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Article

A record of *Haemaphysalis erinacei* (Acari: Ixodidae) collected from Hedgehog and an identification key for the species of *Haemaphysalis* occurring in Iran

Asadollah Hosseini-Chegeni[1], Zakkyeh Telmadarraiy[2]*, Mahdi Salimi[3], Kourosh Arzamani[2] & Omid Banafshi[4]

1 Department of Plant Protection, Faculty of Agriculture, University of Guilan, Guilan, Iran; E-mail: hosseinichegeni@gmail.com
2 Department of Medical Entomology and Vector Control, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran; *E-mail: ztelma@yahoo.co.in; arzamanik@gmail.com*
3 Research Institute of Zoonotic Diseases, University of Shahrekord, Shahrekord, Iran; E-mail: sku.msalimi@yahoo.com
4 Department of Disease Control, Deputy of Health, Kurdistan University of Medical Sciences, Sanandaj, Iran; E-mail: banafshiomid@yahoo.com

* Corresponding author

Abstract

Ticks of the order Ixodida are among the most proficient ectoparasites worldwide. *Haemaphysalis* is the second largest genus within Ixodidae. Southeast Asia is thought to be the original center of development and dispersal of the genus. Six species of *Haemaphysalis*, *H. concinna*, *H. erinacei*, *H. inermis*, *H. parva*, *H. punctata* and *H. sulcata*, have been recorded as occurring in Iran. The current paper deals with notes on taxonomy of *H. erinacei* and provides a provisional key for the identification of *Haemaphysalis* species that occur in Iran.

Key words: Taxonomy, species, identification, pictorial key, tick.

Introduction

Ticks of the order Ixodida are the most competent ectoparasites of land animals worldwide (Kettle 1995). *Haemaphysalis* is the second largest genus of ixodid ticks living in all continents, with the greatest species richness reported in the southeast Asia, suggesting that it may be the origin of development and dispersal of this genus (Hoogstraal 1959b; Kolonin & Andreev 1992). Haemaphysalids are relatively rare in Australia and Africa (Balashov 1994). Generally, *Haemaphysalis* species of that infest livestock are confined to Eurasia and tropical Africa, where the immature stages feed on rodents and other small mammals, as well as on birds (Varma 1993).

Presently, six *Haemaphysalis* species have been recorded by different authors as occurring in Iran, including *H. concinna* (Koch, 1844), *H. inermis* (Birula, 1895), *H. erinacei* (Pavesi, 1884), *H. parva* (Neumann, 1897) (syn.: *H. otophila* Schulze, 1918),

H. punctata (Canestrini & Fanzago, 1878) and *H. sulcata* (Canestrini & Fanzago, 1878) (Abbasian-Lintzen 1960; Maghami 1968; Mazlum 1971; Rahbari *et al.* 2007). All these species except *H. erinacei* parasitize domestic animals and livestock with *H. sulcata* being the most common versus local species *H. concinna* and *H. parva* and the rare *H. inermis* (Mazlum 1971; Rahbari *et al.* 2007; Sofizadeh *et al.* 2014). Furthermore, *H. kopetdaghica* (Kerbabaev, 1962) has been reported on wild goat, leopard, and domestic horse in the Kopet Dag mountains, situated on a border with Turkmenistan, northern Iran (Hoogstraal & Wassef 1979). The latter species, however, was also collected in the Alborz mountains, south of the Caspian Sea in Iran, southwest of the original collection area of *H. kopetdaghica*.

In Iran, it has been suggested that *Haemaphysalis* spp. act as vectors for Crimean Congo hemorrhagic fever virus (CCHFV), and may be responsible for transmission of *Coxiella burneti* the agent of Q fever (Rak 1976; Moradi *et al*. 2008; Telmadarraiy *et al*. 2008; Mehravaran *et al*. 2013). One species of particular interest is due to its host range suspected ability to vector/reservoir of plague among rodents (Pomerantzev 1950) is *H. erinacei*.

