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Variation of elytral colour polymorphism in six species of ladybird beetles in central Iran

(Coleoptera, Coccinellidae)

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Abstract

Twenty localities of Yazd province in central Iran were investigated for lady bird beetles (Coleoptera, Coccinellidae) during y ears 2009-2014. Here we report pol ymorphism of elytra coloration pattern in six species of ladybird beetles from Yazd province. In total, four morphs of *Adalia decempunctata* (LINNAEUS, 1758), and two m orphs of *Clitostethus arcuatus* (ROSSI, 1794), *Exochomus quadripustulatus* (LINNAEUS, 1758), *Menochilus sexmaculatus* (FABRICIUS, 1781)*, Oenopia conglobata contaminata* MÉNÉTRIÉS, 1849*,* and *Oenopia oncina* (OLIVIER, 1808) were recorded.

Zusammenfassung

Zwanzig Lokalitäten der Yazd-Provinz im zentralen Iran wurden während der Jahre 2009 – 2014 hinsichtlich der Marienkäfer (Coleopter a, Coccinellidae) un tersucht. In dieser

Studie berichten wir über den Polymorphismus von sechs Arten der Marienkäfer der Yazd-Provinz. Insgesamt treten vier Morphen von *Adalia decempunctata* (LINNAEUS, 1758), und zwei Morphen von *Clitostethus arcuatus* (ROSSI, 1794), *Exochomus quadripustulatus* (LINNAEUS, 1758), *Menochilus sexmaculatus* (FABRICIUS, 1781), Oenopia conglobata contaminata MÉNÉTRIÉS, 1849, und *Oenopia oncina* (OLIVIER, 1808) auf.

Introduction

Coccinellids are a family of beetles belonging to the superfamily Cucujoidea within order Coleopteran and divided into six subfamilies: Coccidulinae, Coccinellinae, Scymninae, Chilocorinae, Sticholotidinae and Epilachninae, containsnearly 6,000 species of which over 90% are beneficial predators, worldwide distributed (IABLOKOFF-KHNZORIAN 1982; VANDENBERG 2002) of which 132 species reported in Iran (JAFARI et al. 2013). Most species of Coccinellids are predators and major biological control agents of hemipteran pests such as aphids, mealy bugs and scale insects, as well as thrips and mites in all over the world (MORETON 1969; HAWKESWOOD 1987; MAJERUS 1994).

Polymorphismis appearance of forms or morphs different in colour, number of spots and elytra coloration pattern within a single species.The polymorphism can be seen not only between individuals in a population, but also between the sexes as sexual dimorphism (male or female), between geographically separated populations in geographical polymorphism and also between generations flying at different seasons of the year (seasonal polymorphism) (GULLAN & CRANSTON, 2004).

A number of polymorphism in insects have been published: for dragonflies families (CORDERO 1990; ANDRES & CORDERO 1999), aphids (WEBER 1985; TOMIUK et al. 1990), Diptera (MATENA 1995; ROHACEK & BARBER 2005; SCHONROGGE et al. 2006; ROHACEK 2012), Lepidoptera (ZHANG 2004; JI et al. 2005), Social insects (HIGASHI & PEETERS 1990; SUMER ERKAN et al. 2012) and Lady birds (JIGGINS & TINSLEY 2005; BLEHMAN 2007; MICHIE et al. 2010; ZARE et al. 2012).

Polymorphism study is important, because it presents strict reasons among environmental factors and character of living bodies. Among polymorphism researches, studies related to ladybirds has occupied an special situation and specially the result of studies on polymorphism in color and pattern of the dorsal surface of the head, scutellum and elytra are important (BLEHMAN, 2007; ROGERS et al., 1971). The aim of present investigation is to improve our knowledge on polymorphism of the coccinellid beetles in Yazd province, central Iran.

