7	7.9± 0.9
1st–2nd molt	8	18	9.4± 1.5	5.8± 2.1
2nd–3rd molt	6	10	10.8± 3.1	7.4± 2.1
3rd–4th molt	9	10	12.1± 5.1	9.6± 3.5
4th molt to adult	15	15	15.9± 2.9	10.9± 3.4
Total			80.8±14.1	52.6±12.0

A total of 25 pairs of newly emerged adults was separately tested for fecundity. Only 5 pairs produced nymphs; the numbers ranged from 5–31 with a mean of 13.2 nymphs/♀.

Morphological Description

The translucent eggs were 0.5–0.6 mm in length and 0.15–0.20 mm in width with one blunt end.

The longevity of the 1st instar was tested at 15°, 24°, and 30°C. Of 53 nymphs individually tested at 15°C, none underwent the normal molting process to become adults. One individual survived 70 days, but the mean nymphal longevity at 15°C was 14.6 days. There was no significant difference in measurements for nymphs reared at 24° and 30°C (Table 1). Wingpad development was noticeably different after each molt.

Adult color is variable and ranges from a brownish to a greenish tinge. The eyes are conspicuously darker and the wings practically colorless. Some individuals are pale yellow to orange. Females are always larger than the males. Males are usually light green, especially on the abdomen and are ca. 3.0 mm in head-body length; females are usually darker in color and ca. 3.6–4.1 mm in head-body length. The genitalia of male *H. crudus* were compared with the drawing of *H. crudus* by Caldwell (1946) and found to be very similar.

The longevity of adult *H. crudus* was also measured at 24°C. Newly emerged pairs were placed in individual cages with living St. Augustinegrass. The mean life span for males was 7.3 days (maximum of 9.0 days) (N=15) and 7.8 days (maximum of 13 days) (N=10) for females.

A complete study of life cycles on St. Augustinegrass was conducted in 2 temperature incubators (24° and 30°C). The mean generation time at 30°C was 52.6 days and 80.8 days at 24°C (Table 2).

Longevity of Adult H. crudus *on Coconut and Veitchia Palms*

The longest survival of an adult *H. crudus* on veitchia palms was 50 days, 13 days longer than

Table 3.—Quarterly counts of *Haplaxius crudus* attracted to 3 coconut cultivars.

Coconut cultivar	Quarter				Mean
	Dec.–Feb.	Mar.–May	June–Aug.	Sept.–Nov.	
Gold Malayan	145.3*	332.3	382.7	192.3	263.2 a**
Green Malayan	56.3	162.0	243.7	145.3	151.8 ab
Jamaican Tall	26.3	129.7	189.0	74.3	104.8 b
Mean	70.0 c	208.0 ab	271.8 a	137.3 bc	173.3

* Treatment means (avg of 3 replications).
** Marginal means with a row or within a column that are followed by a letter in common does not differ significantly at the $P=0.05$ level, as determined by the LSD test.

on coconut palms. Of the 159 adults tested on the veitchia palms, 37 insects (23.3%) lived more than 25 days. However, only 7 adults (6.1%) of 114 insects tested on coconut palms survived more than 25 days.

Different Attractancies of Coconut Palms in Relation to Counts of H. crudus

An experiment was conducted for a period of 12 mo to demonstrate the variations among the palms in relation to attraction for *H. crudus*. Means of insect counts are presented in Table 3. Coconut cultivars differed significantly ($P<0.005$) in numbers of *H. crudus* counted. The Gold Malayan had the highest number and the Jamaican Tall had the lowest number (Table 3). Insect numbers differed significantly ($P<0.005$) among seasons with the periods March–May and June–Aug. having the largest numbers (Table 3). There was no significant interaction between coconut cultivars and seasons in terms of insect numbers. That is, the numbers collected for any season on any cultivar did not differ significantly from that expected on the basis of the marginal means obtained from the factorial experiment.

Daily Activity of H. crudus

A survey was made from May–Sept. 1976 to study morning and evening activities of *H. crudus*. At the end of 5 mo, a total of 586 *H. crudus* was found in the evening hours as compared to 312 in the morning hours from the same trees.

Discussion

H. crudus (Van Duzee) was first described from Jamaica in 1907 as *Myndus crudus* by Van Duzee. It was reported from Cuba in 1926 by Osborn and from Florida in 1946 by Caldwell. Apparently, this insect has existed in LY affected areas since the 1st reports of this disease by Fawcett (1891). The number of species of *Haplaxius* in the Western Hemisphere cannot be determined until detailed interspecific studies have been conducted. The Kaincope disease in West Africa is thought to be identical to LY (McCoy 1976, Ollagnier and Weststeign 1961). If the species of *Haplaxius* associated with coconut palms in West Africa were known, it might explain the vector specificity of the LY agent.

Temperature is a vital aspect of the microclimate of turf thatch where the nymphs live. Due to local variations in thatch temperature, different rates of growth could be obtained for different individuals in the same niche. This fits in well with the fact that *Haplaxius* is heterovoltine. The fact that nymphs failed to develop into adults at 15°C could explain why this insect does not occur above 30° of north latitude. The different rates of development at 24° and 30°C enables researchers to control the environment of *Haplaxius* colonies to obtain maximum reproduction of test insects for transmission study.

It is interesting to note that the adult *H. crudus* survived longer on the palms than on its breeding host, St. Augustinegrass (Table 2). The reasons for these differences are not known. Only 6.1 and 23.3% of test adults survived more than 25 days on coconut and veitchia palms, respectively. It is conceivable that due to the rather short life span of the majority of adults as measured in these tests, the LY causal agent could be picked up by nymphs feeding on diseased palm roots and incubated long enough for the nymph to become infectious.

H. crudus has been extensively tested in the various transmission trials both in Jamaica and Florida (Schuiling and Johnson 1973, Tsai 1975, 1977a). Should *H. crudus* prove to be the vector of the LY disease, it would pose a serious problem for insect control. They are abundant not only in the thatch of turf grasses (Reinert 1977), but also in the other grasses and weeds, and the nymphs form a waxy nest to protect them from wetness, disease, and predators.

From the quarterly counts, it is important to note that different attractancies existed among the palm cultivars (Table 3). Gold Malayan attracted more *H. crudus* at any given time, and this cultivar is known to be highly resistant to LY disease. We have learned from this study that the populations of *H. crudus* had 2 peaks during the periods Mar.–Aug. (Table 3). More individuals were attracted to the palms during the evening hours and therefore it would seem best to apply contact insecticides in the evening of these periods of high incidence for control of *H. crudus*.

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