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A Study on the life cycle of *Aspidomorpha Sanctaecrucis* (Fabricius).

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Abstract

The present study reveals the life cycle of Cassidinae beetle, *Aspidomorpha sanctaecrucis.* The life cycle period ranges from 30-37 days. The eggs are laid inside a brown cage measuring about 0.3cm in length and generally 3-5 larvas hatched from each egg case. It undergoes five larval stages. The larva and adult feed on aquatic plant *Ipomoea spp* and the entire life cycle is completed on the food plant. Both the larval and adult stages shelter on the undersurface of the leaf.

Keywords: Cassidinae beetle, *Aspidomorpha sanctaecrucis,* Life cycle.

1. Introduction

The Chrysomelidae is one of the largest insect family of the order Coleoptera. It is divided into 19 subfamilies due to its diversity of representatives. Among these Cassidinae stands for being the second largest in the number of species with approximately 16% of the diversity. Each species possesses unique, morphological, biological and ecological characteristics.

Genus *Aspidomorpha* of Chrysomelidae family, commonly known as "Tortoise beetles" (Frogatt, 1907; Mc Keown, 1945; Britton, 1970; Richards and Davies, 1977), because they have lateral margins of the body (i.e. elytra and pronotum) greatly expanded forming a flattened shield like appearance somewhat analogous to the broad carapace of tortoises and turtles. Many species are noted for their extremely brilliant coloration, which fades, unfortunately, very quickly after death.

Muir and Sharp (1904) first recorded the remarkable nature of metamorphosis of some South African species of *Aspidomorpha, Basipta,Cassida* and *Laccoptera.* They found that certain species, the eggs are enclosed in ootheca, often of complex structure. The ootheca is of various degrees of complexity in accordance with the species that forms it. For instance Muir and Sharp (1904) found in *Aspidomorpha puncticosta* that the structures of the ootheca was much more elaborate then the comb formed by bees and wasps. However, in other species, the ootheca were found to be very small and imperfect, with a layer of excrement placed over them.

The larvas of Cassidinae are usually short and oval, somewhat flattened and spiny, assuming bizarre form (Muir and Sharp, 1904; Richards and Davies, 1977). They usually cover the apical (posterior) area of their bodies with black and brown excrement supported by a forked caudal process (Muir and Sharp, 1904). The cast skin also form part of the augmentative covering and the excrement may form solid pad, attached to the exuviae, or assume the condition of long filament.

The adult body of tortoise beetle is oval and flattened shape that gives it the appearance of a miniature turtle, close observation revealed a brightly coloured shell covering the wing and even the head is covered. This tortoise beetle can alter colour from brilliant golden to dull. The golden colour is covered by a thin layer of moisture between the cuticle and inner layer of elytra. This change can occur involuntarily when the beetle is under moisture, stress

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and when it dies. As the life of the tiny creature fades, the bright colour of the outer shell also diminishes.

Host plant: The genus *Aspidomorpha* appers to have strong preference for *Ipomoea* species (Convolvulaceae) as host plants for food and shelter. Indeed the whole sub family Cassidinae appers to be strongly (but not exclusively) associated with members of Convolvulaceae, and *Ipomoea* in particular (Balsbauge and Riley, 1988). Carroll (1978) noted that Cassidinae beetles are not limited in their feeding on Convolvulaceae .Studies revealed that *Aspidomorpha sanctaecrucis* is a polyphagous beetle but it is mostly found in *Ipomoea carnea* and *Ipomoea aquatica*. Both the species of convolvulaceae is shrub like growing as weed. Its stem is robust enough to stand erect but when its height exceeds, the stem tends to fall down by its weight. The plants grow rapidly by asexual reproduction (Nakamura and Abbas, 1987b). Fig. 1: shows the host plant *Ipomoea aquatica*.

Fig. 1: The host plant *Ipomoea aquatica* on which the life cycle was conducted

Habit and Habitat : *Aspidomorpha sanctaecrucis* are generally found along with the population of *Aspidomorpha miliaris* and *Cassida circumdata*. They are generally found on the undersurface of the leaf. The tortoise beetles are herbivores, feeding and spending their entire life on plants like sweet potato, *Ipomoea aquatica*, *Ipomoea carnea* and bindweed. The larva and adult feed on peripheral margins from the lower surface of the leaf. The feeding pattern is highly irregular forming holes of variable size. The larvae are gregarious and feed in clusters whereas adult make big holes in the leaf blade. (Fig. 2 : shows the feeding pattern by adult).

