IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

STUDY OF EMBRYONIC AND POST-EMBRYONIC DEVELOPMENT IN CARYEDON SERRATUS (OL) (COLEOPTERA: BRUCHIDAE)

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Abstract: Control of insect pests is a serious problem, as the use of different chemical pesticides is injurious to human health and the environment. Therefore, the study of all the aspects of insect pests is important but more desirable could be their development which acts as the basic tool for any effective pest management program. Experiments on embryonic and post-embryonic development on *Caryedon serratus* revealed that females prefer laying eggs in the depression on the seeds. *Tamarindus indica* supported the normal development of insects, four larval instars were observed, the first instar penetrates the seed at the same side where the egg is laid and, the fourth instar larva bored its way out of the seed so as to return almost at the spot where from it had bored in as a first larva. Its length increases ten folds from the first instar to the fourth instar but the increase in weight is three hundred times. This fact indicates an exponential reduction in the surface area of the body in relation to its mass, a condition best suited for its mode of life within the seed where oxygen is not available in plenty. Cocoon formation occurs only when proper substratum was available and it measured 7mm in length. The effect of temperature is clearly observed as the total developmental span was 58.34 days ± 1.226 at 25°C decreased to 39.52 days ± 4.20 at 28°C and further declined to 36.28 days ± 1.031 occurred when the temperature was 34°C. Ambient temperature of 28°C and RH 70 % yield the highest survival rate of all the stages of development. The longevity of unmated female increases, further the female lives longer than males under different temperatures.

Keywords: *Caryedon*, development, *Tamarindus*.

Introduction: Protection of stored seeds from the ravages of various pests has engaged the attention of several workers. Since several types of insects damage the stored seeds, the use of chemical pesticides was found favor in the initial stages. However, massive application of pesticides caused the serious problem of genetic resistance by insect species, pest resurgence, residual toxicity, phytotoxicity, vertebrate toxicity, and widespread environmental hazards (Zetter and Cuperus, 1990; Glenn et al. 1994; Guedes et al. 1997; Talukder and Howse, 2000). As a result, the search for various alternatives began in the right earnest, and management of the pest rather than destruction became a more acceptable approach. This awareness created a worldwide interest in the development of alternative strategies and directed the need for a thorough knowledge of insect biology. A study of all the aspects of insect pests is necessary but the most desirable could be their development which acts as a basic tool for any effective pest management program.

A number of previous workers have examined several Bruchids biologically, yet a comprehensive account of this aspect is lacking (Pajni and Mann,1979; Fox *et.al*., 1995; Ahmed *et. al*., 1999; Mulatu and Gefremedhin, 2000; Ehlag, 2000; Yasuoki - Takami, 2002; Park et al. 2003; Chawla and Thind, 2006; Sundria and Kumar, 2004; Sakhare et. al. 2018; Oaya, 2020; Anita et. al. 2021). Particularly *C. serratus* has not been undertaken so far, this warranted a fresh look, especially for the purpose of examining the possible relationship of the developmental stages with the fluctuations in the various physical and biological factors. Present paper deals with the study of embryonic and post-embryonic development stages of *C. serratus* on *T. indica.*

Materials and Methods: Initial supply of *C. serratus* was obtained from a culture maintained on *Tamarindus indica* in the laboratory. The stock culture was kept in a glass trough (25 / 13cm.) covered with muslin, in a BOD incubator at 28°C ± 2 RH-70%. Two types of cages were used for the study, glass tubes (5cm x 2.5 cm) covered with muslin which was held in position with the help of rubber band were used for oviposition, and Petri dishes (diameter 7.5 and 15 cm) covered with muslin cloth were used for observing various developmental stages. Observation on developmental stages was made on seeds of *T. indica* in three experimental batches, the first group at 25°C ± 2: RH 50% in a BOD incubator. Other groups were maintained at 28°C ± 2 RH-70% in another incubator and the third set of observations was made at room temperature (34°C ±5, RH 73 ±5%) during June – July.

