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A review on the economic and vital importance of the Eleven-Spot Ladybug *Coccinella Undecimpunctata* L. and Determination of Its Seasonal and Relative Presence on Absorbent Piercing Insects

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Abstract

The eleven-spot ladybird *Coccinella undecimpunctatata* L. is one of the biological control Agent used against many economically important insect pests. The research showed the following data : The ladybird *C. undecimpunctata* was reared in the laboratory preying upon the alive and frozen black broad bean and cotton aphids .A larva of ladybird were able to develop on these two species complete life cycle and continued to the following generation, their life cycle coincides with the life cycle of the prey, their ability, in both larval and adult stages, to prey on the hosts, and their ability to choose an alternative victim when the numbers of the first prey are small. it has been shown that they attack and feed on twelve other aphids, as well as the eggs and larvae of the slugworm and the larvae of the diamondback moth, The larva of ladybug consumes about 400 medium-sized insects during its development to the pupal stage; while as an adult, it consumes 300 insects before laying eggs. Overall, it consumes 5000 insects during its lifetime, as the appetite of the ladybirds and their high reproductive capacity makes them consume their prey quickly. The importance of ladybugs comes from their presence throughout the year, their coincidence with the presence of aphid species. and that their numbers constituted 50% of the numbers of other predators, which reduced the population density of aphids in the field to the level at which the use of chemical pesticides was dispensed with.

Keywords: Eleven-Spot Ladybug; *Coccinella Undecimpunctata*; Absorbent Piercing.

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Geographical distribution

Ladybugs are among the most widespread predatory insects in the world and have been important in the field of biological control since ancient times. The characteristics of the ladybugs place them at the head of the list of predatory insect groups for many reasons: their life cycle coincides with the life cycle of the prey, their ability, in both larval and adult stages, to prey on the hosts, and their ability to choose an alternative victim when the numbers of the first prey are small. The importance of ladybugs has increased as a successful biological enemy with aphids, which was the reason for reducing large numbers of different species [1; 2]. The ladybug *C. undecimpunctata* was recorded in New Zealand in 1874 and was used to control aphids as the first known insect for biological control. Later on, it has been shown that they attack and feed on twelve other aphids, as well as the eggs and larvae of the slugworm and the larvae of the diamondback moth [3; 4 ;5]. *C. undecimpunctata* is one of the most important predators of many aphid species in Russia [6; 7]. In Britain,[8] reports that the eleven-spot ladybug is one of 41 species of ladybugs recorded in England, and its population density is largely determined by climatic conditions. These bugs prefer warm, humid places, and their population density decreases significantly after cold weather.[9]indicated that it was recorded among 71 species of ladybirds in different areas of Pakistan, and it feeds on five insect species belonging to the order Hemiptera. In a recent study of ladybugs in northwestern Turkey, [10] stated that the eleven-spot ladybugs have a slight existence among 12 species recorded in that area. [11]stated that *C.undecimpunctata* and *Phrynocaria astrolabiana* ladybugs have recently been seen in Australia. In New Zealand, biological enemies, including the ladybug *C. undecimpunctata*, play an important and effective role in controlling aphids without the need for the use of chemical pesticides [12]. In Pakistan,[13]found that the ladybug *C. undecimpunctata* accounts for 50% of the total predators and has a significant role in controlling the aphids in the field. In Saudi Arabia, [14]found that the most widespread ladybugs in the wheat fields are Adonai variegate (Goeze) and *C. undecimpunctata* L.; the latter was characterized by being more effective as a biological enemy in terms of its high fertility, rapid development, survival time, and high population density than the wheat aphid *Schizophis graminum*. In Egypt, [15]noted that the ladybug *C. undecimpunctata* played a major role in reducing insect pests on the cowpea crop and was one of the most prevalent predators in the field.

In Iraq, the ladybugs are widespread and mainly found on the Nerium oleander plants. These plants provide predators of the Coccinellidae family with a food source represented by the oleander aphid *Aphis nerii*. As such, it was recommended to plant them in the form of a sward surrounding the field or orchard [16;17].[18]also mentioned that, in Iraq, the oleander is infected with the oleander aphid, which persists for a relatively long period before the appearance of other aphid species on the plants, providing food for predators of the ladybugs for a long period of time during the year. Others have emphasized the seasonal presence of the predator *C. undecimpunctata* on the clover plants and stated that this predator was present throughout the year but was less dense in mid-July and late August due to the lack of prey and high temperatures during this period [19].