Fig. 2: Feeding pattern along with the adult in the host plant

2. Materials and methods

The life cycle of *Aspidomorpha sanctaecrucis was* studied in natural condition in garden area of Zoology Department of Cotton College during summer months from June to August in the year 2011 and 2012. The *Ipomoea aquatica* plant are grown in garden and 10-15 *Aspidomorpha sanctaecrucis* are released and monitored for their daily activities.The species undertake frequent feeding at regular intervals. The entire set up was netted with clothes from all sides so that the species cannot escape from the experimental site (Fig. 3). The various stages of *Aspidomorpha sanctaecrucis* were observed and data was recorded.

Fig. 3: Experimental site with nets

3. Results

Life cycle of *Aspidomorpha sanctaecrucis*

The life cycle of *Aspidomorpha sanctaecrucis* revealed five larval stages, pupa and adult stages. Eggs

are usually laid on the underside of leaves of *Ipomoea aquatica* or other Convolvulaceae in batches cemented to the leaves. The eggs are concealed in papery oothecum. Ootheca are usually placed on the undersurface of mature, healthy leaves of the food plants. The larva when first hatched, feed together near the discarded ootheca and begin to radiate outwards after 1-2 days, feeding on the epidermal and mesophyll tissue. As they grow older, larvae either disperse or feed on different leaves. Feeding results in small holes being formed between the major veins. Despite such destructive feeding, no leaves were totally destroyed by the larvae.

3.1 Larval Faecal shield

The larva of various members of sub-family Cassidinae (Chrysomelidae), have long been known to naturalist for their odd habit of carrying their feces in various ways by the use of a forked caudal process (Muir and Sharp, 1904; Eisner, Tassell and Carrel, 1967). The function of the faecal shield has been a matter of dispute (Eisner, Tassell and Carrel, 1967). It has been suggested that the shield serves for camouflage, for protection against desiccation or rain and for defence (Weise, 1893). *Aspidomorpha sanctaecrucis* carry the faeces over the forked caudal process which is almost blackish in colour. In the present study it was observed that the faecel shield of these cassidine species is highly manoeuverable device which is capable of being orientated by the larva in virtually any direction through flexion and rotation of the abdomen (Fig. 4: shows the Faecal shield carried by the larva).

Fig. 4: Faecal shield carried by the larva

3.2 Egg

The eggs of *Aspidomorpha sanctaecrucis* are housed in a papery golden brown ootheca of layered membrane filled with eggs. The female after mating (Fig. 5) lays the eggs on the undersurface of the leaves glued near the midrib of the leaves (Fig. 6). The size of the ootheca ranges from 3-5mm (1.41±1) in length (Fig. 7). The eggs are flat with round apices and parallel sides. The incubation period of egg varied from 7 to 12 days (Mean=9.5±2.5).

Fig. 5: Mating of adult beetles

Fig. 6: Eggs attached to the midrib (arrow indicates egg case)

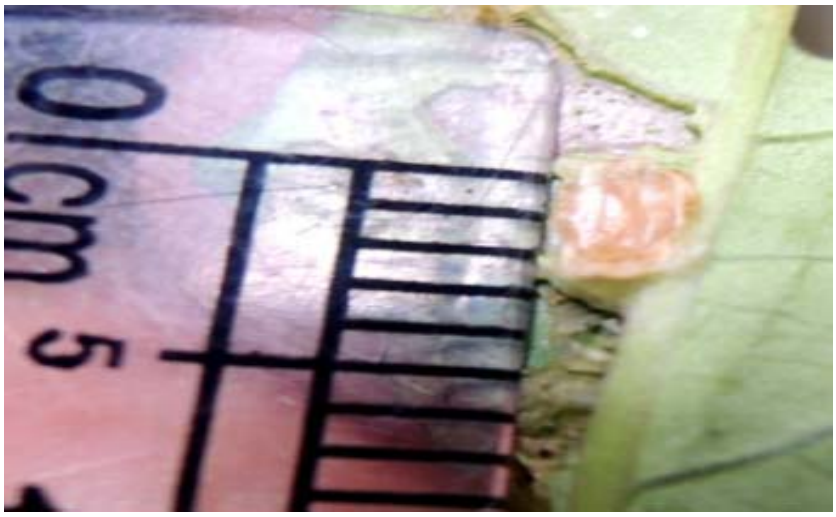

Fig. 7: Egg case (measuring about 3-5mm in length)

