Türk. entomol. derg., 2006, **30** (2): 89-98
ISSN 1010-6960

Population dynamics of ***Bryobia rubrioculus*** Scheuten (Acari: Tetranychidae) and its predatories in sprayed and unsprayed apple orchards in Van

İsmail KASAP* Sultan ÇOBANOĞLU**

Summary

Seasonal population development of ***Bryobia rubrioculus*** Scheuten (Acari: Tetranychidae) was studied on golden delicious and starking delicious apple cultivars in three apple orchards of Van, during 2002-2003. Overwintering eggs of ***B. rubrioculus*** deposited on the bark of apple trunks began to hatch at mid May. ***B. rubrioculus*** population reached a maximum from mid June to early July. In unsprayed orchard, ***B. rubrioculus*** remained at very low levels certainly because of the presence of ***Kampimodromus aberrans*** (Oudemans). (Acari: Phytoseiidae) On the other hand, ***Zetzellia mali*** (Ewing) (Acari: Stigmaeidae) was the most abundant predator on ***B. rubrioculus*** in sprayed orchards. ***B. rubrioculus*** reached the higher population on starking delicious than that on golden delicious.

Key words: Biological control, ***Bryobia rubrioculus***, ***Kampimodromus aberrans***, ***Zetzellia mali***, population dynamics

Anahtar sözcükler: Biyolojik mücadele, ***Bryobia rubrioculus***, ***Kampimodromus aberrans***, ***Zetzellia mali***, populasyon dinamiği

Introduction

Bryobia rubrioculus Scheuten (Acari: Tetranychidae) is widespread in deciduous fruit orchards in the North and South America, Europa, Asia and Japan.

* Yüzüncü Yıl University, Agricultural Faculty, Department of Plant Protection, 65080 VAN, e-mail: ikasap@yyu.edu.tr

** Ankara University, Agricultural Faculty, Department of Plant Protection, 06110 ANKARA
Alınış (Recived): 15.05.2006

This mite is thelytokious and eggs over winter in the bark of fruit trees (Ehara, 1959; Herbert, 1962, 1965; van de Vrie et al., 1972; Jeppson et al., 1975; Düzgüneş, 1977; Helle & Pijnacker, 1985; Osakabe et al., 2000; İncekulak & Ecevit, 2002). Overwintering eggs of ***B. rubrioculus*** hatch earlier than the eggs of ***Panonychus ulmi*** (Koch) and ***Amphitetranychus viennensis*** (Zacher) (Acari: Tetranychidae) in apple (***Malus communis*** L.) orchards in the spring. ***B. rubrioculus*** causes whitish-grey spots on the upper surface of young or spur leaves by sucking. Severely damaged young leaves do not grow and usually fall (van de Vrie et al., 1972; Jeppson et al., 1975; Düzgüneş, 1977; Osakabe et al., 2000).

Population development of ***B. rubrioculus*** depends on the ecological and biological conditions such as temperature, host plants and natural enemies occurence. The chemical contents and morphology of leaf surfaces of host plants affect the reproductive potential, mortality and development rate of spider mites (van de Vrie et al., 1972; Jeppson et al., 1975; Düzgüneş, 1977; Sabelis, 1985). Natural enemies, particularly the species of the family Stigmaeidae and Phytoseiidae (Acari), are regarded as effective predators of ***B. rubrioculus*** on apple trees (van de Vrie et al., 1972; Jeppson et al., 1975; Düzgüneş, 1977; Santos & Laing, 1985; Croft & Slone, 1997; Jamali et al., 2001; Kasap et. al., 2004). In recent years, economical importance of ***B. rubrioculus*** was remarkably increased and the population density of this mite was observed the difference among localities and apple varieties in Van region (Kasap et. al., 2004). However, population dynamics of this mite and its natural enemies in apple orchards was poorly investigated. The present study was primarily designed to provide data on the population dynamics of ***B. rubrioculus*** and its natural enemies, ***Kampimodromus aberrans*** (Oudemans) and ***Zetzellia mali*** (Ewing) (Acari: Phytoseiidae; Stigmaeidae), in sprayed and unsprayed apple orchards (***M. communis*** cvs starking delicious and golden delicious) in Van.

