

A FIELD SURVEY OF ARTHROPOD PARASITES OF BIRDS IN TAIWAN<sup>1</sup>By T. C. Maa<sup>2</sup> and J. S. Kuo<sup>2</sup>

**Abstract:** In winter 1963-64 in lowlands of central and southern Taiwan, 1561 freshly collected wild birds of 105 species were examined for arthropod parasites. An average of 65% of the birds were found harboring Mallophaga; 26%, Hippoboscidae; 2%, Ixodidae; 28%, chiggers or trombiculid larvae; 45%, feather mites; and 19%, nasal mites. No bedbugs or fleas were revealed. Parasitism rate, notably of chiggers and feather mites in a narrow, densely forested valley was generally higher than in a wide deforested or thinly forested area. Eleven species of Hippoboscidae were collected; their host range and preference, species association, as well as disharmonic distributional pattern, are discussed. Determinations of the other parasites are not yet completed.

In early December 1963 a field team was organized for collecting arthropod parasites off wild animals in Taiwan. Places in central, SE and SW parts of the Island selected as sites for field headquarters are respectively: (1) Puli, 23°55'N, 120°55'E, Nantou Hsien, a wide open valley largely of cultivated land, with tiny scattered patches of secondary forests on hillsides, (2) Tzepeng, 22°40'N, 121°5'E, Taitung Hsien, with some cultivated land areas, situated in a deep narrow valley and surrounded by thick secondary forests. (3) Liukuei, 22°50'N, 120°40'E, Kaohsiung Hsien, with similar environments as at Puli but drier. Our hunters and trappers fanned out in all directions, and neighboring villagers were encouraged to bring in animals they shot or trapped. All efforts were made to avoid contamination of the material. Field activities came to an end in early April 1964. During the 4-month period, a few thousand wild animals all from below 500 m, were collected and examined. A good series of arthropod parasites were procured therefrom and are being distributed to specialists for determination. This report concerns only parasites assembled by the 1963-64 Survey off freshly collected wild birds. Parasites off other animals, bird-nests and dry bird-skins as well as those collected in other parts of the Island are not included.

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## I. LIST OF BIRDS EXAMINED

Altogether 1561 freshly killed wild birds of 105 species (14 orders) were examined. In the following list, the number of individual birds for each species is in parenthesis following the name, and letters A, C, F, H, M, N and T stand respectively for miscellaneous mites, chiggers (Trombiculid larvae), feather mites (Analgesoidea), Hippoboscidae (birdflies), Mallophaga (birdlice), nasal mites (Rhinonyssidae, etc.) and Ixodidae (ticks). Sequence of the bird-species is adopted from J. T. F. Chen's (1956) "Synopsis of the Vertebrates of Taiwan."

- (a) Anseriformes 1 sp., Anatidae.  
*Anas c. crecca* Linn. (5) M.  
 (b) Ciconiiformes 5 spp., Ardeidae.  
*Egretta g. garzetta* Linn. (1).  
*Bubulcus ibis coromandus* Bodd. (5) F, M, N.  
*Butorides striatus amurensis* Schrenck (1).  
*Goisakius m. melanolophus* Raffl. (3) H, M.  
*Ixobrychus eurhythmus* Sw. (2).  
 (c) Charadriiformes 2 spp., Charadriidae; 3 spp., Scolopacidae.  
*Charadrius dubius curomicus* Gmel. (3) F, M, N.  
*Ch. d. dubius* Scop. (7) F, M.  
*Tringa ocropus* Linn. (1) M.  
*Actitis hypoleucos* Linn. (7) F, M.  
*Capella g. gallinago* Linn. (1).  
 (d) Gruiformes 3 spp., Rallidae; 1 sp., Turnicidae.  
*Amaurornis phoenicurus chinensis* Bodd. (24) F, H, M, N.  
*Rallina eurizonoides formosana* Seebohm (1) H.  
*Gallinula chloropus indica* Blyth (2) F, M.  
*Turnix suscitator rostrata* Sw. (4) F, M.  
 (e) Columbiformes 4 spp., Columbidae.  
*Sphenurus sieboldii sororius* Sw. (19) F, M, N.  
*Streptopelia orientalis orii* Yamashina (30) F, H, M, N.  
*S. chinensis formosa* Kuroda (56) C, F, H, M, N.  
*Chalcophaps i. indica* Linn. (5) F, H, M.  
 (f) Strigiformes 6 spp., Strigidae.  
*Tyto capensis longimembris* Jerdon (1) M.  
*Strix leptogrammica caligata* Sw. (1) F, M.  
*Otus bakkamoena glabripes* Sw. (20) A, C, F, H,

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M, N, T.

