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ECTOPARASITES OF AVIAN SPECIES VISITING SELECTED FRUIT ORCHARDS OF DAVAO CITY, MINDANAO ISLAND, PHILIPPINES

Elsa May Delima-Baron[1,2,3]*, Marian Dara T. Tagoon[2] & Lyre Anni E. Murao[3]
[1]Research, Publication, and Innovation Center
San Pedro College, 12 Guzman St.,
Davao City, Mindanao, Philippines
[2]School of Business Management,
Education, Arts and Sciences
San Pedro College, 12 Guzman St.,
Davao City, Mindanao, Philippines
[3]Biological Sciences and Environmental Studies Department
College of Science and Mathematics,
University of the Philippines-Mindanao,
Bago Oshiro, Davao City, Mindanao, Philippines
*Corresponding author e-mail: *elsa.delima.baron@gmail.com*

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ABSTRACT

Ectoparasites are essential in disease transmission on several hosts, including avian species. Studies on ectoparasites of birds in various habitats are substantial. However, this study was conducted to add to the minimal information about bird ectoparasites in fruit orchards. Birds were captured via mist netting in two preselected fruit orchards and dusted afterward for ectoparasite collection before release. Ectoparasites were identified based on their morphological features. Twenty-eight avian species (N=468 individuals of birds), 25% of which were Philippine endemic, were recorded in the surveyed fruit orchards. Nine species (N=24 individuals) were captured, all of which are known to occur in areas near human settlements. Ectoparasites were collected from feather dustings of 12 captured non-breeding individuals representing five of the nine bird species. The abundance, as well as the type of ectoparasites among captured birds, varied among bird species. An individual of *Todiramphus chloris* (white-collared kingfisher) had a heavy infestation. A total of 1618 adult ectoparasites were collected: 11 mites (9 identified to species level, two identified to genus level only), one species of flea, and eight louse (seven identified to species level, one identified to genus level only). Most ectoparasites collected were feather mites (order Acari, suborder Astigmata, family Analgoidea) and chewing lice (order Phthiraptera). Data revealed that despite a high degree of disturbance, fruit orchards do harbor and allow the existence of several birds, including endemic species. Despite the low capture rate, most bird individuals were infested with ectoparasites. This data reiterates previous reports that wild birds are important hosts of several ectoparasites including those found in fruit orchards.

Keywords: Agroforestry, host infestation, parasitism, urban biodiversity, wildlife

ABSTRAK

Ektoparasit adalah penting dalam proses transmisi penyakit kepada perumah, termasuk spesies burung. Kajian tentang ektoparasit burung dalam pelbagai habitat adalah ada dijalankan. Walau bagaimanapun, kajian ini dijalankan untuk menambah maklumat tentang ektoparasit burung khususnya di dusun buah-buahan. Burung telah ditangkap menggunakan jaring kabus di dua kebun buah-buahan yang telah dipilih dan disikat bulu pelepahnya untuk pengumpulan ektoparasit sebelum dilepaskan. Ektoparasit dicamkan berdasarkan ciri morfologinya. Sejumlah 28 spesies burung (N=468 individu burung), 25% daripadanya adalah endemik Filipina, telah direkodkan dalam kebun buah-buahan yang dikaji. Sembilan spesies (N=24 individu) telah ditangkap, kesemuanya diketahui berlaku di kawasan berhampiran penempatan manusia. Ektoparasit dikumpul daripada debu bulu 12 individu bukan pembiakan yang ditangkap mewakili lima daripada sembilan spesies burung. Kelimpahan, serta jenis ektoparasit di kalangan burung yang ditangkap, berbeza-beza di kalangan spesies burung. Satu individu *Todiramphus chloris* (Raja Udang Kolar Putih) didapati mengalami imnfestasi yang tinggi Sebanyak 1618 ektoparasit dewasa telah dikumpul: 11 hama (9 dikenal pasti kepada peringkat spesies, dua dikenal pasti kepada peringkat genus sahaja), satu spesies pinjal dan lapan kutu (tujuh dikenal pasti kepada peringkat spesies, satu dikenal pasti kepada peringkat genus sahaja). Kebanyakan ektoparasit yang dikumpul adalah hama bulu (order Acari, suborder Astigmata, family Analgoidea) dan kutu kunyah (order Phthiraptera). Data mendedahkan bahawa walaupun terdapat gangguan yang tinggi, kebun buah-buahan tetap berlindung dan membenarkan kewujudan beberapa burung, termasuk spesies endemik. Walaupun kadar tangkapan rendah, kebanyakan individu burung telah dijangkiti ektoparasit. Data ini mengulangi laporan sebelumnya bahawa burung liar adalah tuan rumah penting beberapa ektoparasit termasuk yang terdapat di kebun buah-buahan.

