Continental Veterinary Journal
Journal homepage: www.cvetj.com

Review Article

Global prevalence and some other important aspects of *Argas persicus* (*Ixodida-Argasidae)* in commercial poultry farms – a mini review

Sahar Mustafa[1], Tooba Batool[2], Hammad Ur Rehman Bajwa[3*], Maqsood Ahmad[4], Muhammad Sajjad Habib[5], Muhammad Hamza Tarteel[6], Muhammad Umar Hayat[7], Muhammad Hassan Rehman[7], Muhammad Azam Farooq Kasli[1], Zeeshan Afzal[8], Munazza Aslam[8], Ifrah Tahir[9] and Rao Zahid Abbas[9]

[1]Department of Clinical Medicine and Surgery, University of Agriculture, Faisalabad Pakistan
[2]Department of Chemistry, Government College University, Faisalabad Pakistan
[3]Department of Pathobiology, University of Illinois, USA
[4]Department of Livestock and Dairy Development, Punjab Pakistan
[5]Faculty of Veterinary and Animal Sciences, The Islamia University of Bahawalpur Pakistan
[6]Institute of Animal and Dairy Sciences, University of Agriculture, Faisalabad Pakistan
[7]Faculty of Veterinary Sciences, Bahauddin Zakariya University, Multan Pakistan
[8]Department of Pathology, University of Agriculture, Faisalabad Pakistan
[9]Department of Parasitology, University of Agriculture, Faisalabad Pakistan

*Correspondence: hrbajwa22@gmail.com

ARTICLE INFO

ARTICLE HISTORY: CVJ-23-0309

Received 19 March 2023
Revised 25 May 2023
Accepted 30 May 2023
Published online 01 June 2023

Keywords:

Ticks
Resistance
Epidemiology
Argus persicus
Poultry

ABSTRACT

Tick infestations can have negative impacts on the poultry industry, especially on broiler and egg-laying hens. Controlling ectoparasites is critical to maintain farm biosafety, and a lack of control increases the risk of poultry-related health problems and economic losses. There are two types of ticks: hard ticks and soft ticks. Among soft ticks, *Argas* ticks are very important because they are found all over the world and help in the transmission of many diseases. *Argas (A.) persicus* is of zoonotic importance and acts as a reservoir and vector for many diseases. It affects poultry and humans and causes major economic losses. It has four life cycle stages: egg, larvae, nymph (5 stages), and adults. The present review aims to outline the global distribution of *A. persicus* as well as major issues, related symptoms, and control methods in poultry production. Therefore, there is a need to disclose and approach the impacts of the species and the ways used to control it worldwide as a way of taking information to the places that are affected by or will suffer from this tick.

To Cite This Article: Mustafa S, T Batool, HUR Bajwa, M Ahmad, MS Habib, MH Tarteel, MU Hayat, MH Rehman, MAF Kasli, Z Afzal, M Aslam, I Tahir and RZ Abbas, 2023. Global prevalence and some other important aspects of *Argas persicus* (*Ixodida-Argasidae)* in commercial poultry farms – a mini review. Continental Vet J, 3(1):17-25.

Introduction

Poultry is the major group of livestock and comprises 30% or more of all proteins from animals. Poultry production is mostly of the commercial type, which accounts for 20% of the entire poultry productivity. Poultry takes the place of a huge number of domestic animal reserves all over the world. Poultry plays an important role in meat production, with backyard flocks converging both in developing and advanced countries (Abdisa and Tagesu 2017). In Nepal, poultry plays a major role in the agriculture production system, contributing 4% to the national GDP (Poudel et al. 2021). Poultry meat is a good source of animal protein all over the world due to its low cost, nutrient density, and affinity (Shah et al. 2021). In Pakistan, the contribution of poultry to the national GDP is 1.3%

(Hussain et al. 2015). Pakistan's broiler production (1163 million per year) is ranked 11th all over the world (Zahid et al. 2021). Poultry meat production has become the foremost meat industry globally. All over the world, it was estimated that poultry meat production during 2005–2050 would increase by 121%. The US has become the number one poultry meat producer in the world (Chowdhury and Morey 2019). According to the CDC's 2020 report, Americans ate more chicken per year than any other meat in 2020 (CDC 2020).

A large number of parasitic species affect poultry birds which broadly classified in to endoparasites and ectoparasites (Naqvi et al. 2017). Ectoparasites are parasites that live outside of the body of the host, and their purpose is to harm their host (Mahmoud et al. 2021). Ticks, mites, blackflies, fleas, mosquitoes, and blowflies are ectoparasites. These parasites are associated with poultry infections, and as a result, humans face major socioeconomic losses (Wanzala 2017). Ticks are the main vectors and reservoirs of many zoonotic pathogens (Feng et al. 2019). These losses are mostly caused by pathogens, i.e., fungi, spirochetes, viruses, bacteria, protozoa, and rickettsia (Wanzala 2017). All these pathogens cause major zoonotic infections, and the most efficient and harmful type of arthropod vectors are ticks because their feeding periods are very long and they can deceive the host immune system very easily (Hurtado and Giraldo-Ríos 2018). The digestive system is absent in ticks, which means ticks can disperse more infectious agents than other hematophagous arthropods (Wanzala 2017). In poultry, ticks, mites, and lice cause anemia by taking blood from the host and also act as mechanical vectors for certain viruses and bacterial microbes (Aljoburi 2019). Ectoparasites in poultry birds cause anemia, decrease growth and decrease egg laying which may lead to death (Kebede et al. 2017). The growing number of poultry, the production of ideal conditions of warmth and moisture, special methods of extraction of the litter, the addition of water to the mixed feed, and many other factors provide a suitable environment for the development of ectoparasites (Paliy et al. 2018). Birds have a huge potential for passive proliferation of organisms, particularly parasitic species such as ticks (Loss et al. 2016). In China, seven species of *Argas* have been discovered, but pathogens spread by soft ticks are very rare (Feng et al. 2019). Even though three genera of ticks are considered valid by all grouping plans, two of them (*Ornithodoros* and *Argas*) have medical and veterinary significance (Rahmani et al. 2023). Argasid ticks affect avian species during feeding by blood meal and cause weight loss, decreased egg production, and anemia (Ouchene et al. 2020).

