Uluslararası Tarım Araştırmalarında Yenilikçi Yaklaşımlar Dergisi
International Journal of Innovative Approaches in Agricultural Research 2023, Vol. 7 (3), 347-355
https://doi.org/10.29329/ijiaar.2023.602.9

Original article

Annual Monitoring Programme of European Red Wood Ants Distributed in Yildiz (Stranjha) Mountains

Özge Gemik [a] & Yılmaz Çamlıtepe [a, *]

[a] Department of Biology, Faculty of Sciences, Trakya University, Edirne, Türkiye

Abstract

In this study, nests belonging to the European Red Wood ant *Formica pratensis* Retzius, 1783 in the Yildiz (Stranjha) Mountains of Kırklareli province of Türkiye were examined in the spring and autumn periods. Field studies were carried out in previously registered regions and in Çağlayık Village, which was registered for the first time. The field results determined that 31 of the 43 known nests were destroyed, and the current number of nests was 31 with 19 newly detected nests. During the field studies of the nests in two separate periods, diameter and height data, nest shape, and habitat characteristics were examined and recorded on the nest identification cards. The results demonstrated that all of the nests are monodome type built in the forest clearing and mostly in sun-drenched areas. Nest volumes were evaluated as an indicator for determining colony density, and the measurements in the two periods were compared to determine the effect of seasonal changes. The factors causing the destruction of nests were determined as a factor causing nest destruction, habitat destruction, and conversion of the land into different usage areas. Distribution maps were prepared with the coordinate data of the nests. Living areas (area of occupancy, AOO) were calculated with a 2x2 km grid added to the distribution maps, and extent of occurrence (EOO) was calculated with appropriate polygons. The results demonstrated that with the destruction of 31 nests, AOO decreased by 45% and EOO by 40% over a period of 4 years. Adding newly found nests to the remaining nests with the current distribution map prepared showed that AOO occupies a smaller area by 20% and EOO by 26% compared to the previous distribution in 2014. Regarding nest volumes, there was no significant difference in the two periods. The data obtained indicates the high extinction rate in a short time and the fact that the current distribution is lower than the previous distribution despite the new nests, indicating the importance of conducting a conservation study.

Keywords: Formica Pratensis, European Red Wood Ant, Conservation Biology, Monitoring, GIS.

Received: 14 September 2023 * **Accepted:** 01 October 2023 * **DOI:** https://doi.org/10.29329/ijiaar.2023.602.9

* **Corresponding author:**

Yılmaz Çamlıtepe, Department of Biology, Faculty of Sciences, Trakya University, Edirne, Türkiye.
Email: yilmazc@trakya.edu.tr

INTRODUCTION

Ants are called keystone species, as they generally establish permanent nests in the ecosystem and they become an important part of the ecosystem they are in, with the continuity they show, the large biomass they represent with their crowded colony members, and the complex networks they establish (Hölldobler and Wilson, 1990). Ants physically and chemically change the structure of the soil with the nests they establish in the ecosystems they live in, and they contribute to soil fertility by enriching microorganisms effective in decomposition (Jakubczyk et al., 1972; Petal, 1978).

Formica pratensis Retzius, 1783 is one of the red wood ants belonging to the F. rufa species group that lives in areas such as forest clearings, shrubs, plains, steppes and meadows (Collingwood, 1979; Czechowski et al., 2002) and builds mound-shaped nests on the ground. These nests can be monodomous with a single mound, or they can be polydomous with multiple queens and more than one mound (Aksoy and Çamlıtepe, 2018; Kiss and Kóbori, 2010; Punttila and Kilpeläinen, 2009). Formica pratensis is considered both a keystone and ecosystem engineer species since their existence at different tropical levels, soil aeration, and their ecological roles (Sorvari, 2016) such as carrying millions of prey to their nests throughout the year (Sörensen and Schmidt, 1987) and pollination of some plants (Rico-Gray and Oliveira, 2007).

Formica pratensis is distributed in many parts of Europe, from various parts of countries such as Switzerland, Italy, and Portugal to Siberia (Collingwood, 1979). Its distribution in Turkey is limited to the Thrace Region, and the species was not found in studies conducted in Anatolia (Aktaç, 1987; Çamlıtepe, 1987; Kıran and Aktaç, 2006; Lapeva-Gjonova and Kıran, 2012). The European distribution species has been evaluated in the NT category under the IUCN red list (IUCN, 2023).