Kata kunci: Agroperhutanan, serangan perumah, parasitisme, kepelbagaian biologi bandar, hidupan liar

INTRODUCTION

Fruit orchards are common in tropical regions like the Philippines, especially in Davao City, where agricultural farming and orchard produce are among the most dependent on income sources with a good economic return. Aside from economic significance, fruit orchards, due to their accessibility, are also preferred areas for various ecological studies to investigate species interactions. One interesting study to venture into in fruit orchards is the birds visiting the trees and their role. Several studies have revealed vital ecological niche that birds visiting orchards play and such included pollination and seed nucleation, especially in areas needing help in succession (Pausas et al. 2006) as well as control for the population of invertebrate and vertebrate pests (Sekercioglu 2006; Simon et al. 2010).

However, the efficiency of the performance of these functions among avian species is affected greatly by the state of health of the species, which then affects its survival fitness (Waite et al. 2012). One factor that contributes to this is the presence of ectoparasites. To date, birds harbor different insect ectoparasites, including flies, fleas, ticks, mites, and lice (Atkinson et al. 2008). Ectoparasites infesting birds were reported to induce maladies in birds and eventually cause fertility decline (Booth et al. 1993; Krasnov et al. 2004).

Aside from determining if ectoparasites may adversely affect avian species' fitness, most insect ectoparasites may also serve as vectors for pathogenic agents that may cause zoonotic diseases in humans (Ogrzewalska et al. 2010). Several species of viruses and bacterial pathogens that infest humans have been detected in birds, with different species of migratory birds contributing to the widespread distribution of arboviruses, influenza A virus, *Chlamydophila* spp., *Anaplasma* spp., *Borrelia* spp., *Campylobacter* sp., *Salmonella* sp. *Pasteurella* spp., and *Mycobacterium avium*, either through direct contact with the birds or through the bite of the associated ectoparasites (Hubalek 2004). A five-year data report demonstrated that the introduction of tick-borne diseases in humans is influenced by bird-facilitated tick introduction in areas with pronounced human domicile (Hamer et al. 2012). Few accounts on ectoparasites infesting varied bird species from the Philippines were reported earlier, but none checked on what bacterial species were associated with these avian ectoparasites (Mironov et al. 2018; Su et al. 2013). Determining then what ectoparasites are associated with birds and what bacterial species these ectoparasites possibly contain also provide essential links in understanding the transmission of diseases with poorly understood vectors.

Although several studies on ectoparasites of wild birds have been done together with important ecological functions performed by birds in various habitat types (Delima-Baron & Ruales 2020), very few are known about ectoparasites of birds sampled from fruit orchards (Mansouri et al. 2021; Roy et al. 2013). This study documented the ectoparasites of birds captured from fruit orchards in Davao City, Mindanao Island, Philippines. The study results provide additional information to scanty data on this topic.

MATERIALS AND METHODS

Study Design, Research Sites, Permit Acquisition

This study was a descriptive and quantitative study. Data was based on ectoparasites collected from the bird species captured via mist netting in two selected fruit orchards of Davao City, Mindanao, Philippines (Figure 1). Field sampling was done in two different private-owned fruit orchards within Davao City: one is a parcel of land with fruit-bearing trees in Catalunan Pequeño ($7^0$04’18”N, $125^0$31’11”E), and a fruit farm in Los Amigos ($7^0$08’07”N, $125^0$28’52”E). These farms were randomly selected biased on accessibility. These orchards are already geographically distant to ensure that the birds that forage or visit each orchard are unique. For uniformity, the orchards contained similar fruit-bearing trees, which include mango (*Mangifera indica*), lanzones (*Lansium domesticum*), durian (*Durio zibethinus*), and rambutan (*Nephelium lappaceum*), and were sampled consecutively during the peak of the fruiting season. The mist nets were stationed within the area of the fruit farms to minimize disturbance to the neighboring communities or interfere with their daily activities.

