



Morphological study and Seasonal Population Dynamics of *Aleiodes carminatus* (Hymenoptera: Braconidae) on Cucurbits in Erbil province, Kurdistan Region-Iraq

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ABSTRACT:

The present work conducted in Grdarasha Field from Erbil province, Kurdistan Region/Iraq in April 2021 until August 2022. *Aleiodes carminatus* (Hymenoptera: Braconidae: Rogadinae) a new species in Iraq studied a detailed morphological description and seasonality population. The *A. carminatus* was used for biological control to manage larvae of lepidopterans. The samples were collected by hand picking, insect net and light traps through various plants of Cucurbitaceae (pumpkin, cucurbit and melon). The morphological study indicated that antenna consist of 38th segments, brown-dark brown, 37th antennomer oval shaped. The apex parts of mandibles have two denticles, outer denticle longer than the inner. Maxillary palps consist of 5 palpimer, the 5th palpimer elongated oval shaped. Wings pale brown, stigma is like swelling. Spiculum gaster V-shaped, pale brown. Ovipositor needle-like. Some important parts were photographed. Date of collection, plant hosts, and localities have been illustrated. The molecular techniques confirmed the identity of the specimens, *Aleiodes carminatus* was first recorded in Iraq and submitted to GenBank with accession number OQ476362 Kafroshi 11. The works conducted was to study the ecology of insects; the population size, and experiments were observed in the field during the autumn and spring seasons on cucurbit, pumpkin and melon vegetable. The maximum population during the fall season was showed that on the pumpkin crop at the 2nd weeks of September 2021 and the highest population during Spring season on the pumpkin crop at the 1st weeks of June/2022.

Keywords: Morphological study, *Aleiodes carminatus*, Seasonal population, Cucurbitacea, Iraq.



1 INTRODUCTION

The family Braconidae is the second biggest family within order Hymenoptera, which is about 19,435 globally described it is estimated there are more than 100,000 species worldwide [24]. As parasitoids, Braconids play an important role in controlling herbivore insects, and makes them essential for the balance of ecosystem as well as for adding to other creatures' diversity [10]. Lepidoptera, Coleoptera, and Diptera species are the primary common hosts of braconid wasps [19]. The most diverse and prevalent Rogadinae wasp in the world is *Aleiodes* Wesmael (Hymenoptera: Braconidae: Rogadinae; tribe Aleiodini) [23]. The strange and unique behavior of *Aleiodes* species which pupate within the remain of the host caterpillar, and then shrivels and turns to a recognizable caterpillar “mummification” has led to them being known as “mummy wasps” [16]. All *Aleiodes* are solitary that target mostly exposed-feeding macrolepidopterans, notably the superfamilies Noctuoidea and Geometroidea, as well as to a lesser degree Papilionoidea and Sphingoidea [16]. Shimbori *et al.*, (2014) observed that the characteristic key was identified from the Ecuador *Aleiodes* species key [17].

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Aleiodes carminatus Van Achterberg and Shaw, 2016 is one of most important species and large group of family Braconidae order Hymenoptera, worldwide [3]. All *Aleiodes* species like *A. carminatus* are the most beneficial of the biological control agents for the suppression of natural insect pest population [16]. VAN ACHTERBERG (1991) reported that its distribution is world-wide and is a somewhat major component of the braconid fauna in the western Palaearctic region, it also adopts morphological and phylogenetic analysis of this genus [21]. In Iraq, DERWESH (1965) recorded ten genera of the families [4]. EL-HAIDARI *et al* (1972) mentioned three genera and four species [5].

The effects of abiotic factors, like temperature and humidity on living things have been the main topic of study in the context of the global environment [11]. Since parasitoids are ectotherms, their survival developments and growth are particularly affected by temperature and humidity; the development of parasitic wasps is generally more temperature-sensitive than that of their hosts [19], [6]. Its incidence among parasitoids in herbs was 92% [2], *Aleiodes* have generally been found a little effect on the number of autumn armyworms in crops. Specifically, temperature has a variety effect on parasitoids, including their lifespan, sex ratio, behavior, fecundity and morphology [8]. Furthermore, the amount of moisture that insects get from their surroundings heavily influenced by humidity levels [13], since humidity changes more often and more sharply than temperature, it is hard to see a long-term pattern in humidity, while temperatures are easier to detect.