Since ants generally live in fixed nests in crowded colonies, the biggest threat they face in the habitats where the nests are located is the destruction of their habitats (Alonso, 2010). Habitats located in various terrestrial areas are subject to change and destruction due to human-induced activities such as deforestation, urbanization, agriculture, grazing, and mining, and to degradation due to natural causes (Philpott et al., 2010). The fragmentation of habitats and the formation of smaller patches, the reduction of density by cutting down trees, and the ratio of core and edge areas of habitats cause nests to be abandoned and their density to decrease rapidly as newly established nests cannot withstand adverse conditions (Sorvari and Hakkarainen, 2007; Leal et al., 2012). In addition, burning land for the growth of pastures is one of the important threats for ants (Dias et al., 2012).

MATERIAL AND METHOD

Working area

Stranjha Mountains are located in the region that covers a certain part of the Thrace Region in Turkey, starting from the southern parts of Bulgaria and extending from the Black Sea coast to the

southeast. Beech (*Fagus orientalis*) forests are dense in the high regions of the northern part of the Kırklareli province, which was selected as the study area within the Stranjha Mountains, due to the humid climate (Yarcı, 1997). In these moist forests, which start from the peaks and continue up to a certain height, oak (*Quercus petrea*) communities can be found in some areas as the altitude decreases. In the northwestern parts, forests, where stemmed oak (*Quercus robur*) is dominant and formed together with hornbeam (*Carpinus betulus*) and beech (*Fagus orientalis*), are encountered. In the low-altitude (200-600 m) plateaus in the southern parts, dry forests are seen and the dominant species are hairy oaks (*Quercus cerris*) (Güngördü, 1999).

Data Collection

The fieldwork was carried out in 21 different localities, in a total of 7 days in two periods in the summer and autumn of 2018 when the nests were active (Table 1).

Table 1. Localities where the fieldwork was carried out.

	Date	*Localities*
	30.05.2018	Elmacık-Kofçaz-Kocatarla-Taştepe-Terzidere-Topçular-Ahmetler
	31.05.2018	Koruköy-Kapaklı-Dereköy-Geçitağzı
	01.06.2018	Balaban-Demirköy-Hamdibey-Yeşilce-İğneada
	02.06.2018	Armağan-Armutveren-Karadere-Çağlayık
	27.09.2018	Koruköy-Dereköy-Karadere-Armağan-Çağlayık-Geçitağzı
	28.09.2018	Kofçaz-Kocatarla-Terzidere-Topçular-Ahmetler
	24.10.2018	Balaban-Hamdibey-Yeşilce-Sivriler-Demirköy

During the field work, the causes of destruction of the vanished F. pratensis nests were examined, the habitat information of the active nests, the monodome and polydome status of the nests and their mound shapes (flattened/steeper) were examined, and the diameters and heights to be used in nest volume calculations were measured. After necessary inspections, each nest was photographed from various angles where both the nest material and the surrounding habitat could be seen. All procedures were carried out for newly detected nests in areas where nests were found, and coordinate information was determined with a GPS device.

The nest volumes to be used in estimating the colony densities of the nests are based on the large diameter (D), small diameter (d) and height (h) data obtained by measuring the parts of the nests protruding from the soil surface (Figure 1). Nest volumes were calculated using the formula $V= 2/3 \times \pi \times D/2 \times d/2 \times h$ (Porter et al., 1992).

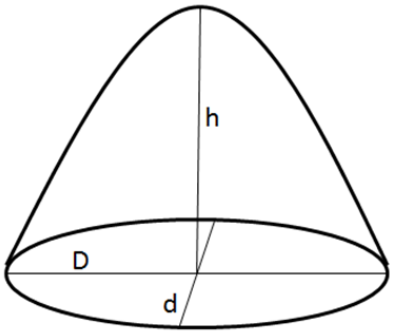

Figure 1. Nest measurement model (D: large diameter, d: small diameter, h: height).

Data Analysis and Creating Maps

R Studio (ver 3.2.1) program was used to analyze the nest measurement data. The coordinate data of the nests were used to map the distribution of the nests in the region using the QGIS (ver 3.6 Noosa) program. The added 2km x 2 km grid and the polygons drawn using the outermost nests were used to map the extent of occurrence (EOO) and area of occupancy (AOO).

RESULTS

Field studies were carried out in 21 different localities and as a result of these studies, it was determined that 31 of the 43 nests recorded in 2014 were destroyed and only 12 nests were alive. The current number of nests is 31, with 19 new nests recorded for the first time (Figure 2). A t-test was applied to determine whether there was a significant difference in the average volumetric changes of the 18 nests that could be measured in both periods, and it was determined that the average volume change in the nests was not significant ($t = -0.0088597$, $p = 0.993$; $p>0.05$). The altitude values of the nests were measured; the highest was 643 m, the lowest was 314 m and the average was 449 m (Figure 3).

