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Survival strategies of instar nymphs of Solifugae (Family: *Galeodidae*, Arachnida) in the laboratory conditions

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Abstract
Favorable conditions always support survival rate of any organisms. Laboratory conditions are favorable in case of instar nymphs of Solifugae. Cannibalism is a common act in the members of class Arachnida. After hatching from the eggs, instar nymphs of Solifugae begin to disperse gradually away. This is essential to avoid competition for food, space and prevent cannibalism among the siblings. The number of juvenile of Solifugae in plastic bottles remains unchanged past one month of separation. All instar nymphs of Solifugae survived in separation but their number was dropped in the association. During our investigations, juveniles of Family *Galeodidae* were kept on same diets. There was difference in survival rate of juveniles. The result showed that cannibalism is a source of energy for Solifugae for an extensive time and surviving rate were declined in association of juveniles but separation of juveniles supports more chances towards life and survival.

Keywords: solifugae, instar, survival, laboratory conditions

1. Introduction
Most know species of Solifuges inhabit tropical and subtropical habitat. Order Solifugae includes 1116 species belonging to 144 genera and 13 families [1]. Solifugae have extreme aggressive behavior to protect them self from prey. The description of gravid female of Solifugae rearing is based on observation in laboratory condition. Until recently, no species of Solifugae had been reared in lab conditions in India. In general the present effort by us is an attempt to fill the gap and contribute towards better understanding Indian Solifugae.
In the natural conditions some environment factors affected its survival rate. Predators like birds, lizards, mammals, ants and diseases are some of factors which affected instar nymphs population at the end more complex to survive and declined its survivorship. Sibling cannibalism entails a high risk of direct and inclusive fitness loss for the mother and her offspring [2]. Many adaptations been evolved in animals to reduce the intraspecific cannibalism. In this way not only adults [3] but, instar nymphs of Solifugae have also been observed to cannibalize each other. Juveniles always showed aggressive foraging behavior due to energy demand. In the laboratory, all favorable conditions are available for instar nymphs growth and its survivorship showed healthy diversity. In environment aspect its in-vitro conservation are more profitable. Survival rate are always positive in separated mode in the laboratory conditions. There are no other competition for food and shelter. Therefore, Maximum survival rate can be achieved.

2. Materials and Methods
2.1 Study Area
The Solifugae were collected from the rural area of the district Alirajpur, It lies in the Malwa region of Madhya Pradesh, near the border with Gujarat and Maharashtra [4]. Alirajpur's topography is predominantly hilly with semiarid climate.

2.2 Sampling Methods
Solifugae were collected during day by turning stones and pitfall traps. All inseminated females were kept in isolation (figure 2: A). Both the females laid eggs almost simultaneously after 27 days in laboratory conditions. Female remained in the nest and guarded their eggs as well as post embryos and up to instar nymphs (figure 2: B). The hatchlings remained with mother Solifugae for a week and then juveniles were divided in two groups. Two groups (1, 2) each of 40 juveniles of Solifugae were studied to compare survival rate in laboratory conditions. In case of spider lings there was significant difference in survival rate [5]. In each group of Solifugae, two subgroups of 20 juveniles (A, B and C, D) were divided up to the third stages of instars nymphs for 30 days. Subgroup (B, D) individual was kept in separated bottles while subgroups of (A and C) were kept in container with association of 20 juveniles.
The juveniles remained with mother Solifugae for a week and then were divided in groups. Two groups each of 40 hatchling of Solifugae were studied to compare survival rate in laboratory conditions. The following treatments were tested.

Table 1: Regularly monitoring required for determine the survival rate of instar nymphs of Solifugae.

Group 1	Sub Group A	With Association	leafhopper, aphids
	Sub Group B	Individual Separated	leafhopper, aphids
Group 2	Sub Group C	With Association	leafhopper, aphids
	Sub Group D	Individual Separated	leafhopper, aphids

Table 2: Means and distribution of failures in the experimental treatments and survival rates according to Kalbfleisch and Prentice [6].

Sub groups	N number of samples	Treatment	Survival time (days)			
			Means	Quartiles		
				75%	50%	25%
A (association) instar nymphs	20	leafhopper, aphids	21	14	21	28
B separated instar nymphs	20	leafhopper, aphids	*	*	*	*
C (association) instar nymphs	20	leafhopper, aphids	18.3	12	18	25
D separated instar nymphs	20	leafhopper, aphids	*	*	*	*

*= No juveniles were died more than 15% at 30th days, although 85% juveniles were survived at the end of month.
The juveniles in each treatment group received identical food amounts. Differences between survival times of groups were calculated by the given methods.