This work's objective is to lay out a novel *Aleiodes* species., with has a high potential for usage in the biological managements of Spodoptera. detail morphological description of this species; using DNA barcode sequences to confirm this species and population dynamic on cucurbitaceous crops in the field.

2 MATERIALS AND METHODS

2.1 IDENTIFICATION

Sample collecting: The specimen were collected by various way such as hand picking, insect net and light traps of Cucurbitaceae family from various plants, like as (melon, cucurbit and pumpkin) during April 2021 tile August 2022, in different localities (Qushtapa, Dugrdkan, Jideeda and Grdarasha) of Erbil province, Kurdistan region – Iraq. the light traps were made by a cylindrical, a plastic funnel (dimensions: 60 cm in height and 30 cm in diameter) and also a bulb light. The funnel was placed in bottom and the light hold up above. The funnel was used to determine number of the insect on the vegetable Cucurbitaceae.

MORPHOLOGICAL IDENTIFICATION

The traditional key used for identification species and supported by molecular DNA by many researchers like [14] and [18] The used molecular techniques confirmed the identity of the specimens, *Aleiodes carminatus* was first recorded in Iraq and submitted to GenBank with accession number OQ476362 Kafroshi 11.

Insect Dissection: the sample after collected were killed by freezing for 24h. Dissecting binocular microscope (Human Scope Stereo microscope) was used to document the sample *Aleiodes carminatus* (10 Female and 10 Male).

To soften the body specimens were placed in boiling water for 4-8 minute and the head, thorax and abdomen were split up, the head and abdomen were submerged in a KOH10% solution, which was put on a hot plate and shaken for 3-6 minutes to dissolve lipid and destroying muscles, following that using distilled water for washing for 4 minutes to reduce alkali. After that each part of the abdomen and mouthparts placed in glass petri dishes that contain amount of each concentration of ethyl alcohol 25%, 50%, 75% and 100% for two minutes respectively, to dehydrate of water, after that the parts placed in Xylol for 2 minutes to clear the parts of the samples. Each part was positioned on a glass slide with a drop of DPX and covered by cover slide, [14], [7] after that the slide placed on hotplate at 45 °C for 4 minutes and transfers the plastic plat under dry atmosphere room for 24h to prepared for examination microscope.

MOLICULAR IDENTIFICATION

DNA of *Aloides carminatus* was extracted using ZYMO Quick- DNA Tissue/Insect Microprep Kit. The extracted DNA was visualized by 1.5% of agarose gel electrophoresis. Spectrophotometer (NANODROP1000 U.K) was used to check the quantity and quality of isolated genomic DNA. The COI gene sequence was applied to Basic Local Alignment Search Tool (BLAST) which is a searching tool that applies the sequence alignment method (<https://blast.ncbi.nlm.nih.gov/Blast.cgi>), and is available at the NCBI (National Biotechnology Information Center) website to comparing and alignment laboratory or query sequence with other biological sequence to find out more similarity with other targets. The species was submitted under accession number (OQ476362 Kafroshi 11). The used primer was Forward C1-J-1718 3' (GGAGGA TTTGGAAATTGATTAGTTCC) 5' and Reverse HCO2198 5'(TAAACTTCAGGGTGACCAAAAAT) 3'.

2.2 STUDY THE POPULATION OF *Aleiodes carminatus*

The experiment field during Autumn and Spring season in 2021 and 2022 at the field Grdarasha of the College of Agricultural Engineering Science / Salahaddin University–Erbil. After managed soil; the design lands were using three

replications and a Randomized Complete Block Design (RCBD) for growing some Cucurbitaceae crops like as (cucurbit, pumpkin and melon). Every experiment-unit area was 12 m² (6×2 m). The abundance population of (*Aleiodes carminatus*) was noticed and monitored during growth of the vegetable plants [8].

The Environmental factors effect of abiotic factor like as relative humidity and temperature on this specimen and the crops were recorded. The meteorological data (temperature and relative humidity) for ecological study were provided by the Planning Departments/General Directorate of Agriculture in Erbil province shown in Figure 1.

