EPIDEMIOLOGICAL AND MORPHOLOGICAL STUDIES ON HYALOMMA SPECIES INFESTING DROMEDARY CAMELS IN ASWAN GOVERNORATE, EGYPT

By
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Abstract
The study evaluated the hard ticks’ prevalence parasitizing dromedary camels (Camelus dromedaries) in Aswan Governorate from July 2020 to August 2021. Of 1190 camels examined 1060 (89%) were infested. Factors were camel age, sex, infested site, and seasonal variations association with the tick distribution, as camels > 10 years were at higher risk rate of 97% (390/410).

The infestation rate was 90% (990/1100) in males and 77.8% (70/90) in females. Exposure to infestation was higher in summer 93.7% (458/489) than other seasons. The face, udder, testes, hind limbs, and tail were the most infested site 97.5% (1160/1190) for each, followed by forelimbs was 96.6% (1150/1190), chest was 94% (1120/1190), and abdomen was 92.4% (1100/1190). Statistical analysis of the possible associated risk factors, camel’s age, gender, sampling season, and infested parts within animal body were all found to be significantly affected and related to hard tick distribution (P<0.05). Also, the identification and morphological characterization of the isolated hard ticks were performed using stereomicroscope.

Key words: Aswan Governorate, Egypt, Camels, hard tick, Hyalomma species.

Introduction
The Arabian one-humped camel (Camelus dromedarius) has a many of characteristic adaptive physical and functional abilities, making them a vital component of the desert and non-desert environments. In Egypt, camel construction is practiced on a small scale and the country burdens are met by importation, mainly from Sudan. Conversely, the financial impact of camel production is troubled by highly infectious and zoonotic diseases, inappropriate veterinary facilities and feed deficiency (Ahmed et al, 2020). Of particular apprehension, the hard ticks are damaging blood sucking ecto-parasites, establish in most if not all the countries of the world, but are of greater economic importance in the tropical and sub-Tropical districts (El-Tigani and Mohammed 2010). The significance of ticks is mainly owing to cause emerging and re-emerging diseases, which are important universal problems of great concern to humans as well as to animal health (Perveen et al, 2021a). Ticks are globally considered important arthropod vectors due to the wide variety of human and animal pathogens they can transmit (Perveen et al, 2020). In North Africa, ticks are one of the utmost damaging pest, and potent vectors for transmission of various bacterial, viral, rickettsial, as well as protozoan diseases of animals and man (Karesh et al, 2005), tick-borne protozoan diseases e.g. theileriosis and babesiosis, rickettsial diseases e.g. anaplasmosis, Rocky Mountain Spotted Fever and heart water or cowdriosis and others (Morsy et al, 2021), Bacterial diseases e.g. tularaemia, Spirochaetes e.g. Lyme disease “tick-borne disease affecting humans” and Relapsing fever), and Viral diseases e.g. Looping
ill and African Swine Fever are the main health, and management problems of livestock (Wall and Shearer, 2001).

The main effect of tick infestation in one humped camel is mild to severe anemia, defeat appetite, leading to a fall in growth rate, and declined productivity (Mohsen et al., 2013). Moreover, ticks are responsible for deterioration of skin due to piercing, sucking blood, extreme pruritus, and infrequent mortalities in untreated and young animals (Constantin et al., 2012). In Egypt, camels tick paralysis was reported only in Sudan by Hyalomma spp. adults, and/or Rhipicephalus spp. adults or nymphs (Musa and Osman, 1990). But, Mosabah and Morsy (2012) in Egypt reported first zoonosis tick paralysis in four hospitalized children living in animals rearing farm in Giza Governorate. Saleh et al. (2016) added that when dealing with children from tick infested areas, tick paralysis must be considered in differential diagnosis of clinically confused diseases as poliomyelitis, myasthenia gravis; Guillain-Barre; paralytic rabies botulism; transverse myelitis and/or diphtheritic polyneuropathy.

