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BIODIVERSITY, SEASONAL DYNAMICS AND GEOGRAPHICAL DISTRIBUTION OF SHEEP AND GOAT TICKS IN SERBIA

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ABSTRACT

The paper examines the results of the research on the tiny fauna of tiny ruminants in the territory of the Republic of Serbia, made in the period 1989-2019. The research covered all the regions from Vojvodina to Kosovo and included long-term tropical biodiversity studies, full dimorphism and seasonal dynamics of occurrence. During our study we established presence of Ixodes ricinus,I.persucatus, Rhipicephalus sanguineus, R.bursa, R.(Boophilus) annulatus, Boophilus calcaratus, Dermacentor marginatus, D.recticulatus, Haemophysalis punctata, Ha.inermis, Ha.sulcata, Hyalomma savignyi,Hy. marginatum marginatum and Hy.detritium. The sex ratio of ixodid species was in favor of females and was 61.02%: 38.98%. More males than females (65.08%: 34.92%) were observed only in the species Rhipicephalus bursa. For the two most commonly found species of Rhipicephalus sanguineus and Ixodes castor, this ratio was 69.50%: 30.50% and 63.42%: 36.58%, in favor of females.

***Keywords**: goats, sheep, ticks, Serbia,*

INTRODUCTION

Ticks belong to the group of arthropods that are of great biomedical importance for the living world, primarily because of the role of vectors of different types of diseases as well as the direct adverse effects of the hemophagic diet. Ticks are a relatively small group of haematophagous arachnids (896 species described so far) from the filum Arthropoda, suborder Chelicerata, class Arachnidae, subclass Acari, suborder Parasitoformes, order Ixodia and superfamily Ixodide. They are

divided into three families: Argasidae soft-armor ticks, Ixodidae hard-armor ticks, and Nuttalliellidae that have features of both ticks.

– Argasidae, of which 183 species are distributed in five genera Argas, Antricol, Nothoaspis, Ornithodoros and Otobius

– Ixsodidae have 241 species from the genus Ixodes and 442 species from the genera Amblyomma, Anomalohimalaya, Bothriocroton, Cosmiomma, Dermacentor, Haemaphysalis, Hyalomma, Margaropus, Nosomma, Rhipicentor and Rhipicephalus.

– Nuttalliellidae is a monospecific family (has only one representative) *Nuttalliella namaqua*

Ticks are strict haematophagus.. After reaching maturity, the female tick attaches to the host. During the suction of the eggs, the ovaries of the females develop eggs. When she finds a good place and starts to feed, she smells the male. The male sniffs at the feeding female and fertilizes her. After copulation, the males die, and the females separate from the host, fall to the ground and lay their eggs in grass, shrubs, or under fallen leaves. The number of eggs ranges from 300 to 9000. During blood sucking, they remain on the host for a long time. The most common hosts are mammals, but in the absence of them, they can be found on birds and reptiles. All developmental stages of the tick starting from the larva are attached to the host (Papazahariadou et al., 1995; Rinaldi et al., 2004 Anderson and Magnarelli, 2008).

When the larvae of the ticks hatch, the hosts are represented by small mammals, primarily rodents, and in the absence of them, any other species of animals can serve as hosts. Larvae unlike other stages of ticks have three pairs of legs. After feeding, they leave the host and change into nymphs. In the nymph stage, they are most commonly found on shrubs in the hunting position. Most often hosts are still small rodents, but also animals such as foxes, dogs, squirrels, as well as any animal species. found there, including man (Anderson and Magnarelli, 2008).

After feeding, they are released from the host and changed into adulthood, and the host waiting places are usually high vegetation or tree canopies from which mammals, birds and reptiles attack (Pavlovic et al., 1997; Stojanov et al., 2014). Small ruminants are frequent hosts of adult ticks worldwide (Pavlovic et al., 1997, 2014, 2016b; Torina et al., 2006; Zangana et al., 2013; Rinaldi et al., 2004, 2014; Arnaudov et al. 2014; Koc et al., 2015).

Ticks belong to the group of arthropods that are of great biomedical importance for the living world, primarily because of the role of vectors of different types of diseases and the immediate deleterious effects of the hemophagic diet. The most known tick-borne diseases are: Lyme borreliosis, Erlihia spp., Babesia spp., Anaplasma spp., Hemorrhagic fever: Crimean-Congo hemorrhagic fever (with and without renal syndrome), Marburg Hemorrhagic fever, Omsk hemorrhagic fever, Kyasanur African swine fever, Spirochetosis, Aegiptela spp., Theilleria spp., Hatma virus, Q fever, arboviruses, adenoviruses, Nairobi disease, Tick-born encephalitis (Proasan encephalitis, Russian spring-summer encephalitis), Typhoid (Siberian tick-borne typhoid, typhoid fever , Th.eritromatosa), Buton fever and other diseases (Nieder et al., 2013; Pavlovic et al., 2002,2012,2016c).

