



## Study of aestivation and hibernation of *Carpocoris coreanus* Distant, 1899 (Hemiptera: Pentatomidae) on Safin Mountain in Erbil – Iraq.

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### ABSTRACT

The present paper focuses on the hibernation and aestivation locations of the Stink bug *Carpocoris corinus* Distant, which infests various economically important crops and plants in the fields. Then, *C. corinus* Distant migrated to aestivation and hibernation sites on Safin Mountain in Erbil City from July 2023 to March 2024. It has been found that the period of aestivation occurs beneath the plants *Astragalus russelii*, *Euphorbia peplus* L., and *Thymbra vulgaris* (Thyme). Also, spend the hibernation period underneath the falling leaves of *Quercus aegilops* L., *Quercus infectoria* L., and *Pistacia atlantica* V. Kurdica. The average number of adults was 420.83 adults/10 m<sup>2</sup> at the top of the mountain in July 2023, while the lowest was 10.25 adults/10 m<sup>2</sup> in March 2024. The highest number of adult insects recorded at the top of the mountain was 66.25 adults/10 m<sup>2</sup> in November 2023; still, the lowest number was 10.25 adults/10 m<sup>2</sup> in March 2024, then the highest number in the middle of the mountain was 7.33 adults/10 m<sup>2</sup> in December 2023, while the lowest approached 3.66 adults/10 m<sup>2</sup> in March 2024. At the mountain base, 0.62 adults/10 m<sup>2</sup> were recorded during November 2023, which increased to 9.83 adults/10 m<sup>2</sup> in March 2024. The existence of adults on the mountain, Safin, Korac, Bradost, Hassan bag, Zozic, Handren, Kalander, Pearan and Sheren takes 515, 768, 1261, 576, 227, 119, 472, 270 and 752 adults/10 m<sup>2</sup> respectively in Summer 2023. In Summer 2024, the count represented 240, 162, 374, 222, 187, 94, 243, 151, and 264 adults/10 m<sup>2</sup> respectively.

**Keywords:** *Carpocoris*, hibernation, aestivation, Safin Mountain..

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### INTRODUCTION

The insect species *Carpocoris coreanus* Distant, commonly referred to as a stink bug, discharges a strong disagreeable scent (odor) using its scent gland when disturbed or crushed [1]. It belongs to the family Pentatomidae and the order Hemiptera / suborder Heteroptera. It has been widely distributed throughout the country's northern regions, including Erbil, Duhok, Ninawa, and Sulaymaniyah [2]. Members of this family are characterized by around or oval bodies, with five-segmented antennae, tibia bristly rather than spiny, three-segmented tarsus, and scutellum that is more or less triangular, almost rarely covering the abdomen [3 and 4]. The Stink Bugs are polyphagous insects that consume a diverse array of plants, including many families such as Leguminosae, Gramineae, Solanaceae, Compositae, and Rosaceae; they hibernate in mountainous areas [5]. The *C. coreanus* Distant is a highly destructive pest that causes yield reduction. They have become the primary pest that causes damage directly to crop loss, which poses a significant economic threat by causing substantial yield losses. It is particularly hazardous to wheat, wild sorghum, barley, oats, and wild plants cultivated in wheat fields in Northern Iraq [6] and [7]. The barley saw a yield drop from 20% to 80%, while the wheat experienced a reduction of 20% to 90% [8]. The decrease in cereal production occurs due to the feeding behavior of the stink bug, which involves extracting nutrients from seeds by its piercing and sucking mouthpart, resulting in a drop in the weight of the affected seeds. The presence of large populations of Sunn Pest can cause significant damage to wheat or barley crops [9]. The *C. coreanus* Distant undergoes two migrations: the first occurs in spring when the over-wintered adults move from the mountains to cereal fields (specifically wheat and barley) in the flat areas to feed and lay eggs. The second migration takes place in summer when the new adults move to the mountains to aestivate and eventually hibernate. They undergo hibernation in protective structures composed of desiccated foliage, clusters of vegetation, flora, and geological formations [10]. The objective of this research was conducted to investigate the yearly presence of pests in mountainous areas and cereal fields, analyze the population density and insect growth in the fields, and examine the relationship between insect migration, summer dormancy, and winter hibernation in connection to ecological factors. Hibernation and aestivation are survival mechanisms that enable insects to endure periods of food scarcity [11] and [12].