Argas is also called the soft tick, and 61 species have been discovered in this genus. In Pakistan, it has four distinct species: *A. persicus*, *A. rousetti*, *A. abdussalami*, and *A. reflexus*. *Argas* ticks have the capacity to lessen dehydration and invade the diapause phase. Their larvae feed slowly and stick to their host for 5–10 days. Each life stage takes a blood uptake to convert into molt. Nymphs feed many times and convert into adult females or males (Zahid et al. 2021). On the American continent, *A. persicus* is present in acrid and subtropical environmental conditions but absent at tropical altitudes (Muñoz-Leal et al. 2018). It is an external parasite of arboriform nesting aviaries, native to Central Asia, but due to associations between human activities and poultry farming, this species has the ability to infect domestic fowl (Monti et al. 2023). *A. persicus* is frequently recognized as fowl tick, commonly associated with domestic birds' farms, mainly domestic chickens, and it causes huge economic losses (Pfäffle and Petney 2017). It is widely distributed all over the world and found in distinct climate zones (Rahmani et al. 2023). Natural cavities and artificial nest boxes may act as a source of parasites, which means the nests of hole-breeding birds favour the study of external parasites, their species habitat necessities, and their life stages. The expansion of data and studies over the years has shown that this tick is present in most aviaries and is considered a potential pest (Veiga and Valera 2020). Therefore, there is a need to disclose and approach the impacts of the species and the ways used to control it worldwide as a way of taking information to the places that suffer or will suffer from this tick. This review aims to describe the global distribution of the species of *A. persicus* as well as major issues, related symptoms, and control methods in poultry production.

Argas (A.) persicus

In 1818, Lorenz Oken first reported *A. persicus* in Meyaneh, Persia, but now it is found all over the world, particularly in warmer areas because it has a close alliance with *Gallus domesticus*. This tick has a nocturnal habit, so it cannot be recognized during the day. Its body color is also similar to their hiding places (Mallesh et al. 2017).

Eggs

The shape of eggs is spherical or oval with openings (slit-like) (Fig. 1). Its diameter, length, and width are 418±11.1µm, 399.5±0.5µm and 452.5±10µm respectively (Montasser 2006, 2010; Mallesh et al. 2017).

Larvae

Two leaf-like valves protect the vertical slit of larvae; each valve has a prolonged, pointed sensillum (Fig. 1). The tarsus of the first two legs consists of Haller's organ, which comprises the former pit and the latter capsule (Montasser 2006; Mallesh et al. 2017). The former pit is circular in shape and has sensilla (7), whereas the latter capsule has dorsal

apertures (20). Seven sensilla are rough and have no holes, grooves, or divisions (Mallesh et al. 2017).

Adult

The dorsal surface has mammillatiors (a disc-like area). Mouth parts have basis capitulam, hypostome, palps, mechano-sensilla, and chelicera (Fig. 1). The tarsus of all legs contains the pulvillus, bottom stalk, and claws (2) (Soulsby 1982; Montasser 2010; Mallesh et al. 2017). The shape of genital aperture in males and females is semicircular and horizontal, respectively. The ventral surface of both sexes has two leaf-like valves, and every valve consists of five or more pointed sensilla. Anus is covered by a hard cuticle (Kakarsulemankhel 2010; Mallesh et al. 2017).