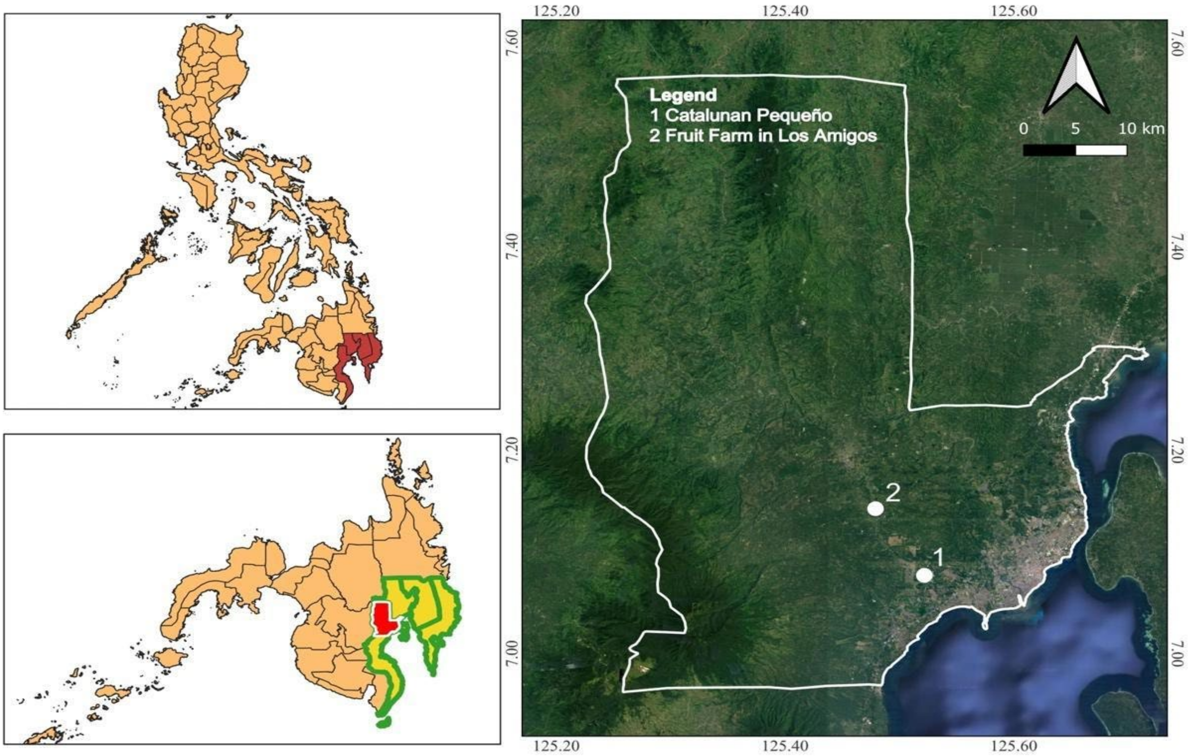

Figure 1. Map of the two sampling areas in Davao City, Davao del Sur, Philippines

Sampling and Identification of Bird Species

Birds were captured using mist netting. For each fruit orchards sampled, five mist nets (2 m high x 10 m long, with 36 mm mesh) were stationed approximately one meter and a half from the ground in series in a possible flyway of the birds for five consecutive days. The nets were left open the whole day until five in the evening and were reopened as early as four in the morning. Nets were immediately closed when the weather condition was not favorable so that birds were not trapped and left unattended. Nets were checked as frequently as possible to avoid death of captured samples. Captures were removed carefully, gently, and quietly by hand from the mist nets to avoid potential injury to the birds. All captures were released immediately after photo documentation for identification support and sampling evidence and dusting of ectoparasites. All captures were placed in individual bird cloth bags to minimize stress and were brought to the processing area for ectoparasite dusting. The Philippine bird field guide (Kennedy et al. 2000) served as reference for bird identification, and confirmation of the bird species identification was done by a seasoned ornithology expert. The endemicity of bird species was based on the geographic range information disclosed in the International Union for the Conservation of Nature database (IUCN 2024).

Collection, Isolation, and Identification of Ectoparasites

Prior to removal of birds from nets and from ectoparasite dusting, the researchers wore appropriate protective gears including a gloves and high collared long sleeved white lab coat to easily spot and collect if an ectoparasite has landed on the researchers' body parts that came in close contact with the birds. Ectoparasites were removed from the birds captured via dust ruffling following the protocol of Clayton and Drown (2001). Birds were removed from each individual cloth bag carefully, then dust ruffling was done by other personnel who preceded by placing pyrethrin dust all over the body of the bird except on the head or areas close to the eyes.

The dust was allowed to penetrate in between the plumage to reach more areas for five minutes. After dusting, the feathers of the birds were smoothed down, including rumpled flight, head, and tail feathers. After dusting, the birds were left to recover prior to release. Processing time was also made as short as possible to prevent the birds from getting exhausted, especially due to heat. Drops of water or Gatorade were given to the bird to hydrate them but intake was not forced into its mouth. The bird box was also placed in a shaded area.

The dustings from each bird sample were collected and stored in clean, white cellophane and delivered to the laboratory for identification. Each dusting was removed from the cellophane and carefully examined for ectoparasites through manual separation of the fragments from the pyrethrin dust. Suspected ectoparasites were examined under a dissecting microscope (Ceti, 40X) and were mounted on clean coverslips and slides and viewed under 4x or 10x magnification of the compound light microscope. Photographs of the ectoparasites were taken directly from the field of view. To confirm species identity of the ectoparasites, Borror and DeLong's Introduction to the Study of Insects (Triplehorn & Johnson 2005) and Goater et al. (2014), were utilized as the main references.