*O. scops botelensis* Kuroda (1) C, F, H, M.  
*Glaucidium brodiei pardalotum* Sw. (2) H, M.  
*Ninox s. scutulata* Raff. (3) H, M.  
 (g) Falconiformes 1 sp., Falconidae; 7 spp.,  
 Accipitridae.  
*Falco tinnunculus interstinctus* Horsf. (6) M.  
*Accipiter virgatus gularis* Temm. & Schl. (1).  
*A. virgatus affinis* Hodgs. (1) F, H, M.  
*A. trivirgatus formosae* Mayr (7) F, H, M.  
*A. badius poliopsis* Hume (2) H, M.  
*Spilornis cheela hoya* Sw. (8) M.  
*Pernis apivorus neglectus* Kuroda (1) A, F, M.  
*Butastur indicus* Gmel. (1) M.  
 (h) Galliformes 4 spp., Phasianidae.  
*Excalfactoria c. chinensis* Linn. (13) F, M.  
*Arborophila crudigularis* Sw. (13) A, F, H, M, T.  
*Bambusicola thoracica sonorivox* Gould (53) C, F, H,  
 M, N, T.  
*Hierophasis swinhoii* Gould (10) A, F, H, M, T.  
 (i) Cuculiformes 3 spp., Cuculidae.  
*Centropus bengalensis lingnator* Sw. (3) C.  
*Cuculus p. poliocephalus* Latham (1) M.  
*C. s. saturatus* Blyth (1).  
 (j) Caprimulgiformes 1 sp., Caprimulgidae.  
*Caprimulgus affinis monticolus* Frankl. (32) H, M.  
 (k) Apodiformes 1 sp., Apodidae.  
*Apus affinis subfurcatus* Blyth (3) A, M.  
 (1) Piciformes 2 spp., Picidae; 1 sp., Capitonidae.  
*Dendrocopos leucotos insularis* Gould (2) A, F, M.  
*D. nanus kaleensis* Sw. (11) A, C, F, H, M, N.  
*Megalaima oorti nuchalis* Gould (259) A, C, F, H,  
 M, N, T.  
 (m) Coraciiformes 1 sp., Alcedinidae.  
*Alcedo atthis bengalensis* Gmel. (8) M.  
 (n) Passeriformes 1 sp., Alaudidae; 2, Hirun-  
 dinidae; 2, Fringillidae; 4, Ploceidae; 2, Dicruridae;  
 1, Sturnidae; 4, Motacillidae; 1, Zosteropidae; 3,  
 Corvidae; 1, Cinclidae; 1, Paridae; 2, Laniidae; 3,  
 Campephagidae; 2, Muscicapidae; 2, Oriolidae;  
 8, Turdidae; 4, Pycnonotidae; 7, Sylviidae; 9,  
 Timaliidae.  
*Alauda gulgula wattersi* Sw. (13) F, M, N.  
*Hirundo rustica gutturalis* Scop. (18) F, M.  
*Riparia paludicola chinensis* Gray (5) M.  
*Emberiza sulphurata* Temm. & Schl. (1).  
*E. spodocephala extremi-orientis* Shulpin (3) F, M.  
*Passer montanus saturatus* Stejneger (18) M, N.  
*P. r. rutilans* Temm. (1) M.  
*Lonchura striata phaethonoptila* Oberholser (15) A,  
 F, H, M, N.  
*L. punctulata topela* Sw. (7) H, M, N.  
*Dicrurus macrocercus harterti* S.-Bkr. (22) F, H, M, N.  
*D. aeneus braunianus* Sw. (16) A, F, H, M, N.  
*Sturnus sinensis* Gmel. (2).