Haemaphysalis erinacei, the mediterranean hedgehog haemaphy-salid, parasitizes hedgehogs as immature and adult, with rodents serving as chief host of both larvae and nymphs (Hoogstraal 1955). *Haemaphysalis erinacei* is closely related to *H. leachi* (Audouin, 1826) (Feldman-Muhsam 1951). Feldman-Muhsam (1953) considered *H. numidiana* (Neumann, 1905) as a junior synonym of *H. erinacei*. Many workers believe that this species comprises several subspecies. Hoogstraal (1959a) assumed that *H. erinacei* consisted of three subspecies: *H. e. erinacei* (Pavesi, 1884) in North Africa, *H. e. taurica* (Pospelova-Shtrom, 1939) in Near East and *H. e. turanica* (Pospelova-Shtrom, 1939) in central Asia. Camicas *et al.* (1998) considered *H. erinacei* under the *erinacei* group including four subspecies *H. erinacei erinacei*, *H. erinacei ornata* (Feldman-Muhsam, 1956), *H. erinacei taurica* and *H. erinacei turanica*. Pomerantzev (1950) and Filippova *et al.* (1993) differentiated two subspecies *H. e. taurica* and *H. e. turanica* based on characters such as coxal hairs and the pulvillus/claw ratio. *Haemaphysalis erinacei* has already been reported from Iran (Reznik 1966; Mazlum 1971; Filippova *et al.* 1976; Kolonin 2009). Filippova *et al.* (1976) reported only larvae and nymphs of species from two bats and eight rodent species (including *Meriones* spp.) in the southern Caspian sea, Khurasan, northeastern and Zagros region. As well, adult *H. erinacei* have been recorded by Abbasian-Lintzen (1960) from Tehran, Mashhad and eastern Kurdistan (located in Iran) on hedgehogs and fox cubes. *Haemaphysalis erinacei* was reported as suspected vector/reservoir of plague among rodents (Pomerantzev 1950).

Iranian hedgehogs are represented by three genera *Erinaceus*, *Hemiechinus* and *Paraechinus* (Lay 1967; Ziaii 1996). The hedgehog *Erinaceus* sp. has been reported as a reservoir host of some of the most significant human pathogenic/parasitic agents (Farhang-Azad *et al.* 1973; Bornstein *et al.* 2001; Skuballa *et al.* 2010). Thus, it is important to study the tick fauna of these interesting, small, nocturnal mammals as well as their probable microbial agents. Unpublished data reports that *H. erinacei* occurs in Iran parasitizes hedgehogs, thus it is required to assess hedgehogs for the species composition to determine real composition of ixodid fauna. The presence of *H. erinacei* reported with insufficient description and ambiguous taxonomic characters introduced in the Iranian ticks identification key, besides its occurrence is still doubtful and not clear for medical and veterinary entomologists. Moreover, the former studies only refer

to certain *Haemaphysalis* spp. occurs in Iran and make many incomplete taxonomic keys. Thus, the current paper deals with the taxonomy of *H. erinacei*, a parasite of hedgehogs and provides a provisional key for the identification of *Haemaphysalis* species that occur in Iran.

Materials and Methods

Tick collection

All tick specimens were collected from domestic animals: sheep, goat and cattle as well as wild mammals. The majority of tick specimens were collected from hosts and then stored in 70% alcohol, 70% ethanol containing 5% glycerin or frozen at −20°C until they were examined.

Determination of specimens

The specimens were diagnosed to genus level using the key presented in Matthysse & Colbo (1987). Specimens of *Haemaphysalis* species were identified based on the criteria presented in keys constructed to the identification of haemaphysalid ticks that occur in the former USSR, Mediterranean and Iran (Delpy 1940; Pomerantzev 1950; Feldman-Muhsam 1951; Hashemi-Fesharaki *et al.* 2002). Unfortunately, the specimens related to *H. concinna* were not available for taxonomic review, thus we relied on the description presented on this species, e.g. Pomerantzev (1950) to make an identification key. The taxonomic characters used for the identification of both male and female specimens were included: basis capitulum, cornua, palpi, scutum and spurs of coxae.