Data Analysis

Rarefaction plot and coefficient of similarity was calculated using PAST (Paleontological Statistics) Software Package version 4.03.

RESULTS AND DISCUSSION

Avian Species from Selected Fruit Orchards of Davao City

A total of 28 avian species (N=468) were recorded from the selected fruit orchards sampled: 25 species from Catalunan Pequeño (Site 1) and 22 species from Los Amigos (Site 2). This record is a cumulative result of the avian individuals counted through sightings, bird calls, and those captured via mist netting (Table 1). Seven of the species are endemic to the Philippines and none of the accounted species are listed under the threatened category of the International Union for the Conservation of Nature (IUCN 2024), as all are listed as Least Concern.

The species rarefaction data show that in terms of sampling effort, both sites are moving towards a plateau and the possibility that only few species will be added to the current list should sampling be extended is very likely (Figure 2). The cluster analysis results also revealed that both sites have high coefficients of similarity (Figure 3), suggesting close similar species composition between sampling areas.

Table 1. Avian individuals documented in the two sampling sites (Legend: LC - Least Concern, * - Non-endemic, + - Endemic) following IUCN, 2024

Scientific Name	Common Name	Mode of Documentation	Site 1 (number of individuals)	Site 2 (number of individuals)
Accipitridae				
Aliastur indus LC*	Brahminy kite	seen, heard	-	20
Alcedinidae				
Halcyon smyrnensis LC*	White-breasted kingfisher	seen, heard, captured (1)	-	4

Todiramphus chloris LC*	White-collared kingfisher	seen, heard, captured (8)	9	15
Ardeidae				
Bubulcus ibis LC*	Cattle egret	seen, heard	6	6
Artamidae				
Artamus leucoryn LC*	Wood swallow	seen	5	-
Apodidae				
Aerodramus mearnsi LC+	Philippine swiftlet	seen, heard	8	-
Collocalia esculenta LC*	Glossy swiftlet	seen, heard	10	28
Columbidae				
Geopelia striata LC*	Zebra dove	seen, heard, captured (1)	16	33
Phapitreron leucotis LC+	White-eared brown dove	seen, heard	10	16
Spilopelia chinensis LC*	Spotted dove	seen, heard, captured (1)	3	14
Corvidae				
Corvus macrorhynchos LC*	Large-billed crow	seen, heard	7	14
Cuculidae				
Centropus viridis LC+	Philippine coucal	seen, heard	3	-
Dicaeidae				
Dicaeum australe LC+	Red-keeled flower pecker	seen, heard	13	4
Dicaeum hypoleucum LC+	Buzzing flower pecker	seen, heard	7	5
Dicaeum trigonostigma LC*	Orange-bellied flower pecker	seen, heard	8	-
Fregatidae				
Fregata ariel LC*	Lesser frigatebird	seen	-	1
Laniidae				
Lanius cristatus LC*	Brown shrike	seen, heard, captured (2)	8	1
Megalaimidae				
Megalaima haemacephala LC*	Coppersmith barbet	seen, heard	3	16
Meropidae				

Merops philippinus LC*	Blue-tailed bee eater	seen, heard	4	-
Nectariniidae				
Cinnyris jugularis LC*	Olive-backed sunbird	seen, heard	13	11
Oriolidae				
Oriolus chinensis LC*	Black-naped oriole	seen, heard	10	-
Passeridae				
Passer montanus LC*	Eurasian sparrow	seen, heard, captured (1)	9	-
Pycnonotidae				
Hypsipetes philippinus LC+	Philippine bulbul	seen, heard	9	-
Poliolophus urostictus LC+	Yellow-wattled bulbul	seen, heard	6	-
Pycnonotus goiavier LC*	Yellow-vented bulbul	seen, heard, captured (5)	7	11
Hipiduridae				
Rhipidura javanica LC*	Pied fan tail	seen, heard, captured (4)	35	39
Sturnidae				
Aplonis panayensis LC*	Asian glossy starling	seen, heard, captured (1)	17	-
Zosteropidae				
Zosterops everetti LC*	Everette's white eye	seen, heard	4	3

