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Nutritional efficiency of the potential biocontrol agent *Galerucella placida* Baly on different species of polygonaceae weeds

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Abstract
Polygonum generally known as Knotweed is a large genus consisting of weedy plants. Many species of polygonaceae family are the weeds especially in the irrigated rice cultivation and tea estates of North East India. As there is expected level of potentially hazardous to environment due to the chemical control measures for this weed which is also a costliest one and requires long term application with the cost of detrimental effects on non target wetland plants. Biological control offers the most logical approach for controlling the weed in the most effective and least environmentally damaging way. Chrysomelidae leave beetle *Galerucella placida* Baly is the insect feeds on aquatic weeds of polygonaceae which can be utilized for the biological control programme. In order to find the efficiency of *Galerucella placida* on different species of Polygonaceae weeds, different nutritional indices such as approximate digestibility (AD), relative consumption rate (RCR), relative growth rate (RGR) and efficiency of conversion of digested food (ECD) are tested under the laboratory condition. The relative growth rate (RGR) and the relative consumption rate (RCR) of *G. placida* was highest on *P. hydropiper* (Linn.) Spach as (0.10 mg/day/mg) and (2.04 mg/day/mg) respectively which was found to be lowest on *P. perfoliatum* Linn. (0.07 mg/day/mg) and *P. perfoliatum* Linn. (0.07 mg/day/mg) respectively. The highest value of approximate digestibility (AD) was recorded in case of *P. densiflorum* Blume (97.89%) followed by *P. minus* Huds. (96.73%). Efficiency of conversion of digested food (ECD) was highest in case of *P. perfoliatum* Linn. (8.92%) followed by *P. minus* Huds. (6.17%) and lowest on *P. hydropiper* (Linn.) Spach (4.22%). Similarly larvae fed on *P. perfoliatum* Linn. (8.19%) had the highest value of efficiency of conversion of ingested food (ECI) and the lowest on values of ECI were in the larvae reared on *P. hydropiper* (Linn.) Spach (4.01%).

Keywords: Biocontrol, polygonaceae weeds, *Galerucella placida,* nutritional indices

Introduction
Polygonum generally known as Knotweed is a large genus consisting of weedy plants. They can thrive well in disturbed areas and spread very fast by both natural means and human activity. Many species of *Emex*, *Polygonum* and *Rumex* of Polygonaceae family are competitive weed in larger number of crops, especially in the crops grown under irrigated conditions such as rice and tea estates of North East India on poorly drained soils [6]. *P. hydropiper* is an annual vine indigenous to temperate regions of the South East Asia such as Bhutan, China and India [36]. Due to the dense, prickly thickets nature that displace native vegetation *P. perfoliatum* has been listed as a noxious weed [23, 21, 24]. *P. minus* Huds is a perennial herb of distinctly wet situations, such as swamps and ditches but at higher altitudes it is also a weed of plantations and pastures cultivated lands [35]. Smart weed is highly competitive and eliminates desirable's native plants and poses an important weed in low lying wet areas. Very less work has been conducted on the chemical control aspects of these weed species [25, 27] which is also a costly, requires long term application with the cost of detrimental effects on non target wetland plants and potentially hazardous to environment. As simply breaking the stem will result in resprouting at the soil surface, cultural control also takes lot of labours, as they must be uprooted. Contrary to all these, biological control offers the most logical approach for controlling the weed in the most effective and least environmentally damaging way. Highly cost effective, non-polluting and self sustaining method for controlling these noxious weeds is Biological control. A small leaf beetle of the the family Chrysomelidae is *Galerucella placida* Baly. The insect feeds on aquatic weeds like *Polygonum hydropiper* L. Spach belonging to the family polygonaceae [9].

