

Annual population dynamics and daily activity rhythm of adult **Oriental** hornets (*Vespa orientalis*), an important pest of Iranian honeybee (*Apis mellifera meda*) in Ahvaz, Iran

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ABSTRACT

The **Oriental** hornet, *Vespa orientalis* L. (Hymenoptera: Vespidae) is one of the most important and **serious** enemies of honeybees. In this study, the annual population dynamics and daily activity rhythm of **Oriental** hornet were examined, based on the number of adults trapped in an apiary located in Ahvaz (southwest of Iran) during a period of two years (January 2021 to December 2022). Samplings were performed using the box traps available in the market. The bait used in the traps was fresh chicken liver, with the traps checked daily in four time periods. The results revealed that the first overwintering queens (gynes) emerged in March and two population peaks of newly emerged hornet workers occurred during the year, one in July and the other in October. In late November and early December, no adult hornet was trapped. The daily activity rhythm of adult hornets was observed mostly during **9 - 12**, almost twice as much as in the afternoon period (**12 - 15**). The lowest activity was recorded in the evening period and night (6 pm - 9 am). During both years of sampling, the seasonal abundance of adult hornets displayed a significant positive correlation with air temperature and a significant negative correlation with relative humidity. By comparing the result of our findings with other studies performed in the same and different climate zones, it can be hoped to present effective methods to control the population of *V. orientalis*, especially in areas that have extensive beekeeping.

Keywords: Bait trap, Khuzestan Province, Population fluctuations, Vespidae.

INTRODUCTION

The Vespidae are a large (**more than** 5000 species) and cosmopolitan family (Pickett *et al.*, 2004; Aguiar *et al.*, 2013), divided into the subfamilies Polistinae (wasps) and Vespinae. The Vespinae are split into four genera including *Dolichovespula*, *Provespa*, *Vespa* (hornets), and *Vespula* (yellow jackets) (Archer, 2012). Hornets of the genus *Vespa* have 22 species where **five of the most important species of this genus include** *V. mandarinia*, *V. tropica*, *V. velutina*

38 and *V. orientalis* are distributed at Asia and Oceania regions, while *V. orientalis* is expanded to
39 north of Africa, Mediterranean regions and across middle-east (Carpenter and Kojima, 1997;
40 Perrard *et al.*, 2013). *Vespa crabro* (European hornet) is naturally distributed at Europe, around
41 Black sea (Carpenter *et al.*, 2013; Perrard *et al.*, 2013), and later imported to North American
42 countries as a biological control agent to control different lepidopteran, coleopteran, dipteran
43 immatures (Cowan, 1991). *Vespa velutina* is native of south Asian regions and migrated to
44 other Asian and European countries lately. This Asian hornet was recorded at South Korea in
45 2003 (Kim *et al.*, 2006; Choi *et al.*, 2012), France in 2004 (Haxaire *et al.*, 2006; Villemant *et*
46 *al.*, 2006) and 2012 at Japan (Sakai and Takahashi, 2014; Minoshima *et al.*, 2015) and right
47 now rapidly spreading across the region (Takeuchi *et al.*, 2017). Two species of *V. orientalis*
48 and *V. crabro* are present in Iran, the first species is distributed throughout the country except
49 for Mazandaran, Golestan, and Guilan provinces (Caspian coast) and the second species is
50 distributed only on the Caspian coast (Ebrahimi and Carpenter, 2012).

51 *Vespa orientalis* is a medium-size hornet with the weight of about 250 mg. In the spring, the
52 overwintering mated queens form the annual colonies, usually in underground cavities. During
53 the summer, the queen reproduces rapidly, such that a queen develops a colony of up to 2000
54 individuals including drones and sterile workers, by the beginning of autumn (Ishay, 1976).
55 The sterile workers function as food gathering, cleaning, enlarging nest, and defense (Cappa *et*
56 *al.*, 2021), while the males attend only to mate with the queens (Cowan, 1991). The young
57 mated females (gynes) will enter diapause during the winter, and as the only overwintering
58 individual of community, they will establish the next year colony (Perez and Aron, 2020).

