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Impact of different substrata on mass rearing of reduviid bug: *Sycanus collaris* (Hemiptera: Reduviidae)

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Abstract
Influence of substrata in the mass multiplication of predator insects is a known fact. This study investigates the impact of different substrata on the development of reduviid bug species,*Sycanus collaris*. It was mass reared on seven different substrata *viz.*, dried jack leaves with twigs (DL), fresh jack leaves with twigs (FL), tea leaves (TL), tea twigs (TT), sand with big stones (SS), tissue paper with white folded A4 sheets (TP) and empty plastic containers (EC). Results showed that, the stadial period of nymphal instars, pre oviposition and better survival rate of *S.collaris* reared on tissue paper with white folded A4 sheets and dried jack leaves with twigs were highly shortened over other substrata. Mortality rate was very high on sand with big stone substrate. Comparatively highest numbers of eggs were collected from the dried jack leaves with twigs substrate category.

Keywords: Mass rearing, reduviid bugs, substrata, stadial period, predator

Introduction
Predator insects provide a natural and harmless alternative to chemical pesticides. They reduce the environmental impacts associated with the use of synthetic chemicals (Sahid *et al*., 2018) [21]. In the light of current needs, mass production of insect predators would be most considerate in Integrated Pest Management (Ambrose *et al*., 2007) [3]. Mass rearing of reduviid bugs also improves the better survival of them when compared to the isolated individual insects (D. Ambrose, 2000) [1]. The Reduviidae is the largest family of predaceous insects and many of its members are found to be important predators of many insect pests (Ambrose, 1999 and 2003 and Ambrose *et al*., 2009) [1, 6, 7].The genus Sycanus is a principal group of harpactorine reduviids with biological control efficiency (Rajan, Suneetha, and Sathish, 2017) [20]. Many desirable biological and behavioral traits noticed in genus Sycanus imply that this species can be mass reared under laboratory conditions and also used to mitigate the population of insect pests (Nitin *et al*., 2017.) [18] *Sycanus collaris* is found to effectively feed on tea mosquito bug, the serious insect pest in tea plantations (Srikumar *et al*., 2017). The substrata used for the rearing practice also serve as an indispensable part, significantly influencing their development, behavior, and overall rearing success (D. P. Ambrose and Claver, 1999.) [2]. The selection of substratum affects various aspects such as egg laying, nymphal development, adult emergence, longevity and ovi position (Geden, 2012) [13]. Proper substrata can also prevent issues such as cannibalism, disease spread and low fecundity, which are critical in high-density rearing conditions (Cohen, 2004) [8], (Pritam & Epsky, 2006) [19]. However rearing substrata could influence the different life parameters of insects that used to rear. Details on the impact of substrata on the life cycle of rearing insects as well as predator's preference of substrata are sparse. Considering the above points, an experiment was made to study the impact of various substrata on the development of *S.collaris*. We choose seven different substrata (dried jack leaves with twigs, fresh jack leaves with twigs, tea leaves, tea twigs, sand with big stones, tissue paper with white folded A4 sheets and empty plastic containers) for the experiment as they prefer shaded surroundings. The current paper collates the effects of the above mentioned seven substrata on hatch-ability, stadial period,adult emergence, pre oviposition, incubation period, sex ratio and adult longevity in the mass rearing of *S.collaris.*

Materials and methods
Laboratory reared *S.collaris* nymphs were used for the experiment. The stock culture (both adults and nymphs) was collected from the experimental tea field of UPASI Tea research institution Valparai, Coimbatore, Tamil Nadu and reared at 23 ± 2 ◦C and 87 ± 3% humidity. The adults and nymphs were placed in 26x11 cm plastic containers with dried jack leaves for shade. Eggs collected and placed in petri plates with wet cotton balls for maintaining humidity. After hatching, the nymphs transferred to plastic containers and start feeding. They were daily fed with 4th and 5th instar larvae of rice moth (*Corcyra cephalonica).* In the laboratory, rice moth rearing also undergone as a food source for *S.collaris* and they were reared using wheat flour and peanut powder at 27 ± 3◦C and 82 ± 2% humidity.
For this experiment, two hundred and ten same day hatched 1st instar nymphs of *S.collaris* were taken from the laboratory culture and placed them in 26x11 cm plastic containers provided with different substrata. Maintained three replications of seven different substrata with 10 number of 1st instar nymphs each. The following substrata types were used. (Figure: 1 to 7)

