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PARASITES OF *COLUMBA LIVIA* (AVES: COLUMBIFORMES) IN TENERIFE (CANARY ISLANDS) AND THEIR ROLE IN THE CONSERVATION BIOLOGY OF THE LAUREL PIGEONS

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Summary:

The prevalence and intensity of the parasites from 50 wild doves (*Columba livia*) from the city of Santa Cruz de Tenerife, in the island of Tenerife (Canary Archipelago), were studied. The following ectoparasites were found in apparently healthy pigeons (prevalences are shown in percentage (%) and mean intensities with their standard deviations): the acari *Dermanyssus gallinae* (De Geer, 1778) (6 241.0 ± 138.9) and *Tinaminyssus melloi* Fain, 1962 (10 %, 218.3 ± 117.3); the louses, *Columbicola columbae* Linnaeus, 1758 (100 %, 111.4 ± 76.8) and *Campanulotes bidentatus* Scopoli, 1763 (94 %, 48.4 ± 26.6); and the pigeon fly, *Pseudolynchia canariensis* Macquart, 1839 (36 %, 6.2 ± 1.6). The endoparasites we found, were: a haemoprotozoan species, *Haemoproteus columbae* Kruze, 1890 (82 %, 14.8 ± 10.3 per 1000); coccidian oocysts, *Eimeria* sp. (50 %, 0.2 × 10^3 ± 1.7 × 10^3 per gr); a cestode species *Raillietina micracantha* (Fuhrmann, 1909) López Neyra, 1947 (44 %, 12.3 ± 9.4); and four nematode species, *Tetrameres* (*Tetrameres*) *fissispina* (Diesing, 1861) Travassos, 1915 (4 %, 99.5 ± 34.1), *Synhimantus* (*Dispharynx*) *spiralis* (Molin, 1858) (8 %, 46.8 ± 11.6), *Ascaridia columbae* (Gmelin, 1790) Travassos, 1913 (40 %, 8.4 ± 8.8) and *Aonchotheca* sp. (18 %, 6.0 ± 3.1). Several species detected in our study can be pathogens for *C. bollii* and *C. junoniae*, which are endemic pigeons of the Canary Islands, considered endangered species. Parasites (ectoparasites, protozoa and helminths) of *C. livia* found in Tenerife and others from wild and farm birds in the island were considered as healthy controls.

KEY WORDS : *Columba livia*, ectoparasites, helminths, protozoa, Tenerife.

Résumé : PARASITES DE *COLUMBA LIVIA* (AVES : COLUMBIFORMES) DE TÉNÉRIFE (ÎLES CANARIES) ET LEUR RÔLE DANS LA BIOLOGIE DE LA CONSERVATION DES PIGEONS

*Nous avons étudié la prévalence et l'intensité des parasites trouvés chez 50 pigeons sauvages (*Columba livia*). Il s'agissait de pigeons de Santa Cruz de Tenerife, capitale de l'île de Ténérife (Îles Canaries). Nous avons représenté les prévalences en pourcentage (%) et les intensités moyennes avec leurs déviations standard. Nous avons trouvé chez des pigeons apparemment en bonne santé les ectoparasites suivants : des acariens,* Dermanyssus gallinae *(De Geer, 1778) (6 %, 241,0 ± 138,9) et* Tinaminyssus melloi *Fain, 1962 (10 %, 218,3 ± 117,3); des poux,* Columbicola columbae *Linnaeus, 1758 (100 %, 111,4 ± 76,8) et* Campanulotes bidentatus *Scopoli, 1763 (94 %, 48,4 ± 26,6); et la mouche du pigeon,* Pseudolynchia canariensis *Macquart, 1839 (36 %, 6,2 ± 1,6). D'autre part, nous avons vu des endoparasites, à savoir, une espèce de hémaprotozoaire,* Haemoproteus columbae *Kruze, 1890 (82 %, 14,8 ± 10,3 pour 1 000); des oocystes de coccidies,* Eimeria *sp. (50 %, 0,2 × 103 ± 1,7 × 103 dans 1 gr); une espèce de cestode* Raillietina micracantha *(Fuhrmann, 1909) López Neyra, 1947 (44 %, 12,3 ± 9,4); et quatre espèces de nématodes,* Tetrameres (Tetrameres) fissispina *(Diesing, 1861) Travassos, 1915 (4 %, 99,5 ± 34,1),* Synhimantus (Dispharynx) spiralis *(Molin, 1858) (8 %, 46,8 ± 11,6),* Ascaridia columbae *(Gmelin, 1790) Travassos, 1913 (40 %, 8,4 ± 8,8) et* Aonchotheca *sp. (18 %, 6,0 ± 3,1). Quelques-unes des espèces étudiées peuvent être pathogènes pour* C. bollii *et* C. junoniae*, lesquelles sont des pigeons endémiques des Îles Canaries, et sont considérées en voie de disparition. Les parasites de* C. livia *de l'Île de Ténérife (ectoparasites, protozoaires et helminthes) et d'autres trouvés dans des oiseaux sauvages et domestiques de la même île peuvent être considérés comme des indicateurs de l'état de santé.*

