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# Life table parameters of *Glyphodes pyloalis* Walker (Lep.: Pyralidae) on four varieties of mulberry *Morus alba* L. (Moraceae)

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ABSTRACT

Lesser mulberry pyralid, *Glyphodes pyloalis* Walker, is a monophagous pest of mulberry and has recently been reported from northern Iran. The effect of four varieties of mulberry *Morus alba* L. (Ichinose, Shin Ichinose, Kenmochi and Mahalii) on the life table parameters and biological characteristics of *G. pyloalis* Walker, was studied at 24 ± 1 °C, relative humidity of 75 ± 5% and a photoperiod of 16: 8 (L: D) h. The developmental time of immature stages was longest on Kenmochi being 37.6 days. The intrinsic rate of increase ($r_m$) was significantly affected by various mulberrys being the highest on Mahalii (0.160) and the lowest on Kenmochi (0.127). The highest and lowest finite rates of increase (λ) were observed on Mahalii 1.174 and Kenmochi 1.136, respectively. The highest amount of gross reproductive rate and the lowest mean generation time (*T*) was observed on Mahalii. The results obtained in this study indicated that Mahalii appeared to be the most susceptible host to *G. pyloalis* among the tested varieties.


## Introduction

Mulberry is the sole host for silkworm (*Bombyx mori* L.) and is also used as shade trees in cities (Kumar et al., 2002). Lesser mulberry pyralid, *Glyphodes pyloalis* Walker, is a monophagous pest of mulberry and has been reported in northern Iran since 2006 (Jaafari Khaljiri et al., 2006). The mulberry moth *G. pyloalis* Walker (Lepidoptera: Pyralidae) on the leaves of mulberry trees is distributed in the USA (Florida, Mississippi and Virginia States), Mexico, India, Japan, Iran, Central Asia and Azerbaijan (Kanchaveli et al., 2009;).

Larvae form threads on the outer part of mulberry leaves and feed on the mesophyll from under those threads, leaving only a network of epidermis (Aruga, 1994). If leaves infected with excreta of larvae are fed to silkworms, they develop constipation and are unable to defecate (Aruga, 1994). In addition, *G. pyloalis* larvae are considered alternate hosts of *Bombyx* densoviruses and picornaviruses (Watanabe et al., 1988). This pest has caused severe damages on mulberry plantations in northern Iran and has turned into a serious concern to silk industry (Khosravi and Jalali Sendi, 2010).

Host plant resistance among crop plants is a major part of integrated pest management (IPM) and is relatively constant, cheap, non-polluting, and compatible with other methods of pest control (Sachan, 1990; Jallow et al., 2004). Studying the various biological, physiological and ecological characteristics of a pest on different hosts are of immense importance in finding a resistant host (Sarfraz et al., 2007).

Antibiosis mechanisms in resistance plants may directly decrease insect survival, size or weight, longevity and fecundity of adults, or they may have an indirect effect by increasing exposure of the insect to its natural enemies due to a prolonged period of development (Sarfraz et al., 2006: Razmjou et al., 2014).

The quality and quantity of the food affects an insect's biology (Razmjou et al., 2006; Soufbaf et al., 2010a,b). In other words what the plant feeding insect eats affects its fitness (Du et al., 2004). Demographic information may also be useful in constructing population models (Carey, 1993). The life table provides a comprehensive description of the survivorship, development and reproduction of any population which could be regarded as essential tools in both theoretical and applied ecology (Taghizadeh et al., 2008). Various host plants can affect life history traits of the insects such as development, survival and reproductive rates (Tsai and Wang, 2001; Kim and Lee, 2002), and have main role in regulating insect populations (Umbanhowar and Hastings, 2002). The shorter developmental time and greater total reproduction of insects on a host plant indicate greater suitability of that plant (van Lenteren and Noldus, 1990).

Population growth rate is a basic ecological characteristic that is usually described as the intrinsic rate of increase (r), an estimate of population growth potential introduced by Birch (1948). Southwood (1966) stated that the intrinsic rate of increase is the most practical life table parameter to compare the population growth potential of different species under specific climatic and food conditions and may help predict the outcomes of pest–natural enemy interactions (Roy et al., 2003). The intrinsic rate of increase (r) summarizes the physiological qualities of an animal relative to its capacity to increase

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(Andrewartha and Birch, 1954). Besides being a measure of population growth, r has been widely used as a bioclimatic index (Hulting et al., 1990), in estimation of insect response to resistant plants (Ruggle and Gutierrez, 1995), and in comparison of different food types that predators consumed (Engel, 1990). Although a large number of factors affect the components of r, there is a close and positive association between the mean relative growth rate and r (Guldemond et al., 1998).

Pests usually cause more damages on susceptible host plants by forming a higher population growth rate than on resistant ones. For this reason, having a basic knowledge on the population of a pest on different varieties of a host plant may provide an idea about the resistance or susceptibility of a particular host. No information is currently available on the life table parameters of *G. pyloalis* on different mulberry varieties.

The goal of this research was to determine the biological characteristics and life table parameters of *G. pyloalis* on four varieties of mulberry.

