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Population growth and compatibility of ***Phytoseiulus persimilis*** Athias-Henriot and ***Amblyseius bibens*** Blommers (Acari: Phytoseiidae) feeding on ***Tetranychus cinnabarinus*** Boisd. (Acari: Tetranychidae) under laboratory conditions

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Summary

Population growth and compatibility of ***Phytoseiulus persimilis*** Athias-Henriot and ***Amblyseius bibens*** Blommers preying on ***Tetranychus cinnabarinus*** Boisd. were studied using leaf arenas in series of Petri dishes, at 20±1°C and 90±5 % R.H. with 0.55 Klux lightning. Mean number of eggs, immature stages and females of ***T. cinnabarinus*** regarding to ***A. bibens*** and ***P. persimilis*** in single and cohabiting arenas were realized. The mean number of eggs, immature stages and females of ***T. cinnabarinus*** were statistically in same group for single species ***P. persimilis*** and cohabited arenas but they were different from single species ***A. bibens*** except adult females.

Population densities of ***P. persimilis*** and ***A. bibens*** were found to be higher in single species experiments than with the two predators cohabited arenas. Both predators eliminated the prey in single and mixed species experiments. In contrast to ***P. persimilis, A. bibens*** showed a relatively slower response to prey in single species experiments. The highest average number of egg, immature stage and female of the prey was 308 total stages/25 cm^2 with ***A. bibens***, and 144 total stages/25 cm^2 with ***P. persimilis***. In cohabiting arenas, the average maximum number of prey was 232 total stages/25 cm^2, which was lower than that of ***A. bibens*** but was higher than that of ***P. persimilis*** in a single species system.

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Competition pressure resulted lower population densities for both predators in cohabited arenas, neither of the predator species completely outcompeted the other.

Key words: ***Phytoseiulus persimilis***, ***Amblyseius bibens***, ***Tetranychus cinnabarinus***, population growth, interference

Anahtar sözcükler: ***Phytoseiulus persimilis***, ***Amblyseius bibens, Tetranychus cinnabarinus***, populasyon gelişmesi, etkileşim

Introduction

Spider mites are serious pests of many agricultural crops around the world (Jeppson et al., 1975). Biological control of spider mites using phytoseiid mites has been applied successfully in many countries (Wysoki, 1985; Blümel and Schausberger, 1996). ***Phytoseiulus persimilis*** Athias-Henriot is one of the best natural enemies of tetranychid mites, especially in greenhouses, due to its high reproductive rate, voracity and prey specific behaviour (Rasmy and Ellaithy, 1988; Goodwin and Wellham, 1992). However, the inability of ***P. persimilis*** to survive in the absence of tetranychid mites requires repeated predator release for every new spider mite infestation (Ashihara et al., 1978). ***Amblyseius bibens*** Blommers, another important predator of several plant feeding mites, feeds primarily on spider mites eggs (Blommers and Van Etten, 1975). In contrast to ***P. persimilis, A. bibens*** can reproduce on different kinds of food e.g. pollen and phytophagous mites (Blommers et al., 1977). Thus, it might survive in the absence of spider mites at the release sites.

For these reasons, using two or more predator species together in the same system might be more effective against pests than using a single species; each sufficing other's negative sides. According to mentioned ideas McMurtry et al. (1984), Yao and Chant (1989), Croft and McRae (1992), and Gillespie and Quiring (1992), worked on compatibility of different phytoseiid species and used more than one predatory species at their experiments. McMurtry et al. (1984) stated that the released nine phytoseiid species did not significantly affect average densities of ***Oligonychus punicae*** (Hirst) and that the population of a native phytoseiid mite, ***Euseius hibisci*** (Chant), was reduced after the release of exotic predators because of competition in Southern California. Croft and McRae (1992), reported that control of spider mites was better in mixed-species releases of ***Metaseiulus occidentalis*** (Nesbitt) and ***Typhlodromus occidentalis*** Scheuten than in single-species release plots. Gillespie and Quiring (1992), found that ***Orius tristicolor*** (White) and ***Amblyseius cucumeris*** Oudemans could be used simultaneously for biological control of western flower thrips (***Frankliniella occidentalis*** (Pergande)) in greenhouse vegetable crops. Yao and Chant (1989), studied population growth and predation interference between ***Iphiseius degenerans*** (Berlese) and ***P. persimilis*** and discussed their compatibility for the multispecies predatory oriented biological control.

