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Life Cycles of *Neochetina bruchi* Warner and *Neochetina eichhorniae* Hustache as Potential Biological Control Agents in the Semi Arid Zone of Nigeria

Hamsatu L. Hamadina, C. E. Anaso, A. Umar

Department of Biological Sciences, Faculty of Science, University of Maiduguri, Maiduguri, Nigeria

Email address:
auntyhafast.ng@gmail.com (H. L. Hamadina)

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Abstract: Biological control is the use of living organism to suppress or control another living organisms, and it is cost-effective and environment-friendly. Water hyacinth *Eichhornia crassipes* infestations in Nigeria stifles economic uses of surface waters, and arthropods have been used as biological control agents to reduce water hyacinth infestations, with smooth water hyacinth weevils *(Neochetina eichhorniae*) and *N. bruchi* being the most utilized. However, these weevils are not easily available due to lack of insectaries in most ecological zones of Nigeria, which underscores the need for this study. The first step is to understand the life cycles of the weevils under the target ecological zones, so that they can be reared when the need arises. This study was conducted, with the aim of quantifying the lifecycles of *Neochetina bruchi* and *Neochetina eichhorniae* under the semi-arid Maiduguri conditions in Nigeria. The life cycles of the *Neochetina* species reared in the semi arid conditions show peculiar characteristics. No significant difference was observed between *N. bruchi* and *N. eichhorniae* in terms of egg duration. However, the larval stage of *N. eichhorniae* lasted for about 2 months, but only one in the case of month for *N. bruchi*. This study highlights the potentials of the two weevils (*N. bruchi* and *N. eichhorniae*) as potential biological control agents in the semi arid climate of Nigeria. The lifecycle of the weevils show that both weevils can act as biological control agents, but *N. eichhorniae* has greater potentials, given its longer-lasting larval stage.

Keywords: *Neochetina* Species, Weevils, Semi Arid Zone, Life Cycle, Acclimatization

1. Introduction

Biological control is the use of living organism to reduce the vigor, reproductive capacity or effects of another living organisms, and it is known to be cost-effective and environmentally safe ([1], [2]). Biological control is not always targeted at eradicating but, rather, regulating populations to levels that will not cause economic losses [2]. This concept is the underlying principle in the biological control of weeds such as water hyacinth [2]. In fact, biological control of weeds arose from concerns about the cost-effectiveness of chemical and mechanical controls, in addition to their environmental effects [3]. A desirable quality of biological control is the self-perpetuating nature of the control agents, which makes the approach sustainable [4]. However, biological control agents can be host-specific, with insignificant impacts on non-target species, which is a major challenge in chemical or mechanical control methods [5]. Weed biological control agents should reduce and maintain the density of the target weeds to acceptable levels, in an inexpensive and self sustaining manner [6].

Biological control is particularly necessary for invasive alien weeds species that cannot otherwise be sustainably controlled [7]. This makes biological control the first choice for the control of alien invasive species such as *Eichhornea crassipes*, i.e. water hyacinth ([8],[9]). Water hyacinth infestations in Nigeria affect the economic uses of surface waters, including fishing, irrigation, and navigation [4]. 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 [10]. Arthropods have been reported to be used as biological control agents to reduce water hyacinth infestations ([11], [12]), with smooth water hyacinth weevils *(Neochetina eichhorniae* Hustache) and the related *N. bruchi* Warner being the most effective [8]. In order to improve on the efficacy of the *Neochetina* weevils, the two species are often deployed together to control heavy water hyacinth infestations ([8], [10]).

The *Neochetina* weevils have been used as biological control agents to clear waterways of massive water hyacinth infestations. However, there is a dearth of supply of these weevils in Nigeria due to non-availability of insectaries in most ecological zones of the country, which underscores the need for this study. The first step is to understand their life cycles under the target ecological zones, with the aim of rearing and releasing them when the need arises. This study, therefore, was conducted with the aim of quantifying the durations of the lifecycles of *Neochetina bruchi* and *Neochetina eichhorniae* under semi arid conditions in Nigeria. This study was limited to observing the lifecycles of *Neochetina bruchi* and *N. eichhorniae* in Maiduguri, semi-arid environment in Nigeria.

