PARASITES OF SCAVENGING CHICKENS IN PENANG ISLAND

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by

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PARASIT AYAM HIDUP MERAYAP DI PULAU PINANG

ABSTRAK

Ayam hidup merayap atau ayam kampung merupakan ayam yang dipelihara untuk tujuan daging dan telurnya. Daging ayam kampung digemari oleh kebanyakan pengguna kerana tekstur daging dan rasanya yang unik. Kebanyakan penduduk kampung memelihara ayam ini dalam bilangan yang kecil untuk tujuan sara hidup, hobi atau mengisi masa lapang. Ayam ini dibiarkan hidup merayap disekitar kawasan rumah dan memperoleh makanan daripada sisa buangan makanan, cacing, siput, serangga dan tumbuh-tumbuhan. Maka, secara umumnya jangkitan parasit adalah tinggi disebabkan oleh peluang terdedah kepada jangkitan telur cacing, larva, sista dan perumah bagi parasit berkenaan. Tujuan penyelidikan ini adalah untuk mengenalpasti status nutrisi atau keadaan tubuh serta parasit di dalam dan di luar tubuh bagi 240 ayam kampung (*Gallus domesticus*) yang diambil secara rawak dari 12 mukim di Pulau Pinang. Berdasarkan kepada pemeriksaan otot pektoral, jumlah peratusan ayam yang tinggi menunjukkan keadaan otot pektoral yang kurang memuaskan. Manakala, hasil bedah siasat yang dibuat menunjukkan terdapat 16 spesies endoparasit yang terdiri daripada *Acuaria hamulosa*, *Acuaria spiralis*, *Amoebotaenia sphenoides*, *Ascaridia galli*, *Brachylaima commutatus*, *Capillaria obsignata*, *Eimeria* sp., *Gongylonema ingluvicola*, *Heterakis gallinarum*, *Hymenolepis carioca*, *Leucocytozoon* sp., *Oxyspirura mansoni*, *Raillietina echinobothrida*, *Raillietina tetragona*, *Syngamus trachea* dan *Tetrameres americana*. Selain itu, sepuluh species ektoparasit yang diperolehi adalah terdiri daripada *Goniocotes gallinae*, *Goniodes dissimilis*, *Haemaphysalis* sp., *Leptotrombidium* sp., *Lipeurus caponis*, *Megninia* sp., *Menacanthus pallidulus*, *Menopon gallinae*, *Ornithonyssus* sp.

dan *Pterolichus* sp. Kajian juga mendapati tiada perbezaan yang signifikan di antara kelimpahan parasit antara jantina dan kumpulan umur.

PARASITES OF SCAVENGING CHICKENS IN PENANG ISLAND

ABSTRACT

Scavenging chicken or 'ayam kampung' is of a dual-purpose type, reared for both its meat and eggs. 'Ayam kampung' meat is preferred by most consumers, probably due to its specific texture and taste. Most of the rural villagers raise the chickens in small flocks for subsistence, hobby or simply for pleasure. The chickens are left scavenging around the backyards and feed mainly on kitchen wastes, worms, snails, insects and vegetation. Thus, the parasitic infection is commonly high due to an increase opportunity to encounter the infective eggs, larvae, and intermediate hosts of parasites. The aims of this study were to examine the state of nutrition or body condition and the presence of internal and external parasites of 240 scavenging chickens (*Gallus domesticus*) obtained randomly from 12 divisions (Mukim) in Penang Island. Based on pectoral musculature examination, a high percentage of chickens showed that the pectoral muscle was poorly developed. Meanwhile, necropsy findings recovered 16 endoparasite species which parasitized these chickens were *Acuaria hamulosa, Acuaria spiralis*, *Amoebotaenia sphenoides, Ascaridia galli, Brachylaima commutatus, Capillaria obsignata, Eimeria* sp., *Gongylonema ingluvicola, Heterakis gallinarum, Hymenolepis carioca, Leucocytozoon* sp., *Oxyspirura mansoni, Raillietina echinobothrida, Raillietina tetragona, Syngamus trachea* and *Tetrameres americana*. Whereas, ten species of ectoparasites were recovered comprising of *Goniocotes gallinae, Goniodes dissimilis*, *Haemaphysalis* sp., *Leptotrombidium* sp., *Lipeurus caponis, Megninia* sp., *Menacanthus pallidulus, Ornithonyssus* sp., *Pterolichus* sp. and *Menopon gallinae*. This study also found that there was no significant difference in parasitic burdens between sex and age groups.

