

Studies of the Life Cycle of the Drilid Beetle, *Selasia unicolor* Gruerin (Coleoptera-Drilidae) and Development of its Larval, Predatory Activities on Nigerian Edible Land Snails.

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Abstract

The life cycle and behavior of the drilid beetle on edible land snails in Nigeria was studied to ascertain the true identity of both the predator and adult. The predator is the larval stage of the beetle, now correctly identified as *Selasia unicolor* (Gruerin). The larval development from egg to adult takes about four (4) months, having sequentially consumed six (6) snails of either *Archachatina marginata*, *Achatina fulica* or *Limicolaria sp* in the process. The larva at full maturity emerged either as winged male or wingless female. All the instar larvae were morphologically similar in appearance, but increasing in size as it grew older into full maturity, which preys on its last snail host to emerge as the adult drilid beetle, *Selasia unicolor* and not a carabid beetle as previously conjectured.

Key-words: Predator; instars; metamorphism; drilid beetle; *Selasia unicolor*

Introduction

Snails, lacking major natural defensive mechanism other than to withdraw into their shell, are often very susceptible and vulnerable to diseases, pests and parasites. Adverse environmental conditions and predators which include amongst others, birds, lizards, snakes, toads, rats, beetles, millipedes and centipedes are also known enemies of the snail. (Odaibo, 1997, Amusan and Omidiji 1998; Ayodele and Asimolowo 1999; Omole *et al.* 2007; Cobbinah, 2008; Akinnusi, 2015). One of the most common problems is the prevalence of predators which are well known enemies of edible land snails in Nigeria. These predators feed on the flesh of snails, leaving empty shells behind, in the forest and on farm lands. One of the predators is named by local people, as *Jegbinjegbin*, meaning snail eater. Hitherto, little is known about the predator

other than their destructive feeding habits on snails which if not controlled can result into major loss and failure of snail farming. As many farmers are going into commercial snail farming, it has therefore become necessary to study the nature and mode of action of these enemies so as to effect appropriate control measures that will minimize their losses. This study was initiated to establish the behavior, nature and mode of attack of the predator with the aim of truly identifying the predator, presently presumed to be the larva of an adult beetle.

Materials and Methods

The study was carried out for about three (3) years, between 2015-2017. Three (3) methods of predators mode of attack on snails were investigated. The predator was captured and incubated at the 3 stages with the live snail host.

- (i) At the stage of live host search
- (ii) At the stage of entering the live host and
- (iii) Immediately after entry into the host.

The predatory larval development from the first immature instar to the mature larva were monitored till adulthood, when the mature beetle emerged. The development of the larva took place in any of three species of snail available including *Limicolaria sp*; *Achatina fulica* and *Archachatina marginata*.

At the emergence of an instar larva from a snail after it had completely consumed the flesh, another snail was provided, and this activity was repeated many times until the larva had developed into mature full size and adult beetle emerged. There was no record of pupal emergence, as the pupation was presumed to have taken place inside the shell.

For further observation, related to the identity of the beetle, eight (8) attached snails were sent to the insect museum of the Department of Crop Protection and Environmental Biology, University of Ibadan. During the period of close monitoring and observation, one winged adult beetle emerged and this was used for the identification after comparing it with existing preserved specimens in the insect museum.

Results

First Observed Action of the Predator and Snail in the Field

The first indication of the predator's mode of attack was when it was seen pushing a snail, *Limicolaria sp* along a bushy path in the field on June, 12, 2015. Both the snail and predator were picked and put inside a

plastic container with moist soil inside. The predator soon entered into the snail and buried itself inside the soil. Seventeen (17) days thereafter a bigger predator emerged, leaving an empty shell behind. Another live snail was provided for the emerged predator and followed another cycle of the same event. This observation confirmed the snail-eating habit of the predator having consumed one, it entered into another snail until the life cycle was fully completed. It was this observation that gave clue into the nature and mode of attack of the predator on snails. It was a lesson learnt from nature that was keenly followed by experimentation to establish the truth.

General mode of attack of predator on different snail species

In either field or under laboratory rearing condition, the predator survived only by feeding on the flesh of any of three (3) species of snails used in this study, namely: *Limicolaria sp*, *Achatina fulica* and *Archachatina marginata*. The abundance of *Limicolaria* at this period makes it more vulnerable to attack of the predator.

