

Review

Tick Infestation in Poultry

ABBAS HAIDER SHAH, MUHAMMAD NISAR KHAN, ZAFAR IQBAL AND MUHAMMAD SOHAIL SAJID

Department of Veterinary Parasitology, University of Agriculture, Faisalabad– 38040, Pakistan

ABSTRACT

This paper reviews the studies on the prevalence, vector role, chemotherapy and biological control of ticks in poultry. Ticks of the genus *Argas* are the most prevalent. Ticks were reported to transmit bacterial, viral and parasitic diseases to poultry. The most important and frequently transmitted disease was found to be the spirochaetosis. A variety of chemicals are used for the control of tick infestation in poultry. These include carbamates, pyrethroids, herbal products, organophosphates and ivermectins. The most promising results, however, were reported with pyrethroids and organophosphates. Biological control although have not widely accepted for application, yet some bacterial and fungal species have been found to be effective. Based on the review, conclusions have been drawn for further research into the tick infestation of poultry.

Key Words: Ticks; Poultry

INTRODUCTION

The ectoparasites of poultry like ticks, lice and mites play an important role in the transmission of certain pathogens which cause heavy economic losses to poultry industry. They cause heavy morbidity by sucking blood and causing irritation to the birds which adversely affects the economical production of poultry (Phulan *et al.*, 1984). Ectoparasites cause weight loss at the rate of about 711 g per bird and decrease the egg yield at the rate of about 66 eggs per bird in a year (Elkifl *et al.*, 1973). Among ectoparasites, fowl ticks may cause ruffled feathers, anaemia, emaciation and lowered production. Heavy tick infestation may cause loss of blood leading to anemia and eventually death (Bergstrom *et al.*, 1999). In addition, they are also known to transmit certain parasitic, bacterial and viral diseases like leucocytozoonosis, Aegyptianellosis, Pasteurellosis, Avian encephalomyelitis, Borreliosis and fowl cholera (Permin & Hansen, 1998). Larval forms of these ticks also cause paralysis (Rosenstein, 1976). The purpose of this paper is to review the studies on tick infestation in poultry and associated risks.

Prevalence. There are a number of species of ticks infesting poultry. These include *Argas persicus* (Fahmy, 1952; Reid, 1956; Frolov *et al.*, 1972; Petrov, 1972; Akhundova & Terskikh, 1972; Galun *et al.*, 1972; Elkifl *et al.*, 1973; Stefanov *et al.*, 1975; Leeftang & Ilemobade, 1977; Glukhov & Noviko, 1978; Gryaznova *et al.*, 1978; Kachekova & Frolov, 1978; Orichova *et al.*, 1978; Buriro & Akbar, 1978; Frolov *et al.*, 1978; Sluda *et al.*, 1979; Soni, 1979; Buriro, 1979; Sokolov *et al.*, 1980; Li & Yarnykh, 1981; Hafeez & Irfan, 1982; Gyurov, 1983; Buriro, 1983; Ayeni *et al.*, 1983; Phulan *et al.*, 1984; Frolov *et al.*, 1985; Khan *et al.*, 1986; Abdu, 1987; Soliman *et al.*, 1988; Dikaev, 1988; Okaeme, 1988; Karim *et al.*, 1988; Mousa *et al.*, 1988; Pavlovic *et al.*, 1988; Tian & Guan, 1989; Oyouun *et al.*, 1990; Pavlovic & Nestic, 1991; Sheikh, 1991; Kumar *et al.*, 1992; Mir *et al.*, 1993; Chhabra & Donora, 1994; Saidu-I *et al.*, 1995; Kulisic *et al.*, 1995; Hassanain *et al.*, 1997; Axtell, 1999; El-Kady *et al.*, 1999; El-Kammah *et al.*, 2001; Habeeb *et al.*, 2001; Keirans & Durden, 2001; Khan, 2001; Permin *et al.*, 2002), *Argas robertsi* (Hoogstraal *et al.*, 1968), *Argas (Persicargas) zumpti* (Hoogstraal *et al.*, 1968), *Argas giganteus* (Kohls & Clifford, 1968), *Argas himalayensis* (Hoogstraal & Kaiser, 1973), *Argas (Persicargas) nullarborensis* (Hoogstraal & Kaiser, 1973), *Argas polonicus* (Sluda *et al.*, 1979), *Argas africolumbae* (Kraiss & Gothe, 1982), *Argas walkerae* (Norval, 1985), *Argas reflexus* (Dikaev, 1988 & Kulisic *et al.*, 1995), *Argas vulgaris* (Dikaev, 1988), *Argas hermanni* (Oyouun *et al.*, 1990), *Argas monolakensis* (Schwan *et al.*, 1992), *Argas miniatus* (Evans *et al.*, 2000), *Argas arboreus* (Belozherov *et al.*, 2003), *Ixodes ricinus* (Bernard & Bieseman, 1986), *Amblyomma variegatum* (Okaeme, 1988), *Ixodes columnae*, *I. persulcatus*, *I. turdus*, *Haemaphysalis flava* and *H. longicornis* (Ishiguro *et al.*, 1997), *Ixodes auritulus* (Evans *et al.*, 2000), *Amblyomma americanum* (Durden *et al.*, 1997; Kinsey *et al.*, 2000; Mock *et al.*, 2001), *Amblyomma maculatum*, *Haemaphysalis leporispalustris*, *Ixodes brunneus*, *I. minor* and *I. scapularis* (Durden *et al.*, 1997 and Kinsey *et al.*, 2000), *Amblyomma tigrinum* (Labrun *et al.*, 2002), *Amblyomma triste* (Labruna *et al.*, 2003), *Haemaphysalis punctata*, *Hyalomma lusitanicum* and *Ixodes frontalis* (Calvete *et al.*, 2003) and *Amblyomma aureolatum* and *Ixodes auritulus* (Arzua *et al.*, 2003).