*Anthus h. hodgsoni* Richmond (15) F, M, N.  
*Motacilla alba leucopsis* Gould (10) F, M, N.  
*M. c. cinerea* Tunstall (8) F, M, N.  
*M. flava taiwana* Sw. (3) F, M.  
*Zosterops palpebrosa taiwaniana* Momiyama (12) F,  
 H, M, N.  
*Dendrocitta f. formosae* Sw. (234) C, F, H, M, N.  
*Urocissa caerulea* Gould (26) C, F, H, M, N.  
*Pica pica sericea* Gould (1) M.  
*Cinclus p. pallasi* Temm. (2) F, M.  
*Parus major commixtus* Sw. (1) M, N.  
*Lanius s. schach* Linn. (19) F, H, M, N.  
*L. cristatus lucionensis* Linn. (10) M, N.  
*Pericrocotus d. divaricatus* Raff. (8) M, N.  
*P. solaris griseogularis* Gould (15) A, C, F, M, N.  
*Coracina melaschistos avensis* Blyth (3).  
*Hypothymis azurea oberholseri* Stressem. (13) F, M, N.  
*Muscicapa v. vivida* Sw. (1).  
*Oriolus chinensis diffusus* Sharpe (8) A, C, F, H, M, N.  
*O. traillii ardens* Sw. (7) C, F, M, N.  
*Myiophoneus insularis* Gould (14) C, F, H, M, N.  
*Monticola solitarius philippensis* Müller (11) A, C,  
 F, M, N, T.  
*Zoothera dauma aurea* Holandre (21) C, F, H, M,  
 N, T.  
*Turdus obscurus* Gmel. (2) F, H, M.  
*T. ch. chrysolaus* Temm. (11) A, C, F, H, M, N.  
*Cinclidium l. leucurum* Hodgson (3) C, F, H.  
*Brachypteryx montana goodfellowi* Og.-Grant (6) F,  
 H, M.  
*Rhyacornis fuliginosus affinis* Og.-Grant (3) F, M, N.  
*Hypsipetes madagascariensis nigerrimus* Gould (119)  
 C, F, H, M, N.  
*Spizixos semitorques cinereicapillus* Sw. (10) C, F,  
 M, N.  
*Pycnonotus sinensis formosae* Hartert (15) F, M, N.  
*P. taiwanus* Styan (6) C, F, M, N.  
*Cettia canturiens borealis* Campb. (1) M.  
*C. c. canturiens* Sw. (3).  
*Prinia flaviventris sonitans* Sw. (1).  
*P. polychroa striata* Sw. (1) A, F, M.  
*P. inornata formosa* Harrington (5) H, N.  
*Phylloscopus b. borealis* Blasius (2) N.  
*Cisticola juncidis tinnabulans* Sw. (3) F.  
*Stachyris ruficeps praecognita* Sw. (4) M.  
*Alcippe m. morrisonia* Sw. (13) F, H, M, N.  
*Yuhina brunneiceps* Og.-Grant (5) F, M, N.  
*Y. zantholeuca griseiloris* Stressem. (6) H, N.  
*Pomatorhinus ruficollis musicus* Sw. (21) A, C, F,  
 M, N, T.  
*P. erythrogenys erythrocnemis* Gould (7) C, M, N, T.  
*Heterophasia auricularis* Sw. (67) A, C, F, H, M, N.  
*Garrulax canorus taewanus* Sw. (17) C, F, H, M, N.  
*G. albogularis ruficeps* Gould (1) F, M, T.

In addition to the above listed were 4 falconid and

7 passerine birds not named to species.

## II. ARTHROPOD FAUNA OF THE BIRDS EXAMINED

According to Chen (*l. c.*), 404 species of wild birds occur in Taiwan and offshore islets. Their arthropod fauna has been little explored. A literature search revealed only 26 species of Mallophaga, 3 Hippoboscidae, 4 chiggers, 16 feather mites and 4 tyroglyphid mites recorded off domesticated and a few wild birds; all other groups are entirely unknown. Our 1963-64 Survey revealed a large number, both in species and individuals, of parasitic insects and acari (the Pentastomida were not thoroughly searched for). A general view of the fauna follows. Further analysis can not be undertaken until determinations are completed.

*Mallophaga or Birdlice.* These are the commonest bird ectoparasites both in nature and in collections. Our material has been sorted first according to bird-genera, then under each bird-genus to species of lice. Each genus of birds usually harbored 3 or more species of lice. In a few cases (e.g. *Dendrocitta*) there were well over 10 louse-species off the same bird-genus. Number of individual lice found on individual birds varied greatly. As a rule, they were rare on the Ciconii-, Charadrii- and Falconiformes and most abundant on doves and pheasants. Their presence on a given bird was indicated by the whitish empty egg-capsules on the host's neck. We often kept bags of freshly killed birds in a refrigerator. Within half a day or so, most if not all the lice left the feathers and died clinging to the inner side of the bags. This saved much time and labor than directly combing them off the feathers.

*Cimicidae or Bedbugs.* These have been found in other countries in nests of swifts and sand martins, but very rarely on the body of the birds. We did not find any in the Survey from either birds or their nests.

*Hippoboscidae or Birdflies.* The Survey revealed 11 species (749 specimens) of these flies which will be discussed in greater detail below.

*Siphonaptera or Fleas.* Like the Cimicidae, these insects have been recorded from other countries off swifts, sand martins, swallows as well as sparrows. But the Survey produced no such fleas.

*Ixodidae or Ticks.* These appeared to be rare in Taiwan. We collected a few off *Otus*, *Arborophila*, *Bambusicola*, *Megalaima*, *Monticola*, *Pomatorhina* and *Garrulax*. On several occasions, *Hierophasis* was found very heavily infested. The ground birds are apparently more liable to be parasitized and therefore their occurrence on *Otus* and *Megalaima* is interesting. Most of the ticks were attached to the head of hosts.

*Chiggers or Trombiculid Larvae.* We collected these ex *Streptopelia*, *Otus*, *Bambusicola*, *Centropus*, *Dendrocopos*, *Megalaima* and a number of passerine birds.

They were often found on bare parts of the host body forming fairly large colonies near the base of legs, wings and at the anal region. Only in a few cases were the colonies on and immediately behind the neck. At Tzepeng, we noticed the chiggers on *Megalaima* and *Dendrocitta* were more prevalent on molting birds. This was perhaps in part to the conspicuousness of chigger-colonies on molting birds, and to more ready formation of colonies at that period.

