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Inventory and kinetics of Ixodidae in sheep in Souk Ahras region

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Informations	Résumé
Mots clés : Inventory, Kinetics, Ixodidae, Souk Ahras. *Correspondance : draouadiatef@gmail.com	We opted for a preliminary study for the first time on the inventory of ticks in sheep and their kinetics, in order to achieve an objective of assessing the importance of the infestation and the dynamics of Ixodidae in sheep in the Souk Ahras region, thus determining the high-risk period is essential for the establishment of a tick control program in order to prevent diseases transmitted by these parasites and their impact on public health. During the period from September 15, 2010 to August 31, 2011; 75 sheep belonging to 3 farms located in Khedara, Ouled Moumen and Merahna located in the region of Souk ahras underwent a search and collection of infesting ticks every fifteen days. At the end of this collection, it turned out that all the sheep examined were carriers of ticks, which represents an infestation rate of 100%. In addition, the number of ticks collected amounted to 3021, this population is made up of 1958 males and 1063 females, or 64.82% and 35.18% respectively. The overall parasite load is forty. The identification of tick species made it possible to highlight three species in two genera: <i>Rhipicephalus sanguineus</i>, <i>Rhipicephalus annulatus</i>, <i>Rhipicephalus bursa</i>, <i>Hyalomma detritum</i>, <i>Hyalomma dromedarii</i> and <i>Hyalomma marginatum</i>.

1. Introduction

Ticks and tick-borne diseases cause an estimated US \$ 13.9 to 18.7 billion loss and an annual shortfall of approximately 3 billion pieces of hide and skin in cattle alone [1, 2]. Ticks are known for their negative impact on livestock and human health through infestation and are capable of transmitting a wide range of pathogens including protozoans, viruses, and bacteria such as the spirochetes and rickettsiae. [3]. Ticks are hematophagous arthropods, with about 900 species divided into two large families of medical interest, the Argasidae (soft ticks) and the Ixodidae (hard ticks) Hoogstraal H[4]. Ixodid ticks develop through three active stages (larva, nymph, and adult), while argasid ticks have up to nine nymphal stages in addition to larva and adult stages. Whereas Ixodidae may feed for days or even weeks, most Argasidae feed for only 20–70 min [5]. These radically different life cycles deeply impact the circulation of many micro-organisms, as the two families clearly differ in their ability to support active foci of pathogens [6]. The ecology and physiology of ticks make them second only to mosquitoes in the number of pathogens they vector [7], while ticks are the most important disease vector of moderate climates [8]. The discovery of tick involvement in transmission of *Borrelia burgdorferi* group bacteria

(the etiological agent of Lyme borreliosis) and *Anaplasma phagocytophilum* to humans sparked a renewed interest in studies of the ecology of these arthropods [8]. Recent studies have been focused on defining the molecular interactions between ticks and the pathogens they transmit, and the roles ticks play in maintaining natural foci of infection [9-13]. By definition, a hematophagous arthropod species that transmits a pathogen during blood-feeding is known as a vector. In this context, vector competence is the innate ability of an arthropod to acquire, maintain, and transmit microbial agents [14].

2. Materials and methods

2.1. Study Areas

This cross-sectional study was carried out on ticks and the blood of small ruminants, (figure 1) in the wilaya of Souk -Ahras, this region is located in the extreme North East of Algeria, and covers an area of 4360 km², limited to the North by the wilayates of El Tarf and Guelma, to the south by the wilayats of Tébessa and Oum El Bouaghi, to the east by Tunisia and to the west by the wilaya of Oum EL Bouaghi.



Fig. 1: Study area and collection points in the wilaya of Souk Ahras

2.2. Animals

During a period of two years April 2011 to March 2013, the study was conducted at different sheep farms in the municipalities of Khedara, Merahna and Ouled Moumen. Livestock in these areas is extensive, the animals belong to the local population, the sheep live outdoors and roam with shepherds accompanied by dogs ten km in search of food, most often in the mountains bordering between green and humid places, clay soil very rich in vegetation, foliage, debris, dry branches and trunks. On each farm we took at random 25 animals, in total 75 sheep were followed for a year. It should be noted that we made sure that no acaricide treatment was applied to the sheep during the entire duration of our experiment, and did not receive acaricide treatment for 4 months before this study.

2.2.1. Research and collection of ticks:

The tick collection took place from September 15, 2010 to August 31, 2011 for a study on the inventory and kinetics of ticks. The ticks were collected directly from the sheep twice a month. The technique consists in examining visually by spreading the coat of the different parts of the body to search for ticks and removing them with forceps, mechanically without any substance being applied to these parasites, so as to keep rostrum and capitulum intact (Two basic elements for identification). All the ticks collected were kept in identified tubes containing ethanol at 70° for the conservation and carrying out of the identifications in the parasitology laboratory of the veterinary department of Chadli Bendjedid University.

3. Results

During the period from September 15 to August 31, 2011, 75 sheep belonging to 3 farms located in Khedara, Ouled Moumen and Merahna underwent a

fortnightly examination targeting the search and the collection of ticks infesting these animals in the Souk ahras region. At the end of this collection, it turned out that all the sheep examined carried ticks, which represents an infestation rate of 100%. In addition, the number of ticks collected rose to 3,021. This population is made up of 1958 males and 1063 females, i.e. 64.82% and 35.18% respectively. The overall parasite load is 40.

Based on the Bouattour diagnostic key [15] and Estrada pena [16], we were able to identify two genera *Rhipicephalus* and *Hyalomma*. The identification of ticks revealed 02 genera with 3 species for each.

