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PREVALENCE OF HELMINTH PARASITES OF HOUSE CROWS (CORVUS SPLENDENS VIEILLOT) FROM THE KELANG DISTRICT OF PENINSULAR MALAYSIA

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Abstract. The occurrence of helminth parasites from the common house crow *Corvus splendens* Vieillot from the Kelang district of Peninsular Malaysia was studied over a 16-month period. Of 232 necropsied, 160 (69.0 %) were infected with strikingly few (only 3) species of helminth parasites. The 3 species recovered were: *Raillietina* (*Paroniella*) *reynoldsae* Meggit, 1926 (Cestoda: Davaineidae); *Lutztrema* sp. (Trematoda : Dicrocoeliidae), probably a new species; and *Cardiofilaria pawlowskyi* Strom, 1937 (Nematoda : Filarioidea). Prevalence of cestodes is the highest (74.4 %), followed by that of trematodes (38.8 %). Filarioid infection, by either the adult (7.5 % prevalence) or its larvae (13.8 % prevalence), was relatively low. Mean intensity of infection was 18.97 worms per infected host for trematode infection, 5.64 adult worms and 4.38 worms for filarioid and cestode infections respectively. Statistical analysis has shown that prevalence and intensity of infection are independent of host sex. Homogeneity in the diet of the host and the stability of the tropical environment may explain the lack of helminth species diversity and association between seasonality and parasite infection. Host age was an important factor influencing the establishment of helminths in crows since adults harbour a higher worm burden than juveniles, due probably to their longer exposure to infective stages.

The house crow, *Corvus splendens* Vieillot, is indigenous to the Indian subcontinent. About 50 house crows from the Ceylon population were first introduced to this country in 1903 to control the insect pests of coffee plantations near the coastal town of Kelang (Willey 1904). Like most species of animals introduced elsewhere, it thrived and built up a substantial population in the Kelang Valley, abetted by the absence of natural predators and the ready availability of food. Today it has successfully colonized the western coastal districts of the Malay Peninsula (Medway and Wells 1976), and Kelang is presently the main nucleus of roosting with an estimated population of nearly 30,000 birds (Charles 1978).

As far as is known, no proper or intensive survey of the helminth parasites of the house crow has been made in Malaysia. To date, the only published works are brief reports by Singh and Sinniah (1980) and Wong et al. (1980). Outside Malaysia, on the other hand, considerable work on the helminth fauna of the genus *Corvus* had been carried out as shown in the checklist by Andrews and Threlfall (1973). The present study was undertaken to determine and statistically analyse the prevalence and intensity of helminth infection in the house crows of the Kelang district of Peninsular Malaysia.

MATERIALS AND METHODS

House crows were trapped alive in 2-ply mist nets of 2 3/8 inch mesh in the evening between 17.30 and 19.30 hours. The nets were set up along the Kelang Bridge which was close to the main roosting site of the Kelang district crows. Trappings were made twice a week during the first two weeks of

each month from June 1980 until September 1981. Captured crows were brought back to the laboratory and kept in clean individual cages. All captive crows were necropsied within two to three days to minimize parasite loss and transfer between birds. After killing the crows were weighed and sexed by internal examination of the gonads. Age and maturity was determined on the basis of pigmentation changes in the buccal epithelium and tongue. A crow was classified as an adult (regardless of the number of adult years completed) if its buccal epithelium was completely black, otherwise it was considered a juvenile, distinguished by its pink-coloured buccal epithelium and white flanges of skin around its bill. Blood was collected from the brachial vein for the examination of blood parasites. Five thin and thick blood smears from each bird were fixed in absolute methanol and stained with Giemsa in a phosphate buffer solution of pH 7.2 (1 : 40). The whole body cavity was carefully searched for any free and encysted helminth larvae. The entire digestive, urinogenital, respiratory and circulatory systems and their associated organs were thoroughly checked for helminth parasites. Each system was divided into various segments which were slit open in separate petri dishes containing physiological saline. Organs were finely teased apart in saline. All contents in the petri dishes were carefully examined and collected under a stereo microscope. As some worms were damaged during removal and dissection of host systems and teasing of host organs, only whole worms were used in counts and measurements. As such, all counts should be considered minimum, and the % infection may be underestimated. Nematodes were first relaxed in saline, then killed in hot (60 °C) 70 % ethanol and stored in 70 % alcohol—glycerol. They were later cleared in glycerol for identification. Similarly cestodes and trematodes were relaxed in saline for several hours before fixation overnight in hot Bouin's fluid or A.F.A. fixative and subsequent storage in 70 % ethanol. Histological and whole mount preparations and staining of cestodes and trematodes for identification followed routine techniques. Statistical tests used were those based on Siegel (1956) and Sokal and Rolf (1969).