The measurement of eggs was done under filar micrometer. All larval stages were weighed prior to the processing and the method of Prevett (1971) was adopted for distinguishing various larval stages, and other morphological studies. Cocoons were broken on 8-day, 12-day, and 16-day of pupal durations to collect pupa (initial), pupa (middle), and pupa (final) stages respectively. The rate of survival of egg/larvae/pupae/ adult was studied under different conditions of temperature and humidity. Eggs were observed until the first instar larvae were formed and these bored into the seeds. The percentage of eggs hatched was noticed. These populations were allowed to develop further at three temperatures (25°C ± 2; RH 50%, 28°C ± 2: RH 70%, and 34°C ± 5: RH 73 ± 5%) until adults were emerged (after 18-20 days).

Observations: The rate of development and survival of different embryonic and post-embryonic stages have been examined for the eggs laid on seeds of *T. indica* (Plate 1).

During development, there was a gradual (although marginal) increase in the weight of the egg from 0.113mg ±0.002 on 0- day to 0.129mg ±0.001 on 1-day and remained constant up to 3-day, on day 4 it further increases to 0.130mg ± 0.001. it was 0.132 mg ± 0.002 on 5-day prior to hatching.

Embryonic development lasted for about five days and after completion larva is upside down with its ventral surface uppermost. I-instar larva rights itself with the help of movements and the legs, then mandibles helped in boring through the lower chorion of the egg as well as seed coat. The larva ate its way into the seed while the eggshell remained intact, attached to the seed. An oval white speck appeared in the middle of the egg just prior to hatching. The egg also turned opaque, while non-viable eggs remained unhatched and were easily distinguishable externally as they remain white and transparent.

During postembryonic changes the larval stages lasted for a total of 23 days, as a rule, four larval stages occurred before pupation. Detailed observations of all four instars were summarized in Table –1.

I- instar larva remained superficially near the point of penetration on the surface of the seed. Larva took about a day to prepare a hole big enough for it to enter into the seed. On being disturbed, became immobile for some time.

II instar larva had small legs and showed brisk local body movements, it also moved for feeding by creeping movements. The body showed curvature with broad anterior and tapering posterior end. III instar larva remained curved and showed slow wriggling movements. The IV instar larva had a fleshy body with curvature on the ventral side. Legs were better developed and larvae at this stage were able to move on horizontal and vertical surfaces. It is interesting to note that the IV instar larva occupies a side near the place where the I instar had penetrated into the seed. Before emerging from the seed, it remained very near to the seed surface, then prepared a hole for its emergence. Most of the larvae (about 70%) emerged in the afternoon (plate 2 & 3)

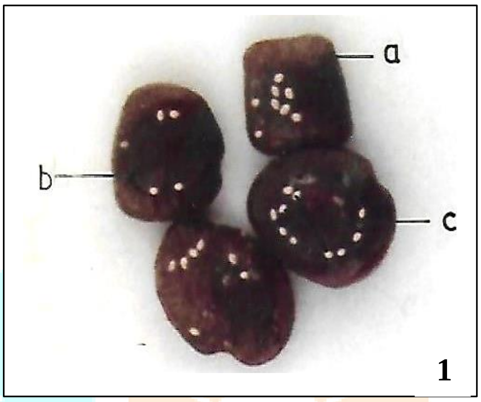
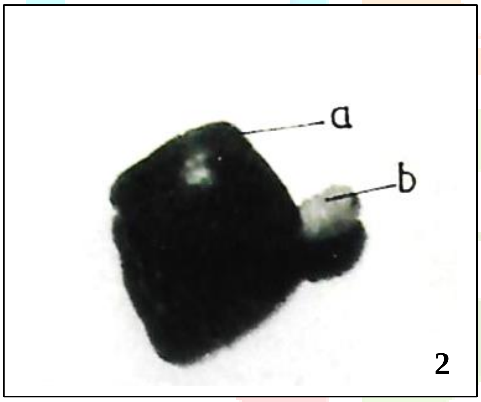