*Analgesoidea or Feather Mites.* Slightly less than 1/2 the species and individual birds were parasitized by such creatures. They were largely found near wing-tips and rarely at tail-tips or in body feathers.

*Nasal Mites (Rhinomyssidae, etc.).* Slightly less than 1/2 of the bird-species were infested by these mites. Only once were they found on *Otus*, and never on Falconi- and Caprimulgiformes, perhaps due to the structure of their nasal passages. Besides flushing the nasal passages with water by using a syringe, we also dissected and examined the air sacs of 800+ birds. The latter method, however, revealed only about 6 specimens.

*Miscellaneous Mites.* For convenience, we lumped together all bird mites other than those mentioned above. These were found on body feathers. In addition, attached to the Mallophaga and Hippoboscidae were some mites which were termed "hyperparasites" by several authors.

## III. FREQUENCY OF THE PARASITES

Of the 105 bird species collected, 12 were free from any arthropod parasites. The general frequency of these parasites on Taiwan birds and on the 38 commoner species from the Survey are given in Tables 1 and 2. The parasitism percentages were computed from actual number of individual birds examined and recorded, this number varying in different parasite groups (Table 1). During our survey, birds collected might have been seriously damaged by shooting making examinations for nasal mites impossible; on other occasions, a villager neglected to put it in a cloth bag im-

Table 1. General frequency of arthropod parasites on birds.

	Total no. of birds examined	Parasitism percentage of individual birds	No. of bird-species free of parasites
Mallophaga	1561	64.8	19
Hippoboscidae	1544	25.5	65
Ixodidae	1561	1.9	95
Chiggers	791	27.6	81
Analgesoidea	1561	44.8	42
Nasal Mites	1526	18.7	57
Misc. Mites	1561	4.4	88

mediately after it was caught or killed, thus rendering the count of hippoboscids incorrect. At the beginning of the Survey, negative results were not completely recorded and chiggers, not thoroughly searched for. Such cases are not counted here.

To exemplify regional differences in parasitism rate, 6 species of the commonest birds are selected: *Streptopelia chinensis* (Columbiformes), *Bambusicola thoracica* (Galliformes), *Megalaima oorti* (Piciformes), *Dendrocitta formosae*, *Hypsipetes madagascariensis* and *Heterophasia auricularis* (last 3 all Passeriformes). In all cases, the rate of chiggers, particularly feather mites (Table 3) in Tzepeng, was noticeably higher than in Puli and Liukuei. Perhaps the humid environments,

in the dense forests of this deep narrow valley favored their propagation. In other parasites, however, differences were either not so significant or did not have the same tendency. For example, the rate of Mallophaga on *Megalaima* in Liukuei (89.6%) was higher than in Puli (66.7%) and Tzepeng (48.9%); that on *Bambusicola* in Liukuei (86.4%), also higher than in the 2 other places (60%, 68.8%). The rate of hippoboscids on *Bambusicola* showed the same tendency (61.9% vs. 26.7% and 23.3%), but that on *Heterophasia* in Puli (45.8%) was much higher than in Tzepeng (25%) and Liukuei (0%). The rate of nasal mites on *Heterophasia* in Puli (47.9%) was also much higher than in the 2 other places (25%, 6.7%). No satisfactory

Table 2. Parasitism percentage of 38 commoner birds by arthropods in Taiwan 1963-64.