59 Oriental hornets are general predators (Richards, 1962). In some areas, they are considered a
60 significant agricultural pest, damaging summer fleshy fruits, such as grapes, peaches, dates,
61 figs, pomegranates, and some vegetables (Dvorak, 2006; Glaiim, 2009; Taha, 2014), which may
62 reduce the marketability of agricultural products (Glaiim, 2009; Al-Mahdawi and Al-Kinani,
63 2011; Abdelaal *et al.*, 2014). Oriental hornets also cause direct damage to the trees by chewing
64 the bark of citrus trees and ornamental trees, to use them in the construction of nest walls
65 (Havron and Margalith, 1995). They are very aggressive and their venoms usually cause painful
66 reactions and anaphylaxis in people sensitive to stings (Landolt, 1998; Landolt and Wash,
67 2000). In some areas, the activity of these hornets may make sensitive people unwilling to leave
68 their house during the summer season (Sackmann *et al.*, 2001; Bacandritsos *et al.*, 2006;
69 Sackmann and Corley, 2007).

70 The relation of native honeybee species (*Apis laboriosa*, *A. dorsata*, *A. cerana*, *A. florea*) and
71 hornet are very old, as these organisms live together since ancient times and still living together

72 at oriental regions. These native honeybee species possess perfect defensive behavior (as,
73 shimmering, bee-carpet, heat balling, changed flying strategy, etc.) against these hornets and
74 economic damage is few (Cappa *et al.*, 2021). The problem was aggravated with the
75 introduction of *A. mellifera* at these regions, where this species lack those defensive behaviors
76 against native hornets, and these hornets have become major problem for *A. mellifera*
77 beekeeping (Chantawannakul *et al.*, 2016).

78 In tropical or subtropical regions, as the ambient temperature rises, the number of various
79 available insects and spiders usually drops, causing increased hunting and more damage to
80 honeybee colonies by these invasive hornets. Hornets usually hunt alone by approaching the
81 hive entrance to catch the foraging workers and drones, or by hunting the honeybee individuals
82 around or away from the hives (Baracchi *et al.*, 2010). In some cases, it has been observed that
83 **Oriental** hornets, in addition to hunting all adult honeybees, enter the hive to feed on all larvae
84 and pupae (Papachristoforou *et al.*, 2007; Ebadi and Ahmadi, 2010). Although the hornets are
85 usually considered the secondary pest of honeybees, in some areas, especially tropical and
86 subtropical regions, the damage caused by these invasive hornets is so serious that they have
87 recently threaten the beekeeping industry in these regions (Khodairy and Awad, 2013).

88 Living organisms with a wide geographical range are exposed to various weather conditions
89 (Bridle and Hoffmann, 2022), which affects their phenotypic, physiological, biological, and
90 genetic characteristics (Jackson *et al.*, 2020). Oriental hornet has a wide geographical
91 distribution and is the only vespid species found in desert environments (Cohen *et al.*, 2022).
92 This hornet shows appropriate adaptation in extreme climatic regions (Spradbery, 1973; Harris,
93 1991), and even recent changes in the climate have led to the further spread of this species into
94 central Asia, Europe, and the Americas (Werenkraut *et al.*, 2021).

95 This study aims to investigate the annual population dynamics and daily activity rhythm of
96 adult **Oriental** hornets (*V. orientalis*) during two years in the southwest of Iran (Ahvaz city, the
97 capital of Khuzestan province) with very extreme weather conditions (38.46 °C and 25.53%
98 R.H., average summer season).

99

100 **MATERIALS AND METHODS**

101 In order to determine the population fluctuations of adult **Oriental** hornets, *V. orientalis*, daily
102 samplings were conducted using bait traps during a period of two years (from **March** 2021 to
103 **February 2023**), at the Unit of Bee Research of Shahid Chamran University of Ahvaz, Iran
104 (southwest of Iran; 31°20'N, 48°38'E). **The monthly average of temperature and relative**
105 **humidity, during 2021-2023, has been mentioned in Figure 1. The Iranian honeybee *A. mellifera***

106 *meda* was comprised of nine colonies, kept in standard Langstroth hives containing 10 frames.
107 The hives were placed at least three meters apart in each direction.