There are also reports from India stating *G. placida* Baly feeding on *P. hydropiper* [15]. Both the beetle and grub feed voraciously on polygonum leaf. Description of the insect was given by Lefroy [15] and Maulik [20]. A large population of *P. hydropiper* was found to be fed voraciously and killed by the insect in the Imphal region of Manipur and bords of Myanmar in 2012 [9]. However, detail works on the growth habit, development, feeding performance of *G. placida* on these plants have not been studied. The detailed information of efficiency of food utilization and responses to food consumption when the insect was feeding upon the host plant is mandatory. The quantity [7, 38, 39, 37, 12, 11] as well as quality (1, 5& 26) of the food consumed by the insect decides survival and reproduction of the phytophagous insects. There are numerous studies on effect of the quality [16, 22, 28, 19] and quantity of food on insects [29, 8, 30, 10]. There are several indices contrived for the vertebrate nutrition such as consumption, digestibility and efficiency of conversion [13, 32] and using of these indices in insects have been discussed by many authors [31, 4, 38, 39].
Therefore, keeping in view of the above consideration, a research programme was undertaken on the nutritional indices for *Galerucella placida* Baly to identify the most efficient host weed for the consumption and conversion as food.

Materials and methods

The investigation on "various nutritional indices of *G. placida* on some Polygonaceous plants." was carried out in the laboratory of the Department of Entomology, College of Agriculture, Central Agricultural University, Imphal during 2015.

Polygonaceous species used for study

Nutritional indices of *G. placida* were determined on six polygonaceous plants viz;

1. *Polygonum hydropiper* L. Spach,
2. *Polygonum chinense* var. *brachiata* Meissn.,
3. *Polygonum perfoliatum* L.,
4. *Polygonum minus* Huds.,
5. *Polygonum glabrum* Willd.,
6. *Polygonum densiflorum* Blume.

The Egg masses from the beetle were collected from *Polygonum hydropiper* L. Spach from the field during June-July. Eggs laid on the leaf were brought to laboratory and kept over a moist blotting paper in petridishes in laboratory at room temperature for hatching. Ten newly hatched preweighed larvae were released on the preweighed leaves of each test plant in petridishes over a moist blotting paper. After 24 hours of feeding, the faeces were removed and dried in oven at 60 °C for 48 hours to obtain dry weight of feaces. The weight of leaf area consumed after removing the faecal matters was measured. The leaves were dried at 60 °C for 48 hours and dry weight of the consumed leaves was obtained. The container was cleaned and newly weighed leaves were provided. This process was continued each day in each replicatation until the formation of pupal stage with the ceased food consumption.
Estimation of daily food consumption of each larva was done by subtracting weight of remaining leaf tissues from the weight of initial leaf that was provided. Dry weight is taken for measuring the nutritional indices. The weight of the pupa and adult from the larvae reared on each test plant were also estimated. Additionally weight of the faeces produced by the larvae on each test plant was also registered daily. Dry weights of the leaves, feaces, and larval stages were weighed after oven-drying them at 60 °C for 48 hours.
The method recommended by Waldbauer [33], Huang and Ho [8] was followed for calculating nutritional indices on the basis of dry weight to calculate efficiency of conversion of digested food (ECD), efficiency of conversion of ingested food (ECI), relative consumption rate (RCR), relative growth rate (RGR) and approximate digestibility (AD).

$$RCR = I/b \times T$$

$$RGR = B/b \times T$$

$$ECI\ (\%) = B/I \times 100$$

$$ECD\ (\%) = B/(I-F) \times 100$$

$$AD\ (\%) = (I-F)/I \times 100$$

Where, 'I' is the dry weight of food consumed, 'F' is the dry weight of feaces produced, 'T' is days of feeding, 'b' is the gained mean larval weight in the feeding duration and 'B' is biomass of the larva.

Statistical analysis

The experiment was set up in Completely Randomized Design with three replications.

Analysis of Variance

The percent data of the evaluation were transformed by using arc sin transformation. Analysis of variance technique was used to statistically analyse the transformed data. When the treatment means were found significant with the F values then the means were compared by using C.D. (critical difference) values. In this way, separation of means were done by LSD test.