Materials and Methots

Field observations

Experiments were conducted in three apple orchards in Van (Edremit I; N 38° 25; E 43° 14; Edremit II; N 38° 25; E 43° 16 and Şamranaltı; N 38° 29; E 43° 21) from 2002 to 2003. Two apple cultivars, golden delicious and starking delicious, were planted in mosaic in these orchards and the age of trees were ranged between 15-20 years old. These varieties are the most common apple varieties in Turkey (Gül & Erkan, 2001). The apple trees in Edremit I orchard were sprayed with fluvalinate (50 ml per 100 *l*) on 4 July and 29 July in 2002 and on 13 July in 2003 to control ***Cydia pomonella*** (L.) (Lepidoptera: Tortricidae) and ***Aphis pomi*** De Geer (Homoptera: Aphididae). The apple trees in Şamranaltı were sprayed with fluvalinate (50 ml per 100 *l*) on 4 July and 29 July in 2002 and with phosolone (200 ml per 100 *l*) to control ***C. pomonella*** on 5 July and fluvalinate (50 ml per 100 *l*) to control ***C. pomonella*** and ***A. pomi*** on 26 July in 2003. In

Edremit II no chemical treatment have been applied since the orchard was established.

The population densities of ***B. rubrioculus*** and its predators were monitored weekly from 30 May to 31 October in 2002 and 1 May to 8 October in 2003. In 2002, ***B. rubrioculus*** was not observed on both cultivars in Şamranaltı. Therefore, in Şamranaltı, ***B. rubrioculus*** population in 2002 was not shown in figures. For the experiments, seven trees were marked for each apple cultivar in three orchard. Ten leaves were collected randomly from periphery (1.2-2.3 m heigh) of the marked trees. The leaves were brought to the lab in plastic containers and stored at 4 °C in the refrigerator. Populations of ***B. rubrioculus***, ***K. aberrans*** and ***Z. mali*** on the leaves were examined under a stereo binocular microscope (magnification 40x) within three days after collection.

Statistical analyses

Before analyses data were checked for ANOVA assumptions. Because of non-normal data concerning the distribution of number of ***B. rubrioculus*** between apple cultivars in each apple orchard, the class of generalized linear models was used for data analysis. These models are an extension of traditional linear models that allows the mean of a population to depend on a linear predictor through a nonlinear link function. In addition, these models allow the response probability distribution to be any member of an exponential family of distributions. Therefore, PROC GENMOD procedure in SAS was used to fit generalized linear models (Anonymous, 2005). Poisson, Negative Binomial and Gamma distributions with log link function were tried and Scaled Deviance was used as goodness of fit criteria. For all the number of ***B. rubrioculus*** between apple cultivars in each apple orchard analyses Negative Binomial distribution found to be better fit the models used.

Results

Seasonal fluctuations of ***B. rubrioculus, K. aberrans*** and ***Z. mali*** on starking delicious and golden delicious in 2002 and 2003 are shown in Figure 1 and Figure 2, respectively. Trends of the fluctuation in each orchard did not vary markedly between 2002 and 2003. ***B. rubrioculus*** reached higher population density on starking delicious than that on golden delicious in Edremit I (Table 1). The population reached the highest peak on July 4, 2002 (27.5 total life stages/leaf), and on June 26, 2003 (17.6 total life stages/leaf) (Figure 1), then formed a smaller peak in August. The population of ***Z. mali*** on starking delicious peaked (3.7 mites/leaf) on August 9 in 2002 (Fig. 1), while it maintained low population density and never exceed 1.5 mites per leaf in 2003 in Edremit I (Figure 1). It is inferred that ***Z. mali*** effectively suppressed ***B. rubrioculus*** population in 2002, but not in 2003. ***K. aberrans*** population on starking delicious remained very low level though it increased 0.22 mites per leaf on July 9 in Edremit I in 2002 (Figure 1).