Here, it was aimed to study the population growth and compatibility of ***P. persimilis*** and ***A. bibens*** feeding on ***T. cinnabarinus*** under laboratory conditions to have parameters for subsequent biological control experiments in greenhouse.

Materials and Methods

Population growth and compatibility of ***P. persimilis*** and ***A. bibens*** feeding on ***Tetranychus cinnabarinus*** Boisd. were examined using a series of bean leaf arenas (about 25 cm^2). Each leaf rested underside up on saturated sponges lined with filter papers in Petri dishes (9.5 cm in diameter and 1.5 cm in depth). The leaf was edged by a wet cotton string to prevent the predators and prey escaping from arenas. Ten newly mated female prey, ***T. cinnabarinus,*** were placed on each leaf. To determine population growth of ***P. persimilis*** and ***A. bibens*** when cohabiting the same arena (mixed species), four ***P. persimilis*** and four ***A. bibens*** eggs were transferred to the same leaf arenas together 24 h after prey inoculation. In addition, population growth of ***P. persimilis*** and ***A. bibens*** were followed individually (single species) by transferring 4 eggs of each predator species separately to prey inoculated arenas. After the initiation of each experiment, observations were made daily until the death of last prey and predator. During the experiment, old leaf arenas were replaced as needed and all the prey and predators were transfered to the new leaf arenas using a 000 camel's-hair brush. The only prey available to the predators was the 10 initial females and their offspring; there was no prey replenishment. The number of eggs, immatures (larvae, protonymph, deutonymph) and adult female stages of prey and predators were recorded daily. Mean number of different stages of ***T. cinnabarinus*** when ***A. bibens*** and ***P. persimilis*** single species separately and cohabited arenas were analysed using One-Way ANOVA, with means separated by the Duncan multiple range test (Nissen, 1988).

Experiments were conducted at 20 ± 1°C, 90 ± 5 % RH with 16 hours of 0.55 Klux illumination in controlled chambers and repeated 10 times.

Results and Discussion

Mean number of different stages of ***T. cinnabarinus*** when ***A. bibens*** and ***P. persimilis*** in single species separately and cohabited arenas are given in Table 1.

The mean number of eggs (94.4), immature stages (42.1), females (3.8), and total number of ***T. cinnabarinus*** (140.4) were the highest in single species ***A. bibens*** arenas. In contrast to ***A. bibens,*** the mean number of all the counted stages of ***T. cinnabarinus*** in single species ***P. persimilis*** arenas were the lowest and the mean number of egg, immature stages, female and total were found to be 35.6, 3.4, 3.0 and 42.1, respectively. Compared with single

species arenas, in cohabiting arenas, all the mean numbers for different stages of ***T. cinnabarinus*** were lower than those obtained from single species ***A. bibens*** but higher in single species ***P. persimilis*** arena (Table 1).

Table 1. Mean number of ***Tetranychus cinnabarinus*** in ***Amblyseius bibens*** and ***Phytoseiulus persimilis*** in single species separately and cohabiting arenas (Mean ± SEM)*

	T. cinnabarinus			
Arenas	Egg	Immature stg.	Female	Total
A. bibens (alone)	94.4 ± 19.5 A	42.1 ± 9.5 A	3.8 ± 0.6 A	140.4 ± 22.1 A
P. persimilis (alone)	35.6 ± 10.8 B	3.4 ± 1.3 B	3.0 ± 0.7 A	42.1 ± 10.6 B
A. bibens + P. persimilis	50.1 ± 15.6 B	8.0 ± 3.1 B	3.1 ± 0.7 A	61.2 ± 16.8 B

* Means followed by a different letter in the same column are significantly different (P = 0.05) based on Duncan multiple range test.

Statistical comparison revealed that adult female numbers of ***T. cinnabarinus*** did not show any differences both in single species and cohabited arenas. But mean numbers of eggs and immature stages of ***T. cinnabarinus*** were lower in ***P. persimilis*** single species and cohabited arenas than that of single species ***A. bibens*** arena.

