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Effect of different host plants on the development time and parasitization rate of *Eretmocerus debachi* Rose and Rosen (Hymenoptera: Aphelinidae) with *Parabemisia myricae* (Kuwana) (Homoptera: Aleyrodidae) as insect host

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Abstract

The effect of six citrus and five non-citrus host plants on the developmental time of *Eretmocerus debachi* Rose and Rosen (Hymenoptera: Aphelinidae), the parasitoid of *Parabemisia myricae* (Kuwana) (Homoptera: Aleyrodidae), was studied under laboratory conditions. On citrus host plants, the mean developmental time from egg to adult was shortest on lemon with 14.6 days and longest on trifoliate orange with 26.3 days. On non-citrus host plants the developmental time ranged between 16.3 days on vine and 23.0 days on pomegranate. Among the various host plants tested, *E. debachi* preferred *P. myricae* on sweet orange. A high mortality of *P. myricae* due to host feeding and parasitization was observed on sweet orange and grapefruit among citrus host plants and on rose among non-citrus host plants.

1 Introduction

The Japanese bayberry whitefly, *Parabemisia myricae* (Kuwana) (Homoptera: Aleyrodidae), is a worldwide pest of citrus. Serious damages are caused by this whitefly in all citrus growing areas in the Mediterranean basin, and it is also known to attack citrus in the USA and several South American countries (SWIRSKI et al., 1980; ROSE et al., 1981; ATAY and ŞEKEROĞLU, 1987; MICHELAKIS and ALEXANDRAKIS, 1989; HAMON et al., 1990; RAPISARDA et al., 1990; ORPHANIDES, 1991; VIVAS, 1992; CHERMITI and ONILLION, 1992; BRUN and BORELLI, 1995). *P. myricae* is a polyphagous pest with host in many different plant families. This pest can be controlled biologically with the hymenopterous parasite *Eretmocerus debachi* Rose and Rosen (Hymenoptera: Aphelinidae). Biological control gave excellent results in all citrus-growing areas where the parasitoid was released (SWIRSKI et al., 1988 a; SWIRSKI et al., 1988 b; UYGUN et al., 1990; ROSE and DEBACH, 1992; ŞENGONCA et al., 1994).

E. debachi was determined on 7 citrus and 37 non-citrus host plants of *P. myricae* in the east Mediterranean region of Turkey (ULUSOY, 1994; ŞENGONCA et al., 1998). ŞENGONCA et al. (1998) showed that non-citrus host plants play an important role in the biological control of *P. myricae* as an alternative host of the whitefly and its parasitoid, *E. debachi*. To improve the biological control and to obtain a better understanding of the dynamics of the host insect and host plant interaction, more detailed laboratory studies are necessary.

The purpose of this study was to determine the host-plant-depending developmental time of *E. debachi* on citrus and non-citrus host plants and the host plant preference under constant laboratory conditions.

2 Materials and Methods

E. debachi was reared on second instars of *P. myricae* at 25 ± 2 °C, 65 ± 10 % RH and a light regime of 16 : 8 light/dark in a climate chamber. Second instars of the whitefly were produced by placing young *Citrus aurantium* L. seedlings into the mass culture of *P. myricae* for an oviposition period of 24 h (ŞENGONCA et al., 1993). The plants were then transferred into another climate chamber and kept for one week, until *P. myricae* reached the 2nd instar (UYGUN et al., 1993). Those plants were enclosed with *E. debachi* females for a 24-h parasitization period. The preimaginal developmental time of *E. debachi* was determined by transferring a single female, maximum two hours old, into a Petri dish, with one host plant leaf bearing approximately 50 *P. myricae* 2nd instars. The leaves were placed with the petiole in a water reservoir and observed daily for development of *E. debachi* under a binocular microscope.

The host plant preference of *E. debachi* was studied with 2nd instar of *P. myricae*. All mature leaves were pruned and only the young shoot-tip leaves were used in the experiments. For each host plant tested at least 100 *P. myricae* were released on shoots for an oviposition period of one hour. The plants were checked daily to determine the whitefly development. When *P. myricae* reached 2nd instar, the number of instars was reduced to 20 individuals on each host plants. Six citrus host plants and five non-citrus host plants were separately enclosed with ten *E. debachi* females for an oviposition period of one hour. In a second experiment, *E. debachi* was allowed to select their host insects among all eleven host plant species (citrus and non-citrus hosts) at the same time.

All experiments were carried out at 25 ± 1°C, 70 ± 10 % RH and 16 h of artificial light in a climate chamber. During the experiments, saccharose solution (10%) was offered to female parasitoids, and the number of dead whitefly nymphs (host feeding and parasitization) was examined by analysis of variance.

