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Studies on the biology of the water hyacinth weevil, *Neochetina eichhorniae* hustache (Coleoptera: curculionidae) at Raipur, Chhattisgarh

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Abstract
Detailed studies conducted on the biology of the water hyacinth weevil, *Neochetina eichhorniae* (Coleoptera: Curculionidae) at Raipur, Chhattisgarh during 2016-17 revealed that the life cycle consisted of egg, larva, pupa and adult. There were five larval instars followed by a pre-pupal and pupal stage. Creamish white oval eggs were laid by the female inside leaf laminar tissue or in the tissue of the petiole either singly or in small groups. Larval duration was quite long and observed to be of about 46 days. The pre-pupal and pupal period lasted for about 2 to 3 and 32 days respectively and the total life cycle took about 92 days for completion.

Keywords: Water hyacinth, water hyacinth weevil, *Neochetina eichhorniae*

Introduction
Water hyacinth (*Eichhornia crassipes* Martius) is an exotic free floating perennial aquatic herb native to South America belonging to the family Pontederiaceae, closely related to Liliaceae (lily family). Originally introduced in 1884 for its beautiful flowers, water hyacinth has invaded most of the Southern United States and many tropical and sub tropical regions around the world. The mature plant consists of long, pendant roots, rhizomes, stolons, leaves, inflorescences and fruit clusters. The plants are up to 1 metre high although 40cm is the more usual height. The inflorescence bears 6 - 10 lily-like flowers, each 4-7cm in diameter. The stems and leaves contain air-filled tissue which give the plant considerable buoyancy and reproduces both sexually and asexually, and reported an increase in surface area by six to ten percent per day. It is capable of doubling its area every 12 to 14 days during the growing season [9]. The consequences are devastating for those communities reliant on water bodies for water, food, sanitation and transport. It changes the ecological balance and habitat of an infested area, and reduces the water flow and increases the siltation. It interferes with fish life by reducing water oxygen levels and producing toxic substances such as hydrogen sulphide. Additionally, dense mats can provide ideal mosquito breeding habitats.

Water hyacinth is one of the most successful colonizers in the plant kingdom. When it made its way into the State of West Bengal, India in the early nineteenth century it was treated as an ornamental plant due to the beautiful bluish-violet flowers. But at present it is known as "Bengal terror", 'blue devil' and noxious species. Water hyacinth is challenging the ecological stability of fresh water bodies [6] and [11]. If not controlled, water hyacinth will cover lakes and ponds entirely, which will block sunlight from reaching native aquatic plants which may die. The decay processes depletes dissolved oxygen in water often killing fish or turtles [10].

Water hyacinth infestations in India affect the economic uses of surface waters, including fishing, irrigation, and navigation. Given the high cost of mechanical or chemical control measures, as well as the adverse effects of these measures on aquatic life, it has become important to focus on the biological control. In order to improve on the efficacy of the *Neochetina* weevils, the two species are often deployed together to control heavy water hyacinth infestations [4].

In Chhattisgarh also the local ponds are found to be heavily infested with water hyacinth, which makes the life of local fishing community difficult due to barriers caused in the ponds during the process of navigation using small boats.

Effectiveness of biocontrol of water hyacinth through release of beetles, of both *Neochitina bruchi* and *N. echhorniae* in the field and their increase in number was mentioned by [8]. Thus, for the eco-friendly management of water hyacinth through biocontrol agent, *Neochetina eichhorniae,* studies on its life cycle details was under taken.

Materials and methods

Stock cultures of water hyacinth (*Eichhornia crassipes* (Mart.) Solms), were obtained from the three local ponds of Raipur, Chhattisgarh namely, Mandir Hasaud, Tikrapara and Fundhar where as water hyacinth weevil, *Neochetina eichhorniae* was obtained from the Directorate of Weed Research (DWR), Jabalpur, Madhya Pradesh. Water hyacinth plants were cultured in concrete tanks 2×1×1 m. filled with water at IGKV, Raipur near DRS office. Six concrete tanks were setup in the campus and stocked with water hyacinth for the present studies. (Plate:1)

Experimental methods

The detail studies regarding life-cycle were conducted in the Biocontrol laboratory, department of Entomology, IGKV, Raipur, during 2016-17. To study the life cycle of the major bio-control agent, *Neochetina eichhorniae* a pair of adult male and female weevils of both species were released separately in petridish containing leaves and petioles of water hyacinth for feeding and oviposition. Leaves and petioles were changed every two days and looked for egg laying.

Two modes of egg laying were observed in both the species of weevils. Eggs were laid on the surface and internally in the petioles, which were seen under the microscope. The eggs were oval in shape and the length and width of the eggs were recorded under trinocular digital microscope. When the eggs were 2-3 days old, they were removed from the laminae and petioles with the help of fine brush under trinocular digital microscope. The eggs were left undisturbed by placing them in petriplate and were examined periodically for hatching. Newly hatched larvae were collected from the petridishes containing petiole and transferred to punctures made in the petioles of water hyacinth.

