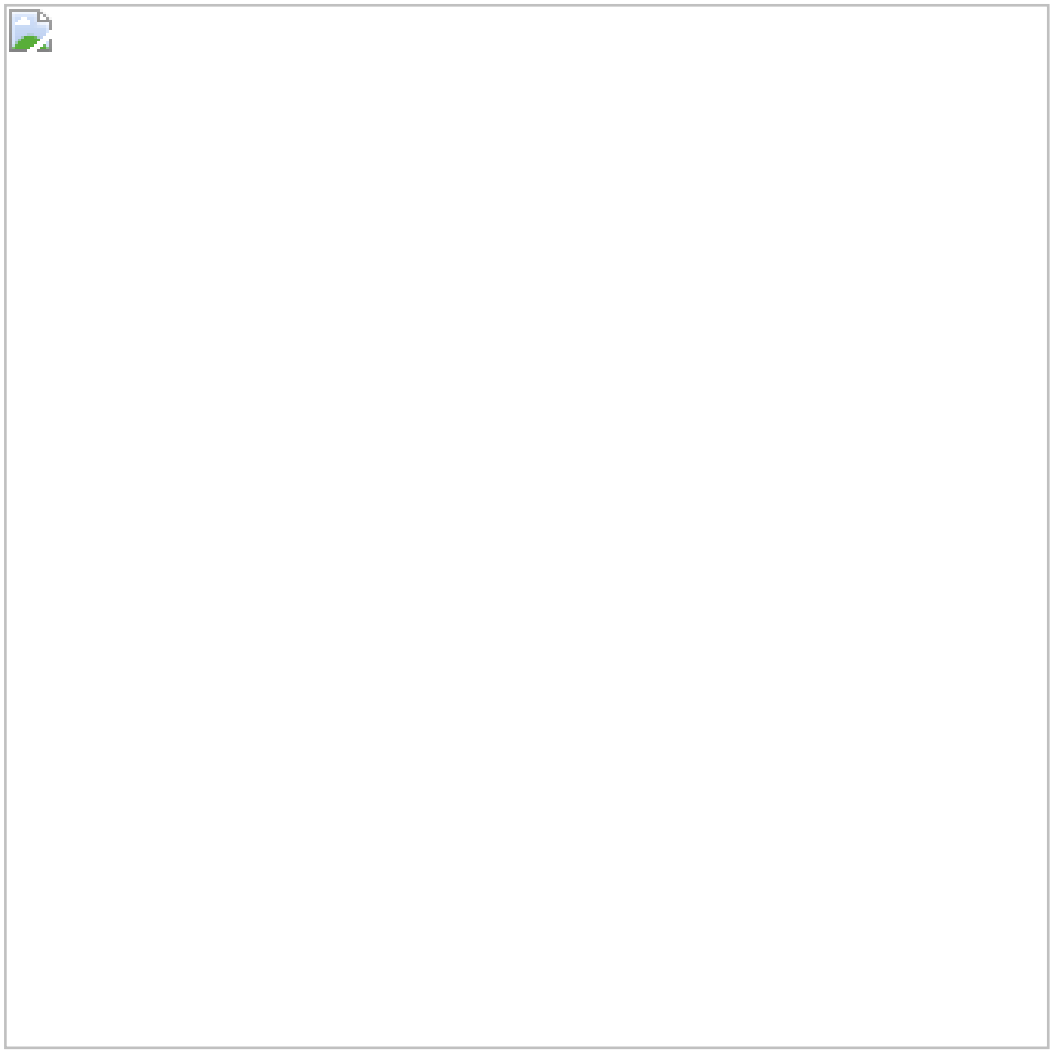

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The Developmental Biology of Grain-Sucking Bug, *Stenocoris elegans* Blöte, on Upland Rice

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ABSTRACT: The grain-sucking bug, *Stenocoris elegans* Blöte (Hemiptera: Alydidae), is an important rice pest in West Africa. Investigation on its developmental biology is important to provide the base and possibility to bring forth further research for the improvement of the pest management strategy. The developmental biology of *S. elegans* was investigated on upland rice variety IDSA 10 in the laboratory in Ibadan, Nigeria. The results showed that pre-oviposition and post-oviposition periods were 9.9 ± 0.49 and 6.1 ± 1.17 days, respectively, under ambient temperature and relative humidity. A mated female of *S. elegans* laid an average of 135.1 eggs during an oviposition period of 33.5 days. The average egg incubation period was 7.9 ± 0.3 days. There were five nymphal instars, and the total developmental period (first instar to adult) averaged 18.0 days. An over-all mean growth ratio of 1.29 was recorded for this species. A regular relationship existed between measurements of nymphal vertex and the duration of their developmental periods, and a significant correlation (0.98) was obtained.