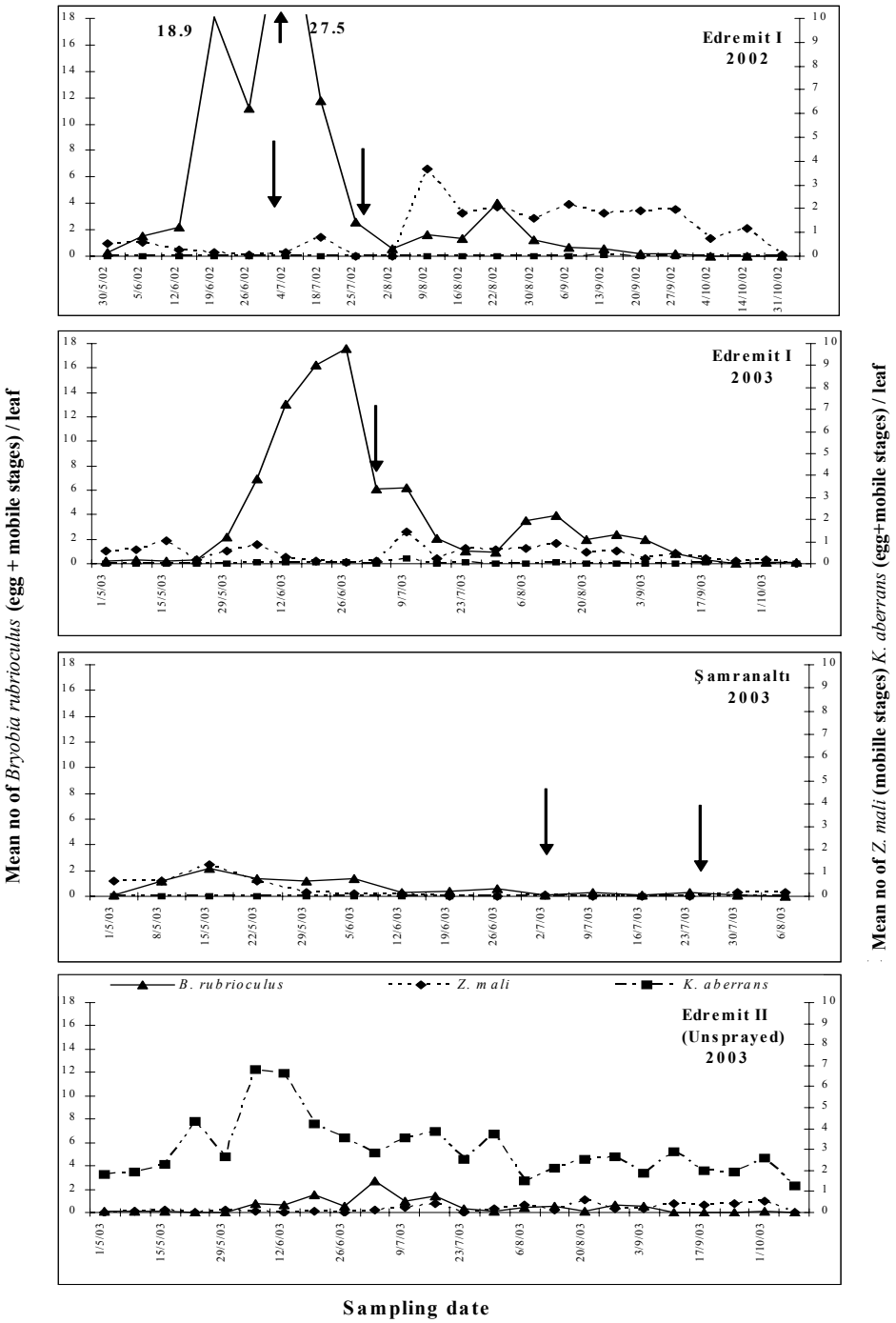

Figure 1. Seasonal populations of ***Bryobia rubrioculus*** Scheuten, ***Zetzellia mali*** (Ewing) and ***Kampimodromus aberrans*** (Oudemans) on starking delicious apple cultivar in 2002 and 2003 (arrows, insecticide spray).

Table 1. Total mean number of ***Bryobia rubrioculus*** Scheuten on two different apple varieties in 2002 and 2003 (mean ±S.E./per leaf)

Apple cultivars	**Edremit I 2002**	**Edremit I 2003**	**Şamranaltı 2003**	**Edremit II 2003**
Starking delicious	4.27±7.31 a n=20	3.68 ±5.09 a n=24	0.39±0.59 a n=24	0.50 ±0.64 a n=24
Golden delicious	0.26±0.39 b n=20	1.26 ±2.10 b n=24	0.19 ±0.36 a n=24	0.42 ±0.82 a n=24
Chi square ratio	25.28; $P<0.01$	6.99; $P<0.01$	1.06; $P\geq0.304$	0.16; $P\geq0.69$

The means followed by different letters are significantly different within columns (chi-square, $P<0.01$)

In Edremit I, the population density of ***B. rubrioculus*** on golden delicious peaked on June 19 (1.3 total life stages/leaf) in 2002 and (9.4/leaf) 2003 (Figure 2), on the other hand, it was lower than that on starking delicious in the same orchard and years (chi square, P<0.01; Table 1). ***Z. mali*** started to increase gradually at early August and peaked (1.7 mites/leaf) on September 20 in 2002 (Figure 2). In 2003, the population density of this predator was lower than that in 2002. It started to increase in early July and peaked (1.7 mites/leaf) on August 6, but decreased gradually after the peak (Figure 2). This also shows the effect of this predatory mite as a natural enemy of this spider mite. ***K. aberrans*** population on golden delicious also remained very low level as well as on starking delicious (Figure 2). They increased to 0.25 mites per leaf on july 9 in 2003, but disappeared entirely after the insecticide application (Figure 2).

The population density of ***B. rubrioculus*** in Şamranaltı was very low on both cultivars, when it was compared with Edremit I. Especially in 2002, ***B. rubrioculus*** was never determined on both cultivars in this orchard. In 2003, ***B. rubrioculus*** population remained very low level, with the highest mean number never exceeding 2.14 mites/leaf on starking delicious and 1.33 mites/leaf on golden delicious in May. ***B. rubrioculus*** population disappeared entirely from the orchard after the last week of June on both cultivars (Figures 1 and 2). In 2003, a small peak of ***Z. mali*** population was found on both cultivars in May, then the population remained at very low level up to the late June (Figures 1 and 2). ***K. aberrans*** was not observed on each apple cultivars during the sampling period. Therefore, it is likely that ***Z. mali*** could suppressed the population of ***B. rubrioculus***.