Material and Methods

Surveys for lady bird beetles (Coleoptera, Coccinellidae) were conducted in twenty localities at different altitudes (1158 to 2987 m) in the Yazd province Iran, from 2009 to 2014 (Table 1, Fig. 1). During each sampling, coccinellid beetles were collected using an aspirator, when observed, or standard sweeping net. In the laboratory, the coccinellids were mounted and identified using keys by (YAZDANI 1990, RAIMUNDO & VAN HARTEN 2000, RAIMUNDO et al. 2006, 2008). The morphological characters and polymorphism of each species were carefully studied under stereomicroscope. Voucher specimens were deposited

in the Entomology Department of the Agricultural Sciences College, Shiraz Branch, Islamic Azad University, Iran.

Results and Discussion

In this study four morphs of *A. decempunctata*, two morphs of *C. arcuatus*, *E. quadripustulatus*, *M. sexmaculatus*, *O. conglobata* and *O. oncina* were recorded as below.

1- *Adalia decempunctata* (LINNAEUS, 1758)

Four different clearly separable color pattern morphs of *A. decempunctata* were observed and identified from the Yazd province, central region of Iran. According tothe background pigmentationand the spots on the elytra, these four morphs can be categorized as follows:

a) Black, separated twoyellow-spotted:
The wing case has black background with oneyellow spots on each wing case.Each elytron has one yellow markings. The yellow marking is at the forward angle of elytron. Pronotum is black (Fig. 2a).
Material examined: Fakhrabad (code no. 04), 1 ♂ 1 ♀, 5.ix.2011, leg. M. Zare Khormizi.

b) Pale red, separated ten black-spotted: The wing case has pale red background and there are 5 black spots on each wing case. The first black marking isat the forward angle and second, third, fourth and fifth are central and toward of eleytron. Pronotum white with black spots, a black m-mark (Fig. 2b).
Material examined: IRAN: Darah (code no. 03),), 2 ♂♂ 3 ♀♀, 20.iv.2014, leg. M. Zare Khormizi. Fakhrabad (code no. 04), 2 ♂♂ 5 ♀♀, 9.iv.2014, leg. M. Zare Khormizi. Khormiz (code no. 08), 1 ♀, 31.v.2013, leg. M. Zare Khormizi. Manshad (code no. 09), 1♂, 5. vi.2013, leg. M. Zare Khormizi. Mehriz (code no. 11), 2♂♂ 4♀♀, 26.vi.2013, leg. M. Zare Khormizi.

c) White, separated ten black-spotted: The wing case has white background and there are 5 black spots on each wing case.The first black marking is at the forward angle and second, third, fourth and fifth are central and toward of eleytron. Pronotum white with black spots, a black m-mark (Fig. 2c).
Material examined: IRAN: Khormiz (code no. 08), 2 ♂♂ 1 ♀, 21.vi.2013, leg. M. Zare Khormizi. Manshad (code no. 09), 1♂, 28.vi.2013, leg. M. Zare Khormizi. Mehriz (code no. 11), 3♀♀, 26.vi.2013, leg. M. Zare Khormizi.

d) White, separated twelve black-spotted: The wing case has white background and there are six black spots on each wing case. The first and second black spots are at the front and third, fourth and fifth are central of elytron. Pronotum white with black spots, a black m-mark (Fig. 2d).
Material examined: IRAN: Khormiz (code no. 08), 3 ♂♂ 3 ♀♀, 21.vii.2013, leg. M. Zare Khormizi. Manshad (code no. 09), 1♂, 13.ix.2013, leg. M. Zare Khormizi. Mehriz (code no. 11), 2♂♂ 2♀♀, 10.ix.2013, leg. M. Zare Khormizi.

2- *Clitostethus arcuatus* (ROSSI, 1794)

Two different clearly separable color pattern morphs of *C. arcuatus* were observed and identified from Yazd province. According to the background pigmentation and the spots on the elytra, these two morphs can be categorized as follows:

a) Brown, separated two white- spotted: The wing case has brown background and there is single crescent-shaped white spots on each wing case. The crescent-shaped white marking is at the middle of elytron. Pronotum is white with brown spots, a brown m-mark (Fig. 3a).
Material examined: IRAN: Fakhrabad (code no. 04), 1 ♂ 3 ♀♀, 12.iv.2014, leg. M. Zare Khormizi. Herat (code no. 07), 1 ♀, 26.vi.2013, leg. M. Zare Khormizi. Khormiz (code no. 08), 5 ♀♀, 18.v.2013, leg. M. Zare Khormizi. Mehriz (code no. 11), 3 ♂♂ 9 ♀♀, 19.xi.2014, leg. M. Zare Khormizi. Zarch (code no. 20), 2 ♀♀, 6. v.2014, leg. M. Zare Khormizi.

