ISSN 2250-3153

Reproductive biology of a soil isopod *Phyloscia javanensis* (Rich) in relation to soil nutrients

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Abstract- Soil isopod *Phyloscia javanensis* was studied for their reproductive biology in relation to soil nutrients. Isopods were acclimatized to laboratory conditions and reared in different nutrient mediums and their sex ratio, breeding cycle, clutch size and intersexuality were studied. It was found that sex ratio of this isopod depends on the nutrient composition, especially the pH and organic carbon content of the soil. The amount of nitrogen and phosphorous in the media determines the ovigerous females. Low amount of these two factors in the soil reduces egg development. Similarly the incidence of intersex formation also increases with increasing the amount of nitrogen and phosphorous in the soil. Thus it was revealed that availability of nutrients in the soil has great influence in the reproductive behavior of soil isopods.

Index Terms- breeding cycle, clutch size, soil isopod, sex ratio.

I. INTRODUCTION

Isopod crustaceans are important link in the terrestrial ecosystem as decomposers. They turn over litter of terrestrial ecosystem (Vandel, 1960). They enjoy worldwide distribution and their density is directly proportional to certain soil factors (Latreille, 1806 and Caseiro *et.al*., 2000). Most of the earlier studies on isopods were confined to population characteristics, sexual dimorphism and haemodynamics. Reproductive aspects such as sex-ratio, the offspring number per brood, the number and duration of the ovigerous periods is important for understanding mating relations and reproductive potential of dioecius organisms (Nair, 1984) which assess the sustainability of the organism. Very few information was available in the reproductive biology of this group especially in relation to soil characteristics. So the present study is undertaken to study some aspects of reproductive biology of a soil isopod *Phyloscia javanensis* in relation to physico-chemical characteristics of growing medium under laboratory conditions.

II. MATERIALS AND METHODS

a. Collection and acclimation of Isopod

Isopod *Phyloscia javanensis* were collected from agricultural and pastes lands. 150 individuals were collected and brought to laboratory and cultured in a well covered round tray with activated charcoal and plaster of paris in the ratio 1:7 as base. The medium was daily moistened with distilled water and the individuals were given decaying leaves as food. After one month thousand of adults, juveniles and young ones were present in the culture medium.

b. Preparation of nutrient rich natural medium

Soil from agricultural land was taken and mixed with the following combination for making nutrient rich vermicompost. a.) Soil with cowdung b.)soil with vegetable waste c.) soil with leaves d.)soil with cowdung, vegetable waste and leaves. 250 culture species of earthworm *Eisenia foetida* were introduced into each of the culture trays (1m X 1m X 0.5m). The trays were watered daily for one month and the vermicompost was collected and the nutrient composition of each compost was determined as per the standard procedures (Jackson, 1958 and Black,1965). The nutrient compositions of control agriculture soil were also determined.

c. Culture of isopods in natural medium of different types of vermicompost

Five well covered trays of 75cm diameter were taken and each were filled with 5cm thickness of different prepared vermicompost and one with control agriculture soil. These trays were watered daily. Hundred mature male and hundred mature female isopods from the base culture were introduced into these medium. They were given decaying moistened leaves as food for one month. After one month the media were separated into large trays and hand sorted to recover the animals and these collected animals were sacrificed and preserved in a mixture of alcohol, glycerol and distilled water medium (80:4:16). From the collected individuals sex ratio, clutch size, breeding cycle and intersex in relation to nutrient composition of the culture medium were analysed.

III. RESULTS AND DISCUSSION

a. Nutrient composition of medium

The mean soil pH of control was 5.863 with a standard error of 0.214. The average pH value of soil with cow dung was 5.326+/- 0.151; 4.128+/-0.128 for soil with vegetable waste, 4.134+/-0.483 for soil with leaves and 5.246+/-0.004 for soil with mixture of all these. The organic carbon content of different medium showed drastic difference. It was an average of 2.864 for control; 2.114 for cow dung soil; 2.842 for vegetable waste soil; 3.124 for leaf soil and 3.486 for soil with all these mixtures. Exchangeable acid (%) and exchangeable base(%) also showed significant difference. The EB% was 7.44, 12.68, 13.48, 7.64 and 9.46 for control, cow dung soil, vegetable waste soil, leaf soil and mixture of these respectively. Similarly EA% was 90.33, 97.45, 96.46, 92.66 and 107.11 for control, cow dung soil, vegetable waste soil, leaf soil and mixture of these respectively.