Results and Discussion

The highest dry weight of food consumed by *G. placida* larva fed was obtained on *P. hydropiper* (Linn.) Spach (18.20 mg) followed by *P. glabrum* Willd. (16.63 mg), *P. chinense* (Linn.) var. *brachiata* Meissn. (15.67 mg), *P. densiflorum* Blume (13.78 mg) and *P. minus* Huds. (10.72 mg) and was lowest on *P. perfoliatum* Linn. (6.71 mg) (Table 1 & Graph 1). The dry weight of faeces produced by *G. placida* was highest on *P. glabrum* Willd. (1.17 mg) which was statistically at par with *P. chinense* (Linn.) var. *brachiata* Meissn. (0.96 mg) and *P. hydropiper* (Linn.) Spach (0.91 mg). It was lowest when fed on *P. densiflorum* Blume (0.29 mg) and was at par with *P. minus* Huds. (0.35 mg) *and P. prefoliatum* Linn. (0.55 mg). Dry weight gained by the larva was highest on *P. hydropiper* (Linn.) Spach (0.73 mg) followed by *P. chinense* (Linn.) var. *brachiata* Meissn. (0.71 mg), *P. densiflorum* Blume (0.70 mg), *P. glabrum* Willd. (0.69 mg), *P. minus* Huds. (0.64 mg). It was lowest on *P. prefoliatum* Linn. (0.55 mg). As it was stated by Foss and Rieske [3] physiological features and chemical characteristics of the host plants decides the process of herbivore host reception and suitability. Ability of the insects to store energy closely depends on the influence of the host plant that insects pass their larval stages on [18]. Body weight is an important fitness index of insect population dynamics is also obtrusive [19]. Among the different host plants used in the present experiment, the lowest weight gain of larvae was noticed on *P. perfoliatum* Linn. which suggests the low-nutritive value of the particular weed species for insect.

P. minus *P. glabrum* *P. hydropiper* *P. chinense*

Fig 1: *Galerucella placida* feeding on different species of Polygonacea weeds

Nutritional indices of larva fed on the six host plants shown in Table 2 and Graph 2 recorded highest value of AD in the larvae fed on *P. densiflorum* Blume (97.89%) followed by *P. minus* Huds. (96.73%), *P.hydropiper* (Linn.) Spach (95.00%). This showed that although the dry weight of food consumed in *P. densiflorum* Blume was less than those consumed in case of *P. hydropiper* (Linn.) Spach but the approximate digestibility was higher in case of *P. densiflorum* Blume which indicated that the actual digestion of food is more in case of *P. densiflorum* Blume. The AD value obtained was lowest when fed *P. prefoliatum* Linn. (91.80%). The current findings are also in line with Batista Pereira [2] who stated that the amount of food utilization is dependent on the efficiency of digested food to convert in to biomass.

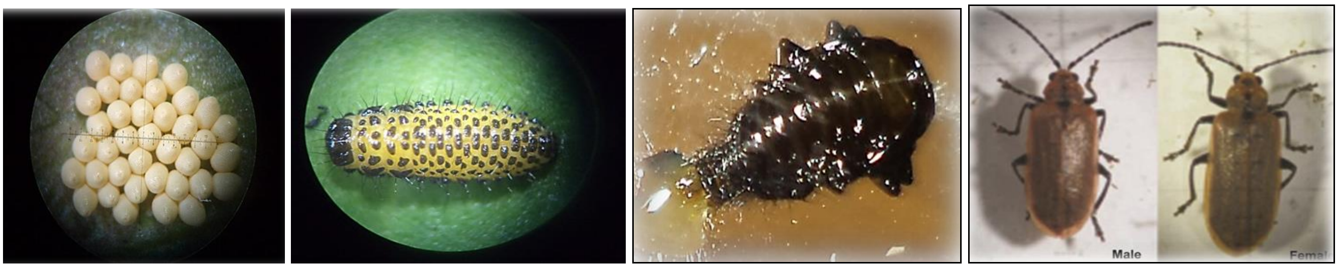


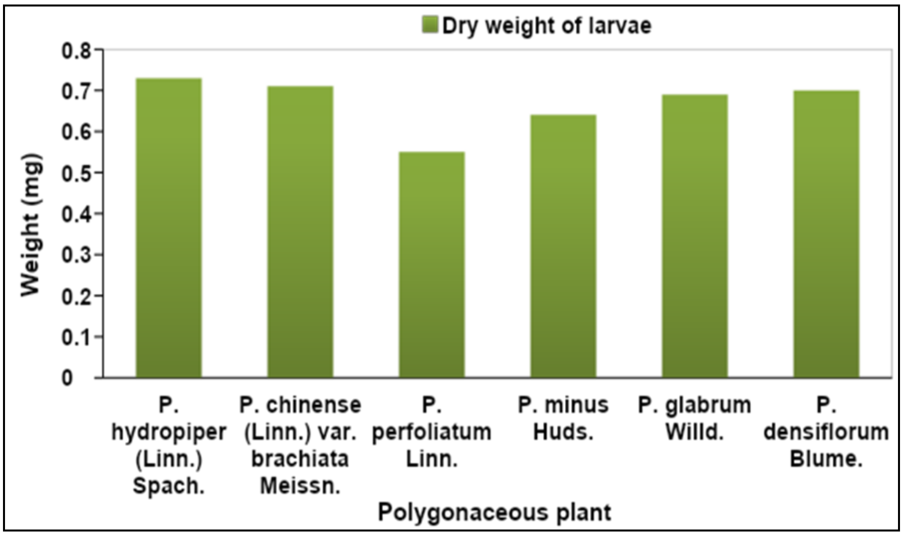
Fig 2: Different life stages of *Galerucella placida* Baly