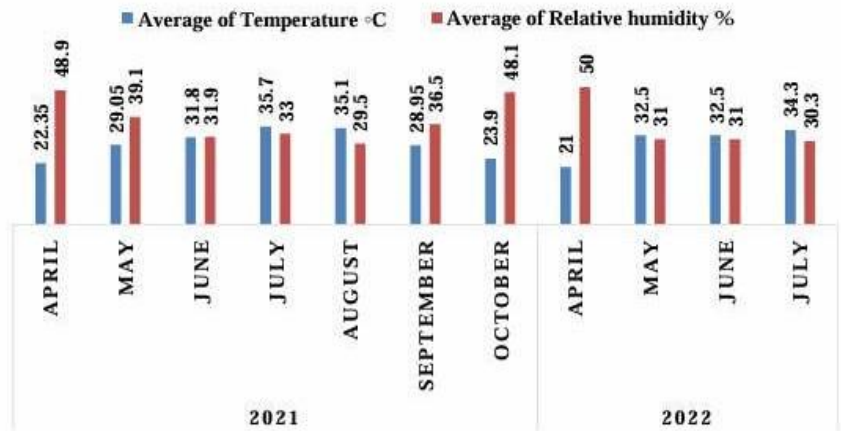


FIGURE1. Relative Humidity and Temperature Data during 2021 and 2022

2.3 DATA ANALYSIS

The data were morphologically analyzed and population density were analyzed by Microsoft office Excel.

3 RESULTS AND DISCUSSIONS

MORPHOLOGICAL IDENTIFICATION

Body: (Fig.2.a) Pale brown-brown, elongate oval, length 3.9-4.3 mm and width 0.9-1 mm. **Head:** Brown- dark brown, spherical, length 0.6-0.7 mm. Vertex low concave, with low dense short yellow setae. Frons flat, with high dense of short yellow setae. Clypeus low concave, with high dense short yellow setae. Eyes oval elongate, length 0.3-0.4 mm, black, convex, the distance between eyes 0.1-0.2 mm. Three dark brown ocelli present. Antenna (Fig.2.b) brown- dark brown, consist of 38 antennomers, length 3.7-3.9 mm, 1st antennomer bulb shaped, 2 times as long as the 2nd antennomer, 2nd antennomer tubular, 37th antennomer oval, slightly 1.2 times as long as the 36th antennomer. Labrum (Fig.2.c) White-pale yellow, semi-rounded, length 0.2-0.3 mm, anterior margin curved at the middle, surface with low of dense short white seta. Mandible (Fig.2.d) pale brown, 0.3-0.4 mm, moderate sclerotized, apical parts with two denticles, outer denticle longer than the inner denticle, scrobe with high dense of white seta. Maxilla (Fig.2.e) yellow- pale brown, maxillary palp consists of five palpimers, 2nd palpimer nearly cup shaped, 3 times longer than the 1st segment, 4th palpimer tubular 1.4 times longer than the 5th palpimer, 5th palpimer elongate oval. Labiam (Fig.2.f) Yellow-pale brown, mentum semi-rounded, labial palps consists of 4th palpimers, 1st palpimer small, nearly cup shaped, 2nd palpimer tubular, 2 times as long as the 1st palpimer, 4th palpimer elongate oval. **Thorax:** Spherical, brown, length 0.7- 0.8 mm, convex, surface with high dense of short white setae, anterior margin curved, the posterior margins semi-round rounded, anterior angle round, the posterior angles acute. Scutellum dark brown, triangular. Fore wings (Fig.2.g) membrane, brightly pale brown, length 3.5-4.0 mm, stigma like-swelling, brown, junction of the m-cu, RS+M and 2M the vein m-cu and 2RS are interstitial with the swelling extending ventrally along m-cu and dorsally into the adjacent corner of both the first and second submarginal cell. Fore legs (Fig.2.h) brown, forecoxae cup shaped, trochanter triangular, forefemur oval, foretibia tubular, length 0.6-0.9 mm, apical with high dense of short yellow spines and 2 short brown spurs. Pretarsus consist of five tarsomers, 1st tarsomer 3 times as long as the 2nd tarsomer, foreclaws simple, stylet shaped. Middle legs similar to the forelegs except mesocoxae funnel shaped, length of tibia 0.9-1 mm, 1st tarsomer 0.6 times longer than the 2nd tarsomer. Hind legs similar to the forelegs aside from, metacoxae bulb formed and length of tibia 1.3-1.4 mm, 1st tarsomer 1.0 times as long as the 2nd tarsomer. **Abdomen:** Elongate oval, narrow, yellow- pale brown, length 1.9-2.2 mm, surface with low dense of short white setae. Abdomen in dorsal view consist of visible six tergites, 1st tergite with round black spot, 2nd tergite rectangular elongate, anterior margin concave, posterior margin convex at the middle, anterior margins of 4th tergite straight, posterior margins rounded. Abdomen in ventral view consist of visible seven

