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Orijinal araştırma (Original article)

Adult survival rate and oviposition preference of *Stephanitis pyri* (F., 1775) (Heteroptera: Tingidae) on different plant species

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Summary

Stephanitis pyri (F., 1775) is a pest of apple, pear trees and ornamental plants of Rosaceae in Palearctic Region. This study was conducted to determine that the oviposition preference of *S. pyri*, which is a poyphagous insect, in the laboratory conditions. No-choice and multi-choice tests were performed on the leaf of different host plant species. Leaves of 13 plant species were tested in no-choice tests. No eggs were laid on *Prunus persica* (L.) Batsch., *Aesculus hippocastanum* L., *Salix alba* L. and *Rhododendron indicum* (L.) Sweet in these tests. Total number of eggs was highest on *Prunus avium* L. (93.8 eggs), *Pirus malus* L. (80.1 eggs), *Rosa* sp. (77.3 eggs) and *Pirus communis sativa* D. C. (73.5 eggs). In multi-choice tests, eggs were laid the highest numbers on *P. malus* (82.7 eggs) than the others. Percent preference of *S. pyri* was firstly *Pirus malus* with 37.2 %. Secondly *P. communis sativa* and following *P. avium* were preferred to oviposit by females. Adults begun to die at day 7th and survival rate was found high in both no-choice and multi-choice tests, although they lived only 4 days without host plant.

Key words: The pear lace bug, Tingidae, host plant, oviposition preference, survival

Anahtar sözcükler: Armut kaplanı, Tingidae, konukçu bitki, yumurtlama tercihi, canlı kalma

Introduction

Lace bugs, Tingidae are plant feeders that live mostly on the lower surface of the leaves of their hosts. The family is widely distributed throughout the tropical and temperate zones of all continents and on most oceanic islands (Drake & Ruhoff, 1965). Feeding by nymphs and adults results in small chlorotic spotted on the upper leaf surface. Leaf undersides are appeared characteristically black or dark brown varnish spotted due to their excrement. They reduce leaf photosynthesis by damaging palisade parenchyma; as a

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result, chlorosis also occurs (Buntin et al., 1996). The eggs of lace bugs are inserted vertically in leaves. The operculum of an inserted egg often is adjacent to a mid-vein or lateral vein and is artfully concealed with shellac-like frass, whose color varies by species (Neal & Schaefer, 2000).

The pear lace bug, *Stephanitis pyri* (F., 1775) (Heteroptera: Tingidae) is known as an important pest of fruit trees from Rosaceae, especially apple and cherry, in Turkey. It overwinters as adult and has three generations in Marmara Region, Turkey (Göksu, 1964; Lodos, 1982; Gulpercin & Önder, 1999; Aysal & Kivan, 2008). As a result of earlier studies, it was determined that the lower developmental threshold was 10.6 ^{o}C and the thermal constant was 428.6 day-degree, and development time from egg to egg was 26.9±0.4 days at 26 ^{o}C (Aysal & Kivan, 2008). At the research on the effects of host plants on *S. pyri* biology, the longest oviposition time was determined 28.5 days and highest fecundity was 186.9 eggs when the females fed on apple at 26 ^{o}C, and there was no significant difference for fecundity on cherry and firethorn (Aysal & Kivan, 2007).

A polyphagous insect is able to oviposit on different host species. Female often prefers to oviposit her eggs according to larval food, because most insect larvae are small and relatively immobile. While choosing oviposition site, the female not only has to evaluate the suitability of host as larval food, she must also take mortality risks, search efficiency, host encounter rates, and must search for the best host before accepting alternatives. Of course, she must also at all times ensure that she herself survives to lay her full complement of eggs. Indeed, the factors determining oviposition preference are still relatively poorly known, and this is an interesting field that deserves much more attention in the future (Janz, 2002).

