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Beneficial Mite (Acari) Fauna of Agricultural Areas and Storages in TURKEY

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Abstract

Determination of beneficial mite species in agricultural areas and storages of Kastamonu province has been aimed. For this purpose, 163 areas have been surveyed in Taşköprü, Hanönü and Centrum of Kastamonu in 2023-2024. In this study, only predatory mite species were focused on in determining beneficial mites. Thirty mite species representing in three orders (Prostigmata, Mesostigmata and Astigmata) were identified. The identified species belong to twelve families, including Ascidae (nine species), Phytoseiidae (seven), Laelapidae (four), Macrochelidae (two), Stigmaeidae (one), Digamasellidae (one), Ameroseiidae (one), Histiostomatidae (one), Parasitidae (one), Eviphididae (one), Veigaiidae (one) and Tydeidae (one). Predatory mites of bulbs and storages were determined for the first time in Türkiye. The most abundant species is *Alliphishalleri* (G.&R. Canestrini) (Eviphididae). The well distributed species is Gamasellodes bicolor (Berlese) (Ascidae:Acaridae).

Keywords: Beneficial mites; Acari; Predatory; Phytoseiidae; Stigmaeidae; Laelapidae; Türkiye

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Türkiye'deki Tarım Arazileri ve Depolardaki Faydalı Akar Faunası

Öz

Çalışmada, Kastamonu ili tarım alanları ve depolarında bulunan faydalı akar türlerinin belirlenmesi amaçlanmaktadır. Bu amaçla 2023-2024 yıllarında Kastamonu İli Taşköprü, Hanönü ve Merkez'de 163 alanda araştırma yapılmıştır. Bu çalışmada faydalı akarların belirlenmesinde sadece predatör akar türleri üzerinde durulmuştur. Arazi örneklemelerinde 3 akar takımını (Prostigmata, Mesostigmata ve Astigmata) temsil eden 30 akar türü tespit edilmiştir. Tanımlanan türler, Ascidae (dokuz tür), Phytoseiidae (yedi), Laelapidae (dört), Macrochelidae (iki), Stigmaeidae (bir), Digamasellidae (bir), Ameroseiidae (bir), Histiostomatidae (bir), Parasitidae (bir), Eviphididae (bir), Veigaiidae (bir) ve Tydeidae (bir) dahil olmak üzere on iki familyaya aittir. Türkiye'de ilk kez çiçek soğanları ve depolarda yırtıcı akarlar tespit edilmiştir. En bol bulunan tür *Alliphishalleri*'dir (G.&R. Canestrini) (Eviphididae). En iyi dağılım gösteren tür ise *Gamasellodesbicolor* (Berlese)'dir (Ascidae:Acaridae).

Anahtar Kelimeler: Faydalı akarlar, Acari, Avcı, Phytoseiidae, Stigmaeidae, Laelapidae, Türkiye

1. Introduction

Pests and diseases are playing an important role in agricultural areas, depending on their effects on crop damage from 10–50%. This estimated values sometimes reaches to 100% depending on the crop species and density of the pest. There are very limited number of studies related to the agricultural plants. Most of them are related to the mite species belonging to onion and bulbouses ornamental plants [1-11].

Because of the highly negative effects of using chemical pesticides on the protection of pests, it is important to predatory mites in the scope of biological control as alternative methods of pest management methods to minimize the environmental problems [12]. In this study, the beneficial mite species on bulbs, their densities and their distribution by weekly samplings on agricultural areas of Taşköprü, Hanönü and Centrum of Kastamonu were determined and their locality GPS datawere recorded (Table 1).

2. Materials and Methods

The surveys were carried out in agricultural areas and storages in different localities of Kastamonu (Taşköprü, Hanönü and Centrum), which is located inland of Black Sea, at weekly interval during 2023-2024 (Table 1; Fig. 1). The plant samples were collected from April to July

of 2023 and 2024. The storage samples were collected randomly from different levels of bulks during storage periods at weekly intervalsfrom August 2023 to April 2024. Agricultural areas, especially garlic and onion fields in Kastamonu province were surveyed in order to identify.

Table 1: Localities and coordinates of sampling areas

TAŞKÖPRÜ			
Alamaşişli Village	41°28'41.6748" N 34°7'38.4888" E	Kızılcaören Village	41°25'6.258" N 3407'34.2408" E
Alisaray Village	41°26'32.75" N 34°16'04.14" E	Centrum Gizlice Village	41°30'25.5996" N 34°12'48.87" E
Aşağıçayırcık Village	41°30'3.852" N 34°10'1.3764" E	Centrum Gökırmak Village	41°30'29.49" N 33°012'26.46" E
Aşağıçit Village	41°25'54.04" N 34°06'27.52" E	Centrum Ortaca Village	N 41°31'10.65" N E 34013'04.81" E
Alatarla Village	41°29'46.7556" N 34°2'4.2828" E	Tekev Village	41°27'59.8104" N 34°05'36.4217" E
Çanşa/Çambaşı Village	41°29'25.4424" N 34°21'18.2024" E	Tekkeoğlu Village	41°32'52.8216" N 34°6'37.8612" E
Kışla Village	41°28'22.05" N 34°2'26.9376" E	Yukarıçayırcık Village	41°29'51.756" N 34°9'0.4212" E
HANÖNÜ District			
Donalar Village	41°33'09.50" N 34°05'50.70" E	İncesu Village	41°35'17.7004" N 34°14'23.5245" E
Erik Village	41°38'12.19" N 34°19'18.20" E	Karapürçek Village	41°33'57.618" N 34°10'26.9376" E
Eskiatça Village	41°31'58.1628" N 34°13'23.8008" E	Kornapa Village	41°35'23.9892" N 34°17'25.008" E
Hamzaoğlu Village	41°36'13.17" N 34°18'44.76" E		
CENTRUM			
Abay Village	41°31'11.21" N 33059'14.07" E	Aşağıayvalı Village	41°29'21.8976" N 33°57'52.7184" E
Çavundur Village	41°28'20.20" N 33°58'58.32" E	Çaycevher Village	41°29'42.09" N 34003'24.02" E
Uzunkavak Village	41°27'50.976" N 34°5'27.4848" E		