108 Samplings were performed using the box traps available in the market. Upon encountering the
109 first adult **Oriental** hornets in the environment, 10 traps were installed at a height of one meter
110 from the ground and near the hives. For this purpose, box traps (30 x 50 cm in size and 30 cm
111 in height) made of wood and metal mesh were used. The bait used in these traps consisted of
112 pieces of fresh chicken liver, which are very attractive for **Oriental** hornets according to
113 previous studies (Al-Heyari *et al*, 2016; Karam kiani, unpublished data). The baits were
114 refreshed every two days, along with the test. During the sampling period, the number of hornets
115 caught in all traps was counted and recorded daily in four periods (including 9 - 12, 12 - 15, 15
116 - 18, and from 6 pm until 9 am the day after). After counting, the captured hornets were removed
117 from the traps and used in other studies. The ambient temperature and relative humidity were
118 recorded by a digital data logger on a daily basis.

119

120 **Data Analysis**

121 One-way repeated measures analysis of variance was used to determine any differences
122 between the numbers of captured adult hornets within all sampling dates. Factorial two-way
123 analysis of variance was employed to analyze the number of trapped adult hornets in different
124 sampling dates (months of the year), and different daily sampling periods (four different
125 periods), as independent fixed factors. The correlation coefficient test was also utilized to assess
126 a possible linear association between temperature and relative humidity with the annual
127 population fluctuations (SPSS, 1998). The Excel software was used to draw the graphs of
128 population changes.

129

130 **RESULTS**

131 **The oriental hornet, *V. orientalis* was the only species of hornet encountered during the study**
132 **period.**

133 The total numbers of captured adult **Oriental** hornets by 10 traps, during each month (Fig. 1
134 A & B) and the mean daily numbers of captured adult **Oriental** hornets by each trap (Figure 1
135 C & D) are presented. The analyses of data revealed that the abundance of the **Oriental** hornet
136 changed significantly during the activity period (from March to December) (in 2021: $P < 0.001$,
137 $F_{9, 1.620} = 66.730$; in 2022: $P < 0.001$, $F_{9, 1.541} = 68.645$).