The percentage of sand, silt and clay were almost same in all the medium (Table 1).

Table 1
The edaphic factors of control and different medium (mean±SE)

Medium/Factor	pH	Organic carbon (%)	Exchangeable acid (%)	Exchangeable base(%)	Sand (%)	Silt (%)	Clay (%)
Control	5.863± 0.214	2.842± 0.011	90.33± 0.824	7.44± 0.01	6.11± 0.042	0.792± 0.001	15.66± 0.001
Cow dung	5.362± 0.151	3.414± 0.0251	97.45± 0.482	12.68± 0.04	6.12± 0.482	0.761± 0.004	15.68± 0.002
Vegetable waste	4.128± 0.128	2.142± 0.577	96.46± 0.082	13.48± 0.012	6.13± 0.424	0.761± 0.008	15.69± 0.004
Leaves	4.134± 0.482	2.124± 0.025	92.66± 0.0482	7.64± 0.082	6.12± 0.044	0.721± 0.004	15.68± 0.002
Mixture	5.246± 0.004	3.486± 0.080	107.11± 0.081	9.46± 0.001	6.12± 0.482	0.732± 0.004	15.64± 0.002
Significance	P=0.0026 P<0.05	P=0.003 P<0.05	P=0.026 P<0.05	P=0.01 P<0.05	P=3.12 P>0.05	P=3.008 P>0.05	P=0.9 P>0.05

Among chemical factors nitrogen showed high variation in different medium. It was 1146, 3836, 3446, 3110 and 3942 ppm for control, cow dung soil, vegetable waste soil, leaf soil and mixture of these respectively. Phosphorus and potassium also showed marked variations in different medium whereas calcium and magnesium showed variation between control and different medium only (Table 2).

Table 2
Chemical factors of soil of different media (Mean±SE)

Medium/Factor	Nitrogen (ppm)	Phosphorus (ppm)	Potassium (ppm)	Calcium (ppm)	Magnesium (ppm)
Control	1146± 0.026	2.822± 0.124	112.8± 0.21	2112± 12.46	117.2± 0.43
Cow dung	3836± 4.283	5.424± 0.824	318.2± 10.21	2126± 6.67	116.3± 0.771
Vegetable waste	3446± 6.7261	4.433± 4.21	521± 0.482	2210± 7.112	117.3± 0.112
Leaves	3110± 8.821	3.428± 1.112	386.2± 2.112	2340± 2.342	118.32± 0.112
Mixture	3942± 12.461	7.432± 0.482	372± 2.112	2420± 2.143	116.34± 0.823
Significance	$P=7.3X10^{-23}$ P<0.01	$P=1.45X10^{-2}$ P<0.01	P=0.0004 P<0.01	P=1.28 P>0.05	P=1.32 P>0.05

b. Sex ratio in relation to nutrient composition of medium

Males and females of length ranging from5-11 mm were obtained from different medium. The control soil had more number of males when compared to females. The ratio of male and female were almost equal in the medium with cow dung and medium of mixture of dung, leaves and vegetable wastes. The number of females were too high in the medium with vegetable waste and medium with leaves (Table 3).