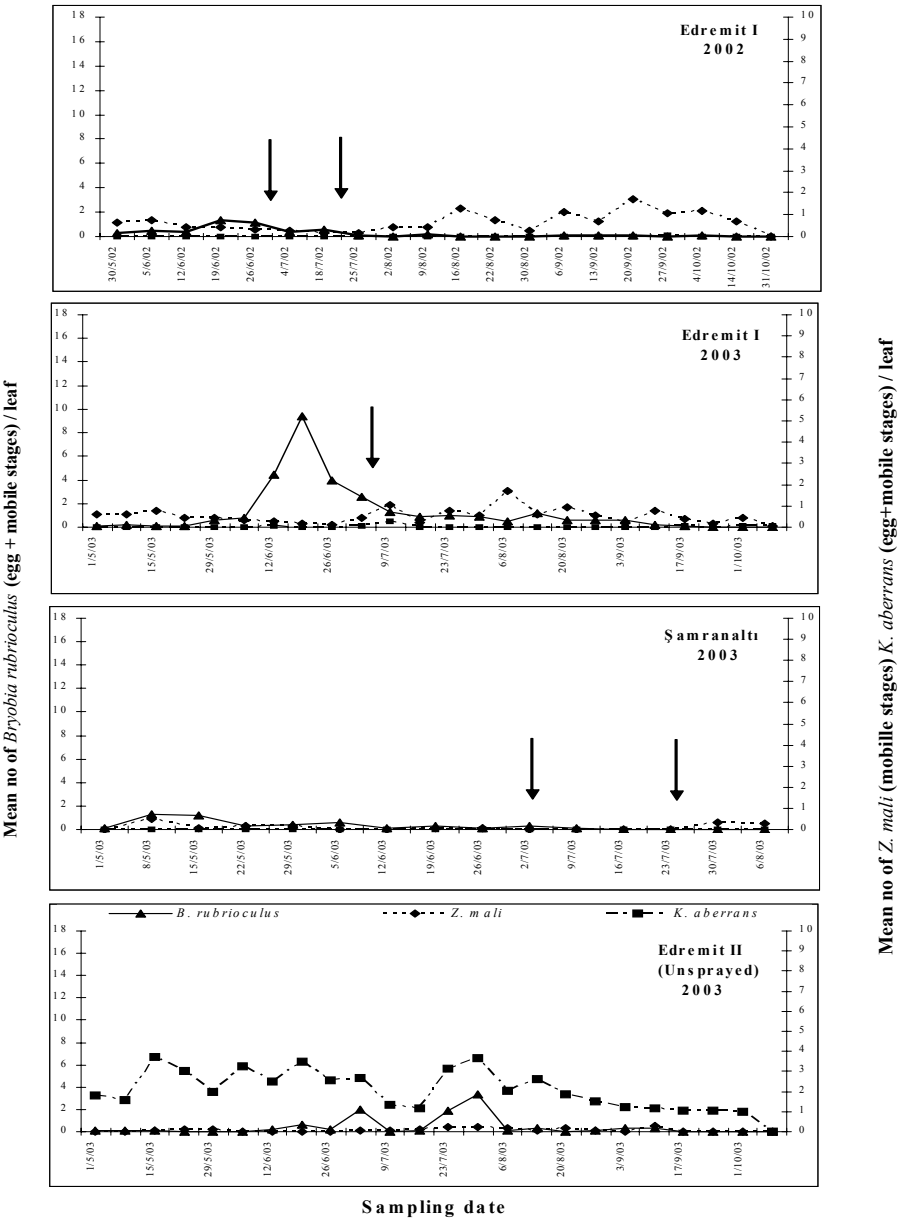

Figure 2. Seasonal populations of ***Bryobia rubrioculus*** Scheuten, ***Zetzellia mali*** (Ewing) and ***Kampimodromus aberrans*** Oudemans on golden delicious apple cultivar in 2002 and 2003 (arrows, insecticide spray).

In Edremit II, unsprayed orchard, the population of ***K. aberrans*** (1-3.7 total life stages/leaf) was remarkably higher than that in Edremit I and Şamranaltı orchards sprayed with pesticides (Figures 1 and 2). On the otherhand, ***Z. mali*** remained at low population density during the experimental period; never

exceeded 0.6 mite per leaf. ***B. rubrioculus*** reached the highest population density 2.7 and 3.4 (mites/leaf) in July on starking delicious and golden delicious, respectively, but declined to very low level later. This is probably that ***K. aberrans*** could be an effective natural enemy of ***B. rubrioculus*** rather than ***Z. mali*** in unsprayed orchard.