Till now, only 27 Hyalomma species were described (Schulz et al., 2020). The most dominant ones were H. dromedarii, H. impeltatum Schulze et Schulttte, 1930, H. excavatum, H. anatolicum Koch, 1844, H. truncatum Koch, 1844, H. marginatum, Hyalomma rufipes, H. turanicum Hoogstraal et Kaiser, 1960, H. schulzei Olenev, 1931, and H. impressum (Abdel-Shafy et al., 2011). El Kady (1993) in Sinai reported Hyalomma dromedarii, H. impeltatum, H. an. excavatum, H. an. anatolicum, H. marginatum and H. schulzei. He added that Babesia sp. and Theileria sp. were recorded in tick guts and haemolymph in most species allover Sinai, Trypanosoma sp. was recorded in guts of ticks collected from Beer El Abd, Nakhel and Dahab, and Anaplasma sp. was in tick guts from Beer El Abd and Dahab, and in haemolymph of ticks collected in Nakhel and Dahab. Mazyad and Khalaf (2002) in North Sinai reported Babesia ovis and Theileria ovis in tick infested animals. They found B. ovis and Th. ovis were in 13 (2.7%), &14 (2.9%) sheep, 14 (7.0%), & 15 (7.5%) goats, 13 (9.6%), & 11 (8.1%) cattle, & 18 (9.5%), & 24 (12.6%) camels respectively. Identified adult ticks were Rhipicephalus appendiculatus, R. bursa, R. turanicus & Haemaphysalis parva on sheep, Hyalomma an. excavatum & Haemaphysalis sulcata on goats, Hyalomma lusitanicum on cattle and Hyalomma dromedarii, H. impeltatum, H. marginatum & H. an. anatolicum on camels. B. ovis and/or Th. ovis in gut and/or salivary glands in R. appendiculatus (20%), R. bursa (16.7%), R. turanicus (10%), Haemaphysalis parva (10%), H. an. excavatum (30%), H. dromedarii (18%), and H. an. Anatomicum (6.7%).

Loftis et al. (2006) in Egypt by PCR reported rickettsial pathogens in ticks; Anaplasma marginale, Coxiella burnetti, Rickettsia aesculimannii, and four novel genotypes similar to “Anaplasma platys”, Ehrlichia canis, Ehrlichia spp. on Asian ticks, and a Rickettsiales endosymbiont of Ixodes ricius. Okely et al. (2021) studied the fauna of hard ticks on domestic animals in seven governorates of Egypt during 2018-2019. A total of 3265 individual tick specimens were collected and identified to the species level; they belong to 11 species within 3 genera (Amblyomma, Hyalomma, & Rhipicephalus). Tick infestation was highest in dromedary camels (70%), followed by dogs (52.5%), cattle (50%), buffaloes (38%), and horses (12%). Ten species were collected from dromedary camels, two from cattle, and a species from dogs, buffaloes, and horses.

This study aimed to investigate the prevalence and risk factors of ixodid tick infesting one-humped camels in Aswan Governorate, with an illustrative descriptive morphology of the recovered ones.

Materials and Methods

The present study was carried out at different main cities in Aswan Governorate (Aswan, Daraw, Kom-Ombo, Nasser, and Edfu), where the camels were managed and ho-
used traditionally, during the period from July 2020 to August 2021. A total 1190 of camels of different ages (between 3 months to 15 year) were examined for tick infestations. Factors as animal age, sex, seasonal variations, infested site and location were registered.

Ticks were collected through weekly visits to the camel herds in the four cities. On each visit, ticks were collected from the skin of perennial area, ear, neck, thorax, abdomen, tail, udder and forelegs of naturally infested camels. They were carefully manipulated from the host by forceps and orientated anti-clockwise until the capitulum was detached from the host; some were placed in labeled clean plastic container with perforated lids to allow ventilation and then immediately transported to the laboratory at the Department of Parasitology, Aswan Faculty of Veterinary Medicine for application with Neem extract. Another samples tick was put in plastic vials of 70% ethanol and 30% glycerin for identification by species and sex by the Standardized International Keys (Hoogstraal, 1956; Walker et al, 2003). Ticks were studied using stereomicroscope (SZ-ST Olympus, Japan), and photographed by a built in digital camera.

Ethical statement: The study was approved by the Ethics Committee Board, Faculty of Veterinary Medicine, Aswan University. The experimental animals used were dealt with according the rules of Helsinki (2000).

Results

The results are shown in tables (1, 2 & 3) and figures (1, 2, 3, 4, 5, 6, 7, 8, 9 & 10).

