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### Biología de *Oligonychus cubensis* Livschitz (Acari: Tetranychidae) en aguacatero (*Persea americana* Miller)

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**ABSTRACT:** The development and reproduction of *Oligonychus cubensis* Livschitz were studied under laboratory conditions at  $22.83\pm 1.31$  °C and  $69.44\pm 8.55$  % HR on excised avocado (*Persea americana* Miller cv. 'Criollo') leaves. Females of laboratory-reared *O. cubensis* were placed in an experimental unit, allowed to lay eggs for 24 hours and then removed. The eggs were observed daily. The larvae that emerged were singly transferred to individual leaf discs with a fine camel's-hair brush (no. 00) until the appearance of adults, which were observed until their death. The phase changes and their duration were recorded. The average duration of the life cycle was  $10.91\pm 0.64$  days. The egg stage was the longest with 4 days, while that of protonymphs was the shortest with 1.62 days. The preoviposition period averaged 1 day, while the oviposition period can last 29 days, with an average of 16 days and a female longevity of 33 days. Sex ratio was 6.28:1 (female:male). The eggs reached 100 % of viability, and no mortality of immature stages was observed. The biological parameters of *O. cubensis* observed indicated it had a high reproductive potential, similar to that of other species within this genus which are avocado pests.

**Key words:** avocado, life cycle, *Oligonychus cubensis*, phytophagous mites, tetranychid mites

**RESUMEN:** Se estudió la duración del desarrollo y la reproducción de *Oligonychus cubensis* Livschitz en condiciones de laboratorio a  $22,83\pm 1,31$ °C de temperatura y  $69,44\pm 8,55$  % de humedad relativa sobre hojas de aguacatero (*Persea americana* Miller cv. 'Criollo'). Las hembras de *O. cubensis* se extrajeron de la cría establecida en el laboratorio y se colocaron en una unidad experimental por 24 horas para ovipositar, periodo después del cual se retiraron. A partir de ese momento los huevos se observaron diariamente a las 8:00 am y 4:00 pm. Cuando comenzaron a emerger las larvas, estas se transfirieron individualmente con un pincel No. 00 a discos de hojas hasta la aparición de los adultos, los cuales se observaron hasta su muerte. Se registraron los cambios de fase y su duración. Se encontró una duración media del desarrollo de  $10,91\pm 0,64$  días. La mayor duración la presentó la fase de huevo con cuatro días, mientras que la de protoninfa fue la menor con 1,62 días. El periodo de preoviposición tuvo una duración medio de un día, mientras que el periodo de oviposición puede durar hasta 29 días, con un valor promedio de 16 días y una longevidad de las hembras de hasta 33 días. El cociente sexual fue 6,28:1 (hembra:macho).

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Los huevos alcanzaron un 100 % de viabilidad y no se encontró mortalidad de las fases inmaduras. Las variables biológicas calculadas indican que *O. cubensis* posee un alto potencial reproductivo, semejante al de otras especies del género, las cuales son plagas del aguacatero.

**Palabras clave:** ácaros fitófagos, ácaros tetránicos, aguacatero, ciclo de vida, *Oligonychus cubensis*

## INTRODUCTION

The avocado (*Persea americana* Miller) had its origin and domestication in the region known as Mesoamerica, which comprises the high parts of Central and Eastern Mexico and Guatemala. It is a crop of tropical and subtropical regions (1). The importance of this fruit not only lies in the preference it has in the population diet, but also in the economy and industry. Due to its flavor and multiple uses, the fruit has a high demand either in the food and pharmaceutical industries or in cosmetics, without counting its nutraceutical qualities (2).

One of the most important problems that avocado cultivation faces, not only in Cuba but worldwide, is the incidence of pests that damage fruits or foliage with the consequent impact on yields. The solution of these phytosanitary problems, in an economic and ecological way, occupies an important quantity of research projects linked to the crop that are carried out (3).

Mites constitute one of the most harmful groups of arthropods in all countries where avocado is grown. The mites of the genus *Oligonychus* spp. are mainly on mature leaves near the ribs, feeding the content of the surface cells of the leaf (4). Typically, infested leaves fall prematurely due to cell disruption; the removal of chlorophyll and saliva injected by mites lead to leaf malfunction with an increased transpiration rate, resulting in wilt and an early fall. In severe attacks, due to the high density of the pest, it can invade new foliage in expansion, causing partial defoliation in the tree, low fruit size, and falling of the new formed fruit (5).