Drake & Ruhoff (1965) reported that most species of Tingidae are largely monophagous or highly specialized in their food habits. However, today, increased knowledge suggests that many species may be oligophagous and even, some of them are polyphagous (Neal & Schaefer, 2000). The pear lace bug, *S. pyri* is one of highly polyphagous species and widespread throughout Europe and Palearctic Region. Its hosts are primarily trees and shrubs of many unrelated genera: *Amygdalus*, *Castanea*, *Chaenomeles*, *Cornus*, *Cotoneaster*, *Crataegus*, *Cydonia*, *Juglans*, *Malus*, *Ligustrum*, *Populus*, *Prunus*, *Pyrus*, *Quercus*, *Ribes*, *Rosa*, *Sorbus*, *Robinia*, *Tilia*, *Ulmus* and *Vaccinium* (Drake & Ruhoff, 1965; Önder & Lodos, 1983).

Although some tingids survived on some plants, no eggs were laid on all of them and even there was no visible feeding damage on theese plants (Dhileepan et al., 2006). The objective of present study was to determine whether some plants from Rosaceae or other plants were really hosts or not for *S. pyri*. With this study, it was assessed adult survival for 15 days of oviposition

period and oviposition preference of *S. pyri* on selected plants in no-choice and multi-choice tests under the laboratory conditions. The selected plant list was constituted choosing from hosts mentioned above. Thus, the new information for *S. pyri* will be provide to explain the viability and prevalence of the pest on plants in nature and it's possibilities of injury to optimum host plants in orchards or gardens.

Material and Methods

Laboratory culture of Pear lace bug

Stephanitis pyri laboratory colony was established from overwintered adults collected on apple trees in Tekirdag (Turkey) in April 2008. Second generation adults were used in the experiments. The adults were put on apple leaves and held on a filter paper disc moistened with distilled water in petri dishes (Ø 8 cm) (Aysal & Kivan, 2008). All experiments were conducted in a climatic room with a 16:8 h photoperiod and temperature of 26±1 ^{o}C.

No-choice tests

A total of 13 plant species which include both fruit and ornamental trees were chosen from the host plants listed by Önder & Lodos (1983) and tested to examine adult oviposition preferences (Table 1). For the tests, leaves were collected from plants in the garden of Faculty of Agriculture. Every plant species was individually placed on wet filter paper in each petri dish (Ø 8 cm). Unmated and 24 h old one female and two males were put in the petri as one replication. Twelve replicates for each plant species were carried out in no-choice test for 21 days. Leaves were changed and distilled water added to paper in every day. Petri dishes were examined daily using a stereomicroscope to count live individuals and eggs. The eggs laid during 15 days of oviposition were counted and transferred on a moistened paper in another petri and kept at the same climatic conditions used for egg hatching. The comparison of female survival was made on days 1, 3, 7, 10, 15 and 20 after the start of the bioassay. When a male died, new one of same old males was added until all females died.

Multi-choice tests

After no-choice test, nine plant species on which occurred oviposition were selected for adult multi-choice trials (Table 1).

Table 1. Plants used in oviposition preference tests of *Stephanitis pyri* (F., 1775) in the laboratory

Family	Species	Common names	No-Choice	Choice
	Pirus malus L..	Apple	+	+
	Pirus communis sativa D.C.	Pear	+	+
	Cydonia vulgaris Pers.	Quince	+	+
	Prunus avium L.	Cherry	+	+
Rosaceae	*Prunus domestica* L.	Plum	+	+
	Prunus amygdalus L.	Almond	+	+
	Prunus persica (L.) Batsch.	Peach	+	-
	Pyracantha coccinea M. Roem.	Firethorn	+	+
	Rosa sp.	Rose	+	+
Juglandaceae	*Juglans regia* L.	Walnut	+	+
Hippocastanaceae	*Aesculus hippocastanum* L.	Horse Chestnut	+	-
Salicaceae	*Salix alba* L.	Willow	+	-
Ericaceae	*Rhododendron indicum* (L.) Sweet.	Rhododendron	+	-

Leaf discs of selected test plants were randomly placed in petri dishes (Ø 15 cm). Unmated, 24 h old 9 females and 18 males were released in the middle of the petri for 21 days. 10 such replications were constituted. The procedure was the same as no-choice tests. Percent preference was calculated as the numbers of eggs per leaf proportion in total numbers of eggs in a petri. Adults were observed on wet filter paper without host plant in each petri for adult survival.