The mite species present in these areas. For this purpose, samples were collected weekly and each area was visited at least once a month (Table 1). Samples were taken from the heads and green parts of garlic and onion plants. In addition, samples of weed species densely present in the study area were collected to fully document the mite diversity. The results of the study

identified the beneficial mite species in garlic and onion and their distribution. The number of observation plots and the number of samples collected were determined according to the method of Bora and Karaca [82], taking into account the size of the plots.

The mites were observed under a stereomicroscope. Eventually all the mite samples were extracted by Berlese funnels and kept in 70% ethyl alcohol, then were cleared in Lacto-phenol solution and mounted in Hoyer's medium, afterwards dried for 15–20 days in an oven at 50°C (Henderson 2001). The slides were identified using the Leica DM 2500 microscope, by [13-19]. The GPS data of the collection sites are shown in Table (1).

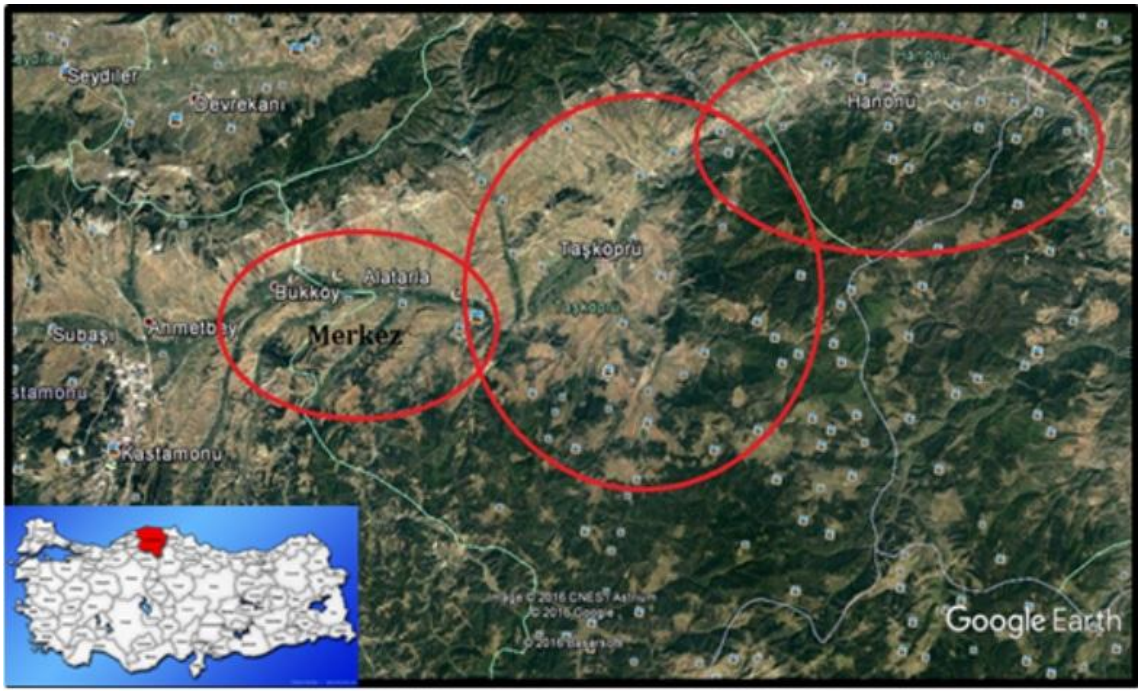


Figure 1: Localities of beneficial mite species collected in agricultural areas and storages of Kastamonu

3. Results and Discussion

3.1. Density and molar volume

A total of 30 mite species belonging to twelve families were identified from head, green parts and storage samples (Table 2). The identified mite samples belonged to Ameroseiidae, Ascidae, Digamasellidae, Eviphididae, Laelapidae, Macrochelidae, Parasitidae, Phytoseiidae, Tydeidae, Stigmaeidae and Veigaiidae, which were mainly predatory species.