Economic importance

The economic importance of the Coccinellidae family is highlighted by the fact that the predators of this family are the primary predators in the control of aphids, especially the species *C. septempunctata* L. [20; 21;22]. Their importance came from the fact that they include many efficient insect predators that, during their larval and adult stages, prey on many types of aphids, mealybugs, scale insects, whiteflies, and eggs of insects of the order of the pteroptera, the lepidoptera, and the hymenoptera [23; 24; 25; 26; 27; 28; 29; 30]. Utilizing ladybugs as a biological control strategy depends on the ease of catching and raising them in different environments, the diversity of their species, and the diversity of their behavior [31; 32]. The larva of ladybug consumes about 400 medium-sized insects during its development to the pupal stage; while as an adult, it consumes 300 insects before laying eggs. Overall, it consumes 5000 insects during its lifetime, as the appetite of the ladybirds and their high reproductive capacity makes them consume their prey quickly [33]. [34] reported that, during 10 days, the consumption rate of the aphid in the adult stage was more than in the larval stage, reaching around 650-788 nymphs. [35]and [36]that the field launch of the ladybugs *C. undecimpunctata* L. at a rate of one predator per 50 insects led to a 99.79% decrease in the population of the cotton aphid *Aphis gossypi*, while others reported that the ladybugs *C. undecimpunctata* have great importance in consuming aphids, as the average number per day of predatory *A. nerii* insects increased significantly with the increase in the density of aphids [37]. [38] also showed the variation in the nature of predation of the larva with the difference in the type of aphid, as well as the rapid increase in the attack rate at the beginning and its ability to search for the predators at

their low and high densities. The importance of ladybugs comes from their presence throughout the year, their coincidence with the presence of aphid species, and their high predatory efficiency. A recent study showed that the highest population density of the seven-spot ladybug reached 54 adults/m^2 in the last week of April in the clover fields [39]. [40] noted that natural enemies, including the eleven-spot ladybug, played an important and effective role in controlling aphids and that their numbers constituted 50% of the numbers of other predators, which reduced the population density of aphids in the field to the level at which the use of chemical pesticides was dispensed with. Others have indicated that the predatory efficiency of the eleven-spot ladybug stages is directly proportional to the population densities of the black bean aphid *Aphis fabae* (Scopoli), and the daily consumption rate increased with the increase in the number of the black bean aphid to reach 20.62 nymphs per day [41]. Another study found that the adult predator *C. undecimpunctata* preys only on the nymphs of the Dubas bug *Ommatrssue lybicus* at their early stages and was unable to prey on these nymphs in their late stages due to the ability of the nymphs to jump and escape from enemies with the help of the tailed wax threads located at the back of their bodies that sense mechanical stimuli from a distance and which increase in length and number with the age of the nymph [42]. The results of the study conducted by [43] showed that the eleven-spot ladybug *C. undecimpunctata* coexisted with a large number of parasites and predators in a citrus orchard located in Al-Numaniyah District / Wasit Governorate, namely: The seven-spot ladybug C. septempunctata, the parasite *Encarsia sp*, the predator *Clitostethus arcuatus*, the predatory mite Pronematus sp., and the predator *chrysoperla carnea*. Lastly, some studies have found that the ladybug *C. undecimpunctata* was dominant on Coccinellidae species on watermelon plants in spring seasons [44].

Life-cycle of the eleven-spot ladybug *C. undecimpunctata*

Egg

The eleven-spot ladybug *C. undecimpunctata* has been described as being yellow in color, spindle-shaped, and often laid in groups close together (mass) and fixed with an adhesive substance on the surface on which they are placed at the bottom of the egg, resembling the eggs of the seven-spot ladybug [45].

Larval stage

The newly hatched larva is gray in color and goes through three moultings to produce four larval stages. Then after, it enters the pupal stage depending on the abundance of food [8]. It has been stated that the duration

of the eleven-spot ladybug's developmental cycle is about 20-30 days [46].

First larval stage

[20]and[47]described the dimensions of the larva at this stage, stating that its length is about 1.3 mm, and its width is 0.5 mm. The newly hatched larvae remain in the eggshell for a few hours to about one day, after which they crawl to the external environment in search of their natural food. Others indicated that the duration of the first larval stage of the predator *C. undecimpunctata* was 3.2 days when it fed on black fava bean aphids [48], while others found that it lasted 50.2 hours when it fed on the same aphids in laboratory conditions at a temperature of 18°C and a relative humidity of 65.7% [28]. [49] found that the duration of the first larval stage of the predator *C. undecimpunctata* varied according to the type of prey, reaching 6.5, 5.25, and 5.23 days when the predator fed on corn aphids *Rhopalosiphum maidis*, clover aphids *Theriophis trifolii*, and mustard aphids *Lipaphis erysimi*, respectively.[50]reported that the duration of the first larval stage of the ladybug *C. undecimpunctata* was 2 days when fed on wheat aphids *Schizophis graminum* and 2.5 days when fed on oat aphids *Rhopalosiphon padi*.

