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Review Paper

Common Ectoparasites of Ostrich (*Struthiocamelus*) and their Control-A review

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Abstract

Parasitic diseases generally constitute major impediments on husbandry, productivity and welfare of poultry. Extensive studies have been conducted on the endoparasites of ostrich, limiting their production through retardation in growth, poor health conditions, reduced egg production, lowered and overall sustainability. However, little is known about the common ectoparasites of ostrich and their control strategies. This paper aims to review theectoparasites of ostrich, where known, their involvement in disease transmission and control measures. Epidemiology, diagnosis and control of these ectoparasites were also discussed. The common ectoparasites of ostrich include; ticks (Amblyomma spp, Hyalomma spp, Rhipicephalus spp, Haemaphysalis and Argus), mosquitoes (Aedes spp and Culex), flies (Struthiobosca spp and Pseudolynchia canariensis), mites (Pterolichus spp) and Lice (Struthiolipeurus spp). Control measures include; use of insecticides, pesticides and other alternative biological control methods. We conclude that a number of ectoparasites are found in ostriches and significant advances in their control are most likely to come through an integrated approach adopting recent research into existing and novel control strategies; this is being combined with improved monitoring and modeling to better inform treatment intervention. This study has provided base line data for future studies on alternative control of ectoparasites. This has implication on the increase in protein production for human consumption and zoonosis.

Keywords: Ectoparasites, endoparasites, fleas, lice, mites, Nigeria, ostrich, ticks.

Introduction

Ostrich (*Struthio camelus*) is the largest and heaviest living bird and is the only bird with just two toes and sole representative of the order *struthioniformes*[1,2]. Ostriches produce red meat similar in both taste and texture to veal and beef meat and have been reported to be of high protein, and low cholesterol than any other protein of animal origin[3-6]. The ostrich industry is considered as a multi-processing business producing a number of commodities which include; leather, fat and feathers (high fashion clothing)[7]. Ostrich farming is still in its infancy stage in comparison to the poultry industry, and many years of research and development are needed in order to reach levels of medical and technological development similar to those found in poultry farming today[8]. Preventive medicine, public health and welfare of the ostriches as poultry are the most significant issues in the future development of ostrich production[9]. Ectoparasitism is considered as a potential health problem hindering the development of ostrich production resulting in economic losses[10,11]. Generally, avian ectoparasites burrow, live on, or puncture into the epidermis, hair or feathers of their host for feed or shelter[12,13]. This exerts strong selection pressures on the avian hosts by lowering nestling survival and growth, increasing the cost of sexual ornamentation, reducing future reproductive success, and in some cases ultimately death[14-16]. The presence of salivary and fecal antigens from burrowing ectoparasites (eg sarcoptes spp) can result in significant hypersensitivity in some animals including ostrich[17]. Furthermore, Feeding activity of some of the ectoparasites such as ticks (eg *Amblyomma* spp) may result in significant blood loss, secondary infestations, pruritus, cellulitis, excoriation, excessive pruning, feather and skin destruction and in some cases premature death[18]. These ectoparasites may also cause indirect harm including behavioural disturbances, such as increased frequency of rubbing or scratching, leading to reduced time in feeding and, in some cases, to self-inflicted wounds[17,19-21]. More significantly, some ectoparasites may act as vectors of protozoa (*Eimeria* spp)[22], bacteria (*Clostridium* spp)[23], viruses (Crimean-Congo haemorrhagic fever)[24], cestodes (*Houttuynia struthionis*)[22] and nematodes (*Libyostrongylusdouglossii*)[25]. Although relatively few in number, through their direct and indirect effects on their hosts, the various species of arthropod ectoparasites have a major effect on the husbandry, productivity and welfare of poultry including ostrich[26-28]. Most health problems in ostriches occur during the first three months of life with mortality ranging between 30-40% which is commonly accepted by many as normal[1,29]. Although there are several other factors that can affect ostrich farming and production, ectoparasitism constitutes some of the major constraints to a viable ostrich farming[1]. Insects including ticks, mites and lice, are the most common and widespread ectoparasites affecting ostriches of all ages. Although most of these ectoparasites are of minor economic

importance, some have however been recognized as causing serious economic losses[8]. The identification and control of these ectoparasites is therefore of great significance. The first and necessary step before implementing appropriate control measures is to know where these ectoparasites can be found in ostrich. In general, little is known about the ectoparasites, not only in their original distribution areas but also in the importing countries. In this paper, an attempt has been made to draw together some salient points concerning the common ectoparasites of ostrich. Appropriate prophylaxis, treatment and major control strategies have been outlined in each case and, where available, references are given to allow for further study of a particular ectoparasite.

