Acarological Studies

A Part of Acarological Science

Volume: 2
Issue: 1
Year: 2020

OPEN ACCESS

DergiPark AKADEMİK

Designed by Müjdat TÖS

Acarological Studies
Vol 2 (1): 1-6

REVIEW

Preventive measures to avoid contact with house dust mites and their allergens

Kosta Y. MUMCUOGLU [1,4], **Ayşegül TAYLAN-ÖZKAN** [2,3]

[1] *Parasitology Unit, Department of Microbiology and Molecular Genetics, Hebrew University, Jerusalem, Israel*
[2] *Department of Microbiology, Faculty of Medicine, Hitit University, Çorum, Turkey*
[3] *Department of Medical Microbiology and Clinical Microbiology, Near East University, Nicosia, Northern Cyprus*
[4] Corresponding author: kostasm@ekmd.huji.ac.il

Received: 16 December 2019 Accepted: 26 January 2020 Available online: 31 January 2020

ABSTRACT: House dust mites (HDMs) of the genera *Dermatophagoides* and *Euroglyphus* are the most important allergens in human habitations to which ca. 7% of the human population in developed countries become allergic. The allergens are excreted through their faeces and the control of mites and the elimination of the produced allergens could alleviate and allergic symptoms. For this purpose, the relative humidity should be kept below 50% at home, as higher humidity enhances the development of HDMs. The biggest attention should be given to the bedroom, and especially to the bed. Mattresses, upholstered furniture, and heavy carpets are the most important biotopes of HDMs and should be regularly vacuumed, treated with acaricides and/or exposed to sunlight. Allergen-tight sheets and pillow covers which do not permit the allergens existing on the mattress or pillows to come in direct contact with the patient should be used. Sheets, blankets, pillowcases and bedcovers should be washed every 2-3 weeks at 60°C and above. Heat will kill dust mites and neutralize a large part of the allergens. The floor should be fitted with tiles, wood, linoleum or vinyl material, and not with wall-to-wall carpets. Heavy carpets, especially those made from wool should be removed from the bedroom. Any object which is not being used on a regular basis and could collect dust, should be removed, washed regularly or kept in allergen-tight plastic bags. In conclusion, mite and allergen avoidance could alleviate the allergic symptoms of HDM allergic individuals and reduce the medication taken to treat such symptoms.

Keywords: House dust mites, *Dermatophagoides, Euroglyphus*, prevention, control.

INTRODUCTION

House dust mites (HDMs) are the leading allergens to which patients with dust allergy are most susceptible. *Dermatophagoides pteronyssinus* (Fig. 1), *Dermatophagoides farinae* (Fig. 2) and *Euroglyphus maynei* (Fig. 3) are the most common mites of the house dust mite fauna worldwide (Platts-Mills et al., 1989).

HDMs are usually found in every household (both allergic and non-allergic), and thousands of HDMs can be found in one gram of house dust collected from the main biotopes of the mites such as mattresses, carpets and upholstered furniture. Their allergens, largely constituted by proteins such as Der p 1 and Der f 1, are excreted through their faeces to the environment, which later are decomposed and become airborne (Arlian, 1991; Arlian et al., 2002; Miller, 2019). The allergens are inhaled by all inhabitants but only those who are allergic develop clinical symptoms (Tovey et al., 1981; Arslan et al., 2019).

Although HDMs are present throughout the year inside human habitations, their number increases particularly during the summer months. The allergens which accumulate during these months decompose and become airborne during the following months. HDM allergic patients complain of dust allergies especially during the autumn months when in addition to HDM allergens, temperature differences inside and outside habitations and the presence of viruses, render the upper respiratory airways more sensitive. The perennial symptoms usually start in childhood ages and can continue into adulthood. HDM exposure in infancy was associated with an increased risk of specific sensitization at 4 years of age (Brussee et al., 2005; Casas et al., 2015; Rubner et al., 2017). A level of 2 µg of Der p 1/g dust, which is equivalent to 100 HDMs is considered as a risk factor for sensitization, while 500 mites/g dust are capable of causing allergic reactions in sensitized patients (International Workshop Report, 1988; Platts-Mills et al., 1989).

Only medication can help when the patient's allergic symptoms begin. For the therapy of symptoms decongestants to help dry up the air passages, antihistamines, nasal steroids, leukotriene inhibitors, and immunotherapy are being used (Pichler et al., 1997; Mener and Lin, 2015; Nelson, 2018).

In developed countries, approximately 30% of the population suffers from one or more allergic disorders, while ca. 7% being allergic to HDM. In such patients HDM avoidance is logical, but there is considerable uncertainty regarding the efficacy and effectiveness of interventions designed to reduce dust mite exposure. While HDM allergen avoidance did not show any effect on the allergic symptoms in some studies, other studies showed a positive effect on patients with asthma, eczema and allergic rhinitis (Demir et al., 2018). In seven of the nine intervention trials, when compared with control, the interventions significantly reduced the HDM load. Acaricides appeared to be the most promising type of intervention; however,

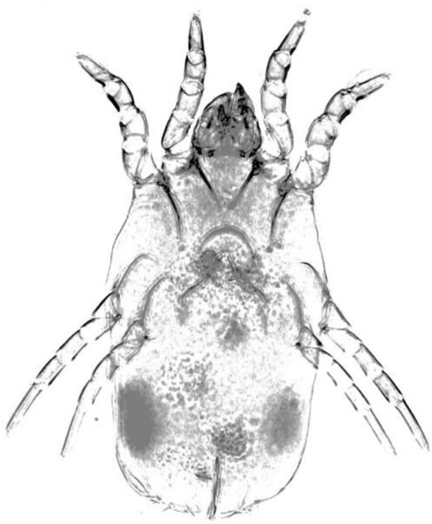


Figure 1. *Dermatophagoides pteronyssinus* (female)

Figure 2. *Dermatophagoides farinae* (male)

Figure 3. *Euroglyphus maynei* (female)

these results should be interpreted carefully due to methodological limitations. Isolated interventions such as the use of impermeable mattress covers offered little clinical benefits (Platts-Mills et al., 1989, 1997; Colloff et al., 1992; Calderon et al., 2015; Singh and Hays, 2016; Miller, 2019).

The aim of this review is to summarize the preventive methods which could be used to reduce the amount of HDMs and the allergens they produce inside the house in order to minimize the exposure and alleviate the allergic symptoms which are related to mites.

Morphology and Taxonomy

HDMs of the genera *Dermatophagoides* and *Euroglyphus* belong to the subclass Acari, the order Sarcoptiformes, the cohort Astigmatina and the family Pyroglyphidae (Krantz and Walter, 2009). From the egg hatches the larval stage, which later develops to protonymph, tritonymph and adult mites. They are whitish in colour and their body is translucent. The size of the adults varies between 250-350 µm (Colloff, 1998; Miller, 2019).

Biology and Epidemiology

HDMs are free-living organisms that have chosen house dust as biotope. Their life-cycle last for about a month and the females which live up to 100 days lay about 300 eggs. They are feeding on human and animal dandruff and the microorganisms such as bacteria and fungi which grow on them (Colloff, 1991; Arlian and Morgan, 2003; Miller, 2019).

The most suitable temperatures for their development are 25-26°C and they thrive best at relative humidity (RH) around 75% (Colloff, 1987). Since the average temperature inside houses is around 23-25°C throughout the year, humidity is the most important factor for their reproduction. Moisture is high when the house is located in the vicinity of seas, lakes and forests; inside the house large quantities of moisture is produced in the kitchen and bathrooms; while the sleeping persons increases the humidity on the bedding and mattress by sweating during the night. In addition, HDMs can absorb moisture from the environment through their cuticles. When the RH decreases below 40%, their number decreases due to dehydration (Arlian, 1992). Accordingly, people living in areas with high moisture have more HDM in their house than those living in dry areas, e.g., deserts. Few mites were found in human habitations in dry areas while in humid areas over 10,000 mites per gram dust were isolated (Mumcuoglu, 1975; Mumcuoglu et al., 1999). A positive correlation was found between the number of mites and the moisture content in the dust collected from different geo-climatic regions of Israel (Mumcuoglu et al., 1999). A positive correlation was also found between the number of HDMs and the altitude of the houses that were examined. In higher altitudes where the climate is usually cold, houses are heated for longer periods and accordingly the relative humidity inside the habitations is low (Mumcuoglu, 1975; Charpin et al., 1991).

Dust mites are quite rare in frequently cleaned hospitals and hotels, where the bedding is also regularly changed.

Pets such as cats and dogs are also shedding dandruff and could be considerate as additional source of dandruff inside the house and HDM were found in their sleeping places, creating additional biotopes for HDMs inside the houses (Mumcuoglu, 1975).

Allergens produced by HDMs in their biotopes can easily become airborne and distributed in all parts of the house, especially in objects which easily accumulate dust and which are rarely cleaned such as libraries, curtains, large lamps and toys (Mumcuoglu, 1975; Mumcuoglu et al., 1999).

Prevention and Control

The biggest attention should be given to the bedroom, where the allergic patient spent third of his day and it is in close contact with mites and allergens existing on the bed, as well as to the living room, where the patient spends several hours of day while watching television, playing, reading, resting, and having guests. If possible, the bedroom of the allergic patient should be on the side of the house with the highest exposure to sunlight. The bedroom should be ventilated regularly, especially on sunny and dry hours of the day. The relative humidity should be kept below 50% at home, and a dehumidifier or air conditioner could be used for this purpose. It should be kept in mind that dust is capable in absorbing humidity from the environment and in the different layers of the dust the conditions could be optimal for the development of mites. It is thought that the increase of dust mite allergies in the USA is caused by the airtight construction of houses for energy saving purposes, which has however the disadvantage that it does not allow the ventilation of the rooms and the lowering of humidity (for review see International Workshop Report, 1988; Arlian, 1991, 1992; Colloff et al., 1992; Marks et al., 1995; Platts-Mills et al., 1997; Perry et al,. 2006; Sheikh et al., 2010; Mener and Lin, 2015; Bremmer and Simpson, 2015; Narkervis et al., 2015; Sánchez-Borges et al., 2017; Wilson and Platts-Mills, 2018).

The floor should be fitted with tiles, wood, linoleum or vinyl material, which is easier to clean and does not collect dust. Such floors should be cleaned with a damp rag, while dry dusting should be avoided.

Mattresses are one of the most important biotopes for HDMs. As they do usually not look dirty, they are not cleaned regularly, resulting in the accumulation of - that is not visible to the eye - layers of dust, especially around the buttons, stitching and the elevated edges of the mattress. Therefore, they should be vacuumed at least ones a month and where possible both sides of the mattress should be exposed to direct sunlight. Mattresses with a flat surface, i.e., without buttons, stitches, and border lines should be used, which allow minimum possibilities for the dust to accumulate and are easier to vacuum cleaning. There are allergen-tight sheets and pillow covers which do not permit the allergens existing on the mattresses and pillows to come in direct contact with the sleeping patient (Arroyave et al., 2014).

Sheets, blankets, pillowcases and bedcovers should be washed every 2-3 weeks at 60^{o}C and above. Heat will kill dust mites and neutralize a large part of the allergens. In general, synthetic bedding instead or organic wool and feathered material should be used. Any components of bedding which are not being used and are kept in draws under the bed should be either removed or kept in allergen-tight bags (Colloff, 1987).

Heavy carpets, especially those made from wool should be removed from the bedroom. Carpets with long fibers are important biotopes of HDMs, where dust is accumulated in the lower levels of the fiber. If not removed, carpets should be vacuumed regularly and/or exposed to sunlight. Powerful vacuum cleaners such as High Efficiency Particulate Air filtered (HEPA) ones could eliminate large quantities of dust, while the less powerful ones remove only the superficial dirt, giving the impression that the carpet is clean (Yu et al., 2009). Wall-to-wall carpets, which render the entire room to a biotope for HDMs, should be avoided (Perry et al., 2006).

Upholstered furniture on which the inhabitants spent many hours of the day, e.g., while watching television, resting or having guests, and on which the RH and temperature is higher due to the body temperature and humidity, should be vacuumed regularly while paying attention to the hidden places of the furniture, and/or should be exposed to sunlight. When replacing upholstered furniture, leather, plastic or vinyl furniture should be preferred (International Workshop Report, 1988).

Any object which is not being used on a regular basis and could collect dust, such as tabletop ornaments, books, magazines, newspapers, stuffed animals, fabric toys, clothes, and bedding, should be removed, washed regularly or kept in allergen-tight plastic bags. Books should be kept in closed cupboards and clothing in drawers and closets. Winter clothes should be kept in plastics bags during the hot months of the year and the opposite should be done with summer clothes during the cold months. Heavy curtains should be replaced by light and washable one, while large lamps should be replaced by small ones.

Some chemical and non-chemical control methods for HDMs were suggested (Skelton et al., 2010; Edrees, 2014), but they are not established ones and there is not enough information about their effectiveness under field conditions.

General Remarks

It should be kept in mind that sleeping overnighting in another house such as those of friends and relatives, especially in those located in humid areas, might expose the patients to HDM allergens, even when large efforts are being done in his/her house in reducing the allergen quantities.

Although pet animals such as cats and dogs could be a direct source of allergies, they can increase the number of HDMs in the house by shedding dandruff and creating optimal conditions for the mite development in their sleeping places inside the human habitations.

Mattresses, upholstered furniture and carpets could be treated twice a year with permethrin containing acaricides, while the necessary precautions should be taken with those suffering from respiratory symptoms, and from children coming in contact soon after the treatment.

In poor and overcrowded conditions, mattresses are piled during the day in a corner of the room, and as they are not ventilated the humidity in such object could be very high, creating and optimal conditions for a quick development of HDMs.

HDM allergic people should stay out of the area being vacuumed while someone else does the work, and enter the room ca. two hours after the cleaning process. If the allergic person has to do himself the vacuuming, he/she should wear a mask to minimize the exposure to allergens, which might become airborne during vacuuming. It would be advantageous to use double sealed or HEPA-filtered vacuum cleaners.

Mites on non-washable items could also be eliminated by either freezing for 24 hours or by using high-temperature steam-cleaners. The former could kill mites, however will not eliminate the allergens.

Moving to a part of the country where the humidity and accordingly the number of HDMs is low could have a significant effect on the wellbeing of the patient.

CONCLUSIONS

Removing mites and their allergens is a complex and difficult task, and in most cases a single avoidance/treatment method will not give the desired results. Though it might be impossible to remove all mites and allergens from the patient's environment, it is however possible to decrease significantly their numbers and allergen quantities. By doing so, it is possible to decrease the number and severity of allergic attacks and to diminish the use of medications.

REFERENCES

Arlian, L.G. 1991. House-dust-mite allergens: a review. Experimental and Applied Acarology, 10 (3-4): 167-186.
doi: 10.1007/BF01198649

Arlian, L.G. 1992. Water balance and humidity requirements of house dust mites. Experimental and Applied Acarology, 16: 15-35.
https://doi.org/10.1007/BF01201490

Arlian, L.G. and Morgan, M.S. 2003. Biology, ecology, and prevalence of dust mites. Immunology and Allergy Clinics of North America, 23 (3): 443-468.
doi: 10.1016/S0889-8561(03)00005-5

Arlian, L.G., Morgan, M.S. and Neal, J.S. 2002. Dust mite allergens: Ecology and distribution. Current Allergy and Asthma Reports, 2 (5): 401-411.
doi: 10.1007/s11882-002-0074-2

Arroyave, W.D., Rabito, F.A., Carlson, J.C., Friedman, E.E. and Stinebaugh, S.J. 2014. Impermeable dust mite covers in the primary and tertiary prevention of allergic disease: A meta-analysis. Annals of Allergy, Asthma and Immunology, 112: 237-248.
doi: 10.1016/j.anai.2014.01.006

Arslan, S., Senel, E., Oztekin, A., Gulhan, M., Kosar, N., and Taylan-Ozkan, A. 2019. Skin Prick test reactivity to aeroallergens in pulmonology and dermatology clinics in Çorum province: A 2-year Retrospective Study. Hitit Medical Journal, 1 (1): 12-14. [In Turkish]

Bremmer, S.F. and Simpson, E.L. 2015. Dust mite avoidance for the primary prevention of atopic dermatitis: A systematic review and meta-analysis. Pediatric Allergy and Immunology, 26: 646-654.
doi: 10.1111/pai.12452

Brussee, J.E., Smit, H.A., van Strien, R.T., Corver, K., Kerkhof, M., Wijga, A.H., Aalberse, R.C., Postma, D., Gerritsen, J., Grobbee, D.E., de Jongste, J.C. and Brunekreef, B. 2005. Allergen exposure in infancy and the development of sensitization, wheeze, and asthma at 4 years. Journal of Allergy and Clinical Immunology, 115 (5): 946-952.
doi: 10.1016/j.jaci.2005.02.035

Calderon, M.A., Linneberg, A., Kleine-Tebbe, J., De Blay, F., Hernandez Fernandez de Rojas, D., Virchow, J.C. and Demoly, P. 2015. Respiratory allergy caused by house dust mites: what do we really know? Journal of Allergy and Clinical Immunology, 136: 38-48.
doi: 10.1016/j.jaci.2014.10.012

Casas, L., Sunyer, J., Tischer, C., Gehring, U., Wickman, M., Garcia-Esteban, R., Lehmann, I., Kull, I., Reich, A., Lau, S., Wijga, A., Antó, J.M., Nawrot, T.S., Heinrich, J., Keil, T. and Torrent, M. 2015. Early-life house dust mite allergens, childhood mite sensitization, and respiratory outcomes. Allergy, 70 (7): 820-827.
doi: 10.1111/all.12626

Charpin, D., Birnbaum, J., Haddi, E., Genard, G., Lanteaume, A., Toumi, M., Faraj, F., van der Brempt, X. and Vervloet, D. 1991. Altitude and allergy to house-dust mites. A paradigm of the influence of environmental exposure on allergic sensitization. American Review of Respiratory Disease, 143: 983-986.
doi: 10.1164/ajrccm/143.5_Pt_1.983

Colloff, M.J. 1987. Effects of temperature and relative humidity on development times and mortality of eggs from laboratory and wild populations of the European house-dust mite *Dermatophagoides pteronyssinus* (Acari: Pyroglyphidae). Experimental and Applied Acarology, 3 (4): 279-289.
doi: 10.1007/BF01193165

Colloff, M.J. 1991. A review of the biology and allergenicity of the house-dust mite *Euroglyphus maynei* (Acari: Pyroglyphidae) [corrected]. Experimental and Applied Acarology, 11 (2-3): 177-198.
doi: 10.1007/BF01246090

Colloff, M.J. 1998. Taxonomy and identification of dust mites. Allergy, 53 (48 Suppl): 7-12.
doi: 10.1111/j.1398-9995.1998.tb04989.x

Colloff, M.J., Ayres, J., Carswell, F., Howarth, P.H., Merrett, T.G., Mitchell, E.B., Walshaw, M.J., Warner, J.O., Warner, J.A. and Woodcock, A.A. 1992. The control of allergens of dust mites and domestic pets: a position paper. Clinical and Experimental Allergy, 22 (Supplement 2): 1-28.
doi: 10.1111/j.1365-2222.1992.tb01763.x

Demir, E., Karasartova, D., Gureser A.S., Mumcuoglu, K.Y. and Taylan-Ozkan, A. 2018. Bibliometric analysis of publications on house dust mites. XV. International Congress of Acarology, 2-8 September, 2018, Antalya, Turkey, p. 11.

Dorward, A.J., Colloff, M.J., MacKay, N.S., McSharry, C. and Thomson, N.C. 1988. Effect of house dust mite avoidance measures on adult atopic asthma. Thorax, 43 (2): 98-102.
doi: 10.1136/thx.43.2.98

Edrees, N.O. 2014. The impact of using *Pistacia lentiscus* and *Boswellia carterii* widely spread at the popular level for incensing on minimizing HDM population density. Life Science Journal, 11 (9): 644-655.

International Workshop Report, 1988. Dust mite allergens and asthma: a world-wide problem. Bulletin of the World Health Organization, 66: 769-780.

Krantz, G.W. and Walter, D.E. 2009. A manual of acarology. Third edition. Texas Tech University Press, Lubbock, Texas, USA, 807 pp.

Marks, B.G.B, Tovey, E.R., Green, W., Shearer, M., Salome, C.M. and Woolcock, A.J. 1995. The effect of changes in house dust mite allergen exposure on the severity of asthma. Clinical and Experimental Allergy, 25: 114-118.
doi: 10.1111/j.1365-2222.1995.tb01015.x

Mener, D.J. and Lin, S.Y. 2015. Improvement and prevention of asthma with concomitant treatment of allergic rhinitis and allergen-specific therapy. International Forum of Allergy and Rhinology, 5 (S1): 45-50.
doi: 10.1002/alr.21569

Miller, J.D. 2019. The role of dust mites in allergy. Clinical Reviews in Allergy and Immunology, 57: 312-329
doi: 10.1007/s12016-018-8693-0

Mumcuoglu, K.Y. 1975. Biology of the house dust mite *Dermatophagoides pteronyssinus*. II. Incidence of mites in the various regions of Switzerland and its dependence on climate. Schweizerische Medizinische Wochenschrift, 105: 1013-1020. [In German]

Mumcuoglu, Y.K., Zavaro, A., Samra, Z. and Lazarowitz, Z. 1988. House dust mites and vernal keratoconjunctivitis. Ophthalmologica, 196: 175-181.
doi: 10.1159/000309896

Mumcuoglu, K.Y., Gat, Z., Horowitz, T., Miller, J., Bar-Tana, R., Ben-Zvi, A. and Naparstek, Y. 1999. Abundance of house dust mites in relation to climate in contrasting agricultural settlements in Israel. Medical and Veterinary Entomology, 13: 252-258.
doi: 10.1046/j.1365-2915.1999.00149.x

Nankervis, H., Pynn, E.V., Boyle, R.J., Rushton, L., Williams, H.C., Hewson, D.M. and Platts-Mills, T. 2015. House dust mite reduction and avoidance measures for treating eczema. Cochrane Database of Systematic Reviews, 1: CD008426.
doi: 10.1002/14651858.CD008426.pub2

Nelson, H.S. 2018. Immunotherapy for house-dust mite allergy. Allergy and Asthma Proceedings, 39 (4): 264-272.
doi: 10.2500/aap.2018.39.4145

Perry, T.T., Wood, R.A., Matsui, E.C., Curtin-Brosnan, J., Rand, C. and Eggleston, P.A. 2006. Room-specific characteristics of suburban homes as predictors of indoor allergen concentrations. Annals of Allergy, Asthma and Immunology, 97 (5): 628-535.
doi: 10.1016/S1081-1206(10)61092-7

Pichler, C.E., Marquardsen, A., Sparholt, S., Løwenstein, H., Bircher, A., Bischof, M. and Pichler, W.J. 1997. Specific immunotherapy with *Dermatophagoides pteronyssinus* and *D. farinae* results in decreased bronchial hyperreactivity. Allergy, 52 (3): 274-283.
doi: 10.1111/j.1398-9995.1997.tb00991.x

Platts-Mills, T.A.E, de Weck, A., Aalberse, R.C., Bessot, J.C., Bjorksten, B., Bischof, E., Bousquet, J., Van Bronswijk, J.E.M.N., Channa Basavanna, G.P., Chapman, M., Colloff, M., Goldstein, R.A., Guerin, B., Hart, B., Hong, C.-S., Ito, K., Jorde, W., Korsgaard, J., Le Mao, J., Miyamoto, T., Lind, P., Lowenstein, H., Mitchell, E.B., Murray, A.B., Nolte, D., Norman, P.S., Pauli, G., Ranganath, H.R., Reed, C., Reiser, J., Stewart, G., Turner, K.J., Vervloet, D. and Wen, T. 1989. Dust mite allergens and asthma - A worldwide problem. Journal of Allergy and Clinical Immunology, 83: 416-427.
doi: 10.1016/0091-6749(89)90128-0

Platts-Mills, T.A.E., Vervloet, D., Thomas, W.R., Aalberse, R.C. and Chapman, M.D. 1997. Indoor allergens and asthma: report of the third international workshop. Journal of Allergy and Clinical Immunology, 100: 1-24.
doi: 10.1016/S0091-6749(97)70292-6

Rubner, F.J., Jackson, D.J., Evans, M.D., Gangnon, R.E., Tisler, C.J., Pappas, T.E., Gern, J.E. and Lemanske, R.F. Jr. 2017. Early life rhinovirus wheezing, allergic sensitization, and asthma risk at adolescence. Journal of Allergy and Clinical Immunology, 139 (2): 501-507.
doi: 10.1016/j.jaci.2016.03.049

Sánchez-Borges, M., Fernandez-Caldas, E., Thomas, W.R., Chapman, M.D., Lee, B.W., Caraballo, L., Acevedo, N., Chew, F.T., Ansotegui, I.J., Behrooz, L., Phipatanakul, W., van Wijk, R.G., Pascal, D., Rosario, N., Ebisawa, M., Geller, M., Quirce, S., Vrtala, S., Valenta, R., Ollert, M.,

Canonica, G.W., Calderón, M.A., Barnes, C.S., Custovic, A., Benjaponpitak, S. and Capriles-Hulett, A. 2017. International consensus (ICON) on: clinical consequences of mite hypersensitivity, a global problem. World Allergy Organization Journal, 10: 14.
doi: 10.1186/s40413-017-0145-4

Sheikh, A., Hurwitz, B., Nurmatov, U, van Schayck, C.P. 2010. House dust mite avoidance measures for perennial allergic rhinitis. Cochrane Database of Systematic Reviews, 7 (7): CD001563.
doi: 10.1002/14651858.CD001563.pub3

Singh, M. and Hays, A. 2016. Indoor and outdoor allergies. Primary Care: Clinics in Office Practice, 43: 451-463.
doi: 10.1016/j.pop.2016.04.013

Skelton, A.C., Cameron, M.M., Pickett, J.A. and Birkett, M.A. 2010. Identification of neryl formate as the airborne aggregation pheromone for the American house dust mite and the European house dust mite (Acari: Epidermoptidae). Journal of Medical Entomology, 47 (5): 798-804.
doi: 10.1093/jmedent/47.5.798

Tovey, E.R., Chapman, M.D. and Platts-Mills, T.A.E. 1981. Mite faeces are a major source of house dust allergens. Nature, 289: 592-593.
doi: 10.1038/289592a0

Wilson, J.M. and Platts-Mills, T.A.E. 2018. Home environmental interventions for house dust mite. The Journal of Allergy and Clinical Immunology: In Practice, 6: 1-7.
doi: 10.1016/j.jaip.2017.10.003

Yu, C.H., Yiin, L.-M., Tina Fan, Z.-H. and Rhoads, G.G. 2008. Evaluation of HEPA vacuum cleaning and dry steam cleaning in reducing levels of polycyclic aromatic hydrocarbons and house dust mite allergens in carpets. Journal of Environmental Monitoring, 11 (1): 205-211.
doi: 10.1039/b807821a

Edited by: Salih Doğan
Reviewed by: Three anonymous referees

Citation: Mumcuoglu, K.Y. and Taylan-Özkan, A. 2020. Preventive measures to avoid contact with house dust mites and their allergens. Acarological Studies, 2 (1): 1-6.

Acarological Studies
Vol 2 (1): 7-17

RESEARCH ARTICLE

Checklist of the Hungarian species of family Macrochelidae (Acari: Mesostigmata)

Jenő KONTSCHÁN

Plant Protection Institute, Centre for Agricultural Research, Hungarian Academy of Sciences, H-1525 Budapest, P.O. Box 102, Hungary.
e-mail: kontschan.jeno@agrar.mta.hu

Received: 29 March 2019 Accepted: 22 November 2019 Available online: 31 January 2020

ABSTRACT: All published Hungarian records of the macrochelid mites are summarized. Occurrences of four species were deleted from list due to misidentification. Currently 34 macrochelid species are known from the area of Hungary.

Keywords: Macrochelidae, occurrences, Hungary.
Zoobank: http://zoobank.org/F882F08A-BA8B-4C5A-9E5F-120E17CBFFDD

INTRODUCTION

The members of the family Macrochelidae are large and fast-moving predators, they are inhabiting soil substrates, litter and decomposing organic matter where feed on nematodes, eggs and larvae of insects or weakly sclerotized mites, and very often live in association with some groups (like flies, beetles) of insects (Mašán, 2003). The family of Macrochelidae is relatively well known in some countries of Europe, like: British Isles (Evans and Browning, 1956; Hyatt and Emberson, 1988), Germany (Karg, 1993), Austria (Johnston, 1970) and Slovakia (Mašán, 2003). But the information about their occurrences in the area of Hungary is insufficient.

The first paper about the Hungarian macrochelids was published by Erőss and Mahunka (1971a), who listed numerous macrochelid mite species from several regions of Hungary, but in same year Erőss andMahunka (1971b) presented another paper to concentrate for the species living in dung substrate and here they did not get any names of the localities, perhaps the name of the localities originated from the previous presented one (Erőss and Mahunka 1971a). Later Kandil (1983) presented 14 species during the survey of the fauna of the Hortobágy National Park, Ambros (1993) investigated another Hungarian protected area, and listed three small mammal associated species in Bükk National Park. Ten years later, new occurrences of numerous species were added by faunistical surveys of Salmane and Kontschán (2005, 2006), and Kontschán (2005). One year later, Kontschán (2006) summarized the knowledge of the Hungarian macrochelid mites, which contained records of 32 macrochelid species. Subsequently, Kontschán (2015) mentioned three species from urban habitat from the capitol (Budapest) of Hungary and one year later, Ács and Kontschán (2014) added several new occurrences to the Hungarian species and recorded firstly three species from Hungary. After that several new data to the mites of agricultural soils with some records of members of family Macrochelidae are reported by Kontschán et al. (2014, 2015a, 2016). In same time, Kontschán et al. (2015b) presented their results about the mites of the highways rest station and listed some macrochelid mites from these disturbed areas. Some years later, Kontschán (2018) described a new species in association with a flower beetle and Kontschán and Hornok (2019) presented a macrochelid species associated with stable fly.

MATERIALS AND METHODS

I gathered all the published papers about the Hungarian macrochelid mites. I gave only the synonymous names mentioned in Hungarian literatures of the species with the firstly published names by the original author together with the published records of occurrences. I also illustrated all Hungarian occurrences on maps (Figs 1-9).

The Hungarian specimens deposited in the Hungarian Natural History Museum of *Macrocheles moneronicus* Bregetova and Koroleva, 1960 (coll. number: HNHM Meso-5146), *Macrocheles violovitschi* Bregetova and Koroleva, 1960 (coll. number: HNHM Meso-5189), *Macrocheles caucasicus* Bregetova and Koroleva, 1960 coll. number: HNHM Meso-2289) and *Macrocheles kolpakovae* Bregetova and Koroleva, 1960 (coll. number: HNHM Meso-5216) are also investigated, but these specimens are in poor conditions, several characters were not visible).

RESULTS

List of the taxa

Macrochelidae Vitzthum, 1930

***Dissoloncha* Falconer, 1923**
Dissoloncha Falconer, 1923: 151.

***Dissoloncha superbus* (Hull, 1918)**
Macrocheles superbus Hull, 1918: 71.
Occurrence. Bátaapáti (Salmane and Kontschán, 2006).

***Geholaspis* Berlese, 1918**
Geholaspis Berlese, 1918: 145.

***Geholaspis berlesei* Valle, 1953**
Geholaspis berlesei Valle, 1953: 332.
Occurrences. Velem, Szentmargitfalva (Kontschán, 2006).

Geholaspis longispinosus (Kramer, 1876)
Gamasus longispinosus Kramer, 1876: 100.
Occurrences. Barcs (Kontschán, 2005), Oroszlány (Vértes) (Salmane and Kontschán, 2005), Budapest, Kőszeg, Magyarhertelend, Nagyrécse, Regéc, Vidosnyaszőlős, Szarud, Szigetbecse (Kontschán, 2006), Stajerházak (Ambros 1987).

Glyptholaspis Filipponi and Pegazzano, 1960
Glyptholaspis Filipponi and Pegazzano, 1960: 136.

Glyptholaspis americana (Berlese, 1888)
Holostaspis marginata var. americana Berlese, 1888: 195.
Macrocheles americana Berlese, 1888: Kandil, 1983.
Macrocheles vagabundus Berlese, 1889: Erőss and Mahunka, 1971a.
Occurrences. Dunavecse, Fertőszentmiklós, Isaszeg, Nagybárkány, Örvényes, Sukoró (Erőss and Mahunka, 1971a), Balmazújváros, Egyek, Kunmadaras, Újszentmargita (Kandil, 1983), Budapest (Kontschán, 2015).
Notes. This species was collected from dungs of horse, cattle and fowl (Erőss and Mahunka, 1971b), and from soil (Kandil, 1983).

Glyptholaspis confusa (Foá, 1900)
Holostaspis confusa Foá, 1900: 137.
Macrocheles plumiventris Hull, 1925: Erőss and Mahunka, 1971a.
Occurrences. Kiskunfélegyháza, Kopáncs, Lajosmizse, Töltéstava, Velence, Zamárdi (Erőss and Mahunka, 1971a), Szekszárd (Kontschán, 2005), Budapest (Kontschán, 2015).

Glyptholaspis saprophila Mašán, 2003
Glyptholaspis saprophila Mašán, 2003: 125.
Occurrences. Szada (Kontschán et al., 2014).
Notes. Only one population was recorded from the leaf litters of a bamboo brush (Kontschán et al., 2014).

Holostaspella Berlese, 1903
Holostaspella Berlese, 1903: 241.

Holostaspella exornata Filipponi and Pegazzano, 1967
Holostaspella exornata Filipponi and Pegazzano, 1967: 230.
Occurrences. Oroszlány (Salmane and Kontschán, 2005).

Holostaspella ornata (Berlese, 1904)
Holostaspis ornatus Berlese, 1904: 277.
Occurrences. Nyíregyháza (Kontschán, 2005).

Longicheles Valle, 1953
Longicheles Valle, 1953: 343.

Longicheles hortorum (Berlese, 1904)
Holostaspis hortorum Berlese, 1904: 265.
Geholaspis hortorum: Kontschán, 2005, 2006, Kontschán et al., 2015b.
Occurrences. Vokány (Kontschán, 2005), Szigetbecse (Kontschán, 2006), Letenye (Kontschán et al., 2015b).

Longicheles longulus (Berlese, 1887)
Holostaspis longulus Berlese, 1887: 9.
Occurrences. Aggtelek (Ács and Kontschán, 2014).
Note. This species was collected in cave habitat (Ács and Kontschán, 2014).

Longicheles mandibularis (Berlese, 1904)
Holostaspis mandibularis Berlese, 1904: 263.
Geholaspis mandibularis: Salmane and Kontschán, 2005, Kontschán, 2006.
Occurrences. Zsujta (Salmane and Kontschán, 2005), Gánt, Velem (Kontschán, 2006).

Macrocheles Latreille, 1829
Macrocheles Latreille in Cuvier, 1829: 282.

Macrocheles decoloratus (C. L. Koch, 1839)
Gamasus decoloratus C. L. Koch, 1839: 14.
Occurrences. Dány, Mecsek Mts (Erős and Mahunka, 1971a), Újszentmargita (Kandil, 1983).

Macrocheles glaber (J. Müller, 1860)
Holastaspis glabra J. Müller, 1860: 178.
Occurrences. Dobogókő, Lajosmizse, Zebegény, Békéscsaba (Erős and Mahunka, 1971a), Miskolc (Ambros, 1993), Dömös (Kontschán, 2005), Budapest (Kontschán, 2015), Gyöngyös (Ács and Kontschán, 2014), Oroszlány (Kontschán et al., 2016), Mátraalmás (Ambros, 1987).
Notes. This species was collected usually from soil, but it was found in association with *Cetonia aurata* beetle (Ács and Kontschán, 2014).

Macrocheles insignitus Berlese, 1918
Macrocheles insignitus Berlese, 1918: 158.
Occurrences. Isaszeg, Töltéstava (Erőss and Mahunka, 1971a), Tiszacsege (Kandil, 1983).

Macrocheles kekensis Kontschán, 2018
Macrocheles kekensis Kontschán, 2018: 98-102.
Occurrences. Kék (Kontschán 2018).
Note. This species was collected in association with cetoniin beetle.

Macrocheles mammifer Berlese, 1918
Macrocheles mammifer Berlese, 1918: 171.
Macrocheles pavlovski Bregetova and Koroleva, 1960: Erőss and Mahunka, 1971a.
Occurrences. Fertőszentmiklós, Isaszeg, Sámsonháza, Zamárdi (Erőss and Mahunka, 1971a).
Notes. This species was collected from dungs of horse, cattle and pig (Erőss and Mahunka, 1971b).