Drawing and photographing of species

The schematic and taxonomic themes of each specimen were drawn by the software Corel Draw Graphics Suite® (version X6).

Results

Five *Haemaphysalis* species, comprising *H. erinacei*, *H. inermis*, *H. parva*, *H. punctata* and *H. sulcata*, were identified in the present study. Some *Haemaphysalis* specimens such as *H. sulcata* were common and collected from many parts of Iran whereas the others such as *H. inermis* or *H. parva* less commonly collected (Fig. 1). Data related to specimens collected from hedgehogs are shown in Table 1.

Table 1. Data related to specimens of *Haemaphysalis erinacei* collected from hedgehog in northeastern and central Iran

Life stage	No. of specimens
Larva	2
Nymph	42
female	4
Male	12
Total	60

All of these specimens were identified as *H. erinacei*, according to taxonomic characteristics outlined in Pomerantzev (1950), Feldman-Muhsam (1953) and Hoogstraal (1955). The specimens of hedgehog were identified as the order Insectivora, family Erinaceidae, and the genus *Erinaceus*. The general shape and scutal pattern of *H.*

erinacei are represented in Figure 3, with the characteristics of the capitulum of *H. erinacei* shown in the Figure 4. In the following sections a taxonomic key with precise drawings related to each species is presented to facilitate identification of the male and female of *Haemaphysalis* species.

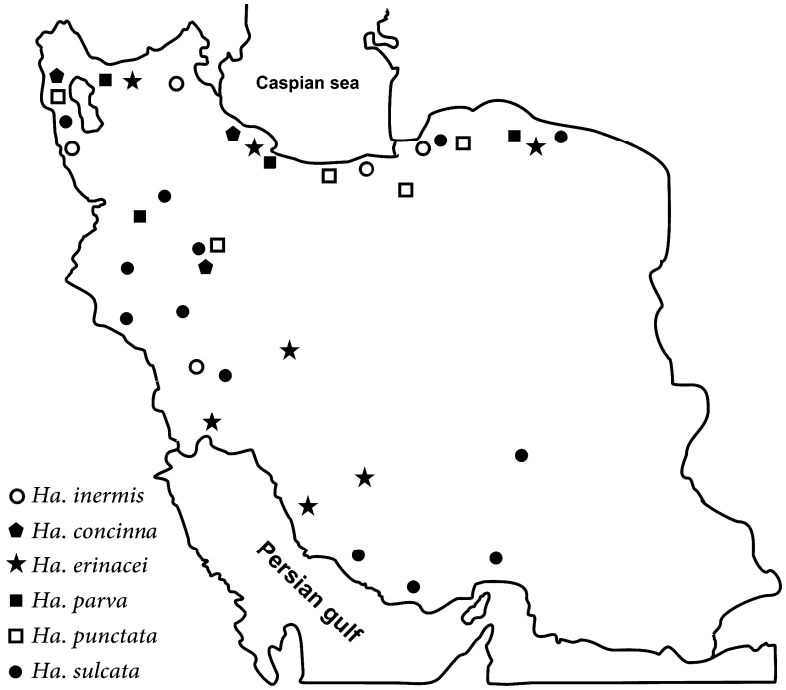

Figure 1. Map indicates known distribution of Iranian *Haemaphysalis* species based on Delpy (1940), Mazlum (1971), Filippova *et al*. (1976), Hoogstraal & Valdez (1980), Nabian *et al*. (2007), earlier publications corresponded by the second author (ZT) (including Moradi *et al*. 2008, Telmadarraiy *et al.* 2008, Telmadarraiy *et al.* 2009, Sofizadeh *et al*. 2014) as well as an unpublished data recorded by the first author (AHC).

Figure 2. Male *Haemaphysalis erinacei* (whole body). Left: ventral view; Right: dorsal view.