Table 2: Predatory and saprophyte mite species that were determined in agricultural areas and storages of Kastamonu

Family	Species	Kind of Species	Locality*			Kind of Samplings
			T	H	M	
Ascidae	*Gamasellodesbicolor*	Predatory	+	+	+	Bulb
						Leaf
						Storages
	Arctoseiuscetratus	Predatory	+	+	+	Bulb
						Leaf
						Storages
	Ascabicornis	Predatory	+	+		Bulb
						Leaf
						Storages
	Proctolaelapsscolyti	Predatory	+			Storages
	Proctolaelapspygmaeus	Predatory	+		+	Storages
	Blattisociustarsalis	Predatory	+		+	Storages
	Blattisociuskeegani	Predatory	+			Bulb
						Leaf
						Storages
	Blattisociusdentriticus	Predatory	+			Leaf
						Storages
	Cheiroseiusnecorniger	Predatory	+			Leaf
	Macrochelessubbadius	Predatory	+			Storages
Macrochelidae	*Macrochelesglaber*	Predatory			+	Bulb
Laelapidae	*Hypoaspisbrevipilis*	Predatory	+	+	+	Bulb
						Leaf
	Hypoaspisaculeifer	Predatory	+	+	+	Bulb
						Leaf
	Hypoaspispraesternalis	Predatory	+	+	+	Bulb
						Leaf
	Androlaelapscasalis	Predatory	+			Storages
Parasitidae	*Parasitusfimetorum*	Predatory	+	+	+	Bulb
						Leaf

						Storages
		Predatory				Bulb
			+	+	+	Leaf
Eviphididae	*Alliphis halleri*					Storages
		Predatory				Bulb
			+	+	+	
Veigaiidae	*Veigaiaplanicola*					Leaf
		Predatory				Bulb
			+	+	+	
	Neoseiulusmarginatus					Leaf
	Neoseiulusbarkeri	Predatory	+	+	+	Bulb
		Predatory				Bulb
			+	+	+	
	Neoseiulusbicaudus					Leaf
Phytoseiidae	*Neoseiulusagrestis*	Predatory	+			Storages
		Predatory				Bulb
			+	+		
	Anthoseiusrecki					Leaf
	Euseiusfinlandicus	Predatory		+		Bulb
		Predatory				Bulb
			+	+		
	Amblyseiusobtusus					Leaf
Digamasellidae	*Dendrolaelapszwoelferi*	Predatory	+			Bulb
Ameroseiidae	*Ameroseiusplumosus*	Predatory	+			Storages
Stigmaeidae	*Eustigmaeussegnis*	Predatory	+			Bulb
Tydeidae	*Tydeuscaudatus*	Predatory	+			Leaf

*T=Taşköprü, H=Hanönü , M=Centrum

Order Mesostigmata

Family Ascidae

Genus *Gamasellodes* (Athias-Henriot), 1961

***Gamasellodes bicolor* (Berlese), 1918**

Width of dorsal idiosom: 183,62±0,11 (166,7-202,24), Length of dorsal idiosom: 342,42±0,19 (316,54-378,04) (n:10).

Species examined: Taşköprü/Alamaşişli Village, 01.IV.2023 (2♀♀, 2♂♂); Storage, 07.V.2014 (1♀); Taşköprü/Karacaoğlu Village, 28.IV.2023 (4♀♀,6♂♂); Hanönü/Çördük

Village,10.VI.2023 (3♀♀,6♂♂); Hanönü/Karapürçek Village, 16.VI.2023 (3♀♀,1♂♂); Taşköprü/Akdeğirmen Village, 08.VII.2023 (9♀♀,8♂♂); Hanönü/Eskiatça Village, 22.IV.2023 (2♂♂); Centrum/Uzunkavak Village Killik Located, 25.IV.2023 (1♀,1♂); Centrum/ Çaycevher Village, 24.V.2024 (3♀♀,3♂♂); Taşköprü/Çanşa Village, 03.VI.2024 (2♀♀); Hanönü/ Kornapa Village, 10.VI.2024 (1♀,2♂♂); Centrum/Çaycevher Village, 24.V.2024 (2♀♀,1♂); Hanönü/AkçasuVillage, 20.V.2024 (2♀♀); Taşköprü/Esenlik Village, 10.V.2024 (5♀♀,3♂♂).

Comments: These mites are small predators living in the soil and feeding with small invertebrates such as mite, nematode, and some species of Collembola [80]. This species was recorded from Türkiye previously by Denizhan [7]. It was determined as a beneficial mite species in onion fields of Izmir province [8]. In this study, G. bicolor was found in 30 villages of Taşköprü, Hanönü and Centrum on bulbs, green parts and storage. It was an important predator species that has been determined most intensively in the surveys.

***Arctoseiuscetratus* (Sellnick), 1940**

Width of dorsal idiosom: 166,77±0,15 (186,77-136,32), Length of dorsal idiosom: 330,40±0,14 (346,56-308,21) (n:10).

Species examined: Taşköprü/Kızılcaören Village, 25.IV.2023 (9♀♀,7♂♂); Centrum/Kızılcaören Village, 01.V.2023 (11♀♀,14♂♂); Centrum/Derebeysibey Village, 23.V.2023 (1♀,2♂♂); Hanönü/Kuyluş Village, 23.VI.2023 (5♀♀,5♂♂); Centrum/Çavundur Village, 01.V.2024 (10♀♀,12♂♂); Taşköprü/Alisaray Village, 23.VI.2024 (1♀,4♂♂); Taşköprü /Kastaş Storage, 10.VIII.2024 (2♂♂).