RESULTS

A total of 232 house crows *Corvus splendens* Vieillot were examined from June 1980 to September 1981. Of these, 193 crows were adults (83.2 %) and 39 juveniles (16.8 %). There were 96 males (41.4 %), 121 females (52.5 %) and 15 juveniles (6.1 %) of indeterminate sex (Table 1).

Table 1. Number of crows (*Corvus splendens* Vieillot) by age and sex

Adult		Juvenile			Total
Male	Female	Male	Female	Indeterminate sex	
88	105	8	16	15	232

Of the 232 crows necropsied, 160 (69.0 %) were infected with helminth parasites. Prevalence or incidence of infection here refers to the percentage of crows infected or parasitized, that is, the proportion of infected birds to all crows examined (Cox 1982). Three species of helminths (Table 2) comprising one species each of trematode, cestode and nematode were recovered. The davaineid cestode, *Raillietina* (*Paroniella*) *reynoldsae*, was the most prevalent helminth, followed by the dicrocoeliid trematode, *Lutztrema* sp. showing a 74.4 % and 38.8 % prevalence respectively. This dicrocoeliid is probably a new species because it is morphologically different from any of the described species of the genus *Lutztrema* Travassos, 1941. A detailed description of this new species is in preparation. The remaining helminth, the filarioid nematode *Cardiofilaria pawlowskyi*, was less frequently occurring, with the adults being found in 12 crows (7.5 % prevalence) and the microfilariae in 32 (13.8 % prevalence). Interestingly, this filarioid occurred in 15 out of the 16 monthly samples of crows necropsied.

The prevalence of various helminth infections in relation to host sex is presented in Table 3. When all the helminth classes are considered together (total helminth), the

prevalence in male crows (68.8 %) was not significantly different from that in female crows (71.9 %). There were also no significant differences in the susceptibility to infection of male and female crows with the various helminth parasites. *R. reynoldsae*, the most prevalent parasite of the helminth fauna, was found to be equally prevalent in

Table 2. Prevalence and intensity of helminth infection in 232 crows collected from Kelang district of Peninsular Malaysia

Parasite species	Micro-habitat	No. of crows infected	Prevalence (%)	Mean intensity
Raillietina (*Paroniella*) *reynoldsae* Meggit, 1926. (Cestoda : Davaineidae)	Small intestine	119	74.4	4.38
Lutztrema sp. (Trematoda : Dicrocoeliidae)	Liver bile duct	62	38.8	18.97
Cardiofilaria pawlowskyi Strom, 1937 (Nematoda : Filarioidea)	Adult in body cavity	12	7.5	5.64
	Microfilaria in blood	32	13,8	—

Table 3. Prevalence of helminth infection in relation to sex of host, *Corvus splendens*

Helminth class	Infected male crow		Infected female crow		Total no. examined	Chi-square (X^2) value / Probability value (p)
	%	No.	%	No.		
Cestode	53.1	(51)	52.1	(63)	144	0.00033/0.9854
Trematode	27.1	(26)	28.1	(34)	60	0.00018/0.9893
Nematode	11.5	(11)	17.4	(21)	32	1.04877/0.3058
Total helminth	68.8	(66)	71.9	(87)	153	0.12650/0.7222

Table 4. Prevalence of helminth infection in relation to maturity/age of host, *Corvus splendens*

Helminth class	infected adult crow		infected juvenile crow		Total no. examined	X^2 value/P value
	%	No.	%	No.		
Cestode	53.9	(104)	36.8	(14)	118	3.04032/0.0812
Trematode	30.1	(58)	10.5	(4)	62	5.20996/0.0225*
Nematode	15.0	(29)	13.2	(5)	34	0.00217/0.9628
Total helminth	72.5	(140)	51.3	(20)	160	0.50387/0.0108*

* Significant at 5 % level.

male and female crows ($p > 0.9$). Nematode infection, by either the adult *C. pawlowskyi* or its larvae, was relatively low, again with no significant difference between male and female hosts.

The prevalence of helminths in relation to host maturity/age is shown in Table 4. The prevalence of total helminth was significantly higher among adult members (72.5 %) of the crow population than among juvenile members (51.3 %) ($p > 0.05$). While the prevalence of cestode and nematode infections did not differ significantly between adult and juvenile birds ($p > 0.05$ and $p > 0.05$ respectively), that of trematode infections was decidedly higher in adults than in juveniles ($p < 0.05$).