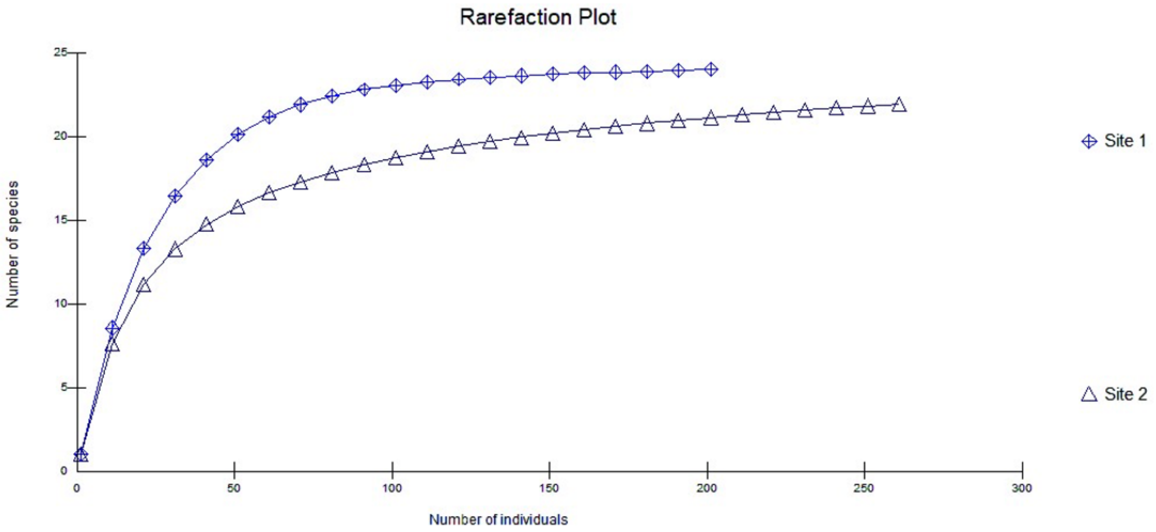

Figure 2. Rarefaction plot showing sampling effort employed in both sampling sites (Total species- 28; total individuals = 468)

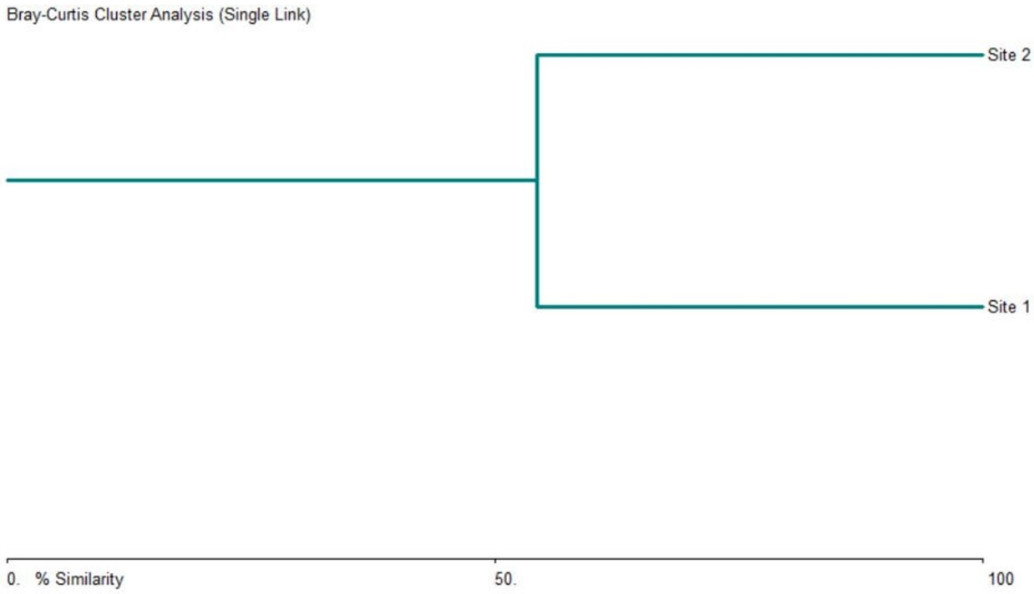

Figure 3. Cluster analysis showing coefficient of similarity of bird species documents in the fruit orchards sampled