When the predator locates a snail, it first ensure that it is alive and of suitable size that could be easily manipulated (Plate A1). It uses its strong anal-suckers to attach itself firmly on the shell, pushing it to a safe and secure place. On securing a safe position, the predator enters the shell, first with the head inside. On safely entering, it pushes out any other internal substances except the flesh, possibly to create a more comfortable internal environment. Sometimes its activity could be restricted if it becomes entangled with the slimy substance of the snail, and not until it was separated from it, that it could continue with further action. When eggs were inside the snail, they were

pushed outside. When it has finally settled inside, the process of gradually feeding on the flesh commences and might last for at least two (2) weeks, when a bigger larval predator emerges to look for another snail to occupy. When the predator had successfully entered, no other one could enter into the snail again.

Immature Larval Predatory stages on different snail species.

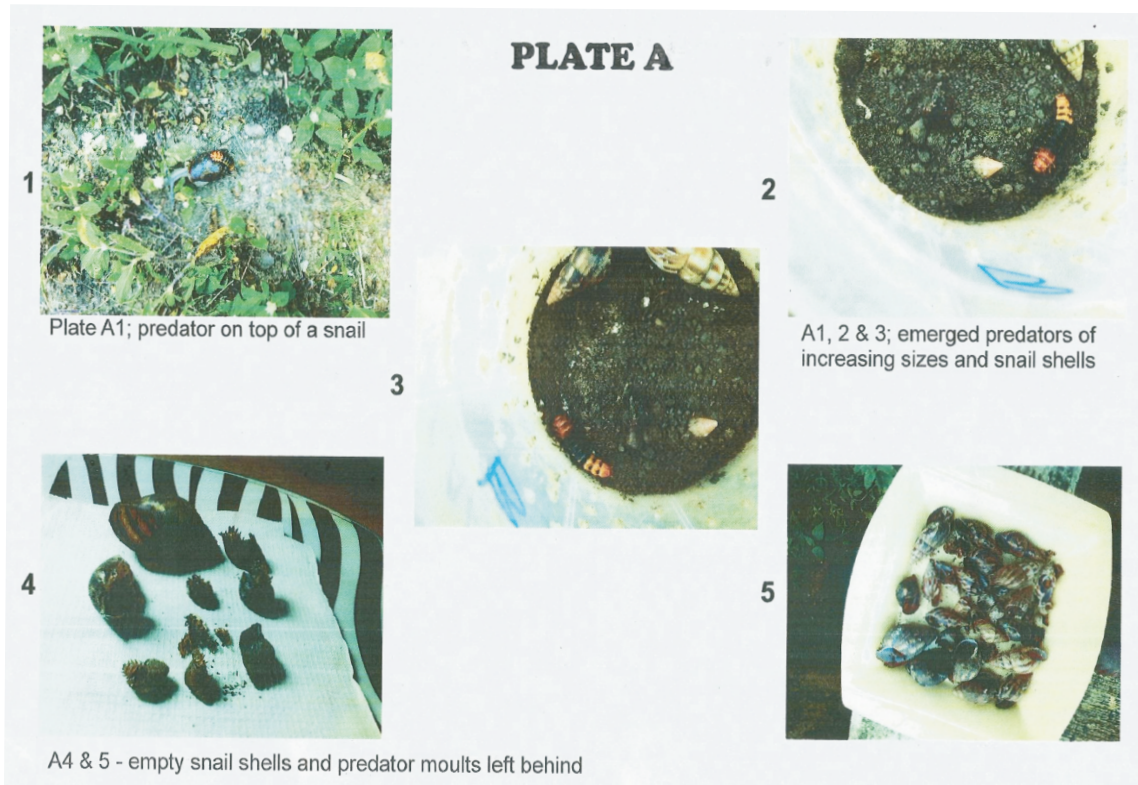
The results of the immature predatory larval development on three (3) species of snail are presented in Table 1. Between June 2015 to September 2017, twenty-two (22) immature larval development stages had occurred in the three species of snail, namely *Limicolaria sp.*, *A. fulica* and *Archachatina marginata*. The period of larval development inside the snail before

the emergence of another instar larva varied from 14 to 36 days with an average period of about 23 days. This was the period taken by the predator to completely consume the flesh before another instar larva emerged.