sternites, anterior and posterior margin of 6th sternite straight. Spiculum gaster (Fig. 2.i) V-shaped, pale brown. Female Ovipositor: (Fig.2.j) Dark yellow- pale brown, length 0.5-0.7 mm, ovipositer needle-like, brown color, length 0.7-0.8 mm. Male resemble female except, the antenna consists of 35-40 segments.



FIGURE 2. *Aleiodes carminatus* van Achterberg and Shaw, 2016

a. Female adult 10X, b. Antenna, c. Labrum d. Mandible, e. Maxilla, f. Labium, g. Fore wing, h. Fore legs i. Spiculumgaster, j. Female ovipositor; (Scale bar: b=1.25mm; c, e, f, i = 0.25 mm; d= 0.35 mm; g= 1 mm; h, j = 0.75 mm)

POPULATION DENSITY OF ALEIODES CARMINATUS ON CUCURBITACEAE VEGETABLE IN THE FIELD

The population density of species *Aleiodes carminatus* on vegetable Cucurbitaceae; the results of fall season showed that in (Fig. 3) the maximum population density of *A. carminatus* was found on melon vegetable at the 1st week of August and 2nd week of September/2021, also the minimum population at the 4th week in August/2021. The highest population density on cucumber vegetable recorded at the 2nd week in September/2021 and the lowest population at the 1st week in August/2021. The maximum population density on pumpkin vegetable found at the 2nd week in September/2021 and the minimum population recorded at the 1st week in August/2021.

The results of Spring season were explained in (Fig.4) the highest population density on melon vegetable recorded at the 4th week in June/2022 and the lowest population at the 1st week in April/2022. The highest population density on cucumber vegetable at the 5th week in May/2022 and the lowest population at the 4th week in April/2022. The highest population on pumpkin vegetable at the 1st week in June/2022 and the lowest population at the 4th week in April/2022.

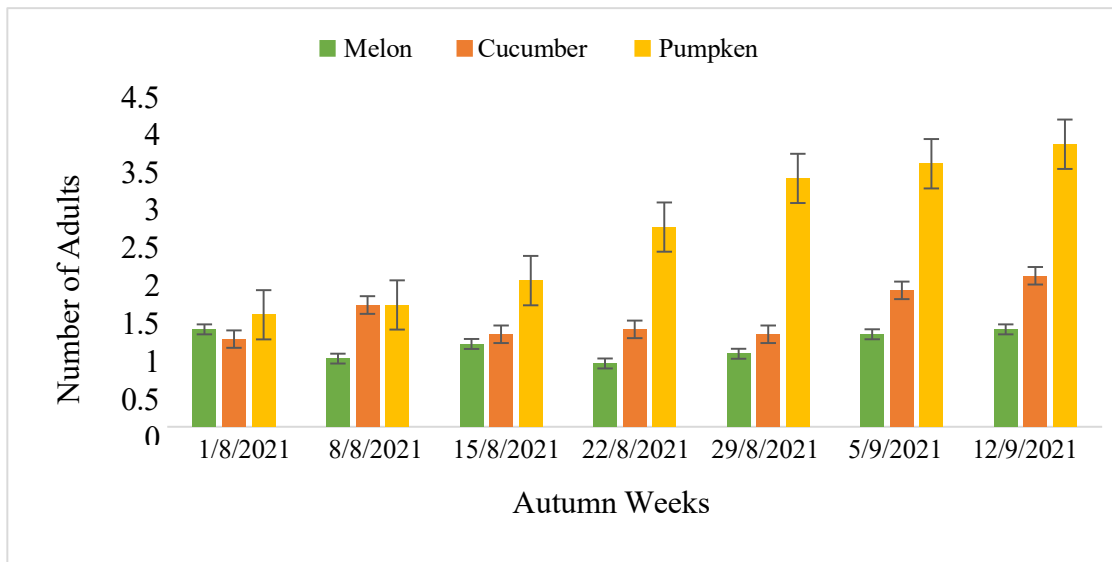


FIGURE 3. population adult stage of *Aleiodes carminatus* on plants during Autumn seasons