An overview of common ectoparasites of ostrich

There are several types of arthropods that constitute the major ectoparasites of ostrich, primarily ticks, fleas, mites and lice[30]. A small number of adult ticks feeding on a small bird can cause anaemia, reduced growth, weight loss and contribute in other ways to a depressed state of health[31]. Birds have also, been reported to suffer tick paralysis, which is a motor paralysis or paralysis of the voluntary muscles from bites of Ar gas species[32]. Ectoparasites, including chewing lice, can impact upon body condition, fitness, and long term survival of their hosts[33]. The impact of ectoparasites on energetics may also be responsible for significant drop in the rate of male courtship display, and thus in the ability of heavily infested males to attract mates[33]. These ectoparasites are hereby enumerated below;

Ticks

Ticks of various species and different life stages infest ostriches and high infestation is associated with areas of high rainfall and dense vegetation[34-36]. The most common site of attack for ticks (80%) is the head and neck. A preferred site of attachment is under the chin[8]. The negative economic significance of ticks for the ostrich industry is twofold. Firstly, ticks do not only cause discomfort to the birds but also mark the hide, thereby reducing its economic value. Secondly, some species of ticks are known carriers of the rickettsial organism that causes "heart water disease" cowdriosis[8,37]. In addition, the long mouth parts of the tick cause extensive damage to the skin when they tunnel through the skin[38]. The ticks (Acani: Ixodidae) (e.g. *Hyalomma* and *Ambylomma* spp.) are common parasites of the ostrich in its native African environment, their main significance being disease vectors during heavy infestations causes ill thrift, slow growth and low egg production[39]. These include the following genera/species.

Amblyomma variegatum, a three-host tick, is one of the most important and widely distributed of the Amblyomma ticks[40,41]. In Zimbabwe, the most commonly occurring Amblyomma species is *Amblyomma hebraeum*, which in the adult stage is parasitic on ostriches and other large animals[41]. Both *A. variegatum* and *A.hebraeum* (bont ticks) are responsible for the transmission of *Rickettsia africae* (Rickettsiales: Ricketsiaceae), the etiological agent of African tick bite fever (ATBF)[42]. Ticks become infected by feeding on the blood of a viraemic or rickettsaemic vertebrate animal. Infection in these tick species is chronic and spans the lifetime of the vector, and ticks appear to be both vector and reservoir for these pathogens[43]. Other notable *Amblyomma* spp in ostriches include; *Amblyomma gemma*-Bont tick from Tanzania and *A. lepidum*[44].

Hyalomma rufipes and *H. truncatum* ("bont poot" ticks),atwo or three host tickand is involved in the transmission of diseases such as Crimean-Congo haemorrhagic fever (CCHF) virus (Bunyaviridae: Nairovirus) and *Rickettsia africae* (Rickettsiales: Ricketsiaceae), the aetiological agent of African tick-bite fever (TBF), are medically important, endemic tick-borne pathogens in South Africa[45,46]. Ticks become infected by feeding on the blood of a viraemic or rickettsaemic vertebrate animal. Infection in these tick species is chronic and spans the lifetime of the vector, and ticks appear to be both vector and reservoir for these pathogens[43]. Examples of these are East Coast fever, tropical theileriosis, Malignant *Rickettsia africae* in ostriches in Zimbabwe[42]. Other significant disease borne ticks include; *Hyalomma luscitanicum, Hyalomma albiparmatum* (Bont-legged tick) (Tanzania), *H. impeltatum, Rhipicephalus appendiculatus* (Brown ear tick) and *Rhipicephalus turanicus*[47].

