

## OCCURRENCE OF CHEWING LICE ON SPANISH RAPTORS

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**SUMMARY.**—*Occurrence of chewing lice on Spanish raptors.* Between 1985 and 1992, 304 falconiform birds of 21 species were surveyed for ectoparasites, mainly chewing lice (Insecta: Phthiraptera). The genera (and in most cases, the species) of the louse populations were determined, both qualitatively and quantitatively. The mean prevalence obtained reached almost 42 %, the number of parasites ranging from 1 to 324 (mean value =  $30.1 \pm 44.1$  lice/host parasitized). Data on seasonal prevalence, intensity of parasitism, and location on the host are presented. The moult of birds was the only factor studied affecting significantly the prevalence and intensity of parasitism.

**Key words:** Occurrence, Phthiraptera, Spanish raptors.

**RESUMEN.**—*Frecuencia de la parasitación por piojos masticadores en rapaces españolas.* Entre los años 1985 y 1992 se muestraron 304 aves de presa pertenecientes a 21 especies con objeto de estudiar los ectoparásitos, principalmente los malófagos (Insecta: Phthiraptera). Se determinaron los géneros (y en muchos casos las especies) de las poblaciones de piojos, tanto cualitativa como cuantitativamente. La prevalencia media alcanzó casi el 42 %, variando el número de parásitos entre 1 y 324 (media =  $30.1 \pm 44.1$  piojos/hospedador parasitado). Se presentan datos sobre la prevalencia estacional, intensidad de la parasitación y localización en el hospedador. La muda de las aves fue el único factor estudiado que afectó de forma significativa la prevalencia e intensidad de la parasitación.

**Palabras clave:** Frecuencia, Phthiraptera, rapaces españolas.

### INTRODUCTION

The Mallophaga are a group of economically important ectoparasitic insects infesting birds and mammals. They do not only affect the fitness, viability and productivity of their hosts, but also play a role as reservoirs and in the transmission of infectious diseases among them (Saxena & Agarwall, 1983; Lee & Clayton, 1995; Clayton & Tompkins, 1995). Mallophagosis, or louse infestation, is commonly reported in birds of prey, each host species usually being parasitized by several species of lice which occupy the different habitats or niches provided by the host plumage. Heavy infestations are probably caused by the confluence of several host and environmental factors (Klockenhoff *et al.*, 1973), and cases proving fatal to birds have been reported (Zlotorzycka & Danecki, 1969). On the other hand, methods for treatment of ectoparasites of birds of prey have been also improved (Cooper, 1985).

Lice that parasitize raptors have been previously surveyed, mainly for taxonomic purposes. Nevertheless, data on these louse populations (e.g., structure, seasonal dynamics or prevalence on hosts) are scarce and, generally, were obtained from a small sample (Zlotorzycka, 1974; Kutzer *et al.*, 1980). Recently, significant data on the occurrence of lice and other parasites on migrating raptors have become available (Cooper *et al.*, 1993).

In this paper data on the occurrence of chewing lice on several species of Spanish birds of prey are presented, and the possible influence of several factors on the infestation level or intensity is discussed.

### MATERIAL AND METHODS

In Spain all raptor species have become protected by law in the last decades. Nevertheless, human pressure is often considerable. Mainly for this reason, the study of free-li-

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ving specimens was avoided and material was collected from birds arriving to several recuperation centres distributed throughout southern Spain.

A total of 304 birds of 21 species was sampled (Table 1) within 24 hours after reception to avoid as far as possible non-natural conditions and contaminations. In order to obtain live material for different studies, the use of diethyl ether or insecticide together with a plastic bag was avoided. The birds were handled by a person on a clean white surface and the whole plumage was profusely and systematically surveyed by another person, in order to remove, as far as possible, all mallophagan specimens found. As an average, we spent about 45 minutes preening the bird feathers (this time was longer in larger specimens, such as vultures and large eagles). Date of sampling, host species, age, sex, locality where host was taken and any observation

on its condition were recorded. The mean number of lice found per parasitized host or mean intensity (M.I.), as well as prevalence were obtained for each species according to Margolis *et al.* (1982). In both the text and the tables, M.I. is included as the average  $\pm$  standard deviation.