b) Black, separated two white- spotted: The wing case has black background and there is single crescent-shaped white spots on each wing case. The crescent-shaped white marking is at the middle of elytron. Pronotum is black (Fig. 3b).
Material examined: IRAN: Mehriz (code no. 11), 4 ♂ 5 ♀, 24. x.2014, leg. M. Zare Khormizi.

3- *Exochomus quadripustulatus* (LINNAEUS, 1758)

Two different clearly separable color pattern morphs of *E. quadripustulatus* were observed and identified from Yazd province. According to the background pigmentation and the spots on the elytra, these two morphs can be categorized as follows:

a) Black, separated 4 red-spotted: The wing case has black background with two red spots on each wing case. Each elytron have two red markings. The first red marking is at the forward angle and second is central of elytron (Fig. 4a).
Material examined: IRAN: Khormiz (code no. 08), 1 ♀?, 9.iv.2009, leg. M. Zare Khormizi. Mehriz (code no. 11), 2 ♂♂ 1 ♀, 19.x.2014, leg. M. Zare Khormizi. Saryazd (code no. 14), 1 ♀, 19.vii.2009, leg. M. Zare Khormizi.

b) Red, without spotted: The wing case with red background and there is not spot on wing case. Pronotum is red (Fig. 4b).
Material examined: IRAN: Mehriz (code no. 11), 1 ♂? 2 ♀♀, 28.v.2013, leg. M. Zare Khormizi. Saryazd (code no. 17), 1 ♂ 2 ♀♀, 20.v.2014, leg. M. Zare Khormizi.
Two different clearly separable color pattern morphs of *M. sexmaculatus* were observed and identified from Yazd province. According to the background pigmentation and the spots on the elytra, these two morphs can be categorized as follows:

4- *Menochilus sexmaculatus* (FABRICIUS, 1781)

a) White, separated sixblack-spotted: The wing case has white backgroundand there are three black crinkle lines on each wing case. The first black crinkle line is at the forward

angle and second is central and thir d is toward of eleytron. Pronotum is white with one anchor-shaped black spots (Fig. 45a).
Material examined: IRAN: Khormiz (code no. 08), 1 ♂, 17.viii.2013, leg. M. Zare Khorm izi. Mehriz (code no. 11), 1♂ 2♀?♀, 23.viii.2014, leg. M. Zare Khormizi.

b) Black, without spotted: The wing case with black background and there is not spot on wing case. Pronotum is white with one anchor-shaped black spots (Fig. 5b).
Material examined: Mehriz (code no. 11), 1♀, 23.viii.2014, leg. M. Zare Khormizi.

5- Oenopia conglobata contaminata MÉNÉTRIÉS, 1849

Two different clearly separable color pattern morphs of *O. conglobata* contaminata were observed and identified from Yazd province. Accor ding to the background pigm entation and the spots on the elytra, these two morphs can be categorized as follows:

a) Pale red, separated ten black-spotted: The wing case has pale red background and there are eight black spots on each wing case. The first, second, third and fourth black marking are at the forward angle and fifthis central and sixth, seventh and eighth toward of eleytron. Pronotum is white with black spots, a black m-mark (Fig. 6a).
Material examined: IRAN:. Baghe shadi Jungle (code no. 01), 5 ♀♀, 4.iv.2014, leg. M. Zare Khormizi. Harabarjan (code no. 06), 1 ♀ , 3.vi.2014, leg. M. Zare Khormizi. Khormiz (code no. 08), 1 ♂ 1 ♀, 18.v.2013, leg. M. Zare Khormizi. Mehriz (code no. 11), 2♀♀, 11.vii.2013, leg. M. Zare Khormizi.