	No. of individual birds examined	Mallophaga	Hippoboscidae	Ixodidae	Chiggers	Feather mites	Nasal mites	Misc. Acarina
<i>Amaurornis phoenicurus</i>	24	12.5	4.2	—	—	37.5	12.5	—
<i>Sphenurus sieboldii</i>	19	89.5	—	—	—	15.8	47.4	—
<i>Streptopelia orientalis</i>	30	96.6	26.6	—	—	10.0	40.0	—
<i>S. chinensis</i>	56	96.4	23.2	—	14.3	42.8	41.8	—
<i>Otus bakkamoena</i>	20	60.0	15.0	5.0	88.8	15.0	25.0	5.0
<i>Excalfactoria chinensis</i>	13	69.2	—	—	—	15.3	—	—
<i>Arborophila crudigularis</i>	13	100.0	30.7	15.3	—	69.2	—	7.7
<i>Bambusicola thoracica</i>	53	73.6	37.7	11.3	10.5	54.7	5.7	—
<i>Hierophasia swinhoii</i>	10	90.0	28.6	60.0	—	50.0	—	10.0
<i>Caprimulgus affinis</i>	32	28.1	43.8	—	—	—	—	—
<i>Dendrocopos nanus</i>	11	9.1	9.1	—	12.5	81.8	9.1	45.4
<i>Megalaima oorti</i>	259	67.9	40.1	1.5	25.2	57.9	3.1	17.7
<i>Alauda gulgula</i>	13	69.2	—	—	—	38.5	25.0	—
<i>Hirundo rustica</i>	18	27.8	—	—	—	11.1	—	—
<i>Passer montanus</i>	18	81.8	—	—	—	—	11.1	—
<i>Lonchura striata</i>	15	46.7	13.3	—	—	40.0	26.7	13.3
<i>Dicrurus macrocercus</i>	22	81.8	9.1	—	—	63.6	41.2	—
<i>D. aeneus</i>	16	68.7	12.5	—	—	68.7	50.0	12.5
<i>Anthus hodgsoni</i>	15	26.7	—	—	—	46.7	26.7	—
<i>Motacilla alba</i>	10	40.0	—	—	—	10.0	77.8	—
<i>Zosterops palpebrosa</i>	12	26.7	8.3	—	—	33.3	33.3	—
<i>Dendrocitta formosae</i>	234	87.6	47.0	—	68.7	59.4	20.6	—
<i>Urocissa caerulea</i>	26	96.1	76.9	—	66.6	92.3	3.8	—
<i>Lanius schach</i>	19	31.6	5.2	—	—	5.2	47.1	—
<i>L. cristatus</i>	10	20.0	—	—	—	—	22.2	—
<i>Pericrocotus solaris</i>	15	26.7	—	—	40.0	60.0	40.0	6.7
<i>Hypothymis azurea</i>	13	30.7	—	—	—	69.2	15.3	—
<i>Myiophonus insularis</i>	14	100.0	57.1	—	50.0	85.7	28.6	—
<i>Monticola solitarius</i>	11	18.2	—	9.1	75.0	27.3	27.3	9.1
<i>Zoothera dauma</i>	21	66.7	38.1	19.0	64.6	57.1	33.3	—
<i>Turdus chrysolaus</i>	11	27.3	9.1	—	50.0	54.5	45.5	9.1
<i>Spizixos semitorques</i>	10	40.0	—	—	25.0	80.0	20.0	—
<i>Pycnonotus sinensis</i>	15	53.3	—	—	—	33.3	23.1	—
<i>Hypsipetes madagascariensis</i>	119	81.5	8.4	—	23.3	54.6	33.6	—
<i>Alcippe morrisonia</i>	13	46.2	23.1	—	—	7.7	15.4	—
<i>Pomatorhinus ruficollis</i>	21	33.3	—	14.3	83.3	23.8	9.5	4.8
<i>Heterophasia auricularis</i>	67	76.1	34.3	—	11.7	35.8	37.3	1.5
<i>Garrulax canorus</i>	17	52.9	35.3	—	75.0	76.5	20.0	—

Table 3. Regional differences in parasitism rate of chiggers (C) and feather-mites (F) on 6 common birds.

	<i>S. chinensis</i>		<i>B. thoracica</i>		<i>M. oorti</i>		<i>D. formosae</i>		<i>H. madagascariensis</i>		<i>H. auricularis</i>	
	C	F	C	F	C	F	C	F	C	F	C	F
Puli	*	27	*	60	*	33	*	33	*	39	*	19
Tzepeng	17	82	25	69	40	90	96	100	56	78	50	100
Liukuei	*	*	0	36	8	18	60	92	0	84	7	73

\* Birds involved insufficient in number or not thoroughly examined for chiggers.

explanation can be offered for these cases.

#### IV. REMARKS ON THE HIPPOBOSCIDAE COLLECTED

Hippoboscid flies collected by the 1963-64 Survey were determined, and several which represent undescribed forms will be dealt with in a separate report.

##### A. LIST OF FLIES AND THEIR HOST RECORDS

The 11 species of 5 genera collected are:

**Ornithoica exilis** Wk. 3 records (1 ♂, 3 ♀♀): 1 each ex *Goisakius melanolophus*, *Zoothera dauma* and *Turdus obscurus*. Not found in Tzepeng. Apparently preferring Passeriformes.

**Ornithoica** sp. "M" 125 records (65 ♂♂, 102 ♀♀, 10 gynandromorphs): 1 ex *Amaurornis phoenicurus*; 1, *Dendrocopos nanus*; 6, *Megalaima oorti*; 1, *Dicrurus macrocercus*; 1, *Zosterops palpebrosa*; 59, *Dendrocitta formosae*; 9, *Urocissa caerulea*; 1, *Lanius schach*; 1, *Oriolus chinensis*; 6, *Myiophoneus insularis*; 5, *Zoothera dauma*; 1, *Cinclidium leucurum*; 2, *Brachypteryx montana*; 4, *Hypsipetes madagascariensis*; 3, *Alcippe morrisonia*; 19, *Heterophasia auricularis*; 5, *Garrulax canorus*. Apparently preferring Passeriformes (117 records). This species of fly is closely allied to *O. stipituri* Schin. of Australia and New Guinea.