KEYWORDS: developmental biology, *Stenocoris elegans*, oviposition, nymphal instar, head capsule, rice

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Introduction

Insect pests constitute a major constraint in rice production in Nigeria, and they perennially result in crop loss which may range from 30 to 100%.[1] There are more than 800 insect species damaging rice worldwide[2] of which about 70 species have been reported in Nigeria.[3] Insects attack rice from the seedling stage to maturity and feed on all parts of the plant. Insect damage decreases the yield and lowers grain quality.[4] Among the most important insect pests of rice reported in Nigeria and other parts of the world are the grain-sucking bugs that attack rice at the panicle stage.[3,5,6] Some of these belong to the family Alydidae, Coreidae, and Pentatomidae. Members of the family Alydidae include species from the genera *Stenocoris*, *Mirperus*, and *Riptortus* in Africa and *Leptocorisa* in Asia.[5] The biology of some of these bugs has been studied either on cowpea or rice.[7–11] Although *Stenocoris elegans* is reported on rice in Nigeria,[3] its development on rice has not been investigated. Consequently, information on the developmental biology of this species is lacking in the literature. Therefore, this study reports on the biology of this pest on upland rice in Ibadan, Nigeria.

Materials and Methods

Rearing cages and culturing of *S. elegans*. Adults of *S. elegans* were collected from rice plants on West African Rice Development Association (WARDA), rice experimental plots at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria to establish a culture in the Laboratory. The culture of *S. elegans* was established in the Entomology Laboratory of the Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, under ambient temperature

(25–28°C), relative humidity (83–92%), and 12L:12D photoperiod. The insects were caged in transparent cylindrical plastic cages of 15.0 cm diameter and 19.0 cm height. A hole of 11.5 cm diameter was made on the lid and covered with a sleeve cloth to allow movement of materials and insects in and out of the cage. Four rectangular openings 4.0 × 5.0 cm were made on the sides of each cage and covered with nylon mesh (30 cm/cm^2) for aeration. Eggs were collected daily from the mated pairs and incubated on moist filter paper until hatched.

Upland rice seeds, variety IDSA 10, was obtained from WARDA office at IITA, Ibadan and raised in plastic pots at the roof top garden of Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria to provide food for the insects. Fresh rice seeds at milky stage were harvested, and moistened cotton wool in Petri dish was kept in each cage as food and water, respectively, for the insects.

Oviposition and life span study. A pair of male and female teneral adults from insect culture was placed in plastic cages and replicated 10 times in the laboratory. Each cage was supplied with rice seeds at milky stage and water daily to feed the insects. Observations were recorded daily on the pre-oviposition period, fecundity, and post-oviposition period of mated females. Observations were also recorded on the longevities of mated males and females. Longevities of unmated male and female adults were observed in 10 males and females caged separately in 10 replicates.

Nymphal development. A total of 40 neonate first instar nymphs were transferred into rearing cages and replicated 16 times. The nymphs were fed daily with fresh rice seeds and water soaked in cotton wool. In all, 10 nymphs each were taken daily in turn from the rearing cages and immobilized with fumes of ethyl acetate in a Petri dish for easy measurement of the width of the head capsule. The widths of the head capsule of nymphal instars were measured using a micrometer eye piece fitted into a binocular microscope. The immobilized nymphs were discarded after the measurement of the head capsules has been made. These procedures continued daily until adults emerged. A test of conformity to Dyar's rule was carried out to determine whether the constant growth ratio of 1.4 proposed by Dyar[12] for lepidopterous insect is applicable to *S. elegans*. The growth ratio for each nymphal instar was determined by dividing the mean width of vertex across the eye of one instar by that of the previous instar.

Table 1. Pre-oviposition, oviposition, post-oviposition periods, fecundity, egg incubation period, and life span of *S. elegans*.