Plate- 1: Photograph showing location of eggs on the seeds of *T. indica.*



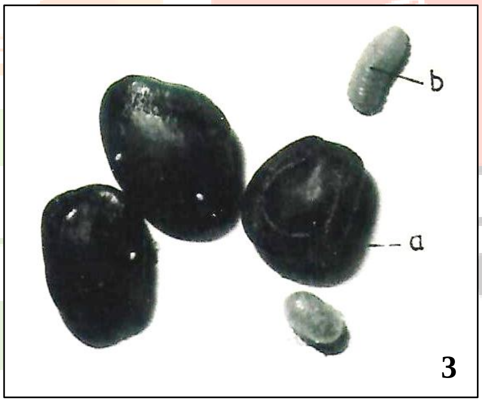


Plate-2: Photograph showing IV-instar larva (b) emerging from *T. indica* seed (a).

Plate-3: Photograph showing IV-instar larva (b) emerged from *T. indica* seed (a).

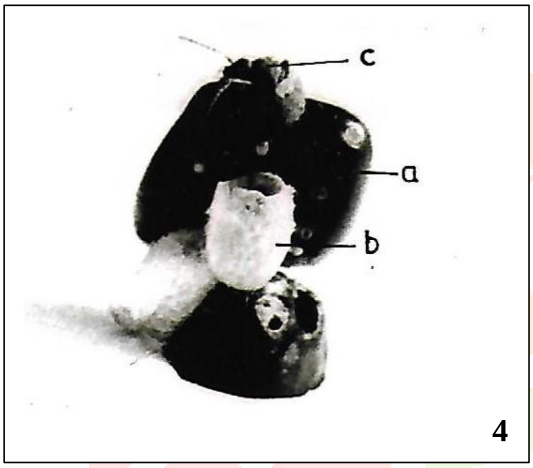
Temperature Developmental	Duration (Days+ SD)			Total
	Embryonic	**Larval**	**Pupal**	**over all span**
$\mathbf{T_1}$	7.31± 0.295	26.27±0.887	24.85 ± 0.229	58.43 ± 1.226
$\mathbf{T_2}$	5.056 ± 0.025	20.90 ± 3.736	13.55 ± 0.458	39.52 ± 4.200
$\mathbf{T_3}$	5.05 ± 0.158	17.42 ± 1.777	13.80 ± 1.368	36.28 ± 1.031

Table:1 Developmental span of *C. serratus* on *T. indica***.**

T_1 =25 ±2°C: RH-50%, T_2 =28 ±2°C : RH-70%, T_3=34±5°C : RH-73±5%

Pupal phase lasted about 18 days. The IV instar larva made a papery cocoon around itself generally within 2-3 hours of its emergence from the seeds. Due to premature emergence, on rare occasions, it waited up to 2 days before making its cocoon. In certain cases where the delay in initiating cocoon formation was extended up to 3 days or more, no cocoon was formed at all. The larva which failed to pupate survived for 13-15 days. Cocoon was usually completed in about half an hour from the time of its initiation. It was spun either external to the seed or inside the seed (plates 4 & 5). It measured 7.5x4.5x4mm and was dusty in color.

An interesting observation was made during the present study that if the IV instar larva was allowed to spin its cocoon which was damaged as soon as it had been completed, after an interval of about 45 minutes, it completed another cocoon, which was relatively thinner than the first one. This process was repeated three times and every time larva spun a new cocoon. A general slowing down in the time of cocoon formation was noted as succeeding cocoons were spun. The cocoon formation did not occur when larvae were separated from the substratum.