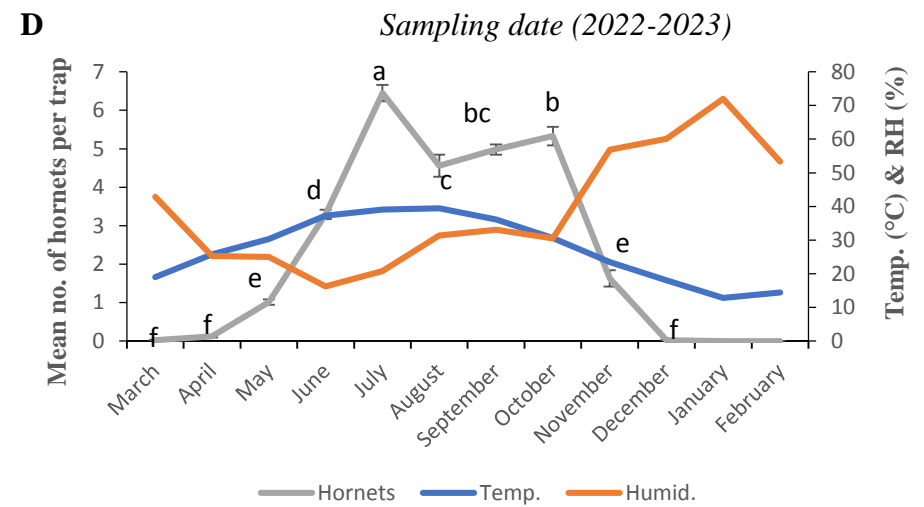
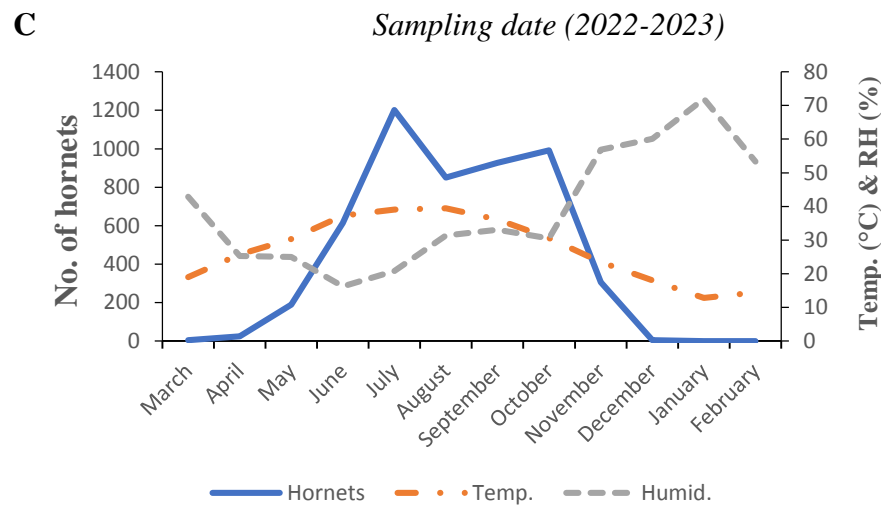
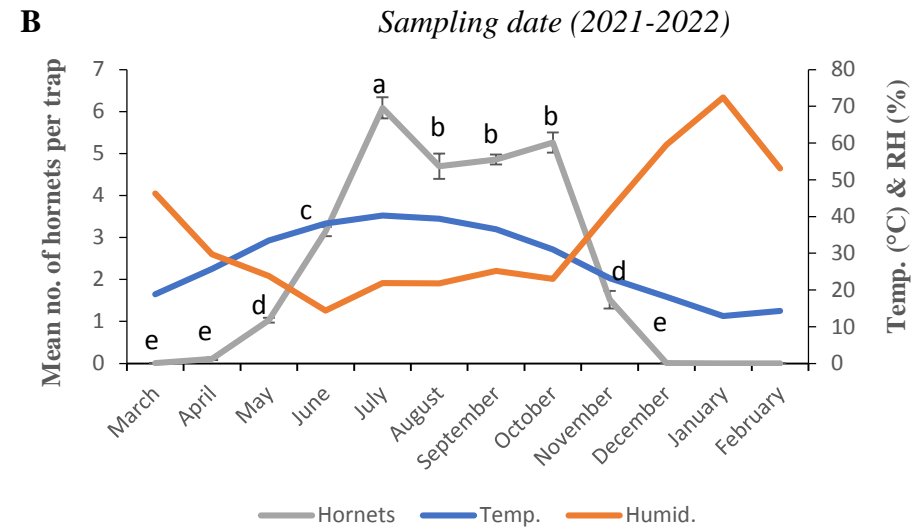
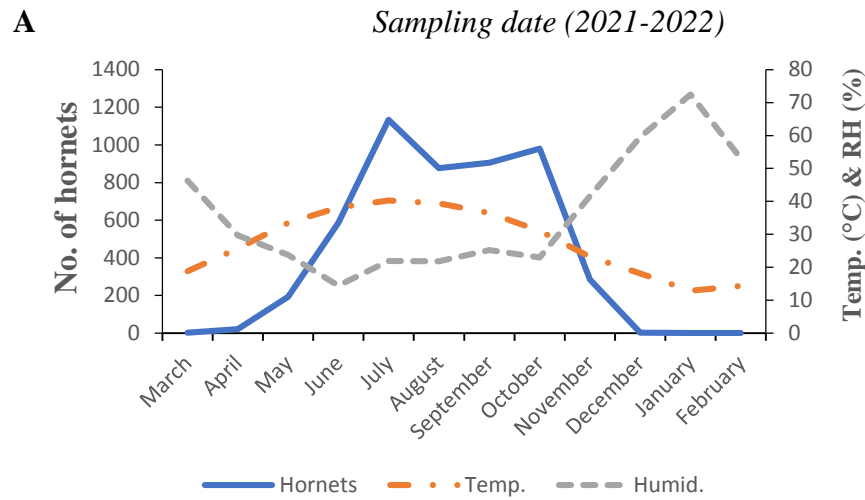
138 During both sampling years, the first overwintering queens (gynes) appeared in the second
139 half of March (on 16th and 18th March, for two years respectively). The gynes' population
140 continued increasingly until the middle of June.

141 The sterile workers produced by emerged gynes gradually emerged and we found two
142 population peaks during the year, one in middle July (6.09 ± 0.25 in Jul. 15, 2021; 6.45 ± 0.21
143 in Jul. 22, 2022) and the other in late September/early October (5.16 ± 0.24 in Sep. 26, 2021;
144 5.33 ± 0.24 in Oct. 01, 2022) (Figure 1 C & D).

