



Preliminary Assessment of Staphylinidae Diversity in Aydos Forest

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Abstract: Turkey's unique geographical position as a bridge between three continents has significantly contributed to its rich insect fauna. Among insects, the Staphylinidae family stands out as the largest in terms of species diversity and is distributed across a wide range of habitats. This study is considered a preliminary assessment for Aydos Forest, located on the Anatolian side of İstanbul. It aimed to identify Staphylinidae species and assess their diversity in two distinct habitats—lake and fortress areas—representing both wetland and forest ecosystems. The study employed pitfall traps filled with an ethylene glycol solution. The traps were checked monthly, and collected specimens were identified in the laboratory. After each sampling event, the traps were replaced with new ones. By the end of the study, a total of six Staphylinidae species belonging to five genera were identified. Diversity was evaluated using the Shannon-Wiener (H') and Simpson (D) indices. The results indicated that Staphylinidae diversity was higher on the lake side of Aydos Forest according to both the Shannon-Wiener (H') and Simpson (D) indices.

Keywords: Aydos forest, diversity, İstanbul, pitfall trap, staphylinidae.

Aydos Ormanı'nda Staphylinidae Çeşitliliğine Yönelik Ön Değerlendirme

***Sorumlu yazar:**

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Öz: Türkiye'nin üç kıta arasında bir köprü konumunda bulunması, zengin böcek faunasına önemli ölçüde katkı sağlamıştır. Böcekler arasında, Staphylinidae familyası tür çeşitliliği bakımından en büyük aile olarak öne çıkmakta ve çok çeşitli habitatlarda yayılış göstermektedir. Bu çalışma, İstanbul'un Anadolu yakasında yer alan Aydos Ormanı için bir ön çalışma olarak değerlendirilmektedir. Ormanda bulunan göl ve kale çevresindeki alanlarında, hem sulak alan hem de orman habitatlarını temsil edecek şekilde, Staphylinidae türlerinin tespit edilmesi ve iki farklı habitatteki çeşitliliklerinin değerlendirilmesi amaçlanmıştır. Çalışmada etilen glikol çözeltisiyle doldurulmuş çukur tuzaklar kullanılmıştır. Tuzaklar aylık olarak kontrol edilmiş ve toplanan örnekler laboratuvarında teşhis edilmiştir. Her örnekleme sonrasında tuzaklar yenileriyle değiştirilmiştir. Çalışmanın sonunda beş cinsine ait toplam altı Staphylinidae türü belirlenmiştir. Biyoçeşitlilik değerlendirmesi için Shannon-Wiener (H') ve Simpson (D) indeksleri kullanılmıştır. Sonuçlar, Aydos Ormanı'nın göl tarafında Staphylinidae çeşitliliğinin her iki indeks (Shannon-Wiener H' ve Simpson D) açısından daha yüksek olduğunu göstermiştir.

Anahtar Kelimeler: Aydos ormanı, çeşitlilik, çukur tuzak, İstanbul, staphylinidae.

INTRODUCTION

Aydos Forest is jointly managed by the Kartal and Sultanbeyli Forest Management Chief Offices, which operate under the Kanlıca Forest Directorate of the İstanbul Regional Directorate of Forestry. The Kartal Forest Management Chief Office is located within the borders of Kartal and Pendik districts of İstanbul, between 29° 05' 42" - 29° 30' 25" east longitudes and 41° 03' 29" - 40° 48' 13" north latitudes. The highest point is Mount Aydos at 537 meters, while the lowest point is at sea level. In terms of climate, the area represents a transitional zone between the Black Sea and Mediterranean climates. Annual

precipitation generally increases from south to north. Due to these characteristics, İstanbul forms a climatic transition zone between the northern and southern regions. *Crocus olivieri* subsp. *istanbulensis* is an endemic species that grows exclusively within the Aydos Forest (Erdem, 2019). The Staphylinidae family, with approximately 67,000 species-34 of which are living (including Silphinae)-is the largest family within the Coleoptera order (Newton, 2022) Staphylinidae species are widely used as bioindicators of environmental conditions in applied sciences such as forest research and conservation. These species can be found in nearly all ecosystems around the world, ranging from the Arctic to humid tropical regions,