MOTS CLÉS : Columba livia, *ectoperasite, helminthe, protozoaire, Ténérife.*

INTRODUCTION

Pigeons are a cosmopolitan group of birds with abundant and large populations associated, in most cases, with human activities. In the Canary Islands, three species of the genus *Columba* are described, the rock dove, *C. livia*, the dark-tailed laurel pigeon, *C. bollii*, and the white-tailed laurel pigeon, *C. junioniae*. The presence of other species such as the stock dove (*C. oenas*) and the woodpigeon (*C. palumbus*) is accidental or irregular and they have been observed in the migration station. *Columba bollii* and *C. junioniae* are endemic species of the Canary Islands. Both are representatives of a characteristic habitat of the Canaries called laurel forest, the forest type with the highest plant diversity of these islands. *Columba bollii* and *C. junoniae* were considered in endangered species at the Bonn Convention 1979 on the protec-

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tion and conservation of bird species. The most common species of pigeon in the Canary Islands is *C. livia* which inhabits in forests, cities and villages. Whereas *C. livia* is considered abundant in Tenerife, only 350-400 individuals of *C. bollii* and 80-120 individuals of *C. junionae* are present in this island (Emmerson, 1985).

The parasitic fauna (arthropoda, protozoa and helminths) of *C. livia* in Europe, Asia, Africa and America is well known. Several helminth parasites decrease host survival and breeding success, and consequently, they can affect the population dynamics of their hosts (Hudson *et al.*, 1992). Helminths of *C. livia* may affect host fitness by increasing morbidity and predation risk as well as reducing clutch size, weakening body condition or altering metabolic rates (Hudson & Dobson, 1995).

In 2001, the canary government allowed the capture of several individuals of *C. livia* in the city of Santa Cruz de Tenerife, located near the laurel forest, in order to study the parasitic infections of these hosts. The aim of this study was to identify the potential risk of parasitic transmission between *C. livia* and the other two endemic and protected pigeon species (*C. bollii* and *C. junionae*) in Tenerife.

MATERIAL AND METHODS

The Canary Archipelago is located between 13° 23' to 18° 8' W and 27° 37' to 29° 24' N in Macaronesia along with the islands of Madeira, Azores, Savages and Cape Verde. Tenerife is the largest island of the archipelago. For this study, pigeons were captured throughout the year 2001 in Tenerife.

In the captured birds, plumages were examined for ectoparasites and the nasal passages were examined for nasal mites using a magnifying glass. The ectoparasites were collected with tweezers and preserved in 70° ethanol for taxonomic identification.

Blood samples were obtained from each animal and blood smears were performed, air-dried, fixed in methanol and stained with Giemsa's solution. The slides were examined under light microsocope at a magnification of 100x. Parasitized and unparasitized cells were counted to estimate the parasite intensity. Hosts were dissected and their digestive tracts, lungs and livers were examined for helminths. Cestode and nematode species were recovered and preserved in 70 % ethanol. Platyhelminths were stained with Semmichon acetocarmine, dehydrated sequentially in alcohol, cleared in xylol, and mounted in Canada balsam. Nematodes were cleared in Amann lactophenol. Faecal samples were collected from the rectum of all dissected pigeons, stored in 2.5 % (w/v) potassium dichromate solution ($Kr_2Cr_2O_7$), maintained at room temperature (23-28° C) for the coccidia sporulation and examined microscopically after flotation using saturated saline solution. Oocysts of coccidia were counted in a 1 g sample of feaces using the McMaster technique.

Several specimens of four nematode species were prepared for Scanning Electronic Microscopy (SEM) study following the general methodology described in the literature (Miquel *et al.*, 1995). The specimens were examined with an electron microscope (Hitachi S-2300). Statistical χ^2 and ANOVA tests were used to determine differences in the prevalences and mean intensities of parasites between males and females of *C. livia* and between seasons (Bush *et al.*, 1997). Species counts were log transformed to normalize the distribution.