Macrocheles matrius (Hull, 1925)
Nothrholaspis matrius Hull, 1925: 212.
Occurrences. Zamárdi, Dömösd, Fertőszentmiklós, Kőszeg, Perkáta, Sári, Sukoró, Törek, Zalavár, (Erőss and Mahunka, 1971a), Nagyvisnyó (Ambros, 1993), Tihany (Salmane and Kontschán, 2005), Bakonybél (Kontschán, 2006), Polgár, Ecséd, Kisbag (Kontschán et al., 2015b).
Notes. This species was collected mostly from soil samples, but also from dungs of horse (Erőss and Mahunka, 1971b).

Macrocheles merdarius (Berlese, 1889)
Holostaspis merdarius Berlese, 1889: 1.
Occurrences. Dobogókő, Dömösd, Dunabogdány, Dunavecse, Isaszeg, Kopáncs, Kőszeg, Lajosmizse,

Nagybárkány, Perkáta, Sámsonháza, Sári, Töltéstava, Vác, Zamárdi (Erőss and Mahunka, 1971a).
Notes. This species was collected from dung of horse, cattle, pig, fowl and from soil (Erőss and Mahunka, 1971b).

Macrocheles muscaedomesticae **(Scopoli, 1772)**
Acarus musca domesticae Scopoli, 1772: 157.
Occurrences. Budapest, Dunavecse (Erőss and Mahunka, 1971a), Balmazújváros, Nagyiván (Kandil, 1983), Bátaapáti (Salmane and Kontschán, 2006).
Notes. Besides specimens found in soil samples (Kandil, 1983, Salmane and Kontschán, 2006), this species was collected from dung of cattle and from human faces (Erőss and Mahunka, 1971b).

Macrocheles nataliae **Bregetova and Koroleva, 1960**
Macrocheles nataliae Bregetova and Koroleva, 1960: 140.
Occurrences. Aggtelek, Dunavecse, Isaszeg, Sukoró, Szabadbattyán, Tátika, Zamárdi (Erőss and Mahunka, 1971a), Egyek, Nagyiván, Tiszacsege, Újszentmargitfa (Kandil, 1983).
Notes. This species was collected from dungs of horse and cattle (Erőss and Mahunka, 1971b), and from soil (Kandil, 1983).

Macrocheles peniciliger **(Berlese, 1904)**
Holostaspis penicilliger Berlese, 1904:
Occurrences. Nadap, Sukoró, Zamárdi (Erőss and Mahunka, 1971a), Egyek, Nagyiván, Újszentmargita (Kandil, 1983) Tihany (Salmane and Kontschán, 2005) Bátaapáti, Oroszlány (Salmane and Kontschán, 2006), Lipót (Kontschán, 2006), Anna-hegy (Kontschán et al., 2015b).

Macrocheles perglaber **Filipponi and Pegazzano, 1962**
Macrocheles perglaber Filipponi and Pegazzano, 1962: 221.
Occurrences. Dömösd, Dunabogdány, Dunavecse, Fertőszentmiklós, Isaszeg, Misina, Nagybárkány, Perkáta, Pócsmegyer, Kopáncs, Sámsonháza, Sukoró, Szabadbattyány, Töltéstava, Vác, Velence, Zamárdi, Zebegény (Erőss and Mahunka, 1971a).
Notes. The differences between the *M. glaber* and *M. perglaber* is very week based on female morphology (Halliday, 1986), but Mašán (2003) listed some characters (e.g. shape of some dorsal setae) of female which can help to separate these two species, but investigation without the males seems to be very uncertain. Erőss and Mahunka (1971a,b) collected this species from dung of cattle, horse and pig, but they did not give information about the sexes of the collected specimens. Therefore the Hungarian occurrence of this species needs to be confirmed.

Macrocheles punctoscutatus **Evans and Browing, 1956**
Macrocheles punctoscutatus Evans and Browing, 1956: 18.
Occurrences. Lajosmizse, Sukoró, Velence (Erőss and Mahunka, 1971a), Újszentmargita (Kandil, 1983).

Macrocheles punctatissimus **Berlese, 1918**
Macrocheles punctatissimus Berlese, 1918: 171.
Occurrence. Aggtelek (Ács and Kontschán, 2014).
Note. This species were collected in cave habitat (Ács and Kontschán, 2014).

Macrocheles robustulus **(Berlese, 1904)**
Holostaspis subbadius var. robustulus Berlese, 1904: 264.
Macrocheles robustulus Berlese, 1904: Kandil, 1983.
Macrocheles punctillatus Willmann, 1939: Erőss and Mahunka, 1971a.
Occurrences. Dunabogdány, Dunavecse, Fertőszentmiklós, Isaszeg, Nagybárkány, Sámsonháza, Töltéstava, Dabas (Erőss and Mahunka, 1971a), Egyek (Kandil, 1983).
Notes. This species was collected from dung of horse, cattle and pig (Erőss and Mahunka 1971) and from soil (Kandil, 1983).

Macrocheles rotundiscutis **Bregetova and Koroleva, 1960**
Macrocheles rotundiscutis Bregetova and Koroleva, 1960: 116.
Occurrences. Tátika (Erőss and Mahunka, 1971a), Egyek, Kunmadaras, Nagyiván, Újszentmargita (Kandil, 1981) Tihany, Villány (Kontschán, 2005).

Macrocheles subbadius **(Berlese, 1904)**
Holostaspis subbadius Berlese, 1904: 264.
Macrocheles vernalis Schweitzer, 1961: Kandil, 1983.
Occurrences. Dömösd, Jósvafő, Misina, Nógrádverőce, Perkáta, Tác, Zalavár (Erőss and Mahunka, 1971a), Újszentmargita (Kandil, 1983).
Notes. This species were collected on soil and leaf litter, but some specimens were found in association with stable flies (Kontschán and Hornok, 2019).

Macrholaspis **Oudemans, 1931**
Macrholaspis Oudemans, 1931: 272.

Macrholaspis opacus **C. L. Koch, 1839**
Gamasus opacus C. L. Koch, 1839.
Occurrences. Sopron, Tátika (Erős and Mahunka, 1971a).
Notes. This species were collected from soil (Erős and Mahunka, 1971a).

Macrholaspis similiopacus **(Mašán, 2003)**
Macrocheles similiopacus Mašán, 2003: 71–73.
Occurrences. Aggtelek (Ács and Kontschán, 2014).
Notes. This species was found in cave (Ács and Kontschán, 2014).

Macrholaspis recki **(Bregetova and Koroleva, 1960)**
Macrocheles recki Bregetova and Koroleva, 1960: 104.
Occurrences. Tátika (Erőss and Mahunka, 1971a), Anna-hegy, Ferihegy, Ecséd, Budaörs, Velence, Törek, Letenye (Kontschán et al., 2015b).

Neopodocinum **Oudemans, 1902**
Neopodocinum Oudemans, 1902: 24.

Neopodocinum meridionalis **(Sellnick, 1931)**
Coprolaelaps meridionalis Sellnick, 1931: 760
Occurrences. Tatabánya (Kontschán, 2006), Visegrád (Ács and Kontschán, 2014).
Note. This species was collected from *Geotrupes* beetle (Kontschán, 2006).

Neopodocinum mrciaki **Sellnick, 1968**
Neopodocinum mrciaki Sellnick, 1968: 253.
Occurrences. Mátraalmás (Ambros, 1984).

Note. This species was collected on *Apodemus flavicollis* mouse species.

***Nothrholaspis* Berlese, 1918**

Nothrholaspis Berlese, 1918: 169.

***Nothrholaspis carinatus* (C. L. Koch, 1839)**

Gamasus carinatus C. L. Koch 1839: 16.

Occurrences. Budapest, Diósjenő, Nadap, Sári (Erős and Mahunka 1971a), Várgesztes (Kontschán, 2006).

***Nothrholaspis montanus* (Willmann, 1951)**

Macrocheles montanus Willmann, 1951: 158.

Occurrences. Aggtelek, Balatonszentgyörgy, Budapest, Csákvár, Diósjenő, Nadap, Sopron, Sukoró, Tátika, Törek, Vác (Erős and Mahunka, 1971a), Egyek (Kandil, 1981), Nagyvisnyó, Miskolc (Ambros, 1993), Zempléni Mts and Paks (Salmane and Kontschán, 2005), Mecsek, Bátaapáti (Salmane and Kontschán, 2006), Villányi Mts (Kontschán, 2005), Várgesztes, Budapest, Szigetbecse, Nagyrécse (Kontschán, 2006).

***Nothrholaspis tardus* (C.L. Koch, 1841)**

Gamasus tardus C. L. Koch, 1841: 14.

Occurrences. Bátorliget, Kaposvár, Kőszeg, Lillafüred, Sári, Sopron, Szár, Velence, Zalavár, (Erőss and Mahunka, 1971a), Oroszlány (Salmane and Kontschán, 2005), Kőszeg, Nagyrécse, Tatárszentgyörgy, Lipót, Villány (Kontschán, 2006).

DISCUSSION

Present paper contains proved occurrences of 34 macrochelid mite species from Hungary. Four species are deleted from these previously presented records. These four species are reported in Erős and Mahunka (1971a), which are misidentifications. The reason of the misidentification can be the poorly known literatures of these mites in the previous century. In the second half of the XX. century, in several cases only the Russian literatures were only available for the Hungarian researchers, therefore some species described from Russia were also presented from Hungary. *Macrocheles moneronicus* Bregetova and Koroleva, 1960 were listed in Erőss and Mahunka (1971a) and in Kandil (1983) as well, but the specimens belong to species *M. subbadius*. Several setae were broken from the idiosoma, but the ornamentation of the sternal shield refers to *M. subbadius* and not to the *M. moneronicus*. *Macrocheles violovitschi* Bregetova and Koroleva, 1960 was reported by Erőss and Mahunka (1971a), but the sternal setae are apically pilose (as in species *M. matrius*) and not smooth in the case of *violovitschi*. Besides of the morphological differences, these two species was described from Sakhalin (Easter Part of Russia), which is far from Hungray and was not found in other part of the Palearctic region. *Macrocheles caucasicus* Bregetova and Koroleva, 1960 was also mentioned by Erőss and Mahunka (1971a). This species was reported only from Caucasus, the Hungarian occurrence was questionable. During the study of the deposited specimens the ornamentation of sternal shield and shape of setae *j5* pilose (as in *M. montanus*) and not smooth (in *M. caucasicus*). The fourth species, *Macrocheles kolpakovae* Bregetova and Koroleva, 1960, was also reported by Erőss and Mahunka (1971a). This species was found only in Dagestan and later was not mentioned from Europe; in the investigation of this specimens it is clear this species is belong to the genus *Geholaspis*, and not to the *Macrocheles*. All characters are not visible well, but the specimens seem to be belonging to species *Geholaspis pontina* Fillipova and Pegazzano, 1960 (based on narrow *z6* setae and ornamentation of the idisoma) and not to other *Geholaspis* species.

Seven species of the listed 34 macrochelids were collected from dung of different animals, three species were found in cave habitats and three species occurred in association with insects. Two species lived in soil of agricultural habitats, other species were reported from soil, moss and leaf litter of natural habitats, often from protected areas.

Regarding to the Slovakian fauna, from where 48 species are reported (Mašán, 2003), the Hungarian fauna seems to be poorly investigated. Contrary with the six newly described macrochelids from Slovakia (Mašán 2003), only one species, *Macrocheles kekensis* is discovered and described from Hungary.

Acknowledgements

This study was supported by NKFIH (OTKA) 108663 grant.

REFERENCES

Ács, A. and Kontschán, J. 2014. Contribution to the Macrochelidae Vitzthum, 1930 fauna of the Carpathian Basin and the Balkan Peninsula (Acari: Mesostigmata). Opuscula Zoologica Budapest, 45 (2): 109-118.

Ambros, M. 1984. Mite species (Acari: Mesostigmata) new to the Hungarian fauna. Miscellanea zoologica hungarica, 2: 43-44.

Ambros, M. 1987. Mites (Acari: Mesostigmata) from small mammals in Hungary. Parasitologia Hungarica, 20: 99-107.

Ambros, M. 1993. Mites (Acari: Mesostigmata) from small mammals (Insectivora and Rodentia) in the Bükk Mts (Hungary). In: Mahunka, S. (Ed.): The fauna of the Bükki Nemzeti Park I. The Hungarian Natural History Museum, Budapest, 449-453.

Berlese, A. 1887. Acari, Myriopoda et Scorpiones hucusque in Italia reperta, 38, 19 text pages + Plates 1-10. Reprint by Junk, The Hague, 1979.

Berlese, A. 1888. Acari Austro-Americani quos collegit Aloysius Balzan. Manipulus primus. Species novas circiter quinquaginta complectens. Bullettino della Società Entomologica Italiana, 20: 171-222, pls. V–XIII.

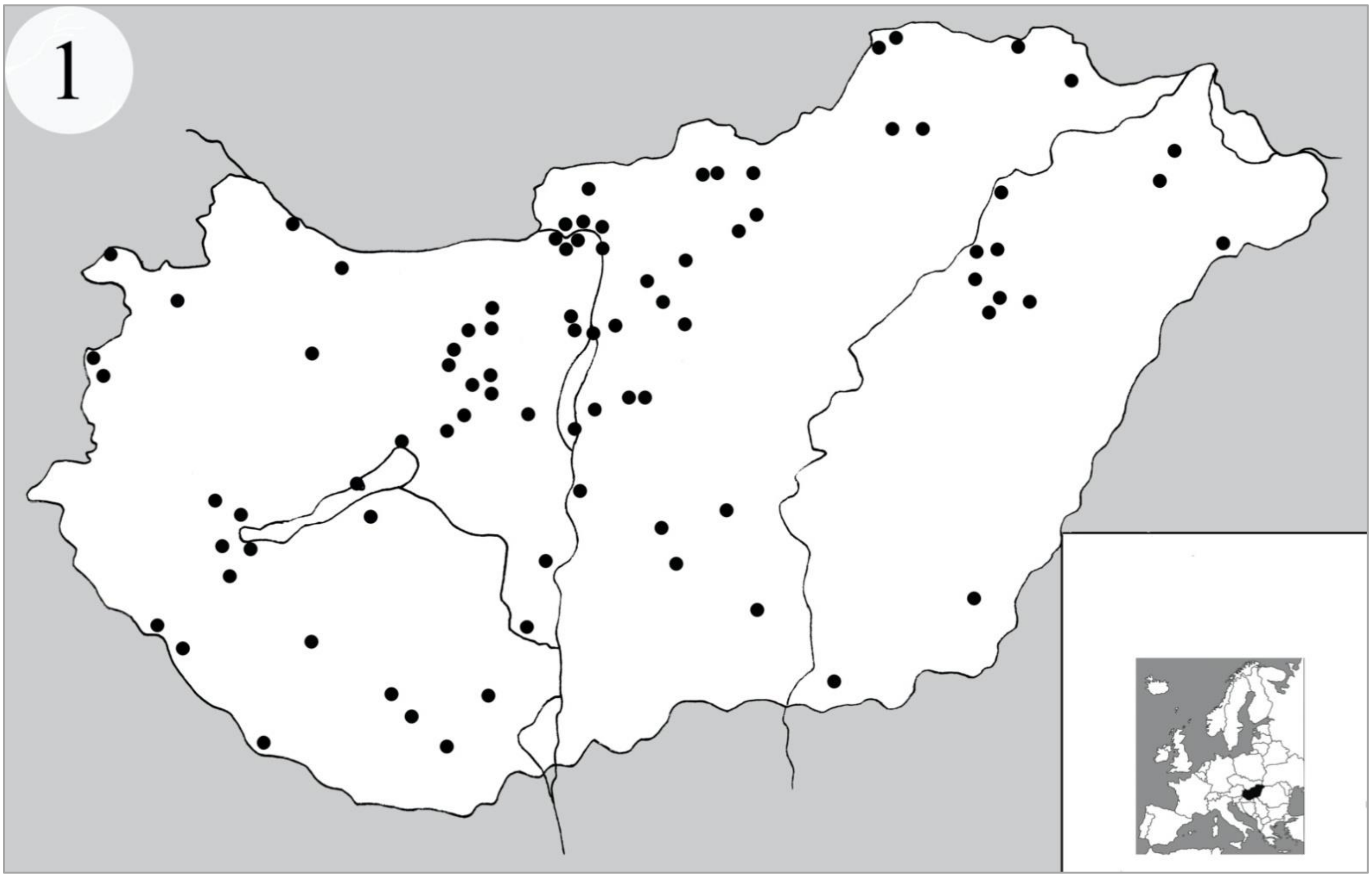


Figure 1. Occurrences of macrochelid mites in Hungary.

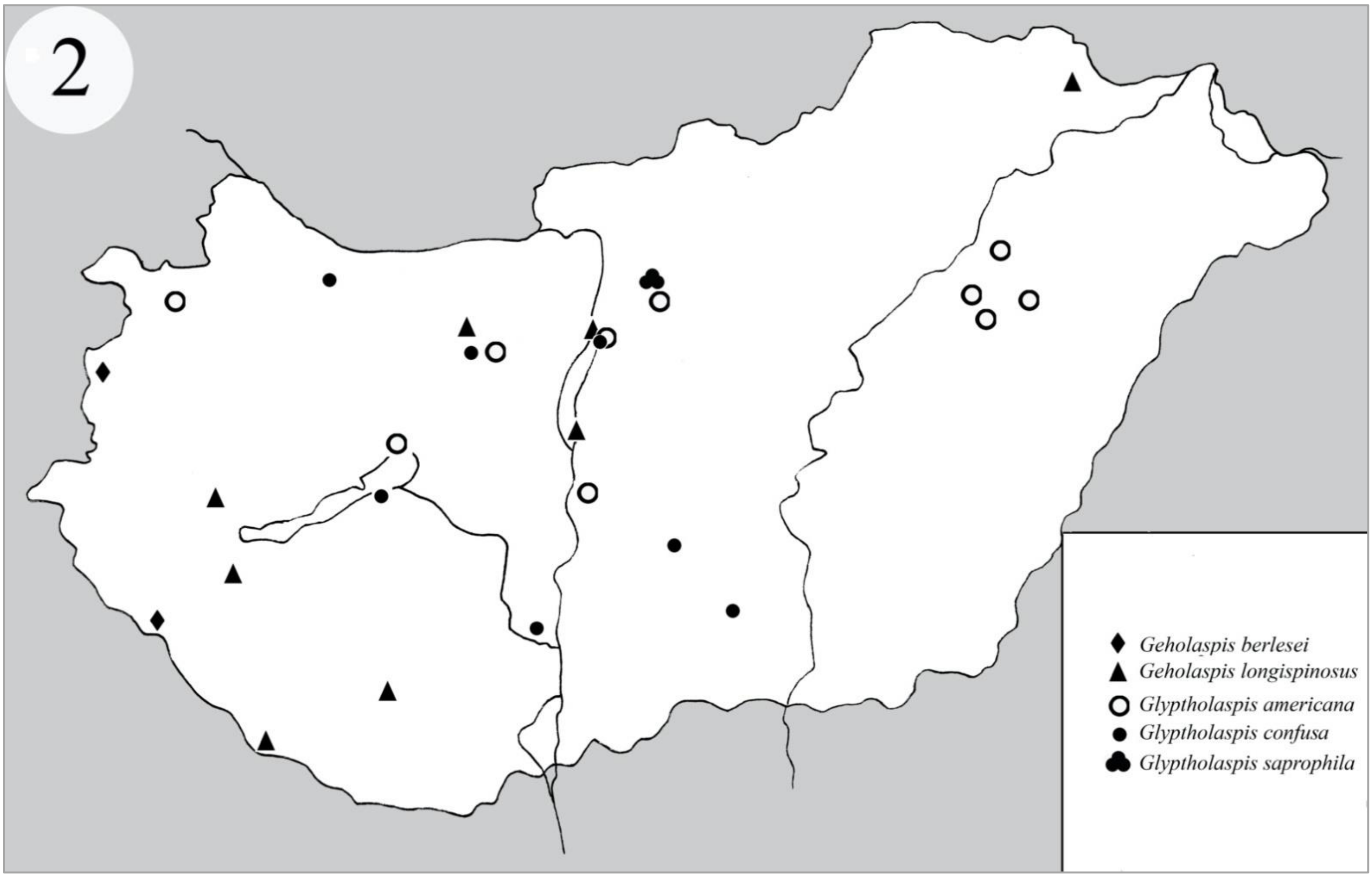


Figure 2. Occurrences of *Geholaspis* and *Glyptholaspis* species in Hungary.

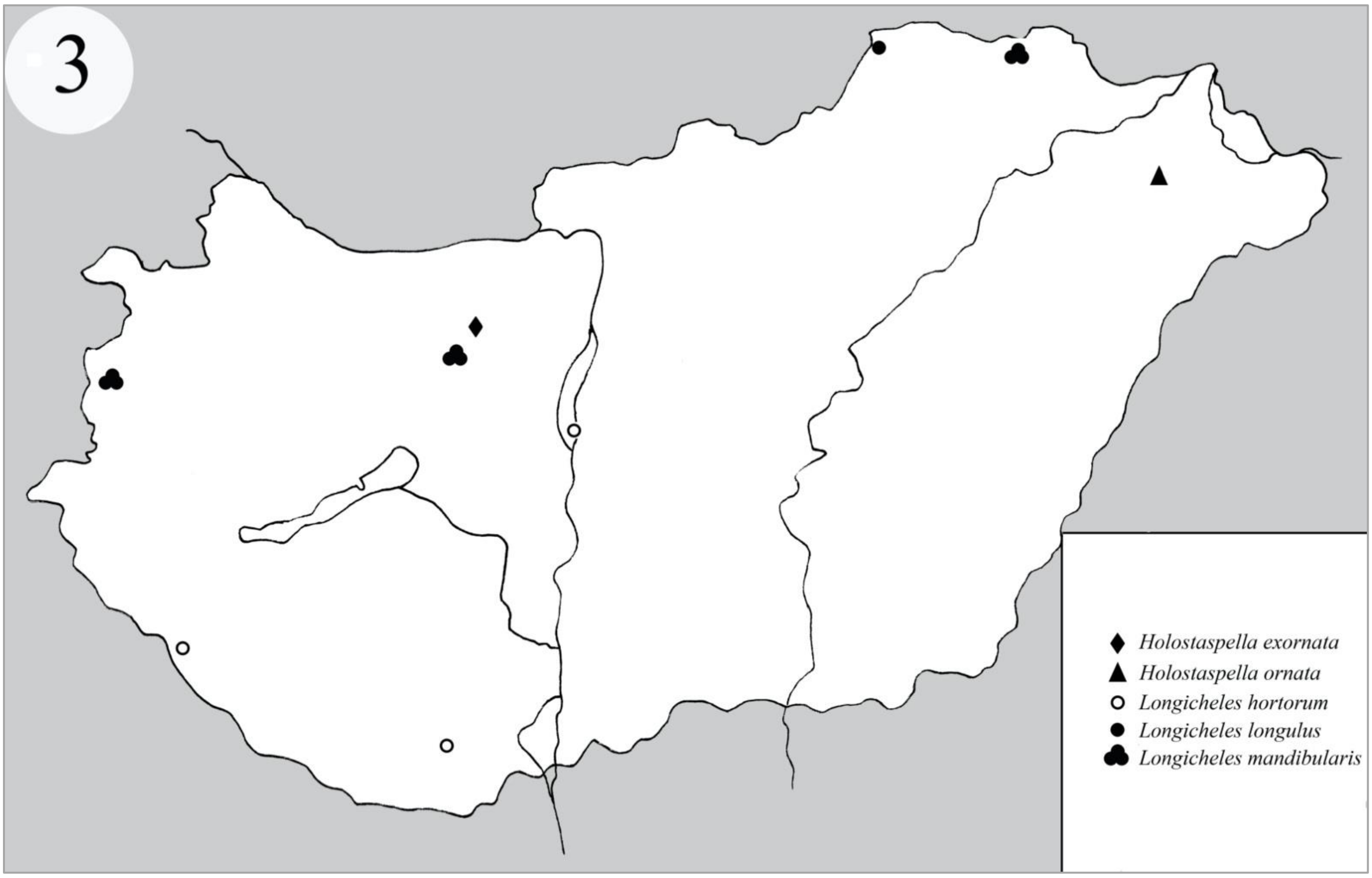


Figure 3. Occurrences of *Holostaspella* and *Longicheles* species in Hungary.

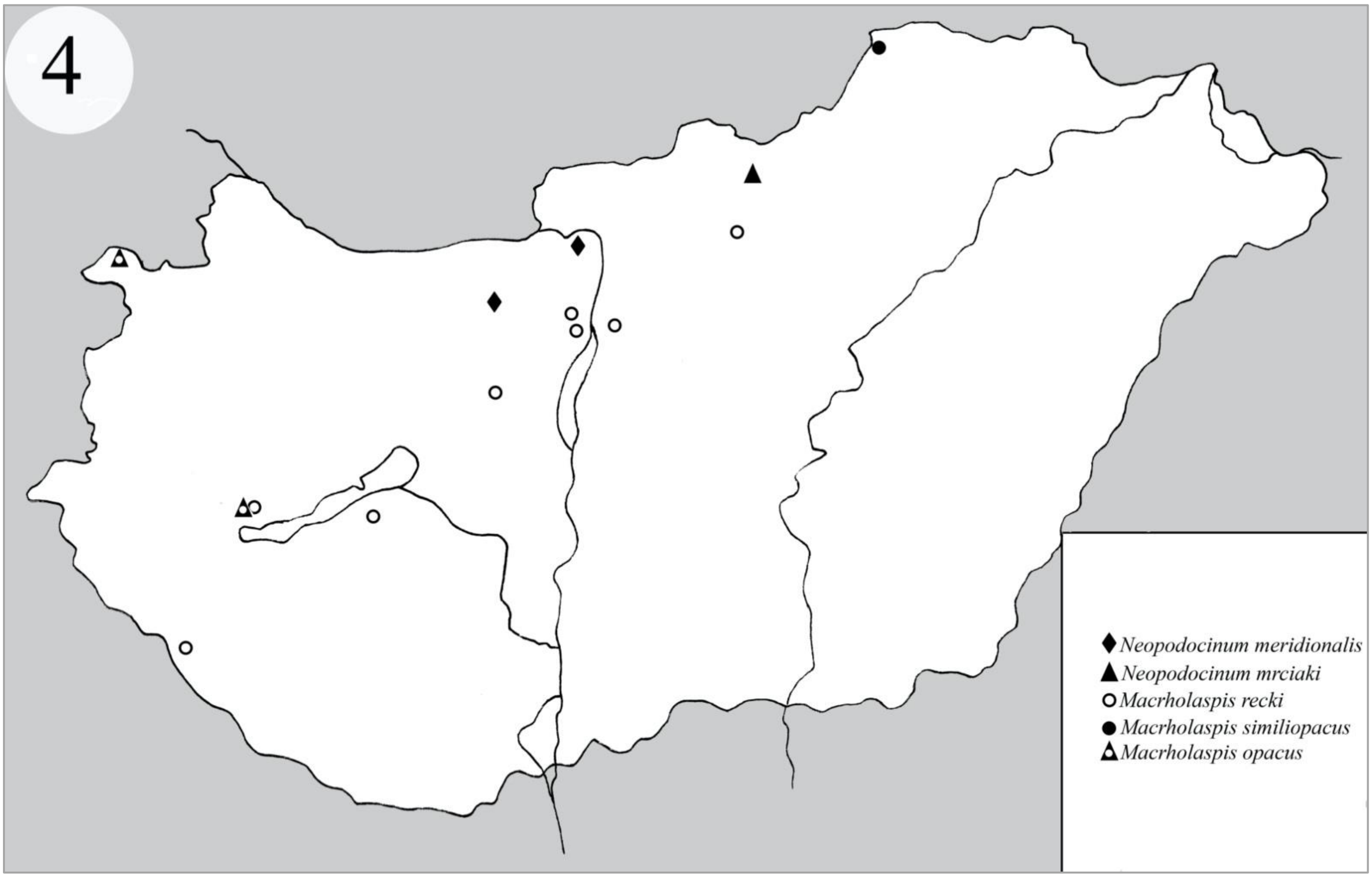


Figure 4. Occurrences of *Neopodocinum* and *Macrholaspis* species in Hungary.

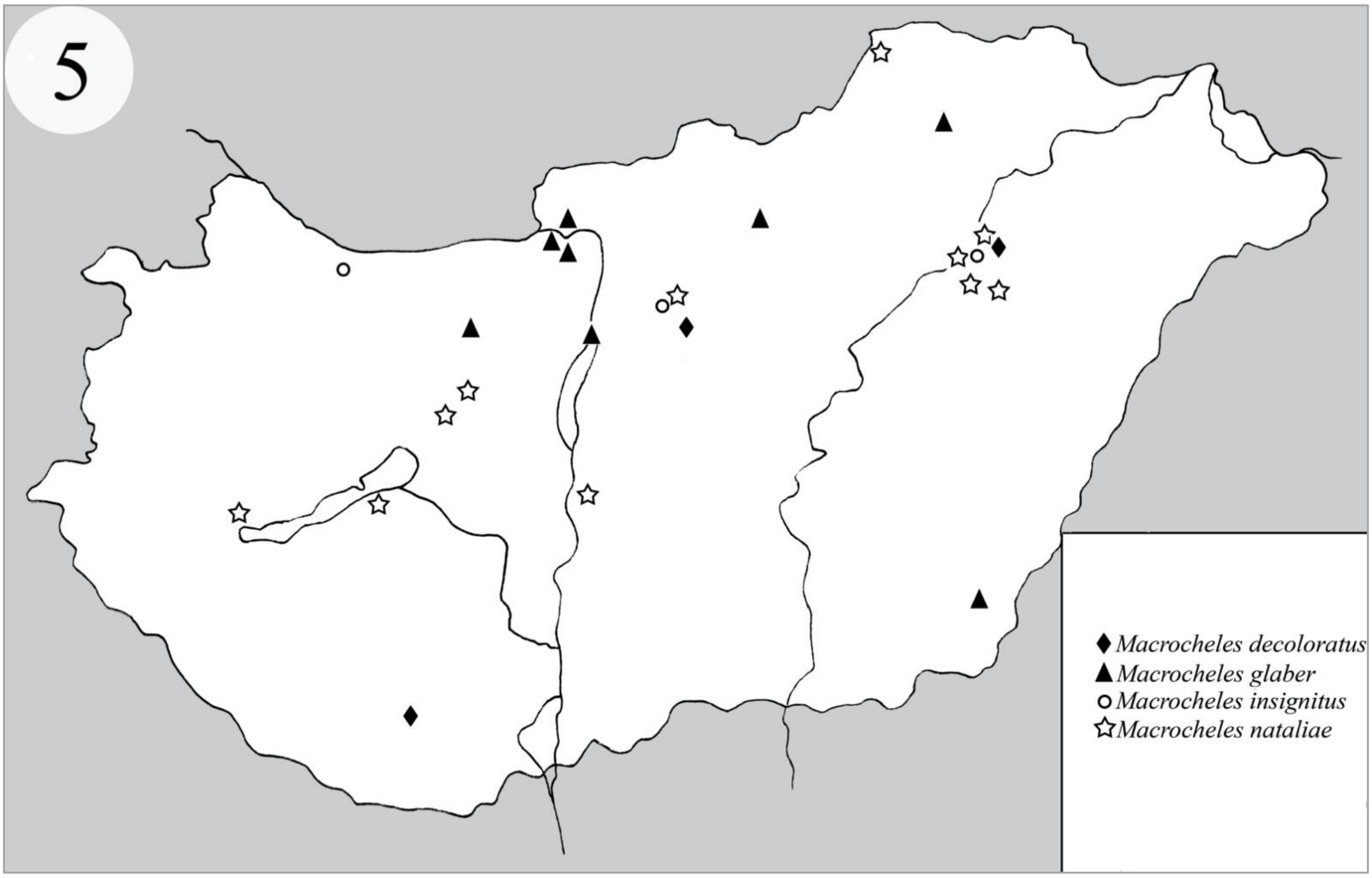


Figure 5. Occurrences of *Macrocheles* species (I) in Hungary.

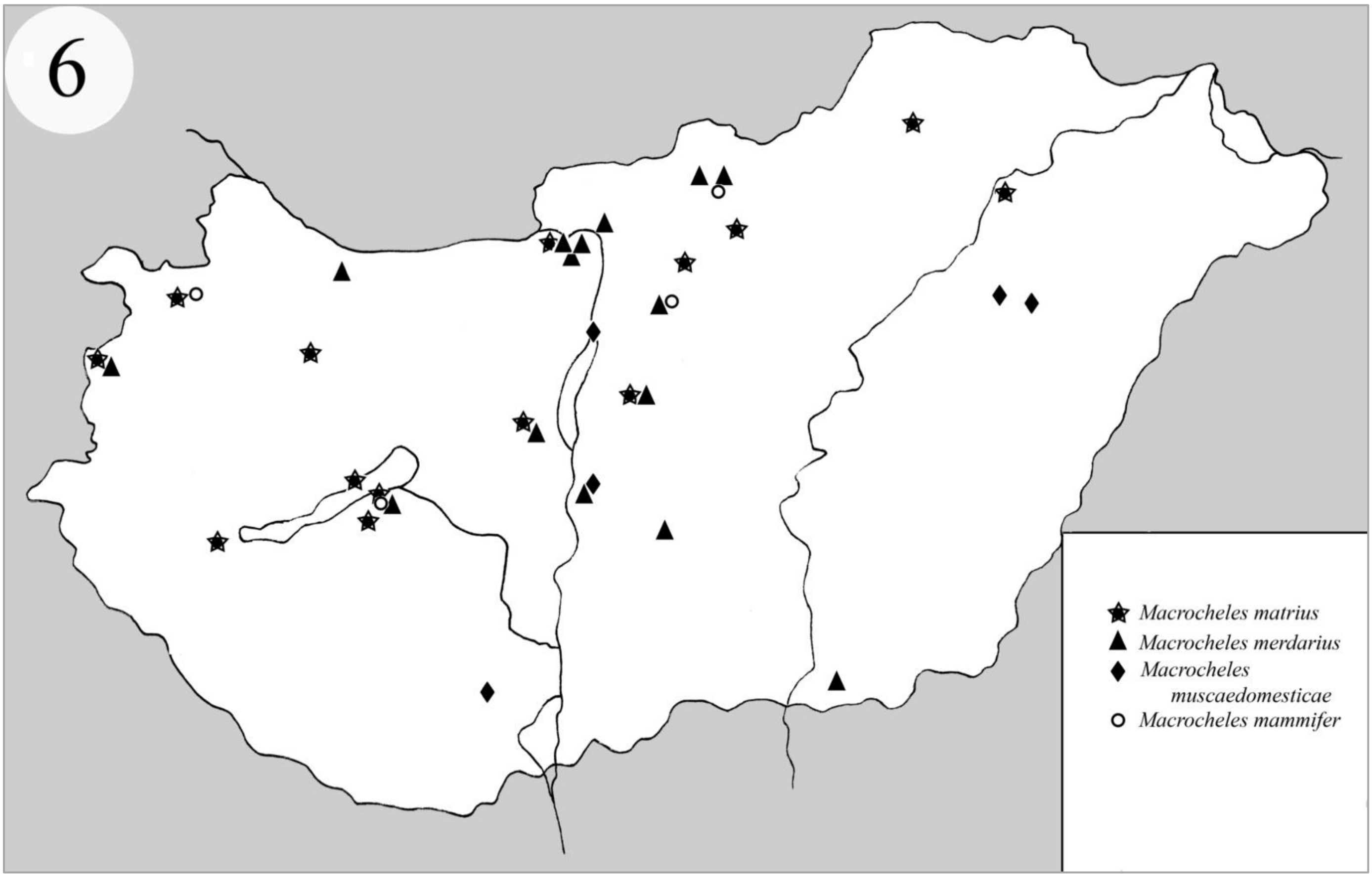


Figure 6. Occurrences of *Macrocheles* species (II) in Hungary.