Table 1: Prevalence of Hyalomma spp. infestation in camels at different area in Aswan Governorate

<table>
<thead>
<tr>
<th>City</th>
<th>Examined camels</th>
<th>Infested camels</th>
<th>%</th>
<th>F&lt;sub&gt;05&lt;/sub&gt;</th>
<th>Sig.</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aswan</td>
<td>180</td>
<td>140</td>
<td>77.8</td>
<td>35.845</td>
<td>0.000</td>
<td>12.846</td>
</tr>
<tr>
<td>Daraw</td>
<td>300</td>
<td>290</td>
<td>96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kom Ombo</td>
<td>240</td>
<td>240</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasser</td>
<td>200</td>
<td>190</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edfu</td>
<td>270</td>
<td>200</td>
<td>74</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1190</td>
<td>1060</td>
<td>89</td>
<td>a,b,c,d, e differed significantly (p&lt;.05)</td>
<td></td>
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</tr>
</tbody>
</table>

Table 2: Prevalence of Hyalomma spp. among infested camels in relation to age, sex, & seasonal distribution

<table>
<thead>
<tr>
<th>Variables</th>
<th>Age in years</th>
<th>Sex</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camels</td>
<td>&lt;5</td>
<td>5-10</td>
<td>10+</td>
</tr>
<tr>
<td>Examined</td>
<td>320</td>
<td>460</td>
<td>410</td>
</tr>
<tr>
<td>Infested</td>
<td>250&lt;sup&gt;a&lt;/sup&gt;</td>
<td>420&lt;sup&gt;b&lt;/sup&gt;</td>
<td>390&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Percentage</td>
<td>78</td>
<td>91.3</td>
<td>97</td>
</tr>
<tr>
<td>F&lt;sub&gt;05&lt;/sub&gt;</td>
<td>11.21</td>
<td>507.84</td>
<td>8.930</td>
</tr>
<tr>
<td>Sig.</td>
<td>0.009</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>LSD</td>
<td>20.19</td>
<td>a, b, c, &amp; d differed significantly (p&lt;.05)</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Prevalence of Hyalomma spp. infestation in different sites of camels

<table>
<thead>
<tr>
<th>Variables</th>
<th>Face</th>
<th>Chest</th>
<th>Fore limbs</th>
<th>Abdomen</th>
<th>Udder, testes</th>
<th>Hind limbs</th>
<th>Tail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex. camels</td>
<td>1190</td>
<td>1190</td>
<td>1190</td>
<td>1190</td>
<td>1190</td>
<td>1190</td>
<td>1190</td>
</tr>
<tr>
<td>Infested site</td>
<td>1160&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1120&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1150&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1100&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1160&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1160&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1160&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Percentage</td>
<td>97.5</td>
<td>94</td>
<td>96.6</td>
<td>97.5</td>
<td>97.5</td>
<td>97.5</td>
<td>97.5</td>
</tr>
<tr>
<td>F&lt;sub&gt;05&lt;/sub&gt;</td>
<td>71.429</td>
<td>a, b &amp; c differed significantly (p&lt;.05)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig.</td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSD</td>
<td>17.51</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Discussion

Ticks are global blood feeding ectoparasites of humans and animals, consequently vectors of many pathogens that causing severe infectious diseases in humans and livestock. Moreover, ticks are responsible for substantial economic losses in a camel productivity as disturbing their health through causing mild to severe anemia, impairment to hide and devitalization udder (Al-Salihi et al, 2018). The dissemination restrictions of ticks are not fixed and continuous, but are determined by a complex interaction of factors as climate, host density and host vulnerability (Solomon, 2003). Such responsible factors are essential for effective tick and...
tick borne diseases (TBDs) control strategies (Alanr, 2011). Therefore, the present study was designed to investigate the up to date prevalence of the hard ticks *Hyalomma* spp. in dromedary camels at Aswan Governorate (Egypt).