The prevalence of tick infestation varies in different months/seasons of the year. It is found highly prevalent in, December, May (Elkifl *et al.*, 1973), April to November (Sluda *et al.*, 1979), August (Phulan *et al.*, 1984), September to November (Anjum, 1990), summer and spring (Oyouun *et al.*, 1990).

The prevalence of tick infestation varies in different months/seasons of the year. It is found highly prevalent in, December, May (Elkifl *et al.*, 1973), April to November (Sluda *et al.*, 1979), August (Phulan *et al.*, 1984), September to November (Anjum, 1990), summer and spring (Oyouun *et al.*, 1990).

al., 1990), spring (Ishiguro *et al.*, 1997) and April (Pavlovic *et al.*, 1988). It is low in, July and August (Elkifl *et al.*, 1973), winter (Sluda *et al.*, 1979), January (Phulan *et al.*, 1984), winter (Oyoun *et al.*, 1990) and autumn (Ishiguro *et al.*, 1997).

The optimum temperature for the development of *A. persicus* is 22-38°C (Petrov & Gecheva, 1975) and for *A. africanum* 27°C (Kraiss & Gothe, 1982). The developmental cycle of *A. persicus* is completed in 41-133 days (Petrov & Gecheva, 1975 and Srivastava *et al.*, 1981) and 13-38 days at room temperature and humidity (Orichova *et al.*, 1978).

Tick infestation varies with different breeds of poultry. It is more in Harco and least in Babcock (Ugochukwu & Omije, 1986).