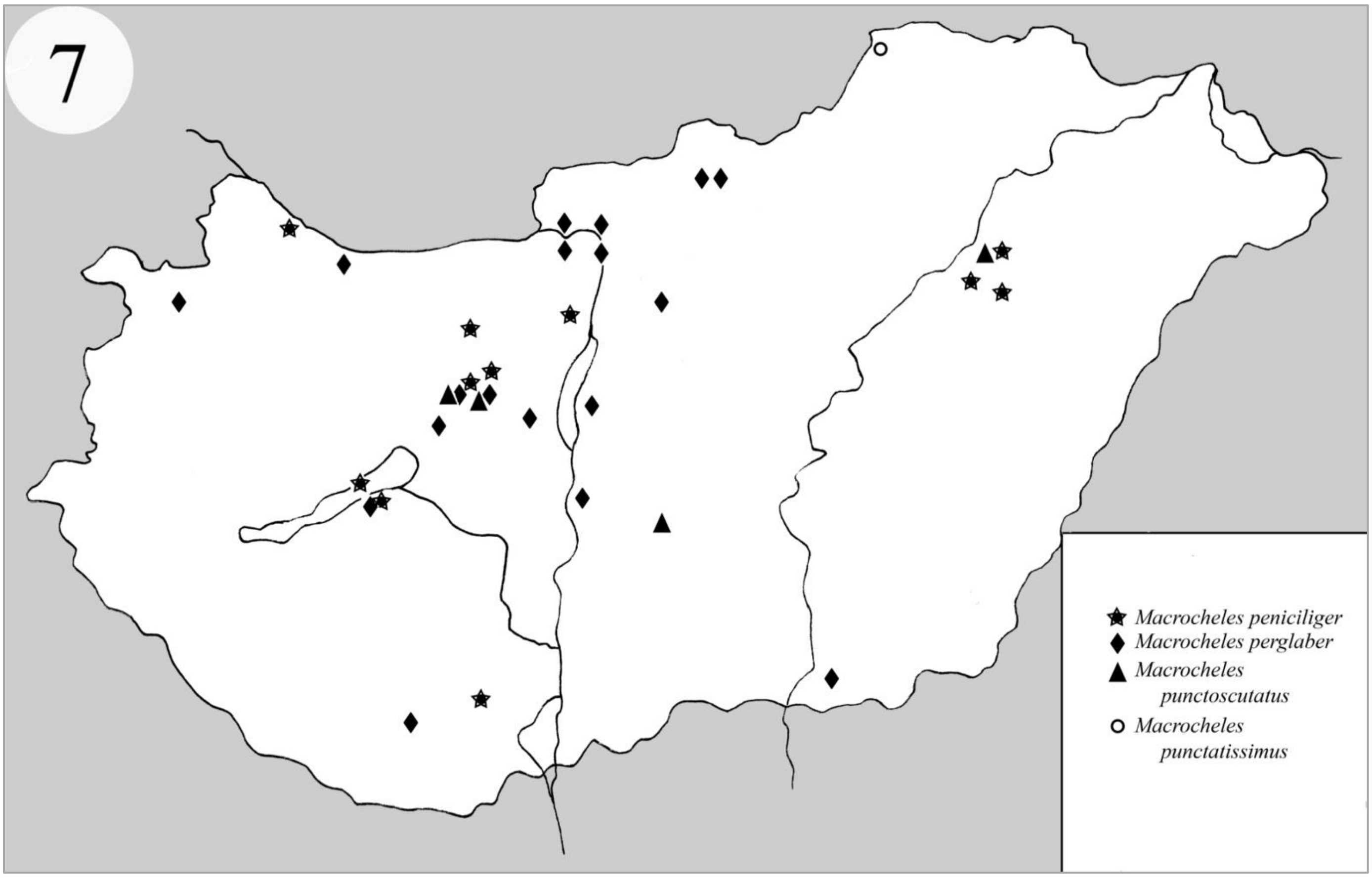


Figure 7. Occurrences of *Macrocheles* species (III) in Hungary.

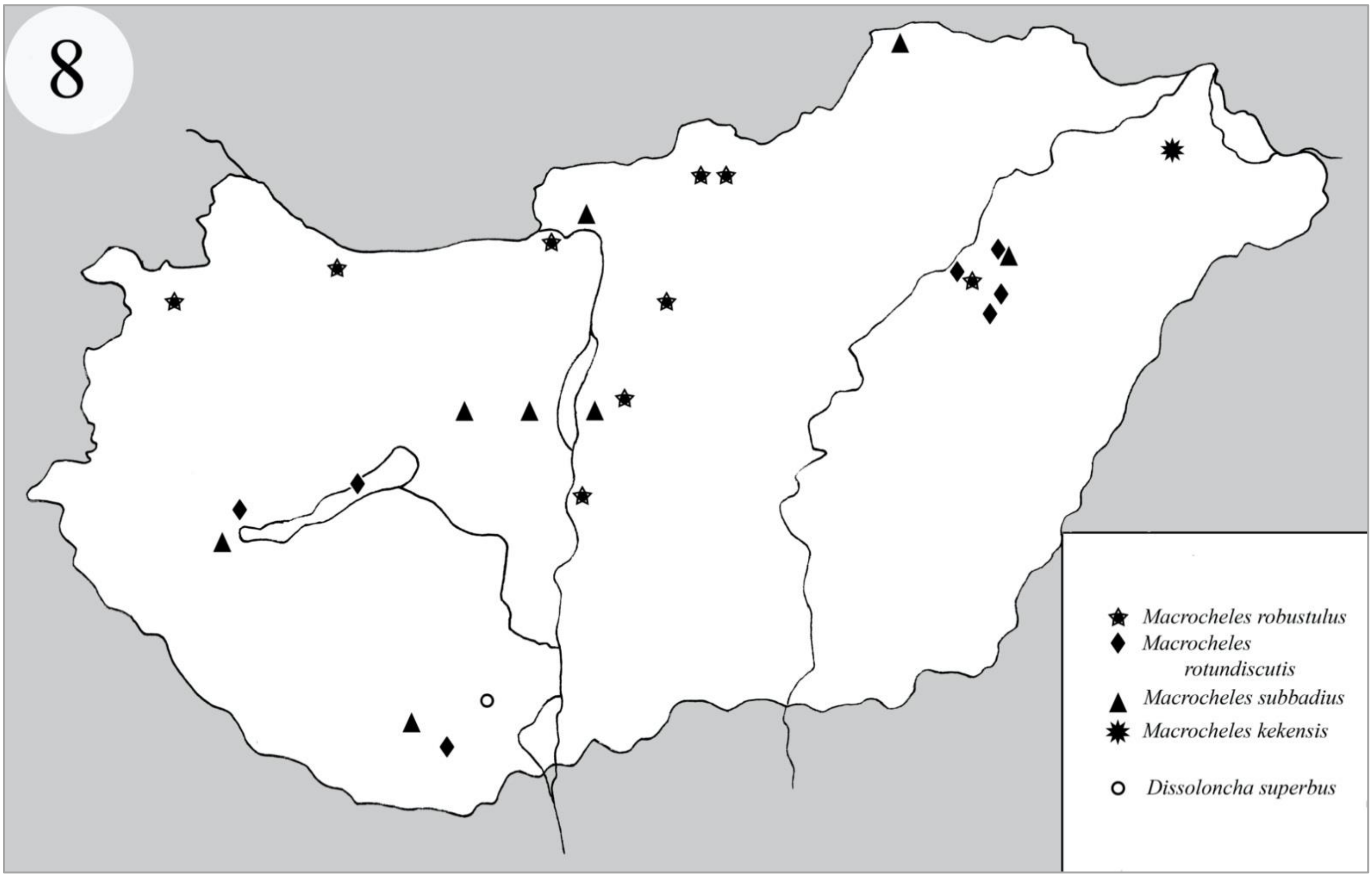


Figure 8. Occurrences of *Macrocheles* and *Dissoloncha* species in Hungary

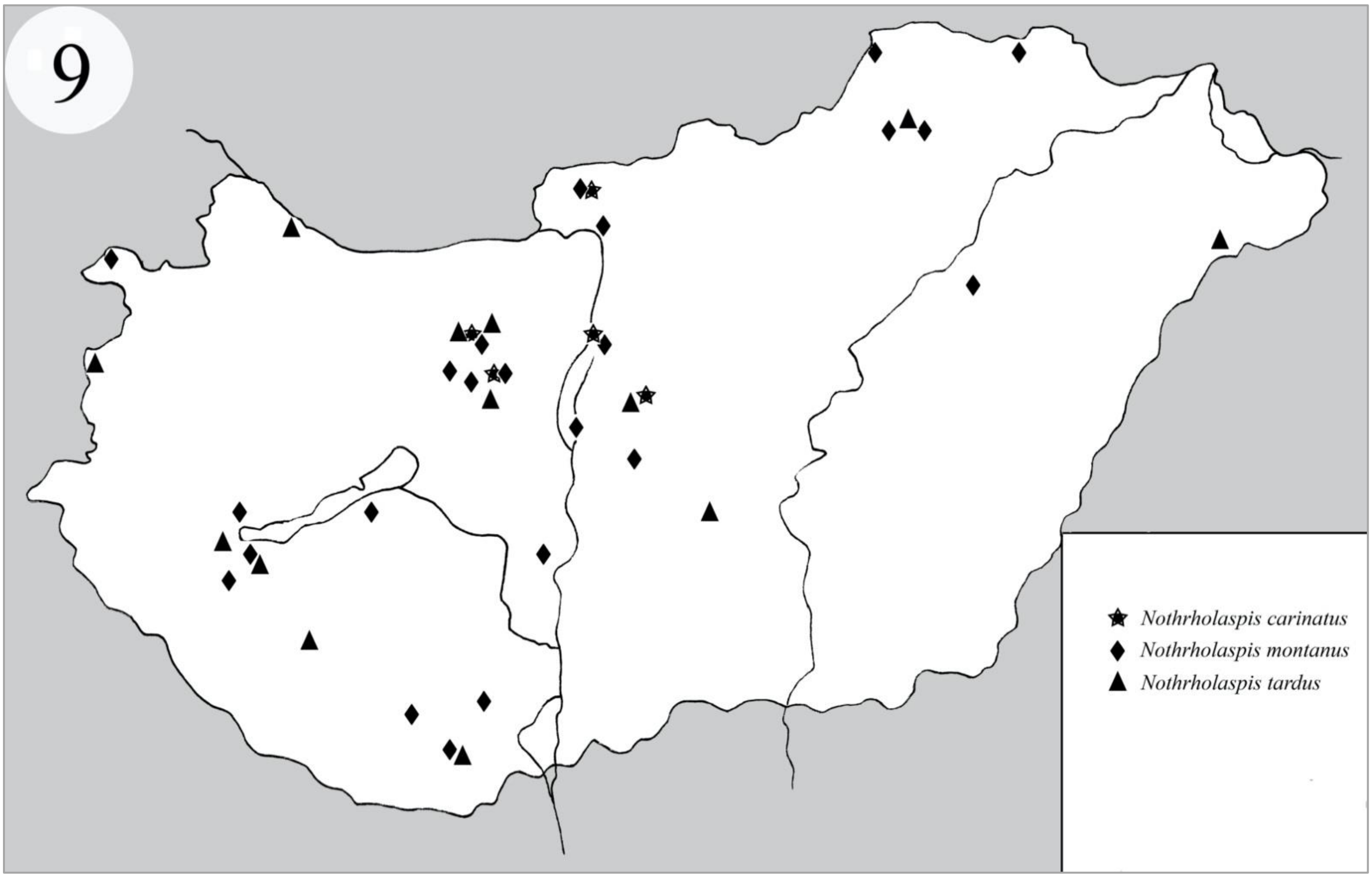


Figure 9. Occurrences of *Northrolaspis* species in Hungary.

Berlese, A. 1889. Acari, Myriopoda et Scorpiones hucusque in Italia reperta, 54, 18 text pages + Plates 1-10. Reprint by Junk, The Hague, 1979.

Berlese, A. 1903. Acari nuovi. Manipulus Ius. Redia, 1: 235-252.

Berlese, A. 1904. Acari nuovi. Manipulus IIus. Redia, 1: 258-280.

Berlese, A. 1918. Centuria quarta di Acari nuovi. Redia, 13: 113-190.

Bregetova, N.G. and Koroleva, E.V. 1960. Mites of the family Macrochelidae Vitzthum, 1930 in the fauna of the USSR. Parazitologicheskii Sbornik Zoologicheskogo lnstituta Akademii Nauk SSSR, 19: 346-411.

Cuvier, G. 1829. Le Règne Animal Distribué d'après son Organisation, pour Servir de Base a l'Histoire Naturelle des Animaux et d'Introduction à l'Anatomie Comparée. In: Cuvier and Latreille, (Eds), Le règne animal distribué d'après son organisation, pour servir de base à l'histoire naturelle des animaux et d'introduction à l'anatomie comparée. Nouvelle édition rev. et aug. Déterville and Cochard, Paris. Vol. 4, Nouvelle Edition: i-xxviii, 584 pp.
doi: 10.5962/bhl.title.49223

Erőss, J. and Mahunka, S. 1971a. Adatok Magyarország macrochelidáinak (Acari, Gamasina) ismeretéhez. (Data to the knowledge of Macrochelidae (Acari. Gamasina) in Hungary.) Parasitologia Hungarica, 4: 201-214.

Erőss, J. and Mahunka, S. 1971b. Investigations on coprophilous and stercoricolous Macrochelids (Acari, Gamasina) in Hungary, as possible agents in the control of synanthropous flies. Parasitologia Hungarica, 4: 215-226.

Evans, G.O. and Browing, E. 1956. British mites of the subfamily Macrochelinae Trägårdh (Gamasina, Macrochelidae). Bulletin of the British Museum (Natural History) Zoology, 4: 1-55.

Falconer, W. 1923. Two British mites new to science and a new subgenus of Macrocheles Latr. Naturalist, 1923, 151-153.

Filipponi, A. and Pegazzano, F. 1962. Specie italiane del gruppo-glaber (Acarina, Mesostigmata, Macrochelidae, Macrocheles). Redia, 47: 211-238.

Filipponi, A. and Pegazzano, F. 1960. Acari del genere *Glyptholapsis* nom. nov. pro *Macrocheles* (Macrocheles) Berlese 1918 (Mesostigmata, Macrochelidae). Redia, 45: 133-171.

Filipponi, A. and Pegazzano, F. 1967. Contributo alla conoscenza del genere Holoytaspella Berlese, 1903 (Acari: Mesostigmata: Macrochelidae). Redia, 50: 219-259.

Foà, A. 1900. Esistono il polimorfismo e la partenogenesi nei Gamasidi? Bolletino della Società Entomologica Italiana, 32: 121-149.

Halliday, R.B. 1986. Mites of *Macrocheles glaber* group in Australia (Acarina: Macrochelidae). Australian Journal of Zoology, 34: 733-752.
doi: 10.1071/ZO9860733

Hull, J.E. 1918. Terrestrial Acari of the Tyne Province. Natural History Transactions of Northumberland and Durham, 5: 13-88.

Hull, J.E. 1925. Acari of the family Gamasidae; new and rare British species. Annals and Magazine of Natural History (series 9), 15: 201-209.
doi: 10.1080/00222932508633202

Hyatt, K.H. and Emberson, R.M. 1988. A review of the Macrochelidae (Acari : Mesostigmata) of the British Isles. Bulletin of the British Museum (Natural History) Zoology, 54: 63-125.
doi: 10.5962/bhl.part.17598

Johnston, D. 1970. Notes on a collection of Austrian Macrochelidae with the description of *Macrocheles beieri*, n. sp. Annalen des Naturhistorischen Museums in Wien, 74: 145-150.

Kandil, M.M. 1983. The Mesostigmata fauna of the Hortobágy National Park (Acari). In: Mahunka, S. (Ed.) The fauna of the Hortobágy National Park. Akadémiai Kiadó, Budapest, 365-373.

Karg, W. 1993. Acari (Acarina), Milben Parasitiformes (Anactinochaeta) Cohors Gamasina Leach. Raubmilben. Jena, Stuttgart, New York Gustav Fischer Verlag, 96-114.

Koch, C.L. 1839. Deutschlands Crustaceen, Myriapoden und Arachniden. Ein Beitrag zur Deutschen Fauna. Regensberg, Herrich-Schäffer. Volume 23-30.

Koch, C.L. 1841. Deutschlands Crustaceen, Myriapoden und Arachniden. Ein Beitrag zur Deutschen Fauna. Regensberg, Herrich-Schäffer. Volume 31-34.

Kontschán, J. 2005. Contribution of the Macrochelidae fauna of Hungary (Acari: Mesostigmata). Folia Historico Naturalia Musei Matraensis, 29: 77-80.

Kontschán, J. 2006. Check list of the Hungarian Mesostigmatid mites. I.–II. Zerconidae and Macrochelidae. Folia Historico Naturalia Musei Matraensis, 30: 129-136.

Kontschán, J. 2015. Atkák mikroskálán: Akarológiai vizsgálat egy kis kertben. (Mites on microscales: acarological studies in a small garden.) Integrált termesztés a kertészeti és szántóföldi kultúrákban. 32: 63-69.

Kontschán, J. 2018. *Macrocheles kekensis* sp. n., a new macrochelid mite associated with a centoniin beetle from Hungary (Acari, Mesostigmata). Zookeys, 768: 97-104.
doi: 10.3897/zookeys.768.24460

Kontschán, J., Ács A. and Neményi, A. 2014. Adatok a magyarországi bambuszok atkáihoz. (Data to the mites of the Hungarian bamboo brushes). Növényvédelem, 50 (7): 339-343.

Kontschán, J., Ács, A., Wang, GQ. and Neményi, A. 2015a. New data to the mite fauna of Hungarian bamboo plantations. Acta Phytopathologica et Entomologica Hungarica, 50 (1): 77-83.
doi: 10.1556/038.50.2015.1.7

Kontschán, J., Ács, A., Suták, A. and Kiss, B. 2015b. A hazai autópályák pihenőinek atkái. Akarologiai tanulmányok 4. (Mites of the rest stops of the Hungarian motorways. Acarological studies 4.). StormingBrain Kiadó, Budapest, 124 pp.

Kontschán, J., Ács, A. and Suták, A. 2016. Contribution to the soil-dwelling mite fauna of the Hungarian agroecosystems (Acari). Acta Phytopathologica et Entomologica Hungarica, 51 (1): 133-143.
doi: 10.1556/038.51.2016.1.12

Kontschán, J. and Hornok, S. 2019. New records, a completed list and identification key of mites (Acari) associated with the stable fly, *Stomoxys calcitrans* (L.) (Diptera: Muscidae). Acarologia, 59 (1): 3-11.
doi: 10.24349/acarologia/20194306

Kramer, P. 1876. Zur Naturgeschichte einiger Gattungen aus der Familie der Gamasiden. Archiv für Naturgeschichte, 42: 46-105.

Latreille, P.A. 1829. Les Arachnides (Arachnides). In: Cuvier, G. (Ed.), Le Règne Animal. 2nd Edition. Vol. 4. Déterville, Paris, 206-291.

Mašán, P. 2003. Macrochelid Mites of Slovakia (Acari, Mesostigmata, Macrochelidae). Bratislava, Institute of Zoology, Slovak Academy of Sciences, 149 pp.

Müller, J. 1860. Die Insektenepizoen mährischen Fauna. Jahresbericht der mährisch-schlesische Gesellschaft, Brünn, 1859, 157-184.

Oudemans, A.C. 1902. New list of Dutch Acari, second part. With remarks on known and description of a new subfamily, nem genera and species. Tijdshrift voor Entomologie, 45: 1-52.

Oudemans, A.C. 1931. Acarologische Aanteekeningen CIX. Entomologische Berichten, 8: 272-280.

Salmane, I. and Kontschán, J. 2005. Soil Gamasina mites (Acari, Parasitiformes, Mesostigmata) from Hungary. I. Latvijas Entomologs, 42: 39-44.

Salmane, I. and Kontschán, J. 2006. Soil Mesostigmata mites (Acari: Parasitiformes) from Hungary II. Latvijas Entomologs, 43: 14-17.

Schweitzer, J. 1961. Die Landmilben der Schweiz (Mittelland, Jura und Alpen). Parasitiformes Reuter. Neue Denkschriften der Schweizerischen Naturforschenden Gesellschaft, 84: 184-186.

Scopoli, J.A. 1772. Annus V. Historico Naturalis. Lipsiae, 8-128.

Sellnick, M. 1931. Zoologische Forschungsreise nach den Jonischen Inseln und dem Peloponnes. Akademie der Wissenschaften in Wien, Mathematische-Naturwissenschaftliche Klasse, Sitzungsberichte (Abt. 1), 140: 693-776.

Sellnick, M. 1968. *Neopodocinum mrciaki*, sp. n., eine neue Milbenart aus Slowakei. Folia Parasitologica, 15: 253-262.

Valle, A. 1953. Revisione di generi e sottogeneri Berlesiani di Acari (Primo contributo). Redia, 38: 316-360.

Vitzthum, H.G. 1930. Acarologische Beobachtungen. 14. Reihe. Zoologischer Jahrbücher, Abteilung für Systematik, 59: 282-348.

Willmann, C. 1939. Terrestrische Acari der Nord-und Ostseeküste. Abhandlungen der Naturwissenschaftlichen Verein zu Bremen, 31: 521-550.

Willmann, C. 1951. Untersuchungen über die terrestrische Milbenfauna im pannonischen Klimagebiet Österreich. Sitzungsberichte Österreichische Akademie der Wissenschaften (Abt. 1.), 106: 91-176.

Edited by: Raşit Urhan
Reviewed by: Three anonymous referees

Citation: Kontschán, J. 2020. Checklist of the Hungarian species of family Macrochelidae (Acari: Mesostigmata). Acarological Studies, 2 (1): 7-17.

Acarological Studies
Vol 2 (1): 18-23

RESEARCH ARTICLE

Description of *Prozercon miraci* sp. nov. (Acari: Mesostigmata: Zerconidae) from Coastal Aegean Section in Turkey, with a key to the Turkish species

Raşit URHAN [1], Mehmet KARACA [2,3], Elif Hilal DURAN[1]

[1] *Department of Biology, Faculty of Science & Arts, Pamukkale University, Denizli, Turkey*
[2] *Department of Electronic & Automation, Denizli Vocational School of Technical Sciences, Denizli, Turkey*
[3] Corresponding author: karacamehmet@pau.edu.tr

Received: 12 November 2019 Accepted: 28 November 2019 Available online: 31 January 2020

ABSTRACT: Specimens of *Prozercon miraci* sp. nov. were collected from oak forest habitats in Coastal Aegean Section in Turkey and their identifications and illustrations were made. Definitions and drawings of female and male specimens, and immature stages were also given. In addition, an updated key to the species known from Turkey of this genus was included in this study.

Keywords: Acari, Mesostigmata, *Prozercon*, zerconid mite, new species, updated key.
Zoobank: http://zoobank.org/3C419586-A39F-43B6-9F87-9A397874752C

INTRODUCTION

Prozercon Sellnick, 1943 is one of the intensive genera of zerconid mites in terms of number of species in the world. Moreover, it is the second crowded genus of this family in Turkey. Thirty-five species of *Prozercon* have been recorded in Turkey up to now (Urhan and Duran, 2019; Urhan et al., 2019a,b). In the present study, *Prozercon miraci* sp. nov. was defined. The materials of new species were found during a research on diversity of zerconid mites in Coastal Aegean Section in Turkey. Identification of this new species will contribute to the acarological richness of our country.

MATERIALS AND METHODS

Examined specimens of *Prozercon miraci* sp. nov. in this study were found from forestland areas of Coastal Aegean Section. Different litter and soil samples including mites were collected from research area and GPS (Garmin GPS-map 62s) information were taken. Collected samples were carried to acarology laboratory and were put in Berlese funnels for extracting mites. Samples were kept for about 1 week in these funnels. After that, bottles including extracted mites were taken to Petri dishes. Then, zerconid mites were selected and collected under a stereo-microscope (Nikon SMZ745T). Collected mites were taken in 60% lactic acid. The illustrating of zerconids were done using a light-microscope (Olympus CX41) with DP25 camera. Examined specimens and holotype were taken in 70% ethanol and stored in Acarology Laboratory of Pamukkale University, Denizli (Turkey). During examinations of new specimens, Mašán and Fend'a (2004) terminology were used. Measurements of different body parts were presented as micrometers (µm). The characters of that new species were used to construct an updated key for Turkish *Prozercon* species.

RESULTS

Family: Zerconidae Canestrini, 1891

Genus: *Prozercon* Sellnick, 1943

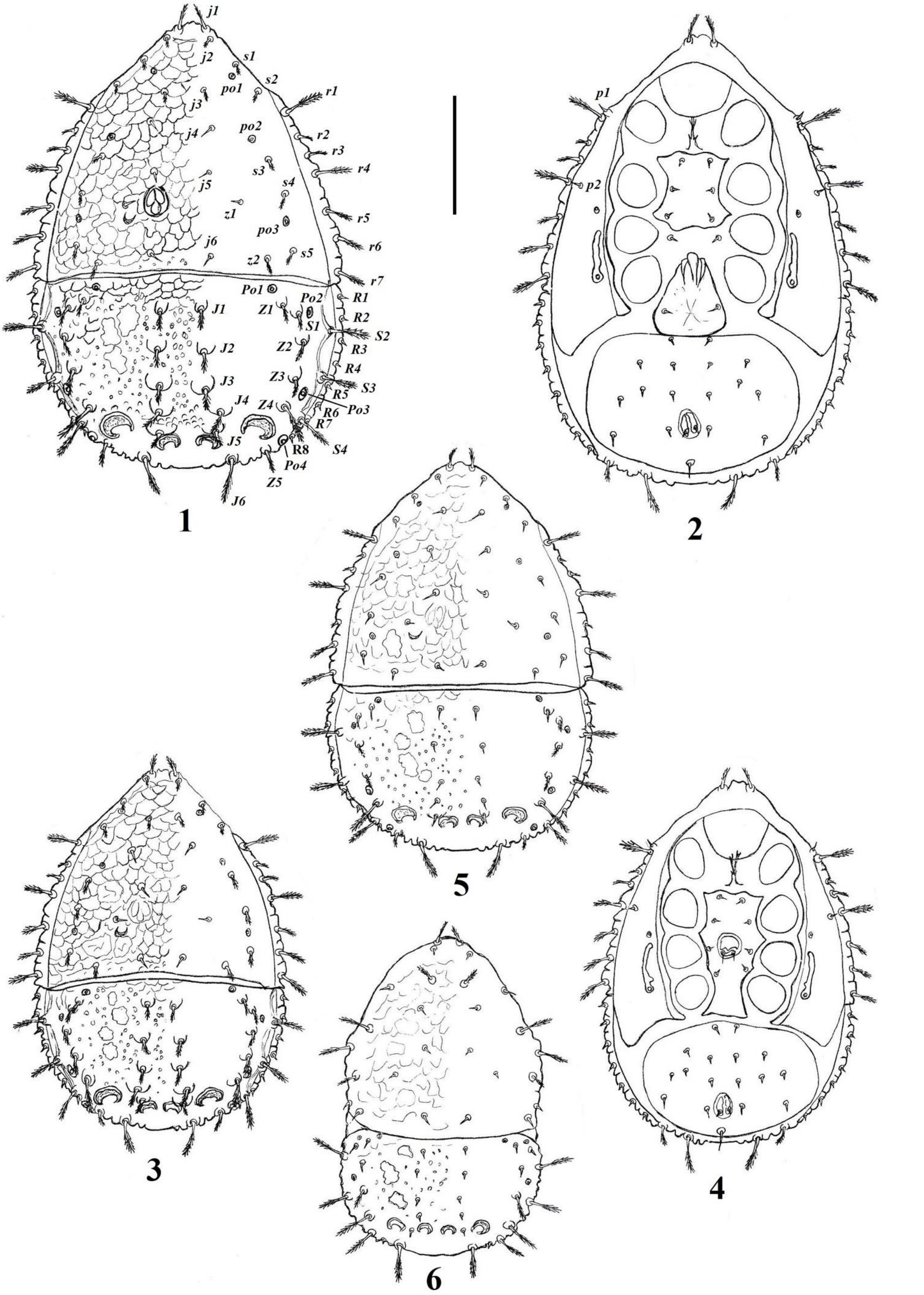
Type species: *Zercon fimbriatus* C.L. Koch, 1839

Prozercon miraci sp. nov. (Figs 1-6)

Type material. Holotype (female), soil and litter samples under oak trees (*Quercus* sp.), 39°18.321' N, 27°54.697' E, 395 m, Fırdanlar village of Manisa province, 7 January 2019. Paratypes: 11 females, 8 males, 6 deutonymphs and 3 protonymphs. All of them were collected from same locality with holotype.

Description. Female. Dorsal site (Fig. 1). Length (without gnathosoma) and width in holotype 337 and 240, respectively. Measurement of 11 paratypes; length 335–351, width 236–245. Shapes of idiosomal shields were illustrated in Figure 1. Dorsal fossae are clear and well developed. Moreover, outer cavities is 2–4 times larger than inners.

Dorsal setae (Fig. 1). 20 pairs of various setae present on podonotum: Number of setae in *j* series with 6 pairs, *z* series with 2 pairs, *s* series with 5 pairs and *r* series with 7 pairs. Setae j_1, r_1, r_4–r_7 markedly elongated, densely plumose, brush-like and apically rounded. Setae j_4–j_6 and z_1 short, smooth and needle-like. Remaining podonotal setae pilose or plumose. 23 pairs of various setae present on opisthonotum: Number of setae in *J* series with 6 pairs, *Z* series with 5 pairs, *S* series with 4 pairs and *R* series with 8 pairs. Setae J_1–J_5, Z_1–Z_3, Z_5 and S_1 plumose and apically tapering. Setae J_6, Z_4 and S_2–S_4 densely plumose, brush-like and apically rounded. Marginal setae R_1–R_8 short, smooth and thorn-like. Setae J_1–J_2 not reaching to insertion of following setae in related rows. Setae J_3 and J_4 reaching to insertion of next setae. Setae J_5 not reaching to posterior margin of opisthonotum. The interval between



Figures 1-6. General views of *Prozercon miraci* sp. nov. 1. Dorsal appearance of female. 2. Ventral appearance of female. 3. Dorsal appearance of male. 4. Ventral appearance of male. 5. Dorsal appearance of deutonymph. 6. Dorsal appearance of protonymph (Scale bar is equal to 100 micrometers).

Table 1. Mean lengths of opisthonotal setae and the distances between their bases in *J*, *Z*, and *S* rows of *Prozercon miraci* sp. nov. (Abbreviations: F: female, M: male, DN: deutonymph, PN: protonymph).

Setae	F	M	DN	PN	Setae	F	M	DN	PN	Setae	F	M	DN	PN
S_1	16	14	8	6	Z_1	16	13	8	6	J_1	16	15	9	5
S_1-S_2	26	24	18	14	Z_1-Z_2	34	26	28	20	J_1-J_2	32	30	26	21
S_2	30	24	27	27	Z_2	18	13	10	8	J_2	18	13	8	5
S_2-S_3	36	32	33	33	Z_2-Z_3	29	21	25	19	J_2-J_3	32	26	29	22
S_3	30	24	28	27	Z_3	20	15	15	18	J_3	17	14	7	5
S_3-S_4	42	30	36	34	Z_3-Z_4	26	19	23	21	J_3-J_4	20	16	16	15
S_4	28	24	28	26	Z_4	36	20	30	32	J_4	15	13	6	4
					Z_4-Z_5	40	25	26	24	J_4-J_5	18	12	12	12
					Z_5	22	15	12	3	J_5	10	9	5	3
										J_5-J_6	26	18	19	15
										J_6	32	26	28	27

Table 2. Comparison of *P. miraci* sp. nov., *P. buraki* and *P. sellnicki*.

	***P. miraci* sp. nov.**	***P. buraki***	***P. sellnicki***
Setae j_2 and j_3	plumose	smooth	plumose
Setae j_4, j_6 and z_1	smooth	smooth	plumose
Setae s_1-s_4	plumose	smooth	plumose
Setae S_1 and Z_5	long and plumose	short and smooth	long and plumose
Setae S_2 and S_3	plumose and reaching beyond the lateral margin of opisthonotum	pilose and not reaching beyond the lateral margin of opisthonotum	plumose and reaching beyond the lateral margin of opisthonotum
Seta Z_4	long, plumose and reaching beyond the lateral margin of opisthonotum	short, plumose and not reaching beyond the lateral margin of opisthonotum	short, plumose and not reaching beyond the lateral margin of opisthonotum

setae J_6 and J_6 is 62–68 apart. None of setae in *Z* series not reaching the insertion of next setae. Setae Z_4 are the longest of idiosoma and protrudes beyond posterior margin of opisthonotum. The interval between setae Z_5 and J_6 is 29–32 apart. Setae S_1 not reaching the insertion of setae Z_2. Setae S_2–S_4 reaching to beyond of lateral margin of opisthonotum.

Pores (Fig. 1). Pores po_1 are located on the line connecting setae s_1–j_3 closer to s_1. Pores po_2 are located above the line connecting setae s_3–j_4 closer to s_3. Pores po_3 are located on the line connecting setae s_4–s_5. Pores Po_1 are located anteroparaxially to insertion of setae Z_1. Pores Po_2 are located outside the line connecting setae S_1–Z_2 or located on the line connecting setae S_1–S_2 closer to S_1. Pores Po_3 are located on the line connecting setae S_3 and Z_4. Pores Po_4 are located on the line connecting setae S_4–Z_5.

Ventral site (Fig. 2). Chaetotaxy and shape of the peritrematal shield are characteristical for *Prozercon* species (Mašán and Fend'a, 2004).

Male (Figs 3-4). Length of idiosoma in 8 paratypes 272–290, width 191–203. Chaetotaxy of idiosomal setae, location of pores on idiosoma and ornamentation of dorsal shields like in females. Interval between setae J_6 and J_6 is 49–54. The interval between setae Z_5 and J_6 is 20–26.

Deutonymph (Fig. 5). Length of idiosoma in 6 paratypes 268–290, width 189–200.

Podonotal setae j_1, r_1, r_4, r_6 and r_7 markedly elongated, densely plumose, brush-like and apically rounded. Setae r_3 and r_5 pilose or plumose, other podonotal setae short, smooth and needle-like. Opisthonotal setae J_1–J_5, Z_1 and setae in *R* series short, smooth and needle-like, setae S_1, Z_2, Z_3 and Z_5 plumose and other opisthonotal setae similar to r_1. The interval between setae J_6 and J_6 is 57–63. The interval between setae Z_5 and J_6 is 20–21.

Protonymph (Fig. 6). Length of idiosoma in 3 paratypes 208–253, width 137–161.

Podonotal setae j_1, j_3, r_3, r_4, r_6 and r_7 markedly elongated, densely plumose, brush-like and apically rounded. Other podonotal setae short, smooth and needle-like. Opisthonotal setae J_1–J_5, Z_1, Z_2, Z_5 and S_1 short, smooth and needle-like, other opisthonotal setae similar to r_3. The interval between setae J_6 and J_6 is 45–57. The interval between setae Z_5 and J_6 is 10–12.

Etymology. The name of the new species is dedicated to Miraç (son of the second author).

Remarks. Mean lengths and ranges of setae on opisthonotum are given in Table 1 for female, male, deutonymph and protonymph specimens. *Prozercon miraci* sp. nov. is quite similar to *P. buraki* Urhan 2008 and *P. sellnicki* Halašková, 1963. The distinctive morphological features of these three species are shown in Table 2.

Updated identification key for *Prozercon* species reported from Turkey (based on adult females)

1 (30) Marginal setae R_1 pilose, plumose and brush-like.

2 (5) An additional unpaired seta between setae J_4–J_4 usually present.

3 (4) Setae S_3 present .... *P. bircanae* Urhan, 1998

4 (3) Setae S_3 absent .... *P. kurui* Urhan, 1998

5 (2) An additional unpaired seta between setae J_4–J_4 absent.

6 (11) Setae S_3 absent.

7 (8) Podonotal setae different formed: in *j, z, s* and *r* setal rows smooth, pilose and plumose setae present .... *P. balikesirensis* Urhan, 2008

8 (7) All podonotal setae (except setae j_5) pilose or plumose.

9 (10) Marginal setae R_1 pilose or plumose, other *R* setae short and smooth .... *P. yavuzi* Urhan, 1998

10 (9) All marginal setae of opisthonotum pilose or plumose .... *P. erdogani* Urhan, 2010

11 (6) Setae S_3 present.

12 (25) All podonotal setae (except setae j_5) pilose or plumose.

13 (14) Setae R_2–R_4 short, smooth and thorn-like .... *P. morazae* Ujvári, 2011

14 (13) Setae R_2–R_4 long and pilose or plumose.

15 (16) Pores Po_3 situated outside the line connecting setae Z_3–Z_4 .... *P. martae* Ujvári, 2010

16 (15) Pores Po_3 situated inside the line connecting setae Z_3–Z_4.

17 (18) Setae J_6 and Z_5 unilateral pilose or plumose and reaching parallely to tip posterior margin of opisthonotum .... *P. banazensis* Urhan et al. 2015

18 (17) Setae J_6 and Z_5 bilateral pilose or plumose and not reaching parallely to tip posterior margin of opisthonotum.

19 (20) Setae S_1 short and smooth. *P. murati* Urhan, 2013

20 (19) Setae S_1 pilose or plumose.

21 (22) Setae S_2 and S_3 long, plumose and brush-like .... *P. kamili* Urhan and Ayyıldız, 1996

22 (21) Setae S_2 and S_3 short, pilose or delicately barbed.