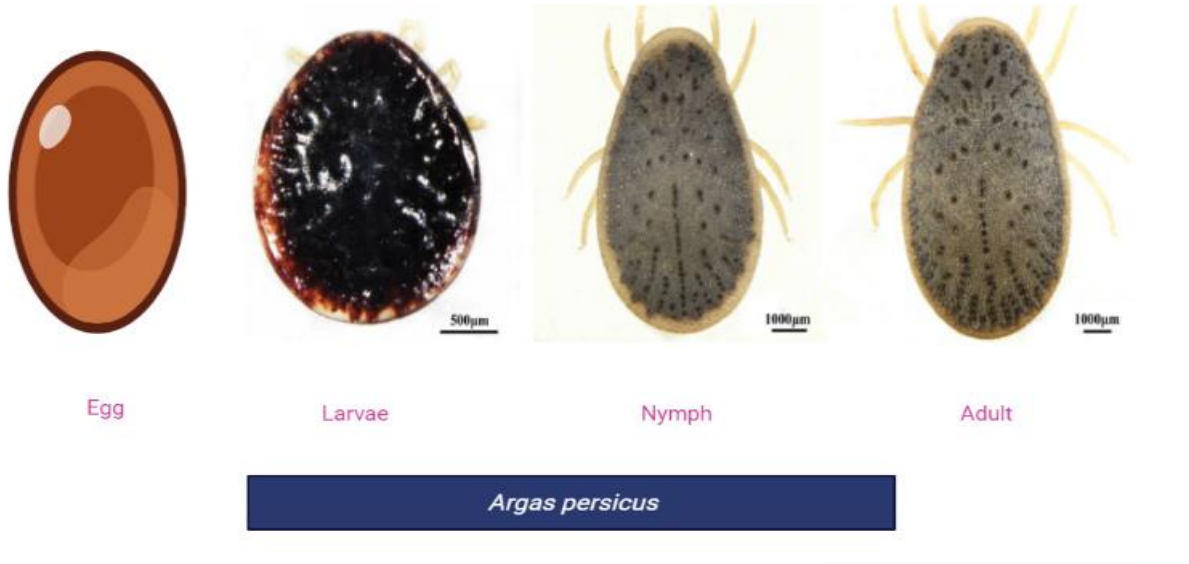

Fig 1: Larvae, nymph and adult seen at 500µm and 1000µm, respectively. *A. persicus* appears yellowish-brown when starved and slatey-blue when engorged. As an adult, it is 6 to 9mm long and a tan to reddish color before it feeds. After it feeds, it turns into a bluish color, hence the nickname given to the pest, 'Blue bug' (Retrived from biorender)

Global distribution of *A. persicus*

A. persicus is spread all over the world, which includes Africa (e.g., Egypt, Zimbabwe, Algeria, Kenya, Senegal, Kenya), Europe (Italy), Asia (Turkey, Iran), Australia, and 21 American countries (Reeves et al. 2002; Petney et al. 2004; Sylla et al. 2004; Abdel-Shafy 2005; Nava et al. 2007; Mungube et al. 2008; Dube et al. 2010; Pantaleoni et al. 2010; Cutler et al. 2012; Barker and Walker 2014; Koc et al. 2015; Davari et al. 2017; Lafri et al. 2018; Muñoz-Leal et al. 2018). One study also proves that *A. persicus* is present in Jeddah's farm in Saudi Arabia and causes huge problems in the poultry industry (Alzahrani and Edrees 2019). *A. persicus* is also found in Algeria, where it lives most closely with domestic chickens (Rahmani et al. 2023). In Algeria, it is found in Mostaganen and Annaba (coastal areas), Tamanrasset (Sahara region) and Setif, M'sila, Medea, and Guelma (inland areas) (Lafri et al. 2017, 2018; Boucheikhchoukh et al. 2018; Ouchene et al. 2020; Nahal et al. 2021). In one study, *A. persicus* was also collected from KP, Pakistan, where it was present in domestic fowl (Zahid et al. 2021). At very low temperatures, *A. persicus* is found in very small quantities worldwide (Uspensky 2008). Peshawar and Lakki Marwat are favorable regions for *A. persicus* because their climate is moderate. In tropical and subtropical areas, it is found in high-temperature and high-humidity environments (Hoogstraal and Kim 1985; Uspensky 2008; Sonenshine and Roe 2013; Ali et al. 2019). In China, *A. persicus* is present in Qinghai, Anhui, Inner Mongolia, and Gansu (Chen et al. 2010; Duan et al. 2022). In one experiment, *A. persicus* is collected from chickens in Gansu's city of Jinqua, China, to study of the life cycle stages of *A. persicus*.

This study reveals that bacterial diversity in larvae and nymphs is higher than that of adults (Duan et al. 2022). Domestic and wild birds can become hosts for a large number of ticks, and their environment can become favorable for tick exchange. In Kalmykia and Russia, birds come close to poultry species during their egg-laying season and exchange ticks with them (Yatsuk et al. 2023).

Impact on host

A. persicus causes stress in birds by sucking blood (Zahid et al. 2021). Heavy infestation of ticks affects bird production capacity, e.g., decreasing weight gain, number of eggs, weight of eggs, and mortality in birds compared to uninfested birds. *A. persicus* causes paralysis in poultry birds (chicken) (Alzahrani and Edrees 2019). An experiment on *A. persicus* on chicken species in Egypt shows that one tick can feed 32/50 or 33/50 male or female chicks at a time. At one feeding, 0.06mg of blood is consumed by a pair of ticks, and 1.9kg of plasma protein loss occurs in chickens. In a year, total 57kg of blood and 2.1kg of plasma protein loss occur in one chicken with one feeding by a pair of *A. persicus* (El Kammah et al. 2002). According to a study on *A. persicus* in chickens in Jeddah, Saudi Arabia, *A. persicus* causes 19% body weight loss in chickens, and it also decreases HCT (52%), WBC (32%), RBC (52%), and HGB (38%), the parameters of blood in chickens, compared to tick-free chicken species (Alzahrani and Edrees 2020). *A. persicus* lays 900–1000 eggs in cracks and crevices in poultry sheds that hatch within 10 days. The young ticks tie themselves to the outside of the bird's body, where they take blood. The favorite side of attachment is naked area, below the wings of the birds. Throughout the day, it mainly lives in the cracks of the poultry house. Its nymphs get attached to the poultry birds from 3–10 days, then they start to fall off, drop their skin, and come out as adults (Ware and Warren 2022). The natural environment for this poultry associated tick was examined in Khyber Pakhtunkhwa, and five nymphal stages were observed prior to the arrival of adults. The life cycle (egg to egg) is finished within 113 to 132 days with a temperature range of 33 ± 3°C and a moisture level of 65 ± 5% (Fig. 2) (Zahid et al. 2021).