The present study showed that the value of ECI of larva was highest on *P. perfoliatum* Linn. (8.19%) followed by *P. minus* Huds. (5.97%) and *P. densiflorum* Blume (5.07%) which can be correlated with the extravagant ability of the larvae converting the ingested food to body mass when fed on these plants. The value of ECI obtained was lowest on *P. hydropiper* (Linn.) Spach (4.01%) which can be attributed to low ability to the larvae in converting the ingested food to body mass when fed on *P. hydropiper* (Linn.) Spach. The higher efficiency in modifying the digested food in to growth is recorded on the larvae reared on *P. perfoliatum* Linn. (8.92%), *P. minus* Huds. (6.17%) and *P. densiflorum* Blume (5.18%) which is indicated by the higher ECD. On the contrary, lower ECD in the larvae fed on *P. hydropiper* (Linn.) Spach (4.22%), *P. glabrum* Willd. (4.46%) and *P. chinense* (Linn.) var. *brachiata* Meissn. (4.82%) indicated lower efficiency in modifying the digested food in to growth. As reported by Batista Pereira [2] the amount of food utilization could strongly be influenced by the digestibility of food that is consumed and the efficiency of conversion of digested food in to biomass. Feeding indices especially ECI and ECD values of insects are affected by the influence of digestive enzymes as stated by Lazarevic *et al.* [15]. Thus, the activity of primary and secondary host plant metabolites can be a one reason behind the differences in ECI and ECD values. More over the larvae reared on *P. perfoliatum* Linn. had the high value of ECI but with the lowest value of RCR and RGR. In comparison to this, the RCR value of the larvae fed on *P. hydropiper* (Linn.) Spach was highest (2.04 mg/day/mg) which also had lowest ECI as well as ECD value. It is also clear that high RCR and RGR values are associated with the larval weight increase and this weight gained could have a direct connection with ECI. In the present experiment, larvae fed on *P. hydropiper* (Linn.) Spach showed highest values of RCR and RGR proposing that *P. hydropiper* (Linn.) Spach was more nutritious for *G. placida* larvae than other host plants evaluated. The order of suitability of various polygonaceous plants for *G. placida* was *P. hydropiper* (Linn.) Spach > *P. chinense* (Linn.) var. *brachiata* Meissn. > *P. glabrum* Willd. > *P. densiflorum* Blume > *P. minus* Huds. > *P. perfoliatum* Linn.

Table 1: Weights of food consumed, faeces produced and weight gained by *G. placida* larvae fed on some polygonaceous plant

Plant (leaves)	**Dry weight of food consumed (mg)**	**Dry weight of faeces produced (mg)**	**Dry weight of larvae (mg)**
P. hydropiper (Linn.) Spach	18.20^{a}	0.91^{ab}	0.73^{a}
P. chinense (Linn.) var. *brachiata* Meissn.	15.67^{c}	0.96^{ab}	0.71^{ab}
P. perfoliatum Linn.	6.71^{f}	0.55^{b}	0.55^{b}
P. minus Huds.	10.72^{e}	0.35^{bc}	0.64^{ab}
P. glabrum Willd.	16.63^{b}	1.17^{a}	0.69^{ab}
P. densiflorum Blume	13.78^{d}	0.29^{bc}	0.70^{ab}
S.E. (d)	0.06	0.23	0.05
CD (P=0.05)	0.14	0.51	0.11

Data represent mean of 3 replications (10 individuals/replication) Means followed by different letters are significantly different at 5% level Means are separated by LSD test; Dry wt. are taken at 60 ℃ for 48 hours.