Table 5. Prevalence of helminth infection in relation to host sex and maturity

Helminth class	Adult crows					Juvenile crows				
	Male host		Female host		Chi-square value (X^2)/Probability value (p)	Male host		Female host		Chi-square value (X^2)/Probability value (p)
	%	(No)	%	(No)		%	(No)	%	(No)	
Total helminth	67.0	(59)	77.1	(81)	1.96976/0.1605	87.5	(7)	37.5	(6)	3.54545/0.0597
Cestode	52.3	(46)	55.2	(58)	0.07110/0.7897	62.5	(5)	31.3	(5)	1.05000/0.3055
Trematode	28.4	(25)	31.4	(33)	0.08885/0.7656	12.5	(1)	6.3	(1)	0.00000/1.0000
Nematode	11.4	(10)	18.1	(19)	1.21280/0.2708	12.5	(1)	12.5	(2)	0.00000/1.0000

Table 6. Results of the G-test on the associations between prevalence of total helminth infection and host sex and maturity

Hypothesis Tested	D. F.	G-value	Significance
Maturity x infection independence	1	3.232	not significant ($p > 0.05$)
Sex x maturity independence	1	1.334	not significant ($p > 0.05$)
Sex x infection independence	1	0.254	not significant ($p > 0.05$)
Maturity x sex x infection interaction	1	8.094	Significant ($p < 0.01$)
Maturity x sex x infection independence	4	12.914	$p > 0.05$

Table 5 shows a cross-tabulation of parasite prevalence in relation to host maturity and host sex. Among adult hosts, a higher prevalence of helminths was observed in females than in males. Compared to their male counterparts, adult female crows tend to have a higher incidence of cestode, trematode and nematode infections. However, this tendency was not statistically significant ($p > 0.1$). In the juvenile population, male crows showed a higher susceptibility to helminth parasites than female crows but the difference was also not significant ($p > 0.05$).

The results of the G test for total helminth infection (Table 6) show that the association between maturity of the host (whether adult or juvenile) and parasite infection

was relatively strong, though statistically not significant ($p > 0.05$). There was no association between host sex and infection, concurring with the result of the X^2-test. However, the three-factor interaction between host maturity, host sex and helminth infection was highly significant. It is noted from Table 6 that, among adult hosts, females were more prone to mixed total helminth infections whereas among juvenile hosts, males were more likely to be infected. As these two associations were in opposite directions — female susceptibility among adults and male susceptibility among juveniles — the associations between host sex and infection and between host maturity and infection were probably weakened. In the analysis of monthly prevalence of infections it was found that the monthly variation in total helminth infection proved statistically insignificant ($x^2 = 20.54$, $df = 15$, $p > 0.1$). Similarly, there were no significant differences in monthly infection with each class of parasite ($p > 0.08$ for cestode; $p > 0.8$ for trematode; $p > 0.9$ for nematode).

The intensity of infection was measured by the number of helminths found per infected crow. Trematode parasites were the most numerically dominant helminth in the house crows. Thus trematode infection showed the highest intensity, with a mean of 18.97 worm per infected crow. Nematode infection was characterized by a relatively low intensity with a mean of 5.64 adult worms per infected bird. Although cestode prevalence was the highest in the present study, the mean intensity was the lowest at 4.38 worms per infected crow.

Table 7. Intensity of helminth infection in relation to host maturity

Helminth class	Intensity						One-way analysis of variance (log-transformed)			Between groups		Within groups	
	Adult			Juvenile									
	Number infected	Mean	Standard deviation	Number infected	Mean	Standard deviation	DF	F. ratio	F. prob.	Sum of squares	Mean squares	Sum of squares	Mean squar
Cestode	105	4.5333	4.526	13	3.1538	3.158	1/116	1.575	0.2119	0.2239	0.2239	16.4836	0.14
Trematode	57	19.5789	22.634	4	10.2500	7.136	1/59	0.094	0.7602	0.0268	0.0268	16.8425	0.28
Nematode	10	5.9000	4.725	1	3.0000	0.0	1/9	0.185	0.6774	0.0245	0.0245	1.1938	0.13
Total helminth	134	12.3209	18.194	15	5.6667	6.207	1/147	2.393	0.1240	0.6775	0.6775	41.6174	0.28

Comparison of the mean intensity of helminth infection between adult and juvenile hosts (Table 7) indicates that adults harboured a higher worm burden than juveniles. Among the adult crows, the mean intensity of total helminth was 12.3, whereas in juvenile crows it was only 5.6. For each class of helminth infection the mean parasite score was found to be higher in adults than in juveniles. However, all differences proved to be not significant ($p > 0.1$ to $p > 0.7$). Likewise, there were no significant differences in mean intensity of helminth infection, whether combined or as individual helminth class, between male and female crows ($p > 0.2$ to $p > 0.8$).