and from marine habitats to high alpine ecosystems (Betz et al., 2018). When reviewing the research conducted in Istanbul thus far, Staphylinidae species have been recorded through field studies in Istanbul. However, no specific research on Staphylinidae has been carried out in Aydos Forest until now. Studies conducted in Istanbul have identified four species from the Omaliinae subfamily, 12 species from the Pselaphinae subfamily, six species from the Tachyporinae subfamily, 44 species from the Aleocharinae subfamily, eight species from the Oxytelinae subfamily, one species from the Euaesthetinae subfamily, 10 species from the Steninae subfamily, 24 species from the Paederinae subfamily, and 32 species from the Staphylininae subfamily. These species were primarily identified in studies conducted by external researchers during the 1900s, with most of the records coming from Belgrad Forest and Alemdağ Forest in Istanbul (Anlaş, 2009).

In addition to these, Aleocharinae species collected from macromycetes in Belgrad Forest identified 11 species, 10 of which were new records for Istanbul (*Atheta fungicola*, *A. nigrifula*, *A. sodalis*, *Autalia longicornis*, *Gyrophana affinis*, *G. bihamata*, *G. hanseni*, *G. joyioides*, *G. minima*) (Toktay Okutan & Turan, 2024). Furthermore, a study conducted in Istanbul's Adalar region documented 23 species from five subfamilies of the Staphylinidae family (Yeneroğlu et al., 2024).

Pitfall traps are commonly used for studying the ground fauna, particularly Carabidae and Tenebrionidae. However, they are also used for species of Cerambycidae, Curculionidae, Staphylinidae, and Scarabaeidae (Anlaş et al., 2011). To date, no comprehensive studies have been conducted on the Staphylinidae species of Aydos Forest. Given this gap in research, the present study aims to preliminary assess and analyze the Staphylinidae species of Aydos Forest by evaluating the biodiversity parameters of wetland and herbaceous vegetation habitats using the pitfall trap method.

There are many indices used to determine alpha species diversity. While simply counting the number of species can serve as a basic index, more advanced and commonly used indices for assessing alpha diversity include the Shannon-Wiener Index and Simpson's D Index. Shannon-Wiener Function (H): $H = -\sum \{p_i \log(p_i)\}$ here p_i represents the proportional abundance of each species. The natural logarithm (ln) of each species' proportional value is taken and then multiplied by its proportion. The sum of all these products, multiplied by -1, gives the Shannon-Wiener diversity index (H). The Simpson Index, proposed by Simpson (1949), is a diversity index that measures the probability that two individuals randomly selected from a population will belong to the

same species. It is often used to assess dominance or evenness in a population (Gülsoy&Özkan, 2008).

MATERIAL AND METHOD

Fieldwork was conducted from April to December 2024 in Aydos Forest, specifically around Aydos Lake and Aydos Fortress (Figure 1). Pitfall traps were set up in five different areas within two separate regions, using a mixture of ethylene glycol and distilled water. The traps were prepared with a 1:1 ratio of 300 ml ethylene glycol to distilled water and were buried in the ground so that the top opening was level with the soil surface (Daşdemir & Tozlu, 2022). In each locality, the traps were placed at intervals of 10 meters. To prevent wildlife from damaging the traps and to avoid debris falling into the traps, the traps were covered with composite material for protection. They were then camouflaged with plant material (Figure 2). Insects collected from the traps were sorted in the laboratory, and Staphylinidae species were identified. During the identification process, existing literature, identification keys and identified specimens in the collection were used. All collected and stored specimens were kept in the Entomology Laboratory of the Department of Biology at Marmara University. The results were then used to calculate biodiversity parameters using the Shannon-Wiener (H') and Simpson (D) indices. Also, all photographs were taken by the authors during fieldwork and 3D image of the trap with composite cover were created by Maxon Cinema4D 2025.1.2.



Figure 1. Aydos Forest (From Google Earth).