• *Rhipicephalus* with:

Rhipicephalus sanguineus (Figures: 04, 05 and 06)

Rhipicephalus annulatus (Formerly *Boophilus annulatus*) (Figure: 07)

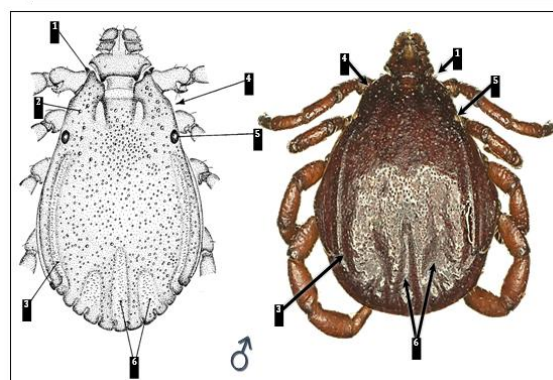
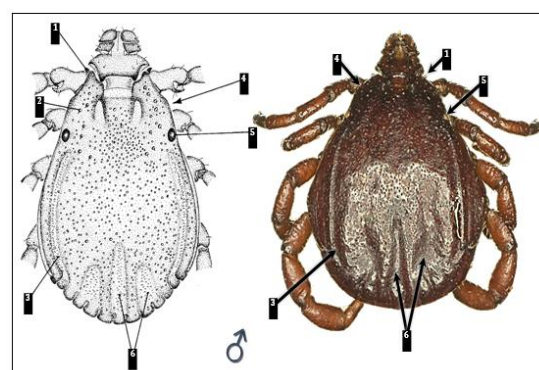
Rhipicephalus bursa (Figures: 02 and 03)

• *Hyalomma* with:

Hyalomma detritum (Figures: 09 and 10)

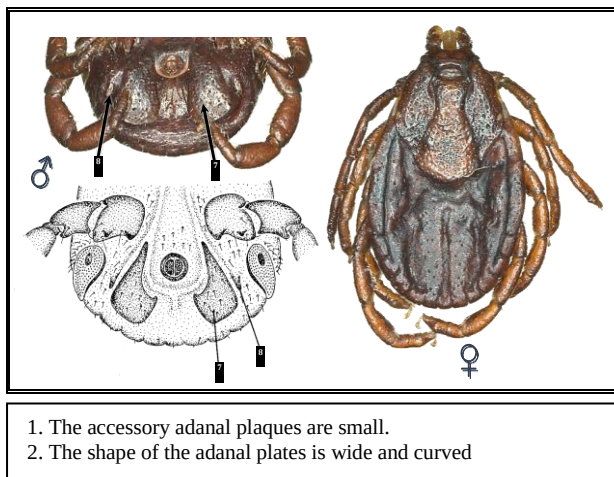
Hyalomma dromedarii (Figures: 11 and 12)

Hyalomma marginatum (Figure 08)



1. Coxa 1 anterior spurs are visible dorsally.
2. The punctuations are indistinct.
3. The interstitial punctuation size is medium to large and the punctuation distribution is dense.
4. The depression of the cervical fields is not apparent and the texture has no wrinkles.
5. The eyes are distinctly convex.
6. The posterior furrows are distinct (shallow with some wrinkled texture).

Fig. 2: *Rhipicephalus bursa* male, dorsal side (Original. 2016).



(Originale 2016).

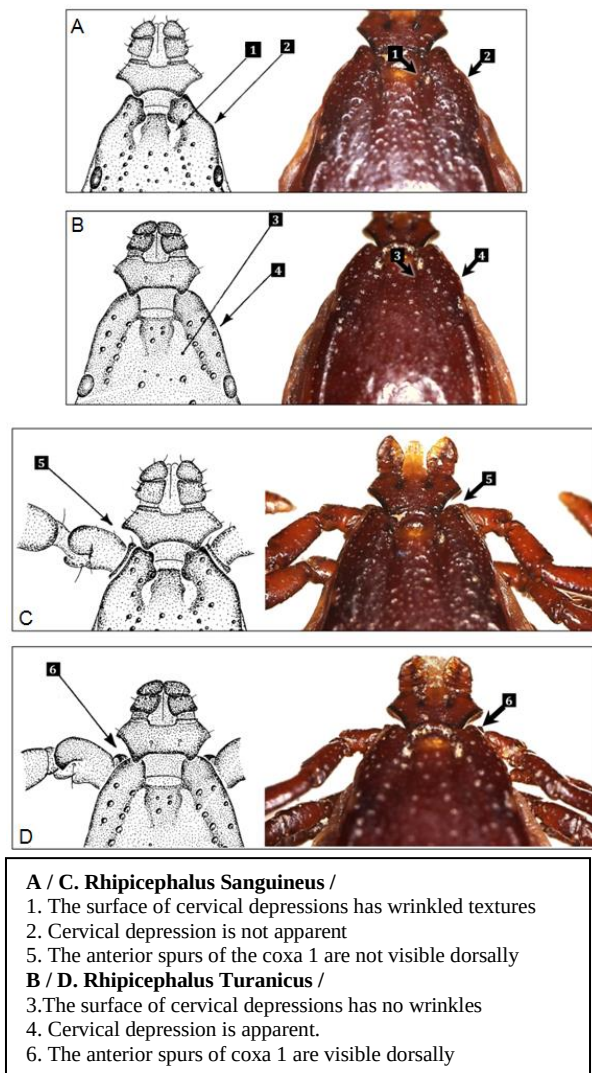


Fig. 4: Key to diagnosis between *Rhipicephalus turanicus* and *Rhipicephalus sanguineus*. Anterior part (Original 2016).