Discussion

The overwintering eggs of ***B. rubrioculus*** begin to hatch in late February and continue throughout the blooming season, the second generation develops in May and the third may partially develop in June on almonds in California, USA (Hoy, 1985). Likewise, the eggs hatch in early March or late February in Kirtipur, Nepal (Osakabe et al., 2000). In Nova Scotia, Canada, the hatch begins before mid May (Herbert, 1962, 1965). In Turkey, ***B. rubrioculus*** population starts to increase in May and reached the peak in June in Amasya (İncekulak & Ecevit, 2002) and peaked in July or August in Erzurum (Ecevit, 1981). The present study showed that the overwintering eggs of ***B. rubrioculus*** began to hatch on the bark of apple tree trunks by mid May and the population density reached the peak from mid June to early July. Therefore, the overwintering eggs hatch in Turkey later in the season in comparison with those in California and Kirtipur. The seasonal timing of the hatching was similar to that in Nova Scotia. İncekulak & Ecevit (2002) reported that ***B. rubrioculus*** population was suppressed by the predators in unsprayed orchards in Amasya. In unsprayed orchard (Edremit II) the population density of ***K. aberrans*** markedly increased and ***B. rubrioculus*** remained at very low population density. However, in sprayed orchard, ***K. aberrans*** disappeared from the orchard after pesticide application. On the otherhand, ***Z. mali*** seems to be a common predator and reached high population levels in sprayed orchards, but it was few in unsprayed orchard. In sprayed orchards, ***Z. mali*** seems to be the most effective predator on ***B. rubrioculus***. ***Z. mali*** has a tolerance for the pesticides and is dominant predatory mite in sprayed apple orchards in Michigan (Strickler et al., 1987). Villanueva & Hamsen (1998) stated that ***Z. mali*** was more abundant in the pyrethroid sprayed plots than in the plots unsprayed with these pesticides. It is inferred that ***Z. mali*** developed the resistance to pyrethroids and could be competitive, especially with phytoseiid mites. ***B. rubrioculus*** was more abundant in starking delicious than that on golden delicious in the same orchard. This might be due to the morphology of leaf surfaces of starking delicious apple variety. Starking delicious leaves have a more hairy structure than that golden delicious. Vatansever et al. (2003) reported that ***Serangium montazerii*** Fürsch (Col.: Coccinellidae) feeding a prey on hairless varieties of cotton had higher reproduction rate and faster development time than on hairy varieties. Also they stated that it has lower mortality on hairless varieties. The possible reason is that the predator activities were affected by the leaf structures of apple cultivars. Predators could be spent much energy and catched more preys to complete their development because hairy structure prevents predators searching prey. For this

reason, the predators were more abundant in hairless apple cultivars than the hairy cultivars. However, Duso & Pasini (2003) reported that ***Amblyseius andersoni*** Chant (Acari: Phytoseiidae) has prefered the highly pubescent apple cultivars because of the availability of oviposition sites and protection from intraguild predation attack. In addition, Kreiter et al. (2002) reported that ***K. aberrans*** was the dominant phytoseiid on hairy leaf of ***Celtis australis*** L. (Ulmaceae) and it prefers the densities of trichome and pollen to development.

The results showed that ***B. rubrioculus*** populations reached a peak at the end of June and first week of July and gradually decreased thereafter in sprayed orchard. In unsprayed orchard, the naturally occuring local population of ***K. aberrans*** has the potential for the biological control of ***B. rubrioculus***. Further experiments should be initiated to determine the biology of ***B. rubrioculus*** on different apple cultivars and interactions between the pest and its predators.