Fruit orchards can be sanctuaries of diverse groups of wildlife, including avifauna (Mellink et al. 2017; Round et al. 2006). In the Philippines, accounts of bird species documented in agro-forested areas and fruit orchards are accessible (Balasa et al. 2023; Mallari et al. 2011; Tanalgo et al. 2015; Tanalgo et al. 2019). These studies reveal that species richness and composition of birds vary among different orchards, with a pronounced limited number of endemic species. The present study parallels these earlier reports. Poor species richness in fruit orchards are greatly influenced by two factors: floristic composition and structure, as well as degree of disturbance. Several accounts of avifauna in agro-ecosystems including fruit orchards highlighted those areas left undisturbed for at least five years, have partial canopies, and are composed of diverse species of shrubs, with extensive ground cover, are likely to support a diverse group of birds (Deikumah et al. 2017; Pomara et al. 2012). Chmielewski (2019) noted that richness and diversity of birds in old orchards is higher because they have more food, more secure spaces to build their nests and less crown transparency. This is regardless whether the orchard is monoculture or planted with mixed fruit trees. Tanalgo et al. (2019) also reported that mixed orchard plantations support higher bird diversity especially when understory vegetation is allowed to grow. The importance of an understory layer which provides additional microhabitats for more bird species was also emphasized by Kajtoch (2017). Mixed orchards that are less maintained can support both frugivores and insectivores. Both sites have stands of mangoes and durian, with few stands of other fruit-bearing plants such as mangosteen, and rambutan. The Catalunan Pequeño orchard has a more covered canopy as opposed to the more open canopy of the Los Amigos orchard. Ground cover is also thick in Catalunan Pequeño as compared to the very thin ground cover of the Los Amigos site. As both sites surveyed do not have diverse floristic composition and are both situated pretty close to human settlements and a national highway, the low species richness values are quite expected. The similarity of floristic composition in both orchards also support the relatively high coefficient of species similarity shown in the cluster analysis results. Given the proximity of the sites to areas with high degree of disturbance, species composition for both sites reflects a community of disturbance tolerant and non-forest dependent birds. The data supports an earlier report of Tanalgo et al. (2015) that the bird composition fluctuates with different vegetation types, and orchards often are composed of tolerant bird species. Callaghan et al. (2019) also noted that birds in urban green spaces including orchards are highly generalists and urban tolerant. The presence of the bird species that are considered generalist feeders *Rhipidura nigritorquis*, *Collocalia esculenta,* and *Pycnonotus goiavier* in both sites also highlights degree of tolerance in the fruit orchards as these species were reported to be common dwellers of agro-forested areas near human communities and (Tanalgo et al. 2015) and in agricultural plots (Achondo et al. 2011).

Ectoparasites Associated with Captured Avian Species

A total of 24 individuals representing nine avian species were captured through mist netting for the entire field sampling duration (Table 2). Eight species were captured in Site 1, while seven species were captured in Site 2. *Todiramphus chloris, Geopelia striata, Spilopelia chinensis, Lanius cristatus*, *Pycnonotus goiavier,* and *Rhipidura javanica* were captured in both sites. *Passer montanus* and *Aplonis panayensis* were captured only in Site 1, while *Halcyon smyrnensis* was captured solely in Site 2. *T. chloris* individuals were captured the most in Site 2. All captured species are known to occur in areas near human settlements (Kennedy et al. 2000). Previous accounts also highlighted these species as common inhabitants of human-modified habitats including fruit orchards (Achondo et al. 2011; Tanalgo et al. 2015; Tanalgo et al. 2019). The dominance of *T. chloris* among the captured samples especially in Site 2 can be attributed to presence of the river near the areas where three mist nets were stationed. Riparian habitats create continuity of different habitats (Bernardo 2017) as it provides cover types and complex layers of vegetation that make it attractive to birds (McClure et al. 2015; Pennington et al. (2008). The mist nets that frequently captured individuals of *T. chloris* appear to have been strategically positioned in the flyway of this species towards the river, thus the higher capture rate.

Among the 24 captured individuals, ectoparasites were collected only from 13 individuals representing five avian species (Table 2) as feather dustings from the eleven individuals contained only debris of non-parasitic nature. Only one species, *Geopelia striata*, was infested with a single species of ectoparasite, while the bulk of captured birds were infested with more than one ectoparasite species. All captured individuals with ectoparasites were non-breeding. The abundance as well as type of ectoparasites among captured birds varied among bird species. While only a few (n = <10) ectoparasites were collected from most captured bird individuals, one *T. chloris* individual had heavy infestation. Although ectoparasitic load is higher among breeding nesting birds (Cantarero et al. 2013), non-nesting birds are also infested, with known cases of heavy infestation as manifested in the data of the present study. *T. chloris* also has the largest body mass among the captured species. The host body mass may be influential to the abundance and diversity of ectoparasites as larger hosts provide more resources to the ectoparasites (Horn et al. 2023).