Vector role of ticks. Ticks transmit bacterial, rickettsial, viral, and parasitic and spirochaetal diseases in poultry. *A. persicus* transmits *Salmonella pullorum* (Stefanov *et al.*, 1975), *Mycoplasma gallisepticum* (Glukhov & Novikov, 1978 and Soliman *et al.*, 1988), *Mycoplasma meleagridis* (Soliman *et al.*, 1988), *Salmonella gallinarum* (Gyurov, 1983), *Aegyptianella pullorum* (Leeflang & Ilemobade, 1977 and Tsanov, 1983), Avian encephalomyelitis and Leucocytozoonosis (Permin & Hansen, 1998), West Nile virus (Abbassy *et al.*, 1993) and *Borrelia anserina* (Leeflang & Ilemobade, 1977; Rodey & Soni, 1977; Buriro, 1979; Hafeez & Irfan, 1982; Khan *et al.*, 1986; Abdu, 1987; Nemova *et al.*, 1990; Rashid & Ali, 1991; Sa-idu-L *et al.*, 1995; Ishiguro *et al.*, 1997; Bhatti *et al.*, 2001; Durden *et al.*, 2001). *Argas persicus* harbours different types of bacteria including those of genus *Salmonella*, *Aerobacter*, *Escherichia*, *Proteus*, *Staphylococcus*, *Flavobacterium*, *Bacillus*, *Pseudomonas* and *Streptococcus* (Buriro, 1983). *Argas persicus* infestation causes paralysis in birds (Rosenstein, 1976; Gryaznova *et al.*, 1978; Soni, 1979). *Argas persicus* larvae have been responsible for simultaneous occurrence of Infectious Bursal Disease and Spirochaetosis (Abdu, 1987). The ticks, *Amblyomma americanum*, *A. maculatum*, *Haemaphysalis leporispalustris*, *Ixodes brunneus*, *I. Minor* and *I. scapularis* transmit *Borrelia burgdorferi* (Durden *et al.*, 1997; Slowik & Lane, 2001). Migratory birds are able to carry Lyme disease *Borreliosis* (*Borrelia burgdorferi*) as a latent infection for several months and this infection can be reactivated and passed on to Ixodid ticks as a result of migratory restlessness thus causing further transmission through ticks (Gylfe *et al.*, 2000; Kaiser *et al.*, 2002).

Chemotherapy. A variety of chemicals are used for the control of tick infestation in poultry either by application to the birds or poultry houses. These include topical application of N, N- diethyl- 2-phenylacetamide (DEPA), N, N- diethyl -3- methyl benzamide (DEET) and Dimethyl phthalate (DMP). DEET and DEPA are more effective (Kumar *et al.*, 1992), feeding of chicks with 100 fg Ivermectin per kg body weight (Mousa *et al.*, 1988), dipping of tick infested chicken legs in 0.05% deltamethrin (Tian &

Guan, 1989), bromocyclen spray to the birds and treatment of their houses with 0.6% bromocyclen (Pavlovic *et al.*, 1988), topical application of 1:20 dilution of pestoban (a liquid concentrate of various non-poisonous plants) (Sinha *et al.*, 1987), application of 0.5% trichlorfon, 0.25% crotoxyphos or 0.25% carbaryl @ 25-50 mL per bird and spraying the poultry houses with 1-2% trichlorfon, 0.25% diazinon, 0.02% dichlorvos, 0.5% crotoxyphos, 0.1% carbaryl or 0.25% dicresyl (Frolov *et al.*, 1985), phosalone, tetrachlorvinphos, porpoxur and fenethacarb (Frolov *et al.*, 1978), application of 1-1.5% fthalofos (phosmet) to poultry houses at the rate of 150-200 mL/sq.m (Frolov *et al.*, 1972), ectocide, a preparation containing 10 g of pyrethrins, 15 g piperonyl butoxide, 3 g benzalkonium chloride and water to make 100 g (Li & Yarnykh, 1981), Aerosol of 2% "4 - 74" (carbamate preparation) (Sokolov *et al.*, 1980) and pyrethroids (bioallethrin, biopresmetrin, neo - pinamin and pybuthrin) (Kachekova & Frolov, 1978).

Biological control. Biological control of tick infestation in poultry includes, the cessation of egg laying by females of *A. persicus* after exposure to irradiation (Galun *et al.*, 1972), Entobakterin and Dendrobacillin (preparations of spores and endotoxin of *Bacillus thuringiensis*) and Boverin (conidiospores of the fungus *Beauveria bassiana*), active alone or in combination with chemical pesticides in the control of arthropods (Frolov, 1974) and activity of *Bacillus thuringiensis* against *A. persicus* (Hassanain *et al.*, 1997).

CONCLUSION

This review suggests different epidemiology of tick infestation in various areas. Therefore, investigations on epidemiological aspects of tick infestation in poultry in Pakistan should be carried out to devise an effective control.