The emerged larva was morphologically similar to the one that entered, but distinctly bigger in size (Plate A1, 2 & 3). When the emerged larva was given another live snail, it went inside, to continue the development for yet another instar to emerge. This cycle of development was repeated several times until the larva attained full maturity. The larva survived only on the consumption of the flesh of the snail, leaving no remnant inside except the moults of the larvae which remained visible, inside or pushed outside (Plate A4 & 5).

Table 1: Immature Larval Predatory Activities on three Species of Snail; showing dates of entry and emergence.

S/N	Dates of Entry	Dates of Emergence	Days of Occupation	Species of Snail
1	12/6/15	29/6/15	17	<i>Limicolaria sp</i>
2	1/7/15	22/7/15	21	<i>Limicolaria sp</i>
3	22/8/15	15/9/15	24	<i>Limicolaria sp</i>
4	28/8/15	23/9/15	26	<i>Limicolaria sp</i>
5	3/9/15	26/9/15	23	<i>Limicolaria sp</i>
6	16/9/15	30/9/15	14	<i>Achatinafulica</i>
7	18/9/15	13/10/15	25	<i>Achatinafulica</i>
8	20/4/16	4/5/16	14	<i>Limicolaria sp</i>
9	21/4/16	7/5/16	16	<i>Limicolaria sp</i>
10	8/5/16	29/5/16	21	<i>Limicolaria sp</i>
11	23/5/16	25/6/16	33	<i>Limicolaria sp</i>
12	9/6/16	1/7/16	22	<i>Limicolaria sp</i>
13	5/7/16	26/7/16	21	<i>Achatinafulica</i>
14	2/8/16	7/9/16	36	<i>Achatinafulica</i>
15	13/8/16	2/9/16	20	<i>Limicolaria sp</i>
16	30/8/16	23/9/16	24	<i>Limicolaria sp</i>
17	2/9/16	22/9/16	20	<i>Limicolaria sp</i>
18	5/9/16	7/10/16	32	<i>Archachatina sp</i>
19	23/9/16	24/10/16	31	<i>Achatina fulica</i>
20	13/10/16	2/11/16	20	<i>Limicolaria sp</i>
21	3/6/17	21/6/17	18	<i>Achatinafulica</i>
22	20/8/17	9/9/17	20	<i>Achatinafulica</i>



Larval Predator Leading to Emergence of Adult Beetle

Result of mature predators on different snail species reared in the laboratory that developed into adult and those collected from the wild is presented in Table 2. From nineteen (19) mature larvae that developed to adult beetle, fifteen (15) were females, while four (4) were males. Of the females, ten (10) emerged from *Limicolaria sp*, while five (5), were from *A. fulica*. From the four (4) males, three (3) came from *Limicolaria sp*, while the remaining one was from *A. fulica*. From the four (4) adults collected from the field, two (2) were females, and two (2) were males. In the seven (7) snails where the time of entry and emergence were known, the period when

the predator was inside the snail, referred to as occupation varied from 29-41 days, averaging 32.7 days, when the snail flesh had been consumed. The adult female showed no morphological resemblance to the larva, was wingless, robust and considerably bigger than the male, which also showed no resemblance to the larva, which was winged. Both the emerged females and males were unequally sized (Plate C4i,iv). There is seemingly no outward resemblance between the females and the males but each bears three (3) pairs of legs typical of insects. The male has a pair of distinctive feather-like antennae and prominent eyes. In all these studies, no pupa was seen to emerge, as this stage was presumed to have occurred inside the snail.

Egg Laying By Teneral Females

Three (3) cases of egg laying by maiden females were observed at different times (Plate B 1,2,3,4). The first was in September 2015, when a cluster of small roundish, yellowish eggs were found around the female. The second was in December 2015 when another maiden female was dissected and found to be loaded with eggs (Plate B3). The third was by another female which laid about four hundred eggs. These eggs coming from unmated females, were infertile and never hatched out, it soon became gradually inactive and died thereafter (Plate B1).