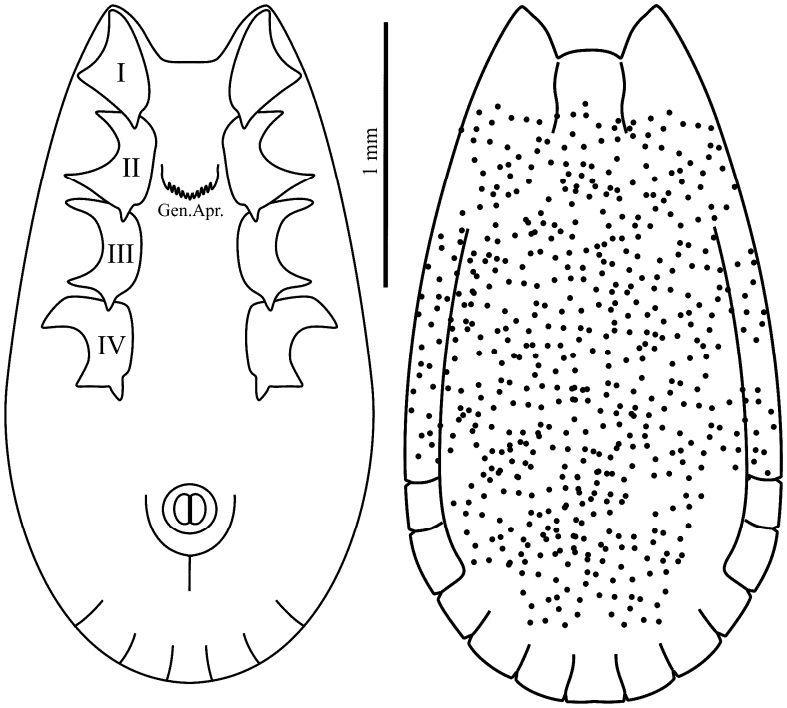

Figure 3. Male *Haemaphysalis erinacei* (except capitulum). Left: ventral view; Right: dorsal view. I-IV: coxae I to IV, Gen. Apr.: genital apron. Dots in dorsal view indicated scutal punctations.

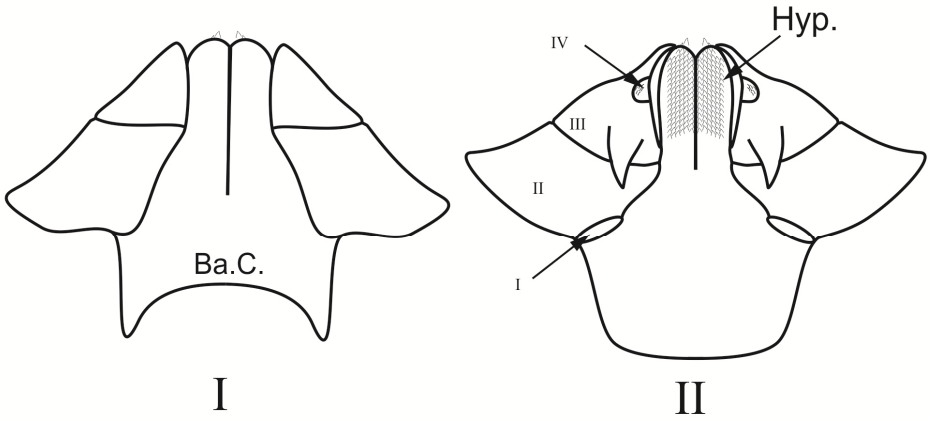

Figure 4. Capitulum of *Haemaphysalis erinacei*. I. Dorsal view; II. Ventral view. Ba. C.: basis capitulum, I-IV: palpal segments, Hyp.: Hypostome.