For the determination of lice, a part of the collected material was fixed in a 75% filtered ethanol solution, cleared in 85% lactic acid (for 4-5 weeks) and mounted on slides using Hoyer fluid. The identification of different louse taxa was carried out primarily following Clay (1958), Clay & Price (1970), Dhandha (1961), Price & Beer (1963), Nelson & Price (1965), Martín Mateo *et al.* (1984), Gállego *et al.* (1987), and Tendeiro (1987). Certain material still requires a comparative study with that of various collections; thus, the specific identification of lice is not complete (Table 2).

TABLE 1

Host species and intensity of parasitization. N<sup>s</sup>: number of specimens sampled. N<sup>p</sup>: number of specimens parasitized.

[Especies hospedadoras e intensidad de parasitación. N<sup>s</sup>: número de ejemplares muestreados. N<sup>p</sup>: número de ejemplares parasitados].

Species	N <sup>s</sup>	N <sup>p</sup>	%	Intensity ( $\bar{X} \pm S.D.$ )	Range
Eurasian Griffon Vulture, <i>Gyps fulvus</i> .....	17	12	70.6	37.6 $\pm$ 23.2	2 - 67
Monk Vulture, <i>Aegypius monachus</i> .....	2	2	100.0	104.0 $\pm$ 125.9	15 - 193
Egyptian Vulture, <i>Neophron percnopterus</i> .....	1	1	100.0	39.0	
Golden Eagle, <i>Aquila chrysaetos</i> .....	6	2	33.3	25.5 $\pm$ 13.4	16 - 35
Spanish Imperial Eagle, <i>Aquila adalberti</i> .....	3	3	100.0	5.0 $\pm$ 2.6	3 - 8
Bonelli's Eagle, <i>Hieraetus fasciatus</i> .....	6	1	16.7	10.0	
Booted Eagle, <i>Hieraetus pennatus</i> .....	27	4	14.8	10.5 $\pm$ 7.7	2 - 18
Snake Eagle, <i>Circaetus gallicus</i> .....	13	7	53.8	46.1 $\pm$ 52.8	3 - 153
Osprey, <i>Pandion haliaetus</i> .....	1	0	0.0		
Common Buzzard, <i>Buteo buteo</i> .....	87	35	40.2	26.2 $\pm$ 53.7	1 - 324
European Honey Buzzard, <i>Pernis apivorus</i> .....	6	3	50.0	20.7 $\pm$ 3.8	18 - 25
Northern Goshawk, <i>Accipiter gentilis</i> .....	9	0	0.0		
Eurasian Sparrowhawk, <i>Accipiter nisus</i> .....	2	0	0.0		
Red Kite, <i>Milvus milvus</i> .....	16	8	50.0	31.9 $\pm$ 27.9	1 - 74
Black Kite, <i>Milvus migrans</i> .....	48	23	47.9	26.7 $\pm$ 17.1	1 - 60
Eurasian Marsh Harrier, <i>Circus aeruginosus</i> .....	8	2	25.0	20.0 $\pm$ 22.6	4 - 36
Montagu's Harrier, <i>Circus pygargus</i> .....	3	0	0.0		
Common Kestrel, <i>Falco tinnunculus</i> .....	38	18	47.4	40.2 $\pm$ 61.9	1 - 254
Lesser Kestrel, <i>Falco naumanni</i> .....	3	2	66.7	28.5 $\pm$ 2.1	27 - 30
Eurasian Hobby, <i>Falco subbuteo</i> .....	3	3	100.0	14.7 $\pm$ 14.8	2 - 31
Peregrine Falcon, <i>Falco peregrinus</i> .....	5	1	20.0	1.0	
TOTAL .....	304	127	41.8	30.1 $\pm$ 44.1	1 - 324

TABLE 2

Species of louse found on each host species. Those species involved in accidental parasitization are excluded.