REFERENCES

- Abbassy, M.M., M. Osman and A.S. Marzouk, 1993. West Nile virus (Flaviviridae: Flavivirus) in experimentally infected *Argas* ticks (Acari: Argasidae). *American J. Trop. Med. Hyg.*, 48: 726-37
- Abdu, P.A., 1987. Infectious bursal disease in pullet chicks. *Avian Dis.*, 31: 204-5
- Akhundova, E.D. and I.I. Terskikh, 1972. The role of avian tick *Argas persicus* and *Ornithodoros coniceps* in infecting birds. Communication II: Experimental transmission of infection to chickens. *Voprosy-Virusologii.* 6: 712-3
- Anjum, A.D., 1990. Weather and disease: I. Prevalence of the poultry diseases in and around Faisalabad and their relationship to weather. *Pakistan Vet. J.*, 10: 43-5
- Arzua, M., M.A. Navarro Da Silva, K.M. Famadas, L. Beati and D.M. Barros-Battesti, 2003. *Amblyomma aureolatum* and *Ixodes auritulus* (Acari: Ixodidae) on birds in southern Brazil, with notes on their ecology. *Exp. Appl. Acarol.*, 31: 283-96
- Axtell, R.C., 1999. Poultry integrated pest management: status and future. *Integrated Pest Management Reviews*, 4: 1, 53-73
- Ayeni, J.S.O., O.O. Dipeolu and A.N. Okaeme, 1983. Parasitic infections of the grey-breasted helmet guinea-fowl (*Numidia meleagris galeata*) in Nigeria. *Vet. Parasitol.*, 12: 59-63
- Belozherov, V.N., D.J. Van Niekerk and H.J. Butler, 2003. Population structure of *Argas arboreus* (Acari: Argasidae) ticks associated with