Research on ticks in Serbia began as early as the beginning of the last century. These studies are still ongoing and have been mainly studied for species of Ixodidae, and above all exophilic species (since they are vectors and reservoirs of many infectious diseases). In ruminants, pigs, dogs and horses, this research has been done continuously since 1989 and in our work we will present the results we have come up with over the past thirty years.

MATERIALS AND METHODS

Research was carried out on the whole territory of Serbia in the period 1989 to 2019 (and still ongoing). Collecting ticks from sheep and goats flocks is usually done by direct visits to the field, at regular intervals, usually once a month in one locality throughout the grazing season. Collection of ticks from infected hosts was performed by manual extraction. Unlike the easy-to-remove suction forms, the tweezers removed smaller males and non-nasal forms, using the same technique as when removing larger specimens. All the ticks found on the hosts reviewed were removed. The most common localization of ticks was on body parts with thinner skin and shorter hair.

The collected specimens of the tick were disposed of in tubes containing 75% alcohol and glycerin at a ratio of 95: 5. Tubes are closed with a rubber or cork stopper. Each tube was labeled with the following data: collection date, locality, and host type. We printed the same information with a graphite pencil on paper that was placed in tubes.

Inspection of materials and determination of tick species was performed in the laboratory for parasitology of the Scientific Institute of Veterinary Medicine of

Serbia in Belgrade. From each tube, the material was placed in Petri dishes. Then the ticks were cleaned of hairs and fragments of skin, which was done with tweezers and a preparation needle. For the determination, we used a binocular magnifier, with illumination from below. Determination of ticks was performed on the basis of characteristic morphological features using descriptions by Kolonin (2009).

RESULT AND DISCUSION

During the study, endophilic species of ixodid ticks were found to be predominantly present. Five genera of ixodid ticks have been reported in small ruminants of Serbia: Ixodes, Dermacentor, Rhipicephalus, Haemophysalis and Hyaloma with the following species:

- From the genus Ixodes the following species have been identified: *Ixodes ricinus* and *I.persucatus*

- From the genus Dermacentor the following species have been identified: *Dermacentor marginatus* and *D.recticulatus*

- From the genus Rhipicephalus the following species have been identified: *R.sanguineus, R.bursa, R. (Boophilus) annulatus* and *Boophilus calcaratus*

- From the genus Haemophysalis the following species have been identified: *Haemophysalis punctata, Ha.inermis* and *Ha.sulcata*

- From the genus Hyalomma the following species have been identified: *Hyalomma marginatum marginatum* (*Hy. savignyi*) and *Hy.detritium*

Sex ratio

During our study, the sex ratio of ixodid species was in favor of females and was 61.02%: 38.98%. More males than females (65.08%: 34.92%) were observed only in the species *R.bursa*. For the two most commonly found species of *R.sanguineus* and *I.ricinus*, this ratio was 69.50%: 30.50% and 63.42%: 36.58%, in favor of females.

Geographic distribution

The geographical distribution of established ticks in domestic and wild animals (mammals) was fairly uniform. Here we present average data by region.

North of Serbia (Vojvodina)

In the north of Serbia, in Vojvodina, the following species have been identified: *I.ricinus* (43.91%), *D.marginatus* (31.91%), *R.bursa* (15.22%), *R.sanguineus* (8.72%), *Hy.savignyi* (*Hy.marginatum*) (3.72 %), *H.punctata* (3.21%) and *D.pictus* (2.72%). (Pavlovic et al., 2017; Becskei et al., 2018).

Belgrade area

I. ricinus (41.91%), *D.marginatus* (32.91%), *R.bursa* (17.22%), *R.sanguineus* (6.72%), *H.punctata* (2.21%) were established in Belgrade.) and *D.recticulatus* (1.17%) (Milutinovic et al., 1997a, 1998b; Pavlovic et al., 2013). The following types of ticks have been identified on the green areas of Belgrade; *I.ricinus, R.sanguineus, D.marginatus,* and *D.recticulatus* (Milutinovic et al.1995; Pavlovic et al.1999; Pavlovic 2016).

Northwestern Serbia

Research conducted in the area of northwestern Serbia (Macva) in small ruminants revealed the presence of *I.ricinus* (16.93%), *R.bursa* (15.98%), *H.punctata* (3.32%), *D.marginatus* (3.00 %), *D. pictus* (1.10%), *R. sanguineus* (0.53%) and *Ha. inermis* (0.31%) (Milutinovic et al., 1998d; Pavlovic et al., 2016a).