Özet

Van ilinde ilaçlı ve ilaçsız elma bahçelerinde kahverengi akar *Bryobia rubrioculus* **Scheuten (Acari: Tetranychidae) ve avcılarının populasyon gelişmesi**

Kahverengi akar ***Bryobia rubrioculus*** Scheuten (Acari: Tetranychidae)'un Van ilinde üç farklı elma bahçesinde golden delicious ve starking delicious elma çeşitleri üzerinde 2002-2003 yıllarında populasyon gelişmesi ve avcıları ile arasındaki ilişkileri gözlenmiştir. ***B. rubrioculus***'un elma ağaçlarının gövde ve çatlakları arasına bıraktığı kışlık yumurtaları, mayıs ayı ortalarında açılmaya başlamış ve ***B. rubrioculus*** populasyonu haziran ayı ortasından temmuz başına kadar tepe noktasına ulaşmıştır. Hehangi bir tarımsal savaş ilacının kullanılmadığı elma bahçesinde ***B. rubrioculus*** populasyonu, avcı akar ***Kampimodromus aberrans*** (Oudemans) (Acari: Phytoseiidae)'ın baskısı ile çok düşük seviyelerde gelişme göstermiştir. Diğer taraftan ilaçlı bahçelerde ***Zetzellia mali*** (Ewing) (Acari: Stigmaeidae), ***B. rubrioculus*** populasyonu üzerinde en etkili avcı akar olarak saptanmıştır. ***B. rubrioculus***'un elma bahçelerinde starking delicious elma çeşidi üzerinde golden delicious çeşidine göre daha yüksek bir populasyon yoğunluğuna ulaştığı belirlenmiştir.

Acknowledgements

We thank the anonymous reviewers for their useful comments on the manuscript. This research was supported in part by the Scientific and Technical Research Council of Turkey (TUBİTAK/TOVAG-2966).

References

Anonymous, 2005. User's manual, version 9.13. SAS, Institute, Cary, NC.

Croft, B. A. & D. H. Slone, 1997. Equilibrium of European red mite (Acari: Tetranychidae) after exposure to three levels of predacious mite diversity on apple. **Environ. Entomol**., **26** (2):391-399.

Duso, C. & M. Pasini, 2003. Distribution of the predatory mite ***Amblyseius andersoni*** Chant (Acari: Phytoseiidae) on different apple cultivars. **J. Pest Science, 76**: 33-40.

Düzgüneş, Z., 1977. The phytophagus mites on different economic plants and their control in Çukurova. J. Faculty of Agric. Çukurova Univ., the Public Lecture: **91:** 1-25 (in Turkish).

Ecevit, O., 1981. The population relations of predator mite ***Amblydromella kazachstanicus*** Wainstain and pest mites ***Bryobia rubrioculus*** Scheuten, ***Tetranychus urticae*** Koch, ***Aculus schlectendali*** (Nal.), ***Calepitrimerus baileyi*** Keifer (Acarina: Phytoseiidae, Tetranychidae, Eriophyidae) on apple orchards in Erzurum, Turkey. **J. Faculty of Agric., Ondokuz Mayıs Univ**., **7** (2): 1-52 (in Turkish with English summary).

Ehara, S., 1959. Mites of the subfamily Bryobiinae from Japan (Tetranychidae). **Jour. Fac. Sci. Hokkaido Univ. Ser**., VI Zool., **14**: 185-195.

Gül, M. & O. Erkan, 2001. Development in apple production on trade in the World and Turkey. **J. Faculty of Agric. Çukurova Univ**., **16** (3): 1-10 (in Turkish with English summary).

Helle, W. & L. P. Pijnacker, 1985. Parthenogenesis, chromosomes and sex. In: Spider Mites. Their Biology, Natural Enemies and Control (W. Helle and M. W. Sabelis, eds.), Elsevier, Amsterdam, World Crop Pests. Vol 1A, pp. 129-139.

Herbert, H. J., 1962. Life history and habits of the brown mite, ***Bryobia arborea*** Morgan and Anderson (Acari: Tetranychidae) on apples in Nova Scotia. **Can. Entomol**., **94**: 934-941.