[Especies de malosgos encontrados en cada especie hospedadora. Se excluyen aquellas especies implicadas en parasitaciones accidentales.]

Host species	Parasite species	Prevalence (%)	Number
<i>Gyps fulvus</i>			
	<i>Laemobothrion (L.) vulturis</i> .....	23.5	38
	<i>Colpocephalum turbinatum</i> .....	52.9	155
	<i>Pterophilus</i> sp. .....	11.8	25
	<i>Aegypoecus trigonocephalus</i> .....	5.9	2
	<i>Falcolipeurus quadripustulatus</i> .....	52.9	220
<i>Aegypius monachus</i>			
	<i>Laemobothrion (L.) vulturis</i> .....	100.0	17
	<i>Colpocephalum aegyptii</i> .....	100.0	36
	<i>Aegypoecus brevicollis</i> .....	50.0	68
	<i>Falcolipeurus quadripustulatus</i> .....	100.0	87
<i>Neophron percnopterus</i>			
	<i>Colpocephalum percnopteri</i> .....	100.0	2
	<i>Aegypoecus perspicuus</i> .....	100.0	30
	<i>Falcolipeurus frater</i> .....	100.0	7
<i>Aquila chrysaetos</i>			
	<i>Colpocephalum</i> sp. .....	16.7	1
	<i>Craspedorrhynchus aquilinus</i> .....	33.3	50
<i>Aquila adalberti</i>			
	<i>Laemobothrion (L.) maximum</i> .....	33.3	3
	<i>Colpocephalum impressum</i> .....	66.7	3
	<i>Craspedorrhynchus fraterculus</i> .....	100.0	10
<i>Hieraaetus fasciatus</i>			
	<i>Degeeriella regalis</i> .....	16.7	10
<i>Hieraaetus pennatus</i>			
	<i>Colpocephalum milii</i> .....	3.7	2
	<i>Degeeriella regalis</i> .....	3.7	18
	<i>Degeeriella fulva</i> .....	3.7	8
	<i>Craspedorrhynchus pennatus</i> .....	3.7	16
<i>Circaetus gallicus</i>			
	<i>Colpocephalum</i> sp. .....	7.7	9
	<i>Degeeriella leucopleura</i> .....	46.1	287
	<i>Falcolipeurus</i> sp. .....	23.1	27
<i>Buteo buteo</i>			
	<i>Laemobothrion (L.) maximum</i> .....	21.8	156
	<i>Colpocephalum meridionale</i> .....	9.2	45
	<i>Degeeriella fulva</i> .....	25.3	598
	<i>Craspedorrhynchus platystomus</i> .....	10.3	167
<i>Pernis apivorus</i>			
	<i>Laemobothrion (L.) maximum</i> .....	16.7	20
	<i>Degeeriella phlyctopygus</i> .....	16.7	19
	<i>Craspedorrhynchus melittoscopus</i> .....	16.7	25

TABLE 2 (continuación)

Host species	Parasite species	Prevalence (%)	Number
<i>Milvus milvus</i>			
	<i>Laemobothrion (L.) maximum</i> .....	18.7	4
	<i>Colpocephalum milvi</i> .....	31.2	78
	<i>Degeeriella regalis</i> .....	37.5	109
	<i>Craspedorrhynchus spathulatus</i> .....	18.7	64
<i>Milvus migrans</i>			
	<i>Laemobothrion (L.) maximum</i> .....	10.4	9
	<i>Colpocephalum milvi</i> .....	22.9	163
	<i>Degeeriella regalis</i> .....	37.5	410
	<i>Craspedorrhynchus spathulatus</i> .....	8.3	38
<i>Circus aeruginosus</i>			
	<i>Colpocephalum turbinatum</i> .....	25.0	17
	<i>Degeeriella fusca</i> .....	25.0	23
<i>Falco tinnunculus</i>			
	<i>Laemobothrion (L.) tinnunculi</i> .....	5.3	11
	<i>Nosopon</i> sp. .....	7.9	3
	<i>Degeeriella rufa</i> .....	42.1	706
<i>Falco naumanni</i>			
	<i>Colpocephalum zerafae</i> .....	33.3	4
	<i>Degeeriella rufa</i> .....	66.7	37
<i>Falco subbuteo</i>			
	<i>Laemobothrion (L.) tinnunculi</i> .....	66.7	33
	<i>Craspedorrhynchus subbuteonis</i> .....	33.3	11
<i>Falco peregrinus</i>			
	<i>Laemobothrion (L.) tinnunculi</i> .....	20.0	1
	<i>Colpocephalum zerafae</i> .....	20.0	25