Table 2. Ectoparasites associated with captured bird species

Host (Number of individuals with ectoparasite)	**Ectparasites (adults)**	**Ectoparasite Type**	**No. of host with ectoparasite/ (No. of ectoparasite)**	
			Site 1	**Site 2**
Aplonis panayensis Site 1 (n=1)	*Trouessartia* cf. *latiducta (♂,♀)*	Mite	1/(18)	-
	Falculifer sp.	Mite	1/(8)	-
	Falculifer cf. *rostratus*	Mite	1/(1)	-
	Lophoralichus sp.	Mite	1/(1)	-
Geopelia striata Site 1 (n=1)	*Aegypoecus* cf. *hopkinsi*	Louse	1/(1)	-
Lanius cristatus Site 1 (n=1)	*Pterotrogus* cf. *panamensis (♂,♀)*	Mite	1/(2)	-
	Anisophyllodes cf. *elaeniae*	Mite	1/(1)	-
	Trouessartia cf *latiducta (♂,♀)*	Mite	-	1/(2)
	Trouessartia cf. *reguli (♀)*	Mite	-	1/(1)
Pycnonotus goaivier Site 1 (n=1) Site 2 (n=3)	*Ceratophyllus* cf. *gallinae*	Flea	1/(1)	-
	Austromenopon cf. *phaeopodis*	Louse	-	1/(4)
	Myrsidea cf. *pycnonoti*	Louse	-	1/(2)
	Philopteroides sp.	Louse	-	1/(1)
	Trouessartia cf. *latiducta (♂,♀)*	Mite	-	1/(3)
Todiramphus chloris Site 2 (n=5)	*Goniocotes gallinae*	Louse	-	2/(5)
	Campanulotes cf. *bidentatus*	Louse	-	1/(4)
	Trouessartia cf. *latiducta (♂,♀)*	Mite	-	5/(1201)
	Antarctophthirus cf. *microchir*	Louse	-	1/(1)
	Trouessartia cf. *reguli (♀)*	Mite	-	2/(316)
	Aegypoecus cf. *hopkinsi*	Louse	-	1/(3)
	Anatoecus cf. *dentatus*	Louse	-	1/(2)
	Trouessartia cf. *calcealgiana*	Mite	-	3/(34)
	Pterodectes cf. *paroariae*	Mite	-	1/(4)
	Glycyphagus sp.	Mite	-	1/(1)
	Freyana cf. *anatine*	Mite	-	1/(1)

A total of 1618 ectoparasites were collected: 28 in *Aplonis panayensis*, six in *Lanius cristatus*, 11 in *Pycnonotus goaivier*, one in *Geopelia striata*, and 1572 from *Todiramphus chloris*. Twenty-one taxa (Table 2) of ectoparasites were identified: 11 mites (9 identified to species level, two identified to genus level only), one species of flea, and eight louse (seven identified to species level, one identified to genus level only). Feather mites were the most abundant ectoparasite collected (1593 individuals), the bulk of this count was extracted from one individual of *T. chloris*. The most abundant species of feather mites was *Trouessartia* cf *latiducta* which was extracted from all bird species collected in Site 2. Mites was observed to be abundant among Passerine birds but is also found among kingfishers.

For this study, *T. chloris* was found to be heavily infested with *Trouessartia* cf. *latiducta*. The ectoparasite *Goniocotes gallinae* found in one *T. chloris* was also observed on quarantined birds (Su et al. 2013), mostly encountered on the down feathers near the skin so that they have easy access to resources such as dried blood, skin debris, and skin secretions. Feather mites were found mostly on all birds with ectoparasite infestation, except for one individual of *G. striata* collected from the first site.

