

Morphological and comparative study of Oxyinae egg pods in relationship to the soil type for farming of grasshopper

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ABSTRACT: The study on grasshoppers, *Oxya velox* (Fabricius) and *Hygracris palutris* (Uvarov) (Orthoptera, Acrididae, Catantopinae, Oxyinae), egg pod and egg morphometric, with two soil types (loamy sand and sandy loam) in Nagaland, India, revealed that egg pods of *H. palutris* showed higher values than *O. velox* in all the parameters measured except the width value. Whereas, regarding eggs of *H. palutris* showed maximum in weight as well as in morphometrics variation, when compared to *O. velox*. Both morphometric variation and weight for egg pods and eggs were observed that sandy loam is preferred over loamy sand in both selected acridid species, indicating that soil types have a crucial impact on it. Though the morphometric variations are recorded, *O. velox* recorded higher biomass. © 2026 Association for Advancement of Entomology

KEY WORD: Ovipositional behavior, soil types, pod length, weight, width, entomophagy

INTRODUCTION

The substrate played an important role for oviposition. Complete behavioral involvement of insects during oviposition is pre-planned site selection by female adults (Cury *et al.*, 2019). The egg pods studies determine the favorable abundance depending on different morphological and bio-ecology factors which varies from species to species (Katiyar, 1957; Shaikh and Sultana, 2018). The loose sandy soil types played a favorable role for oviposition site selection in different grasshopper such as *Atractomorpha crenulata* (F.) (Srivastava, 1957), *Phlaeoba infumata* (Brunner von Wattenwyl) and *Acrida exaltata* (Walker) (Priyadarshini and Singh, 2016). *Romalea guttata* (Stoll) ovipositional behavioral responded at 150 watts, 14:10 L:D cycle and 26±2 °C showed group ovipositional site with a preference for sand in

deposition of the egg pods (Stauffer *et al.*, 1998). Senegalese grasshopper as a pest, gave the complete biological involvement for its abundances when egg pods procured in August had higher result of no diapauses stages than the September collection (Maiga *et al.*, 2010). The laboratory studies on *Oxya japonica* (Thunberg) showed the impact of soil health and the major role in its survival and development (Trisnawati *et al.*, 2015). The egg pods of Indian Acrididae and the ecology of egg laying substrate i.e. moisture for xerophilic, mesophilic, hydrophilic soil and the egg arrangements also determined the identification keys for Acrididae (Katiyar, 1957). The present study was prompted to comprehend and examine the morphometric variation of egg pods among the two selected Oxyinae species, *Oxya velox* (F.) and *Hygracris palutris* (Uvarov) (Orthoptera, Acrididae, Catantopinae). Additionally, different soil

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types were analyzed for their soil preferences among the selected species. Therefore, the study contributes to the lacunae of existing knowledge about the acridids egg pods under laboratory conditions.

MATERIALS AND METHODS

The studies on the acridids egg pods with relationship to soil type study was carried out in Kohima district, Nagaland at coordinates 25°31'44" N - 25°51'45" N latitude and 93°54'30" - 94°14'09" E longitude. Firstly, acridids species were collected through random sampling methods from agricultural areas and surrounding vegetation with the employment of insect aerial net and hand picking. Two acridid species namely, *O. velox* and *H. palutris* belonging to the sub-family Oxyinae, were selected for the study. In laboratory conditions, the minimum and maximum temperature was recorded as 8.42 and 28.2°C respectively along with relative humidity 72.4 to 92.83 per cent. The collected species were reared as stock culture for further experimentation under laboratory conditions with the modified technique proposed by Fry (1927); Hinks and Erlandson (1994); Haldar *et al.* (1998). Inside the cage, the Oxyinae species was fed *ad libitum* with fresh host leaves. For oviposition purposes, an oviposition tray filled with different sterilized soil types was provided, and distilled water was sprayed to keep it moist. The egg pods laid are checked regularly and the retrieved egg pods was cleaned and sorted. The egg pods were weighted and later the frothy material was removed for counting and measurement of the individuals' eggs within a single egg pod. The morphometric analysis such as weight (mg), width (mm) and length (mm) for both egg pods and eggs were measured with the aid of a digital weighing balance and digital vernier calipers. The different types of soil are determined through soil texture methods of USDA textural triangle using a hydrometer by Estefan *et al.* (2013). Statistical data analysis was conducted using MS. Excel 2021 and XLSTAT 2024.

RESULTS AND DISCUSSION

The current work was carried out to determine the ovipositional behavior with association to the egg

pods and soil type preferences namely loamy sand and sandy loam. The Oxyinae egg pods determined that *O. velox* were comparatively smaller than *H. palutris* in all the morphometric analysis even under the same substrate. When the same species were introduced to two different substrate the egg pods showed variation among the morphometric measurements. In *O. velox* egg pods, length was measured about 10.12±1.44 and 10.91±1.51mm whereas width measured about 6.02±0.80 and 6.07±0.8mm for loamy sand and sandy loam respectively. Subsequently, *H. palutris* egg pods for loamy sand and sandy loam length were 11.02±0.77mm and 11.81±1.60mm while width was about 5.60±0.33 and 5.64±0.49mm respectively. The egg pods retrieved under different substrate exhibited different weightage in both Oxyinae species. In *O. velox*, egg pods retrieved from sandy loam had more weight (103.67±16.16mg) as compared to loamy sand (96.90±18.21mg). Similarly, *H. palutris* also showed more egg pods weightage from sandy loam (109.33±19.95mg) then the loamy sand (97.03±5.52mg) (Table 1, 3).