Table 3
Sex ratio of *Phyloscia javanensis* in different medium

Length in mm	Ratio of males to females in different medium				
	Control	Cowdung	Vegetable waste	Leaves	Mixture
5-7	15:1	1:1	1:14	1:12	1:1
6-7	14:1	1:1.2	1:18	1:10	1:1
7-8	18:1	1:1.3	1:16	1:9	1:1.1
8-9	16:1	1:1.2	1:14	1:9.3	1:1.3

9-10	15:1	1:13	1:13	1:8.2	1:1.4
10-11	14:1	1:14	1:12	1:7.2	1:1.2

c. Breeding cycle in relation to the soil properties of the medium

From the hand sorted individuals females were separated. From these ovigerous females were separated. It was found that percentage of ovigerous females was very high in the medium with mixture of dung, leaves, vegetable wastes(85.7%) followed by medium with dung (78.04%) then medium with vegetable wastes (68.9%); leaves (66.66%) and in control agriculture soil (43.59%). It is clear that the nutrients in the medium has a direct effect on the fecundity of female isopod (Table 4).

Table 4
Breeding females of *Phyloscia javanensis* in different medium

Medium/Factor	Total number of females	Number of ovigerous females	Percentage of ovigerous females
Control	78	34	43.59
Cow dung	82	64	78.04
Vegetable waste	74	51	68.9
Leaves	78	52	66.66
Mixture	70	60	85.7

d. Clutch size

In *Phyloscia javanensis* there is a relation between body size and clutch size. The largest number of eggs in the marsupium of females were observed in the largest female. The number of eggs/juveniles in the brood pouch of females were more in the medium of mixture, followed by vegetable wastes, dung, leaves and control (Table 5). There is significant difference in the number of juveniles ($p<0.01$) and eggs ($p<0.05$) in different media.

Table 5
Mean number of juveniles and eggs in the marsupium of brood female isopods in different

Medium/Factor	Number of juveniles in the marsupia	Number of eggs in the marsupia
Control	6	4
Cow dung	15	8
Vegetable waste	16	13
Leaves	11	9
Mixture	18	14
Significance	P<0.01, F=3.001	P<0.05, F=4.828

e. Incidence of intersexuality in different media

Phyloscia javanensis is sexually dimorphic. Males possessing modified 1st, 2nd and 3rd pereopods and a petasma modified from 1st and 2nd pleopods. In females the thoracic region is broader than males, characterized by the presence of a broad pouch composed of imbricately arranged oostegites in the ovigerous forms. In the ovigerous females the brood pouch contains developing egg or juveniles. Fecundity is related to the size of ovigerous females as reported by Achouri *et. al*., 2010. Intersexuality has been noted in all cultures. All the intersexes observed had male external features with a slight expansion of last abdominal segments. Such specimens on dissection had only one testis and other forward into ovary. Some had one rudimentary testis and paired ovaries. It was found that the medium has a role in the development of intersexuality. Highest numbers of intersexes were found in the medium of mixtures followed by vegetable wastes lowest in the medium of leaves (Table 6).

Table 6
Percentage of intersex individuals in different media

Medium/Factor	Percentage of intersex with reduced testis and one pair of ovaries	Percentage of intersex with one testis and one ovary
Control	4	2
Cow dung	14	3
Vegetable waste	8	6
Leaves	4	3
Mixture	10	8

The sex ratio of isopod depends on the nutrient composition of medium. Although all the animals in different media were given same type of food and introduced equal number of males and females in each media in the beginning of experiment. Survival and propagation of male were more in control media, survival and propagation of females were more in leaf soil and vegetable waste soil and survival and propagation of both sexes were equal in dung and mixture soil. From the experiment it was revealed that pH and organic carbon content of the medium influences sex ratio. Males propagate more in medium with high pH and moderate organic content and female propagate more in soil with low pH and low organic carbon content and both sexes propagate well in moderate pH and high organic carbon content.

Percentage of ovigerous females depends on the amount of nitrogen and phosphorous in the media. If the amount of nitrogen and phosphorous is low in the medium, the egg development in female is reduced. This is true in the case of number of juveniles in the marsupial of female also.

The development of intersex also has direct relationship with nitrogen and phosphorous content of the soil. If these elements are more in the medium incidence of intersex formation is also more. Isopods have thin cuticle covering of the body. They can absorb nutrients of the medium into the body fluid through this thin body wall. So the availability of nutrients in the soil has great influence in the reproductive behavior of terrestrial isopods.

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