- seasonally abandoned mixed heronries, dominated by cattle egrets (*Bubulcus ibis*), in South Africa. *Onderstepoort J. Vet. Res.*, 70: 325–30
- Bergstrom, S., P.D. Haemig and B. Olsen, 1999. Increased mortality of black-browed albatross chicks at a colony heavily-infested with the tick *Ixodes uriae*. *Int. J. Parasitol.*, 29: 1359–61
- Bernard, J. and W. Biesemans, 1986. Ectoparasites of birds in Belgium. *Bulletin et Annales de la ociete Royale Belge d'Entomologie.*, 122: 269–71
- Bhatti, W.M., S.M. Kakar, N.M. Soomro, M.S. Phulan and L.A. Siddiqui, 2001. Incidence and gross pathological changes in chickens affected with spirochaetosis. *Pakistan Vet. J.*, 21: 163–5
- Buriro, S.N. and S.S. Akbar, 1978. Incidence and occurrence of ectoparasites of poultry in Pakistan. *Zeitschrift-fur-Angewaldte-Entomologie.*, 86: 1–8
- Buriro, S.N., 1979. Role of *Argas (Percicargas) persicus* in transmission of spirochaetosis. *Pakistan J. Zool.*, 11: 221–4
- Buriro, S.N., 1983. Relative abundance of different species of bacteria isolated from *Argas persicus*. *Pakistan Vet. J.*, 3: 126–8
- Calvete, C., R. Estrada, J. Lucientes and A. Estrada, 2003. Ectoparasite ticks and chewing lice of red-legged partridge, *Alectoris rufa*, in Spain. *Med. Vet. Entomol.*, 17: 33–7
- Chhabra, R.C. and N. Donora, 1994. Ectoparasites of poultry in Zimbabwe and their control. *Zimbabwe Vet. J.*, 25: 26–32.
- Dikaev, B.Yu., 1988. Ectoparasites of poultry and their control. *Veterinariya Moscow*, 10: 47–8
- Durden, L.A., R.G. Mclean, J.H. Oliver, S.R. Ubico and A.M. James, 1997. Ticks, Lyme disease spirochaetes, trypanosomes and antibody to encephalitis viruses in wild birds from coastal Georgia and South Carolina. *J. Parasitol.*, 83: 1178–82
- Durden, L.A., J.H. Jr. Oliver and A.A. Kinsey, 2001. Ticks (Acari: Ixodidae) and spirochetes (spirochaetaceae:spirochaetales) recovered from birds on a Georgia Barrier Island. *J. Med. Entomol.*, 38: 231–6
- El-kady, G.A., I.M. Bahgat and A. Shoukry, 1999. Haemoglobinometry as a method to determine the blood meal size of two argasid tick species. *J. Egypt. Soc. Parasitol.*, 29: 473–81
- El-Kammah, K.M., L.M. Oyoum, G.A. Elkady and S.A. Shafy, 2001. Investigation of blood parasites in livestock infested with argasid and ixodid ticks in Egypt. *J. Egyptian Soc. Parasitol.*, 31: 365–71
- El- Kifl, A.H., A. Wahab, M.K. Kamel and W.A.E. Abdel, 1973. Poultry ectoparasites in Sharikia Governorate. *Agric. Rev.*, 51: 113–20
- Evans, D.E., J.R. Martin and A.A. Guglielmono, 2000. A review of the ticks of Brazil, their hosts and geographic distribution. *Mem. Inst. Oswaldo Cruz.*, 95: 453–70
- Fahmy, M.A.M., 1952. New records of ecto and endoparasites of chickens in Egypt with special reference to the taxonomy of *Subulura brumpti*. *J. Parasitol.*, 38: 184
- Frolov, B.A., R.V. Chirikashvilli and A.Z. Dazhiev, 1972. Ftalofos (phosmet) for the control of *Argas persicus* in poultry houses. *Problemy-Veterinarnoi Sanitarii.*, 41: 331–7
- Frolov, B.A., 1974. Chemical and biological methods of controlling poultry ectoparasites. *Veterinariya Moscow.*, 12: 66–8
- Frolov, B.A., Sh. Kachekova, A. Morozov, R.M. Bulatov and P.A. Lopukhov, 1978. Acaricides for ectoparasites of poultry. *Veterinariya Moscow*, 11: 75–6
- Frolov, B.A., and R.A. Li, 1982. Control of ectoparasites in industrial poultry breeding. *Veterinariya, Moscow*, 9: 22–3
- Frolov, B.A., V.E. Sivokhina and L.P. V-Yunov, 1985. Control of ectoparasites in poultry-rearing premises. *Veterinariya Moscow*, 11: 48–9
- Galun, R., S. Sternberg and C. Mango, 1972. The use of sterile females for the control of the tick *Argas persicus*. *Israel J. Entomol.*, 7: 109–15
- Glukhov, V.F. and V.G. Novikov, 1978. The tick *Argas persicus*—reservoir and carrier of the agent of mycoplasmosis of birds. *First all-Union conference of parasitocoenologists. Abstracts of reports.* Part 1,2,3: 90.
- Gryaznova, V.I., Yu-V. Solov and V.V. Shornikov, 1978. Changes in the composition of blood during tick paralysis caused by the larvae of *Argas persicus*. *Parazitologiya*, 12: 446–8