Herbert, H. J., 1965. The brown mite, ***Bryobia arborea*** Morgan and Anderson (Acarina: Tetranychidae) on apples in Nova Scotia. I. Influence of intra tree distribution on the selection of sampling units. II. Differences in habits and seasonal trends in orchards with bivoltine and trivoltine populations. III. Distribution of diapause eggs. IV. Hatching of diapause eggs. **Can. Entomol**., **97**: 1303-1318.

Hoy, M. A., 1985. Almonds (California). In: Spider Mites. Their Biology, Natural Enemies and Control (W. Helle and M. W. Sabelis, eds.), Elsevier, Amsterdam, World Crop Pests. Vol 1B, pp. 299-310.

İncekulak, R. & O. Ecevit, 2002. A research on determination of harmful and beneficial mite species in apple orchards in Amasya and their population densities. Proc. Fifth Turkish National Congress of Biological Control, Erzurum, pp 297-314 (in Turkish with English summary).

Jamali, M. A., K. Kamali, A. Saboori & J. Nowzari, 2001. Biology of ***Zetzellia mali*** (Ewing) (Acari: Stigmaeidae) in Karaj, Iran. **Syst. Appl. Acarol**., **6**: 55-60.

Jeppson, L. R., H. H. Keifer & E. W. Baker, 1975. Mites Injurious to Economic Plants. University of California Press, California, 615 p.

Kasap, İ., S. Çobanoğlu, Y. Aktuğ, & E. Denizhan, 2004. Harmful and useful mite species determined in apple orchards of around Van Lake. Proceedings of The First Plant Protection Congress of Turkey, 104, Samsun (in Turkish with English summary).

Kreiter, S., M. S. Tixier, B. A. Croft, P. Auger & D. Barret, 2002. Plants and leaf characteristics influencing the predaceous mite ***Kampimodromus aberrans*** (Acari: Phytoseiidae) in habitats surrounding vineyards. **Environ. Entomol**., **31** (4): 648-660.

Osakabe, M., S. Ehara, & S. Adhikari, 2000. Damage to young leaves of pear trees by ***Bryobia rubrioculus*** (Scheuten) (Acari: Tetranychidae) in Nepal. **J. Acarol. Soc. Jpn**., **9** (1): 15-22.

Sabelis, M. W., 1985. Reproductive strategies. In: Spider Mites. Their Biology, Natural Enemies and Control (W. Helle and M. W. Sabelis, eds.), Elsevier, Amsterdam, World Crop Pests. Vol 1A, pp. 265-278.

Santos, M. A. & J. E. Laing, 1985. Stigmaeid predators. In: Spider Mites. Their Biology, Natural Enemies and Control (W. Helle and M. W. Sabelis, eds.), Elsevier, Amsterdam, World Crop Pests. Vol 1B, pp. 197-202.

Strickler, K., N. Cushing, M. Whalon, & B. A. Croft, 1987. Mite (Acari) species composition in Michigan apple orchards**. Environ. Entomol**., **16**: 30-36.

Van De Vrie, M., J. A. Mcmurtry, & C. B. Huffaker, 1972. Ecology of tetranychid mites and their natural enemies: A review. III. Biology, Ecology and pest status and host plant relations of tetranychids. **Hilgardia**, **41** (13): 343-432.

Vatansever, G., M. R. Ulusoy & L. B. Erkılıç, 2003. Improving the mass rearing possibilities of ***Serangium montazerii*** Fürsch (Col.: Coccinellidae) on different host plants of ***Bemisia tabaci*** (Genn.) (Homoptera: Aleyrodidae). **Turk. J. Agric. For**., **27**: 175-181.

Villanueva, R. T. & R. Hamsen, 1998. Studies on the role of the stigmaeid predator ***Zetzellia mali*** in the acarine system of apple foliage. **Proc. Entomol. Soc. Ont., 129**: 149-155.