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Coleopteran Pests Infesting *Astragalus* Plants on Karacadağ Mountain with a New Species for the Turkish Fauna

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ABSTRACT

Karacadağ Mountain, the shield volcano in Southeastern Türkiye, has been a treasure of biodiversity in terms of flora and fauna that serve a diverse number of agricultural practices and forestry. The floral composition is mainly composed and represented by the shrub plant, *Astragalus* spp. which is under threat by insect pests. This study aims to report the coleopteran woodboring species infesting *Astragalus* spp. along with their density and infestation rate on different altitude levels (lowest=1400-1500 m, middle=1600-1700 m, and upper=1850-1950 m) in 2016. Laboratory incubation of the specimens yielded six woodboring species: *Agapanthia coeruleipennis* Frivaldszky, 1878 and *Xylotrechus sieversi* (Ganglbauer, 1890) (Coleoptera: Cerambycidae), *Sphenoptera* (*s.str.*) *anthracina* Jakovlev, 1887, *Sphenoptera* (*s.str.*) *coracina* (Steven, 1829), *Sphenoptera* (*s.str.*) *tragacanthae* (Klug, 1829), and *Anthaxia* (*s.str.*) *truncata* Abeille de Perrin, 1900 (Coleoptera: Buprestidae). Among these species, *S. anthracina* is recorded for the first time in Turkish fauna. The infestation rate did not differ between altitudes while the number of woodborer pests per plant was highest at the highest level of altitude which did not differ between lowest and middle altitude levels.

Keywords: Altitude-dependent density, Mountain fauna, new record, woodboring pests, shrub plants, Southeastern Türkiye.

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INTRODUCTION

The shield volcano structured Karacadağ Mountain is located in Southeastern Türkiye and connects agriculturally important provinces, Diyarbakır, and Şanlıurfa and partly, Mardin. The last eruptions of the mountain are addressed to 100.000 years ago. The mountain, since then, has become a great source of many products having economic importance for people. For example, a previous study revealed that cultivation of einkorn cereals started around the mountain, and ancestors of many kinds of cereals still grow as wild cereals on the slopes of the mountain (Heun et al, 1997). Livestock remains one of the main activities of natives and one of the most important livestock practices, bee-keeping largely depends on the flora of the mountain.

The flora of the mountain is mainly represented by shrub plants. Among the shrub plants, milkvetch, *Astragalus* spp. (Fabaceae) is the most abundant and prevalent plant genus on the mountain (Ertekin, 2002). The *Astragalus* spp. provide a perfect wintering shelter for insect pests of crops such as *Eurygaster* spp. (Hemiptera: Scutelleridae), *Aelia* spp., *Dolycoris* spp. (Hemiptera: Pentatomidae) as well as many other agriculturally important pests and beneficial insects. In addition, *Astragalus* spp. stands among the best feeding sources for pollinator insect species, especially, honeybees, *Apis mellifera* Linnaeus, 1761 (Hymenoptera: Apidae) (Richards, 1987).

Astragalus species could be either in herbaceous or shrub forms. The genus *Astragalus* is native to the Palearctic and Nearctic regions and is present in Middle East countries (PFAF, 2023). One of the most common milkvetch species on the Karacadağ Mountain is Gum tragacanth milkvetch, *Astragalus gummifer* and its distribution commences from 1300m-1400m altitude to the highest points, above 1950 m of altitude (Ertekin, 2002). *Astragalus gummifer* is a thorny plant having small branches and exudes a demulcent gum, which cannot be used internally because of its deficient dissolution (Grieve, 1971).

During the winter surveys for *Eurygaster integriceps*, the most worldwide distributed wheat pest, on February – April of 2016 on Karacadağ Mountain, several broken milkvetch branches and stems having larval feces of woodboring pests were encountered. Dissecting broken branches and some seemingly healthy plants having small holes, many larvae belonging to families, Cerambycidae and Buprestidae (Coleoptera) were located. Many studies have addressed the trophic levels between herbaceous milkvetch species and insect communities. For example, the reproduction of *A. lusitanicus*, a perennial legume, is highly suppressed by a lepidopteran pest, *Tomares ballus* (Lepidoptera: Lycaenidae) in Southern Spain due to its voracious feeding activity on leaves and seeds (Jordano et al, 1990). Seed predation by other insect groups is also possible among milkvetch species such that seed - feeding beetles, *Acanthoscelides* fraterculus, and *A. pullus* (Bruchidae), infests *A. filipes*, a commercially farmed milkvetch species in the United States of America (Cane et al, 2013). Previous studies have focused on the possible association between herbivorous insects and herbaceous *Astragalus* plant species. Thus, our knowledge of insect pests, especially wood-boring insects, of *Astragalus* plants in shrub forms remains scarce and requires attention.