Western Serbia

Faunistic-ecological studies of ticks in western Serbia revealed eight species of ticks, namely: *I.ricinus, H.punctata, D.marginatus, R.bursa, R.sanguineus, D.pictus* and *H.inermis*. Most abudant species was *I.ricinus* (07%) (Milutinovic et al., 1996-97).

Northeastern, Eastern and Southeastern Serbia

Research on tick fauna in the area of northeastern, eastern and southeastern Serbia was conducted by Milutinović et al. (1998a) and found in small ruminants the presence of: *I.ricinus, D.marginatus, R.sanguineus, R.bursa, H.punctata* and *Hy.calcinus*. Similar results were obtained by Becskei et al. (2018) during a study of tick fauna in an indigenous Zackel sheep breed in southern Serbia.

South Serbia and Kosovo

Finally, surveys of ticks in southern Serbia and in the area of Kosovo and Metohija, conducted in 1991-1992 and then in 2001, found the presence of *I.ricinus* (42.96%), *D.marginatus* (28.24%), *R.bursa* (11, 36%), *Hy.savignyi* (8.04%), *H.punctata* (4.40%), *H.inermis* (3.00%) and *B.calcaratus* (2.00%) (Pavlovic et al., 1995, Milutinovic et al. et al., 1997b; Pavlovic et al. 2019).

Impact of climatic conditions on population dynamics

The temperature optimum of activity (the period when most ticks seek the host) is at temperatures of 20-25 ° C when more than 40% of the adulates and 30% of the nymphs are active. An important factor is the humidity, so the optimal amount is 45-80 %. The length of day and night - photoperiod, is also important for tick activity. For species that are in open habitats, solar radiation has a significant influence, which leads to the accumulation of heat in the body of the tick and causes the onset of activity at lower temperatures. From the beginning of September until the first snowfall and the temperature drop below 0 ° C, the new generation has its natural cycle. In the fall, when temperatures drop below 5 ° C, they are buried in the surface of the earth to a depth of 7 cm and remain there until the temperature of the soil rises above 5-8 ° C, when they re-emerge and wait for the victims (Papazahariadou et al.,1995; Milutinovic et al.,1996a,c,d; Pavlovic et al.,2016).

For most species of ticks, the period from mid-March to mid-June represents the time when they are most active. At that time, they lay eggs, evolve, find the ultimate host on which to perform their reproductive role. Between mid-June and late August, there is a time when new individuals have not yet hatched, so that the frequency of finding them is lower during this period.

In our climatic conditions in the pastures, the first occurrences of ticks were observed in the period March-April. In March, we established the presence of: *I.ricinus, R.sanguineus, D.marginatus* and *H.punctata.* In April, the occurrence of species was recorded: *D.pictus, R.bursa* and *H. inermis*. The maximum abundance in April reaches the species *D.marginatus, H. punctata* and *H.inermis.* In the same month, species *B.calcaratus* and *Hy.savignyi* were also found, reaching their peak in September. The species *I.ricinus* reaches its maximum abundance in May, in which we also find the maximum occurrence of the species *D.pictus*. In June, a population peak of the species *R.sanguineus* and *R.bursa* is observed, which are the most commonly found species in both July and August. In September we see an increase in the population of two species of ticks*: I.ricinus* and *D.marginatus*, while in October we see the occurrence of species: *I.ricinus* and *R.sanguineus*.

CONCLUSION

Based on the results presented, it can be concluded that the fauna of small ruminants in Serbia is relatively rich in species. The minimum prevalence in the prevalence is directly dependent on the biotic and abiotic grazing factors found in this herd, Generally speaking, the dominant species encountered is certainly Ixodes castor, which is also the most common tick species in other mammals including humans. *D.marginatus* and *R.bursa* species are abundant in the northwestern and western areas of Serbia. The same species are most numerous after *I.ricinus* and in the northeastern, eastern and southeastern and southern parts of Serbia.

In addition to the direct adverse effects of the haemophagous diet and allergic manifestations of toxins secreted during tick fixation, many infections are transmitted as true or transmissible hosts, many of which are zoonotic in nature. Most infectious agents of tick-borne infectious diseases are biologically transmitted, meaning that these pathogens also infect invertebrate vectors in which they multiply and / or develop before being transmitted to another host vertebrate. For these reasons, regular control of grazing areas must be carried out for the presence of ticks and their suppression in both these areas and the animals themselves (Pavlovic et al., 2000, 2008; Milutinovic et al., 2004). The use of repellents to prevent the protection of animals and humans is also necessary.

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