Comments: *A. cetratus*feeds on nematodes, collembols, earth mites (Oribatida) and Tarsonemidae (Acari: Prostigmata). It was found on onions from İzmir [8]. *A. cetratus* is one of the most intense predator species that were determined in this survey.

***Asca bicornis* (CanestriniveFanzago), 1887**

Width of dorsal idiosom: 227,89±0,17 (257,48-198,19) Length of dorsal idiosom: 348,69±0,13 (371,00-330,93) (n:10).

Species examined: Taşköprü/Centrum Gizlice Avenue, 13.VI.2023 (2♀♀); Hanönü/İncesu Village, 26.IV.2023 (2♀♀); Hanönü/Kornapa Village, 25.V.2023 (1♂); Taşköprü/Aşağıçayırcık Village, 16.VI.2023 (9♀♀,5♂♂); Taşköprü/Akdoğan Tekke Village Storage, 23.VII.2023 (1♀,1♂).

Comments: It was previously recorded on *Gageavillosa*, *Pinus* sp. and wild mushrooms [20,21]. In this survey *A. bicornis* was found on bulbs, leavesand storages in the 6 villages of Taşköprü and Hanönü.

***Blattisociuskeegani* (Fox), 1947**

Width of dorsal idiosom: 212,88±2,41 (178,32-266,08), Length of dorsal idiosom: 399,81±2,00 (364,50-442,20) (n:4).

Species examined: Taşköprü/Centrum Ağcıkişi Avenue, 17.IV.2023 (1♀); Taşköprü /Hamzaoğlu Village, 25.VI.2023 (1♀); Taşköprü/Akdoğan Village Storage, 23.VII.2023 (1♀,2♂♂); Taşköprü/Çanşa Village, 07.XII.2023 (1♂).

Comments: These mites are predators of predominantly stored food pest species [22,23]. It was collected by et al. [24-28]. *B. keegani*, has been identified on bulbs, leaves and storages in 5 villages of Taşköprü in this study.

***Blattisociustarsalis* (Berlese), 1918**

Species examined: Width of dorsal idiosom: 281,96±0,31 (264,47-293,46), Length of dorsal idiosom: 537,07±0,88 (485,64-574,86) (n:6). Taşköprü/Alamaşişli Village Storage, 12.VII.2023 (2♀); Taşköprü/Akdoğan Village Storage, 23.VII.2023 (1♂); Centrum/Village Storage, 10.IX.2023 (1♀); Taşköprü/ Yazıhamit Village Storage, 12.IX.2023 (1♀,3♂♂).

Comments*: B. tarsalis* is one of the most important predator species in the storages [23]. It was previously recorded in İzmir, Edirne, Tekirdağ, Black Sea Region and Malatya on stored products, dried hazelnuts, dried apricot [25,26,29,30]. In this study this species was found only storages in 5 villages of Taşköprü.

***Blattisociusdentriticus (*Berlese), 1918**

Species examined: Width of dorsal idiosom: 647,50±25,28 (535-720), Length of dorsal idiosom: 329,00±15,52 (300-385) (n:5). Taşköprü/Badem Bekdemir Village Storage, 04.XII.2023 (1♀); Taşköprü /Centrum Storage, 04.I.2024 (1♂).

Comments: *B. dentriticus* was reported as a house dust mite in Samsun by Çelik [31]. It was identified on stored plant samples in Taşköprü in this survey.

***Cheiroseiusnecorniger* (Oudemans), 1903**

Species examined: Taşköprü/Centrum Ağcıkişi Avenue, 24.IV.2023, (1♀,2♂♂).

Comments: *C. neocorniger* was mostly found between soil, shredded garbage and plant parts. It was identified on dog grape as a predatory. In this study it was determined on leaves in Taşköprü.

Order Mesostigmata

Family Macrochelidae (Vitzthum), 1930

Genus *Macrocheles* (Latreille), 1829

***Macrocheles glaber* (Müller), 1860**

Species examined: Width of dorsal idiosom: 552,56± 8,22 (483,41-664,23), Length of dorsal idiosom: 879,51± 6,03 (832,35-924,80) (n:5). Centrum/Halaçlı Village, 16.VI.2023,(1♀).

Comments: These mites have been seen on some insects, rodents, birds and some mammals and also on bumble bees [32]. Çobanoğlu recorded *Macrochelesglaber* as phoretic mite which represents the first record of the species in Türkiye [28]. Girişgin et. al., reported that phoretic relationship of *M. glaber* with bumblebees. *M. glaber* was determined on bulbs in Centrum in this study [33]**.**

***Macrochelessubbadius* (Berlese), 1904**

Species examined: Width of dorsal idiosom: 484,94±6,16 (428,20-539,02), Length of dorsal idiosom: 729,05±4,56 (695,27-774,64) (n:3). Taşköprü/Donalar Village Storage, 11.VII.2023 (1♀,1♂); Taşköprü/ Centrum Storage, 12.VII.2023 (1♂).