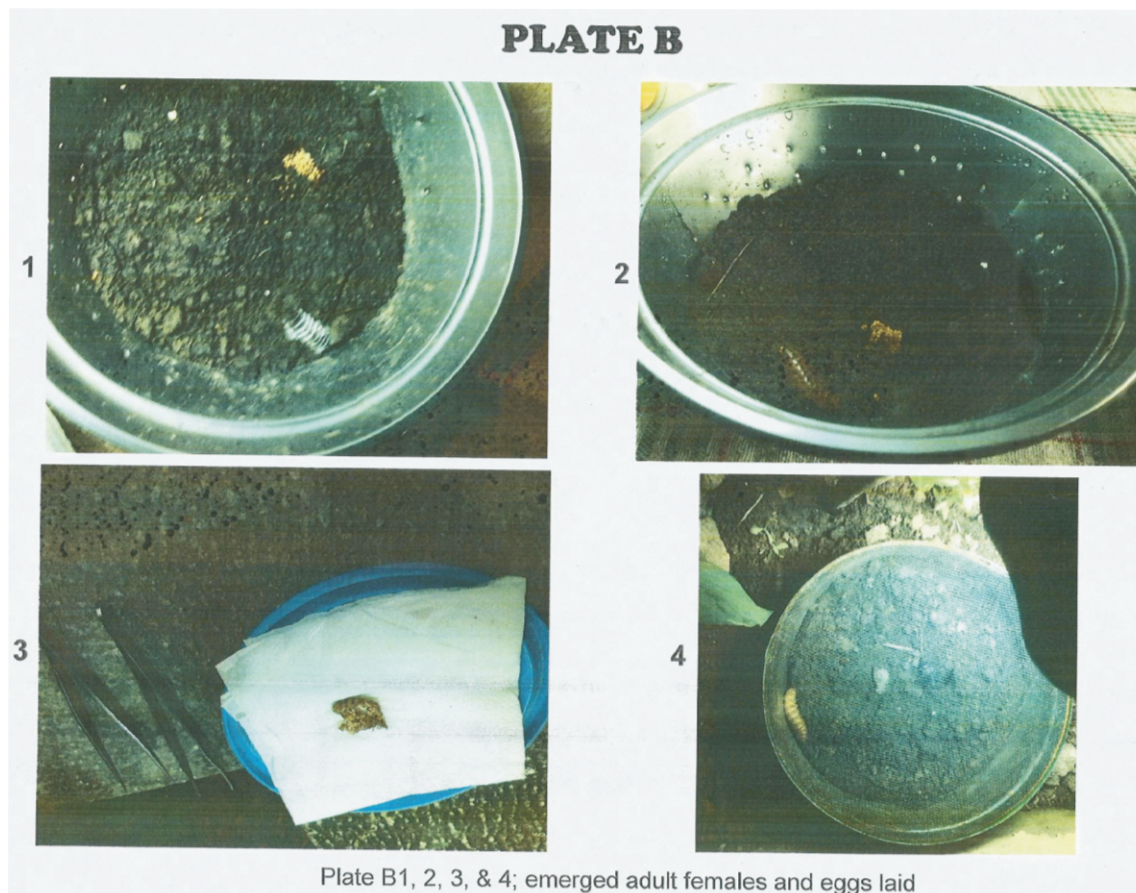
Mating, Egg Laying and Hatchability of First Instar Larvae

When the emerged female and male beetles were brought together under a netted enclosure, mating took place. The male started a courtship relationship by mounting on the back of the female and touching all parts of the female body with its feather-like antennae (Plate C3a). Thereafter it moved towards the posterior end to reposition itself for copulation with a cooperating female that remained motionless (Plate C3b). On separating, the male moved away, while the female remained motionless for sometime and later buried itself in the soil where fertilized eggs

Table 2: Mature Larval Predatory Activities Leading to Adulthood On three Snail species

S/N	Date of Entry	Date of Emergence	Days of Occupation	Emergence of Adult Beetle (Male/Female)	Species of Snail
1	_____	28/9/15	_____	Female	<i>Limicolariasp</i>
2	_____	2/12/15	_____	Female	<i>Limicolariasp</i>
3	_____	17/6/16	_____	Male	<i>Limicolariasp.</i>
4	_____	22/6/16	_____	Female	<i>Limicolariasp</i>
5	_____	28/6/16	_____	Male	<i>A. fulica</i>
6	_____	5/7/16	_____	Female	<i>A.fulica</i>
7	_____	20/7/16	_____	Male	*
8	4/8/16	3/9/16	30	Male	<i>Limicolariasp</i>
9	_____	4/9/16	_____	Female	<i>A.fulica</i>
10	_____	9/9/16	_____	Female	<i>Limicolariasp</i>
11.	7/9/16	8/10/16	31	Female	<i>Limicolariasp</i>
12	15/9/16	22/10/16	37	Female	<i>Limicolariasp.</i>
13	23/9/16	24/10/16	31	Female	<i>A.fulica</i>
14	_____	15/10/16	_____	Female	*
15	_____	16/10/16	_____	Male	<i>Limicolariasp</i>
16	_____	22/10/16	_____	Female	<i>Limicolariasp</i>
17	_____	29/10/16	_____	Male	*
18	_____	1/11/16	_____	Female	<i>A.fulica</i>
19	_____	3/11/16	_____	Female	*
20	_____	26/11/16	_____	Female	<i>Limicolariasp</i>
21	21/6/17	20/7/17	29	Female	<i>A. fulica</i>
22	30/8/17	10/10/17	41	Female	<i>Limicolariasp</i>
23	9/9/17	9/10/17	30	Female	<i>Limicolariasp</i>