Second larval stage

[20]described the second larval stage as larger and more active than the first larval stage. He mentioned the dimensions of this stage as being about 3.2 mm long and 1.2 mm wide and the color as being dark gray to black. Others indicated that the second larval stage lasted around 84.9 hours when feeding on black fava bean aphids under laboratory conditions at a temperature of 18°C and a relative humidity of 65.7% [23]. Others stated that this stage lasted 1.8 and 2.0 days when feeding on live and frozen aphids, respectively [51]. [49]indicated that the duration of this stage reached around 5.60 days when feeding on the corn aphids, while it reached 5.66 and 6 days when feeding on clover aphids *T. trifolii* and mustard aphids *L. erysimi*, respectively. [50]stated that the duration of this stage reached 3.75 and 3 days when feeding on *S. graminum* and *R. padi,* respectively.

Third larval stage

[20] reported that the length of the larvae at this stage is about 4.8 mm, and its width is about 2.1 mm. Others indicated that the bodies of the larvae at the third and fourth stages are more distinct than those at the first and second stages, in which they change the color of the two lateral tubercles of the fourth abdominal segment to yellow-orange, in addition to the lateral tubercles of the first abdominal segment [52]. Others found that the duration of this stage was around 81.6 hours when fed on black fava bean aphids and in laboratory conditions of 18°C and 65.7% relative humidity [28].

[49]found that the third larval stage of the predator *C. undecimpunctata* lasted 7.90, 6.10, and 5.91 days on the corn aphids *R. maidis*, clover aphids *T. trifolii*, and mustard aphids *L. erysimi* [50] indicated that the duration of this stage reached 3.58 days when fed on wheat aphids *S. graminum*, while it was 3.17 days when fed on oat aphids *R. padi*.

Fourth larval stage

[20]indicated that the larva of the fourth stage is characterized by its activity, and its length is about 10.1 mm, while the width is about 3.0 mm. Others stated that the larvae of this stage secrete Coccinellin substance from its tubers, which is a repellent and toxic substance for its natural enemies [28]. He indicated that it lasted 81.5 hours when fed on black fava bean aphids under laboratory conditions of 18°C and 65.7% relative humidity. Others stated that this stage lasted 4.4 days when fed on both live and frozen aphids [51]. [49] indicated that the duration of the fourth larval stage of the predator *C. undecimpunctata* was 8.01 days on the corn aphid *R. maidis,* while it was 7.8 and 8.5 days when fed on the clover aphids *T. trifolii* and the mustard aphids *L. erysimi*, respectively. [50]also reported that the duration of this larval stage was 4.25 days when fed on wheat aphids *S. graminum*, while it was 4 days when fed on oat aphids *R. padi.*

Pupal stage

reported that the length of the pupa is about 6.1 mm, and its width is about 4 mm. It was found that the pupa is yellow in color and later turns to yellowish black [45; 54]. The pupa of this predator is characterized by its small size in addition to the presence of a pair of brown spots on the dorsal surface of the dorsal plates of abdominal segments 5, 6, and 7 [28]. [53]found that the duration of the pupa of the eleven-spot ladybug lasts 3-5 days under laboratory conditions at a temperature of 25°C, a relative humidity of 65%, and a light:darkness period of 16:8 hours. The duration of the pupal stage may reach 6-12 days [46], while [50]indicated that the duration of the pupal stage was 5.17 and 6.0 days when the larval stage fed oat aphids *R. padi* and wheat aphids *S. graminum*, respectively.

Adult stage

The adult ladybug *C. undecimpunctata* L. is characterized by a broad ovoid to convex body, 4.2-5.6 mm long, and a black head with two yellow spots near the compound eyes. The front of the dorsal surface is granular with shiny white hairs, while the chest and anterior back have sharp anterior angles, and the yellow spots on the anterior angles extend to the posterior angles and are wide at the anterior angles and decrease in width towards the back, where they form a narrow strip at the anterior angles under the ilium more widespread than in the anterior angle of the back, and extend towards the