Comments: It was previously recorded in in Kelkit Valley [34]. *M. subbadius* was found only in the storages of Taşköprü in this study.

Order Mesostigmata

Family Laelapidae (Berlese), 1892

Genus *Hypoaspis* (Canestrini), 1884

***Hypoaspisaculeifer* (Canestrini), 1884**

Species examined: Width of dorsal idiosom: 367,83±0,57 (267,45-424,38), Length of dorsal idiosom: 616,19±0,92 (450,61-716,19) (n:10). Centrum/Uzunkavak Village, 25.IV.2023 (9♀♀,5♂♂); Hanönü/Kornapa Village, 27.IV.2023 (2♀♀,2♂♂); Taşköprü/Yukarıemerce Village, 04.VI.2023 (3♀♀,2♂♂); Hanönü/Afşar Village, 16.VI.2023 (2♀♀,1♂);

Taşköprü/Esenlik Village, 10.V.2024 (3♀♀,1♂); Centrum/Çaycevher Village, 24.V.2024 (1♀,2♂♂); Centrum/Abay Village, 24.V.2024 (1♀,3♂♂); Centrum/Uzunkavak Village, 20.VI.2024 (1♀).

Comments: *H. aculeifer* are predatory of mites and nematodes that are particularly harmful on onions and tubers [35,36]. It was previously recorded *H. aculeifer* on cultivated, wild mushrooms, gladiyol, bulbous flowers and onion in Türkiye [5,8,20,38]. *H. aculeifer* was collected on bulbs and leavesin 21 villages of Taşköprü, Hanönü and Centrum in these surveys. This predatory mite was especially found more intensively in the examples where *R. robini* is dense.

***Hypoaspisbrevipilis* (Hirschmann), 1969**

Species examined: Width of dorsal idiosom: 251,23±0,31 (217,81-318,85), Length of dorsal idiosom: 450,11±0,42 (422,61-567,84) (n:10). Centrum/Kızılcaören Village,16.VI.2023 (1♀,1♂); Hanönü/Kornapa Village, 25.V.2023 (2♀♀); Hanönü/ Afşar Village, 16.VI.2023 (2♀♀,1♂); Hanönü/Kornapa Village, 03.VII.2023 (2♀♀,3♂♂); Centrum/Ayvalı Village, 01.VI.2024 (2♀♀,5♂♂); Taşköprü/Esenlik Village, 10.V.2024 (2♀♀,2♂♂); Centrum/Abay Village, 24.V.2024 (3♀♀,2♂♂).

Comments: It was previously recorded by Kılıç et. al., and Bayram et.al., [8,21]. It was found on bulbs and leaves surveys in 6 villages of Taşköprü, Hanönü and Centrum of Kastamonu.

***Hypoaspispraesternalis* (Willmann), 1949**

Species examined: Width of dorsal idiosom: 234,11±0,32 (177,68-297,68), Length of dorsal idiosom: 429,18±0,32 (358,58-483,02) (n:10). Taşköprü/Aşağıçayırcık Village, 24.V.2023 (2♀♀,1♂); Taşköprü/Alamabatak Village, 24.V.2023 (2♀♀,1♂); Hanönü/Donalar Village, 30.IV.2023 (1♀,1♂); Taşköprü/Centrum Ağcıkişi Avenue, 30.V.2023 (4♀♀,1♂); Hanönü/Erik Village, 20.VI.2024 (1♀,1♂); Centrum/ Çayevler Village, 24.V.2023 (2♀♀).

Comments: It has been reported from Denizli on soil samples [38,39]. In this survey, it was determined on bulbs and leaf surveys in Taşköprü, Hanönü and Centrum of Kastamonu.

***Androlaelapscasalis* (Berlese), 1887**

Species examined: Width of dorsal idiosom: 482,17 µm, Length of dorsal idiosom: 720,55 µm (n:3). Taşköprü/Yazıhamit Village Storage, 12.IX.2023 (1♀,1♂).

Comments: These mites are predatory of microartropod species. *A. casalis* was previously found in İzmir on storage foods [25,40]. It was only determined in a storage in this study**.**

Order Mesostigmata

Family Parasitidae (Oudemans), 1901

Genus *Parasitus*(Latreille), 1795

***Parasitusfimetorum* (Berlese), 1904**

Species examined: Width of dorsal idiosom: 342,33±0,66 (274,51-484,17), Length of dorsal idiosom: 543,05±1,15 (428,14-763,65) (n:10). Taşköprü/Kızılcaören Village, 25.IV.2023 (1♀,4♂♂); Hanönü/İncesu Village, 26.IV.2023 (2♀♀,4♂♂); Centrum/Yavuç Village, 23.VI.2023 (4♀♀,3♂♂); Taşköprü/Alisaray Village, 23.VI.2023 (4♀♀,2♂♂);Taşköprü/ Yazıhamit Village Storage, 12.IX.2023 (3♀♀,2♂♂); Taşköprü/Akdoğan Village Storage, 16.IX.2023 (1♀).