Key to the identification of Iranian *Haemaphysalis* species (males)

1. Lateral sides of palpal segment 2 not angled; width of palpi equal to the width of basis capitulum (i.e., palpi not conical or campaniform in appearance) (Fig. 5-I)…….. ……..……..……..……..…*H. inermis*

- Lateral side of palpal segment 2 angled; width of palpi (at the site of the angle) wider than width of basis capitulum (i.e., palpi conical or campaniform in

appearance)……..……..……..…….2
2. Third palpal segments seen as a pincer (Fig. 5-II).....…….*H. concinna*
- Third palpal segments seen as straight……3
3. Lateral side of palpal segment 2 greatly extended that palps resemble a pergola or Chinese house-roof (Fig. 5-III) (parasite of hedgehog, jackal, rodents and foxes)…..... … ……...……...*H. erinacei*
- Lateral side of palpal segment 2 not greatly extended (Fig 5-IV)…….……4
4. Spurs of coxae IV not longer than spurs coxae I-III (Fig. 6-I)……..……*H. parva*
- Spurs of coxae IV longer than spurs coxae I-III.....……5
5. The tip of spur of coxa IV directed centrally (Fig. 6-II)…….....*H. punctata*
- The tip of spur of coxa IV directed laterally (Fig. 6-III)……..……..*H. sulcata*

Key to the identification of Iranian *Haemaphysalis* species (females)

1. Lateral sides of palpal segment 2 without angle; width of palpi equal to width of basis capitulum (i.e., palpi not conical or campaniform in appearance (Fig. 5-I)...…*H. inermis*
- Lateral side of palpal segment 2 with angle; width of palpi (in place of angle) wider than width of basis capitulum (i.e., palpi conical or campaniform in appearance)...……2
2. Scutum rounded (length of scutum not longer than its width) (Fig. 7-I).…*H. concinna*
- Scutum oval (length of scutum longer than its width) (Fig. 7-II)……...….....3
3. Lateral side of palpal segment 2 greatly extended that the palps resemble a pergola or Chinese house-roof (Fig. 5-III) (parasite of hedgehog, jackal, rodents and foxes)……. ……...……..*H. erinacei*
- Lateral side of palpal segment 2 not greatly extended (Fig. 5-IV)…….…….4
4. Coxae II-IV without distinct spurs (Fig. 9-I)…….....……*H. sulcata*
- Coxae II-IV with distinct spurs……..…….……5
5. Dorsal cornua present (Fig. 8-I); the spurs of the coxae IV not larger than of the other coxal spurs (Fig. 9-II).....*H. parva*
- Dorsal cornua absent (Fig. 8-II); the spurs of the coxae IV larger than of the other coxal spurs (Fig. 9-III).....*H. punctata*

Discussion

The genus *Haemaphysalis* can be vector of medical and veterinary pathogen agents (Burkot & Graves 2004; Labuda & Nuttall 2008). In Iran, studies on the economic significant of *Haemaphysalis* ticks unlike *Hyalomma* and *Rhipicephalus* (vectors *Theileria* spp., CCHF virus and *Babesia* spp., respectively) have been neglected. This may be because *Haemaphysalis* are less frequently collected than *Hyalomma* and *Rhipicephalus* during routine tick monitoring likely, because they are more difficult to detect. This question is supported by the observations in the present study and also by Tavakoli (1997), Telmadarraiy *et al.* (2009), and Razmi & Ramoon (2012). Since, *Haemaphysalis* ticks (especially males and unengorged females) are smaller than *Hyalomma* spp., they may be overlooked whenever hosts are examined. In addition to domestic animals, the wild sheep, *Ovis orientalis* serves as the host of *H. sulcata*, *H. parva* and *H. punctata* in Iran; while the wild goat *Capra hircus* is reported as a host for *H. sulcata* (Hoogstraal & Valdez 1980). Furthermore, *H. sulcata* have been collected by drags across vegetation, and taken from many reptile species (Razmi & Ramoon 2012; Keskin *et al.* 2013).