23 (24) Pores Po_2 situated outside the line connecting setae Z_1–S_2, setae S_4 short and delicately barbed, setae J_3 not reaching the base of setae J_4 ....*P. umidicola* Urhan, 2002

24 (23) Pores Po_2 situated outside the line connecting setae Z_1–S_1, setae S_4 long and brush-like, setae J_3 reaching the base of setae J_4 ....*P. orhani* Urhan and Ayyıldız, 1996

25 (12) Podonotal setae different formed: in *j, z, s* and *r* setal rows smooth, pilose and plumose setae present.

26 (29) Setae R_2–R_5 short and smooth ....*P. giresunensis* Urhan, 2013

27 (28) Setae R_2–R_5 long and plumose.

28 (27) Setae z_2, s_5, S_2 and S_3 smooth .... *P. boyacii* Urhan and Ayyıldız, 1996

29 (26) Setae z_2, s_5, S_2 and S_3 pilose or plumose .... *P. mersinensis* Urhan, 1998

30 (1) Marginal setae R_1 short, smooth and thorn-like.

31 (36) Outer cavities considerably larger than inners.

32 (33) Setae j_2–j_3, s_1–s_4, Z_5 and S_1 short and smooth, S_2 and S_3 short, pilose and not reaching beyond the lateral margin of opisthonotum ....*P. buraki* Urhan, 2008

33 (32) Setae j_2–j_3, s_1–s_4, Z_5 and S_1–S_3 long and plumose, setae S_2 and S_3 reaching beyond the lateral margin of opisthonotum.

34 (35) Podonotal setae j_4, j_6, z_1 pilose or plumose, opisthonotal setae Z_4 pilose or plumose and not reaching to posterior margin of opisthonotum .... *P. sellnicki* Halašková, 1963

35 (34) Podonotal setae j_4, j_6, z_1 smooth, opisthonotal setae Z_4 strongly plumose and brush-like, reaching to posterior margin of opisthonotum .... ***P. miraci* sp. nov.**

36 (31) All dorsal fossae uniform.

37 (40) Setae S_3 absent.

38 (39) Podonotal setae j_3–j_4, j_6, z_1–z_2, s_1–s_5 and opisthonotal setae Z_5 smooth .... *P. celali* Urhan, 2010

39 (38) Podonotal setae j_3–j_4, j_6, z_1–z_2, s_1–s_5 and opisthonotal setae Z_5 pilose or plumose .... *P. denizliensis* Urhan, 2002

40 (37) Setae S_3 present.

41 (44) Setae j_5 pilose or plumose.

42 (43) Postero-lateral tip of peritrematal shield longer and reaching between the bases of marginal setae R_5 and R_6 .... *P. graecus* Ujvári, 2011

43 (42) Postero-lateral tip of peritrematal shield shorter and reaching beyond the bases of marginal setae R_2 .... *P. plumosus* Ivan and Călugăr, 2004

44 (41) Setae j_5 smooth.

45 (46) Sternal shield divided 2 seperate parts . *P. blaszaki* (Urhan and Ayyıldız, 1996)

46 (45) Sternal shield not divided 2 seperate parts.

47 (48) Bases of *J* and *Z* setal rows large and bulb-like .... *P. bulbiferus* Ujvári, 2011

48 (47) Bases of *J* and *Z* setal rows uniform.

49 (50) Setae Z_3 short and not reaching posterior margin of opisthonotum .... *P. tragardhi* (Halbert, 1923)

50 (49) Setae Z_3 long and reaching posterior margin of opisthonotum.

51 (52) Setae r_2 short and smooth, J_1 not reaching the base of setae J_2 .... *P. sultani* Duran and Urhan, 2015

52 (51) Setae r_2 pilose or plumose, J_1 reaching the base of setae J_2 .... *P. satapliae* Petrova, 1977

53 (62) Setae S_1 smooth.

54 (57) Setae S_2 short, smooth and not reaching lateral margin of opisthonotum.

55 (56) Setae Z_5 plumose, z_2 and s_5 short and smooth .... *P. luxtoni* Urhan and Ayyıldız, 1996

56 (55) Setae Z_5 short and smooth, z_2 and s_5 plumose .... *P. turcicus* Urhan and Ayyıldız, 1996

57 (54) Setae S_2 long, plumose and reaching beyond the lateral margin of opisthonotum.

58 (59) Setae Z_1 smooth .... *P. rekaae* Ujvári, 2008

59 (58) Setae Z_5 pilose or plumose.

60 (61) Postero-lateral tip of peritrematal shield shorter and reaching beyond the bases of marginal setae R_4 .... *P. fimbriatus* (C. L. Koch, 1839)

61 (60) Postero-lateral tip of peritrematal shield longer and reaching between the bases of marginal setae R_7 or R_8 .... *P. carpathofimbriatus* Mašán and Fend'a, 2004

62 (53) Setae S_1 pilose or plumose.

63 (64) Setae S_1 with antero-lateral position the base of setae Z_1, pores Po_2 on the line connecting setae S_1–S_2 .... *P. rafalskii* Blaszak, 1971

64 (63) Setae S_1 with postero-lateral position the base of setae Z_1, pores Po_2 situated inside the line connecting setae Z_1–Z_2.

65 (66) Setae r_2 and Z_5 short and smooth .... *P. demirsoyi* Urhan and Ayyıldız, 1996

66 (65) Setae r_2 and Z_5 pilose or plumose.

67 (68) Podonotal setae j_1, z_2, s_5 and r_1–r_7 pilose and plumose, j_2–j_6, z_1, s_1–s_4 short and smooth with needle-like .... *P. artvinensis* Urhan and Ayyıldız, 1996

68 (67) Podonotal setae j_1, j_2, j_6, z_1, s_1, s_2, s_4, s_5 and r_1–r_7 pilose and plumose, j_3–j_5 and s_3 short and smooth .... *P. kafkasoricus* Urhan, 1998

Acknowledgements

Present study was supported by TÜBİTAK with 118Z101 project number. We also thank to Prof. Dr. Şevki ARSLAN (Department of Biology, Pamukkale University, Denizli, Turkey) for his linguistic corrections on manuscript.

REFERENCES

Halašková, V. 1963. On the genus *Prozercon* Sellnick 1943. Acta Societatis Entomologicae Cechosloveniae, 60: 145-169.

Mašán, P. and Fend'a, P. 2004. Zerconid mites of Slovakia (Acari, Mesostigmata, Zerconidae). Slovak Academy of Sciences, Institute of Zoology, Bratislava, 238 pp.

Urhan, R. 2008. Contributions to the genus *Prozercon* Sellnick, 1943 (Acari: Zerconidae) from Turkey, with the description of two new species and a key to species. Zoology in the Middle East, 45: 97-104.

doi: 10.1080/09397140.2008.10638312

Urhan, R. and Duran, E.H. 2019. Zerconid mites (Acari, Zerconidae) in Inner Aegean Region, with a new record for the Turkish fauna. Zootaxa, 4568: 323-336. doi: 10.11646/zootaxa.4568.2.7

Urhan, R., Karaca, M., Duran, E.H., Aksu, B. and Bilki, K. 2019a. A new record of the family Zerconidae (Acari: Mesostigmata) from Turkey: *Prozercon rekaae* Ujvári, 2008. 5th International Conference on Engineering and Natural Science, 12-16 June 2019, Prague, Czech Republic, 100-104.

Urhan, R., Karaca, M., Duran, E.H., Aksu, B. and Bilki, K. 2019b. *Prozercon sellnicki* Halašková, 1963: A new record of zerconid mite (Acari, Zerconidae) for Turkish fauna. 8th International Congress on Mathematics, Engineering, Natural and Health Sciences, 5-8 September 2019, Erzurum, Turkey, 259-260. [In Turkish]

Edited by: Salih Doğan
Reviewed by: Three anonymous referees

Citation: Urhan, R., Karaca, M. and Duran, E.H. 2020. Description of *Prozercon miraci* sp. nov. (Acari: Mesostigmata: Zerconidae) from Coastal Aegean Section in Turkey, with a key to the Turkish species. Acarological Studies, 2 (1): 18-23.

Acarological Studies
Vol 2 (1): 24-33

RESEARCH ARTICLE

Phytoseiid species (Acari: Phytoseiidae) on walnut trees in Samsun Province, Turkey

Şeyma ÇAKIR [1], Marie-Stephane TIXIER [2], Sebahat K. OZMAN-SULLIVAN [1,3]

[1] *Department of Plant Protection, Faculty of Agriculture, Ondokuz Mayıs University, Samsun, Turkey*
[2] *Department of Biology and Ecology, Montpellier SupAgro, Montpellier, France*
[3] Corresponding author: sozman@omu.edu.tr

Received: 31 December 2019 Accepted: 28 January 2020 Available online: 31 January 2020

ABSTRACT: This research was conducted to determine the phytoseiid species on walnut trees in Samsun Province, Turkey in 2018. Most of the surveys were done in unsprayed orchards. A total of nine phytoseiid species were collected - *Euseius finlandicus*, *E. gallicus*, *E. stipulatus*, *Kampimodromus aberrans*, *Neoseiulella tiliarum*, *Phytoseius finitimus*, *Typhlodromus* (*Anthoseius*) *rapidus*, *Typhlodromus* (*Anthoseius*) sp. and *Amblyseius* (*andersoni*?) sp. *Euseius finlandicus* was the most abundant species, followed by *Phytoseius finitimus*. Mite density was twice as high on the lower surface as on the upper surface of leaves. These nine species represent a substantial local genetic resource with the potential to improve the efficacy of biological control programs.

Keywords: Acari, Mesostigmata, Phytoseiidae, walnut, Black Sea

INTRODUCTION

There are 21 known walnut species (Juglandaceae: *Juglans* spp.) worldwide. Of them, *Juglans regia* L. is the best known species and Turkey is one of countries to which it is native (Çelik et al., 2011). Turkey is also a leading walnut growing country, ranking fourth in world production after China, the USA and Iran (Martínez et al., 2010). Areas under walnut production have increased considerably in recent years in Turkey, including the Black Sea region.

Many insects and mites feed on walnut trees (Alaoğlu, 1984; Güçlü et al., 1995; Çevik, 1996; Strand, 2003; Kasap et al., 2008; Canıhoş et al., 2014; Khan et al., 2016). There are also predatory insects and mites in the walnut plantation ecosystem, especially where pesticide use is absent or minimal (Strand, 2003; Kasap et al., 2008, 2009; Kabíček, 2010; Kavianpour et al., 2016). It is essential to document these potential biological control agents because they can contribute to the reduction of pesticide use if strategically applied.

One of the important groups of biological control agents is the phytoseiid mites (Acari: Mesostigmata) (Moraes et al., 2004; Chant and McMurtry 2007; Papadoulis et al., 2009). *Phytoseius persimilis* Athias-Henriot, *Amblyseius swirskii* Athias-Henriot, *Neoseiulus californicus* (McGregor), *N. cucumeris* (Oudemans) and *N. fallacis* (Garman) are effective biological control agents of important pests in many field and greenhouse crops globally (McMurtry et al., 1970; Helle and Sabelis, 1985; Gerson et al., 2003). The successful application of these mites has helped raise the profile of biological control (Zhang, 2003). They also play an important role in preventing outbreaks of various phytophagous mites, especially tetranychid and eriophyoid mites, in natural habitats (Edland and Evans, 1998).

In Turkey, 105 phytoseiid species have been recorded from 21 genera in the subfamilies Amblyseiinae, Phytoseiinae and Typhlodrominae (Döker et al., 2017, 2018, 2019; Döker, 2019; İ. Döker, Adana, Turkey, December 2019, personal communication). Among them, some species, such as *P. persimilis, A. swirskii*, *Euseius stipulatus* (Athias-Henriot), *E. gallicus* Kreiter and Tixier, *N. californicus*, *N. cucumeris* and *Iphiseius degenerans* (Berlese), have been mass reared and released as biological control agents in different parts of the world (Düzgüneş, 1963; Şekeroğlu, 1984; Şekeroğlu and Kazak, 1993; Çobanoğlu, 1989, 1997; Cobanoğlu and Özman, 2002; Çakmak and Çobanoğlu, 2006; Faraji et al., 2011; Döker et al., 2014a,b, 2015a,b).

There have been no studies on phytoseiid mites in walnut orchards in Samsun Province which is in the central Black Sea region in northern Turkey. For that reason, this research was conducted to determine the species present and their abundances in representative orchards in each district.

MATERIALS AND METHODS

This study was conducted in 2018 in walnut orchards in Samsun Province, Turkey. Most of the surveys were done periodically in July, August and September in unsprayed orchards in villages of 17 provincial districts, namely Asarcık, Alaçam, Atakum, Ayvacık, Bafra, Canik, Çarşamba, Havza, İlkadım, Kavak, Ladik, Ondokuzmayıs, Salıpazarı, Tekkeköy, Yakakent, Terme and Vezirköprü (Fig. 1).

Surveys were conducted in 68 orchards, according to the methodologies of Lazarov and Grigorov (1961) and Erkam (1981). Fifty two orchards were unsprayed and 16 orchards were sprayed. The numbers of trees in orchards ranged from 5 to 300 and their ages ranged from 5 to 15 years. A total of 101 samplings were done. In each sampled orchard, a total of one hundred leaves were randomly collected from the lower, middle and upper thirds of the trees while the collector walked in a "Z" pattern. The leaves collected were placed in a labeled plastic bag and kept in an ice-box until brought to the laboratory. They were then refrigerated until each sample was checked for mites with a stereomicroscope. All of the collected mites were mounted on slides with the use of Hoyer's medium. Additionally, one orchard was selected in each of 13 districts and samplings were done monthly for 3 months to determine the population density of phytoseiid mites. For that purpose, the active stages of phytoseiid mites were counted in a 4 cm^2 area on the upper and lower surfaces of 30 randomly selected leaves from each orchard. The identifications of the species were done by the second author, using the generic classifications of Chant and McMurtry (2007).

Figure 1. Districts of Samsun Province (Anonymous, 2019a), Turkey where phytoseiid mite species were surveyed in walnut orchards in 2018.

RESULTS

In this study, phytoseiid mites were collected from 61.40% of the 101 walnut leaf samplings. Nine phytoseiid species from 6 genera were identified from the total of 211 specimens collected. The genus represented by most species was *Euseius* (3), followed by *Typhlodromus* (2), with the remaining four genera each represented by one species (Table 1).

Table 1. Phytoseiid mites and their percentages in walnut orchards in Samsun Province, Turkey in 2018.

Species	%
Euseius finlandicus (Oudemans, 1915)	45.50
Phytoseius finitimus Ribaga, 1904	24.64
Euseius gallicus Kreiter and Tixier, 2009	11.37
Neoseiulella tiliarum (Oudemans, 1930)	7.58
Kampimodromus aberrans (Oudemans, 1930)	4.27
Ambyseius (andersoni?) sp.	2.84
Euseius stipulatus (Athias-Henriot, 1960)	2.37
Typhlodromus (*Anthoseius*) sp.	0.95
Typhlodromus (*Anthoseius*) *rapidus* Wainstein and Arutunjan, 1968	0.47

Euseius finlandicus was the most abundant species (45.50%), followed by *P. finitimus* (24.64%) and *E. gallicus* (11.37%); more than two thirds of all the specimens (70.14%) were from the two most abundant species. At the other end of the abundance scale, the least common species were *Typhlodromus* (*Anthoseius*) sp. (0.95%) and *T.* (*Anthoseius*) *rapidus* (0.47%).

The phytoseiid distribution on walnut leaves was also determined in this study. The total number of phytoseiids on the lower leaf surface (68.01%) was more than double the number on the upper leaf surface (31.98%). In Table 2, the mean phytoseiid densities on both leaf surfaces are shown.

Table 2. The mean numbers of phytoseiid mites on walnut leaf surfaces in Samsun Province, Turkey in 2018.

Month	Mean number of mites / 4 cm^2	
	Upper surface	Lower surface
July	0.111	0.233
August	0.097	0.228
September	0.151	0.312

Species:

***Amblyseius* (*andersoni*?) sp.**

Typhlodromus andersoni Chant, 1957

Amblyseius potentillae (Garman, 1958)

Material examined: A total of 6 *Amblyseius* specimens, all males, were collected - Samsun, Ayvacık, Söğütpınar (41°03'57.1"N 36°38'34.3"E), 28.07.2018, 1♂; Ayvacık, Yenice (41°03'18.5"N 36°39'02.8"E), 14.09.2018, 1♂; Canik, Demirciler (41°14'17.7"N 36°15'18.9"E), 15.08.2018, 1♂; Kavak, Bahçelievler (41°04'23.8"N 36°02'43.3"E), 16.08.2018, 1♂; Ladik, Salur (40°59'54.4"N 35°53'20.3"E), 17.08.2018, 1♂; Terme, Sarayköy (41°11'46.8"N 36°57'39.9"E), 30.07.2018, 1♂.

Comments: As only males were collected, identification could not be accurately made to species level but the specimens might be *Amblyseius andersoni* (Chant, 1957) which is very common in the study area. *Amblyseius andersoni* has been recorded from more than 30 countries, including France, Greece, Italy, Syria and the USA (Tixier et al., 1998; Kabíček, 2010; Demite et al., 2014). In Turkey, it has been reported from different plants, including apple, persimmon and hazelnut, in different regions (Çobanoğlu, 1993, 2008; Ozman and Cobanoğlu, 2001; Akyazı and Ecevit, 2003; Bayram and Çobanoğlu, 2007; Ozsisli and Çobanoğlu, 2011; Yesilayer and Çobanoğlu, 2011; Kasap et al., 2013; Satar et al., 2013; Kumral and Çobanoğlu, 2015; Çobanoğlu and Kumral, 2016; Akyazı et al., 2017; Çobanoğlu and Güldali, 2017; Soysal and Akyazı, 2018). As prey, this species prefers spider mites to eriophyoid mites (Dicke et al., 1988).

***Euseius finlandicus* (Oudemans, 1915)**

Seiulus finlandicus Oudemans, 1915

Typhlodromus pruni Oudemans, 1929

Typhlodromus finlandicus Oudemans, 1929

Amblyseius finlandicus Wainstein, 1962

Material examined: *Euseius finlandicus* was the most abundant species collected in this study. The number of females was much higher than the number of males (81♀♀ and 15♂♂) - Samsun, Atakum, Güzelyurt (41°24'19.6"N 36°10'00.9"E), 25.07.2018, 1♂, 2♀♀; Çarşamba, Hacılıçay (41°14'08.9"N 36°41'27.2"E), 25.07.2018, 3♀♀; Yakakent, Kozköy (41°37'34.5"N 35°32'51.9"E), 27.07.2018, 2♂♂; 17.08.2018, 2♀♀; Ayvacık, Söğütpınar (41°03'57.1"N 36°38'34.3"E), 28.07.2018, 1♀; 15.09.2018, 1♀; Ondokuzmayıs, Çetirlipınar (41°28'32.7"N 36°02'12.4"E), 30.07.2018, 1♂; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 30.07.2018, 5♀♀; 17.08.2018, 3♀♀; Tekkeköy, Sepetçiler (41°12'07.3"N 36°26'34.9"E), 17.09.2018, 1♀; Alaçam, Akgüney (41°31'46.0"N 35°43'27.9"E), 31.07.2018, 2♀♀; 17.09.2018, 3♀♀; Vezirköprü, Köprübaşı (41°03'11.9"N 35°30'57.8"E), 31.07.2018, 2♀♀, 1♂; Vezirköprü, Yeniçelik (41°03'40.8"N 35°30'20.2"E), 31.07.2018, 3♀♀; Vezirköprü, Pazarcı (41°04'19.5"N 35°29'52.2"E), 31.07.2018, 2♀♀; Havza, Yenice (41°03'40.8"N 35°30'20.2"E), 31.07.2018, 2♀♀; Ondokuzmayıs, Tepeköy (41°30'33.4"N 36°01'50.4"E), 31.07.2018, 1♂; Ondokuzmayıs, Yukarı Engiz (41°28'56.6"N 36°03'28.9"E), 17.08.2018, 1♀; 17.09.2018, 3♀♀; Canik, Demirciler (41°14'17.7"N 36°15'18.9"E), 15.08.2018, 1♀, 1♂; Alaçam, Alparslan (41°36'53.1"N 35°36'21.2"E), 17.08.2018, 1♂; Alaçam, Soğukçam (41°36'09.0"N 35°45'06.7"E), 17.08.2018, 5♀♀; Terme, Sarayköy (41°11'46.8"N 36°57'39.9"E), 18.08.2018, 1♀, 2♂♂; 13.09.2018, 1♀; Salıpazarı, Cevizli (41°03'19.4"N 36°54'46.8"E), 14.09.2018, 1♀; Salıpazarı, Kuşcuğaz (41°04'54.7"N 36°52'40.3"E), 14.09.2018, 2♀♀; Vezirköprü, Çakırtaş (41°08'09.1"N 35°29'02.2"E), 15.09.2018, 6♀♀, 3♂♂; Vezirköprü, Esentepe (41°06'47.9"N 35°09'02.3"E), 16.08.2018, 2♀♀; Havza, Yazıkışla (41°01'24.2"N 35°35'11.9"E), 29.07.2018, 2♀♀; 16.08.2018, 1♀; 15.09.2018, 7♀♀; Havza, Şeyhli (41°07'45.2"N 36°52'53.0"E), 16.08.2018, 1♀; Havza, Ortaklar (41°01'39.5"N 35°33'45.0"E), 15.09.2018, 2♀♀, 1♂; Ladik, Ayvalı (41°06'47.9"N 35°09'02.3"E), 12.09.2018, 2♀♀; Vezirköprü, Meşeli (41°04'45.8"N 35°29'56.5"E), 15.09.2018, 1♀, 1♂; Bafra, Gökçekent (41°33'05.0"N 35°51'31.1"E), 31.07.2018, 3♀♀; 17.08.2018, 1♀; 17.09.2018, 3♀♀; Bafra, Kozağzı (41°28'58.3"N 35°49'32.7"E), 17.09.2018, 3♀♀.

Comments: *Euseius finlandicus* is a common species on decidious trees (McMurtry and Croft, 1997). It has been reported from New Zealand, Hungary, Serbia, Italy, France, Japan and the USA (Collyer, 1980; Ripka et al., 2013; Demite et al., 2014). It has been collected from almost every region in Turkey and on different plants, including apple, citrus, grape, hazelnut, pear and walnut (Swirski and Amitai, 1982; Düzgüneş and Kılıç, 1983; Şekeroğlu, 1984; Ozman and Cobanoğlu, 2001; Çobanoğlu, 2004; İncekulak and Ecevit, 2002; Yanar and Ecevit, 2005; Kasap et al., 2008, 2009; Denizhan and Çobanoğlu, 2009; Ozsisli and Çobanoğlu, 2011; Yeşilayer and Çobanoğlu, 2011; Satar et al., 2013; Kumral and Çobanoğlu, 2015; Akyazı et al., 2016, 2017; Çobanoğlu and Güldali, 2017; Soysal and Akyazı, 2018). This species is included in the type IV classification of McMutry and Croft (1997), which means that it is a specialized pollen feeder/generalist predator (McMurtry, 1983; McMurtry and Croft, 1997). It can feed on tetranychid, eriophyid, tyroglyphid and tarsonemid mites, pollen, fungal spores and hyphae, the eggs and larvae of insects, honeydew and plant liquids (Schausberger, 1992; Kostiainen and Hoy, 1994; Abdallah et al., 2001).

***Euseius gallicus* Kreiter and Tixier, 2009**

Material examined: The twenty four *E. gallicus* females found in this study were all on the lower leaf surface - Samsun, Kavak, Kayaköy (41°05'46.5"N 36°01'21.3"E), 28.07.2018, 1♀; Havza, Yazıkışla (41°01'24.2"N 35°35'11.9"E), 29.07.2018, 1♀; Salıpazarı, Alan (41°03'47.7"N 36°47'09.5"E), 30.07.2018, 2♀♀; 18.08.2018, 1♀; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 30.07.2018, 1♀; Vezirköprü, Yenice (41°03'40.8"N 35°30'20.2"E), 31.07.2018, 3♀♀; Vezirköprü, Pazarcı (41°04'19.5"N 35°29'52.2"E), 31.07.2018, 1♀; Alaçam, Soğukçam (41°36'09.0"N 35°45'06.7"E), 17.08.2018, 2♀♀; İlkadım, Kapaklı (41°16'12.9"N 36°11'22.3"E), 12.09.2018, 1♀; Ayvacık, Söğütpınar (41°03'57.1"N 36°38'34.3"E), 14.09.2018, 3♀♀; Alaçam, Geyikkoşan (41°37'12.6"N 35°36'28.7"E), 17.09.2018, 1♀; Bafra, Gökçekent (41°33'05.0"N 35°51'31.1"E), 17.09.2018, 3♀♀; Ondokuzmayıs, Yukarı Engiz (41°28'56.6"N 36°03'28.9"E), 17.09.2018, 3♀♀; Tekkeköy, Sepetçiler (41°12'07.3"N 36°26'34.9"E), 18.09.2018, 1♀.

Comments: *Euseius gallicus* was first found and identified in France from the leaves of large-leaved summer linden (*Tilia platyphyllos* Scopoli), sour cherry (*Prunus cerasus* L.), horse chestnut (*Aesculus hippocastanum* L.), laurustinus (*Viburnum tinus* L.) and grape (*Vitis vinifera* L.) in 2009 (Tixier et al., 2009). Later, it was found on *Tilia cordata* (Miller) in Belgium, *Lycium barbarum* L. in Germany, *Rosa* sp. cv. Red Naomi in Holland and *Ipomea* sp. in Trabzon, Turkey (Döker et al., 2014b), and on *Capsicum annuum* L., *Phaseolus vulgaris* L. and *Cucumis sativus* L. in Ordu, Turkey (Soysal and Akyazı, 2018). This study reports this species for the first time on walnut trees in Turkey. *Euseius* species are pollen feeding, type IV generalist predators (McMurtry and Croft, 1997). *Euseius gallicus* has shown potential as a biocontrol agent for western flower thrips and whiteflies on roses when *Typha* sp. (cattail) pollen is supplied as an additional food source (Wackers, 2013). It has been commercially produced since 2014 (Anonymous, 2019b).

***Euseius stipulatus* (Athias-Henriot, 1960)**

Amblyseius stipulatus Athias-Henriot, 1960

Amblyseius (*Amblyseius*) *stipulatus* Ueckermann and Loots, 1988

Material examined: Five females of this species were found on the undersurface of leaves, and only in August - Samsun, Çarşamba, Hacılıçay (41°14'08.9"N 36°41'27.2"E), 17.08.2018, 1♀; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 17.08.2018, 1♀; Terme, Sarayköy (41°11'46.8"N 36°57'39.9"E), 18.08.2018, 2♀♀; Salıpazarı, Cevizli (41°03'19.4"N 36°54'46.8"E), 18.08.2018, 1♀.

Comments: *Euseius stipulatus* is a common predatory mite found mainly in southern Europe (Athias-Henriot, 1960; Mijuskovic and Tomasevic, 1975; Ragusa and Swirski, 1976; McMurtry, 1977; Ferragut et al., 1983). It has been reported from apple, citrus and vegetable orchards in Turkey (McMurtry, 1977; Çobanoğlu, 1989; Satar et al., 2013; Çobanoğlu and Güldali, 2017). This type IV pollen feeding generalist predator can feed on tetranychid mites (McMurtry, 1977; McMurtry and Croft, 1997), especially on *Panonyhus citri* McGregor in citrus orchards (Ferragut et al., 1992). It was introduced to Peru to control *P. citri* and it is now produced commercially for the control of that pest (Aguirre-Gil et al., 2013).

Kampimodromus aberrans **(Oudemans, 1930)**

Typhlodromus aberrans Oudemans, 1930

Typhlodromus (*Typhlodromus*) *aberrans* Beglyarov, 1957

Amblyseius aberrans Athias-Henriot, 1958

Typhlodromus (*Amblyseius*) *aberrans* Chant, 1959

Paradromus aberrans Muma, 1961

Amblyseius (*Kampimodromus*) *aberrans* Pritchard and Baker, 1962

Amblyseius (*Amblyseius*) *aberrans* Tseng, 1976

Kampimodromus aberrans [sic] Kolodochka, 1978 and 1998

Kampimodromus (*Kampimodromus*) *aberrans* Karg, 1983

Kampimodromus aberrans Moraes et al., 2004

Material examined: Nine individuals of this species were collected, and only in Yakakent district - Yakakent, Kozköy (41°37'34.5"N 35°32'51.9"E), 27.07.2018, 2♀♀, 2♂♂; 17.08.2018, 5♀♀.

Comments: *Kampimodromus aberrans* has been collected from different plants, including *Corylus avellana* L., *Diospyrus kaki* L., *Fagus sylvatica* L., *Ficus carica* L., *Morus nigra* L., *Quercus cerris* L., *Malva* sp., *Rosa* sp. and *Sorbus* sp. in different countries (Ragusa and Tsolakis, 1994). It was later recorded on various plants, namely hazelnut, walnut, apple, pear, loquat and rose, in different parts of Turkey (Ozman-Sullivan, 2006; Kasap et al., 2008, 2009; Faraji et al., 2011; Ozsisli and Çobanoğlu, 2011; Yesilayer and Çobanoğlu, 2011; Satar et al., 2013). *Kampimodromus aberrans* is categorized as a generalist predator (Type III). This mite feeds readily on pollen and extracts liquid from leaves (McMurtry and Croft, 1997). It also feeds on tetranychid mites (Tixier et al., 1998; Kasap, 2005, 2019; Lorenzon et al., 2012; Duso et al., 2014; Akyazı et al., 2017; Soysal and Akyazı, 2018) and eriophyoid mites (Duso and de Lillo, 1996); it was observed feeding on *Phytoptus avellanae* Nalepa in hazelnut orchards in Samsun Province, Turkey (Ozman-Sullivan, 2006).

Neoseiulella tiliarum **(Oudemans, 1930)**

Typhlodromus tiliarum Oudemans, 1930

Material examined: Sixteen individuals of this species were found - Samsun, Ladik, Ayvalı (41°24'19.6"N 36°10'00.9"E), 28.07.2018, 1♀; Havza, Yazıkışla (41°01'24.2"N 35°35'11.9"E), 29.07.2018, 2♀♀; Vezirköprü, Esentepe (41°06'47.9"N 35°09'02.3"E), 16.08.2018, 2♀♀; Bafra, Gökçekent (41°33'05.0"N 35°51'31.1"E), 17.08.2018, 1♀; Çarşamba, Hacılıçay (41°14'08.9"N 36°41'27.2"E), 17.08.2018, 1♂; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 17.08.2018, 1♀; Salıpazarı, Alan (41°03'47.7"N 36°47'09.5"E), 18.08.2018, 1♀; Terme, Söğütlü (41°13'22.0"N 36°51'45.7"E), 18.08.2018, 1♀; Ladik, Salur (40°59'54.4"N 35°53'20.3"E), 12.09.2018, 1♀; Terme, Sarayköy (41°11'46.8"N 36°57'39.9"E), 13.09.2018, 1♀; Ayvacık, Söğütpınar (41°03'57.1"N 36°38'34.3"E), 14.09.2018, 1♀; Havza, Ortaklar (41°01'39.5"N 35°33'45.0"E), 15.09.2018, 1♂; Alaçam, Akgüney (41°31'46.0"N 35°43'27.9"E), 17.09.2018, 1♀; Tekkeköy, Sepetçiler (41°12'07.3"N 36°26'34.9"E), 18.09.2018, 1♀.

Comments: *Neoseiulella tiliarum* was found on linden trees in Germany (Oudemans, 1930). Nesbitt (1951) recorded it on apple, linden and pear trees in Canada. More recently, it has been found in many countries, including Turkey, on different plants (Swirski and Amitai 1982; Düzgüneş and Kılıç, 1983; Denmark and Rather, 1996). It feeds on tetranychid and eriophyoid mites (Jeppson et al., 1975; Kozlowski and Kozlowska, 1991).

Phytoseius finitimus **Ribaga, 1904**

Phytoseius (*Dubininellus*) *finitimus* Wainstein, 1959

Phytoseius finitimus Chant, 1959

Phytoseius (*Pennaseius*) *finitimus* Pritchard and Baker, 1962

Pennaseius finitimus Schuster and Pritchard, 1963

Phytoseius (*Phytoseius*) *finitimus* Denmark, 1966

Material examined: Fifty two individuals of this species were found, on the underside of the leaves - Samsun, Atakum, Güzelyurt (41°24'19.6"N 36°10'00.9"E), 25.07.2018, 1♀, 1♂; 17.09.2018, 2♀♀; Çarşamba, Hacılıçay (41°14'08.9"N 36°41'27.2"E), 25.07.2018, 1♀; Ondokuzmayıs, Çetirlipınar (41°28'32.7"N 36°02'12.4"E), 30.07.2018, 2♀♀; 17.09.2018, 2♀♀; Alaçam, Alparslan (41°36'53.1"N 35°36'21.2"E), 30.07.2018, 1♂;

17.09.2018, 2♀♀; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 30.07.2018, 1♀; Alaçam, Akgüney (41°31'46.0"N 35°43'27.9"E), 31.07.2018, 1♂; Ondokuzmayıs, Erenköy (41°26'23.6"N 36°08'12.0"E), 31.07.2018, 1♀; Ondokuzmayıs, Tepeköy (41°30'33.4"N 36°01'50.4"E), 31.07.2018, 4♀♀; Yakakent, Kozköy (41°37'34.5"N 35°32'51.9"E), 17.08.2018, 4♀♀, 2♂♂; Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 17.08.2018, 4♀♀; Ayvacık, Yenice (41°03'18.5"N 36°39'02.8"E), 18.08.2018, 1♂; Terme, Sarayköy (41°11'46.8"N 36°57'39.9"E), 18.08.2018, 4♀♀; Terme, Şeyhli (41°07'45.2"N 36°52'53.0"E), 18.08.2018, 2♀♀; Ondokuzmayıs, Yukarı Engiz (41°28'56.6"N 36°03'28.9"E), 17.08.2018, 6♀♀; 17.09.2018, 1♀; Bafra, Gökçekent (41°33'05.0"N 35°51'31.1"E), 17.08.2018, 1♂; 17.09.2018, 3♀♀; Vezirköprü, Köprübaşı (41°03'11.9"N 35°30'57.8"E), 15.09.2018, 1♀; Alaçam, Geyikkoşan (41°37'12.6"N 35°36'28.7"E), 17.09.2018, 1♀; Tekkeköy, Sepetçiler (41°12'07.3"N 36°26'34.9"E), 18.09.2018, 3♀♀.

Comments: This species is common in the USA, central and northern Europe, and Mediterranean countries (Peverieri et al., 2009; Miñarro and Kreiter, 2012). It has been reported from different plants in different parts of Turkey (Şekeroğlu, 1984; Faraji et al., 2011; Ozsisli and Çobanoğlu, 2011; Yeşilayer and Çobanoğlu, 2011; Kumral and Çobanoğlu, 2015; Akyazı et al., 2016; Çobanoğlu and Güldali, 2017; Soysal and Akyazı, 2018). Öksüz (2019) collected this species from beans, cucumbers, eggplants and potatoes on the Çarşamba and Bafra plains of Samsun Province, Turkey. *Phytoseius finitimus* is a generalist predator that feeds on eriophyid and tetranychid mites, other small arthropods and pollen (Jeppson et al., 1975; Pappas et al., 2013).

***Typhlodromus* (*Anthoseius*) *rapidus* Wainstein and Arutunjan, 1968**

Typhlodromus (*Neoseiulus*) *rapidus* Arutunjan (1970)

Mumaseius rapidus Abbasova (1972)

Anthoseius (*Amblydromellus*) *rapidus* Arutunjan (1977)

Anthoseius rapidus Beglyarov (1981)

Amblydromella rapida Moraes et al. (1986)

Material examined: Only one specimen of this species was found - a female on the lower leaf surface - Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E) on 17.08.2018.

Comments: *Typhlodromus* (*Anthoseius*) *rapidus* was first found on apple and oak trees in Russia (Wainstein and Arutunjan, 1968). Later it was reported from *Betula* spp. and *Quercus* spp. in Latvia (Salmane and Petrova, 2002). It was first collected in Turkey by Çobanoğlu (1997) on *Coryllus* sp. in İzmit. In the current study, it was found on walnut trees in Turkey for the first time. The *Typhlodromus* species are included in the type III classification of McMutry and Croft (1997).

***Typhlodromus* (*Anthoseius*) sp.**

Material examined: Only two males of this unidentified *Typhlodromus* species were collected - Samsun, Tekkeköy, Aşağıçinik (41°11'36.1"N 36°29'00.7"E), 17.08.2018, 1♂; Terme, Şeyhli (41°07'45.2"N 36°52'53.0"E), 18.08.2018, 1♂.