## MATERIALS AND METHODS

The research was carried out in Shaqlawa, a district in the Erbil governorate of Kurdistan, Iraq, to study the wintering season of the stink bug adults (Figure 2 A), spanning from July 2023 to March 2024. The study also investigated the presence of *C. coreanus* Distant during the summer season and examined its development in mountainous regions in aestivation sites (Figure 1a,B and Figure 2B). Most of the investigations were commenced on Safin Mountain, located in Erbil Governorate. From July to November 2023, weekly inspections were conducted to study the summer aestivation of *C. coreanus*. A wooden square frame measuring one square meter was employed to ascertain the population density of the studied insect pests per 10 square meters. The plants that utilized this Pest as a means of protection in the mountainous region were identified. The population of dormant insects beneath the vegetation in Safin Mountain was assessed by investigating their winter hibernation patterns between December 2023 and March 2024. Insect and plant specimens were transported to the laboratory for identification. The *C. coreanus* Distant species was observed at three different altitudes in the mountains: the base (1-650 m), the slopes (651-1290m), and the summit(1291-1938m). An exclusive instrument (Altimeter) was employed to gauge the altitude. The quantity of deceased and living insects was ascertained. The temperature and relative humidity data were collected via a climatological station in Shaqlawa City and through direct measurements using thermo or hydro-meters in the hibernating zones. Data regarding the existence and density of the *C. coreanus* Distant species were collected in July from the Safin, Korac, Bradost, Hassan bag, Zozic, Handren, Kalander, Pearan, and Sheren mountains (Fig 3).



Figure 1. A- Hibernated site. B- Aestivated site of *C. coreanus* Distant on the Safin Mountain

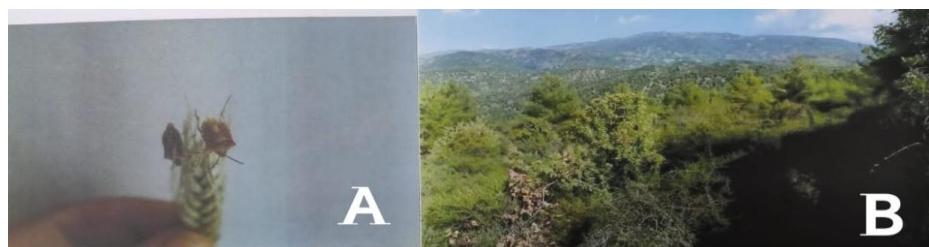


Figure 2. A- Adult of *C. coreanus* Distant. B- Aestivated and hibernated sites on Safin Mountain



Figure 3. Map of Erbil governorate showing the studied mountains. Scale 1:1250000

## Results and Discussions

The recently matured individuals prepared to relocate from the cultivated wheat and barley fields to the dormant areas in the mountains. Before their departure in June, they assembled in clusters on wheat spikes for eating. Wheat harvest activities and a gradual rise in ambient temperatures triggered the relocation of the adults from one field to the adjoining

ones. The migration of *C. coreanus* Distant adults to the highlands is mainly caused by physiological conditions and grain harvest. The adults were driven to relocate due to the temperature rising from 25 to 34°C. They travelled a distance of 10 to 50 kilometres to reach the hibernation places located in the mountains. According to [13], they can fly at elevations ranging from 2000 to 2500 meters in Iran. The migratory date of newly matured individuals was documented during June and the initial week of July. Initially, they migrated towards the mountain's base and, after that, ascended in stages to the higher elevations of the hillside to reach the summit. They undergo aestivation beneath the vegetation during the summer. The population of *C. coreanus* Distant found in Safin Mountain varied between 367 and 473 adults /10 m<sup>2</sup>, with an average of 420.83 adults /10 m<sup>2</sup> in July (Table 1). In August, the adult population declined to 320 individuals per 10 square meters. In September and October, the population further reduced to 114.50 and 24.37 adults /10 m<sup>2</sup>, respectively. The decline in adult populations is attributed to ecological and biological factors, such as parasites, predators like *Trissolcus* spp. and *Phasia* spp., and disease-causing organisms like *Beauveria bassiana*. *C. coreanus* refers to the species named stinkbug.