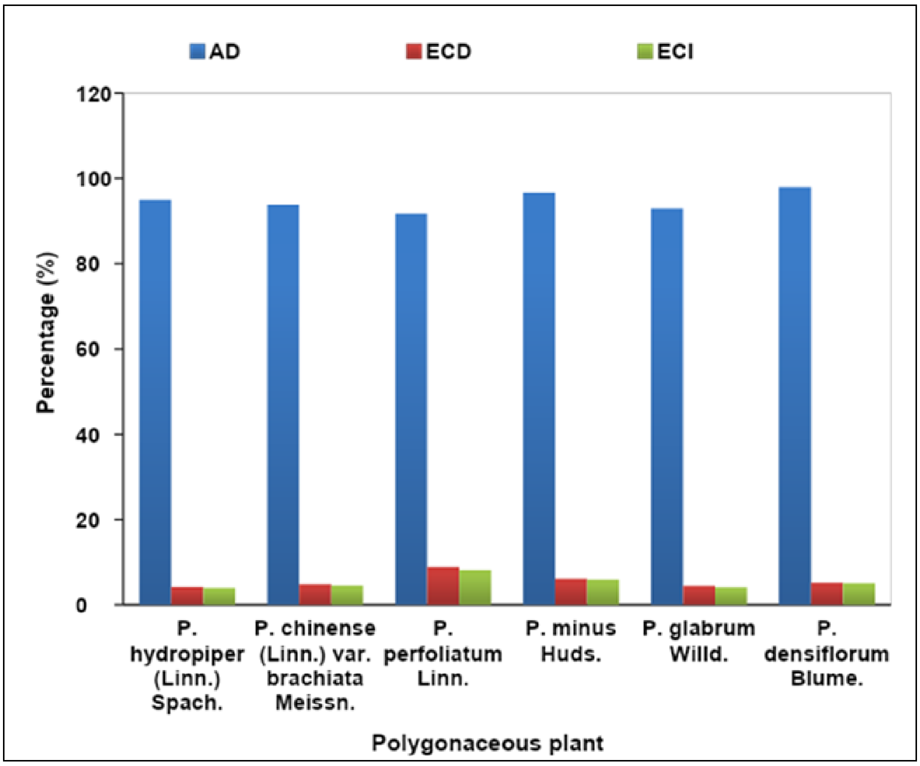


Graph 1: Dry weights of *G. placida* larvae feed on different species of polygonacea

Table 2: Nutritional indices of *G. placida* larvae fed on some polygonaceous plant

Plant (leaves)	Approximate Digestibility (%)	Efficiency of Conversion of Ingested Food (%)	Efficiency of Conversion of Digested Food (%)	Relative Consumption Rate (mg/day/mg)	Relative Growth Rate (mg/day/mg)
P. hydropiper (Linn.) Spach	95.00(77.05) ^{c}	4.01(11.56) ^{d}	4.22(11.81) ^{f}	2.04^{a}	0.10
P. chinense (Linn.) var. *brachiata* Meissn.	93.87(75.64) ^{d}	4.53(12.29) ^{cd}	4.82(12.67) ^{d}	1.75^{b}	0.09
P. perfoliatum Linn.	91.80(73.37) ^{f}	8.19(16.62) ^{a}	8.92(17.35) ^{a}	0.82^{e}	0.07
P. minus Huds.	96.73(79.57) ^{b}	5.97(14.13) ^{b}	6.17(14.36) ^{b}	1.34^{d}	0.08
P. glabrum Willd.	92.96(74.53) ^{e}	4.14(11.72) ^{d}	4.46(12.19) ^{e}	1.73^{bc}	0.09
P. densiflorum Blume	97.89(81.63) ^{a}	5.07(12.98) ^{c}	5.18(13.16) ^{c}	1.47^{c}	0.08
S.E. (d) CD (P=0.05)	(0.06) (0.13)	0.05 0.12	0.06 0.13	0.05 0.12	0.02 NS

Data represent mean of 3 replications (10 individuals/replication)
*Figures in parentheses are transformed angular values
Means followed by different letters are significantly different at 5% level
Means are separated by LSD test



Graph 2: Nutritional indices of *G. placida* larvae fed on some polygonaceous plant

Conclusion

Polygonum hydropiper (Linn.) Spach is likely to be highlt suitable host for feeding of *Galerucella placida* as the larva recorded highest values of weight gained, RGR and RCR with the lowest values of ECI and ECD. Most unsuitable host for *G. placida* is *P. perfoliatum* since the lowest values for larval weight gained, RGR and RCR index, AD and highest values for ECI and ECD is observed on the weed species. *G. placida* was a voracious feeder of polygonaceous plants and has potential to be used as biocontrol agents for controlling polygonaceous plants. The present study indicates there is scope to culture the insect in mass for its release in field for controlling the polygonaceous plants effectively.