RESULTS

A total of fifty pigeons were examined. Five ectoparasite species were recovered and representative specimens were deposited at the Natural History Museum of Tenerife: *Tinaminyssus melloi* Fain, 1962, (accession no. TFMC/AC-18) *Dermanyssus gallinae* (De Geer, 1778) (TFMC/AC-17) (Dermanyssidae) [Acari]; *Campanulotes bidentatus* Scopoli, 1763, (TFMC/ML-16) *Columbicola columbae* Linnaeus, 1758 (TFMC/ML-15) (Phylopteridae) [Mallophaga]; and *Pseudolynchia canariensis* Macquart, 1839 (TFMC/DI-387) (Hippoboscidae) [Diptera]. The ectoparasite species were collected from the plumage of the hosts except for *T. melloi* which was recovered from the nasal passages. The mallophaga were found with high prevalences, *C. columbae* was present in all the examined pigeons and *C. bidentatus* in 94 % of the doves, with a mean intensity and a standard deviation of 111.4 ± 76.8 and 48.4 ± 26.6, respectively. *Pseudolynchia canariensis* was found in 18 hosts (36 %) with a mean intensity of 6.2 ± 1.6. *Tinaminyssus melloi* and *D. gallinae* was found with lower prevalences (10 % and 6 %, respectively) but with high mean intensities, 218.3 ± 117.3 for *T. melloi* and 241.0 ± 138.9 for *D. gallinae*.

Two species of protozoa were found: *Haemoproteus columbae* Kruze, 1890 (Haemoproteidae) in 82 % of the examined animals, with a mean intensity of 14.8 ± 10.3 infected cells per 1,000 red blood cells, and *Eimeria* spp. (Eimeriidae) in the faeces of 50 % of the doves with a mean of $0.2 \times 10^3 \pm 1.7 \times 10^3$ per gr.

Helminth species recovered from the parasitized doves were deposited in the Natural History Museum of Tenerife: *Raillietina micracantha* (Fuhrmann, 1909) López Neyra, 1942 (accesion no. TFMCCS/0006) (Davaineidae) [Cestoda], *Tetrameres* (*Tetrameres*) *fissispina* (Diesing, 1861) Travassos, 1915 (TFMCNA/0006) (Tetrame-

ridae), *Synhimantus* (*Dispharynx*) *spiralis* (Molin, 1858) (TFMCNA/0007) (Acuariidae), *Ascaridia columbae* (Gmelin, 1790) Travassos, 1913 (TFMCNA/0008) (Ascaridiidae) and *Aonchotheca* sp. (TFMCNA/0009) (Trichuridae) [Nematoda]. *Raillietina micracantha* was first described by López Neyra (1947) and Joyeux & Baer (1936). Only males of *T. (T.) fissispina* were found whereas individuals of both sexes were recovered from *S. (D.) spiralis* and *A. columbae*. Species identification of these nematodes was carried out by metrical measurements and SEM studies.

Raillietina micracantha, was presented with a prevalence of 44 % and a mean intensity and standard deviation of 12.3 ± 9.4. The most prevalent nematode was *A. Columbae* which was found in 40 % of the studied hosts with a mean intensity of 8.4 ± 8.8, followed by *Aonchotheca* sp. (18 %, 6.0 ± 3.1). The oesophagial nematodes appeared in a lower number of the doves, with prevalences and mean intensities of 8 % and 46.8 ± 11.6 in *S. (D.) spiralis*, and 4 % and 99.5 ± 34.1 in *T. (T.) fissispina*.

No significant differences in the prevalences and mean intensities of the parasites were found between host sexes. The parasite species were found in all seasons with NS seasonal differences in the prevalences and mean intensities for any species.

DISCUSSION

Ectoparasite species found in our study are commonly cited in Columbiformes and specifically in *C. livia*. *Campanulotes bidentatus* has been recovered from several *Columba* species (Cordero del Campillo *et al.*, 1994). *Columbicola columbae* infects different families of birds, for example Turdidae and Accipitridae (Cordero del Campillo *et al.*, 1994). *Tinaminyssus melloi* is a cosmopolitan species of domestic pigeons (Pence, 1973) and has been reported at another related genera of hosts, such as *Streptopelia* (Cordero del Campillo *et al.*, 1994). *Dermanyssus gallinae* (De Geer), the cosmopolitan poultry red mite or chicken mite, is an economically important ectoparasite of domesticated fowl (Kettle, 1993). It may become a serious pest, causing irritation and anemia and in some cases even death of its host (Kirkwod, 1967). *Dermanyssus gallinae* feeds on the blood of domestic fowl, caged birds and pigeons as well as wild birds (McGarry & Trees, 1991), and it may eventually attack mammals (Ducan, 1957; Hoffman, 1987).

