Artificial rearing of a reduviid predator, *Rhynocoris marginatus* (Fab.) (Hemiptera: Reduviidae) using Meat-based artificial diet

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INTRODUCTION

- *Rhynocoris marginatus* a polyphagous, common predator distributed in various agroecosystems of India.
- Both nymphs and adults are well-known predator of insect's belong to Lepidoptera, Orthoptera, Hemiptera, Isoptera and Coleoptera.
- Laboratory and field studies confirmed its biological efficiency
- The success of the biological control largely depends upon availability of sufficient number of biological control agents for field augmentation programme
- A required number of bioagents can be obtained by rearing them either on their natural host or on artificial diets (Riddick, 2009).
- Literature survey reveals that no published work is available for the artificial rearing of this reduviid using artificial diet

Objectives

1. To compare the influence of meat-based artificial diets and factitious host on the biology of *R. marginatus* at least for three generations consecutively and
2. To record life table parameters of *R. marginatus* reared with artificial diet and factitious host

MATERIALS AND METHOD

Insects culture

- Life stages of the reduviid was collected from Tirunelveli District, Tamil Nadu, India and the stock colony were cultured under laboratory conditions (30±1°C and 73% RH and 11L: 13D) on *Corcyra cephalonica* Stainton (Sahayaraj, 2002).
- Whereas experimental predators were maintained in the environmental chambers at 28 ± 1° C, 75 ± 80 % RH and 11L: 13D h.

Preparation of Artificial diet

- Method of De Clercq and Degheele (1992) was followed with slight modification
- Minced pig liver and pig blood were dried in hot air oven at 60°C for 20 to 30 minutes.
- After drying they were ground well by using mortar and pestle.
- Hundred mL of distilled water was taken in a 500 mL glass beaker and boiled at 100OC for 20 minutes.
- Commercial milk powder was dissolved in 10 mL of the boiled water and allowed to cool.
- Water-soluble yeast extract, dried egg yolk, liquid honey, and acetic acid were added to the remaining 90 mL water and boiled at 100°C.
- After 10 minutes, the source ingredients, multivitamin, vitamin C and E and streptomycin were added and stirred thoroughly.
- Then, the milk powder solution was added and mixed well, allowed cool at room temperature, filtered through filter paper.
- Filtered liquid diet (AD) was stored in refrigerator for the future use on longer than 3 to 4 weeks.

Experimentation

- Biology of *R. marginatus* was monitored on artificial diets (AD) and *C. cephalonica* (CC).
- For each treatment, 150 newly emerged first instars predator were randomly taken from the laboratory culture and place individually in plastic vials (6 cm height and 4.5 cm diameter).
- AD was soaked in cotton wool (0.5mL in 5 mg cotton) and provided to the predator.
- 4th and 5th instar *C. cephalonica* larvae head was crushed, and provided to the predator twice in a week.
- Nymphal developmental period, weight, survival rate, and sex ratio [♀/(♂+♀)] was recorded upon emergence.
- Occurrence of morphological abnormalities was recorded if any.
- 10 mating pairs were maintained in 500 mL capacity plastic box (5.5 cm L and 12.5 cm D) which furnished with filter paper on the bottom
- The oviposition periods, total number of eggs laid by a female and adult longevity were recorded and life table parameters were calculated
- F1 generation nymphs to F2 generation to F3 generation

Statistical analysis

- Developmental times and adult weights were analyzed using paired t-test ($p = 0.05$) using STAT VIEW.
- Reproductive parameters were compared using one-way ANOVA and Tukey 's test.
- Student's "t" test was applied to compare oviposition parameters of *R. marginatus* between CC and AD.

RESULT

Nymphal developmental period

- In factitious host, the developmental period ranged from 44 to 47 days (F2 generation).
- Total nymphal developmental period gradually decreased from F1 (70.17 days) to F3 (65.12 days) generation with survival rate of 68 to 78 % in AD category (Table 1).

Table1. Nymphal developmental period (MEAN ± SE days) (in F1, F2 & F3 *R. marginatus* reared on artificial diet and CC) cephalonica

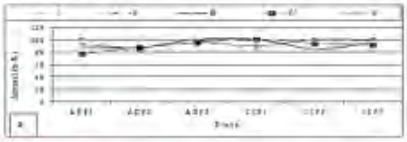
Diet	Nymphal Developmental Period					
	I	II	III	IV	V	Total
AD F1	6.00±0.00 a	13.00±0.58 a	12.00±0.00 a	14.00±0.58 a	25.17±0.71 a	70.17 a
AD F2	5.00±0.45 a	11.20±0.48 a	11.00±0.00 a	13.75±1.21 a	24.25±1.53 a	65.20 a
AD F3	4.75±0.75 a	11.00±0.45 a	11.00±0.58 a	13.13±0.61 a	24.00±1.31 a	65.25 a
CC F1	4.91±0.16 a	9.61±0.25 b	12.51±0.64 a	9.80±0.31 b	11.29±0.68 b	48.86 b
CC F2	5.00±0.13 a	10.00±1.34 b	11.00±0.45 a	9.00±1.00 b	11.00±0.00 b	45.00 b
CC F3	4.54±0.04 a	9.00±0.24 b	11.00±0.00 a	10.20±0.20 b	11.00±0.55 b	45.20 b

* denotes significance at 5% level

Nymphal survival rate and weight gain

- Total nymphal survival rate was increased from first generation to third generation (Figure 1).
- AD reduce 20% of the total nymphal survival rate than factitious host.
- AD enhanced the weight gain than CC (32.3 to 48.6 mg/predator for 1st and 3rd generation, respectively).