**Ornithophila metallica** Schin. 42 records (17 ♂♂, 37 ♀♀): 3 ex *Megalaima oorti*; 1, *Dicrurus macrocercus*; 2, *D. aeneus*; 15, *Dendrocitta formosae*; 3, *Urocissa caerulea*; 1, *Turdus chrysolaus*; 7, *Hypsipetes madagascariensis*; 7, *Heterophasia auricularis*; 2, *Garrulax canorus*. Apparently preferring Passeriformes (39 records).

**Ornithomya** sp. "T" 22 records (9 ♂♂, 20 ♀♀): 1 each ex *Goisakius melanolophus*, *Chalcophaps indica*, *Otus scops*, *Glaucidium brodiei*, *Ninox scutulata*, *Accipiter trivirgatus*, *Urocissa caerulea* and *Alcippe morrisonia*; 3, *Otus bakkamoena*; 2, *Dendrocitta formosae*; 4, *Myiophoneus insularis*; 5, *Zoothera dauma*. Population density of this fly was very low, with hardly more than 1 fly per record. Host range was wide with 1 record for Ciconiiformes, 1 Columbiformes, 6 Strigiformes, 1 Falconiformes, 13 Passeriformes. The Strigi- and Passeriformes are probably preferred. The species is almost inseparable from *O. fuscipennis* Bigot

of Australia and New Guinea and shows a similar tendency in host relationship.

**Lynchia trita** Speis. 94 records (84 ♂♂, 102 ♀♀), all ex *Megalaima oorti* which is almost certainly the only true host in Taiwan. This species was heretofore known from the unique type ex *M. ramsayi* Wald. in Burma. Quite possibly it is monoxenous and confined to the genus *Megalaima*.

**Lynchiam aquilingensis** Ferr. 28 records (28 ♂♂, 24 ♀♀): 1 ex *Goisakius melanolophus*; 1, *Rallina eurizonoides*; 4, *Arborophila crudigularis*; 19, *Bambusicola thoracica*; 2, *Hierophasis swinhoii*; 1, *Megalaima oorti*. Probably preferring if not entirely confined to Galliformes (25 records). It seems safe to surmise that the odd records of 1 each ex Ciconii-, Gru- and Piciformes were stragglers.

**Lynchia** sp. "P" 63 records (53 ♂♂, 76 ♀♀): 1 ex *Bambusicola thoracica*; 44, *Dendrocitta formosae*; 15, *Urocissa caerulea*; 2, *Oriolus chinensis*; 1, *Yuhina xantholeuca*. Apparently preferring if not confined to Passeriformes (62 records), particularly Corvidae (59 records). The odd record ex Galliformes was certainly a straggler. The species is related to *L. chalcolumpra* Speis. of New Guinea.

**Lynchia** sp. "F" 5 records (3 ♂♂, 4 ♀♀): 1 ex *Accipiter virgatus*; 2 each ex *A. trivirgatus* and *A. badius*. Probably preferring Falconiformes. Further collecting may reveal a host range wider than is presently surmised. The species is also a relative of *L. chalcolumpra* Speis.

**Lynchia** sp. "L" 6 records (9 ♂♂, 17 ♀♀): 2 ex *Lonchura striata*; 3, *L. punctulata*; 1, *L.* sp. Probably preferring if not confined to Passeriformes, particularly Ploceidae. The closest relative of this species is *L. minor* Bigot (Africa, Madagascar, Mid East) which shows similar host preference.

**Pseudolynchia canariensis** Mcq. 21 records (23 ♂♂, 27 ♀♀): 8 ex *Streptopelia orientalis*; 13, *S. chinensis*. Obviously preferring Columbiformes.

**Pseudolynchia garzettiae** Rndn. 14 records (11 ♂♂, 22 ♀♀), all ex *Caprimulgus affinis*. Probably as in other countries, confined to the Caprimulgi- and Strigiformes in Taiwan although at present we have no material from Strigiformes.

## B. HIPPOBOSCID FAUNA OF DIFFERENT BIRD-GENERA

Hippoboscid fauna of the different birds examined is enumerated below. To conserve space, names of the host birds are only to genera, and the numeral following each entry signifies total number of positive records for all hippoboscid species off that particular bird-genus (when 2 species were found on the same individual bird, it was counted as constituting 2 records).

*Goisakius*: *Ornithoica exilis*, *Ornithomya* sp. "T",  
*Lynchia maquilingensis*; 3.

*Amaurornis*: *Ornithoica* sp. "M"; 1.

*Rallina*: *Lynchia maquilingensis*; 1.

*Streptopelia*: *Pseudolynchia canariensis*; 21.

*Chalcophaps*: *Ornithomya* sp. "T"; 1.

*Otus*: *Ornithophila metallica*, *Ornithomya* sp. "T";  
4.

*Ninox*: *Ornithomya* sp. "T"; 1.