Argus (Ixodidae: Argasidae): These are soft bodied (soft tick), distendable ticks (*Argas persicus*) which can swell to a large size; may be a serious parasite of poultry if it becomes numerous in poultry and wild birds including ostrich and is the most important ectoparasite of poultry[48]. *Argas persicus* have also been implicated in the transmission of bacterial, rickettsial, protozoan and viral diseases and heavy infestations cause anaemia, ill thrift, slow growth and low egg production[49]. Unlike ixodid ticks, they are intermittent feeders (outside the larval stage) and do not remain on the host for a prolonged length of time. Their habits are very similar to those of bed bugs, given that they feed for very brief periods of time, spending most of their time in secluded areas (cracks and crevices in homes, rodent burrows, and under rugs and carpeting, etc.)[46]. Blood loss from the feeding of larvae and nymphs of soft ticks may even cause fatal anemia. In many tropical countries it has prevented the rearing of imported breeds of poultry including ostrich[50].

Control

In general, infestations byticks are treated by regular and thorough spraying with synthetic pyrethroids or by dosing or injecting with ivermectin. Preparations containing lindane should not be used as this is highly toxic to ostriches[8, 29].

Insects

Biting insects are notorious for irritating ostriches causing stress when they attack in large numbers. They may also be vectors of

Plasmodium struthionis and *Leucocytozoon struthionis* and mechanical transmitters of fowl pox virus or filariosis[8,51]. These insects include the following;

Mosquitoes (Diptera: Culicidae): *Aedes* spp and *Culex* spp of mosquitoes have been involved in the transmission of fowl pox caused by avian poxvirus. Avian poxviruses (genus *Avipoxvirus*, family *Poxviridae*) have a worldwide distribution affecting at least 3% of poultry population[52]. Avian poxvirus is an enveloped double-stranded DNA virus that may be transmitted to ostrich by mosquitoes of the order Culicidae or through mucosal membrane contact with infectious particles[53]. Infections are characterized by two main disease syndromes: a diphtheritic and a cutaneous form. The diphtheritic form, commonly fatal, follows inhalation of virus and involves mucous membranes of the oral cavity, pharynx, and trachea. The cutaneous form is characterized by nodular lesions usually involving unfeathered areas near the eyes, feet, or legs. Commonly, the pathogen is transmitted by the *Culex* spp of mosquitoes (vector-borne mechanical transmission[53,54].

Flies (Diptera: Hippoboscidae): *Struthiobosca struthionis:* Hippoboscoidea are highly specialized ectoparasitic flies with four recognized family-level taxa: Glossinidae, Hippoboscidae, Streblidae, and Nycteribiidae[55, 56]. The well-known Glossinidae (tsetse flies) are free-living and only come into close contact with their host during feeding. The other three families, Hippoboscidae, Nycteribiidae, and Streblidae, are all genuine ectoparasites (i.e., species with a trophic and a spatial association to host) spending all or most of their adult life within the furor among the feathers of their mammal and bird hosts[57]. These families exhibit a large number of unique and striking morphological and physiological adaptations, most of which are specifically associated with their ectoparasitic lifestyle. One of the most remarkable of these is adenotrophic viviparity[55,57]. The larvae develop individually in the female oviduct, where they are fed by secretions from accessory glands[58]. The fully mature 3rd in star larva is deposited either as a motile larva, which quickly pupates within its last larval skin (Glossinidae, Hippoboscidae), or as a more or less soft pre-puparium (Streblidae, Nycteribiidae). At the time of deposition, the weight of the larva can exceed the weight of the female[59]. Generally, biting insects are notorious for irritating ostriches causing stress when they attack in large numbers. They may also be vectors of *Plasmodium struthionis* and *Leucocytozoon struthionis* and mechanical transmitters of fowl pox virus or filariosis[29,51].

Miscellaneous flies include: *Pseudolynchia canariensis,* when in high numbers also irritate the birds, causing them to be restless hence interfere with their feeding and resting time [60].

Control: Best treatment is achieved with 5% carbaryl dust at fourteen-day intervals[61].

Mites: Mites of the family *Pterolichidae* are known to infest ostriches. The feather (quill, shaft) mites *Gabucinia bicaudata* (*Pterolichus bicaudatus*) of ostriches live in the vein in the ventral groove of the feather shaft and feed on blood and gelatinous contents of feather sheath. They can be visualized as small, reddish, dust-like, elongated particles in the feather vein[21,34,62-64]. They are about 0.5 µm long[64]. As ostriches moult continuously, there are always immature feathers for them to feed on, although when their population grows out of control they also attack the ski [63]. These microscopic mites live within the shaft of the feather. Damage is done to the feather when the mites pass through the quills during their life cycle[60]. The presence of the quill mites causes the birds to pull their own feathers, damaging the skin. Apart from feather loss, the stress caused may predispose the birds to other health problems, such as respiratory problems, and also reduce their reproductive ability and gastrointestinal disorders (eg impactions). The mites also cause the birds to be restless hence interfere with their feeding and resting time[60,61].