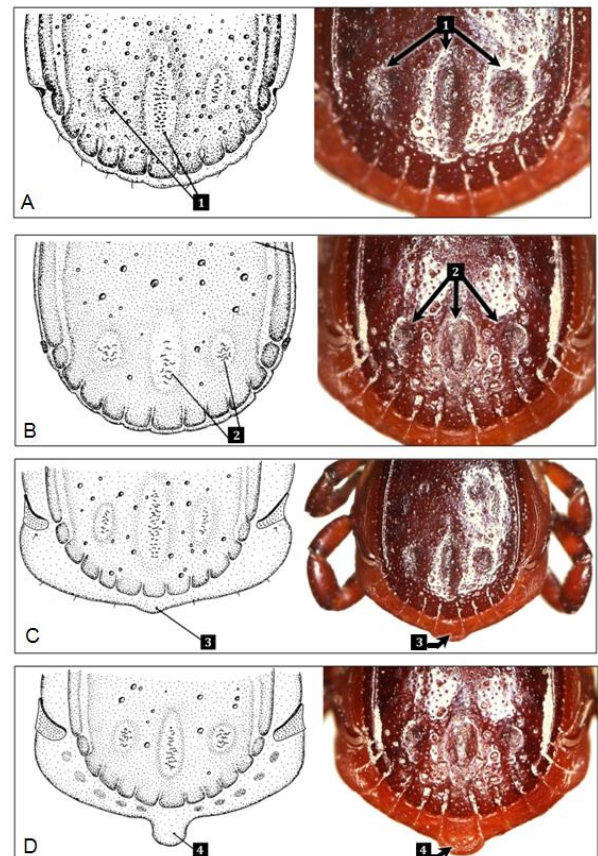
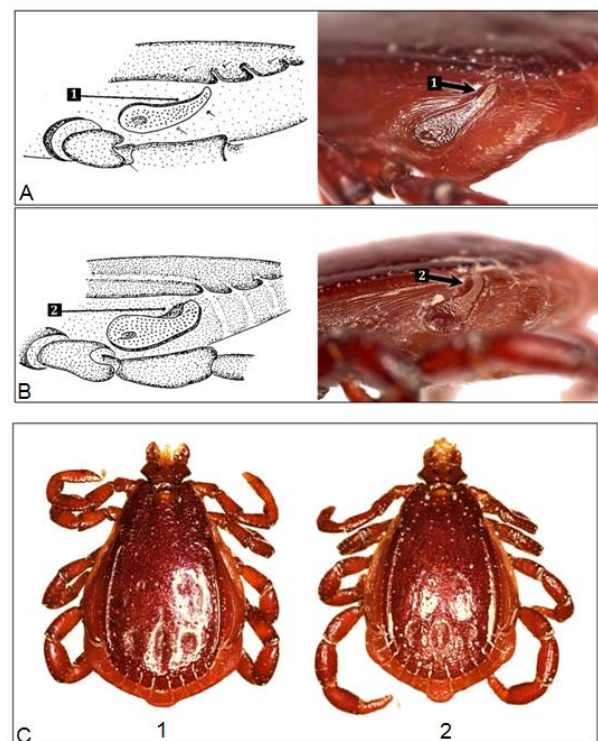


Fig. 5: Keys to diagnosis between *Rhipicephalus turanicus* and *Rhipicephalus sanguineus*. Posterior part (Original 2016).



C / 1. *Rhipicephalus Sanguineus*
A / 1. The spiracular plates are surrounded by sparse bristles. (The spiracular plates have a narrow end part and their width is half of the adjacent scallop).
C / 2. *Rhipicephalus Turanicus*
B / 2. The spiracular plates are surrounded by sparse bristles. (The spiracular plates have a broad end portion and are the same width as the adjacent scallop).

Fig.6: Diagnostic keys between *Rhipicephalus turanicus* and *Rhipicephalus sanguineus*. At the level of the spiracular plates. (Original 2016).

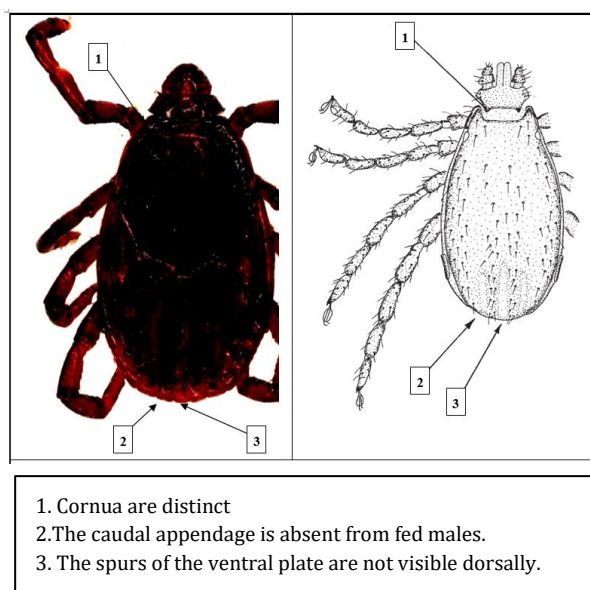


Fig. 7: *Rhipicephalus annulatus*. Female left. Male right, face dorsal (Original 2016).

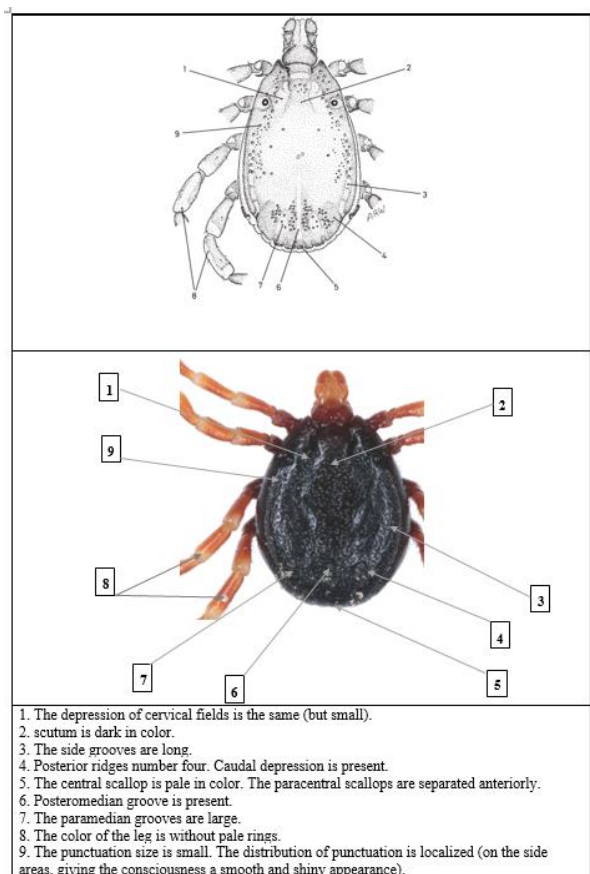


Fig. 8: *Hyalomma marginatum* male, dorsal face (Original 2016).