- Gylfe, A., S. Bergstrom, J. Lundastrom and B. Oslon, 2000. Epidemiology, reactivation of *Borrelia* infection in birds. *Nature*, 403: 724–5
- Gyurov, B., 1983. Role of *Argas persicus* in the epidemiology of fowl typhoid. *Veterinarna Sbirka*, 81: 22–4
- Habeeb, S.M., M.A. Sayed and K.M. El-Kammah, 2001. Studies on chicken acquired resistance to *Argas (persicargas) persicus* (Acari: Argasidae) due to repeated infestation. *J. Egyptian Soc. Parasitol.*, 31: 467–77
- Hafeez, A. and M. Irfan, 1982. Pathology and pathogenesis of experimentally produced spirochaetosis in poultry through *Argas persicus*. *Postgraduate Research in Veterinary Science*, pp. 84–5. University of Agriculture Faisalabad, Pakistan
- Hassanain, M.A., M.F. El-Garhy, F.A. Abdul-Ghaffar, A. El-Sharaby and K.N. Abdul Megeed, 1997. Biological control studies of soft and hard ticks in Egypt. I. The effect of *Bacillus thuringiensis* varieties on soft and hard ticks (Ixodidae). *Parasitol. Res.*, 83: 208–13
- Hoogstraal, H., M.N. Kaiser and G.M. Kohls, 1968a. The Subgenus *Percicargas* (Ixodoidea, Argasidae, Argas). *Argas robertsi*, New Species, A Parasite of Australian Fowl and Keys to Australian Argasid species. *Ann. Entomol. Soc. America*, 61: 535–9
- Hoogstraal, H., M.N. Kaiser and G.M. Kohls, 1968b. The subgenus *Percicargas* (Ixodoidea, Argasidae, Argas) *zumpti*, New species, a parasite of the South African cape vulture. *Ann. Entomol. Soc. America*, 61: 744–9
- Hoogstraal, H and M.N. Kaiser, 1973a. Observations on the subgenus *Argas* (Ixodoidea: Argasidae, Argas) *himalayensis*, New species, parasitizing the snow partridge, *Lerwa lerwa*, in Nepal. *Ann. Entomol. Soc. America.*, 66: 1–3
- Hoogstraal, H and M.N. Kaiser, 1973b. The subgenus *Percicargas* (Ixodoidea, Argasidae, Argas) *nullarborensis*, new species, from western Australia. *Ann. Entomol. Soc. America*, 66: 1296–8
- Ishiguro, F., S. Wada and K. Inada, 1997. Isolation of Lyme *Borrelia* from ticks fed on birds in the Nyu highland Fukui prefecture. *J. Japan Vet. Med. Assoc.*, 50: 555–8
- Kachekova, Sh. and B.A. Frolov, 1978. Insecticidal and acaricidal activity of pyrethroids against poultry ectoparasites. *Problemy-Veterinarnoi-Sanitarii.*, 61: 61–3
- Kaiser, A., A. Seitz and O. Strub, 2002. Prevalence of *Borrelia burgdorferi* sensu lato in the nightingale (*Luscinia megarhynchos*) and other passerine birds. *Intl. J. Med. Microbiol.*, 33: 75–9
- Karim, A.R.M., B.A. Jassim and N.S. Naser, 1988. Infestation and occurrence of ectoparasites (lice, ticks and mites) of pigeons in Erbil area. *Bull. Entomol.*, 29: 173–7
- Keirans, J.E and L.A. Durden, 2001. Invasion: exotic ticks (Acari:Argasidae, Ixodidae) imported into the United States. A review and new records. *J. Med. Entomol.*, 38: 850–61
- Khan, K.N.M., M. Irfan and R.M. Nagra, 1986. Experimental transmission and pathology of avian spirochaetosis. *Pakistan Vet. J.*, 6: 160–5
- Khan, L.A., 2001. Studies on the prevalence, economic losses and chemotherapy of tick infestation on commercial layers. *M.Sc. Thesis, Faculty Veterinary Science, University of Agriculture Faisalabad, Pakistan*
- Kinsey, A.A., L.A. Durden, J.H. Oliver Jr., 2000. Tick infestations of birds in coastal Georgia and Alabama. *J. Parasitol.*, 86: 251–4
- Kohls, G.M. and C.M. Clifford, 1968. The Subgenus *Percicargas* (Ixodoidea, Argasidae, Argas) *giganteus*, from wild birds in western United States and Sonora, Mexico., *Ann. Entomol. Soc. America.*, 61: 1113–6
- Kraiss, A. and R. Gothe, 1982. The life cycle of *Argas* (*Argas*) *africolumbae* under constant abiotic and biotic conditions. *Vet. Parasitol.*, 11: 365–73
- Kuliscic, Z., M. Milutinovic, B. Pavlovic, B. Bobic and N. Aleksic, 1995. Investigation of Ixodid and Argasid ticks on some mammals and birds in the extended area of Belgrad. *Acta – Veterinaria, – Beograd*, 45: 323–30
- Kumar, S., S. Prakash, M.P. Kaushik and K.M. Rao, 1992. Comparative activity of three repellants against the ticks *Rhipicephalus sanguineus* and *A. persicus*. *Med. Vet. Entomol.*, 6: 47–50
- Labrun, M.B, S.L. Souza, A.C. Menezes, M.C. Horta, A. Pinter and S.M. Gennari, 2002. Life-cycle and host specificity of *Amblyomma*