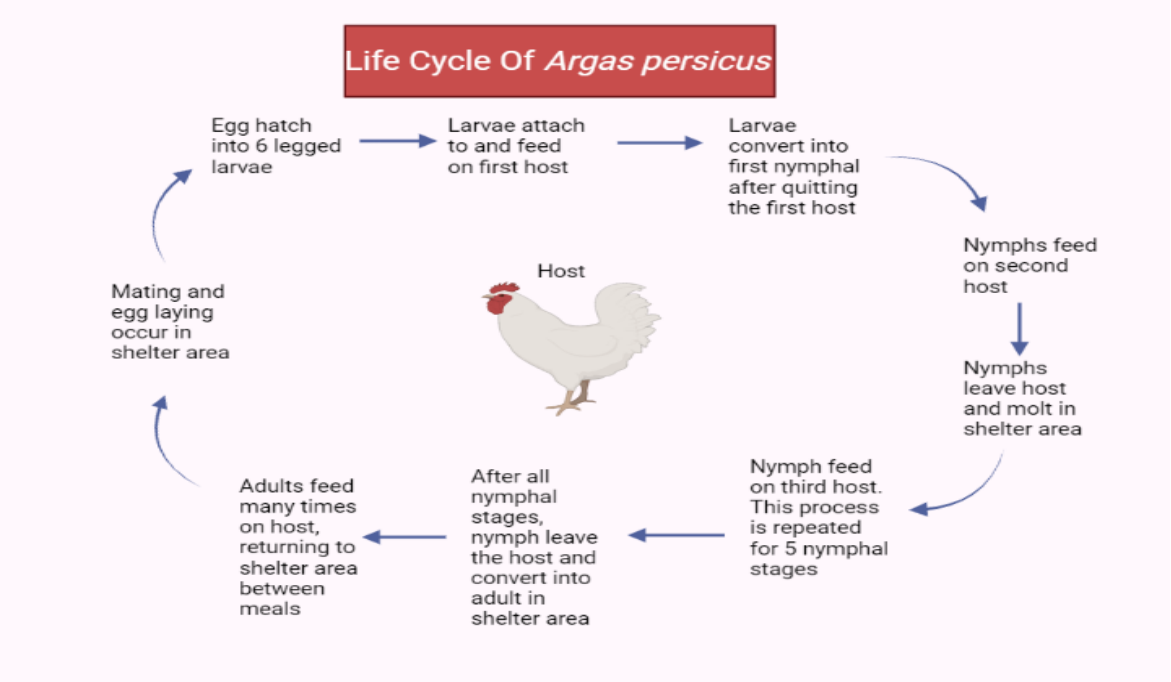

Fig. 2: Life cycle of *A. persicus* (Retrived from biorender)

***A. persicus*: as a vector and reservoir**

A. persicus transmits various pathogens such as *Salmonella pullorum*, *Mycoplasma gallisepticum*, *Mycoplasma meleagridis*, *Salmonella gallinarum*, *Aegyptianella pullorum*, avian encephalomyelitis, avian leucocytozoonosis, West Nile virus, and *Borrelia anserine* (Fig. 3, 4) (Khater et al. 2013; Chegeni and Tavakoli 2018; Hurtado and Giraldo-Ríos 2018; Ouchene et al. 2020; Yatsuk et al. 2023).

Fig. 3: Major pathogens and diseases transmitted by *A. persicus* (Retrived from biorender)

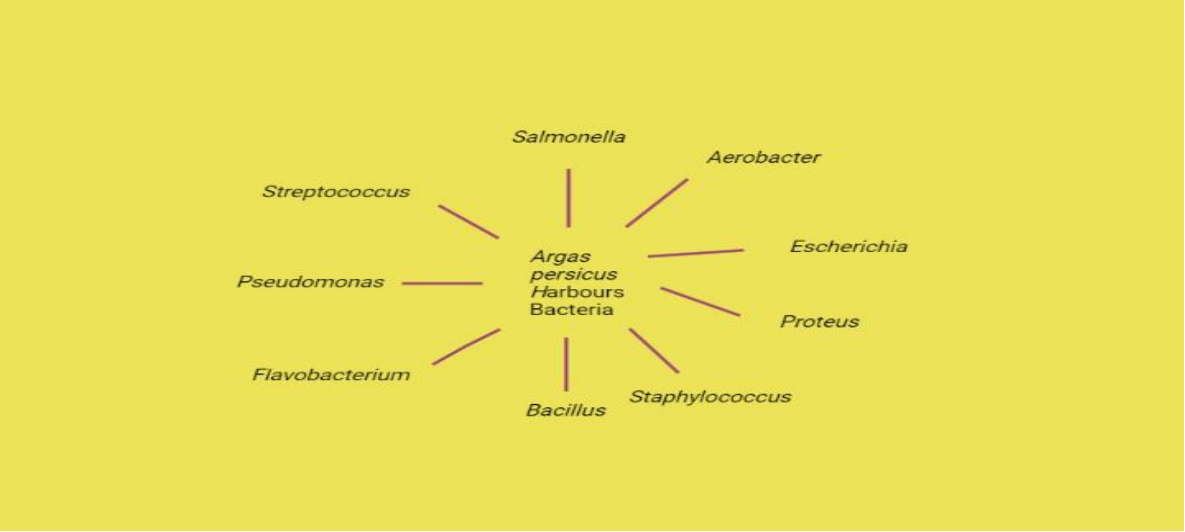

Fig. 4: *A. persicus* harbours bacteria (Retrived from biorender)