2. Materials and Methods

2.1. Culturing Eichhornia Crassipes and Neochetina

Stock cultures of water hyacinth (*Eichhornia crassipes* (Mart.) Solms), as well as eggs, larvae and adults of *Neochetina eichhorniae* and *Neochetina bruchi* were obtained from The National Institute for Freshwater Fisheries Research (NIFFR) in New Bussa, Niger State, Nigeria. The water hyacinth was cultured in concrete tanks measuring 2x2x1 m, filled to ¾ capacity and fertilized with cow dung to nourish the water hyacinth, while the turbidity of the water was routinely checked using a Secci disc. The water used was obtained from groundwater sources. The water in the area is generally soft, with near neutral to slightly alkaline pH [13]. Two concrete tanks were set up and stocked with water hyacinth, one for each species of the *Neochetina* weevils. The concrete tanks were set up under the semi-arid conditions of Maiduguri in northeast Nigeria and the weevils were raised over a period of 35 days to obtain sufficient specimens for this study.

2.2. Experimental Methods

To determine the time it took from egg to larva stage, eggs of either *Neochetina bruchi* or *N. eichhorniae* were incubated in 10-litre plastic buckets filled to ¾ capacities. The setup was replicated five times in a completely randomized design (CRD). In each container, a set of 20 eggs were laid on water hyacinth petiole discs harvested from the rearing tanks, by cutting open the petiole using a sterile blade, before inserting into the petiole and checked daily for hatching until no more hatching was observed. Data on duration (days) for larva to develop from the eggs were recorded.

To study the developmental periods from larva to pupa of *Neochetina bruchi* and *N. eichhorniae*, separate sets of 10 litre plastic basins were filled up to ¾ levels with water and then a healthy water hyacinth plant was placed in each basin. Thereafter, twenty larvae of each *Neochetina* species were laid on petiole discs before introducing them into separate basins as described above. The basins were then covered with an untreated plastic mesh and placed on a wooden bench in a completely randomized design (CRD) with 5 replications. The duration from larva to pupa was recorded.

To study the durations from pupa to adult for the two weevil species, two sets of wide plastic basins (35-liter capacity) were arranged in a CRD with 5 replications. In each container, 20 freshly formed pupae of either *N. eichhorniae* or *N. bruchi* were introduced to the roots of five water hyacinth plants. The containers were also covered with a plastic mesh and the days taken for adults to emerge from the pupa were recorded.

2.3. Statistical Analysis

Throughout the experimental period, data was collected on the number of days taken to complete each phase of the weevils' life cycle. The durations (days) from eggs to larvae; larvae to pupae and pupae to adults emergence were recorded. All data generated were subjected to analysis of variance (ANOVA) and t-test was used to test the difference between means at 5% level of significance.

3. Results

3.1. Acclimatization of Neochetina Species

The *Neochetina* weevils were observed to flourish in the pond with, no noticeable stress, over the 35 days study period, to the semi-arid conditions of Maiduguri; even though they originated from NIFFR New Bussa, which is in the Guinea Savanna zone. However, the two species were observed to differ in terms of their feeding behaviors. *Neochetina bruchi* fed by eating portions of the water the hyacinth leaf until holes were made, then the weevil moves to next convenient point to forage on the leaves again, leaving discrete circular holes on the leaves. In contrast, *N. Eichhornea* fed by scrapping the leaf surface as it traverses the water hyacinth leaves and, in the process, leaving behind trails of scars, not holes, on the leaf surface (Plate 1).