Comments: *P. fimetorum*is a predatory of micro arthropods, nematodes and mites. This mite is one of the most important predators of mite species that damages onions and tubers [41]. It was also reported on onion, tomato and eggplant from İzmir, Ankara, Bursa and Yalova [8]. It was intensely determined on bulbs, leaves, and storages in Taşköprü, Hanönü and Centrum in this study.

Order Mesostigmata

Family Eviphididae (Berlese), 1913

Genus *Alliphis*(Halbert), 1923

***Alliphishalleri* (Canestrini& Canestrini), 1881**

Species examined: Width of dorsal idiosom: 288,37±0,43 (219,97-349,18), Length of dorsal idiosom: 439,25±0,61 (335,01-511,03) (n:10). Taşköprü/Centrum Ağcıkişi Avenue, 16.IV.2023 (34♀♀,26♂♂); Taşköprü/Centrum Ağcıkişi Avenue, 17.IV.2023 (88♀♀,44♂♂); Hanönü/Eskiatça Village, 22.IV.2023 (1♀,1♂); Taşköprü/Kızılcaören Village, 25.IV.2023 (10♀♀,14♂♂); Hanönü/İncesu Village, 26.IV.2023 (5♀♀,6♂♂); Taşköprü/Çetmi Village Storage, 26.IV.2023 (3♀♀,2♂♂); Hanönü/Karapürçek Village Storage, 27.IV.2023 (3♀♀,2♂♂); Taşköprü/Çanşa Village Storage, 28.IV.2023 (6♀♀,2♂♂); Taşköprü/

Boyundurcak Village 29.IV.2023 (6♀♀,6♂♂); Hanönü/Donalar Village 30.IV.2023 (21♀♀,2♂♂); Taşköprü/ Ethem Village 10.VI.2024 (4♀♀,7♂♂); Centrum/Halaçlı Village 16.VI.2024 (4♀♀,2♂♂); Centrum/Çavundur Village 01.V.2024 (13♀♀,8♂♂).

Comments: *A. halleri* was reported firstly on (some/an) organic material from Denizli by Urhan and İpek [42]. It was found intensely on bulbs, leaves and storage samples in Taşköprü, Hanönü and Centrum of Kastamonu.

Order Mesostigmata

Family Veigaiidae (Oudemans), 1939 (Mesostigmata: Acariformes)

Genus*Veigaia* (Oudemans), 1905

***Veigaiaplanicola* (Berlese), 1892)**

Species examined: Width of dorsal idiosom: 299,69± 9,13 (190,41-458,33), Length of dorsal idiosom: 488,64± 12,20 (312,82-804,11) (n:10). Hanönü/Donalar Village 30.IV.2023 (2♀♀,1♂); Taşköprü/Kırha Village 04.VII.2023 (1♂); Taşköprü/Centrum Ağcıkişi Avenue, 10.VI.2023 (1♀).

Comments: These mites are free-living hunters, especially living in soil and non-decaying organic matter. They are mostly hunted on the eggs or larvae of small insects, small mite species, nematodes and Collembola species [43,44]. It was first recorded on ornamental plants by Bayram and Çobanoğlu [21]. It was reported from Denizli [43]. It was collected on bulbs and leaves in Taşköprü and Hanönü in these surveys.

Order Mesostigmata

Family Phytoseiidae (Berlese), 1916

Genus *Neoseiulus*(Hughes), 1948

***Neoseiulusagrestis* (Karg), 1960**

Species examined: Width of dorsal idiosom: 175,61± 3,37(156,63-191,04), Length of dorsal idiosom: 263,58± 4,48 (228,80-293,85) (n:10). Taşköprü/Centrum Gizlice Avenue Storage, 08.X.2023 (1♀,1♂).

Comments: Phytoseiidae species are important predators. In addition to this species fed mites such as Tetranychid, Eriophyid, small insect eggs, fungi and pollen powder. They are

often used as biological control agents in the fight against harmful mites [45]. Phytoseiidae species are the most important natural predators of Tetranychids [46]. It has been reported that some *Amblyseius* sp., *Typhlodromus* sp. and *Phytoseius* sp. species can effectively control the *Brevipalpus phoenicis* that was harmful of tea [47,48]. *N. agrestis* was found in one of the storages in Taşköprü.

***Neoseiulusbarkeri* (Hughes), 1948**

Species examined: Width of dorsal idiosom: 175,61± 3,37 (156,63-191,04), Length of dorsal idiosom: 263,58± 4,48 (228,80-293,85) (n:10). Hanönü/Kornapa Village, 08.V.2023 (1♀); Taşköprü/Yukarıemerce Village, 14.V.2023 (1♀); Hanönü/Kornapa Village, 08.V.2023 (1♂); Hanönü/Kuyluş Village, 23.VI.2024 (1♂).

Comments: It was first recorded on strawberry from Adana [49]. It was also reported on eggplant and tomato from Antalya, Ankara, Bursa and Yalova. It was found on bulbs with a low density in Taşköprü and Hanönü in this study.