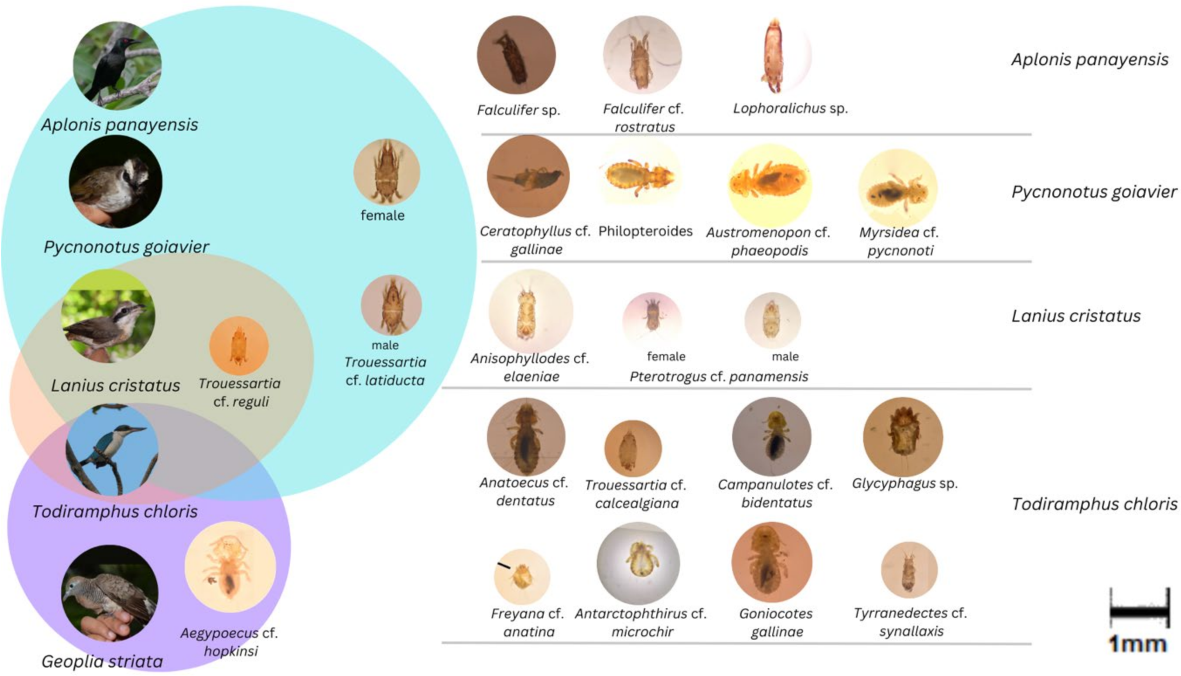

Figure 4. Ectoparasites collected from captured birds from selected fruit orchards in Davao City. (Ectoparasites inside colored boxes are found in two or more bird hosts while ectoparasites outside the colored boxes are found only in one bird species specified)

Most of the ectoparasites were collected on the dorsal region of the birds including the wings. Dabert and Mironov (1999) noted that feather mites occupy four microhabitats within the birds including (1) plumulaceous down feathers, (2) vane surface of contour flight feathers, (3) interior of quills of flight and tail feathers, and (4) surface of the skin. All parasites collected from captured birds were found on either the down or flight feathers. Specifically, one individual of *T. chloris* had heavy infestation on its down feathers. This was the same with the study of Su et al. (2013) wherein they noted that ectoparasites from the Order Phthiraptera were mostly distributed on the wings where down feathers were situated. On the other hand, the same study also noted that feather mites were found on the surface of the feathers. In the paper of Pap et al. (2005), the proponents further noted that feather mites prefer the second outermost primary feathers as its escape behavior against shedding of the primary feathers. Moreover, the same study also noted that feather mites were mostly found on the outer primary feather as they are more exposed to preening oil, which is the source of their food. This was also corroborated in the studies of Blanco et al. (2001) and Doña et al. (2018). Both studies agreed that feather mites are not direct parasites but are detrimental parasites. As they forage and remove oil from the feathers, they also play a commensal-mutualistic relationship with microorganisms such as fungi and bacteria that can degrade feathers that will eventually compromise the health of the host (Blanco et al. 2001; Galvan et al. 2012).

CONCLUSIONS

Results of the present study reveal that despite a high degree of disturbance in the sampled areas, fruit orchards harbor several birds, including endemic species. Despite the low capture rate, most bird individuals were infested with ectoparasites. This data reiterates previous reports that wild birds are important hosts of several ectoparasites. The feather mites (Order Acari, Suborder Astigmata, Family Analgoidea) and chewing lice (Order Phthiraptera) were the commonly collected ectoparasites from the bird hosts. The diversity of ectoparasites extracted from five different species also puts into limelight that a single bird host can cater to a myriad of ectoparasite species. Future researches of similar nature need to increase the number of sampling sites to include fruit orchards with more heterogeneous vegetation and compare it with fruit orchards that have less heterogeneous vegetation. Number of mist nets to be stationed per site must also be augmented to increase possible capture rate. High nets must be considered instead of placing solely ground nets. Nets should also be strategically stationed in sites where birds are observed to hover or are more visible.

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AUTHORS DECLARATION

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Conflict of Interest

The authors declare no conflict of interest.

Ethics Declarations

Prior to field works, entry permits were secured from owners and caretakers of the farms. Wildlife Gratuitous Permit (WGP Number 2020-01) was obtained from the Wildlife Division of the office of the Department of Environment and Natural Resources Region XI, while a certification from an Institutional Animal Care and Use Committee (Animal Ethics Committee) was also secured from Davao Medical School Foundation Institutional Animal Care and Use Committee.

Data Availability Statement

This study received funding from the Department of Science and Technology - Philippine Council for Health Research and Development (DOST-PCHRD). Terminal reports are available from the institution and the project leader.

Authors' Contributions

Elsa May Delima-Baron (EMD-B) conceptualized the research, obtained funding, assisted in the field and lab works, performed data analysis, and wrote the manuscript draft; Lyre Anni E. Murao (LAE.M) provided inputs on procedures and in manuscript writing and review; Marian Dara T. Tagoon (MDT.T) assisted in the field and lab works, performed data analysis, and wrote the manuscript draft. All authors approved the submitted version of the manuscript.

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