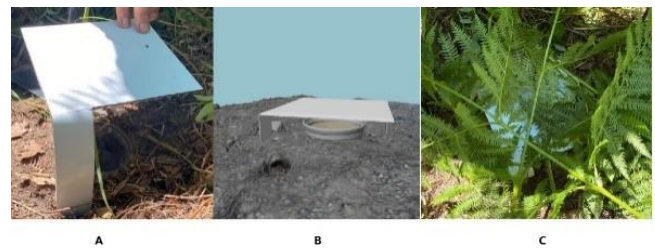


Figure 2. A. Composite cover B. 3D image of the trap with composite cover (Created by Maxon Cinema4D 2025.1.2) C. Camouflaged with plant.

RESULTS

Six Staphylinidae species in five genera were reported during the last session of study using pitfall traps prepared in Aydos Forest (Figure 3). These species were: *Nicrophorus investigator* Zetterstedt, 1824, *Silpha tristis* Illiger, 1798, *Ocypus mus* (Brullé, 1832), *Aleochara bipustulata* (Linnaeus, 1760), *Ocypus curtippennis* Motschulsky, 1849 and *Xantholinus rufipennis* Erichson, 1839. Two of these species (*Nicrophorus investigator*, *Silpha tristis*) belong to the subfamily Silphinae, one to the subfamily Aleocharinae (*Aleochara bipustulata*) and three to the subfamily Staphylininae (*Ocypus mus*, *Ocypus curtippennis*, *Xantholinus rufipennis*).

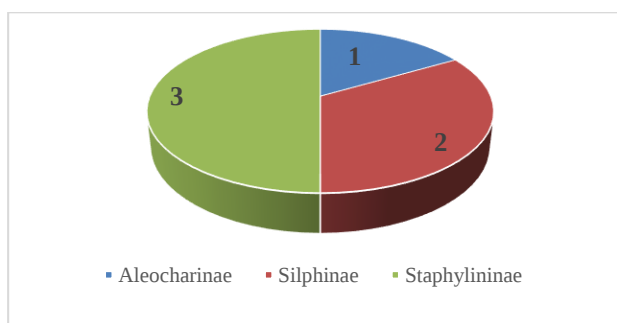


Figure 3. Distribution of species according to subfamilies.

Species Detected in Fieldworks

Subfamily: Aleocharinae Fleming, 1821

Genus: *Aleochara* Gravenhorst, 1802

Aleochara bipustulata (Linnaeus, 1760)

Material Examined: Istanbul, Aydos Forest, Aydos Lake, 40.948974N, 29.234061E, 211 m, 30.06.2024, 1♂.

Subfamily: Silphinae Latreille, 1806

Genus: *Nicrophorus* Fabricius, 1775

Nicrophorus investigator Zetterstedt, 1824

Material Examined: Istanbul, Aydos Forest, Aydos Lake, 40.948974N, 29.234061E, 211 m, 30.06.2024, 1♂ 1♀; Aydos Fortress, 40.950192N, 29.255006E, 257 m, 30.06.2024, 1♂ 1♀; Aydos Fortress, 40.950192N, 29.255006E, 257 m, 19.08.2024, 2♂♂; Aydos Fortress, 40.950192N, 29.255006E, 257 m, 17.09.2024, 2♂♂; Aydos Fortress, 40.950192N, 29.255006E, 257 m, 26.10.2024, 1♀.

Genus: *Silpha* Linnaeus, 1758

Silpha tristis Illiger, 1798

Material Examined: Istanbul, Aydos Forest, Aydos Fortress, 40.950192N, 29.255006E, 257 m, 30.06.2024, 1♂.

Subfamily: Staphylininae Latreille, 1802

Genus: *Ocypus* Leach, 1819

Ocypus curtippennis Motschulsky, 1849

Material Examined: Istanbul, Aydos Forest, Aydos Fortress, 40.950192N, 29.255006E, 257 m, 26.10.2024, 1♂.