DISCUSSION

The striking feature of the findings of this study is that very few (only three) species of helminth parasites have infected the common house crows of the Kelang area. Although the precise causes remain obscure, it is suggested that the paucity of helminth

species is attributed to the limited variety of food that these crows have availed themselves of. Their staple diet consisted largely of ripe oil palm fruits and human household waste food of plant and animal origin (Siew et al. 1979a, b). Such a restricted diet is unlikely to contain a wide range of infective parasitic stages. In his study of the helminth fauna of American herring gulls, Threlfall (1968) suggested that diet was the key to trematode and cestode prevalence, and that environmental conditions for larval development governed nematode prevalence in that area.

Significantly all the three helminth species recovered are heteroxenous parasites requiring intermediate and vector hosts to complete their indirect life cycles which have yet to be studied. Significantly even the most commonly occurring cestode, namely *Raillietina reynoldsae*, showed a low mean intensity (4.38 worms per infected host). Although the intensity of infection with the digenean, *Lutztrema* sp. was relatively much higher than that of the filarioid, *Cardiofilaria pawlowskyi*, the prevalence of these two parasites was still of a low order. This seems to support the view of Lewis and Twigg (1972) that where the life cycle of a helminth parasite involves the use of intermediate hosts, the overall percentage and degree of infection of a host, particularly in a terrestrial environment, with digeneans and cestodes, is significantly lower than that of a monoxenous nematode species.

The relatively higher prevalence of cestode as compared to the other helminths is atrributed to the availability of insect intermediate hosts (such as beetles, houseflies and ants) in the diet of house crows. It is common knowledge that stale waste food in refuse tips attract these insects which are known to act as intermediate hosts for some species of *Raillietina* (Olsen 1974). As reported by Siew et al. (1979a, b) insects, particularly beetles and blowfly larvae, were found in the gizzard of crows, and they constituted a significant part of the food content, even though the overall incidence of insects in the sample (351 birds) studied was rather low.

In the case of *Lutztrema* sp. which is the second most commonly encountered helminth, its relatively low incidence is probably due to the scarcity of molluscan intermediate hosts in the foraging sites of the crows. As for the filarioid, *Cardiofilaria pawlowskyi*, it is the least prevalent helminth. This species is apparently not highly host specific, having a wide host range (Bartlett and Anderson 1980), and is probably transmitted by mosquitoes (Anderson and Freeman 1969). In this study, infection with *C. pawlowskyi* is not occult, microfilariae being found in the blood of the host. The occurrence of *C. pawlowskyi* in 15 out of 16 months sampled reinforces the probability that the infection is not merely sporadic. However, in this case, the incidence of mosquito bites must be rather low resulting in the observed low prevalence of this filarioid.

The statistical analysis of prevalence of infection has established that the helminths of house crows exhibited no potential host sex preference. The combined helminth fauna as well as its constituent classes were equally prevalent in both male and female crows. Similarly, infected male and female birds did not show any significant differences in the intensity of infection. Differences in parasite fauna between hosts of different sexes are less well documented and have been attributed to various reasons (Pfaffenberger et al. 1980; Combes 1972; Threlfall 1968). However, generally most parasites are equally distributed between the sexes although they may show a preference for one sex over short periods (Kennedy 1975).

The analysis has further indicated somewhat strong interactions between the incidence of infection, host sex and host maturity. Thus, it is apparent that, among adult hosts, females were more prone to helminth infection than males, whereas among juveniles hosts, the reverse was the case. However, on this basis, it cannot be unequivocally claimed that host sex (or maturity) had no influence on parasite infections. As the variety of food eaten by males and females were the same, the quantum of food consumed probably differed between the two sexes which may eplain why adult females were more susceptible to infection. Adult females consume more food and probably feed more frequently than adult males, a behaviour necessary to satisfy a more demanding energy requirement that is associated with avian breeding cycles (Farner and King 1973). Consequently, the adult female crow is more likely to encounter infective stages of potential parasites. Since the Kelang house crows breed throughout the year (Nordin and Ahmad 1980), the greater propensity of adult females for helminth infection during the period of study is not entirely unexpected.