***Neoseiulusbicaudus (*Wainstein), 1962**

Species examined: Width of dorsal idiosom: 256,62±0,30 (202,77-285,00), Length of dorsal idiosom: 408,55±0,34 (353,04-469,23) (n:10). Taşköprü/Centrum Ağcıkişi Avenue, 03.IV.2023 (1♀,1♂); Taşköprü/Vakıfbelören Village, 25.VI.2023 (4♀♀,3♂♂); Centrum/ Uzunkavak Village Storage, 10.IX.2023 (1♀); Taşköprü/Yazıhamit Village Storage, 12.IX.2023 (1♀); Hanönü/Kornapa Village Storage, 12.IX.2023 (5♀♀, 2♂♂).

Comments: It was previously recorded on apple tree, *Citrus* fruits, strawberries, aubergine melon and pumpkin from Ankara, Izmir, Aydin and Antalya [50]. In these surveys, it was collected on bulbs, leaves and storage samples in Taşköprü, Hanönü and Centrum of Kastamonu province.

***Neoseiulus marginatus* (Wainstein), 1961**

Species examined: Width of dorsal idiosom: 202,79± 4,78 (169,04-248,54), Length of dorsal idiosom: 344,97± 3,81 (326,21-367,90) (n:10). Taşköprü/Alisaray Village, 12.IV.2023 (1♂); Hanönü/Kornapa Village, 16.IV.2023 (1♂); Taşköprü/Centrum Ağcıkişi Avenue, Village, 19.IV.2023 (1♀,1♂).

Comments: *Neoseiulus marginatus* was reported by Faraji et. al., [18]. *N. marginatus* was identified on bulbs and leaves in Taşköprü and Hanönü districts and it was not found in storages.

***Anthoseiusrecki* (Wainstein), 1958**

Species examined: Width of dorsal idiosom: 234,68±1,06 (216,91-256,10), Length of dorsal idiosom: 342,85±0,73 (326,26-351,45) (n:10). Taşköprü/Yukarıçayırcık Village, 26.IV.2023 (8♀♀,4♂♂); Hanönü/İncesu Village, 26.IV.2023 (2♀♀,2♂♂); Taşköprü /Alamabatak Village, 26.IV.2023 (24♀♀,1♂).

Comments: *Anthoseius recki* was reported on apple orchards which represents the first record of this species in Türkiye. Then it was also recorded on *Pinus nigra*, *Cedrus* sp. and orchards from Zonguldak, İzmir and Çanakkale [51-54]. In this study *A. recki* was found on bulbs and leaves from Taşköprü and Hanönü**.**

***Euseiusfinlandicus* (Oudemans), 1915**

Species examined: Width of dorsal idiosom: 209,3±12,03 (197,4-239,1), Length of dorsal idiosom: 336,2±26.5 (294,8-374,1) (n:2). Hanönü/Kornapa Village, 12.VI.2023 (1♀,1♂).

Comments: *Euseius finlandicus* is a very common species and found throughout Türkiye. Prior to this study, the species was recorded in Türkiye by many researchers [18,37,48,55-66]. In this study, *E. finlandicus* was found on bulbs from Hanönü.

***Amblyseiusobtusus* (Koch), 1839**

Species examined: Width of dorsal idiosom: 274,05± 4,47 (248,09-313,44), Length of dorsal idiosom: 380,33± 4,40 (356,29-416,69) (n:10). Taşköprü/Yukarıçayırcık Village, 26.IV.2023 (1♀,1♂); Hanönü/İncesu Village, 26.I.2023 (9♀♀,3♂♂).

Comments: *Amblyseius* sp. is one of the largest genus of Phytoseiidae family. Members of this genus are predatory of Tetranychidae family and Thrips [67]. Some species are used as biological control agents in the biological control of these [16]. *Amblyseius obtusus* was identified on apple orchards from Ankara for the first time by Chant and McMurtry [16]. In this study, it was identified on bulbs and leaves from Taşköprü and Hanönü.

Order Mesostigmata

Family Digamasellidae (Evans), 1957

Genus *Dendrolaelaps*(Halbert), 1915

***Dendrolaelapszwoelferi* (Hirschmann), 1960**

Species examined: Width of dorsal idiosom: 215,79 µm, Length of dorsal idiosom: 373,21 µm (n:2). Taşköprü/Centrum Ağcıkişi Avenue, 30.V.2023 (1♀,1♂).

Comments: These mites are Mesostigmatide mites that show parasitic, phoretic and predatory behavior [44]. This species feed in early stages of small insects, nematodes, mites, fungi and arthropods (eggs and larvae) [21,68]. Bayram and Çobanoğlu reported *D. zwoelferi* from Ankara as new records for Türkiye [21]. Then it was determined from Samsun [68]. *D. zwoelferi* was found on leaves from Taşköprü.

Order Mesostigmata

Family Ameroseiidae (Evans in Hughs), 1961

Genus *Ameroseius* (Evans and Hughs), 1961

***Ameroseiusplumosus* (Oudemans), 1902**

Species examined: Width of dorsal idiosom: 219,99 µm, Length of dorsal idiosom: 410,44 µm (n:2). Taşköprü Centrum Storage, 16.II.2023 (1♀,1♂).

Comments: Unlike other members of Mesostigmata, *Ameroseius* sp. species feed on mushrooms, pollen and nectar, especially out of the ordinary. In addition, they are also found in forest wastes, garden mulches, nests, tree caverns and stored products, fungi and small microorganisms [69,70]. It was previously reported by [21,24,25]. In this study, *A. plumosus* was found on storages in Taşköprü.