DISCUSSION

A total of nine phytoseiid species were recorded in this study. This relatively high number of phytoseiid species indicates that walnut orchards in the Black Sea region, particularly unsprayed orchards, provide suitable habitat for the establishment and maintenance of phytoseiid diversity. To date, there have been few studies on phytoseiid mites in walnut orchards in Turkey. This study represents the first in the Black Sea region on this subject. Kasap et al. (2008, 2009) recorded *E. finlandicus*, *K. aberrans*, *Paraseiulus soleiger* (Ribaga) and *Typhlodromus* (*Anthoseius*) *bagdasarjani* Wainstein and Arutunjan in walnut orchards in the Van Lake basin in eastern Turkey. Of them, *E. finlandicus* was common, especially in unsprayed orchards, and was observed feeding on harmful mites. Denizhan and Çobanoğlu (2009) investigated the eriophyoid mites and their predators in walnut orchards in Ankara Province of Turkey. In that study, *E. finlandicus* was observed feeding on eriophyoid mites. In another study on parks and green areas, Gökçe (2015) found *E. finlandicus* on walnut trees in Tekirdağ Province in northwestern Turkey. *Euseius finlandicus* was also found in *Amphitetranychus viennensis* (Zacher) colonies on walnut leaves in Iran (Rahmani et al., 2010). In another study in Iran on the distribution of phytoseiid mites, *E. finlandicus, E. amissibilis* Meshkov and *Euseius* sp. were observed feeding on the eriophyid mite, *Aceria erinea* (Nalepa), in walnut plantations (Hajizadeh and Mortazavi, 2015).

Kabíček (2010) studied the population densities of phytoseiid mites on walnut trees, especially uncultivated and unsprayed trees, in summer in the Central Bohemia region of the Czech Republic. In that study, 8 phytoseiid species were collected, namely *A. andersoni, E. finlandicus, Neoseiulella aceri* (Collyer), *N. tiliarum, Typhlodromus* (*T.*) *cotoneastri* Wainstein, *Typhlodromus* (*T.*) *pyri* Scheuten, *Paraseiulus triporus* (Chant and Yoshida-Shaul) and *Phytoseius turiacus* Wainstein and Kolodochka, and their mean combined density was 1.4 mites per leaflet. Of the eight species, *E. finlandicus* (34.8%) was the most abundant species, as in the current study. Another study was conducted in the Kashmir valley of India to determine the distribution and population densities of phytoseiid mites. The highest mean number of phytoseiids per leaf was recorded for *E. pruni* (=*E. finlandicus*) (5.3), followed by *Amblydromella* sp. (5.0) and *E. vignus* Rishi and Rather (4.0), and the lowest mean number was recorded for *Anystis baccarum* (L.) (1.5) (Rather et al., 2015). Sudo and Osakabe (2011) reported that many mite taxa commonly prefer to live on the lower leaf surfaces of wild vegetation. In the current study, the monthly mean phytoseiid numbers on the lower leaf surfaces were slightly more than twice the numbers on the upper leaf surfaces.

Some studies have demonstrated the efficacy of phytoseiid mites against spider mites in walnut plantations. In a study by Welter et al. (2011), *Galendromus occidentalis* (Nesbitt) was released to control *Tetranychus* spp. in walnut plantations in the King region of California. During the same study, *Amblyseius similoides* Buchellos and Pritchard and *Euseius* sp. were also observed in the plantations. The authors stated that *G. occidentalis* successfully controlled the spider mites. In another study, Mills et al. (2013) reported that the spider mite, *Tetranychus urticae* Koch, had become a secondary pest in walnut plantations in California and that *G. occidentalis* and *N. californicus* were effective predators. *Amblyseius similoides*, *E. stipulatus, E. quetzali* McMurtry, *E. tularensis* Congdon, *Metaseiulus* (*Metaseiulus*) *citri* (Garman and McGregor) and *Typhlodromus* (*Anthoseius*) *caudiglans* Schuster were also found in the plantations. In addition, Khan et al. (2016) reported that in walnut plantations in India, *T. urticae* could be controlled by *G. occidentalis*, if the pest population was not too high.

CONCLUSIONS

The high natural diversity of phytoseiid mites in the mostly unsprayed walnut orchards in Samsun Province in the Black Sea region of Turkey may include additional genetic diversity that could be usefully incorporated in IPM and organic control programs in tree crops, field crops and shadehouses.

Acknowledgements

This study was supported by the Scientific Research Foundation of Ondokuz Mayıs University, Samsun, Turkey (Project number: PYO.ZRT.1904.18.010). The authors also thank Dr. Gregory T. Sullivan for both comments and proofreading of this manuscript.

REFERENCES

Abdallah, A.A., Zhang, Z-Q., Masters, G.J. and Mcneill, S. 2001. *Euseius finlandicus* (Acari: Phytoseiidae) as a potential biocontrol agent against *Tetranychus urticae* (Acari: Tetranychidae): life history and feeding habits on three different types of food. Experimental and Applied Acarology, 25 (10-11): 833-847. doi: 10.1023/A:1020431531446

Aguirre-Gil, O.J., Jorge, S.J. and Busoli, A.C. 2013. Controle biologico classico na America Latina: o caso do Peru. In: Topicos em entomologia agricola-VI. Busoli, A.C., de Alencar J.R.C.C., Fraga, D.F., de Souza L.A., de Souza B.H.S. and Grigolli J.F.J. (Eds). Grafica Multipress, Jaboticabal-SP, Brazil, 66-75.

Akyazı, F. and Ecevit, O. 2003. Determination of mite species in hazelnut orchards in Samsun, Ordu and Giresun provinces. Anadolu Journal of Agricultural Sciences, 18 (3): 39-45. [In Turkish]

Akyazı, R., Ueckermann E.A., Akyol, D. and Soysal, M. 2017. Distribution of mite species (Acari) on persimmon trees in Turkey (Ordu), with one newly recorded mite species and one re-described species. International Journal of Acarology, 43: 563-581. doi: 10.1080/01647954.2017.1373149

Akyazı, R., Ueckermann, E.A., Soysal, M. and Akyol, D. 2016. Population dynamics of mites (Acari) on *Diospyros kaki* Thunb. and *Diospyros lotus* L. (Ebenaceae) trees in Ordu, Turkey. Systematic and Applied Acarology, 21 (10): 1334-1346. doi: 10.11158/saa.21.10.4

Alaoğlu, Ö. 1984. Erzurum ve Erzincan yörelerindeki bazı bitkilerde bulunan Eriophyoidea (Acarina: Actinedida) akarlarının sistematiği ve zarar şekli üzerinde çalışmalar. Atatürk Üniversitesi Ziraat Fakültesi Dergisi, 15 (3-4): 1-16. [In Turkish]

Anonymous. 2019a. Samsun'un ilçeleri. Available from: https://www.wikiwand.com/tr/Samsun%27un_il%C3%A7eleri (Last accessed: 24 November 2019).

Anonymous. 2019b. Biobest introduces Dyna-mite®: a new predatory mite strategy in rose. Available from: https://www.biobestgroup.com/en/page/288149/undefined (Last accessed: 04 December 2019).

Athias-Henriot, C. 1960. *Nouveaux amblyseius* d'Algerie (Parasitiformes, Phytoseiidae). Acarologia, 2: 288-299.

Bayram, Ş. and Çobanoğlu, S. 2007. Mite fauna (Acari: Prostigmata, Mesostigmata, Astigmata) of coniferous plants in Turkey. Turkish Journal of Entomology, 31 (4): 279-290.

Canıhoş, E., Öztürk, N., Sütyemez, M., Toker, D.S. and Hazır, A. 2014. Ceviz. TÜBİTAK Tarım, Orman ve Veterinerlik Araştırma Grubu Yayını, Adana, 69 pp. [In Turkish]

Collyer, E. 1980. Phytoseiidae (Acari) from the Pacific Islands. New Zealand Entomologist, 7: 138-139. doi: 10.1080/00779962.1980.9722356

Chant, D.A. and McMurtry, J.A. 2007. Illustrated keys and diognoses for the genera and subgenera of the Phytoseiidae of the world (Acari: Mesostigmata). Indira Publishing House, West Bloomfield, USA, 219 pp.

Çakmak, I. and Çobanoğlu, S. 2006. *Amblyseius californicus* (McGregor, 1954) (Acari: Phytoseiidae), a new record for the Turkish fauna. Turkish Journal of Zoology, 30: 55-58.

Çelik, F., Cimrin, K.M. and Kazankaya, A. 2011. Some physical and chemical characteristics of promising walnuts (*Juglans regia* L.) genotypes selected from Tavas (Denizli). Yuzuncu Yil University Journal of Agricultural Sciences, 21 (1): 42-48. [In Turkish]

Çevik, T. 1996. Faunistic studies on the harmful and beneficial insects on walnuts in central Anatolia. Plant Protection Bulletin, 36 (1-2): 55-72. [In Turkish]

Çobanoğlu, S. 1989. Determination of the Phytoseiidae (Acarina: Mesostigmata) species from vegetable growing areas of Antalya. Plant Protection Bulletin, 29 (1-2): 47-64. [In Turkish]

Çobanoğlu, S. 1993. Systematic studies on the Phytoseiidae (Acarina) species, found in the apple growing areas of Turkey I. Turkish Journal of Entomology, 17 (1): 41-54. [In Turkish]

Çobanoğlu, S. 1997. New phytoseiid mites (Acarina: Mesostigmata) for Turkish fauna. Turkish Journal of Agriculture and Forestry, 21 (4): 361-370.

Çobanoğlu, S. 2004. Phytoseiid mites (Mesostigmata: Phytoseiidae) of Thrace, Turkey. Israel Journal of Entomology, 34: 83-107.

Çobanoğlu, S. 2008. Mites (Acari) associated with stored apricots in Malatya, Elazığ and İzmir provinces of Turkey. Turkish Journal of Entomology, 32 (1): 3-20.

Çobanoğlu, S. and Güldali, B. 2017. Plant parasitic and predatory mites (Acari: Tetranychidae, Phytoseiidae) and population density fluctuation of two-spotted spider mite (*Tetranychus urticae* Koch) on strawberry in the Mersin Province of Turkey. Research & Reviews: Journal of Zoological Sciences, 5 (2): 57-67.

Çobanoğlu, S. and Kumral, N.A. 2016. The biodiversity, density and population trend of mites (Acari) on *Capsicum annuum* L. in temperate and semi-arid zones of Turkey. Systematic and Applied Acarology, 21 (2): 907-918.
doi: 10.11158/saa.21.7.5

Cobanoglu, S. and Özman, S.K. 2002. Beneficial mite species of hazelnut orchard ecosystems from the Black Sea Region of Turkey. Proceedings of the 2nd Meeting of WG 4: Prague 30-31st May 2002, Bio-control of Arthropod Pests in the Stored Products, 91-99.

Denizhan, E. and Çobanoğlu, S. 2009. Eriophyid mites of walnut trees (*Juglans regia* L.) and their predators in Ankara. Yuzuncu Yil University Journal of Agricultural Sciences, 19 (1): 33-37. [In Turkish]

Denmark, H.A. and Rather, A.Q. 1996. Revision of the genus *Neoseiulella* Muma (Acari: Phytoseiidae). International Journal of Acarology, 22 (1): 43-77.
doi: 10.1080/01647959608684080

Demite, P.R., Mcmurtry, J.A. and De Moraes, G.J. 2014. Phytoseiidae database: a website for taxonomic and distributional information on phytoseiid mites (Acari). Zootaxa, 3795: 571-577.
doi: 10.11646/zootaxa.3795.5.6

Dicke, M., Sabelis, M.W. and de Jong, M. 1988. Analysis of prey preference in phytoseiid mites by using an olfactometer, predation models and electrophoresis. Experimental and Applied Acarology, 5: 225-241.
doi: 10.1007/BF02366096

Döker, İ. 2019. First report of *Neoseiulus cinctutus* (Livshitz and Kuznetsov) for Turkey, with an identification key for Turkish *Neoseiulus* Hughes (Acari: Phytoseiidae). Turkish Journal of Biological Control, 10 (1): 73-81.
doi: 10.31019/tbmd.540500

Döker, İ., Kazak, C. and Karut, K. 2015a. A new species and two new records of the family Phytoseiidae (Acari: Mesostigmata) from Turkey. Zootaxa, 3918: 439-445.
doi: 10.11646/zootaxa.3918.3.8

Döker, İ., Yalçın, K. and Kazak, C. 2015b. Phytoseiidae (Acari: Mesostigmata). Available http://www.biyolojikmucadele.org.tr/uploads/Phytoseiidae.pdf (Last accessed: 19 December 2019). [In Turkish]

Döker, İ., Kazak, C. and Karut, K. 2017. Three new species of the family Phytoseiidae (Acari: Mesostigmata) from Turkey. Zootaxa, 4243 (3): 565-576.
doi: 10.11646/zootaxa.4243.3.8

Döker, İ., Kazak, C. and Karut, K. 2018. Phytoseiid mites (Acari: Phytoseiidae) of Turkey: from past to present. Abstracts Book of XV International Congress of Acarology, 2-8 September 2018, Antalya, Turkey, p. 177.

Döker, İ., Kazak, C. and Karut, K. 2019. The genus *Graminaseius* Chant and McMurtry (Acari: Phytoseiidae) in Turkey with descriptions of two new species and re-description of *Graminaseius graminis* (Chant). Systematic and Applied Acarology, 24 (5): 731-741.
doi: 10.11158/saa.24.5.2

Döker, İ., Stathakis, T.I., Kazak, C., Karut, K. and Papadoulis, G.Th. 2014a. Four new records and two new species of Phytoseiidae (Acari: Mesostigmata) from Turkey, with a key to the Turkish species. Zootaxa, 3827: 331–342.
doi: 10.11646/zootaxa.3827.3.3

Doker, I., Witters, J., Pijnakker, J., Kazak, C., Tixier, M.-S. and Kreiter, S. 2014b. *Euseius gallicus* Kreiter and Tixier (Acari: Phytoseiidae) is present in four more countries in Europe: Belgium, Germany, the Netherlands and Turkey. Acarologia, 54 (3): 245-248.
doi: 10.1051/acarologia/20142132

Duso, C. and de Lillo, E. 1996. Grape. In: Eriophyoid mites: their biology, natural enemies and control. Lindquist, E.E., Sabelis M.W. and Bruin, J. (Eds). Elsevier, Amsterdam, The Netherlands, 571-582.

Duso, C., Ahmad, S., Trello, P., Pozzebon, A., Klaric, V., Baldessari, M., Malagnini, V. and Angeli, G. 2014. The impact of insecticides applied in apple orchards on the predatory mite *Kampimodromus aberrans* (Acari: Phytoseiidae). Experimental and Applied Acarology, 62: 391-414.
doi: 10.1007/s10493-013-9741-3

Düzgüneş, Z. 1963. Türkiye'de yeni bulunan akarlar (The mite species newly found in Turkey). Plant Protection Bulletin, 3 (4): 237-246. [In Turkish]

Düzgüneş, Z. and Kılıç, S. 1983. Determination of Phytoseiidae species in important apple growing areas of Turkey and studies on the effectiveness of the most important of them on *Tetranychus viennensis* Zacher. Doğa Bilim Dergisi, 7: 193-205. [In Turkish]

Edland, T. and Evans, G.O. 1998. The genus *Typhlodromus* (Acari: Mesostigmata) in Norway. European Journal of Entomology, 95: 275-295.

Erkam, B. 1981. Marmara Bölgesinde yumuşak çekirdekli meyve ağaçlarında zarar yapan *Parlatoria oleae* Colv. (Homoptera: Diaspididae)'nin tanınması, biyolojisi, yayılışı, konukçuları, zararı ve doğal düşmanları üzerinde araştırmalar. Tarım ve Orman Bakanlığı, Zirai Mücadele ve Zirai Karantina Genel Müdürlüğü, İstanbul Bölge Zirai Mücadele Araştırma Enstitüsü Müdürlüğü Araştırma Eserleri Serisi, No: 17, 94 pp. [In Turkish]

Faraji, F., Çobanoğlu, S. and Çakmak, I. 2011. A checklist and a key for the Phytoseiidae species of Turkey with two new species records (Acari: Mesostigmata). International Journal of Acarology, 37 (1): 221-243.
doi: 10.1080/01647954.2011.558851

Ferragut, F., Garcia-Mari, F. and Marzal, M.C. 1983. Determination and abundance of Phytoseiidae in Spanish citrus. Proceedings of the 1st National Congress of the Spanish Society of Horticultural Sciences, 28 November-1 December 1983, Valencia, Spain, 299-308.

Ferragut, F., Laborda, R., Costa-Comelles, J. and Garcia-Mari, F. 1992. Feeding behaviour of *Euseius stipulatus* and *Typhlodromus phialatus* on the citrus red mite *Panonychus citri* (Acari: Phytoseiidae, Tetranychidae). Entomophaga, 37 (4): 537-543.
doi: 10.1007/BF02372323

Gerson, U., Smiley, R.L. and Ochoa, R. 2003. Mites (Acari) for pest control. Blackwell Publishing, Oxford, UK, 558 pp.
doi: 10.1002/9780470750995

Gökçe, P.G. 2015. Determination of mite species of ornamental plants in green areas of Tekirdağ. MSc. Thesis, Namık Kemal University, Graduate School of Natural and Applied Sciences, Department of Entomology, Tekirdağ, Turkey, 61 pp. [In Turkish]

Güçlü, Ş., Hayat, R. and Özbek, H. 1995. An investigation on phytophagous insect species on walnut (*Juglans regia* Linnaeus) in Erzurum and its neighbouring provinces. Turkish Journal of Entomology, 19 (2): 137-145. [In Turkish]

Hajizadeh, J., and Mortazavi, S. 2015. The genus *Euseius* Wainstein (Acari: Phytoseiidae) in Iran, with a revised key to Iranian phytoseiid mites. International Journal of Acarology, 41 (1): 53-66.
doi: 10.1080/01647954.2014.985712

Helle, W. and Sabelis, M.W (Eds). 1985. Spider mites: their biology, natural enemies and control. Elsevier, 1 B, 458 pp.

İncekulak, R. and Ecevit, O. 2002. A research on determination of harmful and beneficial mite species in apple orchards in Amasya and their population densities. Proceedings of the Fifth Turkish National Congress of Biological Control, 4-7 September 2002, Erzurum, Turkey, 297-314.

Jeppson, L.R., Keifer, H.H. and Baker, E.W. 1975. Mites injurious to economic plants. University of California Press, Berkeley, USA, 613 pp.

Kabíček, J. 2010. Scarceness of phytoseiid species co-occurrence (Acari: Phytoseiidae) on leaflets of *Juglans regia*. Plant Protection Science, 46 (2): 79-82.
doi: 10.17221/32/2009-PPS

Kasap, İ. 2005. Life history traits of the predaceous mite *Kampimodromus aberrans* (Oudemans) (Acarina: Phytoseiidae) on four different types of food. Biological Control, 35: 40-45.
doi: 10.1016/j.biocontrol.2005.05.014

Kasap, İ. 2019. Effect of pollen with different predator release ratios on biological control of *Tetranychus urticae* by the predaceous mite *Kampimodromus aberrans.* Systematic and Applied Acarology, 24 (7): 1310-1318.
doi: 10.11158/saa.24.7.13

Kasap, İ., Çobanoğlu, S. and Pehlivan, S. 2013. Predatory mite species on pome fruit trees and weeds in the province of Çanakkale and Balıkesir. Turkish Journal of Biological Control, 4 (2): 109-124. [In Turkish]

Kasap, İ., Atlıhan, R., Özgökçe, M.S., Kaydan, M.B., Polat, E. and Yarımbatman, A. 2008. Harmful mite species and their predators in the walnut orchards around Van Lake. Yuzuncu Yil University Journal of Agricultural Sciences, 18 (2): 99-102. [In Turkish]

Kasap, İ., Atlıhan, R., Özgökçe, M.S., Kaydan, M.B., Polat, E. and Yarımbatman, A. 2009. Population density of the important harmful mites and their predatories in the walnut orchards of around Van Lake. Turkish Journal of Entomology, 33 (4): 305-314. [In Turkish]

Kavianpour, M., Karimpour, Y. and Nemati, A. 2016. Ascoidea and Blattisociidae (Mesostigmata) mites of Urmia (West Azerbaijan, Iran), with identification keys to genera and species. Biharean Biologist, 12 (2): 1-6.

Khan, A.A., Dar, H., Shah, M.A., Mohi-ud-Din, S. and Majid, S. 2016. Insect pests of walnut and their management. In: Insect pests management of fruit crops. Pandey, A.K. and Mall, P. (Eds). Biotech, India, 308-355.

Kostiainen, T. and Hoy, M.A. 1994. Egg-harvesting allows large scale rearing of *Amblyseius finlandicus* (Acari: Phytoseiidae) in the laboratory. Experimental and Applied Acarology, 18: 155-165.

doi: 10.1007/BF02353683

Kozlowski, J. and Kozlowska, M. 1991. Notes on *Aculus schlechtendali* as food for predatory mites. In: Modern acarology, Vol. 2. Dusbabek, F. and Bukva, V. (Eds). Academia, Prague, Czechoslovakia and SPB Academic Publishing BV, The Hague, The Netherlands, 675-678.

Kumral, N.A. and Çobanoğlu, S. 2015. A reservoir weed for mites: *Datura stramonium* L. (Solanaceae) in the vicinity of cultivated solanaceous plants in Turkey. International Journal of Acarology, 41 (7): 563-573.
doi: 10.1080/01647954.2015.1084043

Lazarov, A.V. and Grigorov, S.P. 1961. Karantina na Rastenijata. Zemin dat, Sofia, Bulgaria, 258 pp.

Lorenzon, M., Pozzebon, A. and Duso, C. 2012. Effects of potential food sources on biological and demographic parameters of the predatory mites *Kampimodromus aberrans, Typhlodromus pyri* and *Amblyseius andersoni*. Experimental and Applied Acarology, 58: 259-278.
doi: 10.1007/s10493-012-9580-7

Martínez, M.L., Labuckas, D.O., Lamarque, A.L. and Maestri, D.M. 2010. Walnut (*Juglans regia* L.): genetic resources, chemistry, by products. Journal of the Science of Food and Agriculture, 90 (12): 1959-1967.
doi: 10.1002/jsfa.4059

McMurtry, J.A. 1977. Some predaceous mites (Phytoseiidae) on citrus in the Mediterranean region. Entomophaga, 22: 19-30.
doi: 10.1007/BF02372986

McMurtry, J.A. 1983. Phytoseiid predators in orchard systems: a classical biological control success story. In: Biological control of pests by mites. Hoy, M.A., Cunningham, G.L. and Knutson, L. (Eds). Division of Agricultural Sciences Publication 3304, University of California, Berkeley, CA, USA, 21-26.

McMurtry, J.A. and Croft, B.A. 1997. Life-styles of phytoseiid mites and their roles in biological control. Annual Review of Entomology, 42: 291-321.
doi: 10.1146/annurev.ento.42.1.291

McMurtry, J.A., Huffaker, C. and Van de Vrie, M. 1970. Ecology of tetranychid mites and their natural enemies: A review: I. Tetranychid enemies: Their biological characters and the impact of spray practices. Hilgardia, 40 (11): 331-390.

Mijuskovic, M. and Tomasevic, B. 1975. The mites on the citrus trees on the Yugoslav littoral. Society for Science and Art of Montenegro Monographs. Section of Natural Sciences, 1: 1–203.

Mills, N.J., Grafton-Cardwell, E.E. and Cois, C. 2013. Spider mite management in walnut. California Walnut Board. Walnut Research Reports, 247-261.

Miñarro, M. and Kreiter, S. 2012. Phytoseiids in vineyards of the appellation Cangas Quality Wine (Asturias, NW Spain). Boletín de Sanidad Vegetal, Plagas, 38 (1): 73-82.

Moraes, G.J. de, McMurtry, J.A., Denmark, H.A. and Campos, C.B. 2004. A revised catalog of the mite family Phytoseiidae. Zootaxa, 434: 1-494.
doi: 10.11646/zootaxa.434.1.1

Nesbitt, H.H.J. 1951. A taxonomic study of the Phytoseiinae (Family Laelaptidae) predaceous upon Tetranychidae of economic importance. Doctoral Dissertation, Carleton College, Ottawa, Canada, 96 pp.

Oudemans, A.C. 1930. Acarologische Aanteekeningen. CII. Entomologische Berichten, 8: 69-74.

Ozman-Sullivan, S.K. 2006. Life history of *Kampimodromus aberrans* as a predator of *Phytoptus avellanae* (Acari: Phytoseiidae, Phytoptidae). Experimental and Applied Acarology, 38: 15–23.
doi: 10.1007/s10493-005-5786-2

Ozman, S.K. and Cobanoğlu, S. 2001. Current status of hazelnut mites in Turkey. Acta Horticulturae, 556: 479-487.
doi: 10.17660/ActaHortic.2001.556.70

Ozsisli, T. and Çobanoğlu, S. 2011. Mite (Acari) fauna of some cultivated plants from Kahramanmaraş, Turkey. African Journal of Biotechnology, 10 (11): 2149-2155.

Öksüz, F. 2019. Determination of mite species and their population densities on summer and winter vegetables in Bafra and Carsamba plains. MSc. Thesis, Ondokuz Mayis University, Graduate School of Sciences, Department of Plant Protection, 156 pp. [In Turkish]

Papadoulis, G.Th., Emmanouel, N.G. and Kapaxidi, E.V. 2009. Phytoseiidae of Greece and Cyprus (Acari: Mesostigmata). Indira Publishing House, West Bloomfield, Michigan, 200 pp.

Pappas, M.L., Xanthis, C., Samaras, K., Koveos, D.S. and Broufas, G.D. 2013. Potential of the predatory mite *Phytoseius finitimus* (Acari: Phytoseiidae) to feed and reproduce on greenhouse pests. Experimental and Applied Acarology, 61 (4): 387-401.
doi: 10.1007/s10493-013-9711-9

Peverieri, G.S., Simoni, S., Goggioli, D., Liguori, M. and Castagnoli, M. 2009. Effects of variety and management practices on mite species diversity in Italian vineyards. Bulletin of Insectology, 62 (1): 53-60.

Ragusa, S. and Swirski, E. 1976. Notes on predaceous mites of Italy, with a description of two new species and of an unknown male (Acarina: Phytoseiidae). Redia, 59: 179-196.

Ragusa, S. and Tsolakis, H. 1994. Revision of the genus *Kampimodromus* Nesbitt, 1951 (Parasitiformes, Phytoseiidae), with a description of a new species. Acarologia, 35 (4): 305-322.

Rahmani, H., Kamali, K. and Faraji, F. 2010. Predatory mite fauna of Phytoseiidae of northwest Iran (Acari: Mesostigmata). Turkish Journal of Zoology, 34 (4): 497-508. doi: 10.3906/zoo-0902-23

Rather, A.Q., Paray, M.A., Mir, G.M. and Gupta, S. 2015. Specificity, distribution and abundance of predatory mites (Arachnida: Arthropoda) on walnut in Kashmir himalaya. Plant Protection Association of India, 43 (4): 524-525.

Ripka, G., Szabó, Á., Tempfli, B. and Varga, M. 2013. New plant-inhabiting mite records from Hungary (Acari: Mesostigmata, Prostigmata and Astigmata) II. Acta Phytopathologica et Entomologica Hungarica, 48 (2): 237-244. doi: 10.1556/APhyt.48.2013.2.5

Salmane, I. and Petrova, V. 2002. Overview on Phytoseiidae mites (Acari, Mesostigmata, Gamasina) of Latvia. Latvijas Entomologs, 39: 48-54.

Satar, S., Ada, M., Kasap, İ. and Çobanoğlu, S. 2013. Acarina fauna of citrus trees in eastern Mediterranean region of Turkey. IOBC-WPRS Bulletin, 95: 171-178.

Schausberger, P. 1992. Comparative investigations on the effect of different foods on development and reproduction of *Amblyseius aberrans* Oud. and *A. finlandicus* Oud. (Acarina, Phytoseiidae). Journal of Applied Entomology, 113: 476-486.

Soysal, M. and Akyazı, R. 2018. Mite species of the vegetable crops in Ordu Province with first report of *Amblyseius rademacheri* Dosse, 1958 (Mesostigmata: Phytoseiidae) in Turkey. Turkish Journal of Entomology, 42 (4): 265-286. doi: 10.16970/entoted.447218

Sudo, M. and Osakabe, M. 2011. Do plant mites commonly prefer the underside of leaves? Experimental and Applied Acarology, 55: 25-38. doi: 10.1007/s10493-011-9454-4

Swirski, E. and Amitai, S. 1982. Notes on predacious mites (Acarina: Phytoseiidae) from Turkey, with description of the male of *Phytoseius echinus* Wainstein and Arutunjan. Israel Journal of Entomology, 16: 55-62.

Strand, L.L. 2003. Integrated pest management for walnuts. Third edition. University of California, Oakland, California, USA, 136 pp.

Şekeroğlu, E. 1984. Phytoseiid mites (Acarina, Mesostigmata) of southern Anatolia, their biology, and effectiveness as a biological control agent on strawberry plants. Doğa Bilim Dergisi, 8 (3): 320-336.

Şekeroğlu, E. and Kazak, C. 1993. First record of *Phytoseiulus persimilis* (Acari: Phytoseiidae) in Turkey. Entomophaga, 38: 343-345. doi: 10.1007/BF02374451

Tixier, M.-S., Kreiter, S., Auger, P. and Weber, M. 1998. Colonization of Languedoc vineyards phytoseiid mites (Acari: Phytoseiidae): influence of wind and crop environment. Experimental and Applied Acarology, 22: 523-542. doi: 10.1023/A:1006085723427

Tixier, M.-S., Kreiter, S., Okassa, M. and Cheval, B. 2009. A new species of the genus *Euseius* Wainstein (Acari: Phytoseiidae) from France. Journal of Natural History, 44 (3-4): 241-254. doi: 10.1080/00222930903383529

Wackers, F. 2013. Food for thought: Nutritional supplements to boost biocontrol. Presentation at the Annual Biocontrol Industry Meeting (ABIM), 21-23 October 2014, Basel, Switzerland. Available https://www.abim.ch/fileadmin/abim/documents/presentations2013/ABIM_2013_3_2_Wackers.pdf (Last accessed: 15 December 2019).

Wainstein, B.A. and Arutunjan, E.S. 1968. New species of predaceous mites of the genus *Typhlodromus* (Parasitiformes: Phytoseiidae). Zoologicheskii Zhurnal, 47 (8): 1240-1244.

Welter, C.S., Bentley, W. and Cave, F. 2011. Biological control of spider mites in walnuts. California Walnut Board. Walnut Research Reports, California, USA, 247-261.

Yanar, D. and Ecevit, O. 2005. Plant injurious and predatory mite species in apple (*Malus communis* L.) orchards in Tokat Province. The Journal of Agricultural Faculty of Ondokuz Mayıs University, 20 (1): 18-23. [In Turkish]

Yeşilayer, A. and Çobanoğlu, S. 2011. The distribution of predatory mite species (Acari: Phytoseiidae) on ornamental plants and parks of Istanbul, Turkey. Turkish Bulletin of Entomology, 1 (3): 135-143.

Zhang, Z.-Q. 2003. Mites of greenhouses: identification, biology and control. CABI Publishing, UK, 244 pp. doi: 10.1079/9780851995908.0000

Edited by: Salih Doğan
Reviewed by: Three anonymous referees

Citation: Çakır, Ş., Tixier, M.-S. and Ozman-Sullivan, S.K. 2020. Phytoseiid species (Acari: Phytoseiidae) on walnut trees in Samsun Province, Turkey. Acarological Studies, 2 (1): 24-33.

Acarological Studies
Vol 2 (1): 34-40

RESEARCH ARTICLE

A new species of the genus *Trombidium* (Acari: Trombidioidea) parasitic on a spider species in Turkey

Sevgi SEVSAY [1,2], Evren BUĞA [1], Mert ELVERİCİ [1]

[1] *Department of Biology, Faculty of Sciences and Arts, Erzincan Binali Yıldırım University, Erzincan, Turkey*
[2] Corresponding author: ssevsay@erzincan.edu.tr

Received: 3 July 2019 Accepted: 28 December 2019 Available online: 31 January 2020

ABSTRACT: *Trombidium demirsoyi* sp. nov. Sevsay and Buğa is described and illustrated from larvae collected as ectoparasites on *Zodarion thoni* Nosek, 1905 and off-host from the soil in Çanakkale Province, Turkey. This is the first record of a species of the spider family Zodariidae as a host for an ectoparasitic larva of a *Trombidium* Fabricius species.

Keywords: Araneae, ectoparasite, host-parasite association, Parasitengona, Trombidiidae.
Zoobank: http://zoobank.org/E711284A-83A1-45B0-8175-2124D285F553

INTRODUCTION

Parasitengona is one of the largest and most diverse mite groups. There are over 11 000 described (nominal) species from more than 80 families and 14 superfamilies (Gabryś et al., 2011; Walter and Proctor, 2013). Mites of the family Trombidiidae (Acari: Parasitengona) are ectoparasitic in their larval stage and predatory in their active, postlarval stages (deutonymph and adult). They feed on a variety of arthropods so may have economic importance (Robaux, 1974; Welbourn, 1983). The genus *Trombidium* Fabricius, 1775 includes known 35 species widely distributed across the world, of which 12 are known only from larvae, 11 from active post-larval instars, and 12 from both (Mąkol and Wohltmann, 2012, 2013; Liu and Zhang, 2016; Saboori et al., 2017). Six species of the genus *Trombidium* have been reported from Turkey, of which three species, *T. geniculatum*, *T. holosericeum* and *T. latum*, are known only from the larvae (Sevsay, 2017).

Ectoparasitic larvae of *Trombidium* spp. have been recorded from a variety of arthropod hosts, including Araneae, Coleoptera, Dermaptera Diptera, Hemiptera, Hymenoptera, Lepidoptera, Mecoptera, Orthoptera, Opiliones and Pseudoscorpiones, and Thysanoptera (Tomić et al., 2015; Felska et al., 2018). The spider families Linyphiidae, Philodromidae, Tetragnathidae and Theridiidae are common hosts for larvae of *Trombidium brevimanum* (Berlese, 1912), which is restricted to arachnids (Mąkol and Felska, 2011). *Trombidium* spp. have been recorded as parasitic on thirteen spider families, namely Agelenidae, Araneidae, Argiopidae, Clubionidae, Corinnidae, Dictynidae, Linyphiidae, Lycosidae, Philodromidae, Pisauridae, Tetragnathidae, Theridiidae and Thomisidae (Welbourn and Young, 1988; Fain and Jocqué, 1996; Felska et al., 2018).

This report is the first record of the spider family Zodariidae as a host for ectoparasitic *Trombidium* Fabricius larvae. This study aimed to describe a new species of larval *Trombidium* Fabricius, 1775 (Acari: Trombidiidae) collected from males of *Zodarion thoni* Nosek, 1905 (Araneae: Zodariidae) and also free living in the soil.

MATERIALS AND METHODS

Two adult male spiders were collected in pitfall traps (39°32'12''N, 26°33'52''E, 70 m a.s.l.) in Çanakkale Province, Turkey. The six engorged *Trombidium* larvae were treated with 10% KOH before clearing and mounting on glass microscope slides, using Hoyer's medium (Walter and Krantz, 2009). Their measurements were taken and the drawings were done by using a BX63 phase contrast Olympus microscope equipped with a drawing tube, and the digital photographs were taken with a DP73 camera mounted on the microscope. The three specimens used for scanning electron microscope (SEM) studies were preserved in 95% alcohol, dehydrated in a graded alcohol series, transferred to hexamethyldisilazane (Fluka Chemicals) and then imaged with an FE-SEM (FEIQUANTA 450). The terminology and abbreviations follow Mąkol (2007), and measurements are given in micrometers (µm). The type material is deposited in the Acarology Laboratory of Erzincan Binali Yıldırım University, Erzincan, Turkey (EBYU).

RESULTS

Family Trombidiidae Leach, 1815

Genus *Trombidium* Fabricius, 1775

Type species. *Acarus holosericeus* Linneaus, 1758

Trombidium demirsoyi sp. nov. Sevsay and Buğa

Diagnosis

Larvae: Hypostomalae setae (*bs*= subcapitular setae) short in the shape of crown, with equal length, finger-like protrusions. Solenidion on tarsus I situated at ca. 2/3 length of the segment. Setae on scutellum situated at half length of the sclerite. *AM* setae nude.

Post larval instars unknown.

Description

Larva (n = 11): Measurements are given in Table 1 (the given measurements are average values from six specimens). Live specimens red, and with dark red eye spots.