In the present study, hard tick infesting camels showed prevalence rate in the four cities Aswan, Daraw, Kom-Ombo, Naser, and Edfu were 77.8%, 96%, 100%, 95%, & 74% respectively, with overall rate of 89%. It was obvious from aforementioned data that the examined camels in different cities of Aswan were heavily infested by hard ticks, in spite of there was a distinct variation on distribution of tick’s among these cities, the highest prevalence rate of infestation was observed in Kom-Ombo City (100%, 240/240) followed by Daraw City (96%, 290/300), and Nasser city (95%, 190/200), while the lowest rate was recorded in Aswan City, and Edfu City in rates of (77.8%, 140/180), and (74%, 200/270), respectively. These variations in prevalence rates among different cities in Aswan Governorate may be attributed to persistent tick’s infestation within animal shelters as a result of the bad hygienic system e.g. lack of regular manure removal, old farm, which have wall and ground crakes and overcrowdings with limited ventilation, and/or irregular treatment ofinfested camels with acaricides, which emerge resistance inside treated ticks.

In the present study, the overall prevalence rate of ticks among camels was (89%). This result was agreed with (Regassa et al., 2014; Hassan et al., 2017; Isse et al., 2017; Al-Salihi et al., 2018; Abdul Al-Hussein et al., 2020; Perveen et al., 2021). But, disagreed with 28.6% (Abdel-Rady, 2014) in Egypt, 59.25% in Iran (Moshaverinia and Moghaddas, 2015), 60.96% in Aswan (El-Seify et al., 2017), 33.6% in Sinai (Allam et al., 2018), 68.2% in Saudi Arabia (Alanazi et al., 2020), 33.33% in Iran (Shamsi et al., 2020), 61.4% in Algeria (Kaaboub et al., 2021). Undoubtedly, the bedouins rear large number of camels on several ecosystems including border of the cities, villages, semi-desert and desert areas exposing the camels to tick infestations (Al-Salihi et al., 2018) and other ecto-parasites as *Cephalopina tilorator* nasal myiasis (Morsy et al., 1999), or Sarcoptic mange (Kotb and Abdelrady, 2015).

In the present study, there was a significant relationship between animal age and tick infestation (P<0.05), camels aged 10-14 years was (97%), 5-10 years was (91.3%), while the lowest was (78%) in aged camel less than 5 years. This more or less agreed with Hussein and Al-Fatlawi (2009), they found (87%) among camel aged 10 years or older followed by (86%) in 5-10 years and lowest was (63%) in camels less than 5 years; Champour et al. (2013) found a rate of (94%) in camels less than 5 years (61%) in camels 6-10 years and (45%) in camels > 10 years; Bala et al. (2018) found a rate (59.54%) in younger camels (5-10 years), and (0.36%) in 16-20 years that increased to (2.78%) in those aged 20 years. Khelifi-Ouchene et al. (2020) in Algeria found that the camels less than one year was 15.08%, between 1-5 years (77.15 %), between 5-10 years (4.31%), and more than 10 years (3.5%). These differences may be attributed to sexually mature camels prone to stress of hormonal changes, which attracted ticks (Hussein and Al-Fatlawi, 2009).

In the present study, sex was another significant risk factor (P<0.05) as males were at higher risk of tick infestation (90%) than females (77.8%). This observation agreed with Nourollahi Fard et al. (2012) they reported (66.2%) in male and (33.8%) female; Champour et al. (2013) reported (72.2%) in male, and (27.8%) in female, Bala et al. (2018) detected that males (17.27%), and females (82.73%), Khelifi-Ouchene et al. (2020) reported (60.77%) in males, and (39.23%) in females, Abdul Al-Hussein et al. (2020) reported males were (93.1%) and females were (99.11%), Shamsi et al. (2020) reported (88.46%) in the males and (11.53%) in females. No doubt, high tick rates on males than...
females since females were kept indoors for reproduction under good and clean observations while males were left outdoors for grazing and thus contact especially contaminated fomites with ticks. However, Al-Salihi et al. (2018) in Iraq found the highest infestation (98.48%) in females than (75%) in males and Elati et al. (2021) in Tunisia found that female camels were more infested (88.3%) than males 65.5%. The difference between male and female tick’s infestation may be attributed the difference in the owners habits, geographical and ecological factors.

In the present study, a seasonal variations of camels infestation were higher in summer (93.7%), and the lowest infestation occur in winter (44.4%), This agreed with Nourollahi Fard et al. (2012), Moshaverinia and Moghadamas (2015), Hassan et al. (2017), Perveen et al. (2020) and Shamsi et al. (2020). But, this disagreed with Bala et al. (2018) they found that the autumn rate was (40.22%), followed by winter (30.07%) and summer (29.71%).