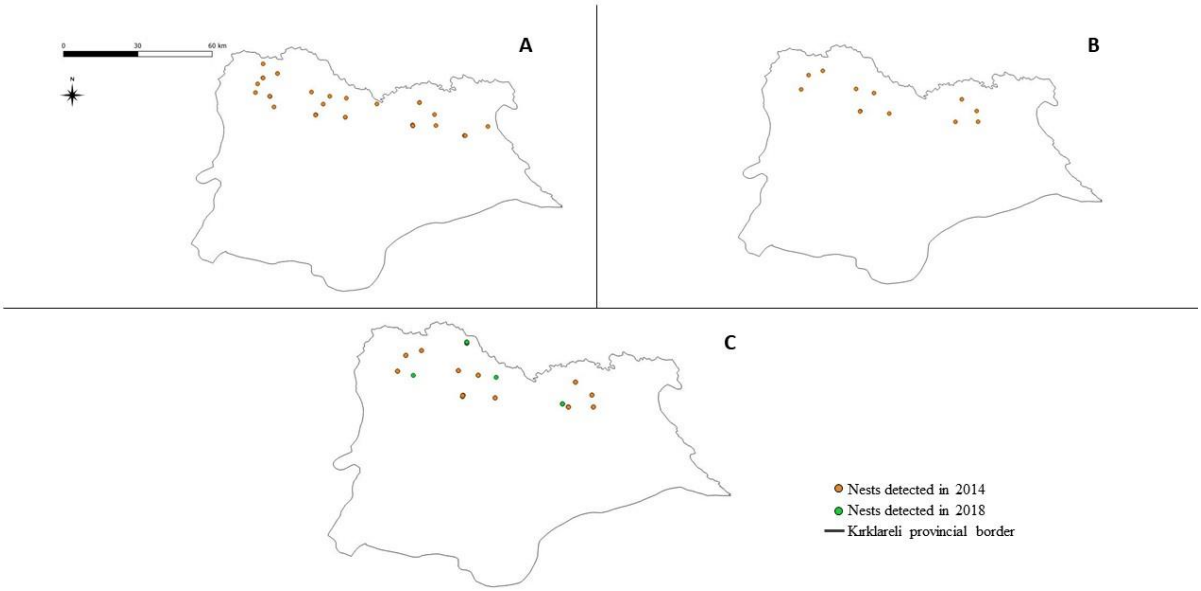

Figure 2. Distribution maps of Formica pratensis nests in the Stranjha Mountains section of Kırklareli province; A: Nests detected in 2014, B: Those still alive from the nests detected in 2014, C: Current distribution in 2018 with new nests found.

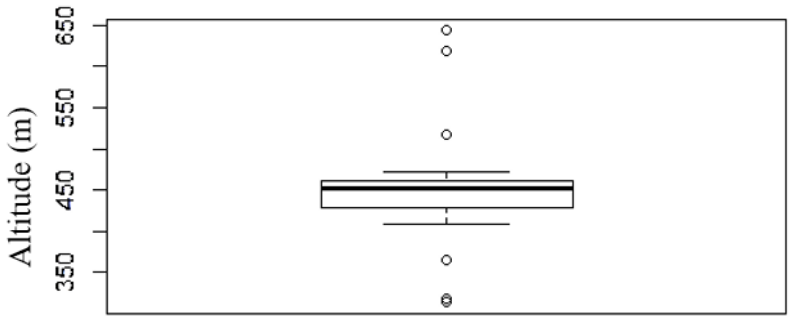

Figure 3. The altitude values of the nests.

A nest is called flattened when the radius measured for the above-ground mound is equal to the mound height (Maavara et al., 1994). Based on this, the nests were defined as flattened when the height was equal to or less than the radius, and steeper when it was greater than the radius. It was determined that 22 of 31 nests were flattened and 9 of them were steeper. All of the nests were found in the forest clearing, and no nests were found in the dense forest cover. It was seen that almost all nests were built under the trees, in the bushes, on the side of the road-field edge or in the fern.