145 With the increase of air temperature in early August (39.4 °C, average monthly), the average
146 density of the hornet population was reduced to a minimum. Then, it again gradually rose and
147 the second peak occurred in late September/early October. The hornet population declined
148 considerably from the second half of November, so that no hornet was captured after late
149 November (Nov. 22, 2021 and Nov. 26, 2022).

150 The seasonal population changes of adult hornets displayed a significant positive correlation
151 with air temperature ($r = 0.468$, $P < 0.001$; $r = 0.454$, $P < 0.001$) and a significant negative
152 correlation with relative humidity ($r = -0.548$, $P < 0.001$; $r = -0.598$, $P < 0.001$), respectively,
153 for two years (Figure 1).

154



155 **Figure 1.** The total numbers of the captured adult **Oriental** hornets, *Vespa orientalis* by 10 baits traps, in different months (A & B) and the mean
 156 daily number of captured hornets by each trap (C & D), under the natural conditions of Ahvaz, Iran during 2021-2023.
 157

158 In both sampling years, the main effects of sampling dates (active months of the year), daily
 159 sampling periods (four different periods), and their interaction were significant on the number
 160 of trapped **Oriental** hornets (Table 1).

Table 1. Two-way ANOVA of the effects of different sampling dates (months of the year; from March to December) and different daily sampling periods (four different periods) on the number of trapped adult **Oriental** hornet (*Vespa orientalis*), under the natural conditions of Ahvaz, Iran during 2021-2022.

Variables	Sampling year					
	2021			2022		
	<i>F</i>	<i>df</i>	<i>P</i>	<i>F</i>	<i>df</i>	<i>P</i>
Sampling months	291.732	9	< 0.001	330.025	9	< 0.001
Daily sampling periods	1494.601	3	< 0.001	1698.936	3	< 0.001
Sampling months×Daily sampling periods	135.611	27	< 0.001	157.338	27	< 0.001
<i>df</i> residue	1200			1200		

161
 162 In all active months (from April to November) of both years, the presence of foraging workers
 163 of *V. orientalis* was significantly higher at the beginning of the days (the period 9 - 12) than
 164 other periods ($P < 0.01$ for all months). Thereafter, higher activity was observed in the
 165 afternoons (between midday and 15). The least number of hornets were captured in the evenings
 166 (15 - 18) and thereafter (from 6 pm until 9 am) (Tables 2 & 3).

Table 2. Mean (\pm SE) number of captured adult **Oriental** hornets, *Vespa orientalis* by bait traps, on different sampling dates and different daily sampling periods, under the natural conditions of Ahvaz, Iran during 2021.

Sampling months	Daily sampling periods				<i>F</i>	<i>df</i>	<i>P</i>
	9-12	12-15	15-18	18-9			
March	0.03± 0.03 Fa	0.03± 0.03 Da	0.00 ± 0.00 Ea	0.00 ± 0.00 Ca	0.667	3, 120	0.574
April	0.38 ± 0.12 Fa	0.22 ± 0.08 Dab	0.03 ± 0.03 Eb	0.06 ± 0.04 Cb	3.879	3, 120	0.011
May	3.29 ± 0.20 Fa	1.93 ± 0.14 Cb	0.77 ± 0.13 Dc	0.22 ± 0.08 BCc	82.558	3, 120	< 0.001
Jun	11.48 ± 0.62 Da	4.70 ± 0.20 Bb	2.35 ± 0.12 ABc	0.32 ± 0.08 BCd	206.710	3, 120	< 0.001
July	27.09 ± 1.32 Aa	5.93 ± 0.18 Ab	2.64 ± 0.13 Ac	0.87 ± 0.15 Ac	324.253	3, 120	< 0.001
August	20.25 ± 1.39 Ca	5.70 ± 0.17Ab	1.74 ± 0.27 BCc	0.54 ± 0.12 ABc	158.833	3, 120	< 0.001
September	21.93 ± 0.02 BCa	5.09 ± 0.13 ABb	1.77 ± 0.15 BCc	0.38 ± 0.08 BCd	914.193	3, 120	< 0.001
October	24.00 ± 1.07 Aba	5.83 ± 0.26 Ab	1.38 ± 0.18 CDc	0.38 ± 0.08 BCc	381.098	3, 120	< 0.001
November	7.16 ± 0.93 Ea	1.93 ± 0.34 Cb	0.03± 0.03 Ec	0.03± 0.03 Cc	45.498	3, 120	< 0.001
December	0.03 ± 0.03 Fa	0.03 ± 0.03 Da	0.00 ± 0.00 Ea	0.00 ± 0.00 Ca	0.667	3, 120	0.574
<i>F</i>	179.070	188.011	58.253	10.699			
<i>Df</i>	9, 300	9, 300	9, 300	9, 300			
<i>P</i>	< 0.001	< 0.001	< 0.001	< 0.001			

168 Means in each row bears the same lower case letter, and means in each column bears the same upper case letter
 169 were not significantly different (One-way ANOVA with post-hoc Tukey HSD; $P > 0.05$).