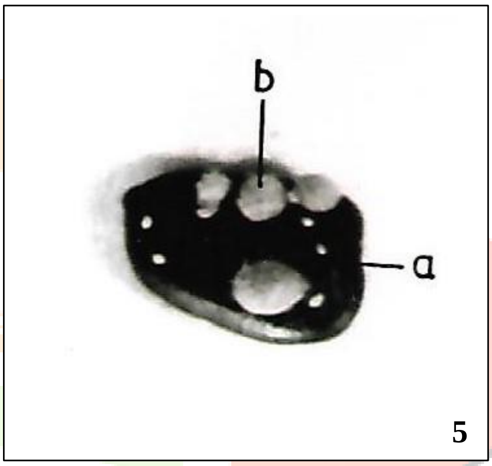


Plate-4: Photograph showing external cocoons (b) on *T. indica* seed (a) and emerging adult (c)

Plate-5: Photograph showing several internal cocoons (b) in *T. indica* seed (a)

Pre -pupal phase lasted for about 6 days (day- 28 to day -33) it resembled the IV instar larvae in body shape, being curved on the ventral surface. It lost pigmentation and its color changed from brown to cream-yellow It measured 7 mm and weighed 26.4± 0.56. Pupa initial phase lasted for 4 days (days 33-36). It had a straight body (body segmentation became distinct) creamish–white in color, 7mm in length, and weighed 24.20mg±0.825 (plate). The pupa middle phase lasted for 3 days (day 36- day 38). The color changes to slight grey, it measured 7mm and weighed 22.80mg±0.434. pupa final phase lasted for 5 days (day 38-day 42). The body was convex, dusky grey in color, measured 7 mm, and weighed 19.54mg±0.623. (Plate, 6).

Adults were greyish-black in color, brisk walking was noted in the early hours of the day (plates 7, and 8).

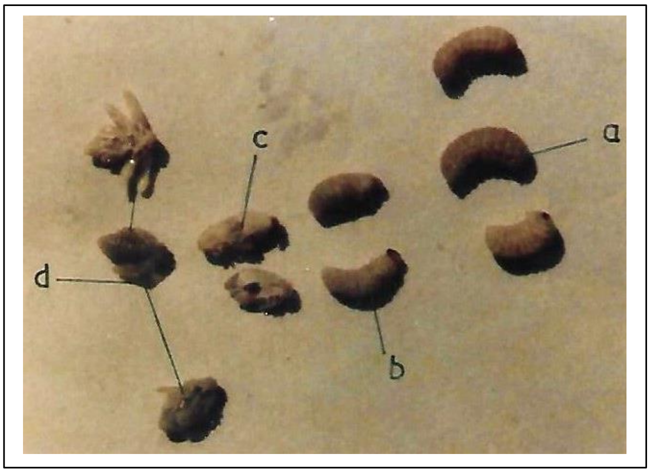


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Plate-6: Photograph showing various developmental stages of *C. serratus*.
A= pre-pupa, b=pupa (initial), c= pupa (middle), d= pupa (final)

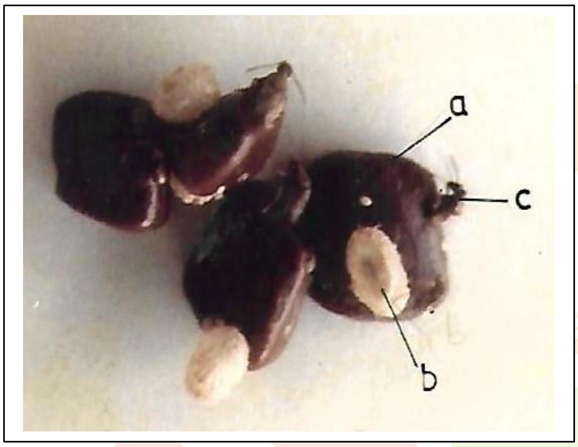

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Plate-7: Photograph showing adult (c) emerging from within the *T. indica seed* (a).
Plate-8: Photograph showing adult (c) emerging from external cocoon *T. indica seed* (b).

They remained motionless and feigned death on being disturbed. Total developmental span, embryonic, larval, and pupal durations at different ambient temperatures were shown in (Table-2) and graphically represented in (Fig.1) which revealed a decline with an increase in temperature.