Ocypus mus (Brullé, 1832)

Material Examined: Istanbul, Aydos Forest, Aydos Lake, 40.948974N, 29.234061E, 211 m, 30.06.2024, 3♂♂ 1♀; Aydos Fortress, 40.950192N, 29.255006E, 257 m, 30.06.2024, 1♂; Aydos Lake, 40.948974N, 29.234061E, 211 m, 17.09.2024, 1♂; Aydos Lake, 40.948974 N, 29.234061E, 211 m, 26.10.2024, 1♂ 1♀; Aydos Fortress, 40.950192N, 29.255006E, 257 m, 26.10.2024, 6♂♂ 4♀♀; Aydos Fortress, 40.950192N, 29.255006E, 257 m, 07.12.2024, 2♂♂ 4♀♀.

Xantholinus rufipennis Erichson, 1839

Material Examined: Istanbul, Aydos Forest, Aydos Lake, 40.948974N, 29.234061E, 211 m, 26.10.2024, 1♂ 1♀.

In this research, pitfall traps were installed in the region of herbaceous vegetation where Aydos Lake is located and also in the region of forest where Aydos Fortress is located. In the inspection of the species of Staphylinidae obtained from the traps, four species of Staphylinidae (*Aleochara bipustulata*, *Nicrophorus investigator*, *Ocypus mus*, *Xantholinus rufipennis*) were received in the lake area. Four Staphylinidae species also (*Ocypus curtippennis*, *Nicrophorus investigator*, *Ocypus mus*, *Silpha tristis*) were caught from the Fortress. On the lake side, no Staphylinidae species were detected in the trap in July, August and December, while on the fortress side, no Staphylinidae species were detected only in July (Table 1).

Upon examining the number of individuals from the species in the observed areas, a total of 12 individuals were recorded on the lake side, while 26 individuals were observed on the fortress side (Figure 4). When examining the number of males and females, a total of 24 males and 14 females were identified. On the lake side, there were eight males and four females, while on the fortress side, 16 males and 10 females were observed (Figure 5).

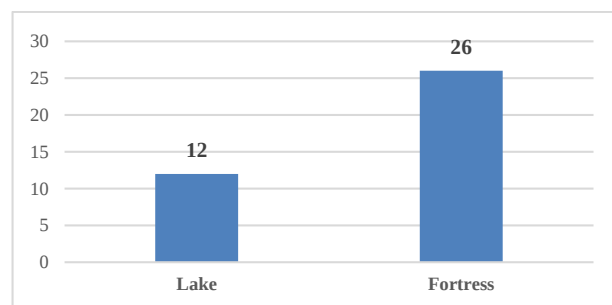


Figure 4. According to areas number of individuals.

Calculation of Diversity Parameters: Shannon-Wiener (H') and Simpson (D) indices were used in diversity analyses (Magurran, 2004). Shannon-Wiener (H')

and Simpson (D) indices were calculated using the PAST 4.03 program (Hammer et al., 2001). The results obtained are shown in Table 1. According to the results obtained, both Shannon-Wiener (H') and Simpson (D) indices show that Aydos Forest's lake side has higher diversity of Staphylinidae.

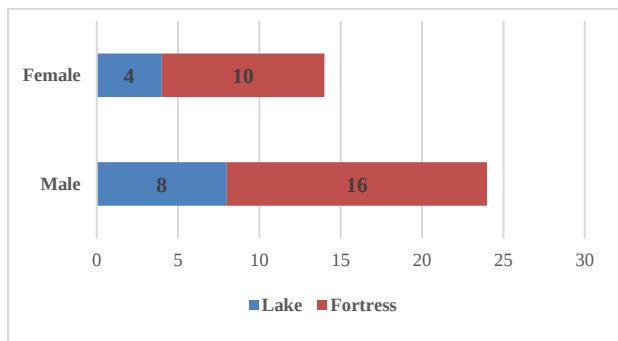


Figure 5. Number of individuals by sex number.

Table 1. Biodiversity indices

	Lake	Lower	Upper	Fortress	Lower	Upper
Taxa_S	4	4	4	4	3	4
Individuals	12	12	12	26	26	26
Simpson_1-D	0.5972	0.4167	0.7361	0.497	0.3225	0.6183
Shannon_H	1.119	0.837	1.358	0.8817	0.5858	1.119

DISCUSSION AND CONCLUSION

As a result of the study, six species from the Staphylinidae family were identified in two different selected habitats (the lake and the fortress area) in the Aydos Forest. Since there have been no previous studies or records in this region, it is difficult to make a comment regarding the number of species identified.