The total area of the grid cells where the nests are located and the areas of the polygons are calculated separately and compared. According to the distribution of 43 nests found in the Stranjha Mountains in 2014, the habitat (area of occupancy, AOO) was calculated as 80 km^2 and the EOO as 789

km^2. However, it was determined that 31 of these nests were destroyed and in order to determine the loss rates, AOO and EOO maps were prepared for 12 living nests and EOO was calculated as 476 km^2 and AOO as 44 km^2. According to these results, it was observed that there was 40% area loss for EOO and 45% area loss for AOO in the four-year period. In the current map created by adding the new nests recorded for the first time within the scope of this study to the 12 living nests, AOO is calculated as 64 km^2 and EOO as 583 km^2, and the current nest distribution is 20% less for AOO and 26% for EOO compared to the distribution in 2014 (Figure 4).

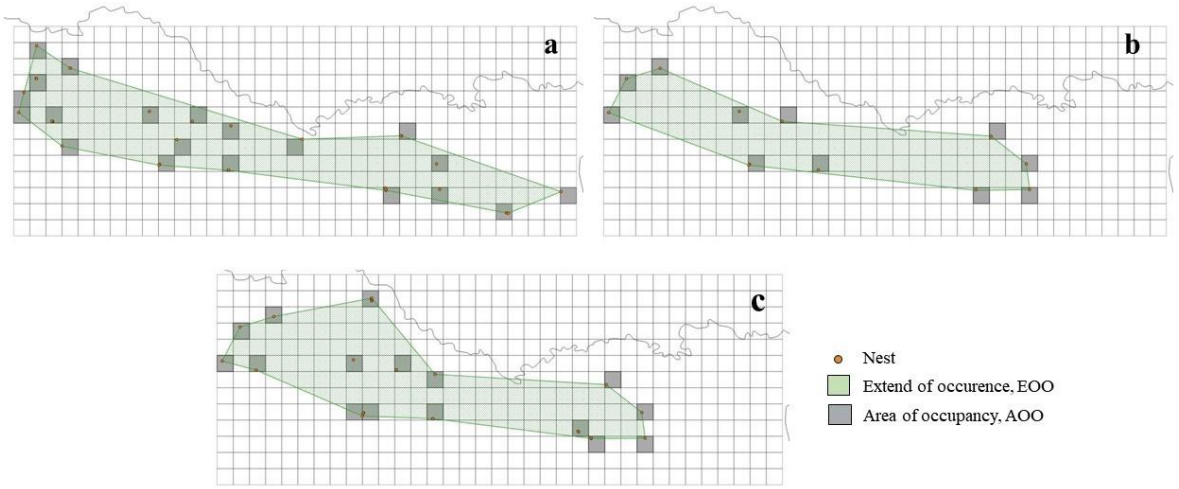

Figure 4. Extent of occurrence and area of occupancy maps. a: Nests determined in 2014; b: Remaining nests determined in 2014; c: Current nests in 2018.

DISCUSSION

While it was known that there were 43 nests in the research area in 2014, it was determined that 31 of these nests were destroyed and only 12 were alive in this research we conducted in 2018. indicating a huge loss of 72% in just 4 years. Whether nests continue to exist or disappear in the research area may depend on many different reasons. Climate change, pollution and various natural causes, especially habitat loss can cause nests to disappear (Sorvari, 2016). In this study, considering the increasing human activities in the region due to the transformation of habitats into different areas or the cases where the nests are destroyed by human hands, it can be said that the biggest factor in extinction is 'anthropogenic' effect, directly or indirectly. Determining the most effective factor(s) in extinction is very important as it will have the biggest share in shaping the necessary conservation studies.

According to the study of Domisch et al. (2005), which is in line with our results, nest monitoring has been made in various forest areas and it has been observed that while there are no nests in the long-term destroyed forest area, it provides the continuity of the nests in a mature forest that is not destroyed.

Another physical feature obtained in addition to the existence information of the nests is seasonal volume differences. Field studies were carried out in two periods and volumes were calculated as a result of the necessary physical measurements. Not all nests could be measured in both periods, only 18 nests could be compared volumetrically. In 8 of these nests, the volume remained constant, increased in 8, and decreased in 2. According to the t-test results, there was no significant difference since the volume averages of the two periods were very close to each other, but when the volumetric differences of the individual nests were examined, it was seen that different factors were effective on the volumes. It was determined that the Çağlayık 2 nest, which was among the nests that shrunk in volume, was crushed by the cattle passing through the area, and the Demirköy nest was also subjected to destruction and thus shrank in this way, especially in line with the decrease in height. In addition to physical destruction, nests can also shrink in volume in line with various environmental factors. For example, it has been documented that heavy metal pollution causes red wood ant nests to shrink in volume (Eeva et al., 2004). Nest volume growth is not always related to the growth potential of the colony; It can also be affected by various environmental factors such as biotope properties and temperature (Freitag et al., 2016). Based on this finding, it can be said that for the 8 nests where no volume change was observed, their growth may have been limited due to ecological factors. 8 nests showing growth can be considered as an indicator that nests tend to grow in cases where there is no physical intervention or environmental limiting pressure.