Table 3. Mean (\pm SE) number of captured adult **Oriental** hornets, *Vespa orientalis* by bait traps, on different sampling dates and different daily sampling periods, under the natural conditions of Ahvaz, Iran during 2022.

Sampling months	Daily sampling periods				<i>F</i>	<i>df</i>	<i>P</i>
	9-12	12-15	15-18	18-9			
March	0.09 \pm 0.05 Fa	0.06 \pm 0.04 Da	0.00 \pm 0.00 Da	0.00 \pm 0.00 Da	1.901	3, 120	0.133
April	0.41 \pm 0.12 Fa	0.25 \pm 0.09 Dab	0.03 \pm 0.03 Db	0.06 \pm 0.04 Db	4.008	3, 120	< 0.004
May	3.16 \pm 0.22 Fa	1.93 \pm 0.14 Cb	0.77 \pm 0.13 Cc	0.22 \pm 0.08 BCDc	68.038	3, 120	< 0.001
Jun	11.96 \pm 0.61 Da	4.87 \pm 0.17 Bb	2.54 \pm 0.12 Ac	0.38 \pm 0.08 BCDd	231.932	3, 120	< 0.001
July	29.29 \pm 1.09 Aa	5.58 \pm 0.20 ABb	2.77 \pm 0.15 Ac	1.09 \pm 0.15 Ac	543.751	3, 120	< 0.001
August	19.70 \pm 1.36 Ca	5.45 \pm 0.18 ABb	1.70 \pm 0.27 Bc	0.54 \pm 0.11 Bc	156.301	3, 120	< 0.001
September	22.45 \pm 0.63 BCa	5.09 \pm 0.14 Bb	1.83 \pm 0.14 Bc	0.51 \pm 0.10 BCd	902.097	3, 120	< 0.001
October	23.74 \pm 1.04 Ba	6.00 \pm 0.26 Ab	1.64 \pm 0.17 Bc	0.61 \pm 0.11 Bc	383.098	3, 120	< 0.001
November	7.38 \pm 0.94 Ea	2.12 \pm 0.35 Cb	0.19 \pm 0.07 CDc	0.12 \pm 0.06 CDc	45.097	3, 120	< 0.001
December	0.09 \pm 0.05 Fa	0.03 \pm 0.03 Da	0.00 \pm 0.00 Da	0.00 \pm 0.00 Da	2.105	3, 120	0.103
<i>F</i>	210.672	176.222	61.400	14.831			
<i>Df</i>	9, 300	9, 300	9, 300	9, 300			
<i>P</i>	< 0.001	< 0.001	< 0.001	< 0.001			

170 Means in each row bears the same lower case letter, and means in each column bears the same upper case letter
 171 were not significantly different (One-way ANOVA with post-hoc Tukey HSD; $P > 0.05$).
 172

173 DISCUSSION

174 Among natural enemies of *Apis mellifera*, hornets appear to be most dangerous predators for
 175 honeybee colony, which can even lead to complete destruction of hives (Matsuura and Yamane,
 176 1990; Power *et al.*, 2022). Our sampling indicated that *V. orientalis* was the only *Vespa* species
 177 distributed in the studied area. This result is consistent with the previous reports where *V.*
 178 *orientalis* proved to be more adapted to arid climates, while *V. crabro* appeared to be more
 179 adapted to cold and dry conditions (Lioy *et al.*, 2023). Similarly, Ebrahimi and Carpenter (2012)
 180 emphasized that the distribution of both species was completely separated from each other in
 181 Iran, so that *V. orientalis* occurred from the southern slopes of the Alburz Mountains to Persian
 182 Gulf, while the distribution of *V. crabro* was limited between the northern slopes of the Alburz
 183 Mountains and the Caspian coasts (Ebrahimi and Carpenter, 2012). Our results, similar to those
 184 of Ebrahimi and Carpenter (2012) question the results obtained by Abd-Rabou *et al.* (2005)
 185 (quoted by Bagjacik and Samin, 2011) who have previously reported *V. crabro* in Khuzestan
 186 Province.