3.3 Larval stages

The larva of *Aspidomorpha sanctaecrucis* is found to have five larval stages. Projecting outwards from the flattened body of typical cassidinae larva, is a marginal fringe of branched spines (Muir and Sharp, 1904; Eisner, Tassell and Carrel, 1967) or lateral processes. These spinose processes apper to be particularly sensitive to contact stimulation and are evidently well adapted to alert the larva to the initial probings of an insect predator e.g. ants (Eisner, Tassell and Carrel, 1967). Stimulation of a single spine and sometimes a mere prodding of one of its branches was sufficient to elicit an immediate defensive positioning of the faecal shield. Even during the conduction of experiment to measure the various larval stages turned to be very difficult because of their sensitive spinose which arise from their body. (Fig 8: shows the sensitive spines on the lateral sides of the larva).

Fig. 8: Sensitive spines of the Larva

3.3.1 1st Instar larva

The 1st instar larva measures about 1.2-1.6 mm (1.4±0.2) in length. The body is elongated, depressed and narrowly oval in shape, broader in thoracic region. All segments of the larva bear long spiny, lateral processes and feces are borne on the terminal part of the larva like tail (Fig. 9). Body sparsely covered with very short, white glistening hairs. Eyes black. Body usually entirely yellow (or brownish yellow with yellow lateral margins). Two long caudal processes arise from the last segment upon which the exuviae of previous instar and feces are borne in a mass.

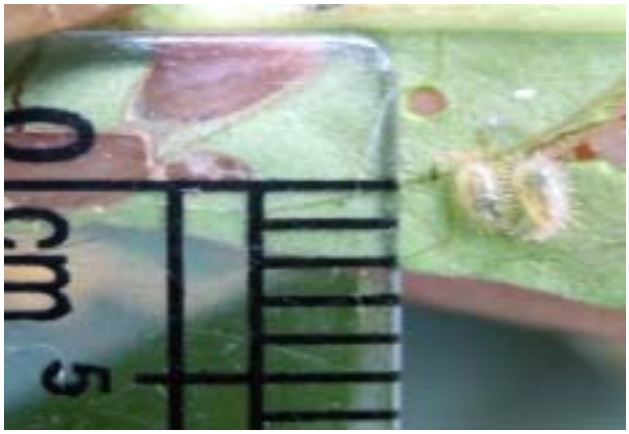

Fig. 9: 1ST Instar larva measuring about 1.2-1.6mm in length

3.3.2 2nd Instar Larva

The 2nd Instar larva are similar in morphology to the previous instar which measures about 3.3-

3.5mm(3.4±0.1) in length, before undergoing next ecdysis. When observed longitudinally, and due to its transparent type of cuticle, the development of feces in the alimentary canal becomes quite visible in the middle part of the body. The caudal process becomes elongated and feces are borne at its tip in mass at the end. (Fig. 10).

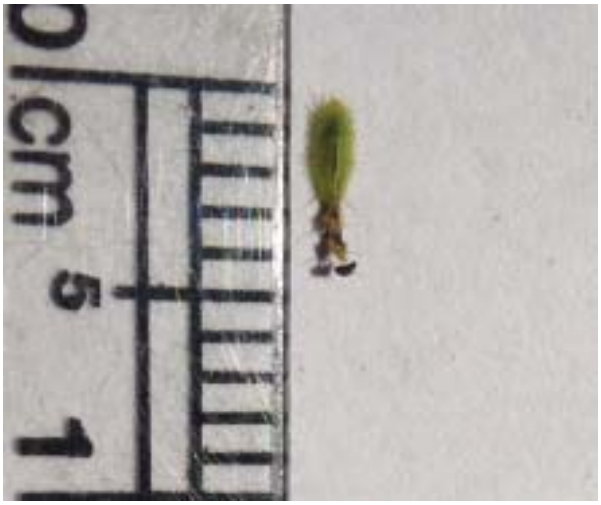

Fig. 10: 2nd Instar larva

3.3.3 3rd Instar larva

It is also similar in morphology to the previous instar which attains a size of 3.6-4.2mm long (3.9±0.3) before undergoing ecdysis. Lateral processes are more extensive than in previous instars. (Fig. 11).