The most common way to manage their populations is by applying chemical acaricides, not always with satisfactory results, which causes the increasing phenomenon of mite-resistance (6,7,8). The chemical control is very

aggressive and its application and dosing is not always done correctly, which has caused the mites to develop resistance to pyrethroids and organophosphates (9). For this reason, the use of acaricides classified as organic, as well as of predatory mites and insects, is an alternative to control high mite populations in avocado orchards (10).

In Cuba, the species *Oligonychus punicae* (Hirst), *O. yothersi* (McGregor), and *O. cubensis* Livschitz are present in the avocado crop (11). However, there are few studies that evaluate the problem of mites in the crop. In particular, knowledge about mite behavior in different avocado genotypes, the influence of climate on population density variations, the predator-predator relationships, and the biological characteristics of the main mite species involved are limited, so the aim of this study was to determine the duration of development and reproduction of *O. cubensis* on leaves of *P. americana* cv. 'Criollo'.

## MATERIALS AND METHODS

The experiments were carried out in the Research Laboratory of the Department of Biology and Plant Health of the Faculty of Agronomy, belonging to the Agrarian University of Havana (UNAH) (Mayabeque, Cuba). The temperature and relative humidity during the execution of all the experiments were  $22.83 \pm 1.31$  ° C and  $69.44 \pm 8.55$  %, respectively, measured with a Thermo-Hygrometer brand Equitherm model TH-439.

For the taxonomic identification of *O. cubensis*, specific fixed preparations were made in Hoyer medium, the specimens were observed under a Model microscope at 400 and 1000 magnifications. The structures of taxonomic interest were measured, and the key of Livshitz and Salinas (11) was used.

Laboratory rearing: For the experimental work, *O. cubensis* was reared in the laboratory by the survival method of leaves of avocado cv. 'Criollo' on wet cotton in Petri dishes (10.5 cm in diameter x 1.5 cm in height). The mature avocado leaves were washed with water and dried with cotton. Then, an abundant population (females and males) of *O. cubensis*, so as to guarantee a wide genetic diversity in the founding colony, was taken from the leaves used to carry out the taxonomic identification and placed in the Petri dishes. The cottons were moistened daily and the leaves replenished weekly.

Experimental arena: In Petri dishes similar to those used for the rearing, discs of 2.25 cm<sup>2</sup> of mature leaves, not affected by pests, of avocado cv. 'Criollo' were placed with the leaf upper side up and the disc edge surrounded with wet cotton, in order to prevent mites from escaping and maintain the turgor of the leaves.

Forty gravid females, randomly selected from the laboratory colony, were placed in a new rearing unit for 24 hours. Afterward, the females were discarded and the oviposited eggs counted. The eggs were then observed daily under the NSTE 606 stereo microscope of Microteb at 20x magnification to determine the incubation time of the egg phase. When the larvae emerged, they were singly transferred to the experimental arena with a fine camel's-hair brush (no. 00). The arenas were examined daily, and the duration of the different life stages was recorded.

Development time per sex, mortality of immature stage, and sex ratio were analyzed. The mean value, the standard deviation, and the maximum and minimum values were determined. Females, from this initial development test, were used to obtain data about fecundity and longevity. Females were paired with males for 24 hours.

Each day, the number of eggs laid per female was recorded and the eggs removed until females died. The mean value, the standard deviation and the maximum and minimum values of the preoviposition, oviposition,

postoviposition periods and longevity, and the number of eggs laid per female were determined. The survival curve (lx) (% of live females /day) and the daily oviposition rate (eggs / female / day) were also calculated. Hatching was monitored in a cohort of 86 eggs. These eggs were observed daily until hatching or shriveling.

## RESULTS AND DISCUSSION

The development stages of *O. cubensis* include egg, larva, protonymph, and deutonymph; each growth stage was determined by the presence of exuviae. The eggs are reddish, rounded, and with a small superior peduncle, and they take an opaquer appearance when they are approaching the moment of hatching. The larva is followed by two nymphal stages with four pairs of legs, becoming larger and with a dark red coloration as the age advances. This coloration is maintained in females and males, which are larger than those in the immature stages.

The development from egg to adult was completed in 10.91±0.64 days. The duration of egg stage was the longest, the protonymph stage was the shortest, and the larval and deutonymphal stages were of approximately equal duration. Male and female developmental periods were similar ([Table 1](#)).