Population growth of ***P. persimilis*** and ***A. bibens*** in single species and cohabiting arenas are shown in Figs. 1-3. When they were in single species arenas, the population densities of egg, immatures, and adult stage of both predators were higher than that in cohabiting arenas, indicating the presence of competition pressure in cohabiting arenas.

The first immatures and adults of ***P. persimilis*** from the eggs introduced to the arenas had an immediate effect on prey population (Fig. 1) compared to the effect of ***A. bibens*** in single-species trials (Fig. 2).

The peaks of egg and immature populations of ***P. persimilis*** in the following cohort also occurred much earlier than with ***A. bibens*** in single species arenas. The early population development of ***P. persimilis*** was due to its high prey consumption rate and shorter oviposition period and development time.

The age class composition of the prey showed that ***P. persimilis*** mainly fed on immatures of ***T. cinnabarinus*** (Fig. 1). This predator eliminated the prey from the arenas in a relatively short time, reached high population levels, declined rapidly, and diminished due to starvation. The highest prey population observed was 144 total stages/leaf arena.

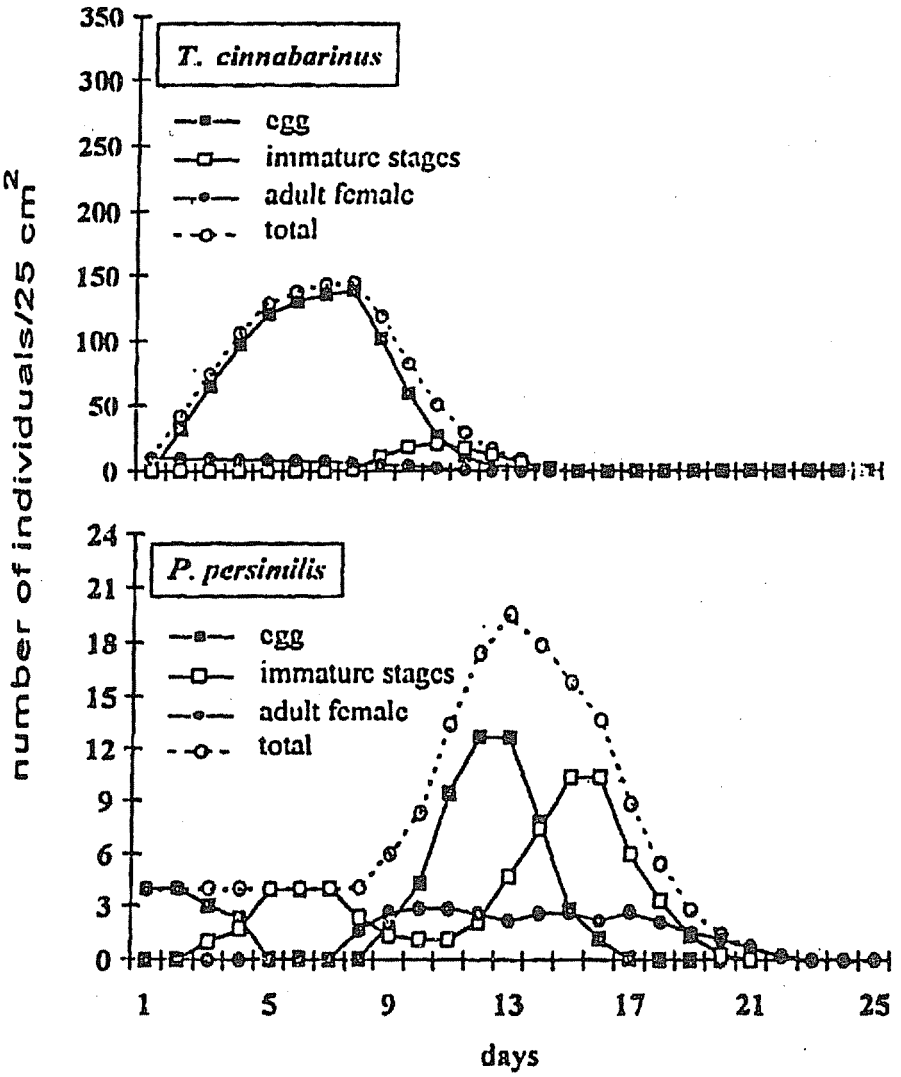

Figure 1. Population changes of ***Phytoseiulus persimilis*** and its prey, ***Tetranychus cinnabarinus,*** in single species arenas.