Pterolichus bicaudatus (Acari; Pterolichidae) (ostrich quill mite): The feather (quill, shaft) mites *Gabucinia bicaudata* (*Pterolichus bicaudatus*) of ostriches live in the vein in the ventral groove of the feather shaft and feed on blood and gelatinous contents of feather sheath[8,62]. They can be visualized as small, reddish, dust-like, elongated particles in the feather vein[34,63,64]. They are about 0.5 µm long[64]. As ostriches moult continuously, there are always immature feathers for them to feed on, although when their population grows out of control they also attack the skin causing scabies-like damage 8.Quill mites (*Gabucinia bicaudata*) and lice (*Struthiolipeurus struthionis*) may infest ostrich feathers, resulting in skin damage, pruritus and excessive feather preening and loss [65]. Also *G. sculpturata* is common in the ostrich[64]. *Struthiobosca struthionis* flies from one animal to another and irritates its host by sucking blood[62].

Control: The best treatment for mites is accomplished by using ivermectin, and lice are treated in a similar manner to tick infestations. Treatment for quill mites is ivermectin at 0.2 mg/kg at 30-day intervals[34,63,66,67], also reported the use of 15% cypermethrin solution by spraying, in the dilution of 1ml/l, is recommended for the control of *Struthiolipeurus* spp. in ostrich.

Lice: Lice of the genus *Struthiolipeurus* can cause intense pruritis, feather damage and feather loss[68]. Both lice and mites can be found by examining the skin and feathers, especially around the vent, legs, wings and neck. Night-time examination of birds may detect parasites that feed at night, but specific identification of the parasite requires microscopic examination[8]. Chewing (biting) lice (feather lice, ostrich lice), *Struthiolipeurus struthionis* cause skin and feather damage in ostriches (which diminish thermoregulatory capacity), and increase feather breakage[11,67]. The lice and eggs can be seen in feathers close to the skin around the vent, legs, wings and neck[34,64,69]. They are narrow-bodied lice with large heads, not sucking blood but feeding on feathers[64]. It is difficult to spot them as they can easily vanish under feathers. Struthiolipeurus eggs are deposited on feather barbs on both sides along the shaft[8]. Chewing lice

(*Ischnocera, Amblycera*) are permanent obligate ectoparasites mostly parasitic on bird species and they feed on feathers and skin scales. Although they have mouthparts designed for chewing, some of the species of Ishnocera can cause skin irritations and suck blood. Chewing lice have harmful effects that lead to decrease in productivity in host[70]. A variety of other lice may also be found on ostrich including *Struthiolipeurus nandu* and *Struthiolipeurus stresemanni*[64,69].

Struthiopterolichus bicaudatus (Acari; Pterolichidae) (lices of the genus Struthiolipeurus).

Struthiolipeurus struthionus (ostrich louse) (*S. struthionis*) both may cause pruritis and /or excessive preening and feather loss. Infestation with these external parasites causes stress and predisposes birds to secondary infections and gastrointestinal disorders (e.g. impactions)[11,7]. Lice and mites can be found by examining the skin and feathers, especially around the vent, legs, wings and neck. Night-time examination of birds may detect parasites that feed at night, but specific identification of the parasite requires microscopic examination[71].

Control: The best treatment is by using 5% carbaryl dust at 14-day intervals[72]. A variety of other lice may also be found on ostrich including *Struthiolipeurus nandu* and *Struthiolipeuruss tresemanni*[64,69]. Pyrethroids are, however, considered one of the safest pesticide groups in the control of lice because of their selective toxicity to insects [11].