The current and old situations of the extenst of occurrence (EOO) and area of occupancy (AOO) were compared with the maps prepared with the coordinate data of the nests. Since there are currently a small number of nests in each locality, it has been observed that the species has lost its presence in various localities along with the loss of nests, and it has been possible to quantify this with area calculations: In only 4 years, a very high loss of 40% for EOO and 45% for AOO was observed. In general, the queens of red wood ants may stay in the existing nest (polygyne) by forming a satellite nest close to the main nest (polydome) or spreads within the population range (Seppä, 2008). It is inevitable that populations of species with low dispersal ability will become vulnerable to threat in the long term due to ongoing habitat destruction (Robinson and Stockan, 2016). During the field work, new nests were detected in addition to the losses, but these nests were generally found to be in areas close to the nesting points, and with current area calculations, it was determined that despite the new nests, they occupied an area of 26% less for EOO and 20% less for AOO, compared to the previous distribution in 2014. In a study conducted on an island in the south of Sweden, a total of 64 *F. pratensis* nests, 44 monodomous and 20 polydomous, were detected in a 300x80 m^2 area in the forest clearing (Pirk et al., 2001). It can be seen more clearly when compared to the study, that the number of nests in the study area is quite low for an area of this size. When we compare these results with ours, it shows that there are very few nests left in our study area (the part of Stranjha in Turkey covers an area of 197 000 hectares), which is much larger than that area in Sweden.

Acknowledgments

This research was supported by the Scientific Research Projects Unit of Trakya University, TUBAP 2018/131.

REFERENCES

Aksoy, V., & Çamlıtepe, Y. (2018). Effects of genetic relatedness, spatial distance, and context on intraspecific aggression in the red wood ant *Formica pratensis* (Hymenoptera: Formicidae). *Turkish Journal of Zoology, 42*, 297-306.

Aktaç, N. (1987). Kırmızı orman karıncalarının *Formica rufa* Group (Hymenoptera: Formicidae) Türkiye deki yayılışları ve taxonomisi üzerine araştırmalar. *Türkiye I. Entomoloji Kongresi*, (pp. 501-509). İzmir.

Alonso, L. E. (2010). Ant Conservation: Current Status and a Call to Action. In L. Lach, C. L. Parr, & K. L. Abbott (Eds.), *Ant Ecology*. Oxford: Oxford University Press.

Collingwood, C. A. (1979). *The Formicidae (Hymenoptera) of Fennoscandia and Denmark, Fauna Entomologica Scandinavica Volume 8.* Klampenborg: Scandinavian Science Press. Ltd.

Czechowski , W., Radchenko , A., & Czechowska , W. (2002). *The ants (Hymenoptera, Formicidae) of Poland.* Warszawa: Museum and Institute of Zoology PAS.

Çamlıtepe, Y. (1987). Trakya Bölgesi (Istranca Dağları) Orman Karınca Faunası. Yüksek Lisans Tezi.

Dias, R. K., Kosgamage, K. R., & Peiris, H. A. (2012). The taxonomy and conservation status of ants (Order: Hymenoptera, Family: Formicidae) in Sri Lanka. In D. Weerakoon, & D. S. Wijesundara (Eds.), *The National Red List 2012 of Sri Lanka: Conservation Status of the Fauna and Flora* (pp. 11-19). Colombo, Sri Lanka: Ministry of Environment.

Domisch, T., Finér, L., & Jurgensen, M. F. (2005). Red wood ant mound densities in managed boreal forests. *Annales Zoologici Fennici, 42*, 277–282.

Eeva, T., Sorvari, J., & Koivunen, V. (2004). Effects of heavy metal pollution on red wood ant (*Formica* s. str.) populations. *Environmental Pollution, 132*, 533–539.

Freitag, A., Stockan, J. A., Bernasconi, C., Maeder, A., & Cherix, D. (2016). Sampling and monitoring wood ants. In J. A. Stockan, & E. J. Robinson, *Wood Ant Ecology and Conservation.* Cambridge: Cambridge University Press .