Plate 1. *Neochetina eichhornea feeding on water hyacinth leaf.*

The larvae and adults of both *Neochetina* species exclusively fed on different parts of the hyacinth plant. The adults feed on the leaves and petioles, while the 1st and 2nd instar larvae feed on the petioles, but the 3rd instar was observed to forage at the base of the crown. The damage caused by larvae of *Neochetina* weevils lets water fill the petioles, which sinks the affected water hyacinth plant [14]. The scars caused by the feeding of the adults results in smaller surface area for photosynthesis, and the leaves to lose more water from the scars [14].

3.2. Duration of Life Stages for Neochetina Species

The mean number of days taken by the *Neochetina* weevils to metamorphose from eggs to adults is shown in Table 1. There was no significant (P=0.05) difference between the number of days taken to complete egg to larval development in *N. bruchi* and *N. eichhorniae*. However, the duration from larvae to pupae was significantly (P<0.05) higher in *N. eichhorniae* than *N. bruchi*. Inversely, the developmental periods (days) from Pupae to adults emergence were significantly (P<0.05) lower in *N. eichhorniae* than *N. bruchi*.

Table 1. *Number of days for life stages of Neochetina species.*

Life stages	*N. bruchi*	*N. eichhorniae*	Significance
	Mean ± SE	Mean ± SE	(P<0.05)
Eggs to Larvae	13.80±0.21	15.00±0.28	ns
Larvae to Pupae	33.80 ±0.31	56.80 ±5.00	**
Pupae to Adults	33.80±0.28	27.00± 0.32	*

4. Discussion

The results of the present study indicate that the duration of eggs to larvae development in *N. bruchi* and ***N.*** *eichhorniae* was 13-16 days. This was higher than the value of 11 days reported by Ogwang and Molo, 1997 [15] in Uganda. The important stage in biological control of water hyacinth is the larval stage, which was 33-35 days for *N. bruchi* in this experiment, and this compares with the work of Ogwang and Molo, 1997 [15] who reported 35 days in Uganda. The pupal stage of *N. bruchi* lasted between 33 and 35 days in Maiduguri, but 33 days in Uganda [15]. The entire life cycle of *N. bruchi* under the semi arid conditions of Maiduguri lasted about 79 days.

As for *N. eichhorniae*, its entire life cycle in this study lasted more than three months, i.e. an average of 98 days. The larval stage lasted between 56 and 58 days in study, which compares equates the period this species took for the larval stages in Kenya or Uganda [15]. In contrast, De Loach and Cordo, 1976 [16] reported a longer duration of 75–90 days for the larval stage of *N. eichhorniae* in a more humid location in Argentina. The pupa stage of *N. eichhorniae* was shorter than that of *N. bruchi* and lasted for 26-28 days.

The life cycle of *Neochetina* species reared in the semi-arid conditions show peculiar characteristics. The egg duration for both species in this study lasted for a period of about 2 weeks, with no significant difference between *N. bruchi* and *N. eichhorniae*. However, this observation contrasts with reports of other studies, especially for *N. eichhorniae*: while a study showed this period to be 11 days for *N. bruchi* in Uganda [15], DeLoach and Cordo, 1976 [16] reported much longer periods for egg duration for *N. eichhorniae* in Argentina.

The most important stage of *Neochetina* weevils for biological control of water hyacinth is the larval stage, which lasted for about 2 months in the case of *N. eichhorniae*, but only one month for *N. bruchi*. This suggests that *N. eichhorniae* could be more efficacious as a biological control agent than *N. bruchi* ([12], [17],), if they were to be deployed alone. Also, the wide variations reported for the larval stages of *N. eichhorniae*, suggest it is possible to manipulate this stage of development, with the aim to maximize its efficacy as a biological control agent, if the factors influencing such durations are understood.

5. Conclusion

This paper highlights the potentials of two weevils (*N. bruchi* and *N. eichhorniae*) as biological control agents for water hyacinth in the semi arid zone of Nigeria. The lifecycle of the weevils show that both of the species can be used to control water hyacinth, but *N. eichhorniae* showed greater potentials, based on its larva duration, than *N. bruchi*.