Despite its low consumption and development rate (Sabelis, 1981; Şengonca and Lababidi, 1987; Zaman and Şekeroğlu, 1992; Çölkesen et al., 1994), ***A. bibens*** also eliminated the prey from the arenas but its response was rather slow; the egg and immature stages of the prey reached higher numbers during the early period of the experiment (peak of 308 total stages/leaf arena) but was gradually reduced to low levels (Fig. 2).

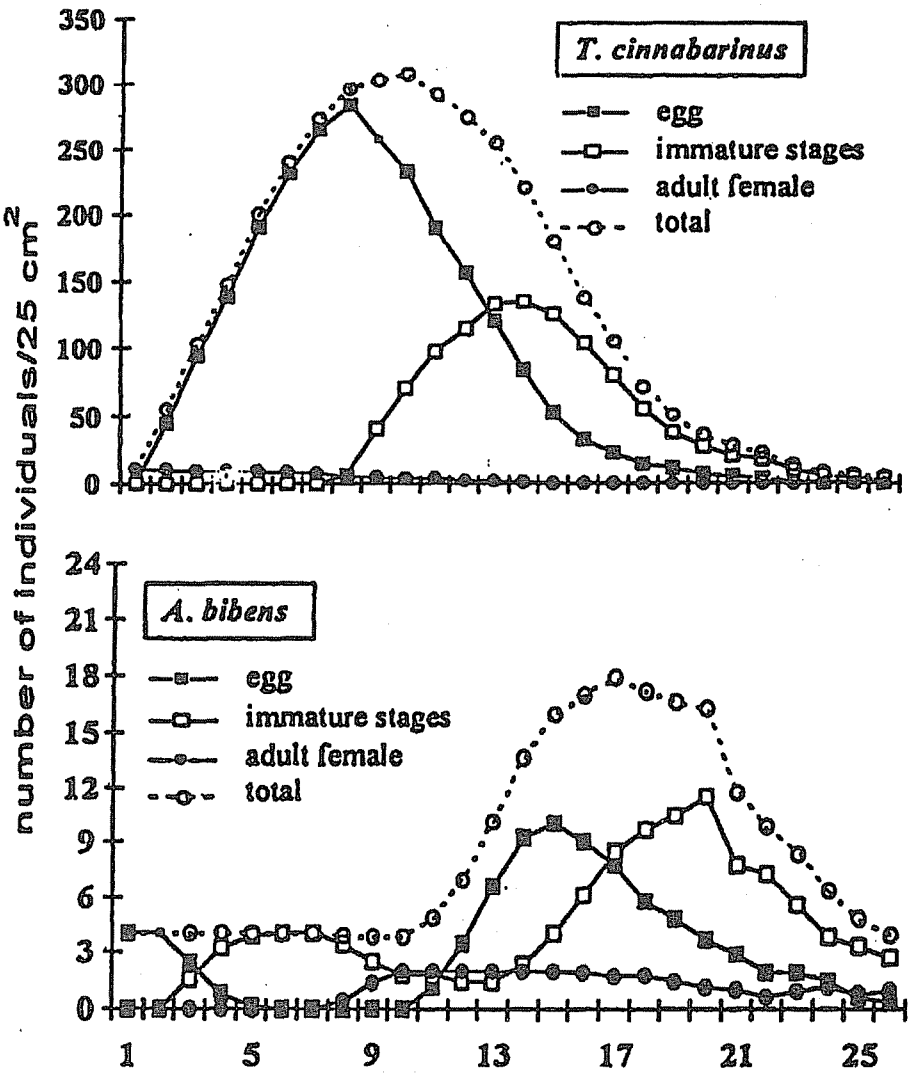

Figure 2. Population changes of ***Amblyseius bibens*** and its prey, ***Tetranychus cinnabarinus,*** in single species arenas.

The oviposition period and immature developmental time of this cohort was extended over a longer time compared to that of ***P. persimilis.*** Adult populations of both predators, slightly higher with ***P. persimilis*** than ***A. bibens,*** were lower than other stages and showed no distinct peak.