back. The sheath contains five black spots, except for the common shield spot located near the dorsal suture, which is equal in size to those spots located near the anterior edge in most cases. There may be an overlap between the sheath spots, and in some cases, we find that the sheath contains only the common shield spot and a wide variation in the number of sheath spots as it ranges between 0-5 spots. For the abdomen, the femoral line of the visible ventral sternal plate reaches the lateral edge of the plate, its branch is short and not connected with it. The last ventral sternal plate in the male has a semi-arched posterior edge containing a clear medial inner denticle defined on both sides by two tufts of hairs. In females, the last ventral sternal plate has a nearly curved posterior sternal plate, and the legs are black [21;20]. Others indicated that the male predator has five spots on each sheath, with a common eleventh point that is round in shape between the two sheaths [28;32].He also explained the ease of distinguishing between the sexes; the female is larger than the male, and the sheaths do not cover the entire last abdominal segment of the male's body, with rows of hairs at the end of the abdomen in the female. The rate of oviposition for ladybug *C. undecimpunctata* is about 724.6 eggs/female [4], Others stated that when raising ladybugs *C. undecimpunctata* on black fava bean aphids, the average age of females at first reproduction is 10 days and the average egg production is 1257.24 eggs [19]. [49]found that the number of eggs laid by a female during the oviposition period was 621, 616, and 601 eggs when the adult was fed on corn aphis *R. maidis*, clover aphids *T. trifolii*, and mustard aphids *L. erysimi*, respectively. In addition, it was found that the number of eggs laid by a female during her lifetime was 480.25 and 521.42 eggs when the predator was fed on corn aphis *R. maidis* and wheat aphid *S. graminum*, respectively [51]. Others showed that the highest density of the seven-spot ladybug was 54 adults/m^2 in the last week of April in the clover fields [39].

Wintering

[55]found that the wintering sites of *C. undecimpunctata* are in the form of clusters under plant fences, fallen leaves, or rocks and tree bark. [9]noted that the adults of the eleven-spot ladybug resort to cracks, crevices, and folded leaves in large clusters to protect themselves during the winter. Others found that the ladybug *C. undecimpunctata* spends the winter as an adult in places that provide it with protection from harsh environmental conditions in the form of clusters consisting of 20-50 individuals under trees, dry reed branches, and cracks[9]

Conclusion: This study focused on the biology of the predator Tenodera sinensis because of its importance in reducing

populations of pest species prevalent in the Iraqi environment. All developmental stages of this insect are predatory, and females produce large numbers of eggs within oothecae. The duration of the predator's life cycle decreases as it consumes greater numbers of the black bean aphid, Aphis fabae. Furthermore, this pest species was preferred over other prey species, likely because of its relatively high protein content, which is required for the predator's growth and development.

Conflict of Interest Statement: The author declares no conflict of interest.

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دراسات بيئية على الدعسوقة ذات الاحد عشر نقطة و تحديد وجودها الموسمي و النسبي على الحشرات الثاقبة الماصة

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الخلاصة

ان الدعسوقة ذات الأحد عشر نقطة *Coccinella undecimpunctata* L تُعَدّ احد عناصر المكافحة الحيوية التي سجل نجاحها في عدة برامج مكافحة عالميا وعربيا للسيطرة على الآفات الحشرية ذات الأهمية الاقتصادية. تمت تربية الدعسوقة *C. undecimpunctata* في المختبر بتغذيتها على حشرات من الباقلاء الأسود ومن القطن الحي والمجمد. وتمكنت جميع اطوارها اليرقة من إكمال دورة حياته الكاملة على هذه الأنواع بشكل كامل حتى وصولها الى البالغات،وتمكنت من وضع البيض والاستمرار الى الجيل الثاني و حيث تتزامن دورة حياته مع دورة حياة الفريسة، إضافة إلى قدرته في مرحلتي اليرقة والحشرة الكاملة على افتراس العوائل، وكذلك القدرة على اختيار فريسة بديلة عند انخفاض أعداد الفريسة الأولى. كما ثبت أنها تهاجم وتفترس اثني عشر نوعًا آخر من حشرات المن، إضافة إلى البق الدقيقي والحشرات القشرية والذباب الأبيض وبيوض حشرات رتبة غمدية الاجنحة ، غشائية الاجنحة ، وبيض ويرقات دودة أوراق القطن (slugworm) ويرقات عثة الظهر الماسي (diamondback moth). وتستهلك يرقة الدعسوقة حوالي 400 حشرة متوسطة الحجم خلال نموها حتى مرحلة العذراء، بينما تستهلك الحشرة الكاملة حوالي 300 حشرة قبل وضع البيض. وبصورة إجمالية، تستهلك الدعسوقة ما يقارب 5000 حشرة خلال فترة حياتها، حيث إن شهيتها العالية وقدرتها التكاثرية المرتفعة تجعلها تلتهم فرائسها بسرعة كبيرة. تكمن أهمية الدعسوقة في وجودها المستمر على مدار العام، وتزامنها مع ظهور أنواع المن المختلفة، إضافة إلى أن أعدادها شكّلت نحو 50% من أعداد المفترسات الأخرى، مما أدى إلى خفض الكثافة العددية للمن في الحقل إلى مستوى تم الاستغناء فيه عن استخدام المبيدات الكيميائية .

الكلمات المفتاحية: الدعسوقة ذات النقاط الإحدى عشرة؛ *Coccinella undecimpunctata*؛ الامتصاص الثاقب.