Grown individuals retreat to a state of summer dormancy at the peak of the mountain. Their movement continues from the mountain top to the mountainsides and the base of the mountain. The number of adult individuals steadily falls to 66.25 adults /10 m<sup>2</sup> in November 2023 and 10.25 adults /10 m<sup>2</sup> in March 2024 at the summit of Safin Mountain. The overwintering adults seek refuge beneath the plants to shield themselves from the harsh winter circumstances. This behaviour was observed in additional regions [14] and [15]. These dormant pests seek shelter beneath various plants to undergo summer aestivation and winter hibernation. These plants naturally grow on mountain tops at various altitudes, typically above 1900 meters. They include *Astragalus russelii* Banks and Sol., *Prunus argentea* (Lam.) Rehd., *Euphorbia peplus* L., *Thymbraya vulgaris* L. (Thyme), *Quercus aegilops* L., *Quercus infectoria* Olivier, *Pistacia atlantica* Desf., *Craxips parviflora*, *Platanus orientalis* L., *Teucrium chamaevrys* L. subsp. *sinuatum* (Celak.) Rech, *Telephium oligospermum* Boiss, *Nepeta* sp., *Silene ampullata* Boiss., *S. stenobotrys* Boiss & Hausskn, *Onosma albo-roseum* Fisch. Mey. Several of these plants have been previously documented [16] and [17]. They are absent on mountain slopes and the lower regions. They offer protection to adults and safeguard insects from adverse environmental factors such as temperature, humidity, wind, sunshine, and predators. The number of dead insects increased in October and November due to the increase in rain, which led to the killing of many of them, and this indicates that the next season will be fewer injuries than the previous season because of the low temperatures in the winter months and the increase in rain which led to the killing of

static insects [18]. These plants are cultivated in dense concentrations and offer increased humidity, which adults prefer during summer aestivation. Some other pests conceal themselves in the soil to access greater moisture levels. The presence of these plants was also documented at the summit of Safin Mountain. Adults prefer dens and shaded vegetation since they provide cooler temperatures and greater moisture levels. Insects also seek refuge behind fallen leaves and rocks for extended periods to shield themselves from harsh winter circumstances [15] and [19].[20] showed that the sunn pest species were overwintered as adults under bushes, dead leaves, weed, and date palm leaf bases. There is a difference in the survival rate of females and males of sunn pests in the overwintering sites [21].

Table 1. Accumulation of *Carpocoris coreanus* Distant adults from July 2022–March 2023 and its relationship to temperatures, relative humidity of the air, and in the shade in hibernated sites.

Time Month	Plant shade Temperature °C	Humidity %	Weather Temperature °C	Humidity %	Insect Average
July	29.3	28.03	33.30	13.00	367 - 473 420.83 ± 2.592
August	30.6	32.80	33.20	13.20	101 - 642 320 ± 2.541
September	23.85	37.75	29.40	16.30	42 - 193 114.50 ± 1.99
October	17.98	44.25	23.20	27.30	2 - 51 24.37 ± 1.05
November	7.93	60.00	14.30	47.50	2 - 131 66.25 ± 0.5
December	5.37	68.50	9.60	57.10	14 - 114 51.16 ± 075
January	0.00	88.00	6.80	56.20	19 - 21 19.75 ± 1.14
February	3.85	80.75	6.10	53.70	9 - 17.5 13.25 ± 0.42
March	9.03	83.17	12.70	60.70	9 - 11 10.25 ± 0.16

The insects on the mountaintop migrated towards the warmer microhabitats beneath the plants as a protective measure against the wind. This downward movement of the insects was seen on the mountainsides between November and March, as shown in Table (2). The insect population density on the mountain peak and sides gradually declined from November to March, reaching 5.83 and 3.66 adults /10 m<sup>2</sup>, respectively. Conversely, the density on the mountain base grew from 0.62 adults /10 m<sup>2</sup>

in November to 9.83 adults /10 m<sup>2</sup> in March. These results were also found in the [22] study, where the number of hibernated insect pests was 10 adults /10 m<sup>2</sup>, but the number decreased because of predators and parasites to 3.5 adults /10 m<sup>2</sup>. [23] recorded the number of hibernated adults, 10 adults /10 m<sup>2</sup>, then increased to 103.5 adults /10 m<sup>2</sup>. [24] noticed adults migrate in the autumn to the mountain base to overwinter beneath trees and under fallen oak leaves.