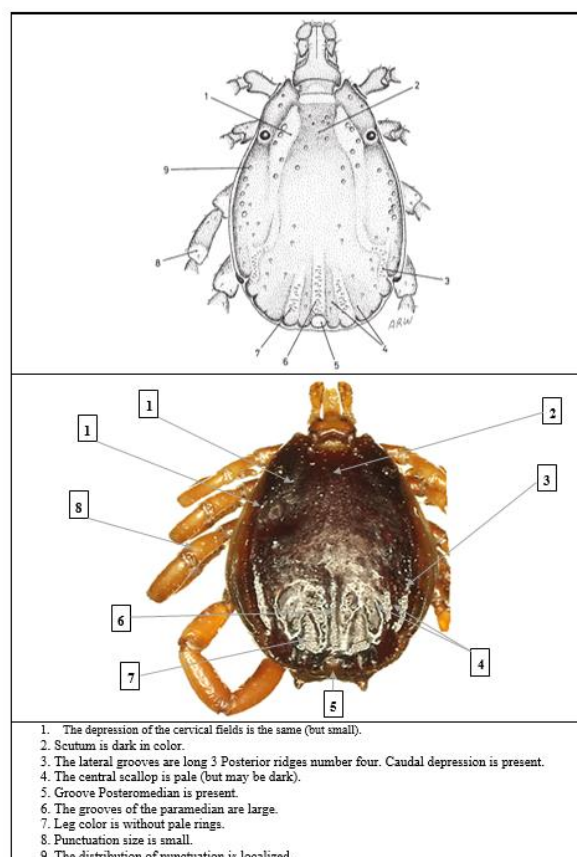


Fig. 9 : *Hyalomma detritum* male, dorsal face (Original 2016).

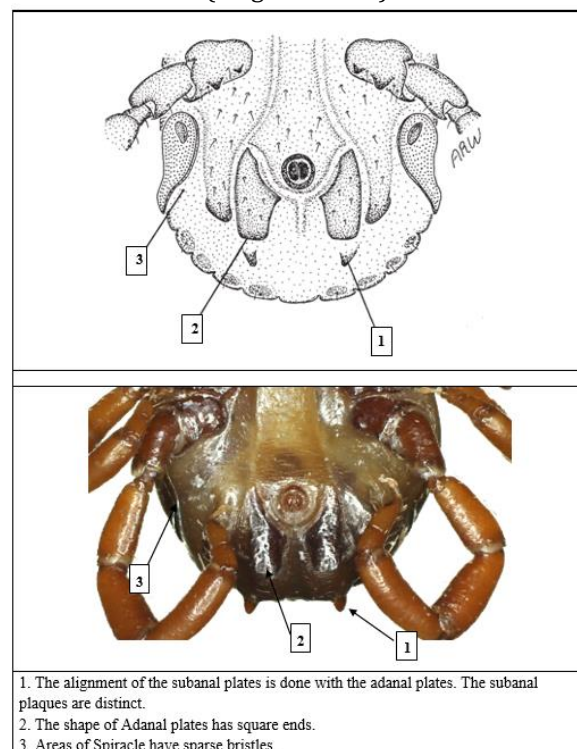


Fig. 10: *Hyalomma detritum* male, ventral face (Original 2016).

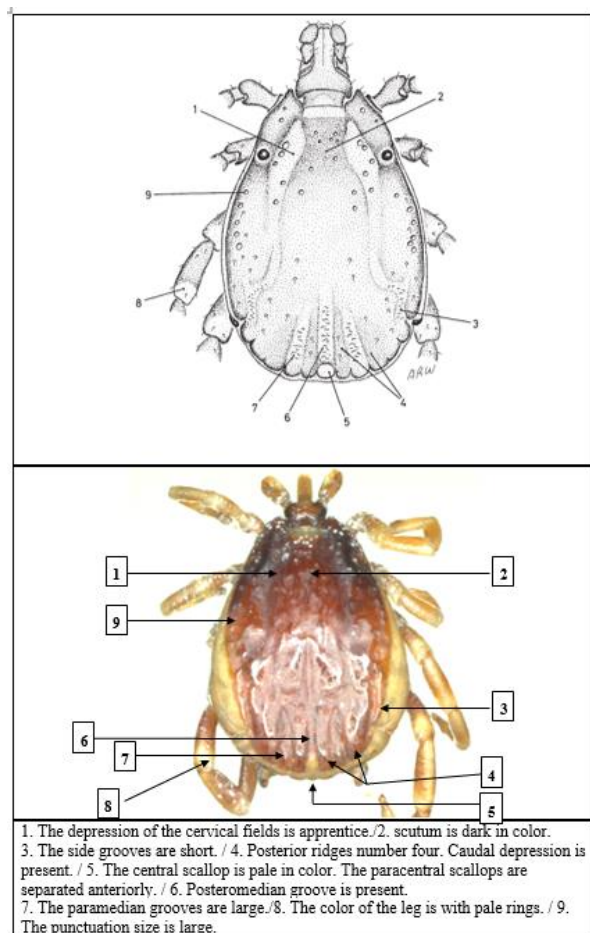


Figure 11: *Hyalomma dromedarii* male, dorsal face (Origine 2016).

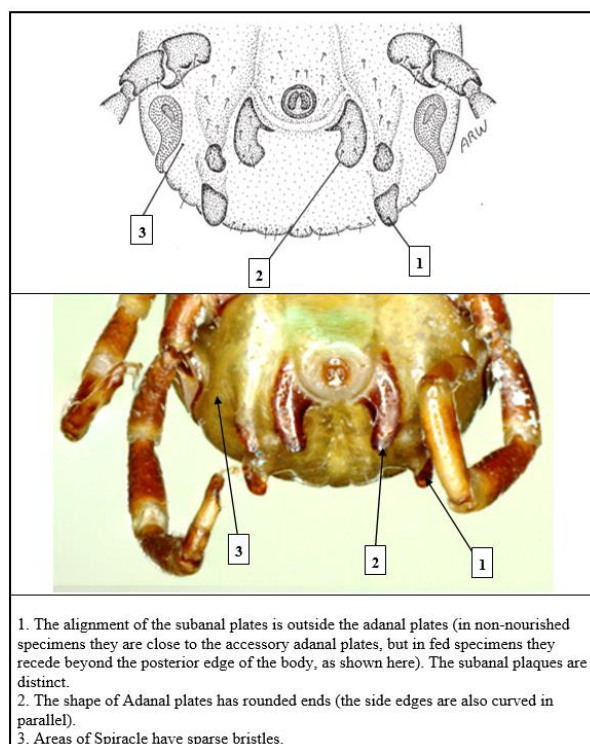


Fig. 12: *Hyalomma dromedarii* male, ventrale face (Original 2016).

a. Relative abundance of tick species (Ixodidae):

Out of 3021 ticks identified 2494 belonging to the genus *Rhipicephalus* which gives us a frequency of 82.56%. The (Figure 13) illustrates the frequency or so-called relative abundance of different species of tick infesting sheep.