Control of *A. persicus*

There are some factors that support the dispersal of ticks on poultry farms. There are poor management policies, inefficient washing and disinfection, overcrowding, impoverished house, poor furniture patterns, and retarded treatment. Ectoparasites can be controlled on poultry farms by different techniques such as cultural control, mechanical control, chemical control, genetic control, biological control, and assimilated pest control (Onyekachi 2021). Absolute control of *A. persicus* is tough, however, if nests, feeders, poultry houses, and roosts are treated with carbolineum, then it will be the best way to control the ticks. The poultry house can be free of these ticks if two or more consecutive sprayings are performed with an interval of 10 days. Before buying, the birds and poultry house should be checked for ticks (Ware and Warren 2022).

Peracetic acid (PAA) and deltamethrin (DMT) can also be used against *A. persicus* larvae by dipping. PPA is a more potent acaricide for larvae than DMT. After 4 weeks, larvae are completely killed with DMT. PPA and DMT inhibit molting effects by 28 and 52%, respectively. 0.5% concentration of PPA can kill larvae (100%) within 2 minutes, and at this concentration, chickens do not show any respiratory or inflammatory signs, but with 0.005%

concentration of DMT, chickens show coughing, ocular inflammation, and sneezing (temporarily) (Khater et al. 2013).

Ivermectin and Fipronil can also be used for tick control in poultry. Ivermectin is more effective than fipronil. Ivermectin (0.2% mg/kg oral) and Fipronil (spray) effects on the ticks at 28th day are 93.9 and 77.8%, respectively (Khalid et al. 2017). Different acaricides are used for tick control in poultry, but these cause environmental pollution and resistance, so other methods are used for tick control (Abbas et al. 2014). One of them is the application of *Metarhizium anisopliae* (entomopathogenic fungus) that affects egg hatching ability and causes mortality of larvae and adult females of *A. persicus*. Larvae are killed (92–100%) by *M. anisopliae* species at 103 and 104 conidia/ml concentrations. Treated overfed females are easily killed (100%) at 107 conidia/ml concentration after 18 days of this treatment compared to starving females (Pourseyed et al. 2010). Extracts of *Consolida orientalis* (*Ranunculaceae*) plants have the best acaricidal effect on *A. persicus* larvae by the dipping method. This plant causes 100% mortality at the minimum concentration (Ghanbarpour et al. 2019). *Beauveria bassiana* (an entomopathogenic fungus) also has an acaricidal effect on overfed females of *A. persicus*. It affects the reproduction, locomotion, and viability of ticks, and damage their tissues and DNA structure. At 10^6 conidia/ml concentration, the mortality rate of females ranges almost from 3.3–13.3% within 3 weeks; however, at 10^{10} conidia/ml, mortality rate is almost 6.7–80% (Baioumy et al. 2021). Lufox (10ul/tick, topically) is used against the adult (female) and nymphal stages of *A. persicus*. Its effect is increased by increasing its concentration. It is toxic for *A. persicus* as it affects the fecundity of the female and causes mortality of the second nymphal stage (100% at 150 ppm). It also affects the legs of nymphs, which affect their locomotion (Bakr et al. 2018). It proves that the *A. persicus* restriction is a significant matter so, there is a requirement to apply biological control techniques as an option or as complementary procedure in control methods for ticks (Rivaz et al. 2015).

Conclusion

Although several studies report visible problems that *A. persicus* causes in birds production, especially in commercial birds, its real impact is still to be defined and studied. As seen in this review, problems have been reported with these tick species for decades. Therefore, understanding of how the infestation caused by these ectoparasites can affect layer and broiler birds and how to control this pest is crucial to reduce losses in poultry production. Studies have already shown the possible resistance of the species to the acaricidal and biological products used in commercial poultry houses. Control and monitoring measures for young birds are important to reduce the risk of the species' presence in laying birds. Therefore, further studies on these species and their population dynamics are required to develop biological control, eliminate these species and reduce the negative effects of these ticks on the poultry industry.

References

Abbas RZ, Colwell DD, Iqbal Z and Khan A, 2014. Acaricidal drug resistance in poultry red mite (*Dermanyssus gallinae*) and approaches to its management. Worlds Poultry Science Journal 70: 113-124.

Abdel-Shafy S, 2005. Scanning electron microscopy and comparative morphology of argasid larvae (Acari: Ixodida: Argasidae) infesting birds in Egypt. Acarologia 45: 3-12.

Abdisa T and Tagesu T, 2017. Review on Newcastle disease of poultry and its public health importance. Journal of Veterinary Science and Technology 8: 441. DOI: 10.4262/2157-7579.1000441

Ali A, Khan MA, Zahid H, Yaseen PM, Qayash Khan M, Nawab J, Ur Rehman Z, Ateeq M, Khan S and Ibrahim M, 2019. Seasonal dynamics, record of ticks infesting humans, wild and domestic animals and molecular phylogeny of *Rhipicephalus microplus* in Khyber Pakhtunkhwa Pakistan. Frontiers in Physiology 10: 793. https://doi.org/10.3389/fphys.2019.00793

Aljoburi AUJM, 2019. Survey study of most important diseases which infected the broiler farms in Samarra city. Tikrit Journal for Agricultural Sciences 18: 138-131. http://dx.doi.org/10.25130/tjas.v18i4.216