Data on location on host plumage of 1061 louse specimens, belonging to the most representative genera, were collected. Possible differences in intensity of parasitization and prevalence with regard to different factors: host sex and age classes, season of the year, and moult status were analyzed in the case of the Common Buzzard, *Buteo buteo*, ( $n=87$ ) by means of a Kruskal-Wallis analysis of variance.

## RESULTS

Nearly 42 % of birds examined were found to be infested by nymphs and/or adult lice (Table 1). The specific prevalence for each species showed a high variability (Table 2), although in those species that are better represented in the total sample it reached values

approaching 50 %. Among these species, the Common Buzzard *Buteo buteo* provided the most significant results because of the number of specimens sampled (Table 1). With regard to the total data set and in absolute values, the number of lice found on parasitized hosts ranged from 1-324 (mean =  $30.1 \pm 44.1$ ). Generally, in those cases in which the number of parasites was large, only one louse species was involved.

Almost 90 % of parasitized hosts harboured 1-50 lice (Fig. 1) on their plumage. In the case of the Common Buzzard, M.I. values were slightly higher in male birds than in females, even though prevalence was higher in this sex; however no significant differences in parasitization between both sexes were observed ( $H=0.93$ ;  $P=0.334$ ; 1 df). Prevalence in young hosts was lower than in adults, although M.I. for youngsters was higher

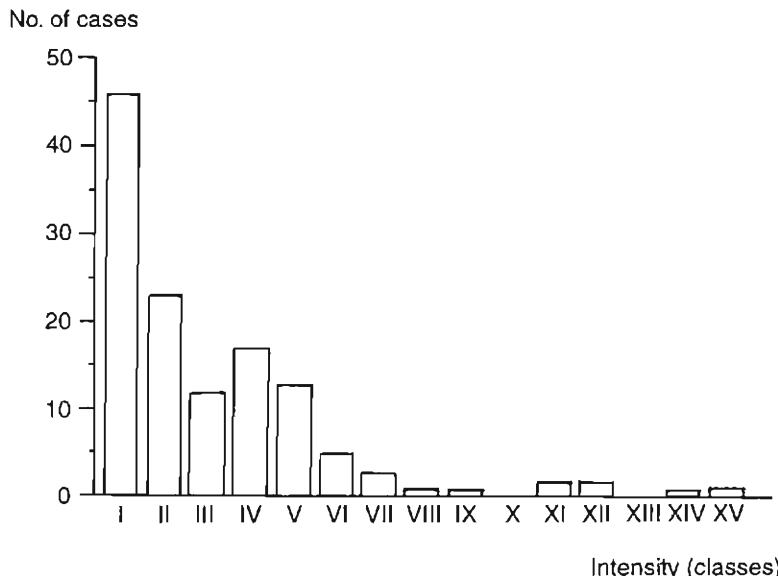


FIG 1.—Frequency of several levels of intensity of parasitization. The groups indicate the number of lice found on each host: I: 1-10; II: 11-20; III: 21-30; IV: 31-40; V: 41-50; VI: 51-60; VII: 61-70; VIII: 71-80; IX: 81-90; X: 91-100; XI: 101-150; XII: 151-200; XIII: 201-250; XIV: 251-300; XV: 301-350.

[Frecuencia de los distintos niveles de intensidad de parasitación. Los grupos indican el número de malófagos encontrados en cada hospedador: I: 1-10; II: 11-20; III: 21-30; IV: 31-40; V: 41-50; VI: 51-60; VII: 61-70; VIII: 71-80; IX: 81-90; X: 91-100; XI: 101-150; XII: 151-200; XIII: 201-250; XIV: 251-300; XV: 301-350.]