When comparing the species identified in this study with those recorded in previous Istanbul studies, it was found that *Aleochara bipustulata*, *Ocypus curtippennis*, *Ocypus mus*, and *Xantholinus rufipennis* had already been observed in Istanbul, although their exact localities had not been specified (Anlaş, 2009). The species *Nicrophorus investigator* and *Silpha tristis* were recorded for the first time in Istanbul in this study. These two species are also important in forensic entomology. When previous forensic entomology studies conducted in Istanbul are examined, it is seen that these two species were not recorded in the study carried out in the Pendik district or in the study conducted at Marmara University's Başbüyük Campus (Yuca, 2009; Mutlu et al., 2024). From this perspective, the detection of these two species is considered to be potentially significant in contributing to the investigation of a murder or suspicious death that may occur in Istanbul.

In the study, two areas were selected: one near a wetland and the other in a more forested region with abundant leaf litter. As a result of the study, four species were identified in each area. Two of these species (*Nicrophorus investigator* and *Ocypus mus*) were found in both habitats. Both species are widely distributed and

commonly encountered throughout Turkey. *O. mus* has been recorded from almost every region of Turkey (Anlaş, 2009). *N. investigator* is also one of the most frequently encountered species in forensic entomology studies. This species was also recorded in a study conducted in Eskişehir (Altınsoy et al., 2017). In the present study, a small rodent carcass was found in one of the pitfall traps where *N. investigator* was captured. In another trap, the high presence of Chilopoda and Diplopoda suggests that *N. investigator* is more attracted to dead and decaying carcasses than to the trap itself. In terms of species diversity, no difference was observed between the two areas. However, when looking at the number of individuals, 12 were found in the lake area, while 26 were recorded in the fortress area. The lower number of individuals in the lake area is thought to be due to its more open structure and the higher presence of other predators in the surroundings. In contrast, the fortress area is more forested, with abundant litter, providing a more sheltered environment for the species found there. When the monthly distribution of the identified species is examined, *N. investigator* and *O. mus* appear to be the species observed for the longest period. Both were recorded from June to December. In a study conducted in the Central Anatolia Region, the seasonal distribution of *N. investigator* was reported to be from March to October (Firat, 2013). *Aleochara bipustulata* was recorded only in June in this study. In a study on Aleocharinae conducted in Central Anatolia, this species was found between June and September (Sert et al., 2015), while in a study on Aleocharinae of the Eastern Black Sea region, it was only recorded in July (Sert et al., 2021). *Silpha tristis* was found only in June, whereas *Ocypus curtippennis* was recorded only in October. In the Central Anatolia study, *O. curtippennis* was observed between May and September (Firat, 2013). *Xantholinus rufipennis* was also recorded only in October in this study. In a study conducted by Assing (2013) in Turkey, records of this species were provided for April and May.

It was observed that no Staphylinidae species were recorded in certain months in either of the two areas. In the lake area, no species were found in July, August, or December; in the fortress area, no species were found only in July. For the lake area, it is thought that the high temperatures in July and August may have prevented the detection of any species. In December, heavy rainfall in the area might have been the reason no individuals were found. In the fortress area, the presence of species in December is thought to be due to the forested structure and abundant leaf litter, which likely provided shelter. As for July, the absence of species is again believed to be due to extreme heat during that period.

In the study, diversity analyses showed that there was no significant difference in diversity between the two areas. However, according to the results obtained, the Shannon-Wiener (H') and Simpson (D) indices indicated that Staphylinidae diversity was slightly higher in the lake area. Although the difference is not substantial, it is thought that the slightly higher diversity in the lake area may be due to its higher humidity, the presence of more suitable habitats for Staphylinidae species, and the combination of both wetland and leaf litter in the area.

As a result, this study is a preliminary investigation conducted in Aydos Forest, examining the presence of Staphylinidae in two distinct habitats: wetland and herbaceous vegetation. The findings are also expected to serve as a reference for future research in the area. To more accurately determine the distribution of Staphylinidae across different habitats in Aydos Forest, large-scale and long-term studies are recommended.

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