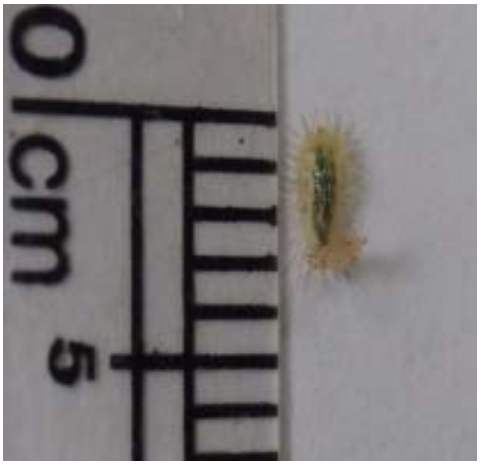

Fig. 11: 3rd instar larva

3.3.4 4th Instar Larva

It is similar in colour and morphology to the 3rd instar and attains a size of 6.5-8.5mm long (7.5±1) before undergoing ecdysis. The larva grows rapidly due to its vigorous feeding. A middle portion of the larval body when observed longitudinally attains a much greyish colour due to accumulation of feces .Lateral process becomes more extensive. (Fig. 12).

Fig. 12: 4th Instar larva

3.3.5 5th Instar Larva

The 5th instar larva resemble the forth instar larva but its colour changes to greenish yellow in the last larval instar. The body becomes almost dorsiventrally flattened and increases in size and attains a size of 7.2-8.5mm long (7.85±0.65). As the 5th instar larva reaches its full maturity it stops feeding and rest the faecel shield over its body and becomes immovable. It totally fixes itself to the leaf and starts pupating. If the larva is removed from the leaf at these stages the larva

Fig. 13: 5th Instar larva

will die. (Fig. 13, 14).

Fig. 14: 5th Instar larva with its Faecel shield

Table 1: Showing the measurement of all the Egg case, larval stages and the pupal stage

Stages of life cycle	Body length	Mean±SD
Eggs case	3-5 mm	1.41±1
1ST Instar Larva	1.2-1.6mm	1.4±0.2
2nd Instar Larva	3.3-3.5 mm	3.4±0.1
3rd Instar Larva	3.6-4.2mm	3.9±4.2
4th Instar Larva	6.5-8.5mm	7.5±1
5th Instar Larva	7.2-8.5mm	7.85±0.65
Pupal Stage	6.2-7.5mm	685±0.65
Adult Stage	7.2-8.2mm	7.7±0.5

3.3.6 Pupal stage

When the 5th instar larva reaches maturity, they stops feeding and becomes somewhat smaller in size as they prepare to pupate and rest the long filament above its body. It doesn't moves throughout the whole pupal stage. At this stage the color of the pupa chances to light green and the color of the filament above the body is light brown in colour. The length of the pupa ranges from 6.2-7.5mm (6.85±0.65). After 1or 2 days of pupation the formation of mouth parts with the broad carapace takes place and frequently the light green colour of the larva fades and changes to brown colour. By the end of the 4-5 day total development of the head, mouth and thorax region takes place. The thoracic region is reddish to brown with irregular buff horizontal marks. The mouth parts are concealed inside the broad pronotum. It is dorsoventrally flattened with spines allover and by the end of the 5-7 day the pupal changes to adult which is light brown in colour (Fig. 15-19).

Fig. 15: Early Pupal stage(Wide 4-6mm)

Fig. 16: Early Pupal stage(6.5-7.5mm long)

Fig. 17: Formation of mouth parts,eys and legs in pupa

Fig. 18-19 : Pupa colour changes to dark brown after 3.5-4 days of pupation

3.3.7 Adult stage

After 5-7 days of pupal stage the adult emerges which is almost light brown in colour (Fig. 20, 21). During the first 3-4 hours of emergence the adult stays near the pupal cast. Slowly after few hours the adult starts moving in the same leaf but does not fly away and its colour changes to dark brown (Fig. 22) and changes to reddish gold after one day (Fig. 23, 24). The adult beetle measures about 7.2-8.2mm long (7.7±0.5) and 5.5-6.5mm wide (6±0.5) (Figs. 20-21). The shape of the body is convex in elevation. It is broadly oval or almost circular in plan. Head is small and buried inside the thorax. Eyes are black and it consist of a pair of segmented antenna which is 3.0-3.2mm long(3.1±0.1).Pronotum is smooth, glabrous, about twice as wide as long and its colour is yellow or orange-yellow. The elytra of the adult beetle are broad, smooth, glabrous and round at shoulder, slightly concave at middle, then rounded towards the apex. The elytra are light yellow at the edge and are metallic golden in the middle.