Strategies for the Control of Ectoparasites in Ostrich: Control of ectoparasite infestations is generally accomplished by a number of procedures including the application of pesticides by dusting, spraying, or misting. Several insecticides are available, mainly pyrethroids, organophosphates, carbamates and synthetic pyrethroids[72]. However, residues of these insecticides in eggs, meat, or other edible ostrich products are of great concern, therefore care must be taken to follow label directions and withdrawal times[73]. Other compounds such as aldrin, benzene, chlordane, DDT, endrin or heptachlor, hexachloride, toxaphene, although highly effective, should never be used on or around equipment, ostrich and other poultry houses, feed, or feed ingredients[50]. Moreover, appropriate control and sustainable use of chemical insecticides may be achieved by directing control efforts towards threshold-based management of disease. Consequently, awareness on the primary causes of many ostrich health problems may be the factors that affect the susceptibility of the ostrich rather than these ectoparasites themselves. In order to allow this approach to be adopted, a comprehensive understanding of the relationships between these ectoparasites intensity, welfare and productivity are, in the view of the current authors, quintessential. Is control of a particular ectoparasite needed and if so when? What promotes susceptibility and how can the cycle of these ectoparasites infestation be broken? Ectoparasite infestation must therefore be designed based on achievable and realistic objectives and as this review suggests, at present, while prevalence of common ectoparasites data exist, studies which quantify the predisposing causes and effects of these ectoparasites on welfare and productivity need to be promoted, to allow such decisions to be implemented.In general, infestations by ticks, mites, flies and lice are treated by regular and thorough spraying with synthetic pyrethroids or by dosing or injecting with ivermectin and adequate sanitary measures. Preparations containing lindane should however not be used as this is highly toxic to ostriches[8].

Alternative control strategies (Ethno-veterinary plants): Due to the resistance to commercial insecticides, certain plants have been suggested as alternative for the control of ectoparasitesin ostrich and this include; ticks (*Monadenium lugardiae*, *Albizia amara*, *Aloe excelsa A.* Berger, *Bauhinia petersiana* Bolle, *Capsicum annuum L.*, *Carissa edulis* (Forssk.), *Cucumis anguria L.*, *Ornithogalum* sp, *Cissus quadrangularis L.*, *Combretum imberbe Wawra.*, *Gnidia kraussiana Meisn.*, *Maerua edulis Gilg*and *DeWolf*, *Ornithogalum* sp, *Vernonia colorata* (Willd.) Drake., *Nicotiana tabacum L.*, *Spirostachys africana Sond.*, *Strychnos spinosa Lam.*, *Terminalia sericea*, *Vigna unguiculata L.*, *Zantedeschia albomaculata* (Hook.), *Pterocarpus angolensis*, *Sansevieria hyacinthoides* (L.), *Senna singueana* (Del.), *Solanum incanum L.*, *Solanum panduriforme*, *Kleinia* sp, *Ricinus communis L.*, *Osyris lanceolata*[74]. Lice (*Aloe chabaudii*, *Rotheca eriophylla*, *Croton gratissimus Burch.*, *Lippia javanica* (Burm.f.), *Datura stramonium L.*, *Strychnos cocculoides Baker.*, *Oxytenanthera abyssinica*, Poaceae, *Jatropha curcas*, Euphorbiaceae, *Azadirachta indica* Meliaceae, *Lophira lanceolata*, Ochnaceae, *Parkia biglobosa*, Mimosaceae, *Hyptis spiciqera*, Lamiaceae, *Steqanotaenia araliacea*, Apiaceae, *Ficusexasperata* Moraceae, *Annonasenegalensis*, Annonaceae, *Tectonagrandi Verbenaceae*, *Indigofera hirsuta* Fabaceae, *Securidaca longepedunculata*, *Polygalaceaea*, *Nicotiana tabacum*, *Solanaceae*[74,75]. Mites (*Tagetesminuta L.* and *Psydrax livida* (Hiern), *Nicotiana rustica* L. (Solanaceae), *Nicotiana rustica* L. (Solanaceae) and *Thuja plicata* Donn ex D. Don[74,75].

Conclusion

The present study revealed that there are several types of arthropods that constitute the major ectoparasites of ostrich, primarily ticks, mites, flies and lice. The economic impact of most of these ectoparasites on ostrich farming is still undetermined. Some of these organisms may be pathogens to (some of) those other possible hosts. Further detailed analyses are required to determine not only their precise host-specific status, but also the risk of infection for other wild and domestic animals including poultry and man. Although it was found that these ectoparasites could be effectively controlled with known registered chemicals, further studies are needed to assess alternative new-generation chemicals for controlling such parasites on ostriches, as the continued use of a limited number of active compounds is likely to lead to resistance to treatment. The method and site of application of existing compounds (e.g. spray, pour-on) is also a topic that requires further research in ostriches.

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