Gnathosoma. Hypostomalae setae (*bs*) stout, crown-like, regularly arranged, distally ca. 10 equal length, finger-like protrusions (Figs 1, 8, 9). Cheliceral blade curved posteriorly, with a small distal tooth-like process on the internal edge of blade. Subcapitulum punctate. Palptibial claw divided entire length. Palpal femur with one nude seta. Palptibia with three setae; two barbed setae (proximal seta distinctly longer than the distal seta), and one nude seta shorter than the others. On palpal tarsus; one long seta with distinct barbs, two short setae with short and sparse barbs, two eupathidia and a solenidion (Figs 2, 10). The pedipalp formula: 0-N-0-BBN-BBBζζω(?ω).

Idiosoma. Scutum and scutellum porous on the whole surface. Scutum rounded anteriorly, posterior border straight and posterior corners rounded (Fig. 3). Anterior part of scutum longitudinally striated and continues slightly to rear of chitinous bar (tear-like). Setae; *AM* nude (Fig. 11), *AL* covered with very fine setulae, *PL* barbed. Sensilla (*S*) located at equal distance to *AL* and *PL* setae. Scutellum bears one pair of barbed c_1 setae (45-52) situated at the middle of the sclerite. Scutum and scutellum of the same width (Fig. 12). Two pairs of eyes at the level of posterior edge of scutum. Anterior lens larger in diameter than the posterior lens (anterior 10, posterior 7). All dorsal setae with barbs. Setae in rows C-F situated on small sclerites, with barbs covering the whole shaft. Setae h_1 located on a common sclerite. *f*D formula: (2)4-6-4-4-2.

Ventral surface of idiosoma with one pair of intercoxal setae (*3a*) between coxae III (Fig. 4). Coxal fields punctate. *f*Cx= NBN-BB-B (including supracoxal seta). Supracoxala and seta *1a* smooth (forked on the right side of the holotype), *1b* distinctly barbed. Setae on coxae II and III barbed. *f*V = 4u-2-2.

Legs. Leg segmentation formula: 6-6-6. Leg setal formula: Leg I (Fig. 5): Tr (1n)- Fe (5n)- Ge (4n, 2σ, 1κ,)-Ti (5n, 2φ, 1κ)- Ta (16n, 1ω, 1ε, 2ζ). Leg II (Fig. 6): Tr (1n)- Fe (4n)- Ge (3n, 1 σ, 1κ)- Ti (4n, 2φ)- Ta (12n, 1ω, 1ε). Leg III (Fig. 7): Tr (1n)- Fe (5n)- Ge (3n, 1σ)- Ti (5n)- Ta (11n).

Solenidion (ω) on tarsus I situated at ca. $^2/_3$ length of the segment. The posterior claw on tarsus III modified, reduced in length and slightly displaced towards the lateral side of tarsus. Tarsus III with short ensiform seta and an accessory sword-like seta. The stylostome (a feeding canal formed within the host tissues) of the engorged larvae quite distinctive (Fig. 13).

Type material

Holotype and paratypes larvae were collected from two adult male *Zodarion thoni* (one larva from one spider and four larvae from the other) captured by pitfall trapping, and six larvae, off-host, were extracted from soil samples with a Berlese funnel. All specimens were collected from the same field in Çanakkale Province, Turkey by M. Elverici on 6 June, 2016. He also identified the spider.

Etymology

This species is named in honour of Emeritus Professor Ali Demirsoy (Hacettepe University) for his efforts to develop entomology, evolutionary biology and zoology in Turkey.

DISCUSSION

Trombidium demirsoyi sp. nov. Sevsay and Buğa differs from all other species of *Trombidium* in the shape of its *bs* setae. There are three different shapes of hypostomalae setae (*bs*) in *Trombidium* (Mąkol, 2002). The first type is simple, with several branches and with slightly thickened and apically narrowing stem. The second type is stout, terminating brush-like. The third type is in the shape of a truncate calyx, with ca. 10-14 finger-like, sharply terminated protrusions of different length distally. Species with the third type are *Trombidium holosericeum* (L., 1758), *T. geniculatum* (Feider, 1955) and *T. latum* C.L. Koch, 1837. *Trombidium demirsoyi* sp. nov. is most similar to *T. latum* but differs from these species in the following character states: crown shaped setae *bs* with ca. 10 equal length, finger-like protrusions distally (vs. *bs* in the shape of calyx, finger-like protrusions differ in length in distal part, the number of protrusions is ca. 13-15 in *T. holosericeum*, ca. 11-12 in *T. geniculatum,* both of which have stouter hypostomalae setae, whereas *T. latum* hypostomalae has ca. 10 slenderer protrusions. The other differences include shorter *bs* (6.5-7.2 vs.14-22); *AM* setae nude (vs. barbed), shorter *AM* (36-45 vs. 53-65); scutum and scutellum of equal width (vs. wider scutellum); h_1 on a common sclerite (vs not located in *T. latum*) and shorter h_1 (70 vs. 88-105); shorter LSS (100-108 vs. 131-153); shorter ASB (69-77 vs. 87-97); more barbed setae on palp tarsus (3 vs. 1-2); and solenidion (ω) on tarsus I situated at ca. $^2/_3$ length of the segment in *T. demirsoyi* sp. nov. (vs. $^1/_4$ length of the segment in others) (Mąkol, 2001, 2002, 2005).

The larvae of Trombidiidae occur most frequently on spiders where they attach to the prosoma and opisthosoma, with an apparent tendency to occupy sites close to the pedicel (Mąkol and Felska, 2011). *Trombidium demirsoyi* sp. nov. had the same attachment sites. One larva was attached to the pedicel of its host whereas four larvae from another host were attached close to pedicel.

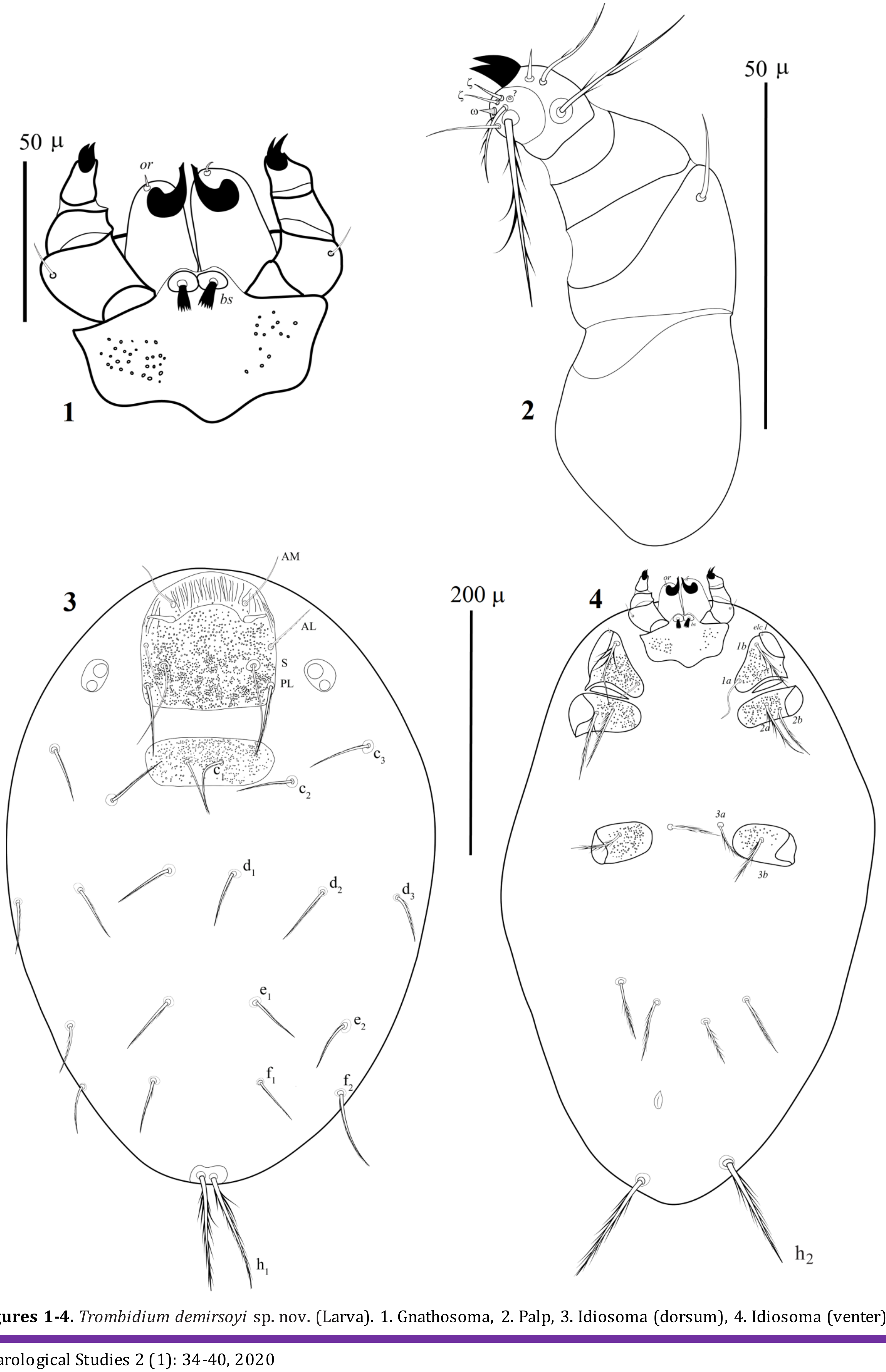
REFERENCES

Fain, A. and Jocqué, R. 1996. A new larva of the genus *Leptus* Latreille, 1796 (Acari: Erythraeidae) parasitic on a spider from Rwanda. International Journal of Acarology, 22: 101-108.
doi: 10.1080/01647959608684084

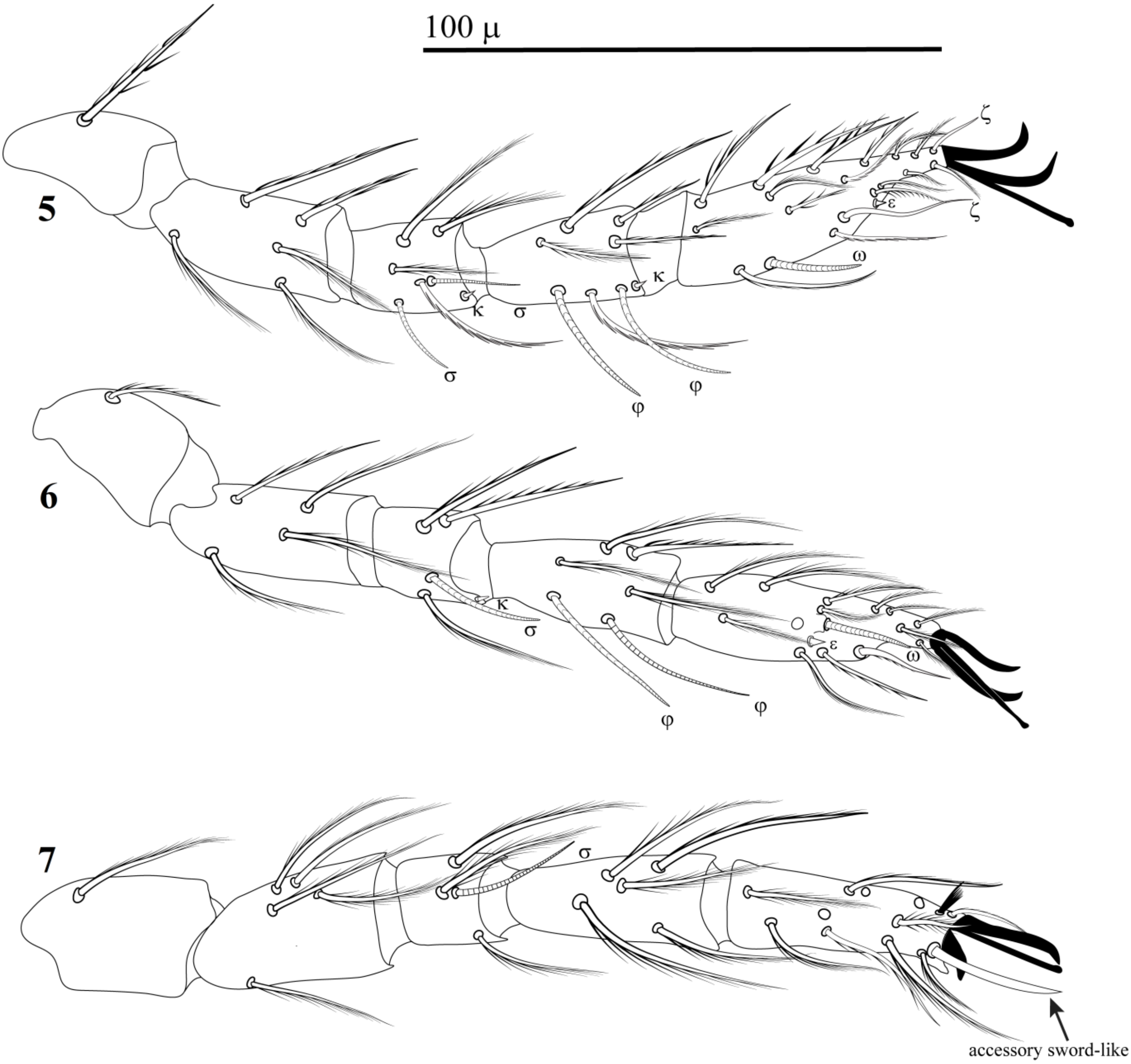
Felska, M, Wohltmann, A. and Mąkol, J. 2018. A synopsis of host-parasite associations between Trombidioidea (Trombidiformes: Prostigmata, Parasitengona) and arthropod hosts. Systematic and Applied Acarology, 23: 1375-1479.
doi: 10.11158/saa.23.7.14

Table 1. Morphometric data for the larvae of *Trombidium demirsoyi* sp. nov.

Characterz	Holotype	Paratype 1	Paratype 2	Paratype 3	Paratype 4	Paratype 5	Mean
L	498	617	968	501	-	-	646
W	344	423	701	442	-	-	478
L/W	1.44	1.45	1.38	1.33	-	-	1.40
AA	58	66	50	56	-	-	58
AW	102	94	92	97	92	94	95
PW	100	96	98	99	94	95	97
SB	72	67	68	68	63	64	67
ASB	76	76	77	77	69	77	75
PSB	36	35	35	36	35	33	35
SD	112	111	112	113	104	100	109
AP	32	30	30	29	27	27	29
AM	43	34	43	45	36	37	40
AL	45	42	43	47	36	40	42
PL	63	60	61	60	51	57	59
PL/AL	1.4	1.42	1.42	1.28	1.42	1.42	1.39
S	70	70	64	49	61	59	62
MA	40	37	39	40	40	41	40
HS	42	49	43	43	43	43	44
LSS	108	108	106	107	100	104	106
SL	48	48	52	53	41	42	47
SS	25	29	28	28	25	28	27
DS_MIN	33	35	32	35	32	-	33
DS_MAX	49	49	48	55	46	-	49
bs	7.2	6.6	7.2	6.5	6.9	6.5	6.7
Cx_I	48	47	47	49	47	58	49
Tr_I	32	32	32	33	33	27	32
Fe_I	40	45	43	42	43	38	42
Ge_I	27	27	27	26	26	28	27
Ti_I	36	39	32	36	35	36	36
Ta_I	54	62	56	63	58	59	59
LEG I	237	252	237	249	242	246	244
Cx_II	47	49	48	51	52	52	50
Tr_II	33	37	34	32	31	29	33
Fe_II	41	41	40	43	42	37	41
Ge_II	26	24	23	23	23	22	24
Ti_II	31	37	32	35	32	35	34
Ta_II	56	54	51	57	55	56	55
LEG II	234	242	228	241	235	231	235
Cx_III	48	51	50	47	48	-	49
Tr_III	35	34	32	29	31	-	32
Fe_III	43	47	40	44	38	-	42
Ge_III	21	22	23	19	22	-	21
Ti_III	38	40	-	42	35	-	39
Ta_III	48	49	-	51	46	-	49
LEG III	233	243	145	232	220	-	215
IP	704	737	610	722	697	477	658



Figures 1-4. *Trombidium demirsoyi* sp. nov. (Larva). 1. Gnathosoma, 2. Palp, 3. Idiosoma (dorsum), 4. Idiosoma (venter).



Figures 5-7. *Trombidium demirsoyi* sp. nov. (Larva). 5. Leg I, 6. Leg II, 7. Leg III.

Gabryś, G., Felska, M., Kłosińska, A., Staręga, W. and Mąkol, J. 2011. Harvestmen (Opiliones) as hosts of Parasitengona (Acari: Actinotrichida, Prostigmata) larvae. International Journal of Arachnology, 39: 349-351.
doi: 10.1636/CP10-93.1

Liu, J. and Zhang, Z. 2016. Hotspots of mite new species discovery: Trombidiformes (2013-2016). Zootaxa, 4208: 1- 45.
doi: 10.11646/zootaxa.4208.1.1

Mąkol, J. 2001. A redescription of *Trombidium geniculatum* (Feider, 1955) (Acari: Actinotrichida: Trombidioidea) with characteristics of all active instars. Annales Zoologici, 51: 251-260.

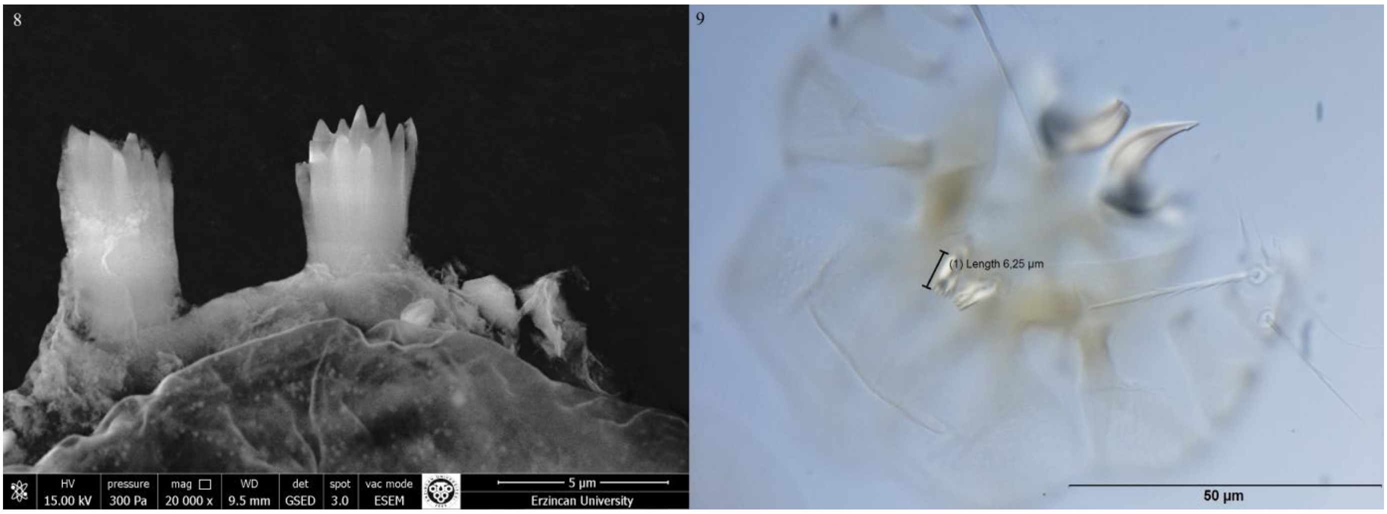
Mąkol, J. 2002. A redescription of *Trombidium latum* (C. L. Koch, 1837) (Acari: Actinotrichida, Trombidioidea) with characteristics of all active instars. Annales Zoologici, 52: 433-442.

Mąkol, J. 2005. Trombidiidae (Acari: Actinotrichida: Trombidioidea) of Poland. Fauna Poloniae. Museum and Institute of Zoology, Polish Academy of Sciences and Natura Optima Dux Foundation, Warsaw, 1-259.

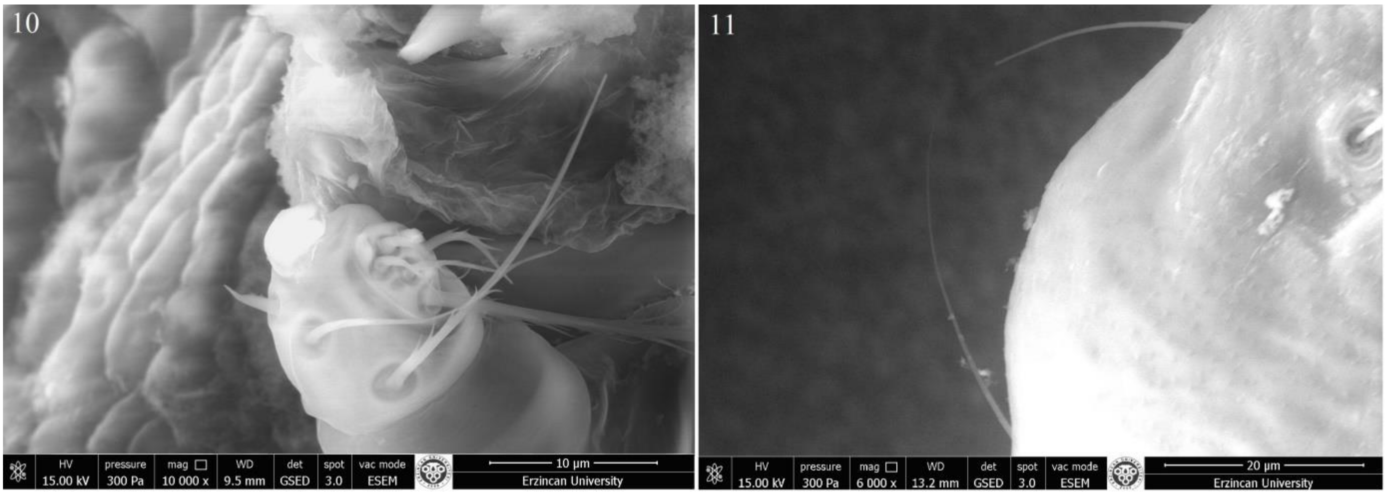
Mąkol, J. 2007. Generic level review and phylogeny of Trombidiidae and Podothrombiidae (Acari: Actinotrichida: Trombidioidea) of the world. Annales Zoologici, 57, 1-194.

Mąkol, J. and Felska, M. 2011. New records of spiders (Araneae) as hosts of terrestrial Parasitengona mites (Acari: Actinotrichida: Prostigmata). Journal of Arachnology, 39: 352-354.
doi: 10.1636/CP10-72.1

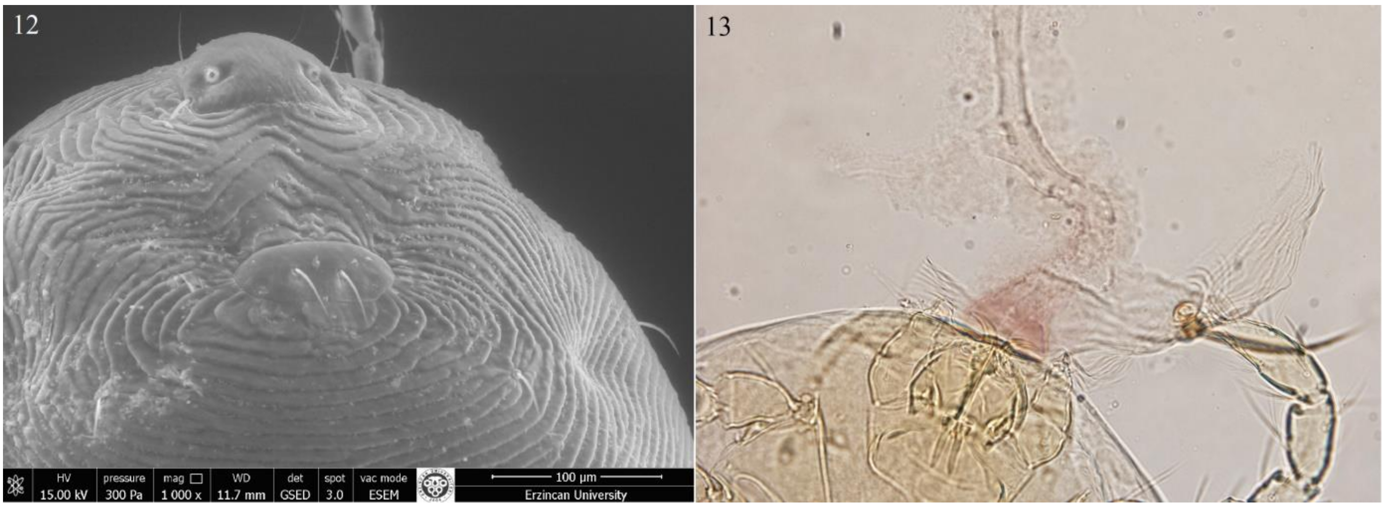
Mąkol, J. and Wohltmann, A. 2012. An annotated checklist of terrestrial Parasitengona (Actinotrichida: Prostigmata) of the world, excluding Trombiculidae and Walchiidae. Annales Zoologici, 62, 359-562.
doi: 10.3161/000345412X656671



Figures 8-9. *Trombidium demirsoyi* sp. nov. (Larva). 8. Hypostomalae seta (*bs*), SEM micrograph, 9. Hypostomalae seta (*bs*), light microscope.



Figures 10-11. *Trombidium demirsoyi* sp. nov. (Larva). 10. Palp, ventral aspect, 11. *AM* setae.



Figures 12-13. *Trombidium demirsoyi* sp. nov. (Larva). 12. Scutum and scutellum, SEM micrograph, 13. Stylostome, light microscope.

Mąkol, J. and Wohltmann, A. 2013. Corrections and additions to the checklist of terrestrial Parasitengona (Actinotrichida: Prostigmata) of the world, excluding Trombiculidae and Walchiidae. Annales Zoologici, 63, 15-27.
doi: 10.3161/000345413X666075

Robaux, P. 1974. Recherches sur le developpement et la biologie des acariens 'Thrombidiidae'. Mémoires du Muséum National d'histoire naturelle Paris (n. s.), Seria A, Zoologie, 85: 1-186.

Saboori, A., Šundić, M. and Pešić, V. 2017. A new species of the genus *Trombidium* Fabricius (Acari: Trombidiidae), with a checklist of terrestrial parasitengone mites of Montenegro. Systematic and Applied Acarology, 22: 584-601.
doi: 10.11158/saa.22.4.12

Sevsay, S. 2017. A checklist of the Erythraeoidea and Trombidioidea (Actinotrichida: Prostigmata) of Turkey. Turkish Bulletin of Entomology, 7 (2): 175-196.
doi: 10.16969/teb.315117

Tomić, V., Mąkol, J., Stamenković, S., Büchs, W., Prescher, Sivćev, I., Graora, D., Sivćev, L., Gotlin-Ćuljak, T. and Dudić, B. 2015. Parasitism of *Trombidium brevimanum* larvae on agrobiont linyphiid spiders from Germany. Experimental and Applied Acarology, 66: 575-587.
doi: 10.1007/s10493-015-9909-0

Walter, D.E. and Krantz, G.W. 2009. Collecting, rearing and preparing specimens. In: A manual of acarology. Third edition. Krantz, G.W. and Walter, D.E. (Eds). Texas Tech University Press, Texas, USA, 83-96.

Walter, D.E. and Proctor, H.C. 2013. Mites: ecology, evolution and behaviour. Springer, London, UK, 494 pp.

Welbourn, W.C. 1983. Potential use of trombidioid and erythraeoid mites as biological control agents of insects pests. In: Biological control of pests by mites. Hoy, M.A., Cunningham, G.L. and Knutson, L. (Eds.). Agricultural Experiment Station, Division of Agriculture and Natural Resources, University of California, Berkeley, USA. Special Publication, 3304: 103-140.

Welbourn, W.C. and Young, O.P. 1988. Mites parasitic on spiders, with a description of a new species of *Eutrombidium* (Acari, Eutrombidiidae). Journal of Arachnology, 16: 373-385.

Edited by: Sebahat Ozman-Sullivan
Reviewed by: Two anonymous referees

Citation: Sevsay, S., Buğa, E. and Elverici, M. 2020. A new species of the genus *Trombidium* (Acariformes: Trombidioidea) parasitic on a spider species in Turkey. Acarological Studies, 2 (1): 34-40.

Acarological Studies
Vol 2 (1): 41-45

RESEARCH ARTICLE

Pülümür Vadisi'nden (Türkiye) yeni bir *Stigmaeus* Koch (Acari, Stigmaeidae) Türü

Sibel DOĞAN [1,3], **Salih DOĞAN** [2]

[1] *Erzincan Binali Yıldırım Üniversitesi, Sağlık Hizmetleri Meslek Yüksekokulu, Erzincan, Türkiye*
[2] *Erzincan Binali Yıldırım Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, Erzincan, Türkiye*
[3] Sorumlu yazar / Corresponding author: sibel.dogan@erzincan.edu.tr

Geliş: 1 Aralık 2019 | Kabul: 25 Aralık 2019 | Online erişim: 31 Ocak 2020
Received: 1 December 2019 | Accepted: 25 December 2019 | Available online: 31 January 2020

ÖZET: Tunceli (Türkiye) il sınırları içerisinde yer alan Pülümür Vadisi'nden alınan döküntü ve toprak örneğinden tespit edilen *Stigmaeus pulumurensis* sp. nov. bilim dünyası için yeni olarak tanımlanmıştır. Ayrıca türün çizimleri ve faz kontrast mikroskop görüntüleri verilmiştir. Yeni tür; apodemal işaretin varlığı, f_1 ile h_{1-3} kılları haricindeki diğer dorsal vücut kıllarının çizgili integüment üzerinde yer alması ve suranal plağın tam yapılı olması ile *Stigmaeus tokatensis* Dönel, Doğan, Sevsay ve Bal türüne benzemektedir. Bununla birlikte, IV. bacak genusunda bir kılın eksik olması, prodorsumun ön yan kenarları ile genital plakların yanlarında benekli desenlerin bulunması ve aggenital kılların ayrı plaklar üzerinden çıkması *ile S. tokatensis*'ten farklılık göstermektedir.

Anahtar Kelimeler: Akar, Stigmaeidae, Pülümür, Raphignathoidea, tanımlama, yeni tür.
Zoobank: http://zoobank.org/780A1A40-A07E-463D-83EF-C2A22D7C53C6

A new species of the genus *Stigmaeus* Koch (Acari, Stigmaeidae) from Pülümür Valley (Turkey)

ABSTRACT: *Stigmaeus pulumurensis* sp. nov. collected in soil and litter samples taken from Pülümür Valley in Tunceli (Turkey), was described as new to the science. In addition, drawings and phase contrast microscopic images of the new species were given. The new species resembles *Stigmaeus tokatensis* Dönel, Doğan, Sevsay and Bal by the presence of apodemal marking, all dorsal setae except setae f_1 and h_{1-3} on the striated integument and suranal shields entire. However, it differs from the latter by: the absence of one setae on genu IV, the presence of punctuated patterns on the both sides of the prodorsum and the genital shield, and the location on the different shields of aggenital setae.

Keywords: Mite, Stigmaeidae, Pülümür, Raphignathoidea, description, new species.

GİRİŞ

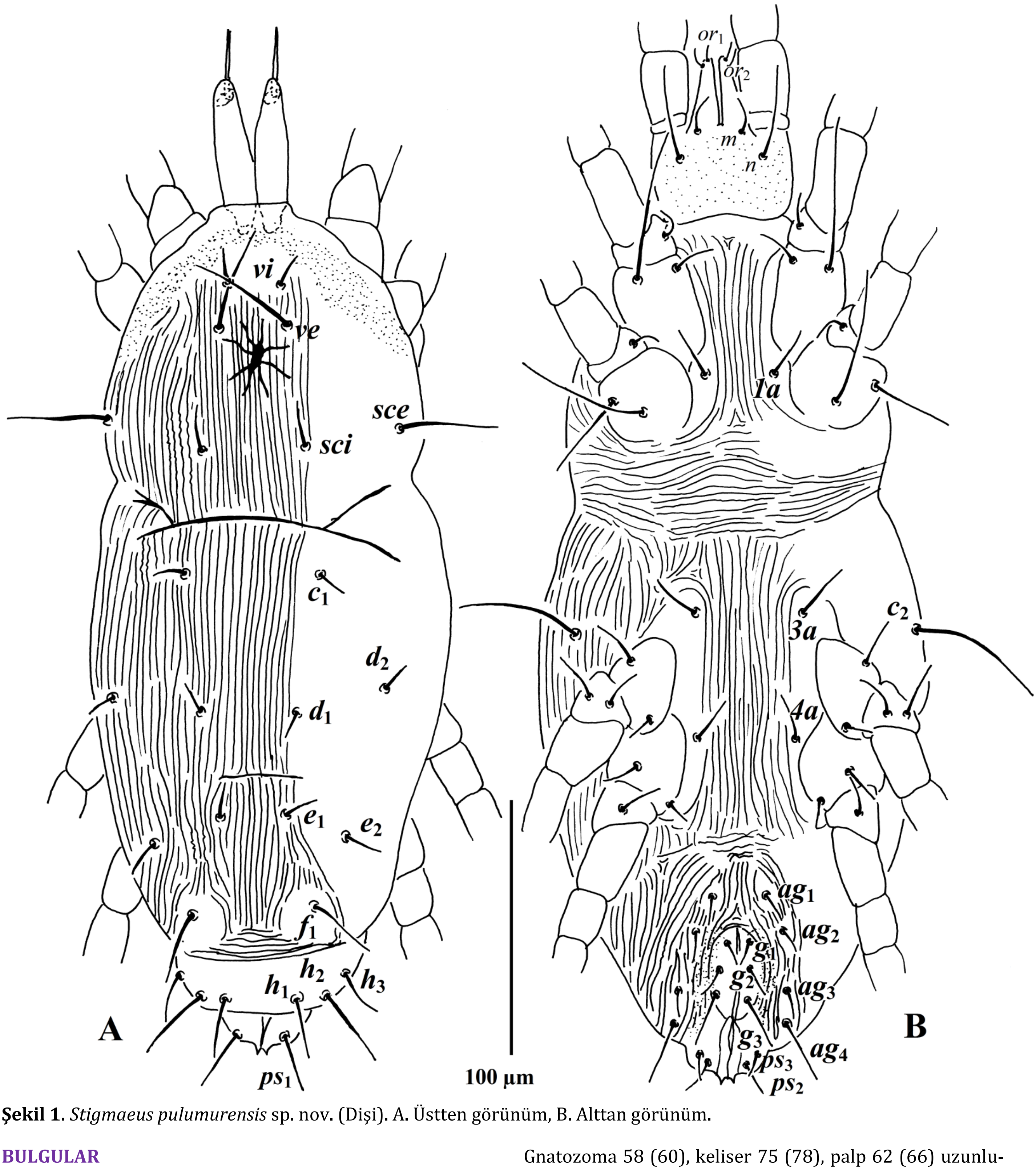
Trombidiformes takımında yer alan raphignathoid akarlar, dünyanın en eski akar gruplarından birini oluşturmaktadır. Geniş bir dağılışa sahip olan bu grubun, şimdiye kadar 11 familyası (Fan ve Zhang, 2005) bilinmektedir. Bu akarlar, çoğunlukla Palearktik, Nearktik, Afrotropikal ve Oriental bölgelerden bilinmekte, Neotropikal bölgeden ise daha az bilinmektedir (Fan ve Zhang, 2005).

Stigmaeidae familyası 33 cins ve 600'den fazla türü ile raphignathoid akarlar içinde en kalabalık grubu oluşturmaktadır (Fan vd., 2016, 2019; Stathakis vd., 2019). Ülkemizde ise şimdiye kadar raphignathoid akarların sekiz familyasının kaydı verilmiştir. Bu sekiz familya içerisinde 11 cins ve tanımlanan 118 türü ile Stigmaeidae en zengin grubu oluşturmaktadır. Stigmaeidae içinde yer alan *Stigmaeus* cinsi ise kaydedilen 46 tür ile çeşitlilik açısından ilk sırada yer almaktadır (Akyol, 2019; Doğan, 2019a,b).

Pülümür Vadisi, Avcı Dağları'nın eteklerinden doğan ve güneye doğru uzanan Pülümür Çayı'nın geçtiği dar ve dik bir vadidir. Pülümür Çayı'nın iki tarafı zengin orman örtüsünün yanı sıra küçük şelaleler ve kayalık dik yamaçlardan oluşur (Işık, 2012; Köksal ve Ulaşoğlu, 2012; Anonim, 2019). Pülümür Vadisi; akarsu ekosistemi, orman ekosistemi, mera ekosistemi, step ekosistemi, kaya ekosistemi gibi farklı ekosistemlere sahiptir. Bölgedeki bu ekosistemlerin çeşitliliği ve daha küçük ölçekte habitatların çeşitliliği, kuşkusuz biyolojik çeşitliliğin kaçınılmaz bir parçasını teşkil etmektedir. Bu çalışmada, topoğrafya ve görüntü açısından eşsiz bir doğa parçası olan Pülümür Vadisi'nden yeni bir *Stigmaeus* türü tanımlanmıştır.