REPRODUCTIVE PARAMETER (n = 10)	MEAN ± S.E
Pre-oviposition period (days)	9.9 ± 0.49
Oviposition period (days)	33.5 ± 4.40
Post-oviposition period (days)	6.1 ± 1.17
Fecundity	135.1 ± 14.8
Egg incubation period (days)	7.9 ± 0.3
Longevity of mated female (days)	49.9 ± 4.6
Longevity of unmated female (days)	53.2 ± 4.1
Longevity of mated male (days)	44.5 ± 4.1
Longevity of unmated male (days)	47.7 ± 4.8

Statistical analyses. The head capsule widths of all nymphal instars were analyzed using analysis of variance and significant means of the head capsule between each instar were separated using the Tukey's honestly significant difference test (HSD; $P = 0.05$). The head capsule widths of all nymphal instars were regressed on the duration of each instar to see if growth in these instars proceeded at regular rate. A regression line was drawn between the data of head capsule width and the accumulated days of nymphal development. The correlation coefficient (r) was determined. A t-test was carried out for conformity of growth rate of *S. elegans* to Dyar's rule.

Results

Pre-oviposition, oviposition, and post-oviposition periods; fecundity; and longevity of *S. elegans*. Table 1 shows that the pre-oviposition period and post-oviposition period for mated adult female of *S. elegans* was 9.9 and 6.1 days, respectively. The mated females laid an average of 135.1 eggs during an oviposition period of 33.5 days. The mean life span of unmated female was longer than that of mated female. Both mated and unmated females lived longer than their respective male counter-parts. Egg incubation averaged 7.9 days.

Nymphal development. Table 2 shows the head capsule measurement of nymphal instars and adults of *S. elegans*.

Table 2. Head capsule (±SE) measurement of nymphal instars of *S. elegans*.

INSTAR	N	MEAN OF HEAD CAPSULE WIDTH (mm)	GROWTH RATIO	STADIUM OF INSTAR (DAYS)	ACCUMULATED DAYS OF DEVELOPMENT
I	30	0.42 ± 0.03a	–	3	0
II	30	0.56 ± 0.00b	1.33	3	3
III	25	0.69 ± 0.05c	1.23	3	6
IV	30	0.92 ± 0.03d	1.33	3	9
V	38	1.17 ± 0.06e	1.27	5–6	12
Mean growth ratio			1.29		

Note: Means followed by different letters along the column are significantly different from each other ($P = 0.05$) (Tukey's HSD).

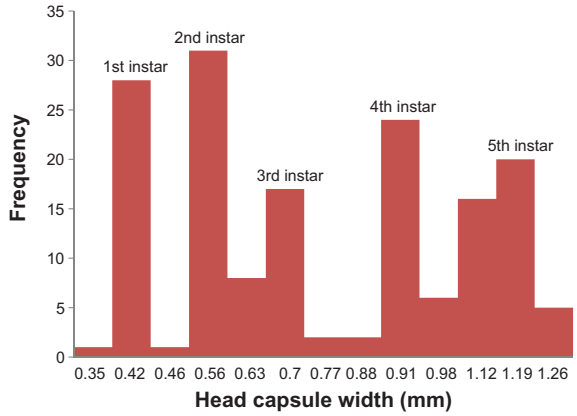

Figure 1. Frequency distribution of the head capsule width of nymphal instars of *S. elegans*.

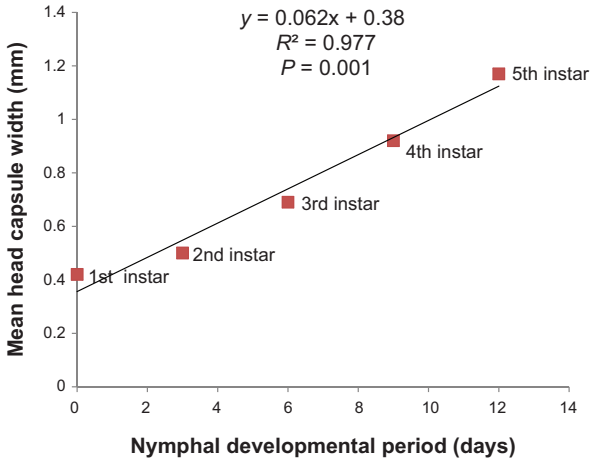

Figure 2. Relationship between head capsule width and nymphal developmental period of *S. elegans*.