The comparative Oxyinae eggs was studied on the basis of weight, length and width. In case of *O. velox* the eggs retrieved from sandy loam soil takes higher advantages in all the analysis. The weight in sandy loam is recorded as 4.00±0.45mg whereas loamy sand is 3.97±0.71mg. While, the length and width in loamy sand is 4.18±0.10 and 1.20±0.06mm which is smaller than the eggs retrieved from sandy loam recorded as 4.21±0.17mm and 1.24±0.06mm respectively. For *H. palutris* eggs weight in loamy sand (4.37±0.49mg) is comparatively lighter than eggs retrieved from sandy loam (4.47±0.57mg) soil. Followingly, both the length and width of sandy loam eggs are 4.46±0.27mm and 1.85±0.08mm respectively. Though, the loamy sand eggs length (4.38±0.26mm) and width (1.84±0.08mm) are slightly smaller when compared to eggs retrieved from sandy loam soil type. Overall, *O. velox* eggs showed lower value than *H. palutris* eggs in all the parameters analyzed for the consideration to determined that comparative morphometric variation among the two species (Table 2, 3).

The Oxyinae morphometric assessment on egg pods

and eggs showed slight similarity with Sultana *et al.* (2020) and Doulo and Sote (2024) findings. In case of *O. velox* egg pods, width and length shows more or less similar to Sultana *et al.* (2020) findings where width and length was 5.40 ± 1.07 and 14.5 ± 1.35 mm. During the study period, it was noted that the soil types lead to a variation in the number of the eggs even among the same species. In *O. velox*, number of eggs in loamy sand and sandy loam soil type has a slight variation with 19.17 ± 3.71 eggs and 20.80 ± 2.35 eggs within a single egg pod respectively. While in *H. palutris*, loamy sand has 21.20 ± 2.17 eggs and sandy loam have 21.50 ± 2.29 eggs within a single egg pod were also recorded.

It was determined that the freshly deposited egg pods are soft later become hardened with similar result reported by Shaikh and Sultana (2018). In both the two soil types, it was observed that freshly deposited egg pods were ivory color but once subjected to environmental condition the color changes to saddle brown which were alike to Sultana *et al.* (2020) and Doulo and Sote (2024) findings. The sculpturing display of the two selected

Oxyinae egg pods were quite similar and display distinctive subcylindrical shape. Both the egg pods were pointed at the anterior end and blunted on the posterior end. Due to its blunted end, greater number of eggs exist and least number of eggs were witnessed in the anterior end. Eggs were arranged tightly and systematically within the pods protected by the frothy material. Both the two selected Oxyinae eggs were banana shaped where similar conclusion was reported by Sultana *et al.* (2020) and Doulo and Sote (2024).

Substrate availability has a major driving factors for oviposition success among the acridid species. Soil preferences for oviposition behavior are selected based upon the different individuals even on relationship to moisture content of the soil (Katiyar, 1957; Pande *et al.*, 1990; Torto *et al.*, 2024). The relationship between the morphometric study showed that even among the same species variation depend on the substrate provided which also agreed with Sultana and Wagan (2009) reason. Comparatively among the other grasshopper species Senegalese grasshopper also showed preferences

Table 1. Comparative morphometric egg pods measurement (Mean $\pm$ SD) for *O. velox* and *H. palutris*

Species	Length (mm)		Width (mm)	
	Loamy sand	Sandy loam	Loamy sand	Sandy loam
<i>Oxya velox</i>	10.12 ± 1.44	10.91 ± 1.51	6.02 ± 0.80	6.07 ± 0.81
<i>Hygracris palutris</i>	11.02 ± 0.77	11.81 ± 1.60	5.60 ± 0.33	5.64 ± 0.49

Table 2. Comparative morphometric eggs measurement (Mean $\pm$ SD) for *O. velox* and *H. palutris*

Species	Length (mm)		Width (mm)	
	Loamy sand	Sandy loam	Loamy sand	Sandy loam
<i>Oxya velox</i>	4.18 ± 0.10	4.21 ± 0.17	1.20 ± 0.06	1.24 ± 0.06
<i>Hygracris palutris</i>	4.38 ± 0.26	4.46 ± 0.27	1.84 ± 0.08	1.85 ± 0.08

Table 3. Comparative weight of both egg pod and eggs (Mean $\pm$ SD) for *O. velox* and *H. palutris*