(Table 3). Nevertheless these differences proved to be not significant ( $H = 2.14$ ;  $P = 0.142$ ; 1 df). Birds examined during the moult proved to be significantly less infested than those surveyed outside this period:  $H = 11.86$ ;  $P = 0.0001$ ; 1 df.

Seasonal prevalence (Table 3; Fig. 2A) reached its highest values (55.1 %) during the autumn, and dropped to its lowest value (31.8 %) in the summer. Conversely, the highest M.I. values were those obtained for spring and summer months and the lowest ones, for autumn and winter. Nevertheless, these differences cannot be considered significant:  $H = 6.75$ ;  $P = 0.080$ ; 3 df (Table 3).

Each parasitized host had a burden of  $1.64 \pm 0.84$  (1-4) louse species. Each host species was infested by a mean of  $3.06 \pm 1.25$  mallophagan species. In table 2 lice parasitizing each host species are detailed. Almost 60 % of the lice removed ( $n = 3910$ ) belonged to the genus *Degeeriella* (Table 4); many of these specimens were located between the

barbs of the long wing remiges, in a position relatively far from the rachis. Lice belonging to the genera *Colpocephalum*, *Craspedorrhynchus*, *Falcoligeurus*, *Laemobothrion* and *Aegyptopoeus* represented the remaining 40 %.

Each ectoparasite species shows a particular degree of host-specificity. The most non-specific species were those belonging to the genus *Laemobothrion*. Clay (1976) reported that *Laemobothrion maximum* is a cosmopolite species parasitizing up to 32 raptor species of 18 genera. The global sex-ratio of adult lice was 0.8:1.0. In ischnoceran genera females were, proportionally, more numerous (0.78:1.00) while the mean sex-ratio in amblyceran genera was 0.98:1.00 (Table 4). Lice belonging to the genera *Craspedorrhynchus* and *Aegyptopoeus* proved to be the most ubiquitous, since they were only observed on the head and nape, mainly in the frontal and occipital regions. Conversely, lice belonging to the remaining genera occupied different locations. Almost 50 % of lice were found on

TABLE 3

Prevalence (%) and intensity of parasitization (M.I.) in relation to host and seasonal factors. N<sup>s</sup>: number of specimens sampled. N<sup>p</sup>: number of specimens parasitized.

[*Prevalencia (%) e intensidad de parasitación (M.I.) en relación a factores estacionales y del hospedador. N<sup>s</sup>: número de ejemplares muestreados. N<sup>p</sup>: número de ejemplares parasitados.*].

	N <sup>s</sup>	N <sup>p</sup>	Prevalence (%)	M.I. ( $\bar{X} \pm S.D.$ )	Min.	Max
Males .....	76	21	27,6	34,8 ± 71,4	1	82
[ <i>Machos</i> ]						
Females .....	66	23	34,8	29,8 ± 51,9	2	254
[ <i>Hembras</i> ]						
Adults .....	263	111	42,2	26,7 ± 35,5	1	254
[ <i>Adultos</i> ]						
Youngs .....	42	16	38,1	52,1 ± 81,1	2	324
[ <i>Jóvenes</i> ]						
During moult .....	84	18	21,4	20,5 ± 19,3	2	68
[ <i>Durante la muda</i> ]						
No moult .....	221	109	49,3	31,7 ± 46,8	1	324
[ <i>Cuando no están mudando</i> ]						
Winter .....	53	24	45,3	25,4 ± 37,9	1	153
[ <i>Invierno</i> ]						
Spring .....	115	48	41,7	35,3 ± 53,5	1	324
[ <i>Primavera</i> ]						
Summer .....	88	28	31,8	27,4 ± 20,5	1	82
[ <i>Verano</i> ]						
Autumn .....	49	27	55,1	29,4 ± 54,5	1	254
[ <i>Otoño</i> ]						

the wing feathers, mainly on the ventral surface of primary and secondary feathers, and infracovers. The abdominal and axillary regions were also frequent sites. The location of lice ranged from a specific region (when several louse genera were found parasitizing the same host) to the whole plumage of the host (mainly when only one genus was found).