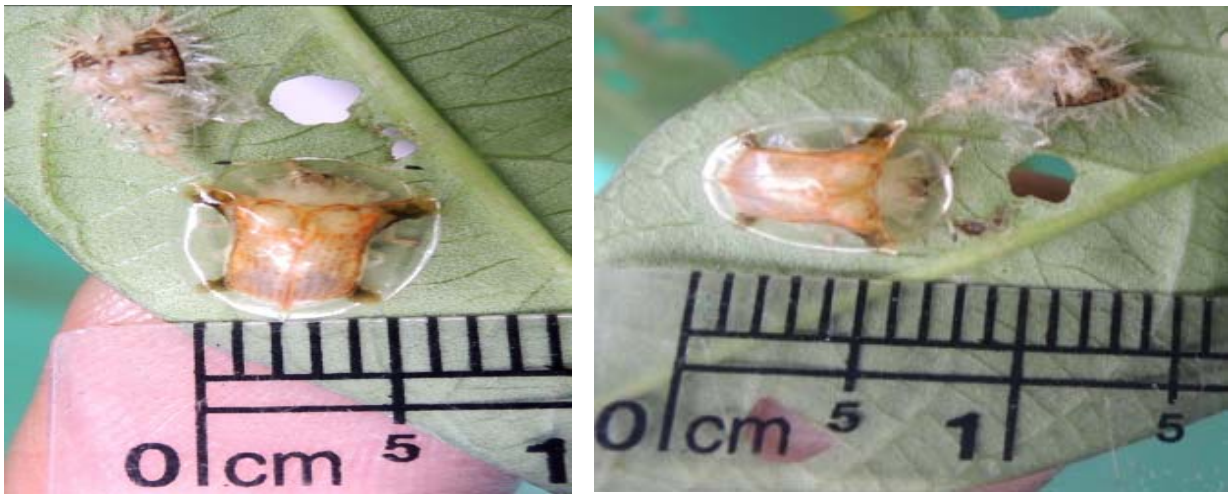

Fig. 20-21: Emergence of Adult beetle near the pupal cast(During 1st hour of emergence)

Fig. 22: Adult after 3-4 hours(Dark brown)

Fig. 23: Adult after 1 day(Reddish Gold)

Fig. 24: Adult after 2-3 days of emergence

4. Discussion

This paper describes the life cycle of beetle *Aspidomorpha sanctaecrucis* and the dependence of the species on various ecological factors for breeding and propagation. The beetle breed during summer month since they require humid habitat and simultaneously rainy season because during rainy season the host plant *Ipomoea* species grow profusely necessary for egg laying, feeding and completion of larval instar stages and transformation to adults. Gomes *et al.*, in 2012 noticed that generally most insects and beetles prefer rainy season for their growth and development because during this season the host plants grow abundantly due to availability of rain.

In the present study it was found that the cassidinae beetle *Aspidomorpha sanctaecrucis* closely associated with *Ipomoea* species and complete their entire life cycle on host plant. Muir and sharp (1904) described that Genus *Aspidomorpha* have strong preference for *Ipomoea* species (Convolvulaceae) and strongly emphasized that the whole sub-family Cassidinae appers to be strongly associated with members of Convolvulaceae, and in particular *Ipomoea.* Palii (1959) also agreed to the above fact and added that Cassidinae beetles are highly specialized in their feeding habits and many species attack a limited group of plants and even a single host plant. The present study recorded that a large number of unwanted herbaceous plants grow along the *Ipomoea* species but the beetles often preferred their host plants (Convolulaceae) for feeding, egg laying and completion of the life cycle. Since the adult beetle can fly around within a limited area so they were found associated with other herbaceous plant also. The eggs of *Aspidomorpha sanctaecrucis* were laid inside a brown colour ootheca on the underside of the leaf.