Until now, avocado mites have not been sufficiently studied in Cuba; most of the work done deals with taxonomical aspects, without analyzing the biology of the species ([12](#)). Therefore, no previous descriptions of the biological characteristics of the native species *O. cubensis* have been found, or information on the duration of the development cycle.

The developmental duration of *O. cubensis* was similar or shorter than that reported for other species of *Oligonychus* pests of avocado. *O. yothersi* has been reported with a duration of 4.96 days for the egg, 3.01 days for the larva and protonymph, 3.89 days for the deutonymph, and 14,34 days for the duration from egg to adult on cv. 'Lorena' ([13](#)). As can be seen, although *O. cubensis* had a similar

**TABLE 1.** Duration (in days) of developmental stages of *O. cubensis* on leaves of *P. americana* cv. 'Criollo'./ Duración del desarrollo (en días) de *O. cubensis* sobre hojas de *P. americana* cv. 'Criollo'.

Phases	Female			Male			Total		
	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max
Egg	4,00±00	4	4	4,00±00	4	4	4,00±00	4,00	4,0
Larva	2,70±0,49	1,71	3,96	2,73±0,66	2,00	3,96	2,70±0,51	1,71	3,96
Protonymph	1,63±0,53	0,75	3,00	1,57±0,55	0,75	2,00	1,62±0,53	0,75	3,00
Deutonymph	2,26±0,55	1,00	3,96	2,07±0,31	1,78	2,07	2,24±0,53	1,75	3,75
Egg-Adult	10,94±0,68	9,30	12,11	10,71±0,38	10,33	11,7	10,91±0,64	9,30	12,11
N	44			7			51		

duration for the egg stage, its remaining immature stages were shorter, resulting in a shorter total cycle indicative of its pest potential.

For *O. yothersi* on mate grass (*Ilex paraguariensis* St. Hil.) (Aquifoliaceae), Alves *et al.* (14) reported averages of developmental cycle duration of 11.2 days for males and 10.9 days for females. However, for this host, De Coll and Saini (15) reported a developmental duration of 14 days. Furthermore, Orozco-Hoyos *et al.* (16) found duration of 12.9 days and 11.7 days at 25° C and 30° C, respectively, for species on leaves of coffee tree (*Coffea arabica* L.).

Imbachi-López *et al.* (17) reported that development time from egg to adult of *Oligonychus perseae* Tuttle, Baker and Abbatiello was 16.6 days. Cerna *et al.* (18) found development times of 7.74, 7.78, and 9.54 days for *Oligonychus punicae* (Hirst) on the cultivars 'Hass', 'Fuerte', and 'Criollo', respectively. These values are lower than those observed in the present study for *O. cubensis*, maybe because they are different species and cultivars, factors having a marked influence on development duration.

The sex ratio was 86 % in favor of females with a ratio of 6.28:1 (female: male) and no mortality of immature stages was observed. The proportion of female:male achieved in this study was much higher than that reported for *O. yothersi* (4.8:1) (13). Differences in sex ratio in tetranychid populations can be explained by the

effect of factors such as amount of sperm supplied by the male, number of spermatozoids introduced, and mating duration.

A very favorable outcome for the biotic potential of the species was the fact that no mortality was found for immature stages. This element is remarkable if it is considered that *O. yothersi* had a 53 % mortality, with the highest mortality in the larval stage (36 %) (13), while the percentage of survival determined for *O. punicae* on cv. 'Fuerte', 'Hass' and 'Criollo' was of 80, 85 and 75 %, respectively (18). This indicates that *O. cubensis* can reach high populations under favorable conditions of high temperature and low relative humidity.

*Oligonychus cubensis* has a short period of preoviposition, only 1.09 days, 16.5 days of oviposition and a longevity of 20.5 days (Table 2). This specie reached a fecundity mean of 55.39 eggs/female, with a maximum of 119 and a minimum of 29 eggs/female. The duration of the period of preoviposition in tetranychid varies from 1 to 2 days, followed by a period of oviposition whose duration depends on the species of mite and the environmental conditions, but it can reach between 10 and 15 days as an average.

The values found for *O. cubensis* are similar or superior to those reported for *O. yothersi* on the cultivar 'Lorraine', where the preoviposition period was of 1.09 days, with 6.64 days for the oviposition period and a longevity of 8.35 days. The fecundity mean was 14.43 eggs/female (13).