Survival Function

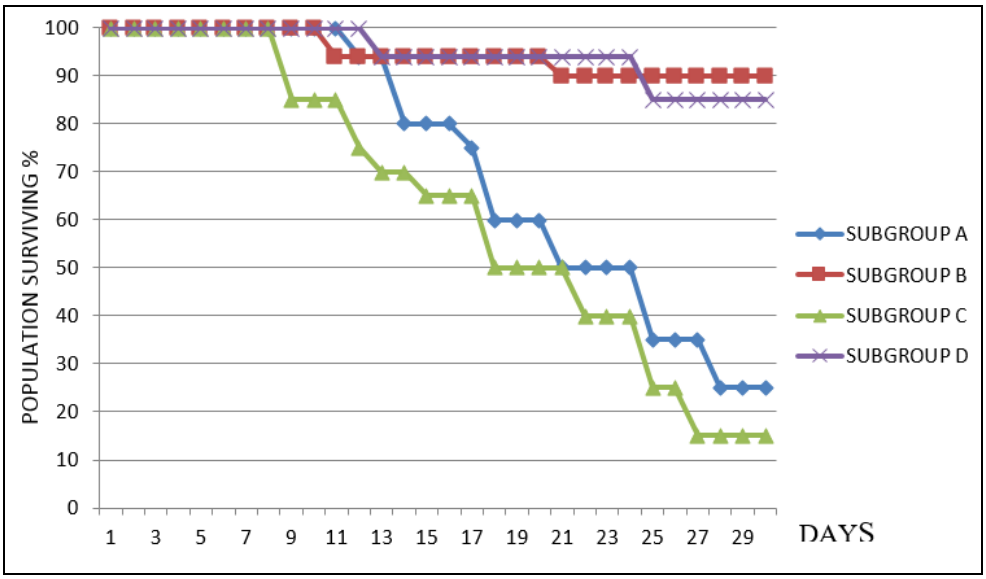

Fig 1: Survival probability percent in relation to surviving time of *Galeodidae* subjected to treatments: subgroup A and C, treated with leafhopper and aphids with association; subgroup B and D, treated with leafhopper and aphids separately.

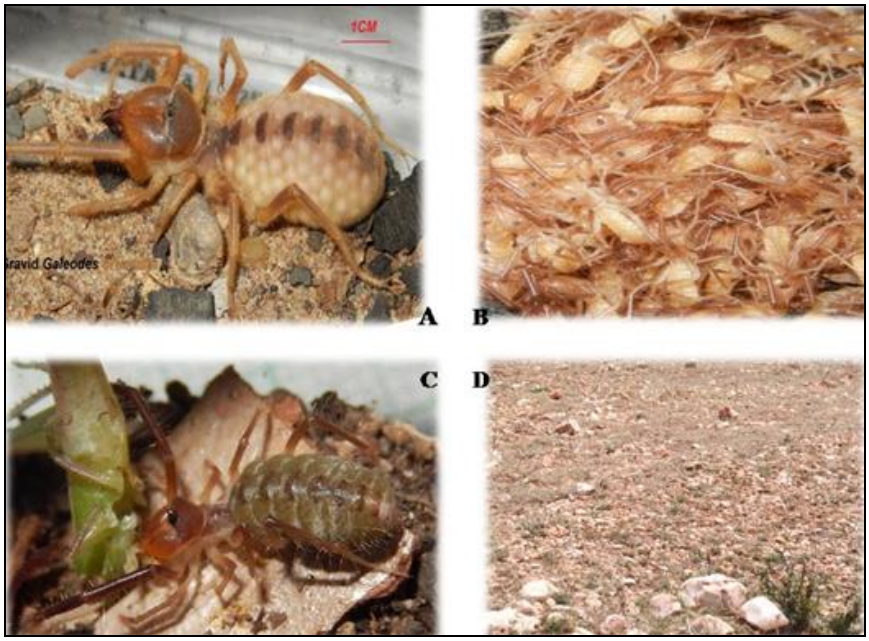

Fig 2: A). Gravid female of family *Galeodidae* in the laboratory conditions., B). First Instar nymphs of Solifugae., C). Isolated 3rd instar of Solifugae in laboratory conditions., D). Collection site.

3. Results and Discussion

Non social animals like Solifugae have evolved aggressive behavior to protect them self from prey. Their number dropped in the association (Figure 1: subgroup A-C) second week of separation. Survived juveniles of Solifugae also could not sustain life due to have injuries in fight and cannibalism. Instar nymphs of Solifugae had strongly sibling cannibalism or intra species killing.

We had reared up to 3rd instar nymphs in laboratory conditions end of 30 days. In the natural conditions, after hatching from the eggs juvenile of Solifugae disperse by running away to longer distances and obtained a solitary life. They fight more for survive in the nature. Though, survival rates of instar nymph are declined in the association due to cannibalistic by behavior, although provided enough amount of food (leafhopper and aphids). This study describes that their numbers increases in case of separated individual of instar nymph in laboratory conditions. Separated subgroups of juveniles were B-D. Study was based on 30 days analysis in laboratory conditions Compared with subgroup A has declined their number from the day 12 to 27 upto 75% simultaneously. Subgroup C has declined their number from the day 9 to 26 upto 75% simultaneously in the association. According to table 1, percentages of survival were decreasing as days increasing in the association of juveniles in the container. While, separated juveniles did not declined their number subgroup B had little variant or declined their number from the day 11 to 20, upto 10%, not more than ≤ 2. Subgroup D also variant or declined their number from the day 13 to 25, upto 15%, not more than ≤ 3. According to table 1, percentages of survival were decreased not more than 15% in the separation of juveniles individually in the container. Figure 1 showed that survival rates are higher in subgroup B and D as compared with subgroup A and C. Increased numbers of instar nymphs showed the survival chances of separated juveniles in the laboratory conditions.

4. Conclusion

Survival of juveniles in the association are very tough as well they are vulnerable due to cannibalistic by behavior but laboratory conditions always favored for growth of separated instar nymphs which were treated with same diet and supports their numbers. Separated juveniles were molted upto 3rd instar with in one month therefore their chances to survive are high in the laboratory conditions.

5. References

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