The present study showed that the adult beetles were found on the underside of the leaf so as to avoid predators and extreme climate. The mating of the beetles, *Aspidomorpha sanctaecrucis* also occured on the underside of the *Ipomoea aquatica* plant (Fig. 5). The female beetle after mating laid their eggs enclosed in ootheca near the midrib of the host plant (Fig. 6). The eggs along with the ootheca were glued near the midrib of leaf so they don't fall off. The size of the ootheca range from 3-5mm (1.14±1) in length (Fig. 10). Gomes. *et al.*, in 2012 noticed similar type of egg laying habit in *Omaspides pallidipennis,* which is also a cassidinae beetle deposits their egg on the abaxial surface of *I. alba.* Hawkeswood (1982) also described that *Aspidomorpha maculatissima* also laid their eggs in ootheca in two or three distinct rows, each row is separated by one or two thin oothecal membrane. Laying the eggs on the underside of the leaf protects the eggs from various ecological factors like rain, extreme sunlight and various types of predators. Hence, Silva. *et al.,* (2011) added that while ovipositing the female beetle considered an appropriate place for the development of juveniles, thus maximizing their adaptive value. So, most of the cassidinae beetles were mostly found laying their egg on the underside of the leaf so as to avoid various unfavorable conditions, leading to the successful hatching of the larva and completion of the life cycle. Craig. *et al*., (2000) reported that most insects generally considered predation risk, host plant quality & quantity, larval mobility, intra and interspecific competition before laying of eggs. The ootheca provided protection to the egg from various ecological factors.

Present study revealed that the larva after hatching feed near the discarded ootheca and moved around near the discarded ootheca. *Aspidomorpha sanctaecrucis* consist of five larval stages. Other cassidinae beetle, *Botanochara impressa* also found to have five larval stages as reported by Habib and Neto. The larva of *Aspidomorpha sanctaecrucis* were short and oval, flattened and possess spines on their lateral sides. Muir and Sharp (1904) and Richard and Davies (1978) described that the cassidinae larva were usually short and oval, flattened and spiny often assuming bizarre form. The larva of *Aspidomorpha sanctaecrucis* possesses a forked caudal process covered with black excrement which they exhibited when some danger or some disturbances occured. Muir and Sharp (1904) also noticed similar type of behavior in other cassidinae beetle where the apical area of the body were covered by black or brown excrement supported by a forked caudal process. Eisner, Tassell and Carrel (1967) further noted that the fecal shield possessed by *Cassida rubiginosa* was used mainly for their defence by manoeuvering in virtually any direction through flexion and rotation of the abdomen.

Study recorded that the larva of *Aspidomorpha sanctaecrucis* often feed in clusters and gregarious feeders. The larva on emergence from the oothecal membrane started feeding on the same leaf near the egg case. Due to their continuous feeding habitat the larva increased in size and began to radiate after 1-2 days. As they grow older, larva either dispersed or feed on different leaves. Feeding resulted in the

formation of small holes between the major veins but despite such destructive feeding, no leaves were totally destroyed by the larva. Due to continuous feeding the size of the larva increased in size and they started molting from one larval stage to another by increasing in the segments of caudal fork from one segment to another. The morphology of all larval stages was similar only their size increased at each molting (Table-1). The first, second and third larval stages were generally green in colour. Their body elongated, depressed and narrowly oval in shape. All the segments of the larva possessed long spiny lateral processes with feces on the terminal part of the larva like tail. But in the fourth instar larva, the middle portion of the body attained a grayish colour due to accumulation of feces (Fig. 12). When the fourth instar larva undergoes its next molting the colour of the larva changed to greenish yellow (Fig. 13). It appeared dorsoventrally flattened and attained a size of 7.2-8.5mm long (7.85±0.65). The fifth instar larva on full maturity stopped feeding and rest the fecal shield over its body and became immovable (Fig.14). It fixed itself to the leaf and started pupating gradually colour changed to light green and formation of mouth parts, head and thorax was seen by the end of 4-5days of pupating (Fig. 17). By the end of 5-7 days the pupa changed to light brown coloured adult (Fig. 20, 21). The adult on emergence stayed near the pupal cast for few hours and its colour changed to dark brown and after one day it changed to reddish golden (Fig. 23).

The paper describes the importance to understand the life cycle of *Aspidomorpha sanctaecrucis* since it is commonly found on gardens and forest in N.E. India. Cassidinae beetles provide an excellent study material because they are easily found and remain restricted to the development site during their life cycle.

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