Temperature	Total eggs Considered	Larvae formed	Pupae formed	Adult emerged	Overall survival
T_1	489	59.10	91.34	100	53.98
T_2	779	82.63	95.57	97.93	77.34
T_3	183	79.23	67.58	100	53.55

Table: 2 Percentage survival of eggs during different stages of development on *T. indica.*

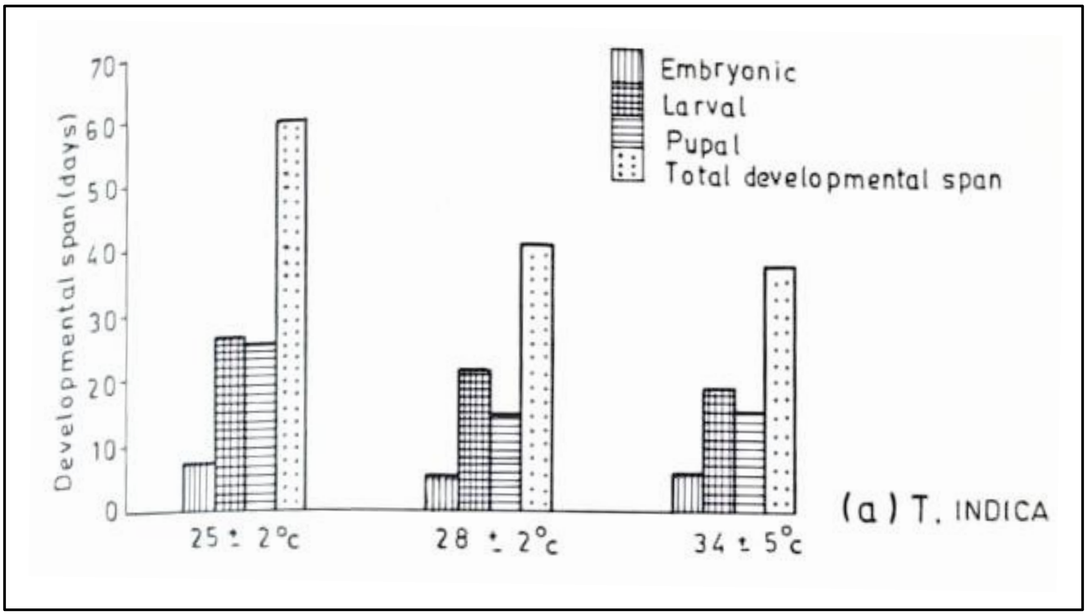

Fig:1 showing the developmental span of different stages during the development of *C. serrstus* at 25°C ±2: RH-50%; 28°C ±2: RH-70%; 34°C ±5: RH-73±5%; on *T. indica*

Trend analyses regarding the impact of temperature on the developmental span of various stages clearly show a marked decline at 25°C and 28°C. However, a similar trend was not maintained during embryonic and pupal stages, when the temperature was further increased to 34°C, Only the larval stage showed a continuous decrease under 34°C as well.

The rate of survival at different stages of development which was observed at three different temperatures (Table 2). The pattern of survival under different temperatures clearly showed a marked increase at 28°C. However, the declining trend was observed when the ambient temperature was 34°C.
It was observed that at all the temperatures the unmated individuals live longer than the mated ones. The female lived longer than males at all temperatures.

Discussion: Seeds of *T. indica* supported the normal development of *C. serratus*. the present observations on the distinctive external changes during the embryonic period have been reported for the first time. In keeping with the findings of Prevett (1967), four larval instars were observed.

The first instar larva penetrates the seed at the same site where the egg is laid. This is advantageous in that the delicate larva is not exposed to any possible risks. In the present study, it was noted that the fourth instar larva bored its way out of the seed so as to return almost to the spot where it had bored in as the first instar larva. This turnabout may be guided by the availability of oxygen through the hole drilled initially, the need for which grows with the increase in larval size.