- Dried jack leaves with twigs: dried leaves filled in the plastic container up to 5cm height and some dried twigs also added for the movement of reduviids.
- Fresh jack leaves with twigs: fresh leaves and twigs were filled up to 5 cm height. For maintaining the freshness replaced the both leaves and twigs in alternate days.
- Tea leaves: both fresh and dry tea leaves were used and filled in the container up to 5 cm height.

- Tea twigs: 8 to 10 tea twigs with 15cm height were used and placed inside the container for easy movement of reduviids.
- Sand with big stones: dry sand spread evenly in the container up to 3 cm height and placed some bigger stones on the top of the sand particles for better hiding and egg laying place for reduviids.
- Tissue paper with white folded A4 sheets: tissue paper spread evenly on the bottom of the container up to 1 cm height. Folded A4 sheets with 15cm height placed on the top of the tissue paper for better hiding and egg laying place for reduviids.
- Empty plastic containers

Ten number of 1st instar nymphs were introduced to each container and monitored daily for checking their growth, moulting and duration of instars. Maintained the replications of each substrata. Stadial period, nymphal survival rate, adult emergence, sex ratio, pre oviposition period, number of eggs laid, incubation period, fecundity and hatch-ability are the different life parameters of *S.collaris* were evaluated during the experiment. After emerging into adult, males and females collected and placed as a pair for evaluating fecundity and pre oviposition period provided with same substrata. After egg laying, egg batches from each substrata collected and placed in separate container for monitoring incubation period (Figure 8 to 13). Counted the number of eggs present in each egg batches for evaluating the hatching rate.

Different substrata used for the experiment

Fig 1: Tea twigs

Fig 2: Empty container

Fig 3: Tea leaves

Fig 4: Dried jack leaves

Fig 5: FoldedA4 sheet with tissue paper

Fig 6: Sand with stones

Fig 7: Fresh jack leaves

Eggs collected from different substrata

Fig 8:Dried Jack leaf

Fig 9: Empty container

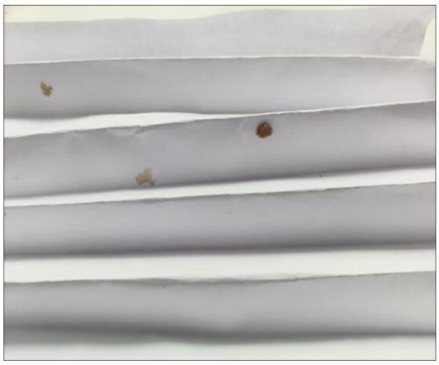

Fig 10: Folded A4 sheet with tissue paper

Fig 11: Tea leaf

Fig 12: Sand with stone

Fig 13: Fresh jack leaf

Result and discussion

Different substrata affect various life parameters of *S. collaris* bugs differently. The longest stadial period was recorded in both fresh jack leaves with twigs and sand with big stones substrata. D. Ambrose, 2000 [5] pointed out that stadial period and better survival of the bugs are very much influenced by the substrata that we provided during the mass rearing. A 100% adult emergence rate was observed in both dried jack leaves with twigs and tissue paper with white folded A4 sheets substrata.

The shortest and longest pre- oviposition period was noted in dried jack leaves with twigs substratum and empty plastic containers respectively. Drukker *et al*.,1995 [10], stated that plastic and its odour reduced the possibility of oviposition of anthocorid bugsthat might be the reason for the extension of oviposition period in reduviids reared on empty plastic containers. Also Ferran *et al*. 1996 [11] reported that oviposition non-preference appeared to be important for predatory bugs population in certain substrate. In tissue paper with white folded A4 sheets and empty plastic containers, the sex ratio was female-biased, whereas sand with big stones substratum had an equal number of males and females. All other substrata exhibited a male-biased sex ratio. Long *et al*., 1958 [17] reported that insect mass-rearing produced larger adults with a greater effect on females.