187 This study found that unlike the climate conditions of the Tel Aviv region, where hornets
 188 regulate their flight activity to provide maximum temperature from the environment (Volynchik

189 *et al.*, 2008), in the Ahvaz region, foraging workers of *V. orientalis* employ some strategies to
190 reduce the negative effects of high ambient temperature, including dedication of the activity
191 rhythm of foragers to the early hours of the day (9 -12) during active season. Generally, it seems
192 that the flight activity rhythm is season dependent and a function of the climatic conditions of
193 the region, so that in cold months of Ahvaz (March, April and December), and in Egypt (Khater
194 *et al.*, 2001; El-Boulok *et al.*, 2019) the activity rhythm of foragers continued until the
195 afternoons (between midday until 15), or even to the evenings (6 pm), in the Minya region of
196 Egypt (Fouad *et al.*, 2021). Despite all these explanations, Volynchik *et al.* reported that the
197 flight activity of Oriental hornets has been more related to the ultraviolet B radiation level than
198 to ambient temperature (Volynchik *et al.*, 2008).

199 The lower density of foraging hornets in September is not expected to be due to the population
200 decline of the colonies, and it seems workers spend most time inside the nest, during this period.
201 Indeed, Oriental hornets, *V. orientalis* use some methods so as not to face unfavorable
202 environmental conditions, such as maintenance of colony temperature at around 35°C (not to
203 exceed 37°C) in hot region and Dead Sea's environment (Volov *et al.*, 2021). This arises from
204 cooling down the colony, carried out actively by adult hornets by means of evaporating water
205 drops and ventilation (Jones and Oldroyd, 2006). This method of lowering the temperature is
206 so effective that the thermal microclimate of the nest, in two different extreme climates,
207 changed only within a narrow range of temperatures (Volov *et al.*, 2021). Under extreme
208 climatic conditions, *V. orientalis* has also the physiological ability to maintain lipid composition
209 with minimal changes (Volov *et al.*, 2021).

210 *Vespa orientalis* is a thermophilic species (Taha, 2014; Thakur and Bagga, 2000), and in
211 accordance with our finding, there was a significant positive relationship between seasonal
212 population changes of adult *V. orientalis* and ambient temperature. Indeed, *V. orientalis* is a
213 thermophilic species and its high adaptability to extreme conditions (desert) results in decline
214 in interspecific competition, especially with other species belonging to this genus.

215 Heat adaptation of living organisms consists of two types: adaptation to humid heat and to dry
216 heat. In the studied area (Ahvaz), both types of weather conditions including dry heat and humid
217 heat occur on different days of summer. Our observations revealed that the number of catches
218 in traps reached minimal values (close to zero) on days with high humidity. It seems that the
219 foraging hornets prefer to stay in the nest during these unfavorable days.

220 Most studies show that overwintering queens (gynes) appear at the beginning of the year when
221 the weather warms up (Ishay *et al.*, 1974; Chhuneja *et al.*, 2008; Volynchik *et al.*, 2008). During
222 both years of sampling in the studied area, the emergence of overwintering females (gyns)

223 started from the beginning of the second half of the March (18.9 °C, average monthly) and it
224 was continued until the middle June (37.7 °C, average monthly). These results were consistent
225 with both studies conducted in Egypt (Khater *et al.*, 2001; Taha, 2014). Also, in another study
226 in Egypt, Shoreit (1998) reported that queens were visible from January to May and reached
227 their highest density in March. The sterile workers produced by gynes were gradually increased
228 and formed two population peaks during a year. These results are in agreement with the data
229 obtained by some researchers on the same hornet species in Egypt (Sharkawi, 1964; Shoreit,
230 1998; Gomaa and Abd El-Wahab, 2006; Ibrahim, 2009; Omran *et al.*, 2011) and in India
231 (Sharma and Raj, 1988; Sihag, 1992).