MATERYAL VE YÖNTEM

Pülümür Vadisi'nden alınan toprak, döküntü, ağaç kabuğu ve yosun örnekleri naylon torbalara konularak etiketlenip laboratuvara getirilmiştir. Akar örneklerinin toplanması, ayıklanması, preparasyonu ve saklanmasında daha önce Fan ve Zhang (2005), Doğan (2006), Walter ve Krantz (2009) tarafından belirtilen yöntemler izlenmiştir. Bütün ölçümler mikrometre (μm) olarak verilmiştir. Metinde geçen ölçümlerde ilk verilen değer holotip, parantez içerisinde verilen değer ise paratip ölçümünü göstermektedir. Türün vücut bölgeleri ile vücut ve bacak kıllarının isimlendirilmesinde Grandjean (1944) ve Kethley (1990) tarafından önerilen sistem kullanılmıştır.



Şekil 1. *Stigmaeus pulumurensis* sp. nov. (Dişi). A. Üstten görünüm, B. Alttan görünüm.

BULGULAR

Familya: Stigmaeidae Oudemans, 1931

Cins: *Stigmaeus* Koch, 1836

Tip Türü: *Stigmaeus cruentus* Koch, 1836

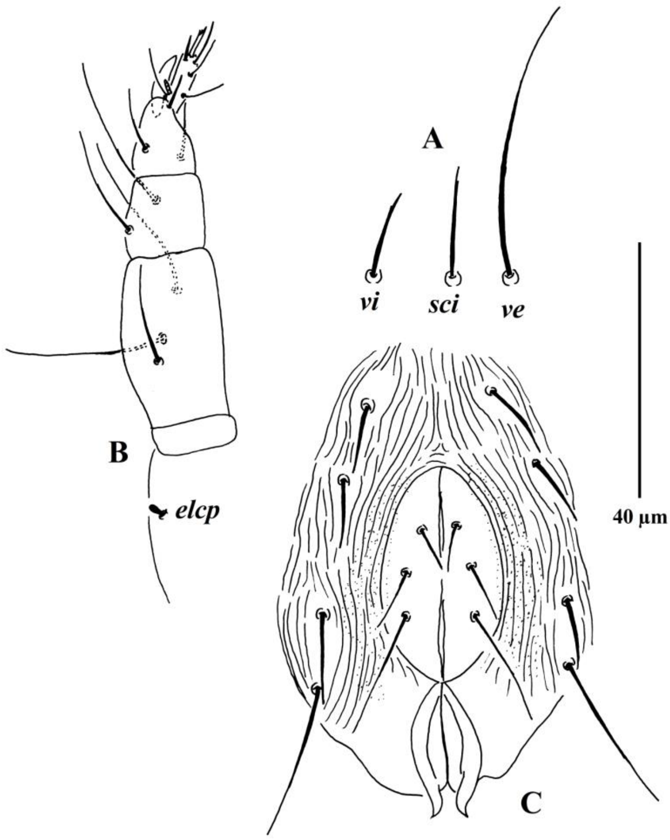
Stigmaeus pulumurensis sp. nov.

Dişi (Şekil 1-6)

Vücut uzunluğu 321 (347), genişliği ise 147 (157).

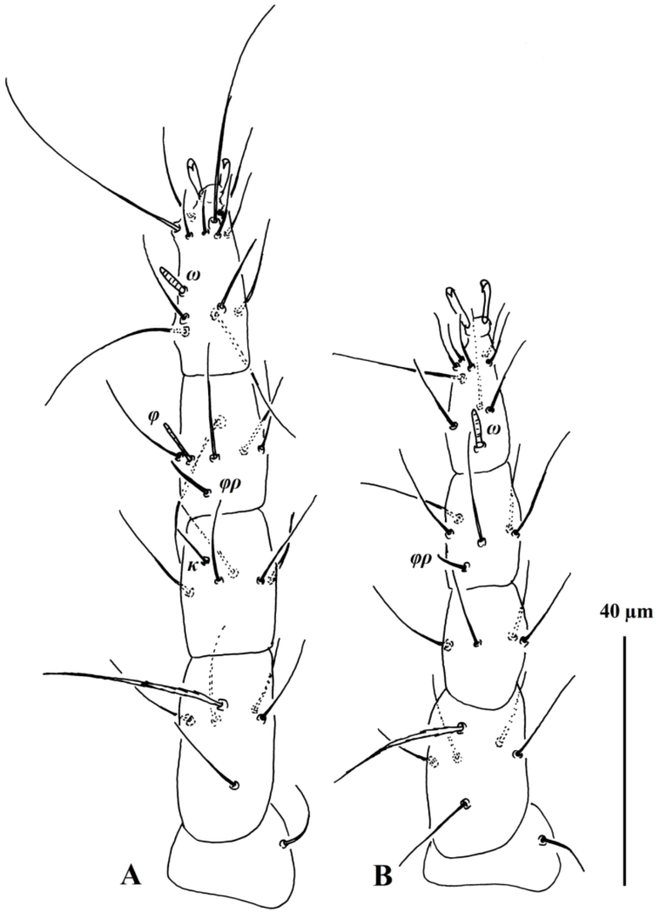
Gnatozoma 58 (60), keliser 75 (78), palp 62 (66) uzunluğundadır. Palp beş segmentli ve palp trokanterinden palp tarsusuna doğru kılların sayısı şu şekildedir: 0, 3, 2, 2+1 tırnak+1 yardımcı tırnak, 4+1ω+1 diken şeklinde öpatidiyum+1 bazalda kaynaşmış uçta çatallanmış terminal öpatidiyum (Şekil 2B). Subkapitulum kıllarının uzunlukları ve aralarındaki mesafeler şöyledir; *m* 12 (13), *n* 26 (26), *m–m* 15 (18), *n–n* 31 (31), *m–n* 10 (11).

Dorsal integüment çizgilidir (Şekil 1A). *vi* kıllarının çıktığı kısımda çizgilenme kaybolmaktadır (Şekil 5). Propodozomanın ön yan kenarları benekli desen ile kaplıdır. Apodemal işaret vardır. Göz ve göz ardı cisim yoktur. Prodorsumun ön yan kenarlarında benekli desenler bulunur. Çift haldeki interkalar plaklar üzerinde f_1 kılları yer almaktadır. Suranal plak bütün halde ve üç çift suranal kıl ($h_{1\text{-}3}$) taşımaktadır. Diğer sırt kılları çizgili integüment üzerinden çıkmaktadır. Humeral plaklar yoktur. Sırt kıllarından *ve*, *sce*, c_2 sivri uçlu ve çentiksidir. Diğer kıllar ise uca doğru hafif çentikli yapıdadır (Şekil 2A). Sırt kıllarının uzunlukları ve aralarındaki mesafeler şöyledir; *vi* 12 (13), *ve* 39 (42), *sci* 19 (18), *sce* 39 (41), c_1 12 (13), c_2 43 (42), d_1 13 (13), d_2 11 (13), e_1 12 (12), e_2 14 (14), f_1 25 (29), h_1 23 (21), h_2 26 (30), *vi*–*vi* 17 (20), *ve*–*ve* 24 (25), *vi*–*ve* 13 (11), *sci*–*sci* 39 (38), *ve*–*sci* 45 (49), *sce*–*sce* 112 (111), *sci*–*sce* 35 (37), c_1–c_1 49 (52), d_2–d_2 103 (101), c_1–d_1 53 (53), c_1–d_2 51 (51), d_1–d_1 36 (?), d_2–d_1 32 (32), e_2–e_2 71 (73), d_2–e_2 56 (60), d_1–e_1 38 (40), d_1–e_2 48 (51), e_1–e_1 24 (26), e_2–e_1 22 (23), f_1–f_1 42 (44), e_1–f_1 35 (38), e_2–f_1 27 (32), f_1–h_1 33 (32), f_1–h_2 31 (27), h_1–h_1 27 (29), h_2–h_2 50 (51), h_1–h_2 9 (8), h_3–h_3 63 (64).

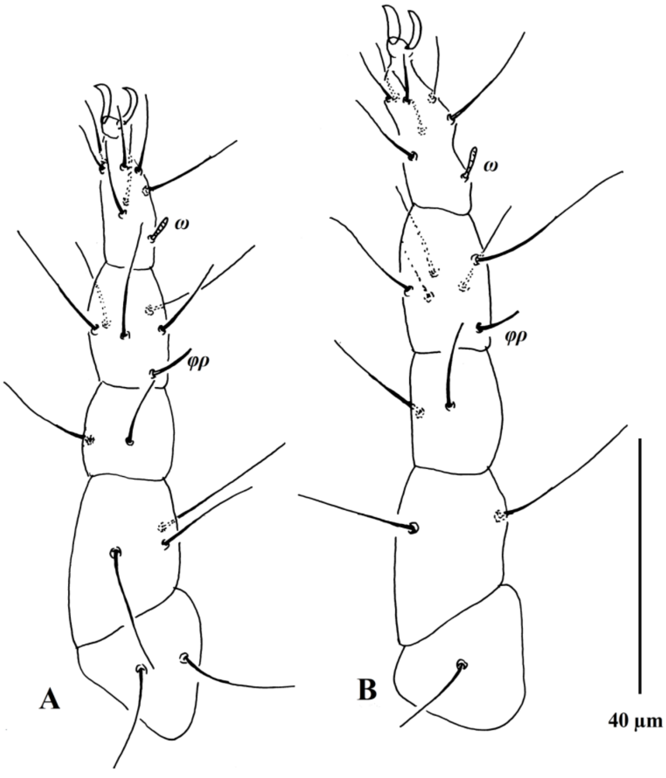


Şekil 2. *Stigmaeus pulumurensis* sp. nov. (Dişi). A. Bazı sırt kılları, B. Palp, C. Anogenital bölge.

Koksisternal plaklar bölünmüş ve üzerinde 1*a*, 3*a* ve 4*a* kıllarını taşımaktadır (Şekil 1B). Bu kılların uzunlukları ve aralarındaki mesafeler şöyledir; 1*a* 21 (22), 3*a* 19 (19), 4*a* 18 (18), 1*a*–1*a* 23 (24), 3*a*–3*a* 40 (38), 4*a*–4*a* 35 (32). Üç çift aggenital kıl vardır. Genital plakların yanlarında benekli desenler bulunur. ag_1 ve ag_2 ayrı plaklar üzerinden, ag_3 ve ag_4 ise aynı plak üzerinden çıkmaktadır. Üç çift genital ve üç çift pseudanal kıl bulunur (Şekil 2C, 6). Bu kılların uzunlukları şöyledir; g_1 5 (6), g_2 9 (10), g_3 18 (17), ag_1 10 (10), ag_2 11 (9), ag_3 13 (12), ps_1 22 (25), ps_2 21 (21), ps_3 11 (12).

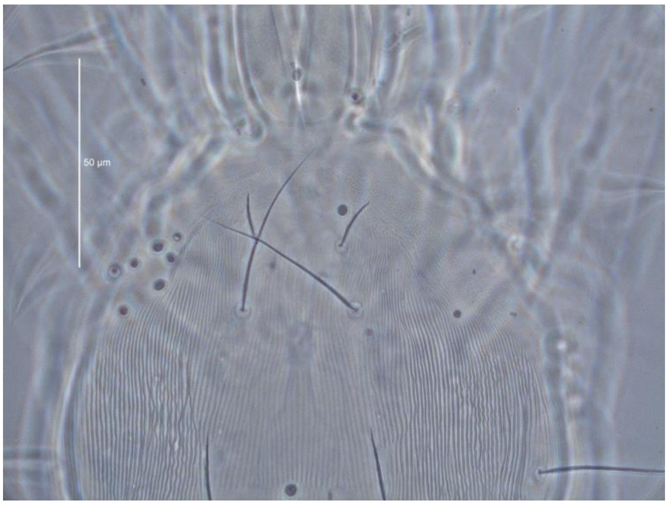


Şekil 3. *Stigmaeus pulumurensis* sp. nov. (Dişi). A. I. bacak, B. II. bacak.



Şekil 4. *Stigmaeus pulumurensis* sp. nov. (Dişi). A. III. Bacak, B. IV. Bacak.

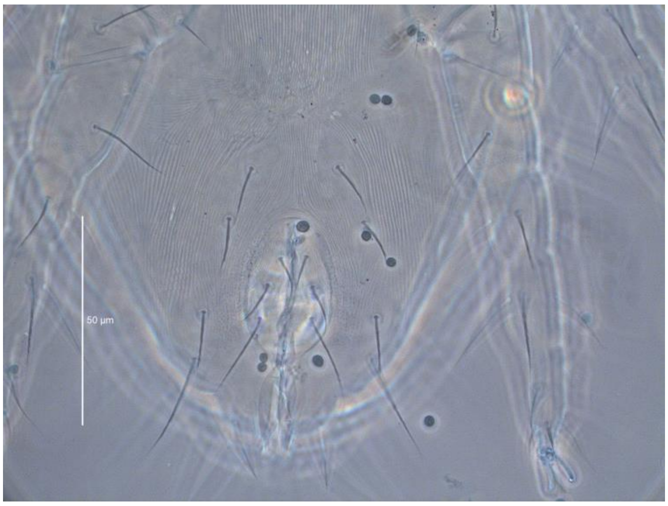
Bacak uzunlukları sırasıyla; I.B 125 (127), II.B 100 (96), III.B 105 (106), IV.B 113 (117) µm'dir. Bacak parçaları üzerindeki kılların dağılımı ise şöyledir; koksa: 2–2–2–2, trokanter: 1–1–2–1, femur: 6–6–3–2, genu: 5(+1κ)–4–2–2, tibiya: 5(+1φρ+1φ)–5(+1φρ)–5(+1φρ)–5(+1φρ), tarsus: 13(+1ω)–9(+1ω)–7(+1ω)–7(+1ω) (Şekil 3, 4).



Şekil 5. *Stigmaeus pulumurensis* sp. nov. (Dişi). Prodorsum.

Tip Örnekleri: Holotip ♀, söğüt (*Salix* sp.) kavuğundan döküntü ve toprak, Zağge mevkii, Pülümür Vadisi, Türkiye, 39°18'05.1''K, 39°46'39.8''D, 1169 m, 27.10.2018. Paratip ♀, holotip ile aynı lokaliteden toplanmıştır.

Etimoloji: Türe, bulunduğu yerin (Pülümür Vadisi) ismi verilmiştir.



Şekil 6. *Stigmaeus pulumurensis* sp. nov. (Dişi). Anogenital bölge.

TARTIŞMA

Bu tür; apodemal işaretin varlığı, *f* ve *h* kılları haricindeki diğer dorsal vücut kıllarının çizgili integüment üzerinde yer alması ve suranal plağın tam yapılı olması ile *Stigmaeus tokatensis* Dönel, Doğan, Sevsay ve Bal türüne benzemektedir (Dönel vd., 2012). Yeni türün bacak parçalarındaki kıl donanımı, *S. tokatensis* ile genel olarak örtüşse de, IV. bacak genusunda bir kılın eksik olması, *vi* kıllarının çıktığı bölgede, integümentin çizgili yapısının kaybolarak plak benzeri bir görünümün ortaya çıkması, prodorsumun ön yan kenarları ile genital plakların yanlarında benekli desenlerin bulunması ve aggenital kılların ayrı plaklar üzerinden çıkması ile *S. tokatensis*'ten farklılık göstermektedir.

Teşekkür

Bu çalışma, 118Z469 numaralı projeyle, Türkiye Bilimsel ve Teknolojik Araştırma Kurumu (TÜBİTAK) tarafından desteklenmiştir.

KAYNAKLAR

Akyol, M. 2019. A new species of the genus *Stigmaeus* Koch (Acari: Stigmaeidae) from the Aegean region of Turkey. Systematic and Applied Acarology, 24 (4): 581-586.
doi: 10.11158/saa.24.4.5

Anonim, 2019. Coğrafi yapı. T.C. Tunceli Valiliği, http://www.tunceli.gov.tr/doga-ve-cografya (Erişim Tarihi: 1 Aralık 2019).

Doğan, S. 2006. Contributions to the knowledge of the raphignathoid mites of Turkey (Acari, Raphignathoidea) with description of a new species. International Journal of Acarology, 32: 371-375.
doi: 10.1080/01647950608684484

Doğan, S. 2019a. A new species of the genus *Stigmaeus* Koch (Acari: Stigmaeidae) from Turkey. International Journal of Acarology, 45 (3): 141-147.
doi: 10.1080/01647954.2018.1549097

Doğan, S. 2019b. Raphignathoidea (Acari: Trombidiformes) of Turkey: A review of progress on the systematics, with an updated checklist. Acarological Studies, 45 (3): 141-147.

Dönel, G., Doğan, S., Sevsay, S. and Bal, D.A. 2012. Two new mite species of the genus *Stigmaeus* (Acari: Stigmaeidae) from Turkey. Turkish Journal of Zoology, 36 (5): 585-591.
doi: 10.3906/zoo-1110-26

Fan, Q.-H. and Zhang, Z.-Q. 2005. Raphignathoidea (Acari: Prostigmata). Fauna of New Zealand, Manaaki Whenua Press, Lincoln, Catenbury, New Zealand, 400 pp.

Fan, Q.-H., Flechtmann C.H.W. and De Moraes, G.J. 2016. Annotated catalogue of Stigmaeidae (Acari: Prostigmata), with a pictorial key to genera. Zootaxa, 4176: 1-199.
doi: 10.11646/zootaxa.4176.1.1.

Fan, Q.-H., Flechtmann C.H.W. and De Moraes, G.J. 2019. Emendations and updates to "Annotated catalogue of Stigmaeidae (Acari: Prostigmata), with a pictorial key to genera". Zootaxa, 4647 (1): 88-103.
doi: 10.11646/zootaxa.4647.1.9

Grandjean, F. 1944. Observations sur les acariens de la famille des Stigmaeidae. Archives des Sciences Physiques et Naturelles, 26: 103-131.

Işık, Y. 2012. Bir tutam Tunceli. TC. Tunceli Valiliği, Anıt Matbaa, Ankara, Türkiye.

Kethley, J. 1990. Acarina: Prostigmata (Actinedida). In: Dindal D.L. (Ed.) Soil Biology Guide. John Wiley and Sons, New York, USA, 667-756.

Köksal, T. and Ulaşoğlu, İ.H. 2012. Tunceli Yıllığı. TC. Tunceli Valiliği, Anıt Matbaa, Ankara.

Stathakis, T.I., Kapaxidi E.V. and Papadoulis, G.Th. 2019. The genus *Stigmaeus* Koch (Acari: Stigmaeidae) from Greece. Systematic and Applied Acarology, 24 (11): 2010-2093. doi: 10.11158/saa.24.11.4

Walter, D.E. and Krantz, G. 2009. Collecting, rearing, and preparing specimens. In: A Manual of Acarology, 3rd ed. Krantz, G.W. and Walter, D.E. (Eds). Texas Tech University Press, Lubbock, Texas, USA, 83-96.

Alan editörü: Raşit Urhan
Akran değerlendirme: Üç hakem tarafından yapılmıştır.

Citation: Doğan, S. and Doğan, S. 2020. A new species of the genus *Stigmaeus* Koch (Acari: Stigmaeidae) from Pülümür Valley (Turkey). Acarological Studies, 2 (1): 41-45. [In Turkish]

Acarological Studies
Vol 2 (1): 46-50

SHORT NOTE

First report of abnormal morphology in the tick *Dermacentor dissimilis* (Acari: Ixodidae) and evidence of molt nymph-adult on hosts from Nicaragua

Lillian DOMÍNGUEZ [1], **Eveling PÉREZ** [1,2], **Sergio BERMÚDEZ** [1,3,4]

[1] *Department of Research in Medical Entomology, Gorgas Memorial Institute for Health Research, Panama*
[2] *Centralamerica Program of Master in Entomology, University of Panama*
[3] *Coiba Scientific Station, (Coiba-AIP), City of Knowledge, Panama*
[4] Corresponding author: sbermudez@gorgas.gob.pa

Received: 4 June 2019 Accepted: 14 August 2019 Available online: 31 January 2020

ABSTRACT: A total of 10 females and 6 males of *Dermacentor dissimilis* were collected from horses and cows in Nicaragua. Four of these females presented malformations, while two nymphs were in the process of molting to adult. Further studies are necessary to find out whether this phenomenon is widespread among *D. dissimilis* specimens, and what the reasons for such malformations could be. Moreover, further research is necessary to better understand the life-cycle of *D. dissimilis*.

Keywords: *Dermacentor dissimilis*, malformations, ectromely, two-hosts tick.
Zoobank: http://zoobank.org/8E6DFF9F-783C-4FEE-93AC-C3DE309A51B8

Anomalies in ticks seem to occur at low frequency in the nature, which could be of interest in taxonomic and ecological studies (Nowak-Chmura, 2012; Buczek et al., 2017). Anomalies and malformations in ticks were described over 100 years ago and among the first descriptions is the presence of a supernumerary eye in *Hyalomma* sp., absence of the left I leg in *Amblyomma* sp., and atrophy of the right IV leg in *Ixodes hexagonus* (Neumann, 1899). With the passing years, new malformations were reported and posteriorly classified as general malformations, that include gynandromorphism, and local anomalies in the idiosome and appendages (Campana-Rouget 1959a,b). Currently, malformations and anomalies have been described in the genera *Argas*, *Ornithodoros*, *Amblyomma*, *Dermacentor*, *Haemaphysalis*, *Hyalomma*, *Ixodes*, and *Rhipicephalus* (Labruna et al., 2002; Buczek et al., 2017).

The genus *Dermacentor* Koch, 1844 comprises 40 species of ticks (Yunker et al., 1986; Apanaskevich and Bermúdez, 2013; Guzmán-Cornejo et al., 2016). In this genus, malformations such as gynandromorphism have been reported in *D. andersoni*, *D. occidentalis* and *D. reticulatus* (Homsher and Yunker, 1981; Oliver and Delfin, 1967; Chitimia-Dobler and Pfeffer, 2017), and local anomalies in *D. andersoni* (Dergousoff and Chilton, 2007; Chitimia-Dobler and Pfeffer, 2017), *D. atrosignatus* (Robinson, 1920), *D. niveus*, *D. marginatus, D. reticulatus* (reported as *D. pictus*) (Campana-Rouget, 1959b). All these species are from the Nearctic and Palearctic ecozones, and there is no information about these phenomena in Neotropical species.

In Central America eight species of *Dermacentor* are known (Yunker et al., 1986; Apanaskevich and Bermúdez, 2013; Guzmán-Cornejo et al., 2016). With the exception of *D. nitens*, a one-host tick parasitizing mainly horses, little is known about the other species in this region. Among these, *D. dissimilis* was initially described in southern Mexico and subsequently reported in Guatemala, Honduras, El Salvador and Nicaragua (Yunker et al., 1986; Bermúdez et al., 2015). Along with *D. nitens*, this species was included in the former genus *Anocentor* (Camicas et al., 1998; Guglielmone et al., 2003), and some authors referred to *D. dissimilis* as having a one-host life cycle (Kohls and Dalmat, 1952).

With the objective of providing more information about *D. dissimilis*, we report for the first time morphological anomalies in this species, and also provide additional information of the nymph to adult molt on the host. This corresponds to the first finding of this phenomenon in *Dermacentor* of Centro America (Neotropical ecozone).

As part of an investigation on ticks parasitizing livestock in Central America, ticks were collected from the Departments Jinotega and Nueva Segovia, Nicaragua, during the years 2015-2019. Fifteen horses and 7 cows were examined and ticks were removed from the neck, mane and around the ears of 3 horses and 2 cows and were preserved in 80% ethanol. Ticks were collected under the supervision and permission of the animal owners and transported to the Research Department in Medical Entomology of the Gorgas Memorial Institute of Health Studies in Panama for identification. A permit was obtained from the Ministry of the Environment (SIM/A-5-19) to conduct this study. Ticks were deposited in the Ectoparasites Collection of the Zoological Collection "Dr. Eustorgio Méndez" of the Gorgas Memorial Institute of Health Studies (AE-CoZEM-ICGES).

Ticks were examined under the stereomicroscope (Leica MZ125) and photographed using the coded stereoscope microscope (Leica M205A). The specimens were identified according to the taxonomic key of Yunker et al. (1986) and confirmed by comparison with the original descriptions of *D. dissimilis* (Cooley, 1947; Kohls and Dal-

Figure 1. Dorsal view of *Dermacentor dissimilis* female with atrophy in right leg III (arrow a) and asymmetry of scutum (arrow b).

Figure 2. Ventral view of *Dermacentor dissimilis* female with atrophy in right leg III and asymmetry of scutum.

Figure 3. Dorsal view of *Dermacentor dissimilis* female with bifurcation in the posterior margin of the idiosoma.

mat, 1952). In order to categorize the anomalies, we followed the suggestion of Campana-Rouget (1959a,b).

Overall 10 females and 6 males of *D. dissimilis* were collected from three horses and two cows. The data collection of these specimens were: 2♀♀, 2♂♂ Nicaragua: Jinotega, San José de Las Latas. 1200m. 13°3'13"N 85°56'3"W. 13 March 2015. Ex: Horse. Col: S. Bermúdez, L. Mejía, L. Hernández. 1 N, 6♀♀, 3♂♂ NICARAGUA, Jinotega, February 28, 2019. Ex: Horse. Col: S. E. Pérez. 2♀♀, 1♂ NICARAGUA, Nueva Segovia, March 10, 2019. Ex: Cow. Col: S. E. Pérez.

Abnormalities were found in: ♀ No. 1: JINOTEGA, San José de Las Latas. 1200m. March 13, 2015. Ex: Horse. Col: S. Bermúdez, L. Mejía, L. Hernández. ♀ JINOTEGA. February 28, 2019. Ex: Horse. Col: S. E. Pérez. ♀ No. 3: JINOTEGA. March 10, 2019. Ex: Cow. Col: S. E. Pérez. ♀ No. 4: JINOTEGA. March 10, 2019. Ex: Cow. Col: S. E. Pérez.

Female 1 exhibited an atrophied right leg III and asymmetry of scutum (Figs 1, 2); female 2 showed bifurcation in the posterior margin of the idiosoma (Fig. 3); female 3 presented several abnormalities in the right side, including atrophied of leg III and ectromely in coxa III and leg IV and atrophy of the left leg IV (Figs 4, 5); female 4 showed an atrophy of the right leg IV (Fig. 6).

In addition, two nymphs were collected in the process of molting to adults. The data collection of these nymphs is: NICARAGUA, Nueva Segovia. March 10, 2019. Ex: Cow. Col: E. Pérez. NICARAGUA, Jinotega. February 28, 2019. Ex: Horse. Col: E. Pérez. In regard to these specimens, in one nymph there are evidences of female characteristics, as a short scutum, presence of porose areas and similar size in coxae (Fig. 7); while the other nymph shows characteristics of males, evidenced in the presence of a large scutum (Figs 8, 9).

This is the first report of malformation in *D. dissimilis* and complements the information of malformations in ticks from Neotropical Regions (Rivera-Paéz et al., 2017). Out of four females, three showed local anomalies and one general anomaly. Ectromely and atrophies in legs have been reported in several species of ticks (Nowak-Chmura, 2012; Kar et al., 2015). Malformations seem to be rare phenomena, since only occurring in low percentages among the population (Chitimia-Dobler et al., 2017). For example, Guglielmone et al. (1999) revised a large series of ticks (n=64,473) in Argentina, but found abnormalities in 62 (≈1%), and Muñóz-Leal et al. (2018), found gynandromorphism in one specimen out of 92 *Amblyomma parvitarsum* examined, showing that malformations are either not noticed or that these kind of observations are usually not published.

It is possible that the origin of malformations in ticks is heavily debated and could be related to physical damage and injuries, congenital mutations, interspecies hybrids or to environmental factors (Campana-Rouget, 1959a; Tovornik, 1987; Nowak-Chmura, 2012; Buczek et al., 2017; Chitimia-Dobler et al., 2017). Moreover, malformations can lead to other abnormalities on the body of ticks, e.g., loss of legs can lead to deformities of the idiosome (Nowak-Chmura, 2012; Kar et al., 2015).

Figure 4. Ventral view of *Dermacentor dissimilis* female with atrophy in right leg III and ectromely in coxa III (arrows a and b), ectromely in right leg IV (arrow c), and atrophy of the left leg IV (arrow d).

Figure 5. Dorsal view of *Dermacentor dissimilis* female with atrophy in right leg III and ectromely in coxa III, ectromely in right leg IV, and atrophy of the left leg IV.

Figure 6. Ventral view of *Dermacentor dissimilis* female with atrophy of the right leg IV.

Dermacentor dissimilis is a parasite of ungulates and is irregularly distributed in areas with temperate climate from Mexico to Nicaragua (Yunker et al., 1986; Bermúdez et al., 2015; Guzmán-Cornejo et al., 2016). The fact of extracted and preserved nymphs molting to adult directly on the host, reaffirms previous assumptions about its one-host life-cycle (Cooley, 1947; Kohls and Dalmat, 1952). However, Cooley (1947) and Kohls and Dalmat (1952) who observed nymphs and adults feeding on animals, did not reported any molting of the ticks. Thus, the present work confirms that at least the second molt occurs on the host, although it is not possible to affirm that it is a one-host tick. So far, the larva of *D. dissimilis* has not been described (Guglielmone et al., 2014).

In our study few specimens of *D. dissimilis* were observed; thus, additional studies could give more information about the biology of this scarcely studied tick. With regard to malformations, it is likely that they are more frequent than previously thought, either because they are not recognized or because they are not considered in scientific reports. Further studies are also necessary to find and describe the larval stage of this species and to find out whether *D. dissimilis* is a one-host tick.

Acknowledgements

We would like to thanks Dr. Joao Varela-Petrucelli (Ministerio de Desarrollo Agropecuario, Panamá) and Dr. Santiago Nava (Instituto Nacional de Tecnología Agropecuaria, Argentina) for his comments to the early version of the manuscript.

REFERENCES

Apanaskevich, D. and Bermúdez, S. 2013. Description of a new *Dermacentor* species, a parasite of wild mammals in Central America. Journal of Medical Entomology, 50: 1190-1201.
doi: 10.1603/ME13121

Bermúdez S., Mejía L., Hernández L. and Apanaskevich D. 2015. First records of *Ixodes boliviensis* Neumann, 1904 and *Dermacentor dissimilis* Cooley, 1947 (Ixodida: Ixodidae) as parasites of domestic mammals in Nicaragua. Systematic and Applied Acarology, 20 (4): 462-464.
doi: 10.11158/saa.20.4.12

Buczek, A., Bartosik, K., Buczek, S. and Zajac, Z. 2017. Anomalies in *Hyalomma marginatum* larvae (Acari: Ixodidae) in relation to taxonomic studies. Systematic and Applied Acarology, 22 (3): 423-430.
doi: 10.11158/saa.22.3.8

Camicas, J., Hervy, J., Adam, F. and Morel, P. 1998. Les Tiques du Monde. Nomenclature, Stades Décrits, Hôtes, Répartition (Acarida, Ixodida). Éditions de L'Orstom. Paris, 223 pp.

Campana-Rouget, Y. 1959a. La tératologie des tiques. Annales de Parasitologie Humaine et Comparee, 34: 209-260.
doi: 10.1051/parasite/1959341209

Figure 7. Dorsal view of a nymph of *Dermacentor dissimilis* with female characteristics in scutum (arrow).

Figure 8. Dorsal view of a nymph of *Dermacentor dissimilis* with male characteristics.

Figure 9. Ventral view of a nymph of *Dermacentor dissimilis* with male characteristics.

Campana-Rouget, Y. 1959b. La tératologie des tiques (fin). Annales de Parasitologie Humaine et Comparee, 34: 354-431.
doi: 10.1051/parasite/1959343354

Chitimia-Dobler, L. and Pfeffer, M. 2017. Gynandromorphism and local morphological abnormalities in *Dermacentor reticulatus* (Acari: Ixodidae). Systematic and Applied Acarology, 22 (4): 449-455.
doi: 10.11158/saa.22.4.1

Chitimia-Dobler, L., Bestehorn, M., Bröker, M., Borde, J., Molcanyi, T., Andersen, N., Pfeffer, M. and Dobler, G. 2017. Morphological anomalies in *Ixodes ricinus* and *Ixodes inopinatus* collected from tick-borne encephalitis natural foci in Central Europe. Experimental and Applied Acarology, 72:379-397.
doi: 10.1007/s10493-017-0163-5

Cooley, R. 1947. *Dermacentor dissimilis*, a new species of ticks from southern Mexico. American Museum Novitates, 1332: 1-3.

Dergousoff, S. and Chilton, N. 2007. Abnormal morphology of an adult Rocky Mountain wood tick, *Dermacentor andersoni* (Acari: Ixodidae). Journal of Parasitology, 93: 708-709.
doi: 10.1645/GE-1073R.1

Guglielmone, A. Castella, A., Mangold, A., Estrada-Peña, A., Viñabal, E. 1999. Phenotypic anomalies in a collection of Neotropical ticks (Ixodidae). Acarologia, 40: 127-132.

Guglielmone, A., Estrada-Peña, A., Keirans, J. and Robbins R. 2003. Ticks (Acari: Ixodida) of the Neotropical zoogeographic region. International Consortium on Ticks and Tick-Borne Diseases, Houten, The Netherlands, 173 pp.

Guglielmone, A., Robbins, R., Apanaskevich, D., Petney, T., Estrada-Peña, A. and Horak, I. 2014. The Hard Ticks of the World (Acari: Ixodida: Ixodidae). Springer, Dordrecht, xiii. 738 pp.

Guzmán-Cornejo C., Robbins, R., Guglielmone, A., Montiel-Parra, G., Rivas, G. and Pérez, T. 2016. The *Dermacentor* (Acari, Ixodida, Ixodidae) of Mexico: hosts, geographical distribution and new records. ZooKeys, 569: 1-22.
doi: 10.3897/zookeys.569.7221

Homsher, P. and Yunker, C. 1981. Bilateral gynandromorphism in *Dermacentor andersoni* (Acari:Ixodidae): morphological and cytogenetic analysis. Journal of Medical Entomology, 18, 89-91.
doi: 10.1093/jmedent/18.1.89

Kar, S., Akyildiz, G., Yilmazer, N., Shaibi, T., Gargili, A. and Vatansever, Z. 2015. External morphological anomalies in ixodid ticks from Thrace, Turkey. Experimental and Applied Acarology, 67: 457-466.
doi: 10.1007/s10493-015-9948-6

Kohls, G. and Dalmat, H. 1952. The male of *Dermacentor dissimilis* Cooley (Acarina: Ixodidae). The Journal of Parasitology, 38 (2): 144-142.
doi: 10.2307/3273832

Labruna, M., Ribeiro, A., Cruz, M., Camargo, L. and Camargo, E. 2002. Gynandromorphism in *Amblyomma cajennense* and *Rhipicephalus sanguineus* (Acari: Ixodidae). The Journal of Parasitology, 88: 810-811.
doi: 10.1645/0022-3395(2002)088[0810:GIACAR]2.0.CO;2

Muñoz-Leal, S., Martins, T., Luna, L., Rodriguez, A. and Labruna, M. 2018. A new collection of *Amblyomma parvitarsum* (Acari: Ixodidae) in Peru, with description of a gynandromorph and report of *Rickettsia* detection. *Journal of Medical Entomology,* 55 (2): 464-467.
doi: 10.1093/jme/tjx194

Neumann, L. 1899. Anomalie d'ixodidés. Archives Parasitologie, 2: 463-465.

Nowak-Chmura, M. 2012. Teratological changes in tick morphology in ticks feeding on exotic reptiles. Journal of Natural History, 46: 911-921.
doi: 10.1080/00222933.2011.651635

Oliver, J. and Delfin, E. 1967. Gynandromorphism in *Dermacentor occidentalis* (Acari:Ixodidae). Annals of the Entomological Society of America, 60: 1119-1121.

Rivera-Páez F., Larbuna M., Martins T., Rodrigues-Sampieri B. and Camargo-Mathias M. 2017. A case of gynandromorphism in *Amblyomma mixtum* (Acari. Ixodidae). Revista Colombiana de Entomología, 43 (2): 268-270.
doi: 10.25100/socolen.v43i2.5956

Robinson, L. 1920. Malformations in ticks. Parasitology, 12: 175-179.
doi: 10.25100/socolen.v43i2.5956

Tovornik, D. 1987. Teratological forms of ixodid ticks. Bioloski Vestnik, 35: 91-100.