Both male and female longevity was high in dried jack leaves with twigs substratum. Sand with big stones substratum is unsuitable for rearing *S. collaris.* According to Kn *et al*., n.d. and Ji *et al*., 2010 [14], the developmental duration of predators got prolonged when the abiotic factors are varied. Table 1 shows the details of different life parameters that evaluated during the study.

More number of egg batches was collected from the dried jack leaves with twigs substrata culture and least number of

egg batches was collected from tissue paper with white folded A4 sheets substrata culture. Gautam, 1990 [12] also reported that predaceous coccinellid beetle prefer cotton and folded tissue paper rather than other glass and plastic substrata for egg laying. The egg batches collected from sand with big stones substrata category harvests a smaller number of eggs (44.2 ± 7.9) and dried jack leaves with twigs substrata category harvests highest number of eggs (74.9 ± 10.8) compared to other categories. The incubation period and egg hatch-ability remain unaffected by substrate type.

D. P. Ambrose and Claver, 1999 [4] stated that substrata did not influence the incubation period of eggs during their studies on *R.marginatus*. Table 2 shows the influence of seven different substrata on the eggs collected from the trial. The current findings suggest that mass-rearing of reduviid predator, *S.collaris* in sand with big stone substratum and tea twig substratum are not advisable and inclusion like dried leaves and twigs or tissue paper with white folded A4 sheets as substrata could improve its mass rearing.

Table 1: Influence of seven different substrata on some of the biological parameters of *S.collaris* (n=30, ±SD)

Parameters	TP	DL	FL	SS	EC	TT	TL
Stadial period	69.6±1.8	72±2.1	83.2±1.6	82.4±1.6	74±1.8	72.7 ± 1.9	70.5 ± 1.9
Adult emerging %	100	100	70	60	70	70	80
Sex ratio (male: female)	1:1.1	1:0.6	1:0.5	1:1	1:1.1	1:0.4	1:0.9
Pre oviposition	18±1.6	17±1.4	28.4 ± 1.2	31.4±0.8	31.6±2.0	29.4 ± 1.2	30.5± 1.9
Male longevity	53.0 ± 2.7	58.6 ± 1.7	39.9 ± 2.1	48.5 ± 0.8	49.2 ± 1.9	49.8 ± 2.3	51.9 ± 2.4
Female longevity	79.5 ± 2.2	88.2 ± 2.4	52.5 ± 2.6	48.6 ± 1.2	52.4 ± 2.4	55.6 ± 2.3	62.5 ± 2.5

Table 2: Influence of seven different substrata on the eggs collected from thetrial.

Parameters	TP	DL	FL	SS	EC	TT	TL
No. Of egg batches collected	16	20	5	4	6	2	10
No of eggs in a batch	73.6 ± 7.7	74.9 ± 10.8	73.8 ± 1.6	44.2 ± 7.9	73.6 ± 1.8	73.0 ± 2.8	72.9 ± 1.9
Incubation period	24.6 ± 1.8	23.4 ± 0.9	24.8 ± 2.0	25.1 ± 0.5	24.5 ± 1.6	23.8 ± 1.8	24.9 ± 0.8
Hatch-ability	96.7 ± 2.0	96.9 ± 1.9	93 ± 2.3	96.2 ± 2.3	96.3 ± 2.4	94.1 ± 2.1	96.4 ± 2.9

Conclusion

The mass rearing of reduviid bugs using dried leaves with twigs and A4 sheet with tissue paper proves to be a superior method due to its cost-effectiveness and ease of maintenance. This will provide a suitable environment for breeding and feeding, promoting higher survival and reproduction rates. As a result, this method enhances the overall success of mass rearing programs, making it a preferable option for entomological studies and biological control initiatives.

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