## Materials and methods

### Insect rearing and plant material

Four host plants were used in this study, including Kenmochi, Ichinose, Shin Ichinose and Mahalii. These varieties were selected because they are the most important economic varieties used in Iran to rear silkworms. Given the economic importance as the sole source of nutrition mulberry silkworm pests study examined the tree is of particular importance. These varieties were collected from mulberry orchards near the city of Rasht (37°16′51″N 49°34′59″E), northern Iran in July 2013. The larvae were reared on fresh leaves of mulberry varieties in the laboratory at 24 ± 1 °C, 75 ± 5% RH and 16:8 (L:D) h photoperiod in transparent plastic boxes (18 × 15 × 7) covered with muslin for aeration. When adults emerged they were separated and placed in transparent plastic boxes (18 × 70) with a 10% honey solution on cotton wool for feeding and mulberry leaves of each variety for oviposition. The eggs were transferred to four mulberry varieties with a camel brush in plastic boxes (18 × 15 × 7 cm) with humid cotton wool. The boxes and leaves were changed every two days for the first instar and second instar, and daily for older larvae.

### Growth and mortality of immature stages

This experiment was initiated with sixty eggs of *G. pyloalis* maintained on each variety. The hatching of eggs was carefully observed and recorded daily. Newly hatched larvae with a camel brush were transferred individually into a plastic box (5 × 6 × 12) and were provided with fresh mulberry leaves of each variety individually. The petioles of mulberry leaves were wrapped in humid cotton wool pieces in order to provide humidity to the leaves. The leaves were changed every two days for earlier instars and daily for older larval instars. Larval growth was observed daily and the number of larval instars was determined based on the remains of head capsules. Developmental stages were observed daily with a stereomicroscope and mortality of eggs to adult were recorded daily.

### Adult longevity and fecundity

A mating pair of each variety was transferred to a transparent cylindrical box (18 × 7 cm) with a 10% honey solution on a cotton wool for feeding and mulberry leaves for oviposition pre-oviposition, oviposition and post-oviposition periods were recorded. The oviposition boxes were observed daily and the number of dead insects was recorded. In the case of early female mortality, the male was provided with 10% honey and maintained until death. The oviposition box, the leaf and the cotton wool soaked in 10% honey were daily changed. The number of laid eggs was recorded daily. Observations continued until the death of the adults.

### Life table study and statistical analysis

Data obtained from above experiments were used to calculate the life and fertility parameters. The life history data were analyzed based on the age-stage and a two-sex life table analysis developed by Chi and Liu (1985); Chi (1988). TWOSEX-MSChart (Chi, 2005) that is written in Visual Basic for the Windows operating system was used for data analysis. The standard errors of the life table parameters were estimated with bootstrap technique (Sokal and Rohlf, 1995). The age-stage specific survival rate ($s_{xj}$) (where $x$ = age in days and $j$ = stage); the age-stage specific fecundity ($f_{xj}$) (daily number of eggs produced per female of age $x$); the age-specific survival rate ($l_x$); the age-specific fecundity ($m_x$) (daily number of eggs produced per individual i.e., this number is divided by all individuals (males and females) of age $x$); and the population growth parameters (the intrinsic rate of increase ($r$); the finite rate of increase ($\lambda$) that $\lambda = e^r$; the gross reproductive rate ($GRR$); the net reproductive rate ($R_0$) and the mean generation time ($T$)) are calculated accordingly (Khanamani et al., 2013; Safuraie-Parizi et al., 2014). To compare the means of the life table parameters, we used multiple comparison sections of TWOSEX-MSChart program in which uses the Tukey–Kramer procedure. The differences in development and reproduction were compared using one-way analysis of variance (ANOVA) and Duncan's multiple range tests at 0.05 level of significance. Statistical analysis was carried out using SPSS statistical software (SPSS, 2004).

## Results

### Developmental times and survival rate

Table 1 shows the developmental times of various stages of *G. pyloalis* on four mulberry cultivars. There were significant differences in the developmental time of immature stages among the four varieties

**Table 1**
Development of various stages of *G. pyloalis* on four varieties of mulberry at 24 ± 1 °C, 75 ± 5% RH and 16:8 (L: D) h.

| Stage | Ichinose | Shin Ichinose | Kenmochi | Mahalii |
|---|---|---|---|---|
| Incubation period | 4.05 ± 0.02b | 3.93 ± 0.04b | 4.44 ± 0.08a | 3.77 ± 0.06bc |
| First instar larvae | 2.95 ± 0.03ab | 2.94 ± 0.04ab | 3.04 ± 0.05a | 2.83 ± 0.06b |
| Second instar larvae | 2.03 ± 0.02ab | 2.00 ± 0.02c | 2.09 ± 0.04a | 2.00 ± 0.00c |
| Third instar larvae | 2.01 ± 0.01b | 2.02 ± 0.02b | 2.11 ± 0.05a | 2.00 ± 0.00b |
| Fourth instar larvae | 2.10 ± 0.04a | 2.12 ± 0.04a | 2.24 ± 0.06a | 2.09 ± 0.04a |
| Fifth instar larvae | 5.10 ± 0.06a | 4.64 ± 0.07b | 5.29 ± 0.08a | 4.73 ± 0.08b |
| Prepupae | 2.89 ± 0.06a | 2.4 ± 0.07b | 2.23 ± 0.06b | 2.00 ± 0.00b |
| Pupae | 8.71 ± 0.08a | 8.22 ± 0.15b | 9.43 ± 0.12a | 8.76 ± 0.16a |
| Adult (male) | 3.90 ± 0.19a | 4.55 ± 0.13a | 4.40 ± 0.18a | 4.85 ± 0.19a |
| Adult (female) | 9.65 ± 0.15a | 9.55 ± 0.18a | 9.60 ± 0.17a | 9.55 ± 0.19a |
| Total (male & female) | 35.80 ± 0.45bc | 36.66 ± 0.43ab | 37.64 ± 0.45a | 35.04 ± 0.43c |

The mean followed by the different letters within rows are significantly different at the 0.05 level (ANOVA).