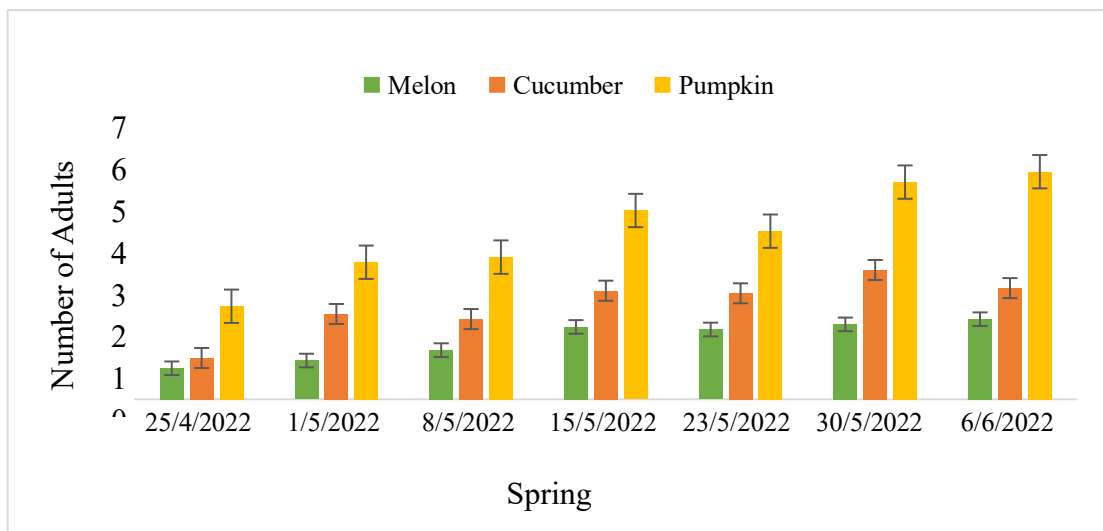


FIGURE 4. population adult stage of *Aleiodes carminatus* on plants during Spring seasons

The insect *Aleiodes* sp. has been described by many researchers and had come out with nearly same result. In our research the parasitoid wasp *Aleiodes carminatus* Wesmael (Braconidae: Rogadinae) was first record from Iraq. Morphological characterization and key identification were conducted for the insect and it was in line with Van Achterberg and Shaw

(2016)'s work which revised *Aleiodes* Wesmael's western Palaearctic species and noted that the fore wing of *A. carminatus* has a relatively narrow wing, the pterostigmata is pale yellowish at the base, and the vein m-cu of the fore wing is straight and at an angle to vein 2-CU1 [22].

Molecular identification using COI DNA barcoding confirmed the species identity. This method is widely recognized as a reliable tool for distinguishing insects [12] and is especially useful for parasitoid wasps with cryptic features [18]. Our sequence deposited in GenBank adds to regional biodiversity records. DNA barcoding is also fast, reproducible, and effective across all life stages, making it a strong complement to morphological identification [1].

Long-term monitoring of population dynamics revealed that *A. carminatus* occurs regularly on cucurbitaceae vegetables such as melon, cucumber, and pumpkin. Weekly sampling across two years and two growing seasons provided valuable insights into seasonal fluctuations. Comparable monitoring studies have shown that parasitoid populations often vary with host abundance, climatic factors, and crop type [15]. A review conducted by VAN ACHTERBERG (1996) revealed that Braconids were available on the melon fruits and their population had been investigated [20]. The presence of *Diabrotica* (Braconidae:Hymenoptera) recorded on the Cucurbitaceae crops parasitizing cucurbit pests in research studied by Walsh *et al* (2003) [24].

CONCLUSION

The morphologically detail description of species *A. carminatus* and The environmental factors have a great impact on the activity and population of the insect, and the insect net and light traps are useful methods for monitoring and time collecting insects.

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