It is interesting to realize that in the low number of examined hosts, the presence of *P. canariensis* and *H. columbae* has considered usual. The pigeon fly, *P. canariensis*, is the intermediate host of this haemoproteid which lives in the nest of the pigeon (Garnham, 1966), and it was incriminated as the vector of *H. columbae* in natural (Klei & de Giust, 1975) and experimental infection (Ahmed & Mohammed, 1977). *Haemoproteus columbae* is the only haemoparasite found in blood smears of the doves examined. It is a common and cosmopolitan parasite of the domestic pigeon in most parts of the world (Garnham, 1966), and it has been found in different species of wild doves of the genera *Zenaida*, *Columbina* and *Scardafell* (Adriano & Cordeiro, 2001), although it is not considered pathogenic. The high prevalence may involve behavioral aspects or some physiological condition within the species (White *et al.*, 1978). From a behavioural point of view, *C. livia* inhabits in Tenerife in large flocks which eases the transmission of vectors and leads to a high prevalence and intensity of parasites.

Eimeria is probably one of the most frequent genera of coccidia in nature (del Cacho *et al.*, 1999). *Eimeria* spp. from pigeons are clearly considered pathogens with a morbidity in young individuals that could rise up to 15-70 % but it is not a pathogen in mature doves (Cordero del Campillo & Hidalgo Argüello, 1999).

Besides *C. livia*, only two other species of this genus are examined for helminths, *C. inornata* and *C. oenas*. In both of them, only one species was found, *Tanaisia bragai* dos Santos, 1934 in Puerto Rico (Arnizaut *et al.*, 1992) from *C. innornata* and *Raillietina echinobothrida* (Megnin, 1880) from *C. oenas* in Spain (Cordero del Campillo *et al.*, 1994). Rock doves from Tenerife harboured a helminth community relatively poor in species if it is compared to many other populations of pigeons of this species. For *C. livia*, a total of 47 helminth species have been cited in the world.

Three species of digenean trematodes [*Brachylaima columbae* Mazzanti, 1899, *Brachylaima fuscata* Rudolphi, 1819 and *Echinoparyphium recurvatum* (Linstow, 1873) Luhe, 1909] were found in *C. livia* from Europe (Catelli *et al.*, 1999; Cordero del Campillo *et al.*, 1994; Kulisic, 1988; Martínez-Moreno *et al.*, 1989). No digeneans were found in our study. In the prospected urban area, terrestrial and aquatic snails seemed to be unimportant in the diet of *C. livia*, but in the laurel forest, with a high diversity and abundance of terrestrial snails, it could be possible that *C. bollii* and *C. junoniae* include these potential intermediate hosts of brachylaimid trematodes (Pojmanska, 2001), in their diets. Davained cestodes, mostly from the genus *Raillietina* Schmidt (1986) or *Raillietina*, *Skrjabinia* and *Furhmannetta* (Jones & Bray, 1994) are dominant species in the fauna of plathyhelminthes against anoplocephalids and hymenolepidids (Foronda, 2002). Only one species, *R. micracantha*, has been previosly cited in the Canary Islands parasitizing *C. livia* (Gijón Botella *et al.*, 1989).

The African mainland is near the Canary Islands (only 100 km away). Individuals of *C. livia* could originally be from Africa but no genetic data on the Canarian and African populations are available. In view of our results, it is difficult to confirm the hypothesis of an interelation between Africa and the Canaries from the helminthological point of view. As in Tenerife, no digeneans were cited in *C. livia* from Africa. The species of the genus *Raillietina* are not good indicators of the geographical origin of *C. livia* in the Canary Islands, because African species of this genus parasitizing rock doves have not been named (Mushi *et al.*, 2000). *Cotugnia digonopora* (Davaineidae) is presented in African and Asian pigeons (Ibrahim *et al.*, 1995; Patel *et al.*, 2000) but it is absent in Tenerife. We compared the helminth fauna of *C. livia* in Tenerife with that of Iberian Peninsula, from the same host, because the human introduction of *C. livia* from Iberia into the Canaries is well known. All the species found in the rock dove in Tenerife were previously denounced in the Iberian Peninsula but they seem to be poor geographic indicators. The endemic cestode species found in Spanish doves, *Hymenolepis cordobensis* Jordano, 1952 was not found in Tenerife. From the rest of cestodes cited in the Iberian Peninsula in *C. livia* (*Choanotaenia infundibulum, Killigrewia delafondi, Paradicranotaenia anormalis, R. echinobothrida, R. joyeuxi, R. micracantha, Furhmannetta pluriuncinata, Skrjabinia bonini, Sobolevicanthus columbae*) (Cordero del Campillo *et al.*, 1994), only *R. micracantha* seems to have possibly been introduced from Spain into the Canary Islands, but this species is widely distributed in this host in Europe (Foronda, 2002) and it is not an specific parasite, for it has been obtained from several genera of birds (*Turdus, Columba* and *Stigmatopoelia*) (Schmidt, 1986). The species, *C. infundibulum* Bloch, 1779 cited in *C. livia* in Spain (Cordero del Campillo *et al.*, 1994) was found in Tenerife parasitizing *Alectoris barbara* (Phasianidae) [Foronda, 2002, Foronda "unpublished data" (GeneBank accession n° AJ555171-AJ555172)]. As well as in *C. livia*, the presence in Tenerife of introducted farm specimens of *Alectoris* sp., from the Iberian Peninsula, could explain the introduction of *C. infundibulum* in the Canary Islands.