*Glaucidium*: *O.* sp. "T"; 1.

*Accipiter*: *O.* sp. "T", *Lynchia* sp. "F"; 6.

*Arborophila*: *Lynchia maquilingensis*; 4.

*Bambusicola*: *L. maquilingensis*, *L.* sp. "P"; 20.

*Hierophasis*: *L. maquilingensis*; 2.

*Caprimulgus*: *Pseudolynchia garzettae*; 14.

*Dendrocopos*: *Ornithoica* sp. "M"; 1.

*Megalaima*: *Ornithoica* sp. "M", *Ornithophila metallica*,  
*Lynchia maquilingensis*, *L. trita*; 104.

*Lonchura*: *Lynchia* sp. "L"; 6.

*Dicrurus*: *Ornithoica* sp. "M", *Ornithophila metallica*;  
4.

*Zosterops*: *Ornithoica* sp. "M"; 1.

*Dendrocitta*: *O.* sp. "M", *Ornithophila metallica*,  
*Ornithomya* sp. "T", *Lynchia* sp. "P"; 117.

*Urocissa*: *O.* sp. "M", *O. metallica*, *O.* sp. "T",  
*L.* sp. "P"; 28.

*Lanius*: *Ornithoica* sp. "M"; 1.

*Oriolus*: *O.* sp. "M", *Lynchia* sp. "P"; 3.

*Myiophonus*: *Ornithoica* sp. "M", *Ornithomya* sp.  
"T"; 10.

*Zoothera*: *Ornithoica exilis*, *O.* sp. "M", *Ornithomya*  
sp. "T"; 11.

*Turdus*: *Ornithoica exilis*, *Ornithophila metallica*; 2.

*Cinclidium*: *Ornithoica* sp. "M"; 1.

*Brachypteryx*: *O.* sp. "M"; 2.

*Hypsipetes*: *O.* sp. "M", *Ornithophila metallica*; 11.

*Alcippe*: *Ornithoica* sp. "M", *Ornithomya* sp. "T";  
4.

*Yuhina*: *Lynchia* sp. "P"; 1.

*Heterophasia*: *Ornithoica* sp. "M", *Ornithophila*  
*metallica*; 26.

*Garrulax*: *Ornithoica* sp. "M", *Ornithophila metallica*;  
7.

It is interesting that 15 of the 32 bird-genera listed above harbored 2 or more species of hippoboscid flies not necessarily found on the same individual birds

(cf. next paragraph). Also, genera *Megalaima* and *Dendrocitta* which we have abundantly collected, each harbored 4 different species of 3 or 4 different genera of flies. The genus *Urocissa* was also found infested by 4 species of flies identical with those on *Dendrocitta*. All birds of the former genus collected were found to have been infested. Perhaps the Corvidae, to which the 2 genera belong, are exceptionally preferred hosts of hippoboscid flies on this Island.

## C. SPECIES ASSOCIATION OF FLIES

There were 34 cases in which an individual bird was found harboring more than one genus and species of hippoboscid flies. In 3 of these cases, the flies were of 3 different genera and species. On the other hand, only one case harbored flies of 2 different species belonging to the same genus. Competition among these flies on the same individual host was therefore largely inter- rather than intrageneric. It was also found that mono- or oligoxenous fly-species predominated over polyxenous ones. However, none was predominant when both or all species were polyxenous. There was no case where an individual bird harbored 2 different mono- or oligoxenous flies. Our data are as follows:

*Ornithoica exilis* / *O.* sp. "M". 1 case, with 1 and 5 specimens respectively for the 2 species; ex *Zoothera*. "M" predominates over *exilis* in Taiwan.

*Ornithoica* sp. "M" / *Ornithomya* sp. "T". 6 cases (1 each also harboring *Lynchia* sp. "P" and *Ornithophila metallica*), with 6 and 8 specimens respectively for the species; 2 cases each ex *Myiophonus* and *Zoothera*, 1 case each ex *Dendrocitta* and *Urocissa*. Both "M" and "T" are polyxenous.

*Ornithoica* sp. "M" / *Ornithophila metallica*. 9 cases (1 each also harboring *Lynchia* sp. "P" and *Ornithomya* sp. "T"), with 13 and 10 specimens respectively; 6 cases ex *Dendrocitta*, 2 ex *Heterophasia*, 1 ex *Hypsipetes*. Both "M" and *metallica* are polyxenous.

*Ornithoica* sp. "M" / *Lynchia* sp. "P". 18 cases (1 also harboring *Ornithomya* sp. "T"), with 26 and 39 specimens respectively for the species; with 14 cases ex *Dendrocitta*, 4 ex *Urocissa*. "P" has a more restricted host range and is hence predominant over "M".

*Ornithoica* sp. "M" / *Lynchia trita*. 1 case, with 1 and 3 specimens respectively; ex *Megalaima*, on which *L. trita* is apparently monoxenous and is therefore predominant over "M".