This study aims to report coleopteran woodboring pests and their altitude-dependent density on Karacadağ Mountain. The findings are discussed in terms of the threat to Karacadağ shrub flora which is composed of Coleopteran pests.

MATERIALS AND METHODS

Study area and surveys

The mountain divides Diyarbakır and Şanlıurfa provinces in the northeast-southwest direction and its slopes lie inside the borders of Mardin province in the south as well. The mountain has a steppe climate. The long period summer months are warm while the mountain has a cold winter period. The highest point on Karacadağ Mountain is 1952 m altitude. The soil covering the mountain mostly represents basaltic characters.

Distribution of *Astragalus* spp. on the mountain commences from 1300 – 1400 meters till the top. The density of *Astragalus* spp. plants increase with altitude since the up-rooting practices by villagers are performed in lower altitudes. In total, nine locations were selected as study sites on Karacadağ Mountain (37°60` N, 39°83` E). Each location consisted of three sampling sites. Every three sites constituted a different altitude range. The sampling sites were located on different altitude levels as lowest=1450-1550 m; middle=1650-1750 m; highest=1850-1950 on Karacadağ Mountain.

Surveys and samplings were performed in February – April 2016. At each study site, 40, 30, and 20 plants were systematically sampled at highest, middle, and lowest altitudes, respectively. These plants were then randomly inspected to assess the presence and abundance of Coleopteran wood borers. All plants having broken branches/stems or holes were up-rooted and dissected while those that did not have similar symptoms were not harmed. The number of larvae and pupae of species belonging to Buprestidae and Cerambycidae was recorded. The specimens were incubated under laboratory conditions (25 ± 2 °C, 60 ± 10 RH, 16 h light). Emerged adults were preserved in 70% ethanol for identification.

Statistical analysis

Several generalized linear models were assessed to reveal whether the density and infestation rate of the coleopteran woodboring pests varied between different altitude ranges (Faraway, 2016; Dunn & Smyth, 2018). The number of coleopteran pests was the response variable and the altitude range was the explanatory variable in the models. The models were compared based on AIC and dispersion parameters (Faraway, 2016; Dunn & Smyth, 2018). Tukey's multiple post hoc tests were employed for comparison. All statistical analyses were performed using R statistical software and the integrated development environment, RStudio (R Core Team, 2022)

RESULTS

The surveys on Karacadağ Mountain shrub plants, *Astragalus* spp. pests yielded two Cerambycid and four Buprestid species (Table 1). The count data representing

the number of coleopteran pests infesting *Astragalus* spp. were subjected to several generalized linear models (Table 2). Zero-inflated negative binomial was considered the best-fit model as it had the lowest Akaike information criterion (ACI) and a dispersion parameter very close to 1. Even though the negative binomial model had a closer value to 1 when compared with the zero-inflated negative binomial model, it had a greater AIC value. However, multiple comparison tests of both models yielded similar results, indicating the number of coleopteran pests was higher at the highest altitude level when compared with the lowest and middle altitudes. There were no differences between the number of coleopteran pests infesting *Astragalus* spp. at lowest and middle altitude levels (Fig. 1). The binomial distribution model for the infestation rate of *Astragalus* plants by the coleopteran pests yielded under dispersion (0.061) and thus was confirmed by a quasibinomial model (Table 2). In both cases, the altitude effect on the infestation rate of *Astragalus* species by coleopteran wood borers was not statistically significant (Table 2, Fig. 1).

Table 1. Coleopteran insect pests infesting *Astragalus* spp. on Karacadağ Mountain in Southeastern Türkiye.

Family	Coleopteran woodboring species infesting *Astragalus* spp.
Cerambycidae	*Xylotrechus sieversi* (Ganglbauer, 1890)
	Agapanthia coeruleipennis Frivaldszky, 1878
Buprestidae	*Sphenoptera (s.str.) anthracina* Jakovlev, 1887
	Sphenoptera (s.str.) coracina (Steven, 1829)
	Sphenoptera (s.str.) tragacanthae (Klug, 1829)
	Anthaxia (s.str.) truncata Abeille de Perrin, 1900

Table 2. The statistical importance and evaluation parameters of the generalized linear models tested for the density and infestation rate of Coleopteran woodboring pests infesting *Astragalus* spp. on Karacadağ Mountain.