Paleartic cestodes of *C. livia* which have been not cited in the Iberian Peninsula for this host, includes the davaineid, *Davainea proglottina* from Serbia (Kulisic *et al.*, 1996) and *R. tetragona* from Greece (Githkopoulos & Liakos, 1987), Italy (Tacconi *et al.*, 1993) and Serbia (Kulisic *et al.*, 1996). However they were reported in Iberia in other hosts, *D. proglottina* was found in chickens, and *R. tetragona* in chickens, *Alectoris rufa* and *Meleagridis gallopavo* (Cordero del Campillo *et al.*, 1994).

The nematode fauna of *C. livia* in Tenerife includes only a habronematoid, an acuarioid, an ascarid and a thrichurid species. *Tetrameres fissispina* was identified by SEM. This species has a wide range of distribution parasitizing farm birds. Moreover, other wild bird species such as *Larus larus* and *Tardona tardona* have been cited as hosts of this nematode. From the north to the south of Spain, this species is widely distributed in diverse bird species (Cordero del Campillo *et al.*, 1994). *Synhimantus spiralis* is present in all biogeographical regions parasitizing Galliormes, Columbiformes and Passeriformes (Hwang *et al.*, 1691). The low specificity of this nematodes for the definitive hosts and the high apparent adaptation of their life cycle in Tenerife could be an important risk for *C. bollii* and *C. junionae* because both, *T. fissispina* and *D. spiralis*, are often capable of causing the death of infected animals (Tarazona Vilas, 1999).

Ascaridia columbae is a typical parasite of *Columba* spp. with a cosmopolitan distribution (Foronda, 2002) that can also affect other genera, such as *Zenaida* (Barus & Herrera Rodríguez, 1969). This parasite causes weight loss and diarrhoea in heavy infections similar to capillariosis in the parasitized birds (Tarazona Vilas, 1999).

The dark-tailed laurel pigeon and the white-tailed laurel pigeon are endemic to the Canary Islands. *Columba bollii* is classified as Rare by IUCN (Groombridge, 1993) and considered Vulnerable at world level (Collar *et al.*, 1994). *Columba junoniae* is classified as Vulnerable at global and European levels (Collar *et al.*, 1994) and it is classified as Rare by IUCN (Groombridge, 1993). Both species were also listed in Annex I of the EU Wild Birds Directive and the Appendix II of the Bern Convention. The diet of both pigeons consists mainly of fruit (Emmerson, 1985). In *C. bolli* besides fruit, the birds feed on leaves, shoots, and leaf and flower buds, and they may, if the opportunity arises, supplement their diet with small invertebrates (Emmerson, 1985).

Only one important viral disease, the Newcastle, is considered dangerous for *C. bollii* and *C. junoniae* (Action Plan for the dark-tailed laurel pigeon, and Action Plan for the white-tailed laurel pigeon, SEO/BirdLife International, Tenerife) due to the absence of data from other parasitic diseases. Our faunistical study of *C. livia* in Tenerife shows that parasite diseases (arthropods, protozoa and helminths) could produce dangerous diseases in the endemic dove populations in Tenerife. Parasites detected in *C. livia* in Tenerife are considered generally as species with a low degree of specificity due to the fact that they are able to establish in different species of Columbiformes and other hosts with a wide range of distribution in the world, therefore it is reasonable to consider them as threats to the endangered species. In the view of the *C. livia* parasites that were found in native and introduced bird species in Tenerife (Foronda, 2002) we consider that an increase

in the frequency of health controls on wild and farm birds in the Canary Islands would be highly recommendable.

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