- tigrinum* (Acari: Ixodidae) under laboratory conditions. *Exp. Appl. Acarol.*, 26: 115–25
- Labruna, M.B., E.Y. Fugisaki, A. Pinter, J.M. Duarte and M.J. Szabo, 2003. Life cycle and host specificity of *Amblyomma triste* (Acari: Ixodidae) under laboratory conditions. *Exp. Appl. Acarol.*, 30: 305–16
- Leeflang, P. and A.A. Iemobade, 1977. Tick borne diseases of domestic animals in northern Nigeria. *Trop. Anim. Hlth. Prod.*, 9: 211–8
- Li, R.A. and V.S. Yarnykh, 1981. Efficacy of ectocide (a pyrethrin preparation) against poultry ectoparasites. *Tok. Zas. Sko. Zhi. ekto.-Toxico. antiparasitic-agents-and protection-of-farm-animals - from-ectoparasites*, p. 48–53
- Mir, A.S., B.A. Pandit, R.A. Shahardar and M.A.A. Banday, 1993. Prevalence of ectoparasites in indigenous fowls of Kashmir valley. *Indian Vet. J.*, 70: 1071–2
- Mock, D.E., R.D. Applegate and L.B. Fox, 2001. Preliminary survey of ticks (Acari: Ixodidae) parasitizing wild turkeys (Aves: Phasianidae) in eastern Kansas. *J. Med. Entomol.*, 38: 118–21
- Mousa, S., N. Gad, A. Soliman, I. Sakkar and M. Abdel Raheem, 1988. Investigations on the efficacy of ivermectin for ectoparasites and nematodes in chicken. iii. Effect of oral administration of ivermectin on different stages of *A. persicus*. *Assiut Vet. Med. J.*, 19: 190–4
- Nemova, N.V., A.N. Alekseev, M.A. Kostukov, Z.E. Gordeeva and A.U. Kuima, 1990. An experimental study of the reproduction of the Hissar virus (Bunyaviridae) in *Argas persicus* ticks. *Med. Parazitol.*, 1: 35–6
- Norval, R.A.I., N.J. Short and M. Chisholm, 1985. The ticks of Zimbabwe. X111. The distribution and ecology of *Argas walkerae*. *Zimbabwe Vet. J.*, 1: 44–53
- Okaeme, A.N., 1988. Ectoparasites of guinea fowl (*Numidia meleagris galeata pallas*) and Local domestic chicken (*Gallus gallus*) in southern Guinea, Nigeria. *Vet. Res. Commun.*, 12: 277–80
- Orichova, M., O.M. Osman and A.A. Ali, 1978. A note on *Argas persicus* in Khartoum province, Sudan. *Bull. Anim. Hlth and prod.*, 26: 321–8
- Oyoun, L.M.I., K.M. El-Kammah, M.H. Madbouly, S.M. Habeeb and K.M. El-Kammah, 1990. Ecological studies on poultry ticks and life cycle study of *Argas hermanni*. *Bulletin-de-la-societe-Entomologique-d. Egypte.*, 69: 287–94
- Pavlovic, I., V. Hadina, V. Blazin, Z. Ilic and B. Miljkovic, 1988. Ectoparasitosis caused by *Argas persicus* ticks on a private poultry farm and its control. *Veterinarski - Glasnik*, 42: 9,585–9
- Pavlovic, I. and D. Nestic, 1991. Parasite fauna in intensively farmed poultry in Serbia in 1989. *Veterinarski Glasnik*, 45: 245–7
- Permin, A. and J.W. Hansen, 1998. Epidemiology, diagnosis and control of poultry parasites. *FAO, Rome*, pp. 4–56
- Permin, A., J.B. Esmann, C.H. Hoj, T. Hove and S. Mukaratirwa, 2002. Ecto-endo and haemoparasites in free range chickens in the Goromonzi district in Zimbabwe. *Prev. Vet. Med.*, 25: 213–24
- Petrov, D., 1972. Role of *Argas persicus* in the epidemiology of Newcastle disease. *Veterinarnomeditsinski-Nauki*, 9: 13–7
- Petrov, D. and G. Gecheva, 1975. Study of some biological peculiarities of *Argas persicus*. *Vet. Med. Nauki*, 12: 25–32
- Phulan, M.S., W.M. Bhatti and S.N. Buriro, 1984. Incidence of *Argas persicus* in poultry. *Pakistan Vet. J.*, 4: 174–5