To study the developmental period from larva to pupa of *Neochetina eichhorniae*, separate set of petridishes with healthy water hyacinth petiole was placed in each petridish. Thereafter, four to five larvae of *N. eichhorniae* were placed on the petiole. The petridish were set in completely randomized design (CRD) with three replications. The duration from larva to pupa were recorded.

Plate 1: Concrete tanks built to maintain water hyacinth and water hyacinth weevil, *N. eichhorniae*

Plate 2: Pairing of male and female and larval study of *N. eichhorniae*

Plate 3: Glass jar for studying pupal period of *N. eichhorniae*

Results and Discussion

The details of the various stages observed during the study are as mentioned below:-

1) Eggs: Eggs of *N. eichhorniae* were whitish in colour ranging between 935.72 µm in length and 633.52 µm in width. Adult female made a hole on the surface of the lamina or petiole of leaf and eggs were laid singly or in small groups directly within the leaf tissues of water hyacinth. The eggs were oval in shape. Females laid only fewer eggs at lower temperature and at temperature beyond 30°C also fecundity was gradually reduced. *N. eichhorniae* laid a maximum of 8 eggs per female. The incubation period was about 10 to 11 days. (Table 1)

Similar, findings with the present studies were reported by [5] who mentioned that the eggs of *N. eichhorniae* are whitish in colour and size ranging between 0.5 and 1.0 mm in length. As far as the incubation period was concerned, it was also similar with the finding of John, 2005 who mentioned that eggs hatched within 6 to 15 days at 20 - 25°C. Similarly,[2] have also reported that *N. eichhorniae* laid 7.3 eggs/♀/day and the eggs hatched in 7.6 days.

2) Larval stage: Larvae were creamish white in colour with a yellowish-orange head. They were apodous (legless). The posterior end of the body was blunt with a pair of dorsally projecting spiracles that the insect is thought to insert in to the plant tissues to extract oxygen. Full grown larvae were C-shaped and five larval instars were observed. The details of the various stages are as given below:-

i) **1st instar:** The first instar larvae was very small measuring an average of 2256.98 µm in length and 464.84 µm in width under 40X magnification of Trinocular digital microscope. The first instar larvae were white or cream coloured with a yellowish-orange head. Newly hatched larvae tunneled towards the base of petiole. The head capsule measured about 237.94 µm in length and 234.93 µm in width. 1st instar period lasted for about 6 days. (Table 1)

ii) **2nd instar:** The 2nd instar larvae resembled the previous 1st instar larvae. The duration of this instar lasted for about 9 days and measured on an average of 3.1 mm in length and 0.5 mm in width. (Table 1)

iii) **3rd instar:** The 3rd instar larvae were similar as the 2nd instar larvae. This instar took about 11 days to complete with measurements of about 4.6 mm in length and 1.0 mm in width. (Table.1)

iv) **4th instar:** This instar took about 13 days to complete with a maximum body length and width of 7.3 mm and 1.5 mm respectively. (Table 1)

v) **5th instar:** The 5th instar lasted for about 7 days, and the body length and width reached up to 9.6 mm and 1.5 mm respectively with creamish white color. (Table 1)

Larval duration: The total larval period observed in the present studies was of about 46 days.

The larval period probably required 30 to 80 days but the duration of pupal period was slightly more (32 days) in the present finding as compared to the cited work who reported to be of 15-20 days.

3) Pre-pupal stage: There was a pre-pupal stage which lasted from two to three days. Before the final moult, the larvae stopped feeding and the body got shortened. The pre-pupa attached itself to the rootlets by a thread like process. It was whitish in color with black colored head. (Table 1)

4) Pupa: The fully developed larvae burrowed out of the stem and moved to the upper root zone just under the surface of the water. They cut off small lateral rootlets and form a spherical parchment-like cocoon around themselves (Plate 2) and get attached to one of the roots. Curiously, at the point of attachment, the larvae chew a notch into the root. This notch possibly functions in gas exchange between the hollow inside of the cocoon and vascular tissue of the plant. They were creamy white and enclosed within cocoon that was formed between the lateral rootlets below the water surface. Pupae with their cases had the appearance of small gall like structures about 5.00 mm in diameter typically on roots near the stem. After the cocoon is formed the larva molts and becomes a pupa. This is an inactive stage during which the transition from larvae to adult occurs. Emerging hole from the pupa was also observed. Pupal period lasted for about 32 days. (Table 1)

The present studies slightly differs with the studies of [7, 1] and [3], who reported that the duration of pupal period was of 25 ± 0.86 days in *N. eichhorniae*

5) Adult: The adult female *N. eichhorniae* measured about 5.00 mm in length and adult male measured about 4.9 mm in length with elytra darker, more or less uniformly covered with gray scales mottled with brown or dark brown scales. As the adults emerged they split the cocoon and pulled themselves out. Once they come out they climb up onto the emergent leaves of the plant to feed and mate.