In the present study, the face, udder, testes, hind limbs, and tail were the most infested site with rate of (97.5%, 1160/1190) for each, followed by fore limbs (96.6%, 1150/1190), chest (94%, 1120/1190), and abdomen (92.4%, 1100/1190). This more or less agreed with Nazifi et al. (2011) in Iran found adult ticks on axilla (36%), groin (20%), interdigital cleft (14%), genital area (12%), anus (10%), tail-brush (4%) and ears (4%), Nourollahi Fard et al. (2012) found that perineum and chest infested rate was (91.1%), external ear (6.3%), shoulder (2.6%), Perveen et al. (2020) reported that most c ticks were found attached to the perianal, and vulvar regions, the inner surface of thighs, udder, and inguinal region, but fewer ticks were on pinna, and chest region, Al-Deeb and Muzaffar (2020) found that the highest number of ticks were on tail area followed by abdomen, and Elati et al. (2021) in Tunisia illustrated the preferred attachment sites for adult Hyalomma ticks were the sternum (38.3%), around the anus (36.2%), udder (18.4%), and inner thigh (6.9%).

In the present study, genus Hyalomma was easily identified from other genera of Ixodid as female (6-17mm), and male (5-7mm) in length, Hyalomma scutum brownish in colored. Enamel (= ornamentation) was absent from the scutum and conscutum, basis capituli with angular lateral margins, cervical fields depression was apparent, convex eyes at scutum edge, four pairs of legs with paler rings ended with pulvilli. Festoons were present in males and in females but unclear in fed females. Ventrally had coxae at all legs with uniform dark color and smooth texture, only first pair with distinct paired spurs large, equal internal and external spurs, female genital aperture with deep anterior groove, and posterior lips, ventral plates in males only as three distinct pairs, anal groove was posterior to anus in male and female Hyalomma, spiracular plates were large and posterior to fourth legs (Mehlhorn, 2012).

Diagnosis of female Hyalomma spp. was difficult in engorged ones, due to variability in taxonomic characters that may overlapped in different species without distinctive characters. Morphological variation in different Hyalomma spp. may cause misidentification among closely related taxa, H. excavatum, H. asiaticum and H. marginatum. Taxonomic characteristics to differentiate of species in males included cervical groove, basis capituli and lateral grooves on scutum (Hosseini-Chegeni et al, 2013), engorged female Hyalomma anatolicum was more closely similar to H. excavatum as the females species overlap in some areas (Walker et al, 2003).

In the present study, identification of female Hyalomma spp. was difficulty and inaccuracy to classify the isolated Hyalomma spp. unless using the SEM or diagnostic PCR, which was unavailable. It was important to isolated Hyalomma spp., as male of Hyalomma dromedarii, H. anatolicum, H. excavatum, and H. marginatum easily recognized by keys (Hosseini-Chegeni et al, 2013).
Hyalomma dromedarii male, body length 7mm, varied between yellowish brown to dark brown, anterior region, dorsally characterized by presence of blade shape hypostome with paired chelicerae, three palp articles like segments on each hypostome side, basis capituli with blunt lateral angels and medium angular lateral margins, short cornua paired projections from outer margins of posterior dorsal surface of basis capituli, convex eyes at both conscutum edge, apparent large curved cervical field depression along each side of intercervical field, small to medium interstitial punctuation sparsely distributed via male dorsal surface. Ventrally palp which are paired structures of the mouthparts at each side of hypostome and composed of three pairs of articles like segments, and second one longer than first and third article, all legs coxae normal with uniform dark color and smooth texture and first legs with distinct paired spurs (large, equal internal & external spurs). Genital aperture located between second coxae. Posterior region dorsally has short lateral grooves, large paramedian groove upto parma, distinct po-steromedian groove, central festoon (parma) pale, and paracentral festoons separate anteriorly, subanal plates projected beyond body posterior margin, and seen dorsally in blood engorged male. Posterior end ventrally characterized by large comma shape spiracular plates posterior to fourth coxae, anal groove posterior to anus, anal shields (3 pairs of ventral plates); pair of adanal plates with round ends and curved medially, pair of subanal plates outside longitudinal axis of adanal plates, and another pair of accessory adanal plates.