It appears clearly that the species of *Rhipicephalus* largely predominates those of *Hyalomma*, thus *Rhipicephalus sanguineus* is the most frequent species with a relative abundance of 41.64%, it is followed by *Rh bursa* 22.21% and *Rhipicephalus annulatus* 18.70%. It should be noted that the species of *hyalomma* are less frequent; *Hyalomma detritum* is present with a frequency of 9.00%, those of *H Hyalomma dromedarii* and *Hyalommamarginatum* have relative abundances not exceeding 5%.

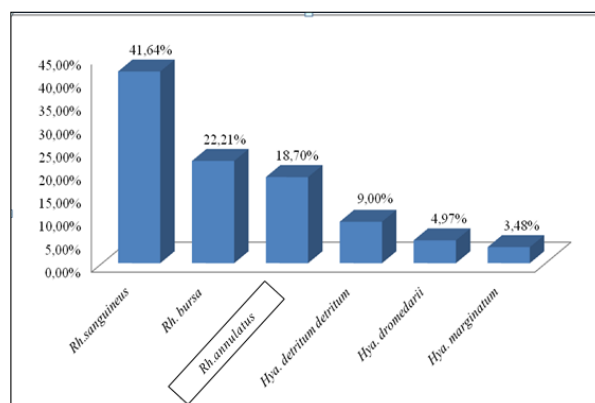


Fig. 13: Inventory and relative abundance of tick species collected

b. Seasonal evolution of the relative abundance of the species *Rhipicephalus* (*Rhipicephalus sanguineus*, *Rhipicephalus bursa*, *Rhipicephalus annulatus*)

The calculation of parasite indices will allow us to assess the relative abundance of the species *Rhipicephalus*. Our data reveal that the three species have a marked relative abundance mainly in spring and summer season with a dominance of the species *Rhipicephalus sanguineus*, however, as for the species *Rhipicephalus annulatus* it presents a peak of this rate in autumn season and it is in winter season that no activity is reported (Figure 14).

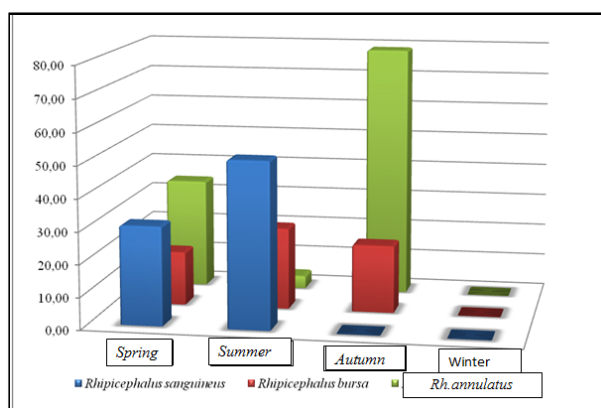


Fig. 14: Seasonal evolution of the relative abundance of the *Rhipicephalus* species (*Rhipicephalus sanguineus*, *Rhipicephalus bursa*, *Rhipicephalus annulatus*)

3.3 Monthly evolution of the relative abundance of the species *Rhipicephalus* (*Rhipicephalus sanguineus*, *Rhipicephalus bursa*, *Rhipicephalus annulatus*)

In figure 29 are recorded the results of the calculation of the monthly evolution of the relative abundance of the species *Rhipicephalus* during the twelve months of the study in the region of Souk-Ahras. The highest rate is observed in the species *Rhipicephalus sanguineus* and *Rhipicephalus bursa* in June and July (52.59 and 26.25) respectively, the lowest rate is observed in April in the two species, however although in *Rhipicephalus annulatus* two peaks are observed in April and September. (84 and 78), a very low rate is observed in the other months compared to the peak recorded in this species (Figure 15).

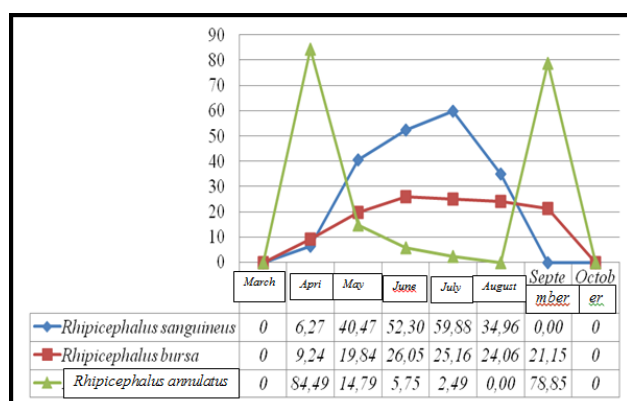


Fig. 15: Monthly evolution of the relative abundance of the *Rhipicephalus* species (*Rhipicephalus sanguineus*, *Rhipicephalus bursa*, *Rhipicephalus annulatus*)

3.4. Seasonal evolution of the relative abundance of the species *Hyalomma* (*Hyalomma detritum*, *Hyalomma dromedarii*, *Hyalomma marginatum*)

Our observations show that in the different identified species, an almost similar relative abundance indicates in all the *Hyalomma* species in spring and summer, we note, in fact, that this index

is absent in the other seasons. In the *Hyalomma detritum* species and in summer, where we observe a marked abundance that in spring, on the other hand in *Hyalomma dromedarii* only one season corresponds to its activity (summer), the last species counted, *Hyalomma marginatum* presents a more marked abundance in summer season (Figure 16).