References

1. Barney WP, Rock GC. Consumption and utilization by the Mexican bean beetle of soybean plants varying in levels of resistance. J Econ. Entomol. 1975; 68:497-501.
2. Batista Pereira GL, Petacci F, Fernandes BJ, Correa AG, Vieira PC, Silva MF *et al*. Biological activity of astilbin from *Dimorphandra mollis* against *Anticarsia gemmatalis* and Spodoptera frugiperda. Pest Management Science. 2002; 58:503-507.
3. Foss LK, Rieske LK. Species-specific differences in oak foliage affect preference and performance of gypsy moth caterpillar. The Netherlands Entomological Society,2003; 108:87-93.
4. Gordon HT. Minimal nutritional requirements of the German roach, *Blattella germanica* L. Ann. N.Y. Acad. Sci., 1959; 77:290-351.
5. Hatchett JH, Beland GL, Hartwig EE. Leaf-feeding resistance to bollworm and tobacco budworm in three plant introductions. Crop Sci. 1976; 16:277-280.
6. Holm LG, Doll J, Holm E, Pancho JV, Herberger JP. World Weeds: Natural Histories and Distribution. New York, USA: John Wiley & Sons Inc, 1997.
7. Honek A. Intraspecific variation in body size and fecundity of insects: a general relationship. Oikos, 1993; 66:483-492.
8. Huang Y, Ho SH. Toxicity and antifeedant activity of cinamaldehyde against the grain storage insect, *Tribolium castaneum* and *Sitiphilus zeamais*. J Stored Prod. Res., 1998; 34:11-17.
9. Imsland AK, Foss A, Gunnarsson S, Berntssen M, FitzGerald R, Bonga SW, Naevdal G *et al*. The interaction of temperature and salinity on growth and food conversion in juvenile turbot (*Scophthalmus maximus*). *Aquac*. 2001; 198:353-367.
10. Indranisana RK. Studies on biology of *Galerucella placida* Baly infesting *Polygonum hydropiper* Linn. M.Sc. Thesis, Central Agricultural University, Imphal, India. 2014, 38.
11. Jalali MA, Tirry L, Clercq PD. Effects of food and temperature on development, fecundity and life-table parameters of *Adalia bipunctata* (Coleoptera: Coccinellidae). J Entomol., 2009; 133:615-625.
12. Karsai I, Hunt JH. Food quantity affects traits of offspring in a paper wasp, *Polistes metricus*. Environ. Entomol. 2002; 31:99-106.
13. Kelly L, Debinski DM. Effects of larval food-limitation on *Vanessa cardui* Linnaeus (Lepidoptera: Nymphalidae). Am. Midl. Nat. 1999; 141:315-322.
14. Kleiber M, The Fire of Life. Wiley, New York, 1961.
15. Lazarevic J, Peric-Mataruga V, Vlahovic M, Mrdakovic M, Cvetanovic D. Effects of rearing density on larval growth and activity of digestive enzymes in *Lymantria dispar* L. (Lepidoptera: Lymantriidae). Folia Biologica, 2004; 52:105-112.
16. Lefroy MH. Indian Insect Life. A manual of the insects of the plains (Tropical India). 1909, 4.
17. Levesque KR, Fortin M, Mauffette Y. Temperature and food quality effects on growth, consumption and post-ingestive utilization efficiencies of the forest tent caterpillar *Malacosoma disstria* (Lepidoptera: Lasiocampidae). Bull. Entomol. Res. 2002; 92:127-136.
18. Liu Z, Gong P, Wu K, Wei W, Sun J, Li D. Effects of larval host plants on overwintering preparedness and survival of cotton bollworm, *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae). J Insect Physiol., 2007; 53:1016-1026.
19. Liu Z, Li D, Gong PY, Wu KJ. Life table studies of the cotton bollworm, *Helicoverpa armigera* (Hubner) (Lepidoptera, Noctuidae), on different host plants. Environ.l Entomol., 2004; 33:1570-1576.
20. Massey FP, Hartley SE. Physical defenses wear you down: progressive and irreversible impacts of silica on insect herbivores? J Animal Ecol., 2009; 78:281-291.
21. Maulik S. The Fauna of British India, including Ceylon and Burma. Coleoptera: Chrysomelidae (Galerucinae). Taylor and Francis, London, 1936, 648.
22. McCormick LH, Hartwig NL. Control of noxious weed mile-a-minute (*Polygonum perfoliatum* L.) in reforestation. Northern J Appl. For., 1995; 12:127-132.
23. Moreau J, Berney B, Thiery D. Assessing larval food quality for phytophagous insects: are the facts as simple as they appear. J Compilation British Ecol. Soc. 2006; 20:592-600.
24. Mountain WL. Mile-a-minute weed (*Polygonum perfoliatum* L.) update distribution, biology, and control suggestions. Pennsylvania Department of Agriculture, Bureau of Plant Industry, Regulatory Horticulture. Weed Circular. 1989; 15:21-24.
25. Oliver JD. Mile-a-minute weed (*Polygonum perfoliatum* L.), an invasive vine in natural and disturbed sites. Castanea. 1996; 61:244-251.
26. Park TS, Park JE, Ryu GH, Lee IY, Lee HK, Lee JO. Effective weed control in direct-seeded rice under dry fields. Korean J of Weed Sci. 1995; 15(2):99-104.
27. Scriber JM, Slansky FJR. The nutritional ecology of immature insects. Ann. Rev. Entomol. 1981; 26:183-211.
28. Seong KY, Lee CW, Oh YJ, Park RK, Kyon YW. The systematic application of herbicides for dry-drill seeding of rice. Res. Rep. Rural Dev. Adm. Rice. 1991; 33(2):41-45.
29. Sillanpaa S. How do food quality and larval crowding affect performance of the autumnal moth, *Epirrita autumnata*? Entomol. Exp. Appl., 2008; 129(3):286-294.
30. Slansky FJR. Quantitative food utilization and reproduction allocation by adult milkweed bugs *Oncopelyus fasciatus*. Physiol. Entomol., 1980; 5:73-86.
31. Temming A, Herrmann JP. A generic model to estimate food consumption: linking von Bertalanffy's growth model with beverton and holt's and lvlev's concept net conversion efficiency. Can. J Fish. Aquat. Sci. 2008; 66:683-700.
32. Trager W. Insect Physiology, Wiley, New York. K.D. Roeder (Ed.), 1953, 350.
33. Tyler C. Animal Nutrition. Chapman & Hall, London.