Statistical analysis

Observations were made daily and the total numbers of eggs for per plant were counted. Preference was quantified by the average number of eggs laid by a female, preoviposition time, adult survival, and the hatch rate and time of eggs. The values of percent egg hatching and the proportion of lace bugs surviving on different plants were transformed (arc-sine) before statistical analysis. Data were subjected to one-way Anova and Duncan's multiple range test ($p<0.05$) (SPSS, 2006).

Results

No-choice tests

Females of *Stephanitis pyri* begun to lay their eggs at the fourth or fifth day of trials after adult emerging. Shortest preoviposition periods were counted on cherry, pear, apple and rose, and longest egg laying periods were on walnut and plum, respectively (Table 2). No oviposition was observed on peach, horse chestnut, willow and rhododendron.

The number of eggs laid during each series of experiments is given in Table 2. There were significant differences in the numbers of eggs per female per host leaf among plant species. Egg counts from the oviposition no-choice test showed in four ranges of plants: Cherry = Apple = Rose = Pear > Firethorn > Almond = Quince = Walnut > Plum. The arranging of plants was harmonious in preoviposition period and total egg numbers (Table 2).

Table 2. Oviposition preferences of *Stephanitis pyri* (F., 1775) in no-choice tests: responses in preoviposition and total egg numbers (mean+SE) within 15 days of oviposition

Plant species	Preoviposition (days)*	Total egg numbers (eggs/female)*
Pirus malus	5.1±0.1 **a**	80.1±10.2 c
Pirus communis	4.9±0.3 **a**	73.5±11.6 c
Cydonia vulgaris	6.4±0.5 **ab**	32.5±6.6 ab
Prunus avium	4.7±0.2 **a**	93.8±8.6 c
Prunus domestica	8.8±3.4 **c**	20.1±5.3 a
Prunus amygdalus	6.3±0.7 **ab**	37.3±6.9 ab
Prunus persica	-	0
Pyracantha coccinea	6.3±0.7 **ab**	45.6±6.4 b
Rosa sp.	5.3±0.2 **a**	77.3±7.7 c
Juglans regia	8.3±1.4 **bc**	25.7±6.7 ab
Aesculus hippocastanum	-	0
Salix alba	-	0
Rhododendron indicum	-	0

* The means followed by different letters in the column are significantly different according to Duncan's multiple range test (p=0.05).

During 20 days of trials, adults survived on horse chestnut, peach, willow and rhododendron, on which females did not lay their eggs, for the mean 5.5 days, 7.6 days, 9.4 days and 10.5 days, respectively. However, at the end of experiments, there was no live adult on rhododendron, peach and willow, while adult survival rate on horse chestnut was 8.3 % (Figure 1). Adult survival was highest on rose and apple and lowest on almond and plum. The proportion of live individuals on horse chestnut begun to decline in the first three days after the beginning of the trial, although percentage alive was 100 % on the other test plants (Figure 1). On some plants (apple, cherry, firethorn and rose), the survival rate did not differ at day one from day ten (100 %), even on rose all adults live at day 15. After 20 days, live *S. pyri* adults could be found on most plant species (Figure 1).