Alzahrani AM and Edrees NO, 2019. Seasonal distribution of *Argas persicus* in local poultry farms (Baladi Chicken) in Jeddah Governorate, Saudi Arabia. Global Veterinaria 21: 268-277. DOI: 10.5829/idosi.gv.2019.268.277

Alzahrani AM and Edrees NO, 2020. Effect of the fowl tick *Argas persicus* (Oken, 1818) (Acari: Argasidae) infestation on the health of Baladi chicken in Jeddah, Saudi Arabia Journal of Animal Health and Production 8: 13-18. DOI | http://dx.doi.org/10.17582/journal.jahp/2020/8.1.13.18

Baioumy AA, Swelim HH, Ibrahim AA, Mohamed FES, Marzouk AS and El-Alfy SH, 2021. Acaricidal and pathogenic effects of the entomopathogenic fungus *Beauveria bassiana* on engorged females of the fowl tick, *Argas persicus* (Argasidae). Experimental and Applied Acarology 85: 331-354. https://doi.org/10.1007/s10493-022-00707-w

Bakr RF, Salem DA, Radwan WA, Helmy N, Shanbaky NM and Abd El Hamid AE, 2018. Effect of the insect growth regulator "Lufox" on

some biological aspects of the soft tick *Argas persicus* (Oken). Egyptian Academic Journal of Biological Sciences. A, Entomology 11(1): 1-17. DOI: 10.21608/eajb.2018.11908

Barker SC and AR Walker, 2014. Ticks of Australia. The species that infest domestic animals and humans. Zootaxa 3816: 1-144. https://doi.org/10.11646/zootaxa.3816.1.1

Boucheikhchoukh M, Laroche M, Aouadi A, Dib L, Benakhla A, Raoult D and Parola P, 2018. MALDI-TOF MS identification of ticks of domestic and wild animals in Algeria and molecular detection of associated microorganisms. Comparative Immunology, Microbiology & Infectious Diseases 57: 39–49. DOI: 10.1016/j.cimid.2018.05.002.

Centers for Disease Control and Prevention, 2020. Chicken and food poisoning.

Chen Z, Yang X, Bu F, Yang X, Yang X and Liu J, 2010. Ticks (acari: ixodoidea: argasidae, ixodidae) of China. Experimental and Applied Acarology 51: 393-404. DOI: 10.1007/s10493-010-9335-2

Chegeni AH and Tavakoli M, 2018. *Aegyptianella pullorum* (Rickettsiales: Anaplasmataceae) in tick *Argas persicus* (Acari: Argasidae) from Iran: a preliminary assessment. Persian Journal of Acarology 7: 307-311. http://dx.doi.org/10.22073/pja.v7i3.37407

Chowdhury EU and Morey A, 2019. Intelligent packaging for poultry industry. Journal of Applied Poultry Research 28: 791-800. https://doi.org/10.3382/japr/pfz098

Cutler S, Abdissa A, Adamu H, Tolosa T and Gashaw A, 2012. Borrelia in Ethiopian ticks. Ticks and tick-borne diseases 3: 14-17. https://doi.org/10.1016/j.ttbdis.2011.08.004

Davari B, Alam FN, Nasirian H, Nazari M, Abdigoudarzi M and Salehzadeh A, 2017. Seasonal distribution and faunistic of ticks in the Alashtar county (Lorestan Province), Iran. The Pan African Medical Journal 27: 284. doi: 10.11604/pamj.2017.27.284.10341

Duan DY, Liu YK, Liu L, Liu GH and Cheng TY, 2022. Microbiome analysis of the midguts of different developmental stages of *Argas persicus* in China. Ticks and Tick-borne Diseases 13: 101868. DOI: 10.1016/j.ttbdis.2021.101868.

Dube S, Zindi P, Mbanga J and Dube C, 2010. A study of scavenging poultry gastrointestinal and ecto-parasites in rural areas of Matebeleland Province, Zimbabwe. International Journal of Poultry Science 9(9): 911-915. DOI:10.3923/IJPS.2010.911.915

El Kammah KM, Oyoun LM and Gabr HS, 2002. Studies on the feeding effects of *Argas persicus* and *A. hermanni* (Acari: Argasidae) on chicken and pigeon blood and plasma protein. International Journal of Acarology 28: 273-276. DOI:10.1080/01647950208684303

Feng J, Wu M, Huang T, Zhang J, Renbatu N and Riletu G, 2019. Identification of two genotypes of *Argas persicus* and associated rickettsia-specific genes from different regions of Inner Mongolia. Journal of Parasitology 105: 92-101.

Ghanbarpour K, Tavassoli M and Shamsi L, 2019. Pesticide effects of *Consolida orientalis* extract on larval stage of *Argas persicus* (Acari: Argasidae). Persian Journal of Acarology 8. https://doi.org/10.22073/pja.v8i3.45290

Hoogstraal H and Kim KC, 1985. Tick and mammal coevolution, with emphasis on Haemaphysalis. 1985: 505-568.

Hurtado OJB and Giraldo-Ríos C, 2018. Economic and health impact of the ticks in production animals. Ticks and tick-borne pathogens 2018: 1-19.

Hussain J, Rabbani I, Aslam S and Ahmad HA, 2015. An overview of poultry industry in Pakistan. World's poultry science journal 71: 689-700.

Kakarsulemankhel JK, 2010. Re-description and new record of *Argas* (*persicargas*) *persicus* (Oken, 1818) (Acarina: Argasidae) from Balochistan, Pakistan. Pakistan Entomologist 32: 82-94.