- Collected from the wild



were laid and covered up for incubation.

All the instar larvae that emerged during the developmental phase were immature and of varying sizes (Plate C4ii). Any of the three (3) snail species was used as prey for the larva. Thus, *Limicolaria sp* which are of smaller sizes and being abundantly available was most vulnerable, while the juveniles of the others, namely *A. fulica* and *Archachatina marginata* when available, were equally acceptable to the predator.

In the first case study, by about thirty-five (35) days under incubation, several tiny, fast moving little immature predator referred to as the 1st instar larvae were seen moving in various directions underneath

the net (Plate C4 iii), but only a few ones are shown. They were very many, but only about fifty (50) were captured and preserved, while five (5) others were saved and provided with equally smallish *Limicolaria* snails. To minimize the load of the work, only one preyed snail was successfully reared to maturity (Table 3)

Another case study, was when male and female adults were seen together in October 22, 2016, and by November 29, 2016, about 38 days thereafter, tiny immature larvae had started to emerge, the number counted daily over a period of (Five) days was 500, while a few of them escaped.

Rearing From First Instar Larvae to Adult Beetle

The result of rearing from first instar larvae on two species of snail, namely *Limicolaria sp* and *A. fulica* is presented in Table 3. It covered a period of 124 days, from July 26, 2016 to November 27, 2016. The period when an instar larval predator remained in the snail, varied from 14-25 days, averaging 20 days. The shortest period in this study was from the first to second instar development which was for 14 days and thereafter, the time became longer as the larva grew older. During this period of development, six snails were consumed, including both *Limicolaria sp* and *Achatina fulica*. The emerged adult was female (Plate C5).

Identification of the Emerged Adult Beetle

From eight (8) snails already preyed, delivered to the University of Ibadan, one adult beetle emerged. This adult beetle was used for the identification. When it was matched and compared with all the preserved beetles in the insect museum, all its distinctive features and morphological characteristics, fitted only one of them, the drilid beetle which had already been identified and taxonomically classified as follows:-

Order – Coleoptera
 Family – Drilidae
 Genus – *Selasia*
 Species – *unicolor*
 Author-Gruerin – Meneville