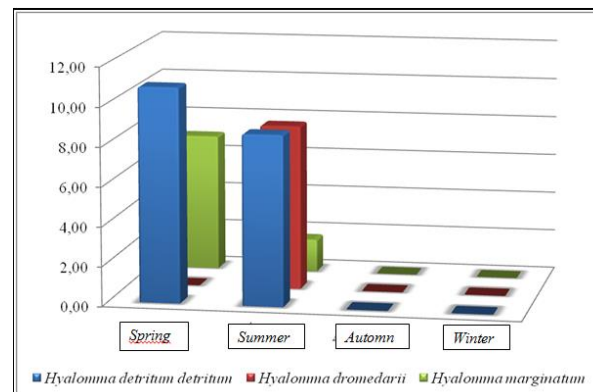


Figure 16: Seasonal evolution of the relative abundance of the *Hyalomma* species (*Hyalomma detritum*, *Hyalomma dromedarii*, *Hyalomma marginatum*)

3.5. Monthly evolution of the relative abundance of the *Hyalomma* species (*Hyalomma detritum*, *Hyalomma dromedarii*, *Hyalomma marginatum*)

The species *Hyalomma detritum* presents a high rate (15.12) in May and June respectively then it decreases remarkably in the other months, moreover, it is there *Hyalomma dromedarii* which presents the most important rate in months August (36), in the other months it is low, but *Hyalomma marginatum* has a maximum rate (9.7) in May and almost constant and low in June, July and August (Figure 17).

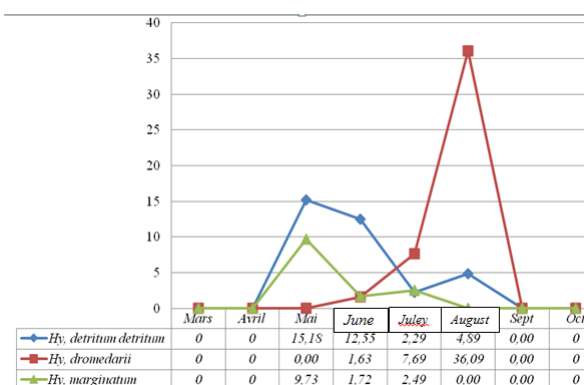


Figure 17: Monthly evolution of the relative abundance of the species of the tick *Hyalomma* (*Hyalomma detritum*, *Hyalomma dromedarii*, *Hyalomma marginatum*)

3.6. Dynamics of sheep tick infestation

3.6.1. Monthly dynamics of the intensity of the infestation of sheep by ticks

It was in 2010 and in September that we observed a slight tick activity which lasted only one month, the rest of the year and the first three months of 2011 were reported nothing on this activity. Figure 32 indicates that the ticks collected in this study present a start of activity in April, the latter increases in May and it becomes very important in June, this rate gradually decreases, reaching 15.92% in months in July and arrives at a rate of 8.81% in August of 2011 (Figure 18).

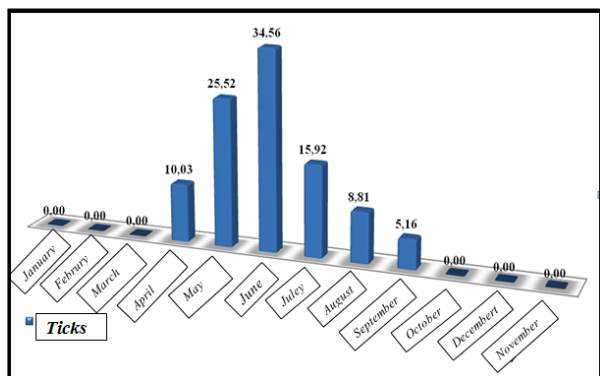


Figure 18: Monthly dynamics of the intensity of sheep tick infestation

3.6.2. Seasonal dynamics of the intensity of sheep tick infestation

The seasonal evolution of the intensity of infestation illustrated in figure (19) shows a start of activity in the fall season of 2010 with a value of 5.16 ticks per sheep, and a total absence of this activity in winter the season values are close to zero. In 2011 an activity mainly in the spring season begins to appear, the values approach 35.55 ticks per sheep, reaching 59.29 ticks per sheep in summer.

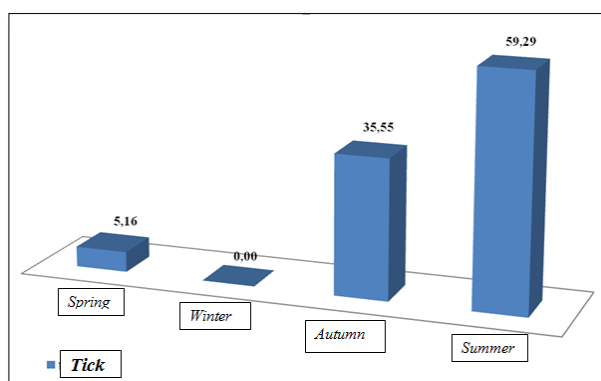


Figure 19: Seasonal dynamics of the intensity of sheep tick infestation

3.6.3. Monthly evolution of the intensity of the infestation of the species *Rhipicephalus* (*Rhipicephalus sanguinius*, *Rhipicephalus bursa*, *Rhipicephalus Annulatus*)

Figure 34 illustrates the intensity of infestation of *Rhipicephalus*. It turns out from the results that the

maximum intensity for *Rhipicephalus Sanguinius*, *Rhipicephalus Bursa* was recorded in June (07 and 04 ticks / sheep) while this value is recorded in April for *Rhipicephalus Annulatus*. The value takes a decreasing curve as we advance and we approach the coldest months (Figure 20).