Species	Egg pod weight (mg)		Egg weight (mg)	
	Loamy sand	Sandy loam	Loamy sand	Sandy loam
<i>Oxya velox</i>	96.90 ± 18.21	103.67 ± 16.16	3.97 ± 0.71	4.00 ± 0.45
<i>Hygracris palutris</i>	97.03 ± 5.52	109.33 ± 19.95	4.37 ± 0.49	4.47 ± 0.57

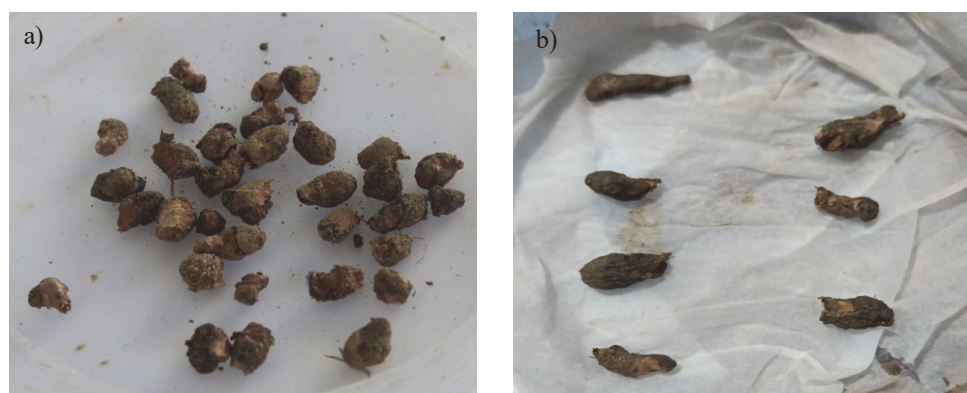


Fig. 1 Retrieved egg pods of - a) *O. velox*; b) *H. palutris* under lab-based farming

on sandy-loamy soil types for oviposition (Maiga *et al.*, 2010). Grasshopper preferred on moderately firm soil for oviposition about 3cm in *Oxya hyla hyla* (Serville) (Pande *et al.*, 1990) with moderate compactness rather than very tight or loose soil type (Toleubayev *et al.*, 2007). Studied on *Aulocara elliotti* (Thomas) and *Opeia obscura* (Thomas) egg pods subjected to fire in the ecosystem resulted to depth of the egg pods in the soil however find out that the *A. elliotti* has higher mortality rate due to narrow egg pods location as compared to *O. obscura* (Branson and Vermeire, 2013). Under experimental condition different soil moisture and soil types correspondingly contributes to the oviposition preference for the same species (Umrani *et al.*, 2007). The soil moisture also contributes to the egg pods as well as the nymphal development (Mukerji and Gage, 1977). It was reported that about 10-11 percent egg undergo diapause stages for around 20 to 23 months (Shaikh and Sultana, 2018). The key feature for grasshopper farming led to the preferences of multivoltine species which ultimately contributes to higher biotic biomass production (Das *et al.*, 2012a, b; Das, 2014). The population incidence of the individual's species can also refer for farming (Sote and Doulo, 2024). However, in environmental condition climatic factors, seasonal factors, elevation, soil moisture and soil type contribute to the availability of the grasshopper species (Katiyar, 1957; Pradhan and Peswani, 1961; Pande *et al.*, 1990; Wei *et al.*, 2023).

Presently, edible insects are highly recognized due to its rich nutritional value as a supplementary diet.

Though edible insects are considered as a conventional food source but figuratively about 92 per cent of edible insect are collected from wild (Yen, 2015) which lead to insect farming under laboratory as significant contribution in food security (Das *et al.*, 2012a, b; Das, 2014). Specifically, acridids are known for rich protein content (Anand *et al.*, 2008; Ganguly *et al.*, 2009, 2013; Das and Mandal, 2014; Ghosh *et al.*, 2016; Das, 2018; Gosh and Mandal, 2019; Samira *et al.*, 2019) and as alternative diet or even animal feeds (Das and Mandal, 2014; Ghosh *et al.*, 2016; Gosh and Mandal, 2019). The high biomass production is the key leading aspects for insect farming. Studies also concluded that selection of certain host plants for specific acridid species also contributed to high yielding biomass in laboratory condition (Das *et al.*, 2012a). Temperature influences the developmental stages of grasshopper (Ali, 1982). For mass acridid production, certain environmental condition is taken into consideration whereby at 35 ± 2 °C and 12:12 light and dark respectively are closely considered to be optimum temperature and light intensity for *O. hyla hyla* (Das *et al.*, 2012b). Additionally, the space utilization by acridids showed that 25 adults of *O. fuscovittata* and 35 adults of *Spathosternum prasiniferum prasiniferum* (Walker) required $10 \times 10 \times 25$ cm³ to prove higher potential of mass rearing (Das *et al.*, 2009). The present study concluded that, sandy loam has more edge over loamy sand in both Oxyinae egg pods and eggs. The study comprehends the different soil type preferences which lead to the morphometric variation among the two selected Oxyinae species.

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