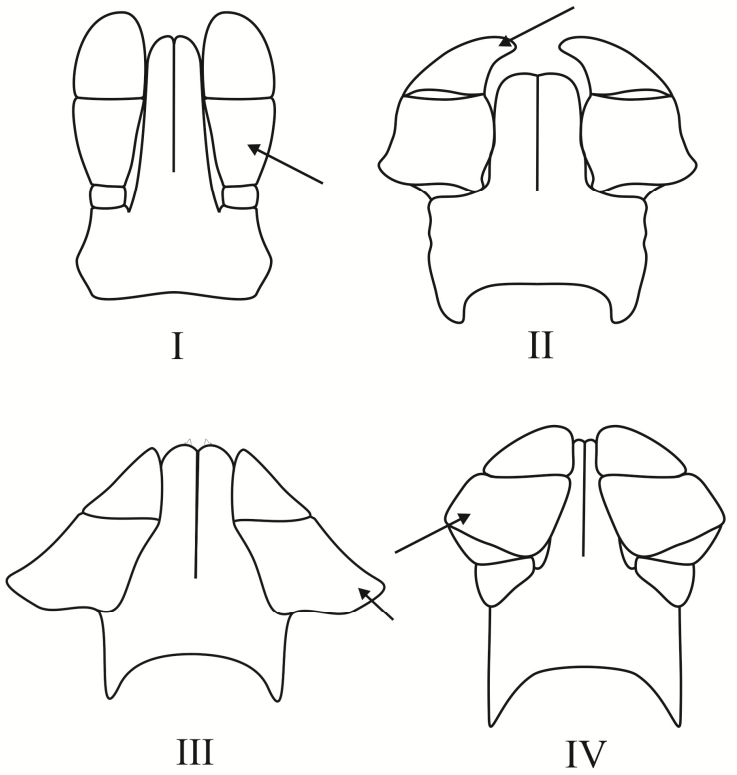

Figure 5. Dorsal view of basis capitulum in males. Arrows in parts I, III and IV indicates lateral side of palpal segment 2. I. Not angled; III. Resembles a pergola or Chinese house-roof; IV. Having little angle. Arrow in part II indicates pincer-like form of palpal segments 3.

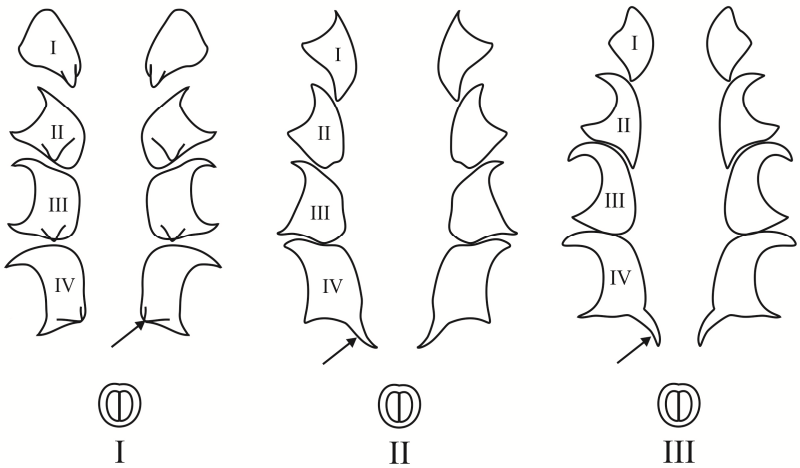

Figure 6. Ventral view of coxae I-IV in males. I. Spurs of coxae IV are not longer than spurs coxae I-III i.e., spur of coxa IV is short (arrow); II. Spurs of coxae IV are longer than spurs coxae I-III and tip of spur coxa IV (arrow) is directed centrally; III. Spurs of coxae IV are longer than spurs coxae I-III and tip of spur coxa IV (arrow) is directed laterally.

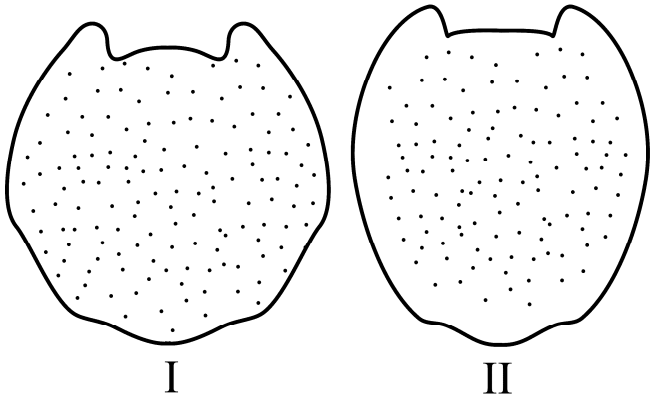

Figure 7. Dorsal view of scutum in females. I. Rounded; II. Oval.