Yunker, C., Keirans, J., Clifford, C. and Easton, E. 1986. *Dermacentor* ticks of the New World: a scanning electron microscope atlas. Proceeding of the Entomological Society of Washington, 88: 609-627.

Edited by: Salih Doğan
Reviewed by: Three anonymous referees

Citation: Domínguez, L., Pérez, E. and Bermúdez, S. 2020. First report of abnormal morphology in the tick *Dermacentor dissimilis* (Acari: Ixodidae) and evidence of molt nymph-adult on hosts from Nicaragua. Acarological Studies, 2 (1): 46-50.

Acarological Studies
Vol 2 (1): 51-53

SHORT NOTE

Free-living *Panthera onca* (Carnivora: Felidae) as host of *Amblyomma mixtum* and *Rhipicephalus microplus* (Ixodida: Ixodidae) in Darién, Panamá

Lillian G. DOMÍNGUEZ [1,5], Josué ORTEGA [2], Ricardo MORENO [2,3], Sergio E. BERMÚDEZ [1,4]

[1] *Department of Research in Medical Entomology, Gorgas Memorial Institute of Health Studies, Panama City, Panama*
[2] *Yaguara Panama Foundation, City of Knowledge, Panama*
[3] *Smithsonian Tropical Research Institute, Balboa Ancon, Panama*
[4] *Coiba Scientific Station, Coiba AIP, City of Knowledge, Panama*
[5] Corresponding author: ldominguez@gorgas.gob.pa

Received: 23 August 2019 Accepted: 23 November 2019 Available online: 31 January 2020

ABSTRACT: We report the parasitism of a male of *Amblyomma mixtum* and a molt nymph-adult of *Rhipicephalus microplus* in Darién, Panamá. These data increase the number of tick species that parasitize free-living jaguars in Panama and add information on the environmental conditions that favor the parasitism of *A. mixtum* and *R. microplus*.

Keywords: Environment, *Panthera onca*, *Amblyomma mixtum*, *Rhipicephalus microplus*, new tick-host record.
Zoobank: http://zoobank.org/3370EC75-2415-43F1-A131-1B0A3A50F776

Jaguars, *Panthera onca* (Linnaeus), are the largest species of Felidae in America and the only of the genus *Panthera* in this continent (Sunquist and Sunquist, 2002). These predators occupy different environments from the southwest of the United States to northern Argentina; however, its distribution and population has been reduced by habitat loss and hunting (Loveridge et al., 2010). In Panama, the jaguars maintain a discontinuous distribution, living in regions ranging from 0 to 3000 meters above sea level, both in mature forests, as in secondary forests and in buffer areas near parks and nature reserves (Meyer et al., 2019; Moreno et al., 2016). Being a flagship species, in Panama jaguars are mainly studied to determine their ranges of distribution, abundance, density, ecology and potential conflicts with humans, which are designed for the conservation of the species in different countries (Moreno, 2006; Moreno et al., 2016). In contrast, there are few works designed to estimate the parasitic load that these animals can hold.

In general, since predators are in close contact with their prey, they can carry ticks of their own species or those of their prey (Samish and Rehacek, 1999). Under these circumstances, their wide home range exposes to a greater variety of tick species. With the purpose of increasing the knowledge of ticks that parasitize jaguars, this work presents new data obtained from a specimen captured and equipped with a GPS collar in a region of the province of Darién where patches of forests with pastures and stubble collide. The specimen captured as part of a monitoring and conservation study of the jaguar, which was approved through research protocol No. SE/A-15-2019 (Environmental Ministry of Panama), which includes the dosages for anesthesia and animal welfare for veterinarian of wildlife (Fig. 1). Prior to its release, it was checked for ectoparasites, removing two ticks, which were placed in 70% ethanol and transported to the Department of Research in Medical Entomology of the Gorgas Memorial Institute for Health Studies.

Ticks were identified using a Leica MZ125 stereo microscope and photographed with a Leica M205A (Leica Microsystems, Germany) stereoscopic. Following the taxonomic criteria of Bermúdez et al. (2018), ticks were identified as a male of *Amblyomma mixtum* Koch (Fig. 2) and a nymph of *Rhipicephalus microplus* (Canestrini), which had female characteristics (Fig. 3). Both specimens were deposited in the Ectoparasite Collection of the "Dr. Eustorgio Méndez" Zoological Collection of the Gorgas Memorial Institute for Health Studies (CoZEM-ICGES).

This is the first report in Panama of a jaguar as a host of *A. mixtum* and *R. microplus*. Both species are sympatric in paddocks; however, its biology varies considerably. *Amblyomma mixtum* is a native species, three-hosts tick and highly opportunistic, particularly immatures (Guglielmone et al., 2014). In Panama so far, about 20 species of mammals, two of birds and two of reptiles have been found parasitized to this species, although it seems to maintain preferences towards equines and ponchos *Hydrochoerus isthmius* (Goldman) (García et al., 2014; Bermúdez et al., 2018). In addition to pastures, this species is distributed in deciduous forests and riparian vegetation (Fairchild et al., 1966; Bermúdez et al., 2016). On the contrary, *R. microplus* is an introduced species, one-host tick and closely related to cattle; consequently, its distribution is in grazing areas (Guglielmone et al., 2014). These data indicate that the jaguar had to wander in a pasture, or either to move between patches of forest and to prey on domestic animals.

In early studies from Panama, it was reported that jaguars are parasitized by adults of *Amblyomma ovale* Koch, *Ixodes affinis* Neumann and *Ixodes boliviensis* Neumann. Adults of these species are mainly parasites of wild carnivores in perturbed and mature forests, but also domestic mammals in rural zones (Fairchild et al., 1966; Bermúdez and Miranda, 2011; Guglielmone et al., 2014). These species have environmental preferences that restrict their distribution, e.g. *A. ovale* and *I. affinis* inhabit forested and rural regions below 700 meters above sea level, and *I. boliviensis* subsists at elevations above 1700 m a.s.l. (Fairchild et al., 1966; Bermúdez et al., 2018).

Figure 1. Female jaguar captured and fitted with a GPS collar to monitor her movement. Under sedation the vital signals were monitored while a black towel was used to cover her eyes (© J. Ortega Yaguara Panama Foundation).

Other works in America report a diversity of ticks that parasitize jaguars, according to the region. In a study covering several states and biomes of Brazil nine species of tick were collected in 26 jaguars, highlighting *Amblyomma cajennense* s.l., *R. microplus* and the equine tick *Dermacentor nitens* Neumann (Labruna et al., 2005). In Mexico, adults of *Ixodes scapularis* Say and *A. mixtum* (cited as *A. cajennense*) were collected from a female jaguar captured in Tamaulipas (Almazán et al., 2013). In Belize, Lopes et al. (2016) reported larvae of *Amblyomma coelebs* Neumann, and adults of *A. ovale*, *Amblyomma* cf. *oblongoguttatum* Koch, and *I. affinis* in two jaguars. These data stand out the importance of jaguars as hosts of different tick species, both in ticks that parasitize carnivores, and in those that are opportunistic. Moreover, the presence of ticks as *A. mixtum*, *A. cajennense*, *R. microplus* or *D. nitens*, indicates the presence of jaguars hunting in grazing areas, which is potentially indicative of habitat loss and possibly also of prey.

Figure 2. Dorsal view of *Amblyomma mixtum* male.

Finally, despite the ecological importance of ticks are often underestimated in studies of large carnivores in several Latin American countries. Ticks may provide information on types of environments and also data on potential risks of disease transmission. In this sense, studies in Brazil demonstrate the presence of ticks-borne pathogens in jaguars, such as *Rickettsia* and *Ehrlichia* (Widmer et al., 2011) or parasites such as *Cytauxzoon felis* and *Hepatozoon* (Furtado et al., 2017a,b); although, it is not known how these pathogens could affect the health of their host. Consequently, more research will be needed to assess the impact that parasitism of ticks can have on predators such as jaguars.

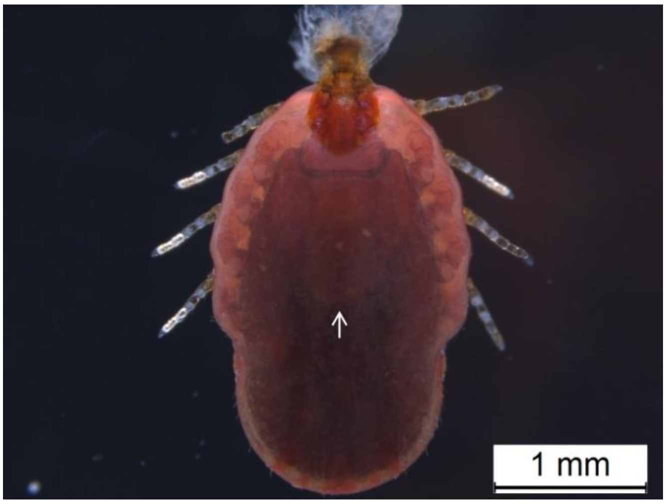


Figure 3. Dorsal view of the nymph of *Rhipicephalus microplus* with female characteristics in scutum (arrow).

Acknowledgements

To Natalia Young, Arturo Puertes, Edgar Sánchez, Leonardo Pretelt, Alejandra Flores, Iliana Cisneros, Erasmo De León, Jean De Leon, Vayron De Gracia for their support in this project; Antonio De La Torre, Ivonne Cassaigne, Ricardo Jiménez, Bernardo Castillo, Susana Ilescas Furter and Eloisa Astorga, for their support in the capture, management and release of the captured jaguar; João Varela-Petrucelli for his revision to the English. Yaguara Panama Foundation has fund of National Secretary of Science and Technology (grant No. 70-2017) and supporting of the Environmental Ministry of Panama (SE/A-15-2019).

REFERENCES

Almazán, C., Castro-Arellano., I. and Camacho-Puga, R. 2013. Black-legged ticks (*Ixodes scapularis*) on the jaguar (*Panthera onca*). The Southwestern Naturalist, 58 (1): 122-124.
doi: 10.1894/0038-4909-58.1.122

Bermúdez, S. and Miranda, R. 2011. Distribution of ectoparasites of *Canis lupus familiaris* L. (Carnivora: Canidae) from Panama. Revista de Medicina Veterinaria y Zoonosis, 16, 2274-2282.
doi: 10.21897/rmvz.285

Bermúdez, S., Castro, A., Trejos D., García, G., Gabster, A., Miranda R., Zaldívar, Y. and Paternina, L. 2016. Distribution of spotted fever group Rickettsiae in hard ticks

(Ixodida: Ixodidae) from Panamanian urban and rural environments (2007–2013). EcoHealth, 13 (2): 274-284.
doi: 10.1007/s10393-016-1118-8

Bermúdez, S., Apanaskevich, D. and Domínguez, L. 2018. Garrapatas Ixodidae de Panamá. 129 pp. [In Spanish]

Fairchild, G., Kohls, G. and Tipton, J. 1966. The ticks of Panama (Acarina: Ixodoidea). Ectoparasites of Panama. Wenzel, R. and Tipton, V. (Eds). Field Museum of Natural History, Chicago, US, 167-207.

Furtado, M., Taniwaki, S., Metzger, B., Dos Santos, K., O'Dwyer, H., de Almeida, A., Porfírio, G., Silveira, L., Sollmann, R., Tôrres, N. and Ferreira, J. 2017a. Is the free-ranging jaguar (*Panthera onca*) a reservoir for *Cytauxzoon felis* in Brazil? Ticks and Tick-borne Diseases, 8 (4): 470-476.
doi: 10.1016/j.ttbdis.2017.02.005

Furtado, M., Metzger, B., de Almeida, A., Labruna, M., Martins, T., O'Dwyer, H., Paduan, K., Porfírio, G., Silveira, L., Sollmann, R., Taniwaki, S., Tôrres, N. and Ferreira, J. 2017b. *Hepatozoon* spp. infected free-ranging jaguars. Journal of Parasitology, 103 (3): 243-250.
doi: 10.1645/16-99

García, G., Castro, A., Rodríguez, I. and Bermúdez, S. 2014. Ixodid ticks of *Hydrochoerus isthmius* Goldman 1912 (Rodentia: Caviidae) in Panama. Systematic and Applied Acarology, 19 (4): 404-408.
doi: 10.11158/saa.19.4.4

Guglielmone, A., Robbins, R., Apanaskevich, D., Petney, T., Estrada-Peña, A. and Horak, I. 2014. The hard ticks of the world. Springer, Dordrecht, The Netherlands, 738 pp.
doi: 10.1007/978-94-007-7497-1

Labruna, M., Jorge, R., Sana, D., Jacomo, A., Kashivakura, C., Furtado, M., Ferro, C., Perez, S., Silvera, L., Santos, T., Marques, S., Morato, R., Nava, A., Adania, C., Teixeira, R., Gomes, A., Conforti, V., Azevedo, F., Prada, C., Silva, J., Batista, A., Marvulo, M., Morato, R., Alho, C., Pinter, A., Ferreira, P., Ferreira, F. and Barros-Battesti, D. 2005. Ticks (Acari: Ixodidae) on wild carnivores in Brazil. Experimental and Applied Acarology, 36: 149-163.
doi: 10.1007/s10493-005-2563-1

Lopes, M., May, J., Foster, R., Harmsen, B., Sanchez, E., Martins, T., Quigley, H., Marcili, A. and Labruna, M. 2016. Ticks and Rickettsiae from wildlife in Belize, Central America. Parasites and Vectors, 9: 62.
doi: 10.1186/s13071-016-1348-1

Loveridge, A., Wang, S., Frank, L. and Seidensticker, J. 2010. People and wild felids: conservation of cats and management of conflicts. In: Biology and Conservation of Wild Felids. Macdonald, D.W. and Loveridge, A.J. (Eds). Oxford University Press, New York, US, 161-198.

Meyer, N., Moreno, R., Sutherland, C., De la Torre, A., Esser, H., Jordan, C., Olmos, M., Ortega, J., Reyna-Hurtado, R., Valdes, S. and Jansen, P. 2019. Effectiveness of Panama as an intercontinental land bridge for large mammals. Conservation Biology, 1-13.
doi: 10.1111/cobi.13384

Moreno, R. 2006. Parámetros poblacionales y aspectos ecológicos de los felinos y sus presas en Cana, Parque Nacional Darién, Panamá. Universidad Nacional, Costa Rica, 135 pp. [In Spanish]

Moreno, R., Valdés, S., Artavia, A., Young, N., Ortega, J., Brown, E., Sánchez, E. and Meyer, N. 2016. Conflicto entre felinos y humanos en Panamá: avances en la resolución del conflicto, educación y conservación del jaguar. In: Conflicto entre felinos y humanos en Latino América. Castaño-Uribe, C., Lasso, C., Hoogesteijn, R., Diaz-Pulido, A. and Payan, E. (Eds). Serie Editorial Fauna Silvestre Neotropical, Instituto de Investigaciones de Recursos Biológicos Alexander von Humboldt, Bogota. D.C., Colombia, 61-72. [In Spanish]

Samish, M. and Rehacek, J. 1999. Pathogens and predators of ticks and their potential in biological control. Annual Review of Entomology, 44: 159-182.
doi: 10.1146/annurev.ento.44.1.159

Sunquist, M. and Sunquist, F. 2002. Wildcats of the world. The University of Chicago Press, Ltd., London, GB, 462 pp.
doi: 10.7208/chicago/9780226518237.001.0001

Widmer, C., Azevedo, F., Almeida, A., Ferreira, F. and Labruna, M. 2011. Tick-borne bacteria in free-living jaguar (*Panthera onca*) in Pantanal, Brazil. Vector-Borne and Zoonotic Diseases, 11 (8): 1001-1005.
doi: 10.1089/vbz.2011.0619

Edited by: Kosta Y. Mumcuoglu
Reviewed by: Two anonymous referee

Citation: Domínguez, L.G., Ortega, J., Moreno, R. and Bermúdez, S.E. 2020. Free-living *Panthera onca* (Carnivora: Felidae) as host of *Amblyomma mixtum* and *Rhipicephalus microplus* (Ixodida: Ixodidae) in Darién, Panamá. Acarological Studies, 2 (1): 51-53.

Acarological Studies
Vol 2 (1): 54-57

SHORT NOTE

Süne (*Eurygaster integriceps*) üzerinde parazit olan *Leptus* (*L.*) *esmailii* (Acari: Erythraeidae) akar türünün Türkiye'den ilk kaydı

Eyüp Efe PAMUK [1], Sevgi SEVSAY [2,3]

[1] *Erzincan Halk Sağlığı Laboratuvarı, Erzincan, Türkiye*
[2] *Erzincan Binali Yıldırım Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, Erzincan, Türkiye*
[3] Sorumlu yazar / Corresponding author: ssevsay@erzincan.edu.tr

Geliş: 28 Kasım 2019 | Kabul: 13 Aralık 2019 | Online erişim: 31 Ocak 2020
Received: 28 November 2019 | Accepted: 13 December 2019 | Available online: 31 January 2020

ÖZET: İran'dan süne, *Eurygaster integriceps* Puton (Hemiptera: Scutelleridae), üzerinde ektoparazit olarak kayıt edilen *Leptus* (*L.*) *esmailii* Saboori ve Ostovan larvaları, yine aynı tür konukçu üzerinden ülkemizden toplanmıştır. Larvaların kısaca tanımı yapılarak daha önce İran'dan verilen örnekler ile karşılaştırılmış ve önemli kısımlarının ışık mikroskobunda alınan görüntüleri verilmiştir. Bu çalışma, *Leptus* cinsinin ülkemizden ikinci kaydıdır.

Anahtar Kelimeler: Akar, dış parazit, larva, *Leptus,* Parasitengona, süne.
Zoobank: http://zoobank.org/4402A908-4A15-4306-894F-B0CA65CA4AC5

First record of the mite species of *Leptus* (*L.*) *esmailii* (Acari: Erythraeidae) parasitising on sunn pest (*Eurygaster integriceps*) from Turkey

ABSTRACT: The larvae of *Leptus* (*L.*) *esmailii* Saboori and Ostovan given as ectoparasitic on sunn pest, *Eurygaster integriceps* Puton (Hemiptera: Scutelleridae) from Iran were collected from the same species host in Turkey. The larvae were briefly described and compared with the specimens which are previously given from Iran, also light microscope images of important parts of the specimens were presented here. This study is the second record of the genus *Leptus* from Turkey.

Keywords: Acari, ectoparasite, larva, *Leptus*, Parasitengona, sunn pest.

Prostigmata alt takımında yer alan Erythraeidae ve Trombidiidae familyaları böcekler üzerinde parazit olup, onlara zarar vererek beslenirler (Welbourn, 1983). Erythraeidler ergin dönemde predatör olup genellikle çeşitli eklembacaklılarla beslenirken, larvalarının büyük bir çoğunluğu ise sinek, afit, çekirge gibi farklı böcek grupları üzerinde parazittir. Bu yüzden ekonomik öneme sahiptirler (Welbourn, 1983; Goldarazena vd., 2000; Sevsay ve Karakurt, 2013).

Leptus Latreille cinsinin üyeleri Palearktik bölgede geniş yayılış göstermekte olup çöl, otlak alanlar, mağara ve ormanlar gibi çok farklı ortamlarda yaşarlar (Wohltmann, 2000). Bu cins, iki alt cinse sahiptir. *Amaroptus* alt cinsi bir türle, *Leptus* alt cinsi ise 281 türle temsil edilmektedir (Mąkol ve Wohltmann, 2012; Haitlinger ve Šundić, 2014; Šundić vd., 2017; Saboori vd., 2018; Bernard vd., 2019). *Leptus* türlerinin en karakteristik özellikleri; kristanın her bir kenarında birer göz, iki çift duyusal kıl ve skutela kılı (*AL* ve *PL*) taşıyan üçgenimsi bir skutumun varlığı ile palpfemur ve palpgenusunun iki kıl taşımasıdır.

Bugüne kadar *Leptus esmailii* larvaları *Eurygaster integriceps* Puton (Hemiptera: Scutelleridae) üzerinden sadece İran'dan verilmiştir (Saboori ve Ostovan, 2000). Larva evresinden bilinen bu türün ergin evresi bilinmemektedir. Ülkemizden bu cinse ait sadece bir tür, *L. rosellae*, Haitlinger (1999) tarafından tanımlanmamış ve bir Acridiidae (Orthoptera) üzerinden parazit olarak İzmir ilinden verilmiştir (Sevsay, 2017).

Bu çalışmada, Erzincan ilinden toplanan süneler üzerinde parazit olarak bulunan *L. esmailii* Türkiye faunası için yeni kayıt olarak verilmiştir. *Leptus* cinsinin ülkemizden ikinci, türün ise dünyadaki ikinci kaydıdır.

Temmuz 2018'de farklı zamanlarda gidilen arpa ve buğday tarlalarından elle toplanan süneler plastik şişelere alınarak laboratuvar ortamına canlı olarak getirilmiştir. Stereo mikroskop altında incelenen ve üzerinde larva olan örnekler yaşam şişelerine (alçı-kömür karışımlı) konularak larvaların konukçu üzerinden beslenip, konukçudan ayrılması için bekletilmiştir. Bu yöntem, larva sayısı fazla olan konukçular için larvadan deutonimf oluşturmak amacıyla kullanılmaktadır. Fakat çalışma kapsamında toplanan süneler üzerinde larva sayısı az olduğu için diğer yaşam evreleri gözlenememiştir.

Tespit edilen sünede örneklerinin birinde bir parazit larvası, diğerinde ise iki adet larva olmak üzere toplam iki akar örneği toplanmıştır. Fakat larvalardan bir tanesi fungus bulaştığı için incelenememiştir. Her iki konukçu da parazit akarlar sünenin abdomenin son segmentinde bulunmuştur.

Teşhis için kullanılan iki örnek KOH ile temizlenerek (Mąkol, 2005) Hoyer ortamında preparatları yapılmıştır.

Teşhis, çizim ve ölçüm işlemleri Leica DM 3000, fotoğraf çekimleri ise Olympus BX63 DIC donanımlı ışık mikroskobunda yapılarak, ölçümler mikrometre (µm) cinsinden verilmiştir.

Bu çalışmada değerlendirilen örneklerin vücut bölgeleri ile kıllarının isimlendirilmesinde Southcott (1961, 1992) tarafından önerilen sistemler esas alınmıştır. Çalışmada sunulan akar örnekleri Erzincan Binali Yıldırım Üniversitesi Fen Edebiyat Fakültesi Biyoloji Bölümü Akaroloji Laboratuvarında saklanmaktadır.

Familya: Erythraeidae

Altfamilya: Leptinae Billberg, 1820

Cins: *Leptus* Latreille, 1796

Altcins: *Leptus* Latreille, 1796

Leptus (*L.*) *esmailii* Sabori ve Ostovan 2000

Teşhis: Palpfemur bir, palpgenu iki kıllı, interkoksala 4'den daha fazla kıllı, ayrıca bir çift 1*a* ve 2*a* sterna kılı taşır.

Tanım: İdiosoma oval şekilde, dalcıklı kıllar taşır (Şekil 1). Skutumun genişliği boyundan daha fazladır, iki çift duyusal (sensilla) iki çift de skutum kılı taşır (*AL* ve *PL*). *AL* kılı, *PL* kılından uzundur.

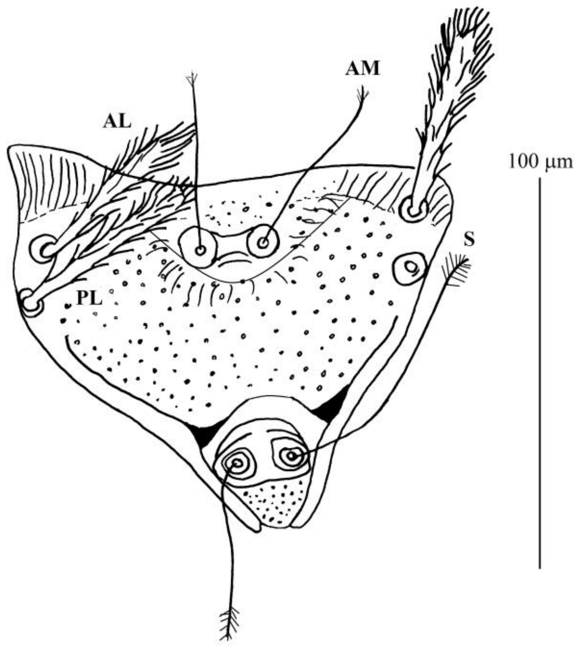
Şekil 1. *Leptus* (*L.*) *esmailii* (Larva). Dorsal görünüm.

Skutumun ön kısmı derin olarak iç bükeydir (Şekil 2) ve anteriyor duyu kıllarını da içine alacak şekilde ön kısımda sertleşmiş ve boyuna çizgilidir (Şekil 3). Skutumun yan taraflarında tek mercekli bir çift göz bulunur. Dorsal kılların hepsi dalcıklıdır; Fd= 127-125.

İdiosomanın ventral yüzeyindeki koksalar 1*b*, 2*b* ve 3*b* şeklinde birer kıl taşır (Şekil 4) 1*b* kılı, 3*b* kılından en az iki kat daha uzundur. Gnathosoma dardır. Palpfemur bir uzun dalcıklı kıla, palpgenu eşit uzunlukta iki kıla sahiptir. Palptarsus bir solenidiyum ve bir öpathidiyum da dâhil 9 kıla sahiptir (Şekil 5, 6).

Bacaklardaki kıl donanımı: I. Bacak: Ta- 1ω,1ε, 2ζ, 14 n; Ti- 2φ, 1κ, 9n; Ge- 1σ, 1κ, 4n; TFe- 4n; BFe- 2n; Tr- 1n; Cx- 1n. II. Bacak: Ta- 1ω, 1ζ, 18n; Ti- 2φ, 10n; Ge- 1σ, 7n; TFe- 5n; BFe- 1n; Tr- 1n, Cx- 1n. III. Bacak: Ta- 1ζ, 20n; Ti- 1φ, 12n; Ge- 6n; TFe- 4n; BFe- 1n; Tr- 1n; Cx- 1n.

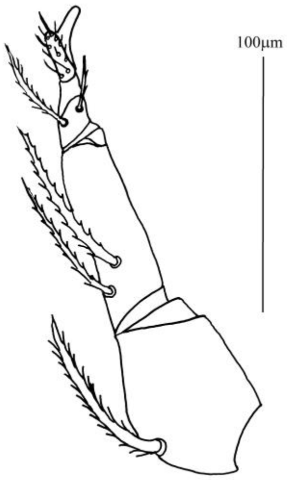
Şekil 2. *Leptus* (*L.*) *esmailii* (Larva). Skutum.



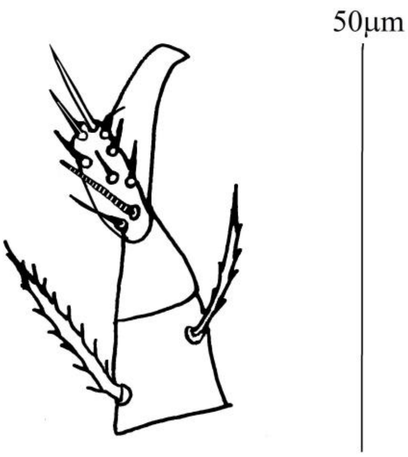
Şekil 3. *Leptus* (*L.*) *esmailii* (Larva). Skutum.

Eurygaster integriceps üzerinden parazit olarak toplanan ve larva evresinde olan *Leptus esmailii*, şimdiye kadar sadece İran'dan verilmiştir (Saboori ve Ostovan, 2000). *Leptus* türleri temelde palpgenu ve femur ile I-III. koksalar arasındaki kıl sayısıyla birbirlerinden ayrılırlar. *L. esmailii* palpgenuda iki, palpfemurda bir, bir çift 1*a* ve 2*a* kıla sahip olmasıyla bu cinse ait olan dokuz türünden biridir. Erzincan'dan toplanan örneklerde vücut uzunluğu 1122 (1136-1108) µm'dir. Örneklerimizin 1*a*, 1*b*, 2*b* ve 3*b* kıllarının İrandan verilen tip örneklerinkinden daha uzun olduğu söylenebilir. Örneklerimizin 1*a* uzunluğu 39 µm (diğerlerinde 33-34), 1*b* 64-67 µm (diğ. 58), 2*b* 26 µm (diğ. 16-22) ve 3*b* kılı 28-34 µm arasında iken tip örneklerinde 23-27 µm'dir. Ayrıca bacakların kıl sayılarında da bazı farklılıklar vardır: I. bacağın tibiyasında iki solenidiyum (diğ. bir), II. bacak tarsusunda bir öpathidiyum (diğ. iki) vardır. Örneklerimiz, bazı kılların uzunluğu ve bacaklardaki kılların sayısı bakımından tip örneklerinden farklılık göstermekte, diğer yapısal özellikleri bakımından tip örnekleriyle uyuşmaktadır (Tablo 1).

Şekil 4. *Leptus* (*L.*) *esmailii* (Larva). Ventral görünüm.



Şekil 5. *Leptus* (*L.*) *esmailii* (Larva). Palp, dorsal görünüm.



Şekil 6. *Leptus* (*L.*) *esmailii* (Larva). Palpin tibiya ve tarsus parçaları.

Teşekkür

Sünenin teşhisinde yardımcı olan Doç. Dr. Şener TARLA'ya (Uşak Üniversitesi, Ziraat ve Doğa Bilimleri Fakültesi, Bitki Koruma Bölümü, Uşak, Türkiye) teşekkür ederiz.

KAYNAKLAR

Bernard, R., Felska, M. and Mąkol, J. 2019. Erythraeid larvae parasitizing dragonflies in Zambia-description of *Leptus* (*Leptus*) *chingombensis* sp. nov. with data on biology and ecology of host-parasite interactions. Systematic and Applied Acarology, 24 (5): 790-813. doi: 10.11158/saa.24.5.6

Goldarazena, A., Zhang Z-Q. and Jordana R. 2000. A new species and a new record of ectoparasitic mites from thrips in Turkey (Acari, Trombidiidae and Erythraeidae). Systematic Parasitology, 45: 75-80. doi: 10.1023/A:1006289526619

Haitlinger, R. 1999. Three new larval mites (Acari: Prostigmata: Eutrombidiidae, Erythraeidae, Trombellidae) from Australia, Turkey and Thailand. Zeszyty Naukowe Akademii Rolniczej we Wrocławiu, Zootechnika, 45 (362): 57-73.

Haitlinger, R. and Šundić, M. 2014. *Leptus* (*Leptus*) *chiusicus* nov. sp. (Acari, Prostigmata, Erythraeidae) from Sicily, Italy. Linzer Biologische Beiträge, 46: 1509-1515.

Mąkol, J. 2005. Trombidiidae (Acari: Actinotrichida: Trombidioidea) of Poland. Fauna Poloniae. Museum and Institute of Zoology, Polish Academy of Sciences and Natura Optima Dux Foundation, Warsaw, 1: 1-259.

Mąkol, J. and Wohltmann, A. 2012. An annotated checklist of terrestrial Parasitengona (Actinotrichida: Prostigmata) of the world, excluding Trombiculidae and Walchiidae. Annales Zoologici, 62: 359-562.

Saboori, A. and Ostovan, H. 2000. A new species of the genus *Leptus* Latreille, 1796 (Acari: Erythraeidae) ectoparasitic on sunn pest, *Eurygaster integriceps* Puton (Hemiptera: Scutelleridae) from Iran. Systematic and Applied Acarology, 5: 143-147. doi: 10.11158/saa.5.1.16

Saboori, A., Hartmann, M., Hakimitabar, M., Khademi, N. and Katouzian, A.R. 2018. A new species of larval *Leptus* (Acari: Erythraeidae) from Markazi Province of Iran. International Journal of Acarology, 44: 90-95. doi: 10.1080/01647954.2018.1461241

Sevsay, S. 2017. A checklist of the Erythraeoidea and Trombidioidea (Actinotrichida: Prostigmata) of Turkey. Turkish Bulletin of Entomology, 7 (2): 175-196. doi: 10.16969/teb.315117

Sevsay, S. and Karakurt, İ. 2013. The morphology and developmental stages of *Eutrombidium trigonum* (Hermann) (Acari: Microtrombidiidae). Turkish Journal of Entomology, 37 (1): 145-157. [In Turkish]

Tablo 1. *Leptus* (*L.*) *esmailii* larvalarının Türkiye örnekleri ile İran'dan verilen örneklerin karşılaştırılması

	Türkiye Örnekleri (n=2)		İran Örnekleri (n=5)			Türkiye Örnekleri (n=2)		İran Örnekleri (n=5)	
Karakter	**1.örnek**	**2.örnek**	**Min.**	**Mak.**	**Karakter**	**1.örnek**	**2.örnek**	**Min.**	**Mak.**
IL	1136	1108	407	835	**Ta I (H)**	17	19	16	16
IW	776	739	289	642	**Ti I**	180	176	184	184
SD	99	120	88	99	**Ge I**	130	142	132	132
W	122	128	118	124	**TFe I**	95	91	99	102
AW	103	98	99	104	**BFe I**	104	98	110	118
PW	115	114	108	115	**Tr I**	50	52	55	55
SB	13	17	15	16	**Cx I**	82	84	69	77
ISD	58	-	58	60	**Ta II (L)**	129	131	138	138
AP	15	14	14	19	**Ta II (H)**	18	18	14	14
AL	53	54	44	49	**Ti II**	150	157	154	154
PL	51	-	42	44	**Ge II**	110	114	107	107
AM	36	-	36	52	**TFe II**	79	79	82	82
S	77	54	72	74	**BFe II**	87	88	88	88
DS	29-38	15-33	27-33	30-39	**Tr II**	56	49	55	55
1a	39	39	33	34	**Cx II**	83	85	69	74
1b	67	64	58	58	**Ta III (L)**	153	171	165	165
2b	26	-	16	22	**Ta III (H)**	15	18	14	14
3b	28	34	23	27	**Ti III**	221	228	220	220
GL	211	213	220	231	**Ge III**	119	125	124	124
PaScFeD	64	61	55	60	**TFe III**	99	101	102	110
PaScGev	52	29	42	47	**BFe III**	104	108	102	104
PaScGed	58	-	55	61	**Tr III**	49	53	50	55
Ta I (L)	155	159	160	160	**Cx III**	78	78	67	77

Southcott, R.V. 1961. Studies on the systematics and biology of the Erythraeoidea (Acarina), with a critical revision of the genera and subfamilies. Australian Journal of Zoology, 9: 367-610.
doi: 10.1071/ZO9610367

Southcott, R.V. 1992. Revision of the larvae of *Leptus* Latreille (Acarina, Erythraeidae) of Europe and North America, with descriptions of post-larval instars. Zoological Journal of the Linnean Society, 105: 1-153.
doi: 10.1111/j.1096-3642.1992.tb01228.x

Šundić, M., Haitlinger, R. and Pompermaier, V.T. 2017. A new species of larval *Leptus* Latreille from Brazil (Acari, Prostigmata, Erythraeidae). Spixiana, 40: 89-93.

Wohltmann, A. 2000. The evolution of life histories in Parasitengona (Acari: Prostigmata). Acarologia, 41: 145-204.

Welbourn, W.C. 1983. Potential use of trombidioid and erythraeoid mites as biological control agents of insect pests. In: Biological Control of Pests by Mites. Hoy, M.A., Cunningham, G.L. and Knutson, L. (Eds). Agricultural Experiment Station, Division of Agriculture and Natural Resources, University of California, Berkeley, No: 3304, 103-140.

Editör: Salih Doğan
Akran değerlendirme: Üç hakem tarafından yapılmıştır.

Citation: Pamuk, E.E. and Sevsay, S. 2020. First record of the mite species of *Leptus* (*L.*) *esmailii* (Acari: Erythraeidae) parasitising on sunn pest (*Eurygaster integriceps*) from Turkey. Acarological Studies, 2 (1): 54-57. [In Turkish]

Acarological Studies
Vol 2 (1): 58

ERRATUM

Correction: Raphignathoidea (Acari: Trombidiformes) of Turkey: A review of progress on the systematics, with an updated checklist

Salih DOĞAN

Department of Biology, Faculty of Sciences and Arts, Erzincan Binali Yıldırım University, Erzincan, Turkey
e-mail: salihdogan@erzincan.edu.tr

Available online: 31 January 2020

A family name was misspelt on pages 133 and 139 (Table 2) in Doğan (2019): 'EUPALOSELLIDAE' should be 'EUPALOPSELLIDAE'*.

*Dr. Sibel DOĞAN of Erzincan Binali Yıldırım University kindly brought the error to the author's attention.

REFERENCE

Doğan, S. 2019. Raphignathoidea (Acari: Trombidiformes) of Turkey: A review of progress on the systematics, with an updated checklist. Acarological Studies, 1 (2): 129-151.