The lower population densities of all stages of both predators indicated the presence of competition pressure in cohabiting arenas (Fig. 3). However, neither

of the predator species completely outcompeted the other from the arenas. The average maximum number of prey (232 total stages/leaf arena) was lower than with ***A. bibens*** but was higher than with ***P. persimilis*** in the single species systems. This suggests that the presence of both predators in the same arena exerted heavier predator pressure on ***T. cinnabarinus*** than ***A. bibens*** alone but not as strong as ***P. persimilis*** alone. ***A. bibens*** was observed feeding on eggs of ***P. persimilis*** even in the presence of prey. The tendency of ***A. bibens*** to feed primarily on egg stages of spider mites was recorded by Blommers (1976). ***A. bibens*** seemed to prefer egg stages without discriminating prey species. ***P. persimilis*** was not observed to feed no any stages of ***A. bibens.*** Cannibalism on eggs and larvae by ***P. persimilis*** was only observed in the absence of prey but ***A. bibens*** showed no cannibalistic behaviour.

The decreased egg production and immature numbers of ***P. persimilis*** in two- species system relative to one-species system suggested that ***P. persimilis*** adults were not suffering from a food shortage, because the prey was more abundant in two-species system. Moreover, the immatures require only relatively small amount of food for survival and development. These observations on differences in population changes between one and two-species systems and the direct evidence from witnessing the feeding behaviour of ***A. bibens,*** indicated that the greater mortality of ***P. persimilis*** was attributed to predation by ***A. bibens.*** In their interactive experiments, Yao and Chant (1989), reported that higher mortality observed for ***P. persimilis*** in two species-system was caused by predation by ***I. degenerans*** present in the system. In contrast to ***P. persimilis*** the much lower population curves for egg and immatures of ***A. bibens*** in two-species systems compared to those of when it was alone (Figs. 2 and 3) were mainly due to starvation. By the time the individuals of ***A. bibens*** from the introduced eggs reached the adult stage food was scarce and the prey was already diminished as the first members of the cohort started to appear.

When natural enemies are used to control a pest population, the introduction of multiple species of natural enemies often is considered to be a favoured measure (Huffaker et al., 1971; Waage and Hassell, 1982; Croft and McRae, 1992; Gillespie and Quiring, 1992). However competition may affect population levels (McMurtry et al., 1984) and it may lead to competitive exclusion (Ehler and Hall, 1982).

The results from this study suggest that despite the elimination of the pest species from the arenas, the introduction of ***P. persimilis*** and ***A. bibens*** together would not be advisable under limited food supply in restricted arenas such as very local pest populations frequently seen in greenhouses. Before drawing further conclusions on the impact of interspecific predation on the population dynamics of cohabiting phytoseiid predators and their prey, the possibility of such predation should be examined closely in the pest environment both in greenhouses and open fields.