Güngördü, M. (1999). *Marmara Bölgesinin Bitki Coğrafyası.* İstanbul: İstanbul Üniversitesi Edebiyat Fakültesi Yayınları.

Hölldobler, B., & Wilson, E. O. (1990). *The Ants.* Cambridge: The Belknap Press of Harvard University Press.

IUCN (2023). Retrieved from http://www.iucnredlist.org (accessed 10.08.2023)

Jakubczyk, H., Czerwinski, Z., & Petal, J. (1972). Ants as agents of the soil habitat changes. *Ekologia Polska, 20*, 153-161.

Kıran, K., & Aktaç, N. (2006). The Vertical Distribution of the Ant Fauna (Hymenoptera: Formicidae) of the Samanli Mountains. *Linzer Biologische Beiträge, 38*(2), 1105-1122.

Kiss, K., & Kóbori, O. T. (2010). *Formica pratensis* supercolony in the Hoia Forest (Cluj Napoca, Romania). *Acta Scientiarum Transylvanica, 18*(1).

Lapeva-Gjonova, A., & Kıran, K. (2012). Ant fauna (Hymenoptera, Formicidae) of Strandzha (Istranca) Mountain and adjacent Black Sea coast. *North-Western Journal of Zoology, 8*(1), 72-84.

Leal, I. R., Filgueiras, B. K., Gomes, J. P., Iannuzzi, L., & Andersen, A. N. (2012). Effects of habitat fragmentation on ant richness and functional composition in Brazilian Atlantic forest. *Biodiversity and Conservation, 21*(7), 1687–1701.

Maavara, V., Martin, A.-J., Oja, A., & Nuorteva, P. (1994). Sampling of Different Social Categories of Red Wood Ants (*Formica* s. str.) for Biomonitoring. In B. Markert (Ed.), *Environmental Sampling for Trace Analysis.* Weinheim: VCH.

Petal , J. (1978). The role of ants in ecosystems. In M. V. Brian (Ed.), *Production Ecology of Ants and Termites.* Cambridge: Cambridge University Press.

Philpott, S. M., Perfecto, I., Armbrecht, I., & Parr, C. L. (2010). Ant Diversity and Function in Disturbed and Changing Habitats. In L. Lach, C. L. Parr, & K. L. Abbott (Eds.), *Ant Ecology.* Oxford: Oxford University Press.

Pirk, C., Neumann, P., Moritz, R., & Pamilo, P. (2001). Intranest relatedness and nestmate recognition in the meadow ant *Formica pratensis* (R.). *Behavioral Ecology and Sociobiology, 49*(5), 366–374.

Porter, S. D., Fowler, H. G., & Mackay, W. P. (1992). Fire Ant Mound Densities in the United States and Brazil (Hymenoptera: Formicidae). *Journal of Economic Entomology, 85*(4), 1154-1161.

Punttila, P., & Kilpeläinen, J. (2009). Distribution of mound-building ant species (*Formica* spp., Hymenoptera) in Finland: preliminary results of a national survay. *Annales Zoologici Fennici, 46*, 1-15.

Rico-Gray, V., & Oliveira, P. S. (2007). *The Ecology and Evolution of Ant-Plant Interactions.* Chicago: The University of Chicago Press.

Robinson, E., & Stockan, J. (2016). Future directions for wood ant ecology and conservation. In J. A. Stockan, & E. J. Robinson, *Wood Ant Ecology and Conservation.* Cambridge: Cambridge University Press.

Seppä, P. (2008). Do ants (Hymenoptera: Formicidae) need conservation and does ant conservation need genetics? *Myrmecological News, 11*, 161-172.

Sorvari, J. (2016). Threats, conservation and management. In J. A. Stockan, & E. J. Robinson, *Wood Ant Ecology and Conservation.* Cambridge: Cambridge University Press.

Sorvari, J., & Hakkarainen, H. (2007). Wood ants are wood ants: deforestation causes population declines in the polydomous wood ant *Formica aquilonia*. *Ecological Entomology, 32*(6), 707–711.

Sörensen, U., & Schmidt, G. (1987). Vergleichende Untersuchungen zum Beuteeintrag der Waldameisen (Genus: Formica, Hymenoptera) in der Bredstedter Geest (Schleswig-Holstein). *Journal of Applied Entomology, 103*(1-5), 153-177.

Yarcı, C. (1997). Flora of Demirkoy (Istranca Mountains / Kirklareli European Turkey). *Flora Mediterranea, 7*, 55-99.