Kebede A, Abebe B and Zewdie T, 2017. Study on prevalence of ectoparasites of poultry in and around Jimma town. European Journal of Biological Sciences 9: 18-26. DOI: 10.5829/idosi.ejbs.2017.18.26.

Khalid S, Rehman A, Amir MY, Sarfaraz I and Asif M, 2017. Comparative efficacy of ivermectin and fipronil on controlling tick infestation in commercial layers: a randomized controlled trial. Pakistan Journal of Zoology 49(3): 1139-1142. DOI: http://dx.doi.org/10.17582/journal.pjz/2017.49.3.sc9.

Khater HF, Seddiek SA, El-Shorbagy MM and Ali AM, 2013. Erratum to: The acaricidal efficacy of peracetic acid and deltamethrin against the fowl tick, *Argas persicus*, infesting laying hens. Parasitology research 112: 3669-3678.

Koc S, Aydın L and Cetin H, 2015. Tick species (Acari: Ixodida) in Antalya City, Turkey: species diversity and seasonal activity. Parasitology Research 114: 2581-2586.

Lafri I, El Hamzaoui B, Bitam I, Leulmi H, Lalout R, Mediannikov O, Chergui M, Karakellah M, Raoult D and Parola P, 2017. Detection of relapsing fever *Borrelia spp., Bartonella spp.* and Anaplasmataceae bacteria in argasid ticks in Algeria. PLOS Neglected Tropical Diseases 11: e0006064.

Lafri I, Benredjem W, Neffah-Baaziz F, Lalout R, Abdelouahed K, Gassen B, Bakhouch S, Chergui M, Karakellah M, Adjmi-Hamoudi H and Bitam I, 2018. Inventory and update on

argasid ticks and associated pathogens in Algeria. New Microbes and New Infections 23: 110-114. https://doi.org/10.1016/j.nmni.2018.02.009.

Loss SR, Noden BH, Hamer GL and Hamer SA, 2016. A quantitative synthesis of the role of birds in carrying ticks and tick-borne pathogens in North America. Acta Oecologica 182: 947–959. 10.1007/s00442-016-3731-1

Mahmoud WG, Hassan ESM and Abdel Hafez MSA, 2021. Effect of medicinal plants against intestinal coccidiosis and capillariassis infecting pigeons. Journal of the Egyptian Society of Parasitology 51: 51–54.

Mallesh P, Kumar MU and Sreenivasa GS, 2017. Ultrastructural Studies on *Argas persicus*. International Journal of Livestock Research 7: 159-166.

Montasser AA, 2006. The camel tick, *Haylomma* (*Hyalomma*) *dromedarii* Koch, 1844 (Ixodoidea: Ixodidae): Description of the egg and redescription of the larva by scanning electron microscopy. International Journal of Zoology Research 2: 14-29. DOI: 10.3923/ijzr.2006.14.29

Montasser AA, 2010. The fowl tick, *Argas* (*Persicargas*) *persicus* (Ixodoidea: Argasidae): Description of the egg and re-description of the larvae by scanning electron microscopy. Experimental and Applied Acarology 52: 343-361. DOI: 10.1007/s10493-010-9377-5

Monti F, Baratti M, Viviano A and Mori E, 2023. Ticks in the box: *Argas persicus* occurrence in nest boxes of secondary cavity-nesting bird species in Italy. European Journal of Wildlife Research 69: 23. DOI:10.1007/s10344-023-01656-4

Mungube EO, Bauni SM, Tenhagen BA, Wamae LW, Nzioka SM, Muhammed L and Nginyi JM, 2008. Prevalence of parasites of the local scavenging chickens in a selected semi-arid zone of Eastern Kenya. Tropical Animal Health and Production 40: 101-109. DOI: 10.1007/s11250-007-9068-3

Muñoz-Leal S, Venzal JM, Nava S, Reyes M, Martins TF, Leite RC, Vilela VLR, Benatti HR, Ríos-Rosas D, Barros-Battesti DM, GonzálezAcuña D and Labruna MB, 2018. The geographic distribution of *Argas* (*Persicargas*) *miniatus* and *Argas* (*Persicargas*) *persicus* (Acari: Argasidae) in America, with morphological and molecular diagnoses from Brazil, Chile and Cuba. Ticks and Tick-borne Diseases 9: 44-56. https://doi.org/10.1016/j.ttbdis.2017.10.009.

Nahal A, Righi S, Boucheikhchoukh M and Benakhla A, 2021. Prevalence of ectoparasites in free-range backyard chicken flocks in northeast Algeria. Veterinarska Stanica 52: 693–702.

Naqvi MAH, Khan MK, Iqbal Z, Rizwan HM, Khan MN, Naqvi SZ, Zafar A, Sindhu ZUD, Abbas RZ and Abbas A, 2017. Prevalence and associated risk factors of haemoparasites, and their effects on hematological profile in domesticated chickens in District Layyah, Punjab, Pakistan. Preventive Veterinary Medicine 143: 49-53.

Nava S, Lareschi M, Rebollo C, Benítez Usher C, Beati L, Robbins RG, Durden LA, Mangold AJ and Guglielmone AA, 2007. The ticks (Acari: Ixodida: Argasidae, Ixodidae) of Paraguay. Annals of Tropical Medicine and Parasitology 101: 255-270. https://doi.org/10.1179/136485907X176319

Onyekachi O, 2021. Prevalence of ectoparasites infestation of chicken in three poultry farms in Awka. Asian Basic and Applied Research Journal 2021: 1-13.