The means of head capsule of the instars increased from the first instar to the fifth instar and were significantly different from one another. The total developmental period of nymphal instars was 18 days. The duration of the fifth nymphal stage (5–6 days) was longer than other nymphal stages. The morphometrics of the head capsule width of the immature stages showed that there were five distinct nymphal instars with mean growth ratio of 1.29. The frequency distribution of the head capsule width of the immature stages also showed five distinct groups corresponding to five nymphal instars (Fig. 1). In the first instar, the head capsule width of 0.42 cm occurred 28 times. Head capsule width of 0.56 mm which is the only one in second instar occurred 31 times. Head capsule width of 0.70 mm had the highest occurrence of 17 among the third instar, whereas head capsule widths of 0.91 and 1.19 mm had the highest frequency distributions of 24 and 20 times in fourth and fifth instars, respectively.

A test of conformity of the head capsule width of *S. elegans* to Dyar's rule was carried out. A *t*-value greater than 2.78 was needed to indicate a significant difference between the observed and the calculated averages. However, a *t*-value of 0.30 was obtained (Table 3) indicating no significant difference. There was a regular relationship between measurements of the head capsule and accumulated days of nymphal development. The linear regression line and the correlation coefficient ($r = 0.98$, $P = 0.01$) obtained from the relationship between measurements of head capsule and duration of the instars is shown in Figure 2.

Table 3. The head capsule width for nymphal instars of *S. elegans* and test of conformity to Dyar's rule.

INSTAR	OBSERVED AVERAGE	GROWTH RATIO	CALCULATED AVERAGE	DIFFERENCES
I	0.42			
II	0.56	1.34	0.54	0.02
III	0.69	1.23	0.73	−0.04
IV	0.92	1.34	0.89	0.03
V	1.17	1.27	1.19	−0.02

Notes: T (cal) = d/s $(4)^{1/2}$ = 0.30, where d = average difference = 0.0025, s = standard dev. of difference = 0.333, and t (tab) = (4) (0.05) = 2.78.
Reject Ho if t (cal) > t (tab).
Decision: do not reject Ho: growth rate conforms to Dyar's rule.

Discussion

Mated females of *S. elegans* laid an average of 135.1 eggs over a period of 33.5 days while the total developmental period (nymph to adult) averaged 18.0 days. Similarly, alydid bugs, *Mirperus jaculus* Thunberg, *Riptortus dentipes* Fabricius, and *Leptocorisa oratorius* Fabricius completed their nymphal developmental periods in 20.67, 19.8 and 18.5 days, respectively.[7,13,14] In another development, *L. oratorius* Fabricius has been reported to complete its nymphal developmental period in 18.9 and 18.7 days under field and green house conditions, respectively.[15] The moderately high number of eggs (69–211) and short developmental period (18.0 days) ensured a faster rate of population build-up of *S. elegans*. In addition, the long period of oviposition (19–55 days) and long adult life span (25–75 days) may allow for many generations of the bug to build up and overlap.

The growth ratios of the successive nymphal stages and their mean (1.29) tend to be very close to the constant growth ratio (1.4) proposed by Dyar[12] for the head capsule of Lepidoptera larva. A test of conformity of the head capsule width of *S. elegans* to Dyar's rule indicated no significant difference between this growth ratio and that predicted by him. The mean growth ratio was also closer to the mean growth ratio of 1.3 determined respectively for hemipterous bugs, *Oxycarenus gossypinus* Distant,[16] *Aspavia armigera* Fabricius,[8] *Cletus fuscecens* Walker,[17] and *M. jaculus* Thurnberg.[7] The significance of this is that growth progresses at a constant rate in each moult. The regular relationship of the nymphal vertex and the significant correlation coefficient ($r = 0.98$) clearly confirmed that

no stadium was overlooked during the developmental period. The frequency distribution of the head capsule could be separated into five distinct groups corresponding to five nymphal instars. Therefore, the life cycle of *S. elegans* consists of egg, five nymphal instars, and the adult.

Author Contributions

Conceived and designed the experiments: OTA and FKE. Analyzed the data: OTA and FKE. Wrote the first draft of the manuscript: OTA and FKE. Contributed to the writing of the manuscript: OTA and FKE. Agree with manuscript results and conclusions: OTA and FKE. Jointly developed the structure and arguments for the paper: OTA and FKE. Made critical revisions and approved final version: OTA and FKE. All authors reviewed and approved of the final manuscript.

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