*Ornithomya* sp. "T" / *Ornithophila metallica*. 1 case (which harbored *Ornithoica* sp. "M" too), with 1 specimen each, ex *Dendrocitta*. Both flies are polyxenous.

*Ornithophila metallica* / *Lynchia* sp. "P". 4 cases (1 of them harboring *Ornithoica* sp. "M" too),

with 5 and 10 specimens respectively for the species; with 2 cases each ex *Dendrocitta* and *Urocissa*. "P" has a much more restricted host range and is hence predominant over *metallica*.

#### D. FREQUENCY OF FLIES ON DIFFERENT BIRD-ORDERS

Among the 14 orders of birds examined, the Anseri-, Charadrii-, Cuculi-, Apodi- and Coraciiformes lacked sufficient material and revealed no hippoboscoid flies. For the remaining orders, the parasitism rate and number of flies collected therefrom are:

Ciconiiformes, 25%, 4 flies, 3 records; average 1.3 flies/rec.

Gruiformes, 6.4%, 2 flies, 2 records; average 1 fly/rec.

Columbiformes, 20%, 51 flies, 22 records; average 2.3 flies/rec. Two young birds (*Streptopelia chinensis*) revealed 10 flies each.

Strigiformes, 22.2%, 9 flies, 6 records; average 1.5 flies/rec.

Falconiformes, 22.2%, 10 flies, 6 records; average 1.7 flies/rec.

Galliformes, 30.6%, 50 flies, 26 records; average 2 flies/rec.

Caprimulgiformes, 43.8%, 33 flies, 14 records; average 2.4 flies/rec.

Piciformes, 38.6%, 197 flies, 105 records; average 1.9 flies/rec.

Passeriformes, 22.2%, 368 flies, 199 records; average 1.8 flies/rec.

The grand average was 1.8 flies / rec. Parasitism rate was highest in Caprimulgi-, Pici- and Galliformes with percentages above 30; next highest in Passeri-, Ciconii-, Strigi-, Falconi- and Columbiformes with percentages about 20; lowest in Gruiformes. Average number of flies per record in the different orders approximated each other.

#### E. DISHARMONY IN HOST-PARASITE DISTRIBUTION

The hippoboscoid fauna of countries neighboring Taiwan has been little investigated and the frequency of such flies on different birds is scarcely known. This renders detailed analysis and comparison of distributional patterns impossible. But even from our limited material, a few points may be noted:

(a) Scarcity of *Ornithoica exilis*. This is quite

significant, particularly when compared with abundance of *O. sp. "M"*. A similar phenomenon was also found in Borneo. But in Thailand, Philippines, New Guinea etc., *exilis* is either more abundant or as abundant as close relatives of "M". Birds of the genera *Goisakius*, *Accipiter*, *Pernis*, *Chalcophaps*, *Centropus*, *Dicrurus*, etc. are known as hosts of *exilis* in other countries but apparently not in Taiwan.

(b) Abundance of *Lynchia trita* and *Pseudolynchia garzettae*. The former is represented in collections by only 3 Burmese specimens (2 of them unrecorded in literature), and the latter has rarely been recorded from the Orient. Possibly both are due to insufficient collecting in other countries, and also due in the latter species to confusion with *Ps. canariensis* Mcq.

(c) Concentration of *Pseudolynchia canariensis* on *Streptopelia* spp. This is known to parasitize *Treron* and other columbid birds. Since *Sphenurus* is closely related to *Treron*, one would expect *canariensis* on the former genus of which we had 19 negative records but no positive one.

(d) Absence of *Lynchia longipalpis* and several other species. From our knowledge of host-range and host-preference of hippoboscoid flies in neighboring countries, we expected to find *L. longipalpis* Mcq. on *Spilornis cheela*, members of *Ornithomya biloba* group and the genus *Crataerina* on swallows and sand martins, as well as *Ornithoicta plicata* v. Olf. and *O. australasiae* Fabr. on a great variety of birds since such hosts are rather common in Taiwan and we had examined a number of them. Their absence in this Survey is surprising.

Further collecting may necessitate certain modifications of our view upon these points. Obviously the occurrence of certain true breeding hosts or preferred hosts in a certain place does not always mean the simultaneous occurrence of the parasite. On the other hand, vicariism or geographical replacement in closely allied parasites is significant insofar as the hippoboscoid fauna of birds in Taiwan is concerned: *Ornithoica sp. "M"*, *Ornithomya sp. "T"*, *Lynchia sp. "P"* and *L. maquilingsensis* of Taiwan are clearly counterparts of *Ornithoica stipituri* Schin., *Ornithomya fuscipennis* Bigot, *L. chalcopra* Speis. and *L. simplex* Wk. of New Guinea respectively. *L. sp. "L"* is the counterpart of *L. sp. "X"* of Malaya and even *L. minor* Bigot of Africa and Asia Minor.