## DISCUSSION

Because lice were hand-removed without the use of any kind of insecticides, data obtained can be subject to certain error, but since a routine method of examination was used and the same operator inspected all birds, the degree of accuracy is such that comparisons can be made (Edgar *et al.*, 1949). The prevalence reached its lowest value in spring (just when the percentage of birds moulting was

higher and the M.I. reached the maximum value) and summer, becoming higher in autumn. These prevalence values agree with those obtained by Eveleigh & Threlfall (1976) for lice parasitizing Alcidae and even with data on trichodectids from the White-Tailed Deer, *Odocoileus virginianus* (Watson & Anderson, 1975). Rates of parasitization obtained were similar to those given by Cooper *et al.* (1993) for migrating Common Buzzards in Israel. According to Derylo (1975) these seasonal variations in the intensity of infestation relate particularly to temperature and environmental humidity, high temperature rates together with low humidity becoming adverse factors for the viability of lice and, in a wide sense, of ectoparasites. No significant differences were observed when parasitization rates were compared between males and females or between adult and young birds, although M.I. in youngsters was higher. If

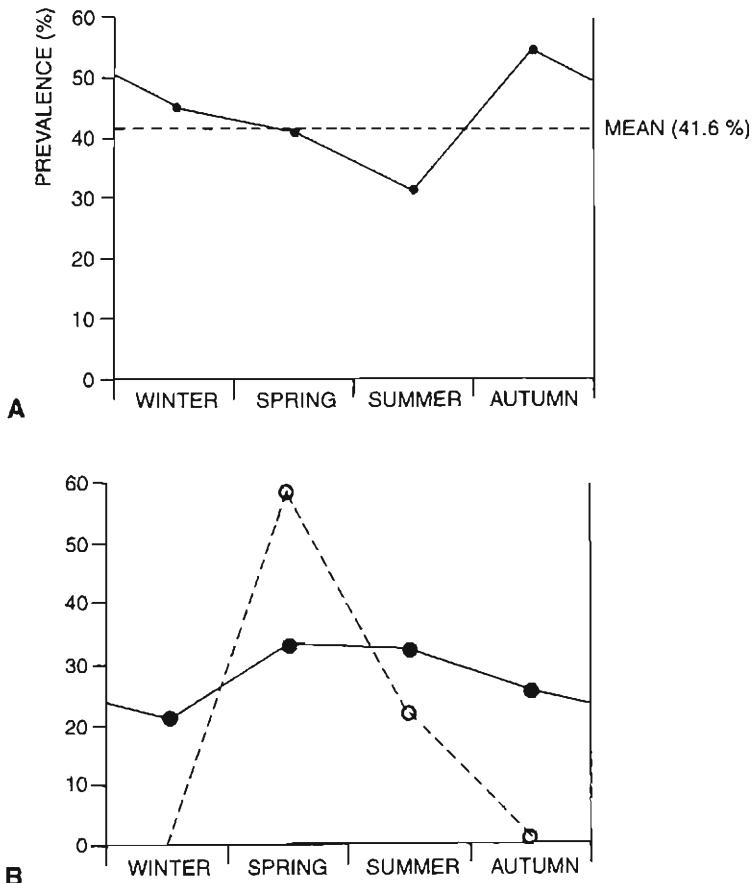


FIG 2.—Seasonal prevalence, (A) in percentage and (B) intensity of parasitization, (no. lice/host parasitized, M.I.). Continuous line: M.I.; dotted line: number of birds moulting.  
[Prevalencia estacional, (A) en porcentaje y (B) intensidad de la parasitación (n.º de malosagios/hospedador parasitado; M.I.). Línea continua: M.I.; línea discontinua: número de individuos en muda.]

this occurs in *Buteo buteo*, in which probably the main way of lice transmission is vertical (from the parents to the young), we cannot assume that the same happens in gregarious raptor species (e.g. the Lesser Kestrel, *Falco naumanni*), horizontal transmission being probably more frequent. The host moult seems to be a negative factor for louse populations, affecting both the prevalence and M.I.