232 The hornet population in the apiary was significantly reduced in August due to the high daily
233 temperature (39.4 °C, 26.6% R.H. average monthly). Thereafter, with a relative decline in the
234 ambient temperature in late summer, the population of workers was again increased in late
235 September (36.3 °C, 29.15% R.H. average monthly), and reached the peak in middle October
236 (30.8 °C, 26.75% R.H. average monthly). In the fall, with the weather cooling down (late
237 November: 23.35 °C, 49.25% R.H.), a significant decline in the population was observed and
238 finally the hornet workers disappeared. Other studies suggested that while the weather cools
239 down in the fall, the queen starts laying eggs that will develop into drones and new queens. The
240 drones will die after mating, and the young fertilized queens go to overwintering (Chhuneja *et*
241 *al.*, 2008; Volynchik *et al.*, 2008).

242

243 CONCLUSIONS

244 The results of the present study revealed that the seasonal dynamics of the population and the
245 daily activity of the *V. orientalis* outside the nest are completely coordinated with the
246 environmental conditions. In this study, the flight of queens was firstly observed in middle
247 March and continued until the beginning of June. The peak population of emerged workers
248 occurred during July and October. The daily activity rhythm of adult hornets was observed
249 mostly during 9 am-12 noon. Since the present study was carried out in very extreme weather
250 conditions, comparing the result of our findings with other studies performed in the same and
251 different weather conditions (Sharkawi, 1964; Sharma and Raj, 1988; Sihag, 1992; Shoreit,
252 1998; Gomaa and Abd El-Wahab, 2006; Chhuneja *et al.*, 2008; Omran *et al.*, 2011), can
253 increase our knowledge about the annual population dynamics and daily activity rhythm of
254 adult **Oriental** hornets. This information, especially the exact time of overwintering queens'
255 appearance and the population peaks of the sterile workers, may be used to better control the
256 population of *V. orientalis*, in areas that have extensive beekeeping.

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260
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429

430 **پویایی جمعیت سالانه و ریتم فعالیت روزانه هورنت های شرقی بالغ (*Vespa orientalis*) ، آفت**
431 **مهم زنبور عسل ایرانی (*Apis mellifera meda*) در اهواز، ایران**

432

433 نرگس کرم کیانی، آرش راسخ، پرویز شیشه بر، و غلامحسین طهماسبی

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چکیده

436

437 زنبور هورنت شرقی، (*Hymenoptera: Vespidae*) *Vespa orientalis* L. یکی از مهم ترین و جدی ترین دشمنان
438 زنبورهای عسل است. در این مطالعه، پویایی جمعیت سالانه و ریتم فعالیت روزانه هورنت شرقی بر اساس تعداد بالغین
439 گرفتار شده در زنبورستان واقع در اهواز (جنوب غربی ایران) طی یک دوره دو ساله (ژانویه 2021 تا دسامبر 2022)
440 مورد بررسی قرار گرفت. نمونه برداری با استفاده از تله های جعبه ای موجود در بازار انجام شد. طعمه مورد استفاده
441 در تله ها جگر مرغ تازه بود که تله ها روزانه در چهار دوره زمانی بررسی می شدند. نتایج نشان داد که اولین ملکه های
442 زمستان گذران (ژین ها) در ماه مارس ظهور کردند و دو پیک جمعیتی کارگران شاخدار تازه ظهور کرده در طول سال،
443 یکی در ماه جولای و دیگری در اکتبر رخ داد. در اواخر نوامبر و اوایل دسامبر، هیچ هورنت بالغی به دام نیفتاد. ریتم
444 فعالیت روزانه هورنت های بالغ بیشتر در ساعت 9 تا 12، تقریباً دو برابر بیشتر از دوره بعد از ظهر (12-15) مشاهده
445 شد. کمترین میزان فعالیت در ساعات عصر و شب (6 عصر تا 9 صبح) به ثبت رسید. در طول هر دو سال نمونه برداری،
446 فراوانی فصلی هورنت های بالغ همبستگی مثبت و معنی داری با دمای هوا و همبستگی منفی معنی دار با رطوبت نسبی
447 نشان داد. با مقایسه نتیجه یافته های ما با سایر مطالعات انجام شده در مناطق آب و هوایی مشابه و متفاوت، می توان
448 امیدوار بود که روش های موثری برای کنترل جمعیت *V. orientalis* به ویژه در مناطقی که زنبور داری گسترده
449 ای دارند ارائه شود.