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Table 1. Mean preimaginal developmental time of *Eretmocerus debachi* on *Parabemisia myricae* and different host plants

Host Plants	Preimaginal developmental time (days)		
Citrus	**n**	**Mean ± SE**	**Min.–Max.**
Grapefruit	83	20.0 ± 0.36 C	17–26
Lemon	21	14.6 ± 0.37 A	13–18
Mandarin	43	19.4 ± 0.38 C	17–25
Sour orange	33	17.2 ± 0.23 B	15–20
Sweet orange	45	19.2 ± 0.15 C	17–21
Trifoliate orange	29	26.3 ± 0.73 E	21–37
Non-Citrus			
Mulberry	41	21.7 ± 0.42 CD	17–29
Peach	27	17.9 ± 0.51 BC	15–24
Pomegranate	32	23.0 ± 0.52 D	18–30
Rose	34	20.4 ± 0.27 C	19–24
Vine	48	16.3 ± 0.23 AB	14–21

Within columns, means followed by the same letter do not differ significantly (P = 0.05), LSD range test.

3 Results and Discussion

Eretmocerus species are solitary, internal parasitoids of whitefly nymphs (FOLTYN and GERLING, 1985; GERLING et al., 1990). Their developmental rate is partially influenced by the host whitefly species and is inversely related to temperature (ŞENGONCA et al., 1994). Host plants, that is plants fed upon by insect pest hosts, can influence the behavior and efficiency of parasitoids.

The development of *E. debachi* involves an egg, three larval stages, a prepupae and pupal stage. Since *Eretmocerus* species deposit their eggs under rather than into the host and the host penetration occurs in the first or second larval stage of parasitoid, it is difficult to determine the accurate larval stage (FOLTYN and GERLING, 1985; GERLING et al., 1990). Thus, in this study only the developmental time from egg to adult and the parasitization rate of the *E. debachi* were recorded.

The developmental time of *E. debachi*, on citrus host plants was shortest on lemon with 14.6 days and longest on trifoliate orange with 26.3 days. On non-citrus host plants, the shortest development time of 16.3 days was determined on vine and the longest with 23.0 days on pomegranate (table 1). ULUSOY et al. (1999) reported that *P. myricae* finished its development in a shorter time on lemon than on trifoliate orange, and developed significantly faster on vine than pomegranate. Regardless of the host plant, *E. debachi* developed about two times faster from egg to adult than its host *P. myricae* from the 2nd instar to adult (UYGUN et al., 1993; ULUSOY et al., 1999).

Table 3. Overall mortality (host-feeding and parasitization) of *Parabemisia myricae* 2nd instar attacked by *Eretmocerus debachi* on five non-citrus host plants in a choice experiment at 25 ± 1 °C (n = 20)

Non-citrus host	Mean ± SE	Parasitization rate
Mulberry	12.6 ± 1.21 A	63.0
Peach	13.6 ± 0.93 A	68.0
Pomegranate	13.7 ± 0.49 A	68.5
Rose	14.4 ± 0.51 B	72.0
Vine	12.3 ± 1.02 A	61.5

Within columns, means followed by the same letter do not differ significantly (P=0.05), LSD range test.

Table 2. Overall mortality (host-feeding and parasitization) of *Parabemisia myricae* 2nd instar attacked by *Eretmocerus debachi* on six citrus species in a choice experiment at 25 ± 1 °C (n = 20)

Citrus host	Mean ± SE	Parasitization rate
Grapefruit	17.4 ± 0.87 B	87.0
Lemon	17.2 ± 0.37 B	86.0
Mandarin	16.5 ± 0.24 B	82.5
Sour orange	16.6 ± 0.25 B	83.0
Sweet orange	17.4 ± 0.24 B	87.0
Trifoliate orange	12.2 ± 0.80 A	61.0

Within columns, means followed by the same letter do not differ significantly (P = 0.05), LSD range test.

The different host plants strongly affected the developmental time of *E. debachi* as well as that of it insect host *P. myricae* (ULUSOY et al., 1999). The developmental time in *Eretmocerus* depends on the development of its host insect (POWELL and BELLOWS, 1992; ŞENGONCA et al., 1994), thus, a short developmental period of *P. myricae* on a certain host plant, induced a short developmental period of the parasitoid.

Only little differences were observed in parasitization rate of *P. myricae* among different citrus host plants (82.5–87.0 %), with the exception of trifoliate orange showing a significant lower acceptance for *E. debachi* that results in a parasitization rate of only 61.0 % (table 2). Among different non-citrus host plants, *E. debachi* preferred *P. myricae* on rose for parasitization. There were little differences in parasitization among the non-citrus host plants (table 3).