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References

[1] Reinhardt C.F. 2000. Weed Manage Practices in Natural Ecosystem: a critical over view. Koedoe 43 (1): 67-74 Pretoria. In Catalogue of Biological Control Interventions on Invasive Alien Plants: Kruger National Park 2001. No4/01.

[2] Ghosheh H.Z. 2005. Constrains in Implementing Biological Control: A Review, Weed Biology and Management, 5: 83-92 doi: 10, 1111/j. 1445-6664.2005.001 63x.

[3] Pemberton, R.W. and Turner, C.E. 1990. Biological control of Senecio jacobaea in northern California, an enduring success. Entomophaga 35: 71-77.

[4] Adebayo R.A. and U.O. Uyi, 2010. Biological Control of Invasive Weeds Species: Nigerian experience. Int. J. Agric. Res., 5: 1100-1106.

[5] Denslow J.S. and Antonio 2005. After biocontrol: Assessing indirect effects of insect releases. Biological Control 35: 307-318.

[6] Julien M.H. and M.W. Griffiths, 1998. Biological Control of weeds: World catalogue of agents and their target weed. Fourth Edition. Wallingfort, UK: CAB International.

[7] Dubois, A. 2006. Species introductions and reintroductions, faunistic and genetic pollution: some provocative thoughts. Alytes, 24:147 – 164

[8] Harley K.L.S. 1990. The Role of Biological Control in the Management of Water Hyacinth. Biocontrol News and Information, 11, 11-22.

[9] Martin B.W. and FoxCroft L. C., 2001. Catalogue Biological Control Interventions of Invasive Alien Plants: Kruger National Park

[10] Jimenez 2003. Progress on water hyacinth (*Eichhornia crassipes*) management In R. Labrada (Ed.) Agriculture and Consumer Protection Weed management for developing countries (Addendum 1). Food and Agriculture Organisation, Rome, Italy

[11] Hill M.P., Cilliers C.J. and Neser S. 1999.Life History and Laboratory Host Range of *Eccritotarsus catarinensis* (Carvalho) (Heteroptera: Miridae), a New Natural Enemy Released on Water Hyacinth (*Eichhornia crassipes* (Mart.) Solms-Laub.) (Pontederiaceae) in South Africa. Biological Control 14: 127-133.

[12] Ciliers C.J, Hill, M.P., Ogwang, J.A. and Ajuonu, A. 2003. Aquatic weeds in Africa and their control. In: Neuenschwander, P., Borgemeister, C. and Langewald, J.,[eds.]. Biological Control in IPM systems in Africa. CAB International, Pp. 161- 178.

[13] Kolo, B., Dibal, J.M. and Ndakawa, I.I. 2009. Elemental Analysis of Tap and Borehole Waters in Maiduguri, Semi Arid Region, Nigeria. European J. Appl. Sci. 1(2): 26-29.

[14] Ogwang, J.A. and Molo, R. 1997. Biological control of water hyacinth in Uganda. 6th East African Biennial Weed Science Conference Proceedings, 247–253.

[15] Bashir M.O. El-Abjar Z.E., and Irving N.S.2004. Observations on the effect of the weevils *Neochetina eichhorniae* Warner and *Neochetina bruchi* Hustache on the growth of water hyacinth. Hydrobiol 110: 95-98.

[16] DeLoach, C. J., and H. A. Cordo. 1976. Life cycle and biology of Neochetina bruchi a weevil attacking water hyacinth in Argentina, with notes on N. eichhorniae. Ann. Entom. Soc. Am. 69(4): 643-652.

[17] DeLoach, C.J. and H.A. Cordo 1983. Control of water hyacinth by Neochetina bruchi (Coleoptera: Curculionidae: Bargoini) in Argentina. Environmental Entomology 12:19-23.