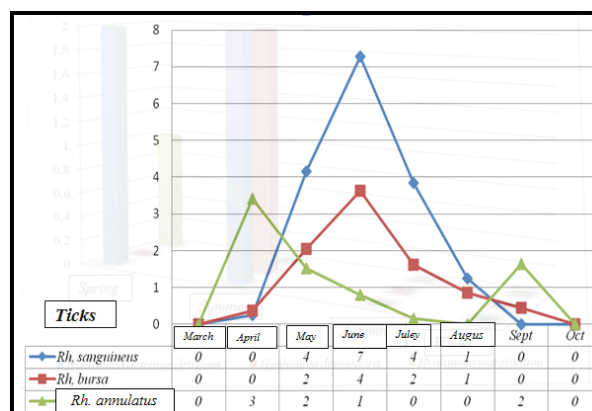


Figure 20: Monthly evolution of the intensity of the infestation of the tick species *Rhipicephalus* (*Rhipicephalus Sanguinius*, *Rhipicephalus bursa*, *Rhipicephalus annulatus*)

3.6.4. Seasonal evolution of the intensity of infestation of the *Rhipicephalus* species (*Rhipicephalus Sanguinius*, *Rhipicephalus Bursa*, *Rhipicephalus Annulatus*)

The results relating to the seasonal evolution of the intensity of infestation of the species *Rhipicephalus* showed a value which is close to 04 ticks per sheep during the spring seasons. This value takes an increasing curve to reach the peak (12 ticks/sheep) in summer. The same pattern with lower values is observed in the species *Rhipicephalus Bursa* which is close to the value of 02 in spring and the 06 ticks per sheep in summer season while in the species *Rhipicephalus annulatus* it is quite the opposite, the values in spring reach the limits of 05 ticks per sheep and 01 per sheep in summer, this species is the exception in the fall season and has a value of 02 ticks/sheep. The three tick species of the genus *Rhipicephalus* have a common feature in which they are absent in the winter and fall season with the exception of *Rhipicephalus annulatus* (Figure 21).

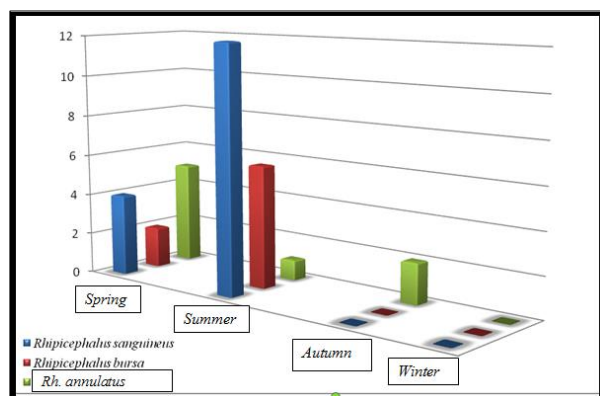


Figure 21: Seasonal evolution of the intensity of infestation of the tick species *Rhipicephalus* (*Rhipicephalus sanguineus*, *Rhipicephalus bursa*, *Rhipicephalus annulatus*).

3.6.5. Monthly evolution of the intensity of infestation of the *Hyalomma* species (*Hyalomma detritum*, *Hyalomma dromedarii*, *Hyalomma marginatum*)

The results of the monthly change in the intensity of infestation of the *Hyalomma* species, showed a maximum rate for the months: May, June and August respectively for *Hyalomma detritum*, *Hyalomma dromedarii*, *Hyalomma marginatum* (Figure 22).

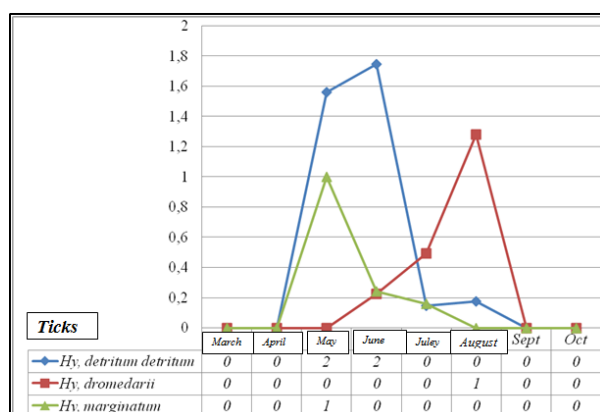


Figure 22: Monthly evolution of the infestation intensity of the tick species *Hyalomma* (*Hyalomma detritum*, *Hyalomma dromedarii*, *Hyalomma marginatum*).

3.6.6. Seasonal evolution of the intensity of infestation of the *Hyalomma* species (*Hyalomma detritum*, *Hyalomma dromedarii*, *Hyalomma marginatum*)

The seasonal evolution of the intensity of infestation of the *Hyalomma* species showed a mode of bi-seasonal activity for *Hyalomma detritum* and seasonal uni for *Hyalomma dromedarii*, *Hyalomma marginatum* (Figure 23).

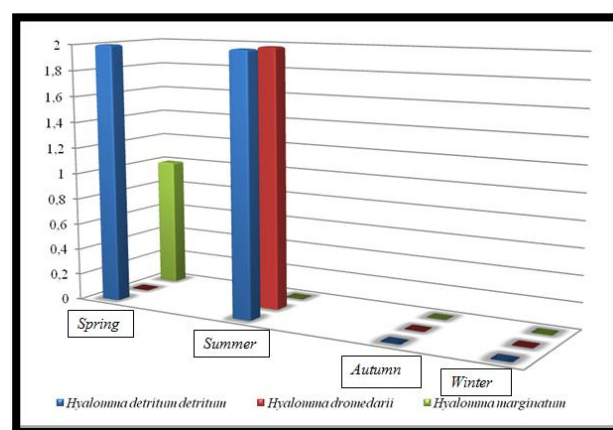


Figure 23: Seasonal evolution of the intensity of infestation of the tick species *Hyalomma* (*Hyalomma detritum*, *Hyalomma dromedarii*, *Hyalomma marginatum*).

4. Discussion

During the period from September 15 to August 31, 2011, 75 sheep belonging to 3 farms located in Khedara, Ouled Moumen and Merahna underwent a fortnightly examination targeting the search and collection of ticks infesting these animals in the Souk region. -Ahras. Thus a total number of 3021 ticks was recorded, made up of 1958 male ticks and 1063 female ticks, i.e. respective rates of around 64.82% and 35.18%.

In the light of the results presented on the balance sheet of sheep tick collections in the Souk-Ahras region, it turned out that all the sheep examined carried ticks, which represents an infestation rate of 100%, with an overall parasitic load of 40.

Note that rare are the works which are interested in the study of the dynamics and the seasonal kinetics of the ixodidae of the sheep, thus because of the absence of the specificities of species of ticks and following the specificities of our farms where the cohabitation of animals dominates, we will discuss our results with the work that has been done on cattle and other animal species.