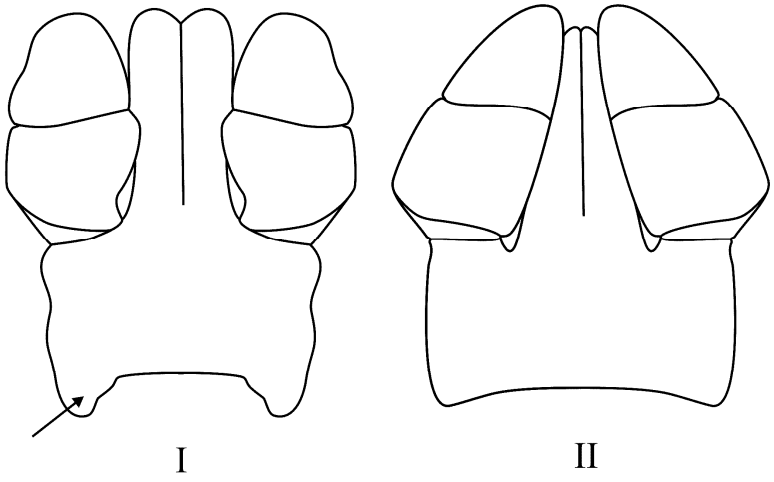

Figure 8. Dorsal view of basis capitulum female. I. Cornua (arrow) present; II. Cornua absent.

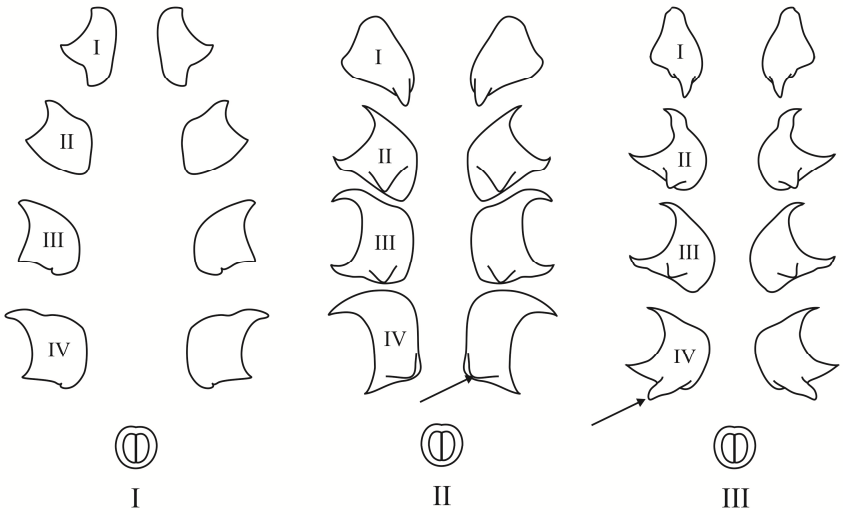

Figure 9. Ventral view of coxae I-IV in females. I. Coxae II-IV are without distinct spurs; II. Spurs of the coxae IV (arrow) are not larger than of the other coxal spurs; III. Spurs of the coxae IV (arrow) are larger than of the other coxal spurs.

Migratory birds act as hosts for many *Haemaphysalis* species, including *H. punctata*, *H. sulcata* and *H. parva*, an issue that is considered as a significant route in disseminating of tick borne pathogens (Hoogstraal *et al.* 1963). Likewise, some species, e.g. *H. parva* and *H. concinna*, rarely were beside the Caspian Sea, in mountainous, and semi-desert zones (Rahbari *et al.* 2007). The distribution of former should be considered as being confined to northern region of Iran from Khurasan to Kurdistan (Hoogstraal & Valdez 1980; our observation).