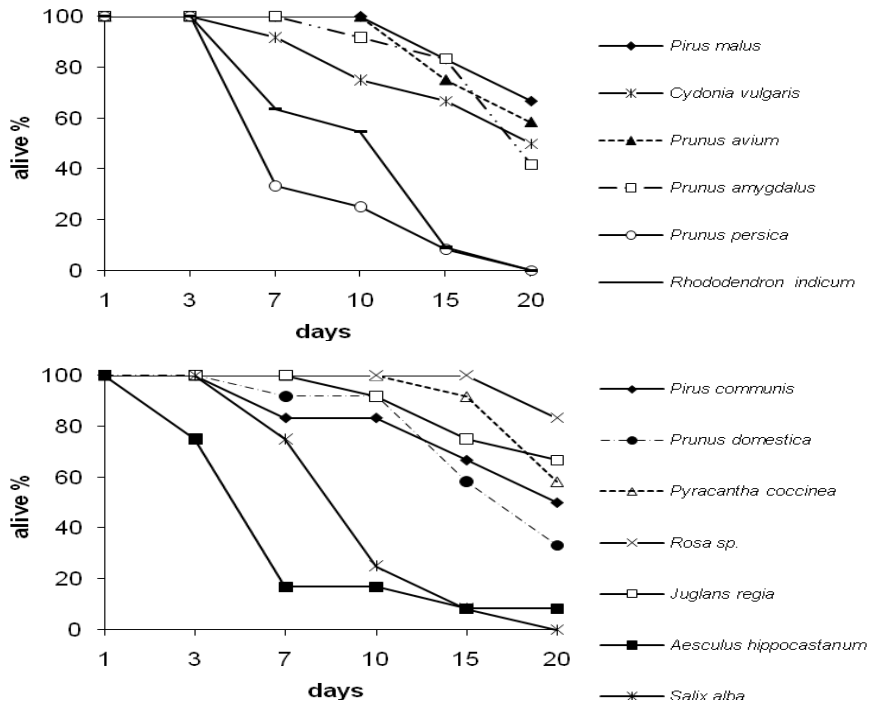

Figure 1. Percent of *Stephanitis pyri* (F., 1775) females surviving on different plants in no-choice tests.

The incubation time was different significantly on the test plant species, but the hatch rate was not (Table 3). Embrio was completed its development in shortest period on the pear and the secondly on the firethorn and rose, while the longest one was on quince. All eggs on the test plants were hatched at ratio of 60.2 to 74.4 % (Table 3).

Table 3. The incubation time and hatch rate (mean+SE) of *Stephanitis pyri* (F., 1775) eggs laid on different plants in no-choice tests

Plant species	Incubation (days)	Eggs hatched (%)
Pyrus malus	11.7±0.1 **bc**	72.8±1.8
Pirus communis	10.3±0.1 **a**	71.2±5.7
Cydonia vulgaris	11.9±0.1 **c**	60.2±1.7
Prunus avium	11.7±0.1 **bc**	74.4±6.9
Prunus domestica	12.5±0.1 **d**	71.2±2.7
Prunus amygdalus	11.6±0.1 **b**	72.9±1.9
Pyracantha coccinea	11.5±0.1 **b**	66.6±1.9
Rosa sp.	11.5±0.1 **b**	70.9±3.4
Juglans regia	11.8±0.1 **bc**	63.5±4.0

The means followed by different letters in the column are significantly different according to Duncan's multiple range test (p=0.05).

Multi-choice tests

In choice tests, *Stephanitis pyri* females laid their eggs in more or less number on all the test plants. There were significant differences in the numbers of eggs per plant among plant species (Table 4). Multiple comparison tests placed the nine plant species into seven groups: apple > pear > cherry > firethorn > quince > almond = rose = plum > walnut. Listing these plants in order was similar in those of no-choice test. Eggs were laid considerably higher numbers on apple, pear and cherry than the others, however, there was a interesting situation on the rose. In choice tests, the number of laid eggs on the rose was significantly lower than those of no choice tests. It may be due to the fact that the leaves were collected from different rose plant in multi-choice tests. In addition, it was concluded that some rose varietes were less preferred to oviposit if there was more suitable host plants and, females laid a great number eggs on alone rose without other host plants.