The observation of the dichotomous characteristics of our samples of ticks collected bi-monthly from sheep in the Souk-Ahras region during the period described above made it possible to identify 6 species:

- *Rhipicephalus sanguineus* 41.64%
- *Rhipicephalus bursa* 22.19%
- *Hyalomma detritum* (scupense) 9.0%
- *Hyalomma dromedarii* 4.98%
- *Hyalomma marginatum* 3.49%
- *Rhipicephalus annulatus* (Formerly *Boophilus annulatus*). 18.7%

Dib L, [17] in his study carried out on tick infestation of cattle in the El Tarf region, reported the presence of 7 species *Rhipicephalus sanguineus*, *Rhipicephalus bursa*, *Hyalomma detritum*, *Hyalomma dromedarii*, *Hyalomma marginatum*, *Rhipicephalus annulatus* and *Ixodes ricinus*, the latter was not identified in our

study probably because of the difference in biotope between El Tarf and Souk Ahras. Also in the El Tarf region, another work of Leulmi H carried out in El Ghora where the altitudes are around 1200 m on the infestation of sheep with ticks revealed the presence of 5 species: *Rhipicephalus sanguineus*, *Rhipicephalus bursa*, *Hyalomma lusitanicum*, *Hyalomma detritum* and *Ixodes ricinus* [18]. On his side Zeroual F in 2014, on 111 wild boars including 80 infested had found an infestation rate of 72.1 %. The highest rates of infestation were observed in summer and spring. The highest rate of infestation was observed for the species *Rhipicephalus turanicus* (62.2 %), followed by *Dermacentor marginatus* (36.0%), *Hyalomma marginatum* (6.3 %) and finally *Ixodes ricinus* (3.6 %)[19]. Boulkaboul A for his part in 2004, in a study on parasitic ticks in cattle in the Tiaret region, reported in addition to the genera we have listed, the genera *Dermacentor* and *Haemaphysalis*[20]. In Tunisia, Morel in 1982, in his study on the distribution of ticks in various stages of vegetation, described the presence of 13 species attached to 5 genera: *Ixodes ricinus*, *Haemaphysalis punctata*, *Haemaphysalis sulcata*, *Rhipicephalus sanguineus*, *Rhipicephalus turanicus*, *Rhipicephalus bursa*, *Hyalomma lusitanicum*, *Hyalomma excavatum*, *Hyalomma anaticum*, *Hyalomma implectatum*, *Hyalomma marginatum*, *Hyalomma detritum*, *Dermacentor marginatus*[21]. In Morocco, Sarihin 1998, identified 6 species affiliated with 3 genera: *Hyalomma marginatum*, *Hyalomma detritum*, *Hyalomma anaticum*, *Rhipicephalus bursa*, *Rhipicephalus sanguineus*, and *Rhipicephalus annulatus*[22]. It emerges from all the studies undertaken in the Maghreb countries, that the population of ticks has as basic structure 4 main genera, however the species vary from one region to another, thus suggesting the impact of environmental factors on the distribution of ticks. *Rhipicephalus sanguineus*, *Rhipicephalus bursa*, *Rhipicephalus annulatus* observed and identified throughout the study period appear to have seasonal activity.

A variation in the parasitic load of these mites collected on sheep is observed during the 12 months of study, as shown in Figure 30, showing a high intensity of infestation with *Rhipicephalus sanguineus* between May and August with a maximum value of 7 ticks / sheep in June. Our results differ from those of Morel [23] and Dib [17], where they reported that *Rhipicephalus annulatus* hygrophilic species, is encountered everywhere where the rainfall is between 200 and 1000 mm, the present tick was encountered during the month of April or a maximum infestation intensity of 03 ticks / sheep is recorded. However, it should be noted that Rjeibi in 2014, by studying the carriage of pathogens by parasitic ticks in sheep in Tunisia, described the existence of *Rhipicephalus bursa* during the same period of activity as that recorded in our study region. , this species is present from May to August

with a maximum infestation intensity recorded in June of the order of 1.4 ticks / sheep[24]. *Hyalomma detritum* is a thermophilic species which explains its absence during the cooler months. On the other hand, for this species, the highest parasitic loads were recorded in the spring (2 ticks / infested sheep). With regard to the species *Hyalomma marginatum*, a species with spring activity, a low intensity of infestation was recorded in the month of May, ie 01 ticks per infested sheep. Camels are the preferred hosts for *Hyalomma dromedarii*, but cattle, sheep, goats and horses can also be infested. In areas where camels are less common, it appears that cattle may be infested with this tick [18]. The presence of this species in our inventory is probably due to a transhumance carried out by the nomads in search of food after the harvest season.

5. Conclusion

In Algeria, the breeding of small ruminants, represented, for the most part, by sheep, followed by goats contributes to the satisfaction of the demand for red meat, however, this demand is constantly growing, due to the strong demographics while the annual growth rate of small ruminant populations remains low given the difficulties encountered by breeders, in particular, low productivity, mainly due to health problems. Among the diseases potentially implicated, those transmitted by arthropods and in particular ticks, which are blood-sucking parasites with a high capacity for transmission of a certain number of pathogens. A large number of bacteria vectorized by ticks inducing serious pathologies have been identified, such as borreliosis, anaplasmosis, Q fever, and rickettsial tick diseases, recently the prevalence of these bacterial diseases transmitted by ticks has considerably increased and has emerged in the world. Similarly, *Theileria* spp and *Babesia* spp the causative agents of theileriosis and babesiosis, respectively, are among the most economically important hemoparasitic diseases in ruminants worldwide. In this study, we sought to update the repertoire of tick species infesting small ruminants and the parasitic and bacterial diseases vectorized by the latter in Algeria by an approach of application of standard PCR, real-time PCR and sequencing. , as diagnostic tools for vectorized pathogens. This study reports the first direct evidence by molecular detection of hemoprotozoa (*Theileria ovis* and *Babesia ovis*) and bacteria (*Anaplasma ovis*, *Borrelia theileri* and *Coxiella burnetii*) in ticks (*R. bursa* and / or *R. turanicus*) and in blood, in small Ruminants (sheep and goats) in the wilaya of Souk Ahras. Future epidemiological studies using more domestic animals and ectoparasites from more regions are needed to determine the actual prevalence and distribution of these diseases in Algeria. Other investigations are also warranted in order to isolate these species and determine their clinical significance.

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