Order Prostigmata

Family Tydeidae (Kramer), 1877

Genus *Tydeus* (Koch), 1835

***Tydeus caudatus* (Duges), 1834**

Species examined: These mites are predatory of carrion and phytophagous. Some of them may live phoretic on moths of the Noctuidae family (Krantz 1978). Taşköprü/Centrum Ağcıkişi Avenue 24.IV.2023 (2♀♀).

Comments: *T. caudatus* was determined on bushes, vineyards and hazelnut orchards from Ankara, İzmir, Manisa, Çanakkale, Denizli and Samsun [62,71,72]. *T. caudatus* was found on plant leaves from Taşköprü.

Order Prostigmata

Family Stigmaeidae (Oudemans), 1931

Genus *Eustigmaeus* (Berlese), 1910

***Eustigmaeus segnis* (Koch), 1836**

Species examined: The genus *Eustigmaeus* is one of the largest groups in the family Stigmaeidae. The members of this genus generally are free living on mosses, lichens, grass and various litters, and a few are parasitic on sandflies [73]. Taşköprü/Alisaray Village, 28.VI.2024 (2♀♀).

Comments: *Eustigmaeus segnis* is very common on various plants in all regions of Türkiye. Prior to this study, the species was recorded in Türkiye by many researchers [74-79]. *E. segnis* was found on agricultural areas from Taşköprü.

Gamasellodes bicolor (Berlese), *Alliphis halleri* (G. & R. Canestrini) and *Arctoseius cetratus* (Sellnick) have also been identified in agricultural areas. It is important that *Gamasellodes bicoloris* identified as an intense predatory group and an effective predator on subsoil pests such as *Rhizoglyphus robini*. Genus *Gamasellodes* that is as a small group in Mesostigmata is known as the predator of soil pests. It was found among the most intense species in soil pest in Lithuania. *Arctoseius cetratus* feeds on nematodes, Collembols, Acaridae mites, soil mites, (oribatids) and Tarsonemidae (Acari: Prostigmata). It has been reported to live phoretically with fungal flies belonging to the Sciaridae family [80]. In another research, it has been determined that *G. bicolor*, *Hypoaspis* sp. and other predatory mite species are effective on harmful mites under the soil and they intensive presence of mites in their habitats. It has also been found that *Hypoaspis aculeifer* is an effective predator, firstly harmful nematodes especially in onions and tubers [36]. Lesna et. al., determined that *H. aculeifer* is the most effective predator on *R. robini* according to *Lasioseius bispinosus* (Evans) and *Parasitus fimetorum* (Berlese) [81].

4. Conclusion

Beneficial mite fauna of agricultural areas in Türkiye was identified for the first time, their biodiversity and distributions have been determined. The densities of beneficial mite populations onagricultural areas were determined for the first time. In this study, the important predatory species on plant areas such as *Gamasellodes bicolor* (Berlese), *Alliphis halleri* (G. & R. Canestrini) and *Arctoseius cetratus* (Sellnick) were identified. Especially determination of *G. bicolor* that is an intense predatory against to *R. robini* on bulbs is important. In the field and storage surveys, *Hypoaspis* species were determined. It is very important because *Hypoaspis* mites may play a role in suppressing populations of harmful mites, ravens feed with *R. robini* and it is an important biological control agent of harmful mites on fields. As a result of this study, it was concluded that *G. bicolor*, *Hypoaspis* sp. and other predatory mite species are effective on harmful mites under the ground and these mites are important in biological control because they are found in their habitats intensively. *Hypoaspis aculeifer* is an effective predator especially on nematodes on onions and tubers. In this survey, determination of this mite species is important.

Our study found that *Gamasellodes bicolo r*was the most intense predator on garlic heads. This species was mainly distributed in underground areas where *R. Robini* colonies were located, and it was a predator of *R. robini*. This suggests that the genus *Gamasellodes* has great potential as a biocontrol agent for soi lroot mite ssuch as *R. robini*, and it is of great significance to use it more effectively to control underground mite pests.

In this study, important beneficial mites such as *Gamasellodes bicolor*, *Arctoseius cetratus* and *Hypoaspis* sp. species were recorded intensely in storages. These species have high potential to be used for biological control programs in Kastamonu province. The findings obtained from this study constitutes the basis for future studies aiming to determine the biological characteristics and differences of predators. In our study, *Gamasellodes bicolor* was determined as the most intense predatory species on bulbs. Especially this species was found intensely under the soil where *R. robini* colonies were found. This situation shows that the biological control agent potential of *Gamasellodes* sp. against soil root pest mites such as *R. robini* is high and shows importance of the more effective use of *Gamasellodes* sp. In fighting subsoil pest mites. In the study, it has been found that increasing the biodiversity in the bulbs, leaves and storages is beneficial for mite species.

The high diversity of beneficial mites and the high number of mites in the region have promoted the use of biological pest control methods. Mos tfarmers in the region prefer to use pesticides, which are used in large quantities and unconsciously in the cropp in areas. Therefore,

it is important to organize training programs to make farmers aware of the increase in the number of beneficial mites.

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