Table 4. Oviposition preferences of *Stephanitis pyri* (F., 1775) in multi-choice tests: responses in egg numbers and percent preference (mean+SE) within 15 days of oviposition

Plant species	Total egg/leaf	Preference (%)
Pyrus malus	286.0±23.1 **f**	37.2±1.5 **e**
Pirus communis	155.1±22.2 **e**	20.2±1.6 **d**
Cydonia vulgaris	51.4±3.9 **bc**	6.7±0.6 **b**
Prunus avium	111.0±15.8 **d**	14.4±1.7 **c**
Prunus domestica	14.3±7.1 **ab**	1.9±2.0 **a**
Prunus amygdalus	31.8±4.8 **ab**	4.1±0.9 **b**
Pyracantha coccinea	84.1±10.2 **cd**	10.9±1.1 **c**
Rosa sp.	28.8±6.6 **ab**	3.7±1.4 **b**
Juglans regia	6.7±3.4 **a**	0.9±1.5 **a**

The means followed by different letters in the column are significantly different according to Duncan's multiple range test (p=0.05).

Preference of *S. pyri* was, shown in Table 4, primarily apple. It was collected 37.2 of total eggs from apple among all tested plants in a petri. Secondly pear and following cherry were preferred by females.

Incubation times and hatchability of eggs were significant differences among plant species (Table 5). As result of these trials, the shortest incubation time was 11.1 days on almond and the longest was 12.3 days on plum, while hatching rates were 70.0-82.7 %.

In multi-choice tests, adult survival was found high for both sexes at day 7 after the beginning of the trial. However, by day 15, survival rate was 56.1 % for males while it was 90.1 % for females (Figure 2). Both females and males live the most for 4 days without host plant and all the adults died fifth day of trials (Figure 2).

Table 5. The incubation time and hatch rate (mean+SE) of *Stephanitis pyri* (F., 1775) eggs laid on different plants in multi-choice tests

Plant species	Incubation (days)	Eggs hatched (%)
Pyrus malus	11.9±0.1 **cd**	82.7±3.1 **b**
Pirus communis	12.2±0.1 **e**	74.9±1.4 **ab**
Cydonia vulgaris	11.7±0.1 **c**	76.1±3.8 **ab**
Prunus avium	11.3±0.1 **b**	81.2±5.7 **ab**
Prunus domestica	12.3±0.1 **e**	69.3±2.3 **a**
Prunus amygdalus	11.1±0.1 **a**	75.4±4.0 **ab**
Pyracantha coccinea	11.7±0.1 **c**	72.7±1.1 **ab**
Rosa sp.	12.0±0.1 **d**	73.9±4.5 **ab**
Juglans regia	11.3±0.1 **ab**	70.0±5.6 **a**

The means followed by different letters in the column are significantly different according to Duncan's multiple range test (p=0.05).

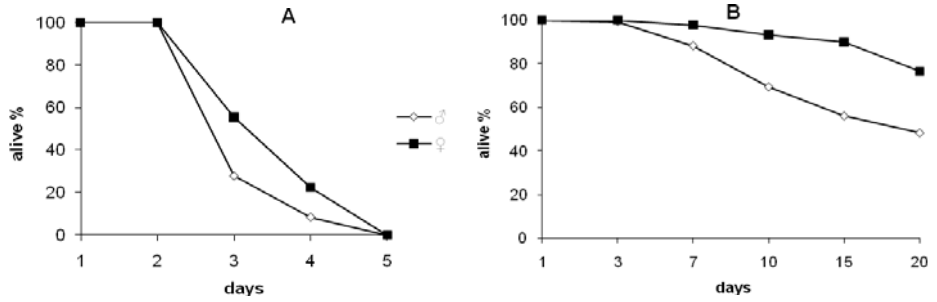

Fig. 2. The mean adult survival (%) of *Stephanitis pyri* (A) without host plant (B) on all tested plants in multi-choice tests.