The identification of some haemaphysalid species, such as closely related species *H. sulcata* and *H. punctata*, can be difficult due to variation in the morphology of the coxal spurs in both the males and females of these species, and the issue also was discussed in Filippova (1997). Further confusion can arise due to variations in the direction of spurs on coxae IV (Senevet & Caminopetros 1936). Furthermore, the level of intra and inter species variation has not been elucidated in the Iranian species (especially concerning *H. sulcata* and *H. punctata*). The problem of synonymy in some Iranian taxa, including *H. sulcata* (syn.: *H. cholodkovskyi*), *H. punctata* syn.: *H. cinnabarina punctata*) and *H. parva* (syn.: *H. otophila*), those cited in Maghami (1968) and Rahbari *et al.* (2007), also needs to be resolved. *H. cinnabarina* is considered as a valid name by some authors such as Camicas *et al.* (1998) and Guglielmone *et al.* (2010). However, the valid name of *H. parva*, cited in Guglielmone *et al.* (2010), should be clarified from the name *H. parva*, a synonym of *H. intermedia* (Warburton & Nuttall, 1909), which was elucidated by Hoogstraal & Trapido (1963). The genus *Haemaphysalis* appears to be the most suitable indicator of phylogenetic evolution and speciation in the Ixodoidea (Hoogstraal 1965). *Haemaphysalis inermis* is a distinctive morphological and biological link between primitive ixodids and the remainder of the haemaphysalids (Hoogstraal 1961). It is proposed that further studies on *Haemaphysalis* species of wild mammals are required, especially of *H. kopetdaghica* and *H. kashmirensis* (Hoogstraal & Varma, 1962). These two have been recorded by Hoogstraal & Wassef (1979) and Hoogstraal & Valdez (1980) in northern and southern parts of the country.

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گزارش *Haemaphysalis erinacei* (Acari: Ixodidae) جدا شده از جوجه تیغی و کلید شناسایی برای گونه‌های *Haemaphysalis* ایران

اسدالله حسینی–چگنی[1]، زکیه تلمداری[2]* ، مهدی سلیمی[3]، کوروش ارزمانی[2] و امید بنفشی[4]

۱ گروه گیاهپزشکی، دانشکده کشاورزی، دانشگاه گیلان؛ رایانامه: hosseinichegeni@gmail.com

۲ گروه حشره‌شناسی پزشکی و کنترل ناقلان، دانشکده بهداشت، دانشگاه علوم پزشکی تهران، تهران، ایران؛ رایانامه: ztelma@yahoo.co.in ؛arzamanik@gmail.com

۳ مؤسسه پژوهشی بیماری‌های زونوتیک، دانشگاه شهرکرد، شهرکرد، ایران؛ رایانامه: sku.msalimi@yahoo.com

۴ گروه کنترل بیماری، دانشکده بهداشت، دانشگاه علوم پزشکی کردستان، سنندج، ایران؛ رایانامه: banafshiomid@yahoo.com

* نویسندهٔ مسئول مکاتبات

چکیده

کنه‌های راسته Ixodida از جمله تخصص یافته‌ترین انگل‌های خارجی در همه جهان محسوب می‌شوند. جنس *Haemaphysalis* از لحاظ تعداد گونه در رتبه دوم در این راسته قرار دارد. به نظر می‌رسد جنوب شرق آسیا خاستگاه رشد و پراکندگی جنس *Haemaphysalis* باشد. شش گونه *Haemaphysalis* شامل *H. concinna*، *H. erinacei*، *H. inermis*، *H. parva*، *H. punctata* و *H. sulcata* از ایران گزارش شده‌اند. مقاله حاضر به بررسی حضور *H. erinacei* در ایران پرداخته و همچنین کلید شناسایی تصویری برای گونه‌های ایران فراهم آورده است.

واژگان کلیدی: تاکسونومی، گونه، شناسایی، کلید تصویری، کنه دامی.

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