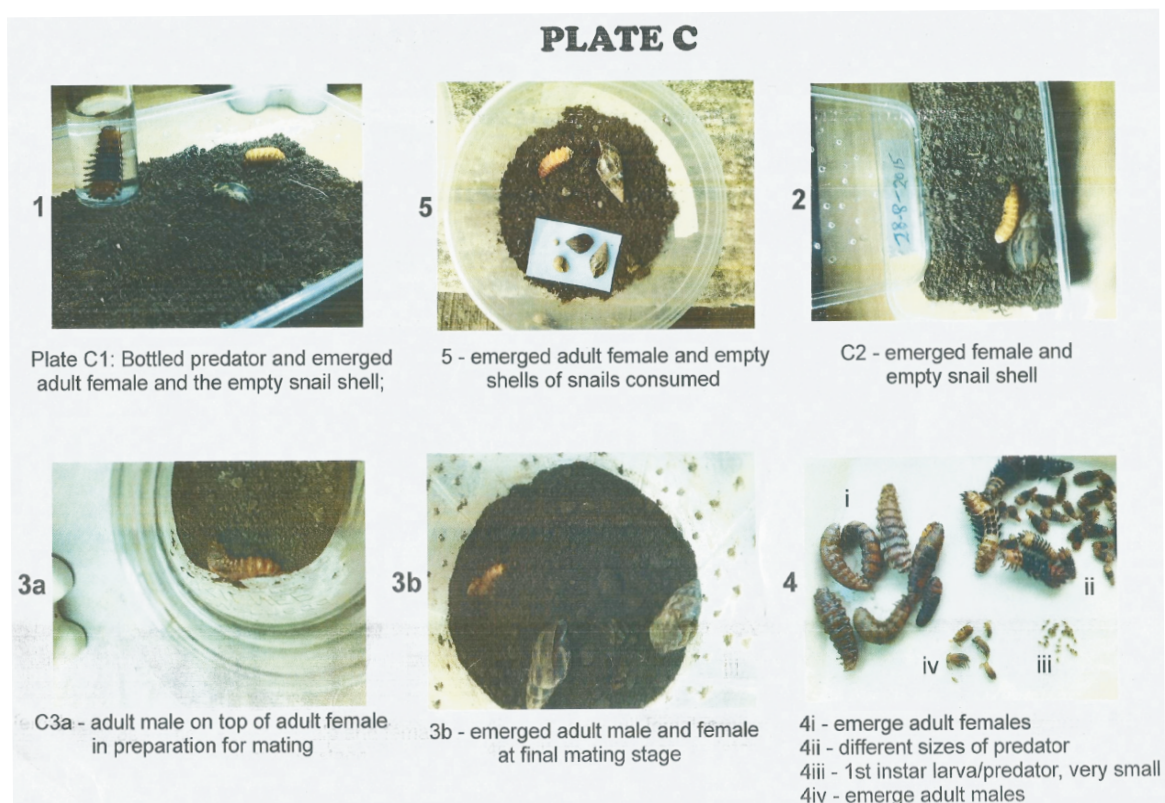
Furthermore, when the beetle used for the identification was again compared with those that emerged from this study, they were both of similar features and characteristics denoting a truthful identity. From this study, the well known predator of edible snails in Nigeria is a drilid beetle, and not a carabid, as previously conjectured. Its life cycle is a complete metamorphosis. It begins with the eggs that hatch into larva, which passes through other instar developmental stages into elusive pupa to emerge as adult male or female beetle (Plate C4 i, iv), which is now correctly identified as *Selasia unicolor* (Gruerin)

Discussion and Conclusion

The predator which is one of the known enemies of edible land snails in Nigeria has now been successfully established to be the larva of the Drilid beetle and not a carabid beetle as previously conjectured (Amusan and Omidiji 1998; Omole *et. al*, 2007 and Cobbinah, 2008). The development stages of the predator had been followed through

Table 3: Stages of Predatory Instar Larval Development to Adult Beetle

S/No	Dates of entry	Date Emerged	Days of occupation	Larval/Instar Status	Type of Snail
1.	26/7/16	9/8/16	14	2 nd Instar	<i>Limicolariasp</i>
2	13/8/16	2/9/16	20	3 rd Instar	<i>A. fulica</i>
3	2/9/16	22/9/16	20	4 th Instar	<i>Limicolariasp</i>
4	22/9/16	13/10/16	21	5 th Instar	<i>A. fulica</i>
5	13/10/16	2/11/16	20	6 th Instar	<i>Limicolariasp</i>
6	2/11/16	27/11/16	25	Adult-female	<i>Limicolariasp</i>



three (3) edible snails to reach adulthood, feeding entirely and surviving only on the flesh of the snails. Some earlier reports had also shown that the larvae of *Drilus* and *Selasia* were known to feed entirely on snails (Crawshay, 1903; Williams, 1951; Sarkar and Kundrata, 2015), while Barkar (1969) in his own studies had reported that the larva of the Drilid beetle, *Selasia unicolor* had developed into adult beetle when preyed on *Limicolaria* snails. In this current study, the life cycle of the beetle, from egg to adult, lasted for about four (4) months, during which period had consumed six (6) snails of either *Archachatina marginata*, *Achatina fulica* and *Limicolaria sp.* The adult male is smallish and winged, while the female is wingless, rotund and of bigger size, possibly because it has to carry

a large number of fertilized eggs, sometimes during the reproductive stage. This report has successfully opened up a new frontier of knowledge for further research. For example, there are other larvae commonly seen in the field that require further investigation to ascertain their adult identity, possibly belonging to another species of *Selasia*, where many species had been reported to exist (Sarkar and Kundrata, 2015). In the area of control, this will await further studies, but from what is now known about the behavior of the predator, picking and destroying it before locating its snail prey could be one of the ways to control the population and minimize the damaging effect on snail farming in Nigeria.

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