Discussion

In no-choice tests, no oviposition was observed on peach, horse chestnut, willow and rhododendron, although most of them were mentioned as the host plants of *Stephanitis pyri* in literature (Drake & Ruhoff, 1965; Önder & Lodos, 1983). They were not preferred to oviposit by females in present study. In earlier records, *S. pyri* individuals may be collected from these plants, but there are not detailed studies on them which were host plants of *S. pyri*. It was suggested that the host plants of *S. pyri* should be revised by new researches.

It was concluded that *S. pyri* females preferred to oviposit usually their eggs on Rosaceae, but oviposition occurred on only one nontarget species, walnut (Juglandaceae). However, some plants of oviposited Rosaceae, such as plum and almond, had less eggs, while more eggs were oviposited on pear, apple or cherry in both no-choice and multi-choice tests. At the same time, peach from Rosaceae had no egg oviposited on it in no-choice tests. On the

other hand, *S. pyri* adults have fed these plants. Because adults lived on all test plants for 15 days in no-choice tests, although adults can be lived only 4 days without host plant, so without feeding.

Females prefer to oviposit most eggs on the optimal host plants as long as it is present, and to make possible the deposition of eggs on sub-optimal plants when the optimal plant is not present (Janz, 2002). In particular, it was showed that as females become more host-limited they are selected to oviposit on less favourable hosts, whilst still ovipositing on more favourable hosts (West & Cunnigham, 2002). Just as *S. pyri* females oviposited a large number egg on rose whilst there was not another host plant in no-choice tests.

Rosaceae plants are previously reported as the hosts of *S. pyri* by Drake & Ruhoff (1965) and Önder & Lodos (1983). The results of this study also indicate that *S. pyri* might have a large number of host species from Rosaceae but not all, and confirms its oviposition preference for apple, pear and cherry, which are optimal hosts of *S. pyri*. There was the large number of other potential host plants and adult survival of *S. pyri* on them was considerable, especially on fruit trees.

Özet

Farklı bitki türlerinde *Stephanitis pyri* (F., 1775) (Heteroptera: Tingidae)' nin canlı kalma oranı ve yumurtlama tercihi

Stephanitis pyri (F., 1775) Palearktik Bölge'de Rosaceae familyasından elma, armut ve süs bitkilerinin bir zararlısıdır. Bu çalışma, polifag bir böcek olan *S. pyri*'nin laboratuvar koşullarında yumurtlama tercihini belirlemek için yapılmıştır. Farklı konukçu bitki yaprak-larında tercihsiz ve çoklu tercih denemeleri gerçekleştirilmiştir. Tercihsiz denemelerinde 13 bitki türünün yaprakları test edilmiştir. Bu denemelerde *Prunus persica* (L.) Batsch., *Aesculus hippocastanum* L., *Salix alba* L. ve *Rhododendron indicum* (L.) Sweet üzerine hiç yumurta bırakılmamıştır. Toplam bırakılan yumurta sayısı en yüksek *Prunus avium* L. (93.8 yumurta), *Pirus malus* L. (80.1 yumurta), *Rosa* sp. (77.3 yumurta) ve *Pirus communis sativa* D. C. (73.5 yumurta) üzerinde saptanmıştır. Çoklu tercih denemele-rinde, en yüksek sayıda yumurta *P. malus* (82.7 yumurta) üzerine bırakılmıştır. *S. pyri*'in tercih oranı % 37.2 ile öncelikle *Pirus malus*'tur. Dişilerin yumurta bırakmak için tercih ettiği ikinci bitki *P. communis sativa* olup bunu *P. avium* izlemiştir. Erginler bitkisiz sadece 4 gün yaşarken, tercihsiz ve çoklu tercih denemelerinde canlı kalma oranı yüksek bulunmuş ve erginler 7. günde ölmeye başlamıştır.

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