Table 2. Population density of adults in top, mid, and mountain base from November 2022–March 2023

Month	Top of mountain	Mid of mountain	Base of mountain	Temp. C	R.H.
November	2 - 131	2 - 10	2 - 3	7.93	60.00
	66.25 ± 0.5	5.83 ± 0.72	0.62 ± 0.24		
December	14 - 114	4 - 9	2 - 5	5.37	68.50
	51.16 ± 0.75	7.33 ± 0.61	6.33 ± 0.80		
January	19 - 21	4 - 7	3 - 7	0.00	88.00
	19.5 ± 1.14	5.3 ± 1.12	8 ± 0.80		
February	9 - 17.5	3 - 8	6 - 7	3.85	80.75
	13.25 ± 0.42	5 ± 1.18	8.66 ± 0.63		
March	9 - 11	2 - 5	7 - 11	9.03	63.17
	10.25 ± 0.16	3.66 ± 0.43	9.83 ± 0.61		

The existence of *C. coreanus* Distant adults studied on the mountain, Safin, Korac, Bradost, Hassan bag, Zozic, Handren, Kalander, Pearan, and Sheren takes 515, 768, 1261, 576, 227, 119, 472, 270 and 752 adults /10 m<sup>2</sup> respectively in summer 2023. In summer 2024, the count represented 240, 162, 374, 222, 187, 94, 243, 151, and 264 adults /10 m<sup>2</sup>, respectively Table (3). The decline in adult populations is attributed to the impact of environmental and biological variables. The grownups encountered frigid and snowy winter weather [24] and [22]. This makes them vulnerable to fungi, which leads to the death of many of them in hibernation places [18]. Upon emerging from hibernation, they resumed their activity and embarked on a migration towards the fields of wheat and barley to engage in feeding and reproduction. Iraq's dormancy period was distinct from other regions because the weather is cold in winter in this region compared to other regions [25].

Table3. Population density of adults at the top of mountains in 2023 and 2024

Mountain	Number of Insect adults /10 m <sup>2</sup> -2023	Number of Insect adults /10 m <sup>2</sup> -2024
Safin	515	240
Korac	768	162
Bradost	1261	374
Hassan bag	576	222
Zozic	227	187
Handren	119	94
Kalander	472	243
Pearan	270	151
Sheren	752	264

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## دراسة السبات الصيفي والسبات الشتوي لحشرة *Carpocoris coreanus Distant,1899* على جبل سفين في محافظة أربيل – العراق.

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### الخلاصة

تناولت الدراسة الحالية موقع السبات الصيفي والسبات الشتوي لحشرة بق النتن *Carpocoris coreanus Distant* التي تهاجم المحاصيل والنباتات ذو الأهمية الاقتصادية في الحقول ثم تهاجر وتقضى فترتي السبات الصيفي والشتوي على جبل سفين التابع لمحافظة أربيل، اعتباراً من تموز 2023 لغاية آذار 2024. تبين نتيجة البحث أن الحشرة تقضي فترات السبات الصيفي تحت نباتات جوني *Astragalus russelii* وأم الحليب *Euphorbia peplus L.* والزرعتر *Thymus vulgaris L.* كذلك تقضي الحشرات الشتوية تحت الأوراق المتتساقطة لنباتات البلوط *Quercus infectoria L.* *Quercus Aegilops L.* والعفص *Thyme* *Pistacia atlantica v. kurdica* سجلت أعلى معدل الكثافة العددية للحشرة على قمة الجبل خلال شهر تموز 2023، بينما كان أعلى معدل الكثافة العددية للحشرة كانت 10,25 كاملاً / 10م<sup>2</sup> في شهر آذار من موسم 2024، وكان أعلى تعداد لهذه الحشرة 66,25 كاملاً / 10م<sup>2</sup> في شهر تشرين الثاني من موسم 2023 وافق تعداد للحشرة بلغت 10,25 كاملاً / 10م<sup>2</sup> في شهر مارس 2024 على قمة الجبل. أما على سفح الجبل فقد بلغ أعلى تعداد لها 7,33 كاملاً / 10م<sup>2</sup> في شهر كانون الأول سنة 2023، ولكن أقل تعداد في السفح بلغ 3,66 كاملاً / 10م<sup>2</sup> في آذار 2024. وعند قاعدة الجبل فقد سجل 0,62 كاملاً / 10م<sup>2</sup> في تشرين الثاني من موسم 2023 ثم ازداد ليصبح 9,83 كاملاً / 10م<sup>2</sup> في آذار موسم 2024. ظهور الحشرة خلال موسم الصيف سنة 2023 على جبال سفين، كورك، برادوست، حسن بك، زوزك، هندرین، فلندر، بيران وشيرين كان 515، 768، 1261، 227، 576، 472، 119، 270، 752 كاملاً / 10م<sup>2</sup> على التوالي. وفي موسم الصيف سنة 2024 كان التعداد 240، 222، 374، 187، 162، 243، 94، 151، 264 كاملاً / 10م<sup>2</sup> على التوالي.

الكلمات المفتاحية: حشرة السونة، التشتهية، السبات الصيفي وجبل سفين.