b) White, separated ten black-spotted: The wing case has white background and there are eight black spots on each wing case. The first, second, third and fourth black marking are at the forward angle and fifth is central and sixth, seventh and eighth toward of eley tron. Pronotum is white with black spots, a black m-mark (Fig. 6b).
Material examined: IRAN:. Baghe shadi Jungle (code no. 01), 2 ♂♂ 10 ♀♀, 4.iv.2014, leg. M. Zare Khormizi. Chenar naz (code no. 02), 1 ♂? 1 ♀ , 16.vii.2013, leg. M. Zare Khormizi. Darah (code no. 03),), 1♀, 20. iv.2014, leg. M. Zare Khormizi. Fakhrabad (code no. 04), 3 ♂♂ 5 ♀♀, 10.v.2014, leg. M. Zare Khormizi. Harabarjan (code no. 06), 1 ♀ , 10.vi.2014, leg. M. Zare Khormizi. Khormiz (code no. 08), 1 ♂ 2 ♀♀, 9.iv.2009, leg. M. Zare Khorm izi. Manshad (code no. 09), 4♂♂ 4♀, 5.vii.2013, leg. M. Zare Khormizi. Maryamabad (code no. 10), 1 ♂ 3 ♀♀, 4.vi.2014, leg. M. Zare Khormizi. Mehriz (code no. 11), 2♂♂ 1♀, 3.viii.2009, leg. M. Zare Khormizi. Nodoshan (code no. 12), 2 ♂♂ 1 ♀ , 22.vi.2013, leg. M. Zare Khormizi. Pandar (code no. 13), 1♂, 29.v.2014, leg. M. Zare Khormizi. Saryazd (code no. 14), 1 ♀, 3.xi.2009, leg. M. Zare Khormizi Shahedieh (code no. 15), 4♂♂ 11♀♀, 18.iv.2014, leg. M. Zare Khormizi. . Taft (code no. 17), 2 ♂♂ 2♀♀, 9.v.2014, leg. M. Zare Khormizi**.** Yazd (code no. 19), 2♀, 24.v.2013, leg. M. Zare Khormizi. Zarch (code no. 20), 6♂♂ 20 ♀♀, 6.v.2014, leg. M. Zare Khormizi.

6- *Oenopia oncina* (OLIVIER, 1808)

Two different clearly separable color pattern morphs of *O. oncina* were observed and identified from Yazd province. According to the background pigmentation and the spots on the elytra, these two morphs can be categorized as follows:

a) Black, separated tenred-spotted: The wing case has black background and there are fivered spots on each wing case. The first red marking is at the forward angle and second, third, fourth and fifth are central and toward of eleytron.Pronotum is black (Fig. 7a).
Material examined: IRAN: Baghe shadi Jungle (code no. 01), 1 ♂ 2 ♀♀, 4.iv.2014, leg. M. Zare Khormizi. Chenar naz (code no. 02), 1 ♂ , 25.iv.2014, leg. M. Zare Khormizi. Darah (code no. 03), 3♀♀, 12.vi.2014, leg. M. Zare Khormizi. Gerdekoh (code no. 05), 1 ♂, 14.ix.2014, leg. M. Zare Khormizi. Herat (code no. 07), 1 ♂ 2♀♀, 26.vi.2013, leg. M. Zare Khormizi. Khormiz (code no. 08), 1 ♂ 2 ♀♀, 7.ix.2009, leg. M. Zare Khormizi.. Manshad (code no. 09), 1♂ 4♀♀, 11.x.2013, leg. M. Zare Khormizi. Mehriz (code no. 11), 1♂ 1♀, 18.v.2014, leg. M. Zare Khormizi. Saryazd (code no. 14), 2 ♂♂ 3 ♀♀, 20. v.2014, leg. M. Zare Khormizi**.** Shirkoh (code no. 16), 1 ♀, 20.v.2014, leg. M. Zare Khormizi**.** Tange chenar(code no. 18), 1 ♀, 7.iv.2013, leg. M. Zare Khormizi**.**

b) Black, separated two red-spotted: The wing case has black background and there is one red spot on each wing case. The red marking is at the forward angle of eleytron. Pronotum is black (Fig. 7b).
Material examined: IRAN: Baghe shadi Jungle (code no. 01), 1 ♂, 4.iv.2014, leg. M. Zare Khormizi. Khormiz (code no. 08), 1 ♂ 2 ♀♀, 3.vi.2009, leg. M. Zare Khormizi Mehriz (code no. 11), 1♀, 18.v.2011, leg. M. Zare Khormizi.