- Rashid, J., and A. Ali, 1991. Comparative study of pathogenicity of experimentally produced *Borrelia anserina* infection in commercial and desi chicks. *Pakistan J. Zool.*, 23: 361–2
- Reid, W.M., 1956. Incidence and economic importance of poultry parasites under different ecological and geographical situations in Egypt. *Poult. Sci.*, 35: 926–33
- Rodey, M.V. and J.L. Soni, 1977. Epidemiology of spirochaetosis in chickens: effective measures for control of ticks – *Argas persicus*. *Poult. Guide*, 14: 10, 35–7
- Rosenstein, M., 1976. Paralysis in chicken caused by larvae of the poultry tick, *Argas persicus*. *Avian Dis.*, 20: 407–9
- Sa-idu-L, R.I., S. Agbede and A.P. Abdu, 1995. Prevalence of avian spirochaetosis in Zaria (1980–1989). *Israel J. Vet. Med.*, 50: 39–40
- Schwan, T.G., M.D. Corwin and S.J. Brown, 1992. *Argas (Argas) monolakensis*, new species (Acari: Ixodoidea: Argasidae), a parasite of California gulls on islands in Mono Lake, California: description, biology, and life cycle. *J. Med. Entomol.*, 29: 78–97
- Sheikh, M.A., 1991. Taxonomical study of ectoparasites of indigenous poultry and effect of fowl tick (*A. persicus*) on different blood parameters. *M.Sc. Thesis*, College of Veterinary Science University Agriculture Faisalabad, Pakistan
- Sinha, R.P., R.S. Prasad, S. Roy and M. Zahinuddin, 1989. Effect of pestoban against ectoparasites of livestock and poultry. *Livestock Advisor*, 12: 26–30
- Slowik T.J. and U.S. Lane, 2001. Birds and their ticks in Northwestern California: minimal contribution to *Borrelia burgdorferi* enzootiology. *J. Parasitol.*, 87: 755–61
- Sluda, K., H. Hoogstraal, C.M. Clifford and H.Y. Wassef, 1979. Observations on the subgenus *Argas (Ixodoidea Argasidae = Argas)*. *Argas (A.) polonicus* sp. N. parasitizing domestic pigeon in Krakow, *Poland J. Parasitol.*, 65: 170–81
- Sokolov, V.D., S.R. Mamleev, A.A. Tal-drik, E.D. Klevtsov, A.S. Shcherbakov, V.V. Shornikov, T.N. Nemilova and E-Ya. Sokolov, 1980. Aerosols against poultry ectoparasites (carbamate preparation “4-74”). *Veterinaria-Moscow*, 12: 28–30
- Soliman, A.M., S.A. Mousa, N. Gad, U. Desouky and I.M. Sokkar, 1988. Rodents and ticks, as a reservoir of Mycoplasma in poultry farms. *Assiut Vet. Med. J.*, 9: 184–90
- Soni, J.L., 1979. An outbreak of tick paralysis in white leg horn chicks due to *Argas persicus*. *Indian Vet. J.*, 56: 149–52
- Srivastava, S.C., M.H. Khan and R. Moin, 1981. Note on the biology of poultry tick, *Argas persicus* (Oken) (Acarina: Argasidae). *Indian J. Anim. Sci.*, 51: 3,387–9
- Stefanov, V., I. Matev and I. Balimezov, 1975. Role of ticks of the species *Argas persicus* in the epizootology of pullorum disease in birds. *Vet. Med. Nauki*, 12: 45–50
- Tian, Q.Y. and Y. Guan, 1989. Sensitivity test of *Argas persicus* to 4 acaricides and the use of deltamethrin dips to kill *A. persicus* on chicken. *Chinese J. Vet. Med.*, 15: 24–5
- Tsanov, Ts.S., 1983. Epizootiology of aegyptianellosis in poultry. *Vet. Med. Nauki.*, 20: 41–6
- Ugochukwu, E. and F.A. Omije, 1986. Ectoparasitic fauna of poultry in Nsukka. *Int. J. Zoon.* 13: 93–7

(Received 23 August 2004; Accepted 10 September 2004)