According to the data obtained, four louse genera (two ischnoceran and two amblyceran) can be considered as characteristic ectoparasites of Spanish raptors: *Degeeriella*,

*Craspedorrhynchus*, *Colpocephalum* and *Lae-mobothrion*. In certain cases we can find several modifications of this pattern. *Falcolipeurus* usually is found on large raptors such as vultures. It is able to coexist with *Degeeriella* on certain hosts, such as the Short-toed Eagle, *Circaetus gallicus* (Table 2). *Aegypoe-cus* is a louse genus with morphology, habits and location on the host closely related to those shown by *Craspedorrhynchus* spp. Nevertheles, its distribution is restricted to vultures (Dhanda 1961).

Lice belonging to the genus *Degeeriella* were the most frequently found on raptors,

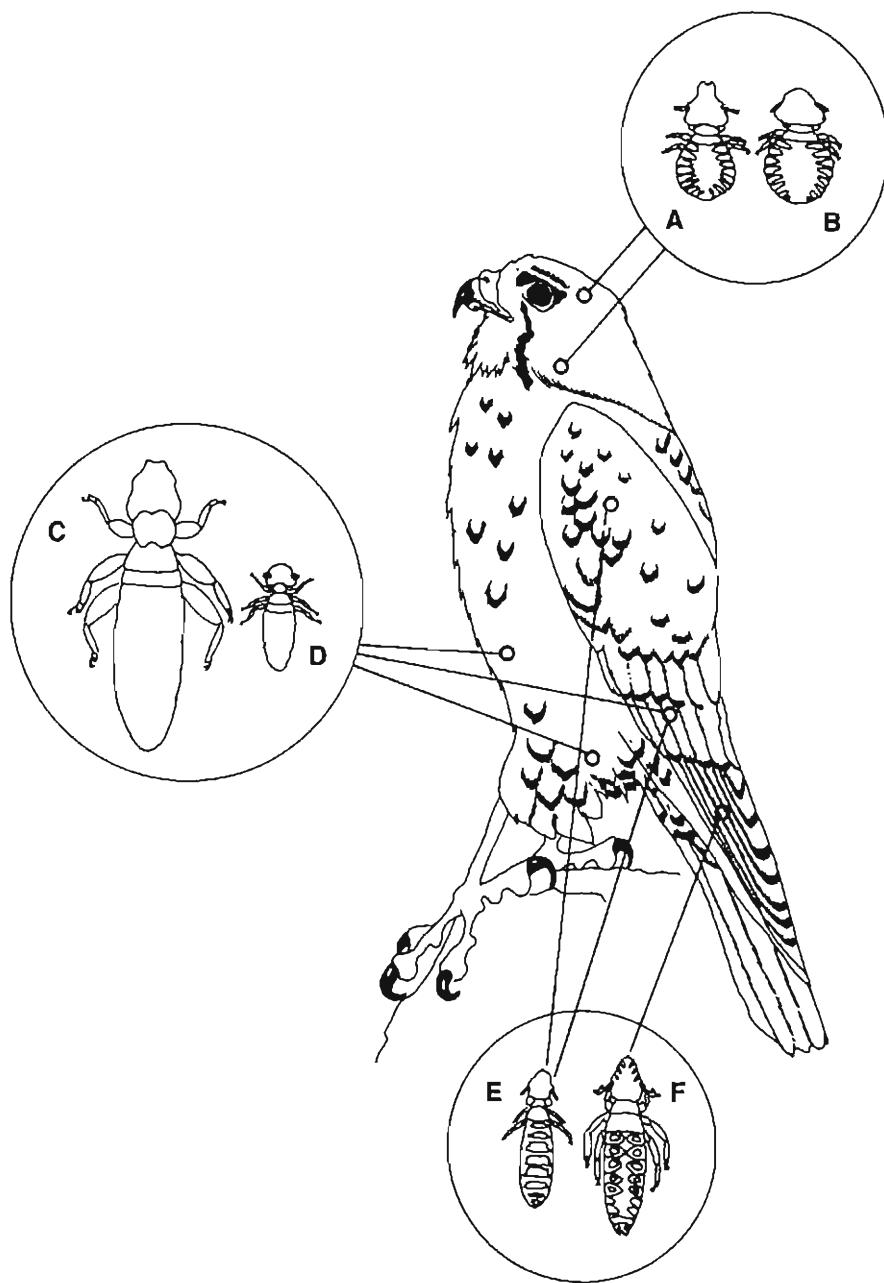


FIG 3.—Location on the host of the main genera of lice. Raptor figure from Cooper, 1985. Courtesy of the Standfast Press. A: *Craspedorrhynchus*, B: *Aegypoecus*, C: *Laemobothrion*, D: *Colpocephalum*, E: *Degeeriella* and F: *Falcolipeurus*.

[*Localización en el hospedador de los principales géneros de malófagos. La figura de la rapaz extraída de Cooper, 1985. Cortesía de Standfast Press. A: Craspedorrhynchus, B: Aegypoecus, C: Laemobothrion, D: Colpocephalum, E: Degeeriella and F: Falcolipeurus.*]

TABLE 4

Genera of lice parasitizing different species of raptors. (a): accidental parasitizations: *Columbicola* is a genus parasitizing members of the order Columbiformes, while *Strigiphilus* is distributed throughout hosts belonging to the order Strigiformes. N<sup>P</sup>: number of specimens parasitized. The sex ratio (♂♂:♀♀) for those louse genera with  $n \geq 100$  specimens is included.