Apparent polymorphism in several species, such as beetles *Adalia bipunctata* (L.) and *A. decempunctata* (L.) has been studied well (HODEK & HONEK 1996, MAJERUS & ZAKHAROV 2000). So far, a few studies have been carried out on lady bird beetles polymorphism in Iran (KOOHPAYEHZADEH ISFAHANI 1991; BAGHERI 1995; MOODI 1994; ALEOSFUR 2003; ZARE et al. 2012; ZARE KHORMIZI et al. 2013,). Although the results of the present paper make a contribution to our knowledge of ladybird morphs in Iran, but we believe that further study on pigmentation variations of coccinellid beetles should be encouraged.

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Table 1. List of the sampling localities in the Yazd province of Iran.

Cod no	Locations	Coordinate of location	Altitude (m)
01	Baghe shadi jungle	29°48'27"N54°09'18"E	1916
02	Chenar naz	30°70'54"N 53°59'49"E	1651
03	Darah	31°35'78"N 54°16'18"E	1500
04	Fakhrabad	31°36'65"N 54°15'08"E	1480
05	Gerdekoh	31°19'43"N 54°57'07"E	1813
06	Harabarjan	30°20'29"N 54°11'72"E	2034
07	Herat	30°05'33"N 54°23'33"E	1993
08	Khormiz	31°31'70"N 54°25'97"E	1528
09	Manshad	31°31'56"N 54°26'15"E	2245
10	Maryamabad	31°80'44"N 53°14'73"E	1527
11	Mehriz	31°34'36"N 54°26'60"E	2420
12	Nodoshan	32°35'51"N 53°44'91"E	1583
13	Pandar	31°27'11"N 54°11'82"E	2400
14	Saryazd	31°36'23"N 54°55'07"E	1420
15	Shahedieh	31°57'38"N 54°15'95"E	1258
16	Shirkoh	31°37'02"N 54°72'24"E	2427
17	Taft	31°43'95"N 53°50'74"E	2055
18	Tange chenar	34°24'34"N 54°21'33"E	1584
19	Yazd	31°47'91"N 54°24'43"E	1272
20	Zarch	32°59'56"N 54°13'03"E	1158