**TABLE 2.** Duration (in days) of preoviposition, oviposition, and postoviposition periods and longevity of *O. cubensis* on *P. americana* cv. 'Criollo'./ Duración en días de los periodos de preoviposición, oviposición, posoviposición y la longevidad de *O. cubensis* sobre *P. americana* cv. 'Criollo'. (N=44).

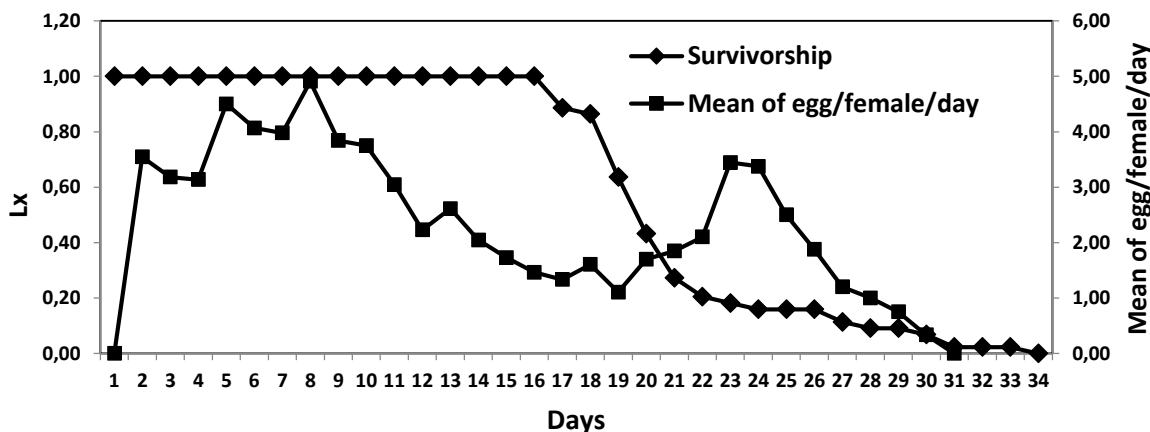
Stage	Min	Max	Mean±SD
Preoviposition	1	2	1,09±0,29
Oviposition	9	31	16,07±4,88
Postoviposition	1	9	3,34±1,79
Longevity	14	33	20,50±4,31

The daily oviposition rate is illustrated in [Figure 1](#). The first eggs were laid approximately within one or two days after mating. The average number of eggs laid per female increased from the beginning of the oviposition and reached a maximum between the fifth and tenth day. Furtherly, the number decreased with time, and egg laying ceased on day 31 after the beginning of oviposition. However, a number of females survived until the 34th day. Female of *O. cubensis* reached the peak oviposition rate of 5 eggs per female per day on the eighth day. Percentage of *O. cubensis* survivorship is also shown in [Figure 1](#). Mortality increased after most of the females stopped ovipositing. From cohorts of observed eggs, 100 % of egg

hatchability was found.

Adult females of *O. yothersi* showed two peaks of oviposition, the first on day 9 with 12 eggs and another after 14 days with 11 eggs. However, there are very fecund females which lays an average of 7 eggs in 20 days ([13](#)). Fecundity rates of 4.05, 2.86 and 4.38 eggs per female per day was determined for *O. punicae* on the cultivars 'Fuerte', 'Hass', and 'Criollo', respectively. The maximum age-specific fecundity was 5.50 eggs/female/day on the 'Hass' variety in 16 days, while on 'Fuerte' and 'Criollo' varieties were 4.92 and 4.62 eggs/female/day in 14 and 16 days, respectively ([18](#)). The preoviposition period of *O. perseae* was of 3.37±1.69 days, and of the oviposition 10.75±5.99 days, the longevity of 17.33±5.27 days, with 10.94 eggs/female/day, an average of 13.29 eggs laid during its lifetime ([17](#)).

The biological variables for *O. cubensis* in this study demonstrate that this species has the biological attributes necessary to become a serious pest of avocado crop, in particular when the temperature and humidity conditions are appropriate for increasing their populations. These results are important to establish the possible management measures to regulate their populations. Therefore, it is necessary to evaluate their population behavior under production conditions and to determine the



**FIGURE 1.** Daily oviposition rate and survivorship of *O. cubensis* on *P. americana* cv. 'Criollo'./ Media de huevos por hembra por día y superviviencia de *O. cubensis* sobre *P. americana* cv. 'Criollo'.

biotic and abiotic factors that modulate their populations.

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