Host age or maturity was shown to be a consistently important factor which influenced the establishment of helminths in the Kelang house crows. This factor has also been found to influence the composition of the parasite fauna of any host animal (see Dogiel 1964; Kennedy 1975). The incidence of combined total helminth infection and also of trematode infection alone was decidedly higher in adult than in juvenile members of the crow population. Though the comparison between adult and juvenile crows did not produce significant results in the case of cestode and nematode infections, adult rather than juveniles were, on the average, found to harbour these parasites more frequently. Similarly, whilst the differences in intensity of infection between adults and juveniles for individual helminth species were not statistically significant, adult crows again tended to harbour a higher worm burden.

Differences in parasite infection levels between adult and juvenile birds have also been reported elsewhere (Zekhov 1949, 1953; Bykhovskaya-Pavlovskaya 1953; Threlfall 1968; Andrews and Threlfall 1975; Cawthorn and Anderson 1980: Forrester et al. 1983). It has been suggested that the older the host, the longer it has had to make contact with a parasite, and hence, an increase in the incidence and level of infection with age can be expected. Threlfall (1968) while examining 410 gulls for their parasites, found that adult birds were far more heavily parasitized than chicks, both with regard to number of birds infected and number of species per infected bird. He suggested that this difference may be the result of longer exposure to infective stages in the older birds than in the chicks.

Immunity acquired by older or more mature adult birds is believed to reduce the intensity of infection, whereas changes in diet in the life cycle of the birds work in the other direction. Mature birds, because of the variety and quantity of food consumed, would have a greater incidence or prevalence of infection (Dogiel 1964; Kennedy 1975). Zekhnov (1949) noted that with age the incidence of infestation of *Corvus frugilegus* with endoparasites rose while the intensity of infestation diminished. He ascribed the changes to two causes: changes in diet and the acquisition of age immunity to some parasites. Since adult and juvenile house crows evidently consume similar food (Siew et al. 1979a, b) diet may be ruled out as an explanation for the observed age effect in this study. A plausible explanation for the differences in the incidence and intensity of helminth infection (between adult and juvenile hosts) is the longer exposure of adult crows to potential parasites present in their food as well as the ingestion of a greater amount of food by the bigger adults.

There is a large element of stability in the diet of the Kelang house crows since the Malaysian environment, being tropical in nature, is generally stable. Therefore, the food and feeding habits of these birds would not be expected to vary with time. This contention finds support in the studies by Siew et al. (1979a, b, 1980) on this aspect of the feeding biology of house crows. Therefore, this homogeneity in the diet and feeding habits is perhaps a valid explanation for the lack of association between seasonality and parasite infection.

РАСПРОСТРАНЕНИЕ ГЕЛЬМИНТОВ — ПАРАЗИТОВ ЮЖНОЙ ДОМОВОЙ ВОРОНЫ (*CORVUS SPLENDENS VIEILLOT*) ИЗ ОБЛАСТИ КЕЛАНГ В ПОЛУОСТРОВНОЙ МАЛАЙЗИИ

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Резюме. В течение 16 месяцев изучали встречаемость гельминтов, паразитирующих у южной домовой вороны (*Corvus splendens* Vieillot) в области Келанг в Полуостровной Малайзии. Среди 232 вскрываемых ворон 160 (69,0 %) экземпляров было заражено только тремя видами гельминтов: *Raillietina* (*Paroniella*) *reynoldsae* Meggit, 1926 (Cestoda: Davaineidae), *Lutatrema* sp. (Trematoda: Dicrocoeliidae), вероятно новый вид, и *Cardiofilaria pawlowskyi* Strom, 1937 (Nematoda: Eilarioidea). Было обнаружено 74,4 % цестод и 38,8 % трематод, тогда как филярии были сравнительно малочисленные (7,5 % взрослых экземпляров и 13,9 % личинок). Средняя интенсивность заражения была 18,97 червей на хозяина и трематод, 5,64 взрослых червей у филярий и 4,38 червей у цестод. С помощью статистического анализа было доказано, что встречаемость и интенсивность заражения не зависят от пола хозяина. Гомогенность рациона хозяина и стабильность тропической среды объясняют низкую разновидность гельминтов и ассоциацию между сезонностью и заражением паразитами. Век хозяина представлял собой важный фактор, оказывающий влияние на количество гельминтов в хозяине; взрослые вороны были заражены бóльшим количеством паразитов, чем ювенильные, вероятно вследствие более продолжительного выставления инфекционным стадиям паразита.

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