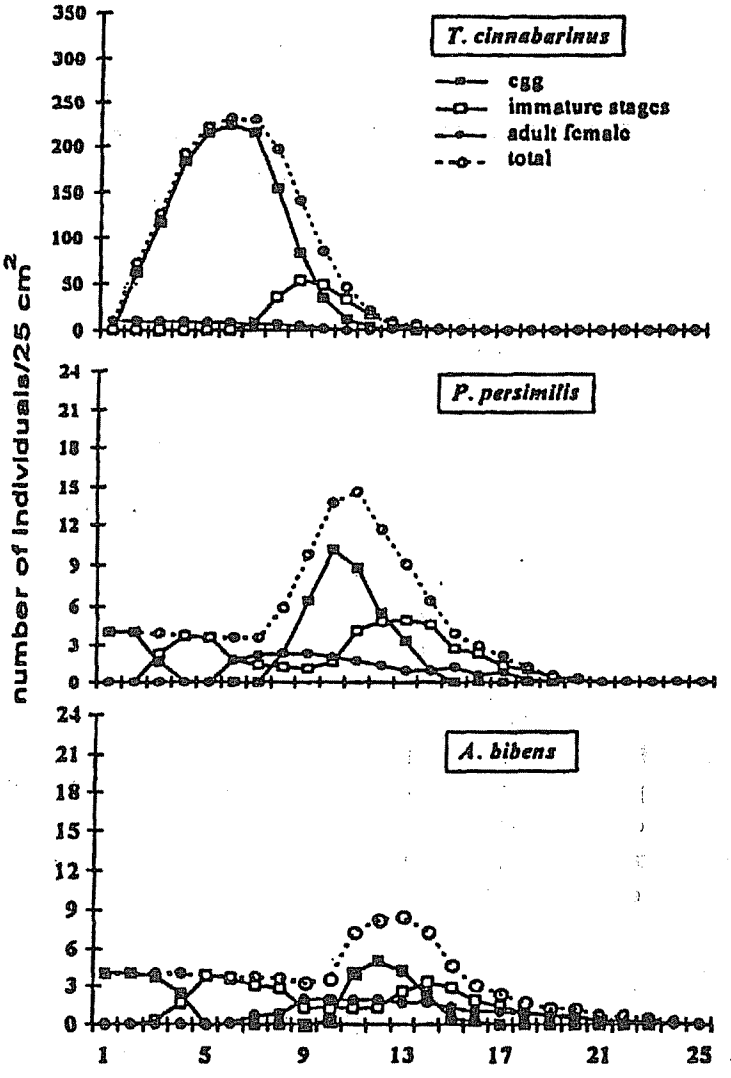

Figure 3. Population changes of ***Amblyseius bibens*** and ***Phytoseiulus persimilis,*** and their prey. ***Tetranychus cinnabarinus,*** in cohabiting arenas.

Özet

Tetranychus cinnabarinus **Boisd. (Acari: Tetranychidae) üzerinde beslenen** *Phytoseiulus persimilis* **Athias-Henriot ve** *Amblyseius bibens* **Blommers (Acari: Phytoseiidae)'in laboratuvar koşullarında populasyon gelişmesi ve etkileşimleri**

Tetranychus cinnabarinus Boisd. üzerinde beslenen avcı akar ***Phytoseiulus persimilis*** Athias-Henriot ve ***Amblyseius bibens*** Blommers'in laboratuvar koşullarında populasyon gelişmesi ve birbirlerine olan etkileri 20 ± 1°C sıcaklık ve % 90 ± 5 nem içeren

ortamda 0.55 Klux aydınlatma koşullarında Petri kaplarına yerleştirilen yaprak diskleri üzerinde çalışılmıştır. Avcı akarların ortamda tek ve birarada olduğu koşullarda populasyon gelişimlerine bağlı olarak ***T. cinnabarinus***'un yumurta, ergin öncesi ve ergin dişi bireylerinin ortalama yoğunlukları saptanmıştır. ***T. cinnabarinus***'un yumurta, ergin öncesi ve ergin dişi bireylerinin ortalama yoğunlukları ***P. persimilis***'in ortamda tek ve ***A. bibens*** ile birlikte bulunduğu koşullarda istatistiki olarak aynı grup içinde yer alırken, ortamda yalnızca ***A. bibens***'in bulunduğu koşullarda saptanan ortalama ***T. cinnabarinus*** yoğunluğu ise ergin dişi dışında iki gruptan daha yüksek ve istatistiki olarak farklı bulunmuştur.

P. persimilis ve ***A. bibens***'in ortamda tek olduklarında saptanan ortalama yoğunlukları ikisinin birarada bulunduğu koşullarda saptanan yoğunluktan daha yüksek olmuştur. ***A. bibens, P. persimilis***'in aksine ortamda tek avcı bulunduğu koşullarda daha yavaş populasyon gelişmesi göstermiştir. En yüksek ortalama av yoğunluğu ***A. bibens***'in tek olarak bulunduğu koşullarda 308 adet/25 cm^2 olarak gerçekleşirken, bu değer ***P. persimilis*** için 144 adet/25 cm^2 olmuştur. Her iki avcı akarın birarada olduğu koşullarda ise ortalama en yüksek ***T. cinnabarinus*** değeri 232 adet/25 cm^2 olarak saptanmıştır. Bu değer ***A. bibens***'in ortamda tek olduğu koşullarda elde edilen değerden daha düşük olurken, ***P. persimilis*** için bulunan değerden daha yüksek olmuştur.

Avcı akarlar arasındaki çekişme nedeni ile her iki türün bir arada bulunduğu koşullarda her iki avcı akar türü için daha düşük populasyon yoğunluğu saptanmış, yalnız çekişme nedeni ile türlerin hiçbirisi ortamdan yok olmamıştır.

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