1964, 253.
34. Waldbauer GP. Growth and reproduction of maxillectomized tobacco hornworms feeding on normally rejected non-solanaceous plants. Entomol. Exp. Appl. 1962; 5:147-158.
35. Waldbauer GP. The consumption, digestion and utilization of Solanaceous and non-Solanaceous plants by larvae of the tobacco hornworm, *Protoparce sexta* (Johan.) (Lepidoptera: Sphingidae). Entomol. Exp. Appl. 1964; 7:253-269.
36. Womersley JS. Hand books of the Flora of papua New Guinea, Melbourne university press, Melbourne. 1978; 1:278.
37. Wu Z, Raven PH. Flora of China. Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis. Multiple volumes, some in draft form. 2003. Available from http://flora.huh.harvard.edu/ china/.
38. Yasuda H. Effects of prey density on behaviour and development of the predatory mosquito, *Toxorhynchites towadensis*. Entomol. Exp. Et Appl. 1995; 76:97-103.
39. Zheng Y, Danne KM, Hagen KS, Mittler TE. Influence of larval dietary supply on the food consumption, food utilization efficiency, growth and development of the lacewing *Chrysoperla carnea*. Entomol. Exp. Appl., 1993; 67:1-7.
40. Zheng Y, Danne KM, Hagen KS, Mittler TE. Influence of larval food consumption on the fecundity of the lacewing *Chrysoperla carnea.* Entomol. Exp. Appl., 1993a; 67:9-14.