The quantum of increase in length from the first instar to the fourth instar larva is about ten folds, but the corresponding increase in weight from the first to fourth instar is about three hundred times. This fact indicates an exponential reduction in the surface area of the body in relation to mass, a condition best suited for its mode of life within the seed, where oxygen is not available in plenty.

Cocoon formation occurred only when the proper substratum was available. The present observation that the fourth instar larvae which were deprived of the seed failed to spin a cocoon, clearly indicates the role of proper substratum for pupation.

The role of nutrition is also indicated through present experiments in which the cocoon was damaged repeatedly, with successive damage, the time span for remaking a cocoon became longer and the walls of the cocoon became increasingly thin.

Variations in time spans of total development and its three parts (embryonic, larval, and pupal) in *C. serratus* are regulated by the fluctuation in temperatures. An increase in temperatures reduces the total developmental span thus helping the completion of the life cycle with a short span. The reason for this aspect can be due to the higher metabolic rate at high temperatures thereby less time spent by the larva in the seed. From the standpoint that this phase of development is the only stage when the animal acquires nourishment, it is natural that the subsequent developmental stages get seriously jeopardized, if proper nutrition cannot be stored by the larva.

In the present observations, the temperature for quick development of *C. serratus* in the shortest span of time was generally 34°C, this is in conformity with the findings of Howe and Currie (1964) on other Bruchids. The humidity at which development is best within the shortest span is 73%. This is in agreement with the findings of Yadav and Pant (1978) on other Bruchids. The overall survival is species-specific and is influenced by both food and temperature (Cf Donaldson, 1985) at 25°C: RH 70% yields the highest overall survival rate.

The unmated individuals of both sexes lived for a longer duration than the mated ones. Gokhale and Srivastva (1975) and Chawla and Thind (2005) reported similar findings. The plausible reason for this aspect can be attributed either to low fecundity or the absence of oviposition. The mature eggs which are not laid show oosorption. The material freed during oosorption can essentially use as nutrients which act as food reserves for non-feeding adults and lead to increased longevity. It has also been noticed that longevity was greater in individuals at 25°C: RH 50%. It decreased with a rise in temperature and humidity. Apparently, a higher rate of metabolism results in cutting short the life.

Conclusion: The biology of *C. serratus* from egg to adult stage revealed that *Tamarindus indica* supported the normal development of an insect, four larval instars were observed. An exponential reduction in the surface area of the body in relation to its mass is a condition best suited for its mode of life within the seed where oxygen is not available in plenty. A proper substratum is necessary for cocoon formation. Total developmental span is affected by temperature as decreases with an increase in temperature. Ambient temperature of 28°C and RH 70 % yield the highest survival rate of all the stages of development. The longevity of unmated female increases, further the female lives longer than males under different temperatures. The larval stage of the insect survived longer than all other stages of development. It is a proven fact that the larval stage is the most destructive stage in the cycle. It is therefore suggested that control measures within the storage environment should be applied immediately after harvest to limit the activities of this destructive stage.

References:

Ahmed, K. S., Iino, T. and Ichikawa, T. 1999. Effects of plant oils on oviposition preference and larval survivorship of *Callosobruchus chinensis* (Coleoptera: Bruchidae) on azuki bean. Applied Entomology and Zoology, 34(4): 547–550.

Chawla, A. K. and Thind, A. D. K. 2006. Effect of seasonal variation on mating behaviour of *Caryedon serratus* (Coleoptera: Bruchidae). Trends in Life Sciences, 21 (2) : 73-77.

Elhag, E. A. 2000. Deterrent effects of some botanical products on oviposition of the cowpea bruchid *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae), International Journal of Pest Management, 46(2): 109–113.

Fox, C.W., Mc-Lennan, L.A. and Mousseau, T. A. 1995. Male body size affects female lifetime reproductive success in a seed beetle. Anim. Behav., 50: 281-284.