When offering all eleven host plants (citrus and non-citrus host) simultaneously to *E. debachi* in a choice experiment, sweet orange revealed the highest parasitization rate with 86.5 %. The lowest parasitization rates were observed pomegranate (53.5 %) and mulberry (53.0 %) (table 4). ŞENGONCA et al. (1994), reported that

Table 4. Overall mortality (host-feeding and parasitization) of *Parabemisia myricae* 2nd instar attacked by *Eretmocerus debachi* in a choice experiment with six citrus and five non-citrus host plants at 25 ± 1 °C (n = 20)

Host Plants	Mean ± SE	Parasitization rate
Grapefruit	16.7 ± 0.31 DC	83.5
Lemon	16.4 ± 0.34 DC	82.0
Mandarin	16.3 ± 0.30 DC	81.5
Mulberry	10.6 ± 0.33 A	53.0
Peach	12.3 ± 1.33 B	61.5
Pomegranate	10.7 ± 0.87 A	53.5
Rose	12.8 ± 0.87 B	64.0
Sour orange	14.7 ± 0.34 C	73.5
Sweet orange	17.3 ± 0.34 D	86.5
Trifoliate orange	11.7 ± 0.32 AB	58.5
Vine	11.7 ± 0.34 AB	58.5

Within columns, means followed by the same letter do not differ significantly (P=0.05), LSD range test.

parasitization and mortality rate of *P. myricae* instars on sour-orange attacked by *E. debachi* was 62.6 % in no-choice and 31.8 % in choice experiments at 25 ± 1 °C.

It is suggested that the preservation or even the establishment of non-citrus host plants adjacent to citrus groves will greatly enhance the host-parasitoid interaction (ŞENGONCA et al., 1998). *P. myricae* is only abundant in orchards during flushing periods of citrus trees and, thus, almost absent or at very low population densities during most of the time of the year (ATAY and ŞEKEROĞLU, 1987; UYGUN et al., 1990; YUMRUKTEPE and AYTAS, 1994). ŞENGONCA et al., (1998) stated that the whitefly and its parasitoid are able to maintain their population on non-citrus host plants that grow in the vicinity of citrus groves. *P. myricae* colonize the orchards again when new shoots appear on citrus. The parasitoid *E. debachi* follows the spread of the whitefly from non-citrus host plants to citrus without any delay and, thus, keeping the pest population at very low levels during the entire vegetation period (ŞENGONCA et al., 1998).

For all host plants, the overall mortality was higher on the citrus (table 2) and non-citrus host plants group in choice experiment (table 3) compared to the all host plants together choice experiment (table 4). This may be due to the higher parasitoid density in the citrus (10 females per 20 *P. myricae* 2nd instar × 6 citrus host plants) and non-citrus host plant (10 females per 20 *P. myricae* 2nd instar × 5 non-citrus host plants) choice experiment compared to choice experiment (10 females/20 *P. myricae* 2nd instar × 11 citrus and non-citrus host plants) when all host plants were compared simultaneously.

The developmental time of immature stages of *E. debachi* showed differences among host plants of its insect host *P. myricae*. In general *E. debachi* preferred parasitization of *P. myricae* on citrus. According to the obtained results, *E. debachi* could be reared best on citrus species except on trifoliate orange. The short developmental time of only 14 to 20 days and high parasitization of approximately 80 % would be a benefit by reducing culturing time and laboratory costs. On the other hand, non-citrus host plants could serve as an important alternative host for *P. myricae* and as a refuge for its parasitoid *E. debachi*.

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Zusammenfassung

Einfluß verschiedener Wirtspflanzen und *Parabemisia myricae* (Kuwana) (Homoptera: Aleyrodidae) auf die Entwicklungsdauer und Parasitierungsrate von *Eretmocerus debachi* Rose and Rosen (Hymenoptera: Aphelinidae)

Der Einfluß von sechs Zitrus- und fünf Nichtzitruswirtspflanzen auf die Entwicklungsdauer von *Eretmocerus debachi* Rose and Rosen (Hymenoptera: Aphelinidae), dem Parasitoiden von *Parabemisia myricae* wurde unter Laborbedingungen untersucht. Auf Zitruspflanzen war die durchschnittliche Entwicklungsdauer vom Eistadium bis zum Adult auf Zitrone mit 14,6 Tagen am kürzesten und auf Trifoliate-Orange mit 26,3 Tagen am längsten. Auf Nichtzitruspflanzen varierte die Entwicklungsdauer zwischen durchschnittlich 16,3 Tagen auf Wein und im Mittel 23,0 Tagen auf Granatapfel. Unter den getesteten Wirtspflanzen parasitierte *E. debachi* bevorzugt *P. myricae* auf Süßorange. Eine hohe Mortalität (Wirtsfraß und Parasitierung) des Wirtsinsektes *P. myricae* wurde zudem auf Grapefruit (Zitruswirtspflanzen) sowie auf Rose (Nichtzitruswirtspflanzen) festgestellt.

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