Hyalomma an. anatolicum male was distinguished from other closely related species as H. dromedarii. H. anatolicum 3-4 mm in length, smooth shiny and pale in color, central festoon (parma) pale, paracentral festoons separates anteriorly (a distinctive feature from H. excavatum), legs yellow brownish colored or marbled pattern, with indistinct rings, punctuation small with sparse distribution, adanal plates with a round end, subanal plates indistinct, and no accessory adanal plates.

Hyalomma an. excavatum male, 3-4 mm in length, dark in color, Paramedian grooves indistinct, paracentral festoons joined anteriorly to form an arch, central festoon pale, leg marbled light brownish in color, adanal plates with square ends, small accessory adenal plate, and distinct subanal plates.

Hyalomma marginatum male, 3-4 mm in length, dark brown color, lateral grooves long, paramedian grooves small (all posteri or grooves shallow indistinct), marbled leg coloration with pale rings, central festoon dark, and paracentral festoons separated anteriorly, adanal plates shape with square ends, small accessory adanal plate, and small distinct subanal plate.

Conclusion

Generally, mosquitoes and ticks are the main arthropod-vectors of many zoonotic diseases, whether virus, bacteria or protozoa. The outcome resulted showed that camels in the four main cities in Aswan Governorate were infested with many Hyalomma species. The health of camels can be altered by the direct and indirect effects of ticks, causing significant losses in the production of meat, milk, and leathers, and in many cases the death of the affected camels. The damage produced by ticks when feeding on the blood of their hosts, while the indirect losses are related to the zoonotic infectious agents transmitted by ticks, and the high costs associated to the treatment and control

This must be in mind of the camels’ owners as well as the Public Health and the Agricultural Authorities to suggest feasible control measures

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Explanation of figures
Fig. 1: Hyalomma spp. female with variable length (6mm-17mm).
Fig. 2: Hyalomma spp. female (Dorsal view); a- Fully engorged female, b- Engorged female, c- Partially engorged female, d- Non-engorged female.
Fig. 3: Hyalomma spp. female (Ventral view); a- Fully engorged female, b- Engorged female, c- Partially engorged female, d- Non-engorged female.
Fig. 4: Hyalomma spp. engorged female, anterior end Left D.V. a- Basis capituli with sharp angular lateral margins. b- Cervical apparently depressed. c- Convex eyes at scutum edge. d- Intercervical field. e- Scutum posterior margin slightly sinuous Right V.V., a- Coxae of all legs.
normal with a uniform dark color and smooth texture and only first legs with distinct paired spurs (large, equal internal and external spurs). b- Genital aperture with deep anterior groove. c- Genital aperture posterior lips have a narrow V shape.

Fig. 5: *Hyalomma* spp. engorged female posterior end, Left D.V., Right V.V.: a- Anal opening. b- Anal groove. c- Large spiracular plate posterior to legs 4.

Fig. 6: *Hyalomma* spp. engorged male with variable length (5-7mm).

Fig. 7: *Hyalomma* spp. (Left); fully engorged female with 17mm in length. (Right); fully engorged male (7mm)

Fig. 8: *Hyalomma dromedarii*: fully engorged male anterior region Left D.V.: a- Hypostome. b- Palp articles. c- Basis capituli with medium angular lateral margins. d- Convex eyes at constrictum edge. e- Scapular or cervical depressed. f- Punctuation large size, punctuation sparsely distributed. g- Intercervical field. Right V.V.: a- Palp articles 2 longer than articles 1 & 3. b- Coxae of all legs normal with a uniform dark color and smooth texture and first legs with distinct paired spurs (large, equal internal & external spurs). c- Genital aperture between coxae 2.

Fig. 9: *Hyalomma dromedarii*: fully engorged male posterior region, Left D.V. a- Short lateral grooves, b- Large paramedian grooves, c- Postmedian groove, d- Central festoon is pale colored. Paracentral festoons are separate anteriorly. e- Festoons. f- Subanal plates projected beyond posterior margin of the body. Right V.V.: a- Large spiracular plate posterior to legs 4. b- Anus. c- Anal groove. d- Accessory adanal plates. e- Adanal plates. f- Subanal plates.

Fig. 10: Illustration of male *Hyalomma dromedarii*, *H. anatolicum*, *H. excavatum* and *H. marginatum*. 
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<th>Dorsal surface</th>
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**F. 10**