Glenn, D. C., Hoffmann, A. A., Mc Donald, G. 1994. Resistance to pyrethroids in *Helicoverpa armigera* (Lepidoptera: Noctuidae) from corn: Adult resistance, larval resistance, and fitness effects. Journal of Economic Entomology, 87 (5): 1165–1171.

Gokhale, V. G. and Srivastava, B. K. 1975. Oviposition behaviour of *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae) –I Distribution of eggs and relative oviposition preference on several leguminous seeds. Indian J. Ent., 37 (2): 122-128.

Guedes R. N. C., Kambhampati, S. and Dover, B. A. 1997. Allozyme variation among Brazilian and U.S. populations of *Rhyzopertha dominica* resistant to insecticides. Entomologia Experimentalis et Applicata, 84(1): 49–57.

Howe, R. W. and Currie, J. E. 1964. Some laboratory observations the rates of development, mortality and oviposition of several species of Bruchidae breeding in stored pulses. Bull. Ent. Res., 55: 437-477.

Mulatu, B. and Gebremedhin, T. 2000. Oviposition-deterrent and toxic effects of various botanicals on the Adzuki bean beetle, *Callosobruchus chinensis* L. Insect Science and its Application, 20(1): 33–38.

Oaya C. S. (2020) Study on the biology of groundnut bruchid, Caryedon serratus Olivier [Coleoptera: Bruchidae] on stored groundnut in Ganye area, Adamawa State, Nigeria. Agricultural science and technology, vol. 12, No 3, pp 272-276.

Pajni, H. R. and Mann, B. K. 1979. Some aspects of the biology of *C. serratus* (Ol.). Bull. Grain. Tech., (17): 43-47.

Park, C., Kim, S. I. And Ahn, Y. J. 2003. Insecticidal activity of asarones identified in *Acorus gramineus* rhizome against three coleopteran stored-product insects. Journal of Stored Products Research, 39(3): 333–342.

Prevett, P. F. 1967. The larva of *Caryedon serratus* (Ol), the groundnut beetle (Coleoptera, Bruchidae). J. Stored Prod. Res., 3: 117-123.

Prevett, P. F. 1971. The larva of some Nigerian Bruchidae (Coleoptera). Trans. R. Ent. Soc. Lond., 123(3): 247-312.

Sakhare, V. M., Mutkule D. S. and Kharade, V. G. (2018) Biology of groundnut bruchid, *Caryedon serratus* (Olivier) on different groundnut varieties. Journal of Entomology and Zoology Studies 2018; 6(4): 1577-1580.

Sharma, A., Sharma, P., Choudhary, S., and Sharma, M., Kumawat K. C. and Khinchi S. K. (2021) Studies on biology of *Caryedon serratus* (Olivier) on groundnut Arachis hypogaea (L.) The Pharma Innovation Journal 2021; 10(12): 3005-3008.

Sundria M. M., Kumar A. (2004) Biology of groundnut bruchid, *Caryedon serratus* (Ol.) on different test hosts. Annals of Plant Protection Sciences.; 12(1):9-12.

Talukder, F. A. and Howse, P. E. 2000. Isolation of secondary plant compounds from *Aphanamixis polystachya* as feeding deterrents against adults *Tribolium castaneum* (Coleoptera: Tenebrionidae). Journal of Plant Diseases and Protection, 107(5). 498–504.

Yadav, T. D. and Pant, N. C. 1978. Developmental response of *Callosobruchus maculates* (Fab.) and *C. chinensis* (Linn.) on different pulses. Indian J. Ent., 40 (1): 7-15.

Yasuoki-Takami. 2002. Mating behavior, insemination and sperm transfer in the Ground beetle *Carabus insulicola*. Zoological science, 198: 1067-1073.

Zettler, J. L. and Cuperus, G. W. 1990. Pesticide resistance in *Tribolium castaneum* (Coleoptera: Tenebrionidae) and *Rhizopertha dominica* (Coleoptera: Bostrichidae) in wheat. Journal of Economic Entomology, 83: 1677–1681.