[Géneros de malófagos parásitos de las distintas especies de rapaces. (a): parasitaciones accidentales: *Columbicola* es un género parásito de *Columbiformes*, mientras que *Strigiphilus* se distribuye sobre hospedadores del orden *Strigiformes*. N<sup>P</sup>: número de individuos parasitados. Se incluye la razón entre sexos (♂♂:♀♀) de aquellos géneros con un  $n \geq 100$  ejemplares.]

Genus	Suborder	N <sup>P</sup>	%	No. Lice	%	Sex-ratio
<i>Degeeriella</i> .....	Ischnocera	76	24.9	2.225	56.9	0.8:1.0
<i>Colpocephalum</i> .....	Amblycera	44	14.4	540	13.8	0.9:1.0
<i>Craspedorrhynchus</i> .....	Ischnocera	24	7.9	381	9.7	0.9:1.0
<i>Falcolipeurus</i> .....	Ischnocera	15	4.9	341	8.7	0.7:1.0
<i>Laemobothrion</i> .....	Amblycera	40	13.1	294	7.5	1.1:1.0
<i>Aegypioecus</i> .....	Ischnocera	3	1.0	100	2.6	1.2:1.0
<i>Pterophilus</i> .....	Amblycera	2	0.6	25	0.6	
<i>Nosopon</i> .....	Amblycera	3	1.0	3	0.1	
<i>Columbicola</i> (a) .....	Ischnocera	2	0.6	2	0.05	
<i>Strigiphilus</i> (a).....	Ischnocera	1	0.3	1	0.02	

being usually present where there was high level of infestation (Zlotorzycka, 1974; Moccia & Restivo, 1978; Kutzer *et al.*, 1980). The same is observed with *Breuelia* spp. (a closely related phloeopterid genus) parasitizing Passeriformes (Wheeler & Threlfall, 1986). Nevertheless, in our opinion, *Laemobothrion* could be considered to be the most important louse genus, from a veterinary point of view, not only on account of its considerable size (around 10 mm), but also due to its haemato-phagous habits (Zlotorzycka & Danecki, 1969; Pérez *et al.*, 1994).

According to Zlotorzycka (1982) the number of species of chewing lice present drops in zoo-bred birds. She found 1.8 species of lice per host species studied. In contrast, our results appear more similar to the situation described in free-living birds by Cooper *et al.* (1993).

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