Model	χ^2 (df=2)	P	AIC*	Dispersion**
No. coleopteran wood borers				
Poisson model	137.53	<0.001	2719.30	7.82
Negative binomial	20.06	<0.001	1346.70	0.97
Zero-inflated	51.92	<0.001	1607.83	1.90
Zero-inflated negative binomial	28.45	<0.001	1342.61	1.07
Hurdle	91.92	<0.001	1607.83	1.90
The infestation rate				
Binomial distribution	0.15	0.929	18.73	0.061
Quasibinomial distribution	2.38	0.305	NA	0.061

*AIC=Akaike information criterion; The lower the AIC value is, the better the model fits data.
** Dispersion parameter (DP): if DP>1.

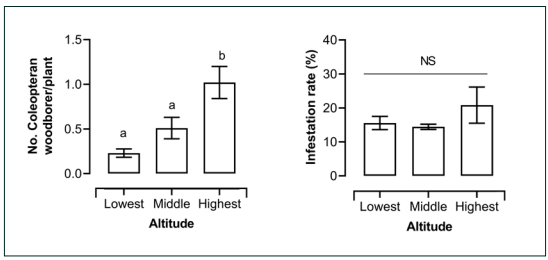

Figure 1. The mean density (left) and infestation rate (right) of coleopteran woodboring species infesting *Astragalus* spp. on different levels of altitude (Lowest=1450-1550m; Middle=1650-1750m; Highest=1850-1950m) on Karacadağ Mountain.

DISCUSSION

This study was performed to document the severe damage by coleopteran woodboring pests infesting *Astragalus* spp., the shrub plants on Karacadağ Mountain located in Southeastern Türkiye. The coleopteran woodboring community consisted of six species i.e., two cerambycids and four buprestids. The number of all larvae and pupal specimens was calculated as the total number of coleopteran wood borers. Therefore, the species-dependent relative abundances of wood borers are undefined as the preimaginal stages of species belonging to each family were quite identical. However, the majority of wood-boring beetles were represented by the cerambycids especially *X. sieversi* when compared with other species (personal observation).

The number of coleopteran wood borers infesting *Astragalus* spp. differed between altitude levels. For example, the density of the pests was highest at the highest altitude levels and did not differ between the lowest and middle altitude levels. The recorded pests together with their host plants were present at higher levels of altitudes with cold winter and calm summer climatic conditions. The percent number of infested plants was between ~14-21% and did not differ between altitude levels. Therefore, the presence of the pests in different levels could be more dependent on the presence of their host plants rather than adapting to specific climatic conditions as the host is a higher altitude specific plant.

The surveys targeted the infestation of *Astragalus* spp. by coleopteran wood borers on Karacadağ Mountain and it is well-known that *Astragalus* plants having shrub form are native to western Asia countries including middle east countries such as Iraq, Iran, Lebanon, Syria, and Türkiye. They are also widely distributed to several close countries like Afghanistan, Pakistan, and Russia (Verbeken, Dierckx, & Dewettinck, 2003). This study was unable to extend the range of the study area to other mountains of Türkiye and surrounding countries. The coleopteran wood-borers, especially *X. sieversi* and *A. coeruleipennis* infesting shrub plants have been reported in Türkiye for a long time (Özdikmen, 2013; Rapuzzi & Sama, 2018). Among the buprestids, only *S. coracina* was reported in Diyarbakır (Kısmalı et al, 1995) while the other species have never been reported in Southeastern Türkiye. The presence of *A. truncate* was reported in Erzurum province with a single female being collected on high elevation levels i.e., 1750m with no further details (Tozlu & Özbek, 2000). Furthermore, no study was located reporting the presence of *S. anthracina* in Türkiye while S. *tragacanthae* is also reported in Türkiye (Kubáň et al, 2016). The presence of the pest was reported in neighboring countries such as Azerbaijan, Armenia, Iran, and also in Turkmenistan (Kubáň et al, 2016). Therefore, this study is the first to report the presence of *S. anthracina* in Türkiye. The studies aiming to report the presence of such pests have been faunistic studies that are highly dependent on random and irregular samplings and generally overlook the tropic interactions including host, pest, and natural enemies such as parasitoids. Since the identification of species being reported in this study relies on the incubated samples, the herbivory of the host plants by the coleopteran wood borers is now confirmed. Incubation of *Astragalus* plants infested by coleopteran

wood borers yielded several Braconid and Ichneumonid specimens, however, we could not identify the samples due to overloaded work. Therefore, a detailed sampling procedure should be devoted to the identification of natural enemies of the coleopteran wood borers on the mountain.

The infestation of *Astragalus* species on the mountain by wood borer pests seemingly compromises a threat to the protection of the mountain soil structure and consequently may trigger erosion that can negatively affect the agricultural, apicultural, and livestock practices as well as the composition of the flora and fauna. Further studies targeting to collect data on the bioecological life traits of the pests that could benefit future control measures are required.

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