Total duration of life cycle: On an average, the total duration of life cycle of *N. eichhorniae* was found to be of 92 days.

Conclusion

Thus, from the present studies on the biology of the water hyacinth weevil, *Neochitina echhorniae* Hustache at Raipur, Chhattisgarh revealed that the duration of the total life cycle was of about 92 days and consisted of four stages i.e. eggs, larva, pupa and adult. The larval stage consisted of five instars with duration of about 46 days. The pupal stage was observed in the root zone under water which was of around 32 days.

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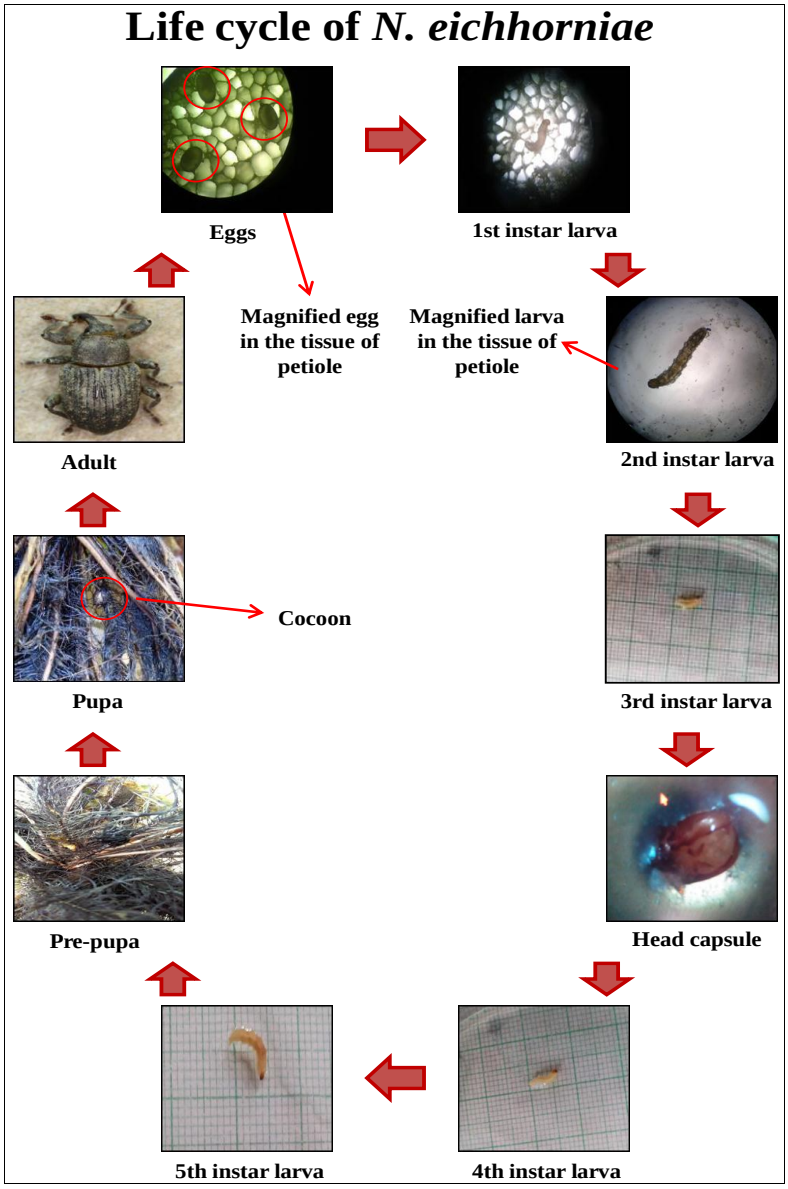

Plate 2: Showing different life stages of *N. eichhorniae*

Table 1: Duration of various stages of the water hyacinth weevil, *N. eichhorniae*

S.N.	Development stage	Average size (length×width) (mm.)	Total mean duration (days)
1.	Eggs	935.72 µm×633.52 µm	
2.	Incubation period		10-11
3.	Larval stage		
i	1st instar	2256.98 µm×464.84 µm	6
ii	2nd instar	3.1×0.5	9
iii	3rd instar	4.6×1.0	11
iv	4th instar	7.3×1.5	13
v	5th instar	9.6×1.5	7
	Larval duration		46
4.	Pre-pupal stage		2-3
5.	Pupal stage	5.00×5.00	32
6.	Adult stage		
i	Female	5.00×3.00	
ii	Male	4.9×2.50	
7.	Total life cycle		92

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