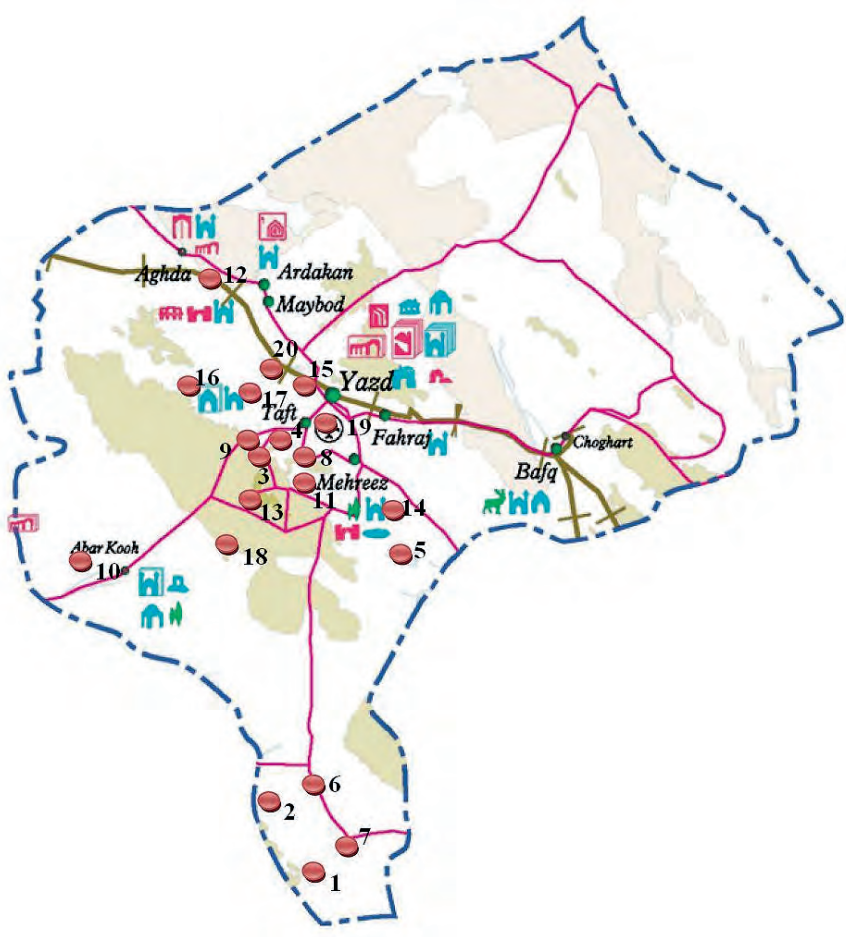

Fig. 1. Locations of sampling in the Yazd province, Iran.

Fig. 2. Elytral color patterns of *Adalia decempunctata* (LINNAEUS, 1758).

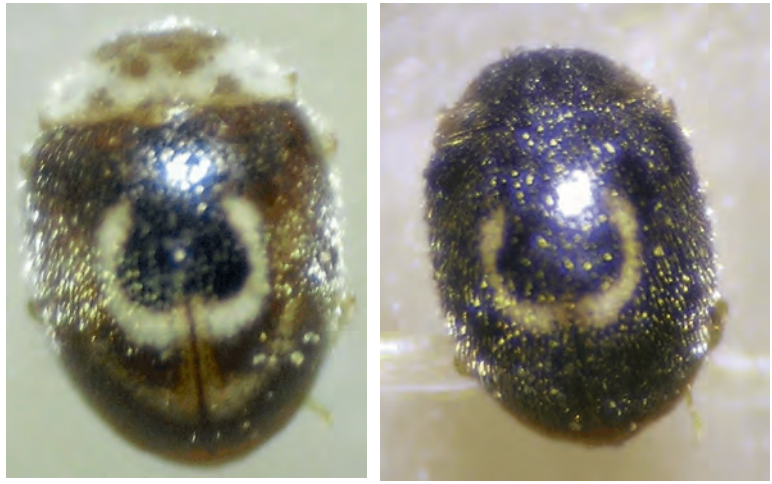

Fig. 3. Elytral color patterns of *Clitostethus arcuatus* (ROSSI, 1794).

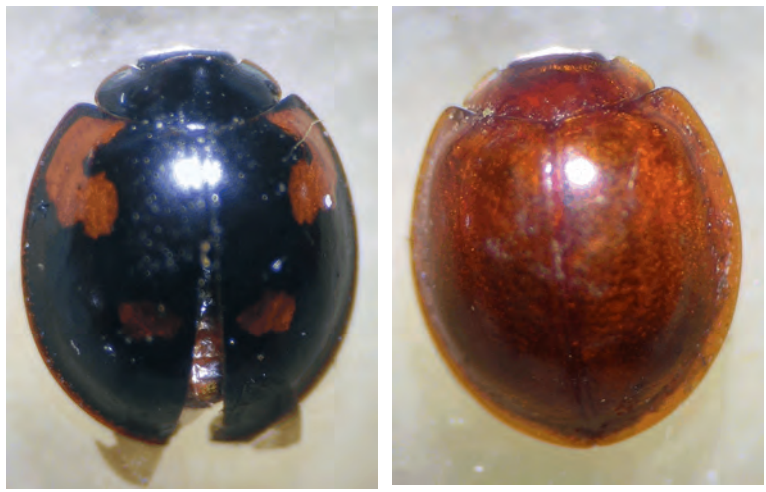

Fig. 4. Elytral color patterns of *Exochomus quadripustulatus* (LINNAEUS, 1758).

Fig. 5. Elytral color patterns of *Menochilus sexmaculatus* (FABRICIUS, 1781).

Fig. 6. Elytral color patterns of *Oenopia conglobata contaminata* MÉNÉTRIÉS, 1849.

Fig. 7. Elytral color patterns of *Oenopia oncina* (OLIVIER, 1808).

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