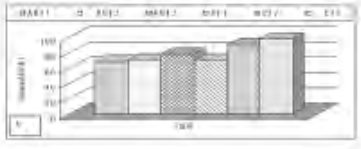
Figure 1. Individual nymphal (I) and total nymphal survival rate (in %) of *R. marginatus* reared on artificial (AD) and factitious host.



Sex ratio and adult longevity

- Sex ratio was female biased (eg: In CC 0.68, 0.72 and 0.82 and in AD 0.62, 0.79 and 0.68).
- In general, irrespective of the categories, female lived longer than the males. Among the categories, predator reared with CC lived longer than AD (Figure 2).

Figure 2. Adult longevity of *R. marginatus* male (MALE) and female (FALE) (in days) reared on artificial and factitious host.



Reproduction

- The total incubation period was ranged from 6-8 days in CC category.
- Predator reared with CC laid a more eggs (177 eggs/female), whereas, reduviid reared AD laid 53 eggs/female (Table 2)

Table 2. Oviposition period (PEROP), incubation period (INPD), total number of eggs laid (TNE), number of egg batches (NEB) and number of eggs laid per batch (NEPB) in *R. marginatus* (F2 Generation) on different diets

Diet	LNEPP	LNPD	EGGTO	TNE/ind	NEB/ind	NEPB
AD F1	48.00±0.00	7.0±0.24 a	122.8±1.24 a	4.00±0.00	1.0±0.00	53.14
AD F2	51.2±0.20	6.5±0.44 a	53.1±0.24 a	4.0±0.12	1.0±1.2	53.14
AD F3	51.0±0.75	7.0±0.22 a	54.1±0.45 a	5.0±0.12 a	1.0±0.24	53.14
CC F1	20.2±0.04	6.0±0.10 b	24.1±0.32 b	177.0±0.2 b*	3.0±0.15	53.14
CC F2	20.0±1.3	6.0±0.15 b	23.5±0.10 b	165.7±0.2 b*	4.0±0.15	53.14
CC F3	22.1±1.5	6.1±0.2 b*	25.2±0.23 b	172.2±0.24 b*	3.0±0.25	53.14

* denotes significance at 5% level

Life table studies

- Net reproductive rate was decreased from F1 to F3 in CC and an opposite trend was recorded for AD category.
- The mean length of generation, innate capacity of natural increase, corrected rm, gene ration time, finite rate of increase, and weekly multiplication time were reduced in artificial diet reared reduviids than CC (Table 3).

Table 3. Life table parameters of *R. marginatus* reared on factitious host and artificial diet

Parameters	Factitious host (*C. cephalonica*)			Artificial diet		
	F1	F2	F3	F1	F2	F3
Net reproductive rate (R_0)	75.00	73.5	69.5	43.23	40.75	39.85
Mean length of generation (T)	30.00	30.10	30.44	40.15	43.05	44.30
Innate capacity of natural increase (r_m)	0.90	0.84	0.15	0.058	0.053	0.047
Corrected r_m	0.92	0.87	0.91	0.060	0.054	0.049
Gene ration time (Mean life time) (GT)	30.0	30.00	31.00	40.0	43.23	44.91
Finite rate of increase (λ)	2.00	2.10	2.30	1.06	1.05	1.05
Weekly multiplication time (WMT)	1.00	1.00	1.00	1.00	1.00	1.00
Doubling time (DT)	11.55	11.10	11.40	11.55	11.55	11.55
Reproductive potential (RP)	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Morphogenesis

- Nearly 6 - 8% of adults are deformed while reared with meat-based artificial diet

DISCUSSION

Sahayaraj *et al*. (2006) first developed AD for this predator.

Prey	TDP	FAL	FC	NRR	WM	DT	Citation
S. litura	46.71	128.04	348.6	292.29	-	10.15	Sahayaraj & Paulraj, 2001
S. litura	70.38	79.87	191.39	69.95	1.399	14.49	George,1999
E. insulana	76.93	88.47	151.44	41.35	1.314	17.07	George,1999
C. cephalonica	83.47	65.29	121.75	27.90	1.272	20.15	George,1999

TDP – Total developmental period (in days); FAL – Female adult longevity; FC=Fecundity; NRR=Net reproductive rate; WM – Weekly multiplication and DT – Doubling time (in days)

- The nymphal development time, body weight and reproduction of *R. marginatus* on AD were not significantly different from that of factitious host reared insects (see the table).
- Also, the failure of some individuals reared on artificial diets to produce a normal adult did not affect the performance of the first generation adults.
- A nutritional deficiency is likely to appear while the predator reared with AD as reported by Castane and Zapata (2005).
- Meat diet produced smaller, light weight insect with longer embryonic and nymphal development is a common feature discussed by Grenier and De Clereq (2003) and Castane and Zapata (2005).
- Generally the reproductive rate of predators reared on artificial diets is reduced (De Clercq and Degheele, 199; Rojas *et al*., 2000; Wittmeyer and Coudron, 2001; Coudron *et al*., 2002) as observed in our study.
- The reduced egg production attributed to the failure to form mature follicles (Adams, 2000).
- Our study demonstrates that integration of yeast extract, vitamin E and Egg yolk have the potential of being used as a dietary supplement for artificial diets of R. marginatus.

CONCLUSION

Rearing method proposed in this work constitutes an alternative to the conventional method and represents an improvement in the production of this predator. However, the AD composition could be altered to induce the reproductive ability of the reduviid.

RECOMMENDED

For adults, along with AD supplementary feeding of either natural or factitious host can be recommended

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Plate 1. Oligidic diets (a), rearing methods (b&c), feeding behaviour and object preference (d, e, g and h) of *Rhynocoris marginatus* life stages