Ouchene N, Nebbak A, Ouchene-Khelifi NA, Dahmani A, Zeroual F, Khelef D, Bitam I, Benakhla A and Parola P, 2020. Molecular detection of avian spirochete Borrelia anserina in *Argas persicus* ticks in Algeria. Comparative Immunology, Microbiology and Infectious Diseases 68: 101408. https://doi.org/10.1016/j.cimid.2019.101408

Paliy AP, Mashkey AM and Sumakova NV, 2018. Distribution of poultry ectoparasites in industrial farms, farms, and private plots with different rearing technologies. Biosystems Diversity 26: 153-159.

Pantaleoni RA, Baratti M, Barraco L, Contini C, Cossu CS, Filippelli MT, Loru L and Romano M, 2010. *Argas* (*Persicargas*) *persicus* (Oken, 1818) (Ixodida: Argasidae) in sicily with considerations about its Italian and west-mediterranean distribution. Parasite 17(4): 349-355. https://doi.org/10.1051/parasite/2010174349

Petney TN, Andrews RH, McDiarmid LA and Dixon BR, 2004. *Argas persicus* sensu stricto does occur in Australia. Parasitology Research 93: 296-299.

Pfäffle MP and Petney TN, 2017. *Argas persicus* (Oken, 1818). In: Estrada-Peña A, Mihalca AD, Petney TN (eds), Ticks of Europe and North Africa: a guide to species identification. Springer, Cham. pp: 15-19.

Poudel U, Dahal U and Dhakal S, 2021. Review of poultry production and poultry vaccine manufacture in Nepal. Global Journal of Agricultural and Allied Sciences 3: 1-7. https://doi.org/10.35251/gjaas.2021.001.

Pourseyed SH, Tavassoli M, Bernousi I and Mardani K, 2010. *Metarhizium anisopliae* (Ascomycota: Hypocreales): an effective alternative to chemical acaricides against different developmental stages of fowl tick *Argas persicus* (Acari: Argasidae). Veterinary Parasitology 172: 305-310. https://doi.org/10.1016/j.vetpar.2010.05.014

Rahmani A, Laatamna A, Yu Z, Lafri I, Herrada Z, Chitimia-Dobler L and Bakkes DK, 2023. Molecular characterization and phylogenetic analysis of *Argas persicus* (Oken, 1818) (Acari: Argasidae) from domestic birds in eastern Algeria. Parasitology Research 122: 275-284.

Reeves W, Durden L and Wills W, 2002. New records of ticks (Acari: Argasidae, Ixodidae) from South Carolina. Journal of Agricultural and Urban Entomology 19: 197-204.

Rivaz S, Abdigoudarzi M, Karimi G, Motamedi G, Payekari H and Nasiri V, 2015. A survey on virulence of *Metarhizium anisopliae* (M14 strain) for biological control of *Argas persicus*. Medicine 19: 23.

Shah SMT, Islam MT, Zabin R, Roy PC, Meghla NS and Jahid IK, 2021. Assessment of novel probiotic strains on growth, hematobiochemical parameters, and production costs of commercial broilers in Bangladesh. Veterinary World 14: 97-103. doi: 10.14202/vetworld.2021.97-103

Sonenshine DE and Roe RM, 2013. Biology of tick's, Vol. 2. Oxford University Press, UK.

Soulsby EJL, 1982. Helminths, arthropods and protozoa of domesticated animals, 7th Ed. The English Language Book Society and Bailliere, Tindall, London. pp: 452-453.

Sylla M, Pourrut X, Faye N, Bâ K, Cornet JP and Camicas JL, 2004. Argasidae (Acari: Ixodida) parasites of wild and domestic animals in Senegal: 1 - Review and distribution. Acarologia 44: 137-149.

Uspensky I, 2008. Argasid (soft) ticks (Acari: Ixodida: Argasidae). Mehlborn H (Ed.). Encyclopedia of parasitology, 3rd Edition; Springer Publishing Co. pp: 283-287. DOI:10.1007/0-306-48380-7_298

Veiga J and Valera F, 2020. Nest box location determines the exposure of the host to ectoparasitesAvian Conservation and Ecology 15: 11. https://doi.org/10.5751/ACE-01657-150211

Wanzala W, 2017. Potential of Traditional Knowledge of Plants in the Management of Arthropods in Livestock Industry with Focus on (Acari) Ticks. Evidence-Based Complementary and Alternative Medicine 2017: 8647919. https://doi.org/10.1155/2017/8647919.

Ware HG and Warren AG, 2022. Poultry parasites. Oklahoma Cooperative Extension Service. pp: 1-12

Yatsuk A, Kolesnikov V, Davydova Y, Malovichko L, Campos-Cerda F and Matyukhin A, 2023. The Persian tick *Argas persicus* (Ixodida: Argasidae) in Kalmykia (Russia). Persian Journal of Acarology 12: 371-375 DOI: https://doi.org/10.22073/pja.v12i2.77948

Zahid H, Muñoz-Leal S, Khan MQ, Alouffi AS, Labruna MB and Ali A, 2021. Life cycle and genetic identification of *Argas persicus* infesting domestic fowl in Khyber Pakhtunkhwa, Pakistan. Frontiers in Veterinary Science 2021: 302. https://doi.org/10.3389/fvets.2021.664731