CHAPTER ONE

1.0 INTRODUCTION

Chickens are the most abundant birds in the world which provide protein in the form of meat and eggs. Scavenging chickens or 'ayam kampung' meat has a strong flavor and is juicier than that of commercial chickens. Therefore, they command higher prices than commercial chickens, more so, if they have not been treated with antibiotics, hormones or antihelminthics. Most of the rural villagers still keep the chickens in small flocks. They are allowed to range free around the house or the backyard. They require little attention and feed mainly on kitchen wastes, broken grains, worms, snails, insects and vegetation. Due to their free-range and scavenging habits, parasitic infections are commonly high (Amin-Babjee *et al.*, 1985; Wu, 1994). The chickens have an increased opportunity to encounter infective eggs, larvae and intermediate hosts of parasites that can cause serious debilitating infections. On the other hand, inadequate hygiene and the physical environment such as rainfall, humidity, and ambient temperature provide optimum conditions to maintain helminth populations. Severe cases of parasitism can cause mortality (Soulsby, 1982).

Parasites infecting chickens can be ecto- or endoparasites most of which are helminths. Nematodes are the important helminths in the Phylum Nemathelminthes and diseases caused by helminths or parasitic worms are generally known as verminoses or helminthiases (Manual of Tropical Veterinary Parasitology, 1989).

The protozoans, *Plasmodium* spp. and *Leucocytozoon* spp., are the most common blood parasites found in erythrocytes of chickens. The life cycles of the blood parasites require some arthropod vectors. Birds kept in free-range systems are exposed to a number

of vectors that transmit blood parasites during blood sucking. For example, avian malaria is a disease caused by many species of *Plasmodium* which are transmitted by culicine mosquitoes (Permin and Hansen, 1998). Meanwhile, the most widespread disease caused by endoparasitic protozoan infection in chickens is coccidiosis. Coccidians are protozoan parasites belonging to the genus *Eimeria*, which develop in the epithelial cells of the alimentary canal and are transmitted mainly via faecal contamination.

The ectoparasites of chickens are Arthropods. There are two main classes: the Arachnida, including the order Acarina (ticks and mites), and the Insecta, including the order Phthiraptera (lice), Siphonaptera (fleas) and Diptera (flies and mosquitoes). Scavenging chickens are found to be infested with different species of lice, mites and ticks. Heavy infestations can result in increased stress to the chickens and subsequently reduced egg production, poor health, anaemia and severely affected chickens may die (Fatunmbi and Adene, 1979; Soulsby, 1982; Fink *et al.*, 2005).

A check list of poultry parasites in Malaysia had been provided by several authors (Lancaster, 1957; Audy *et al.*, 1960; Omar and Lim, 1968; Shanta *et al.*, 1971; Mustaffa-Babjee, 1980; Shanta, 1982; Krishnasamy *et al.*, 1983; Mustaffa-Babjee, 1984; Vattanodorn, 1984; Amin-Babjee and Ragavan, 1985; Sani *et al.*, 1986; Lee *et al.*, 1991; Amin-Babjee and Lee, 1994; Wu, 1994; Amin-Babjee *et al.*, 1997). Most of these studies were confined to poultry outside Penang Island. There were some studies on parasites of domestic chickens in Penang Island (Khairul and Khamis, 1978; Rahman *et al.*, 2009) but the studies are confined to isolated areas of the island.

THE OBJECTIVES

The objectives of this study were:

1) To examine internal and external parasites

2) To study the state of nutrition or body condition of scavenging chickens

3) To study the degree of infestations in relation to age and sex of scavenging chickens

CHAPTER TWO

2.0 LITERATURE REVIEW

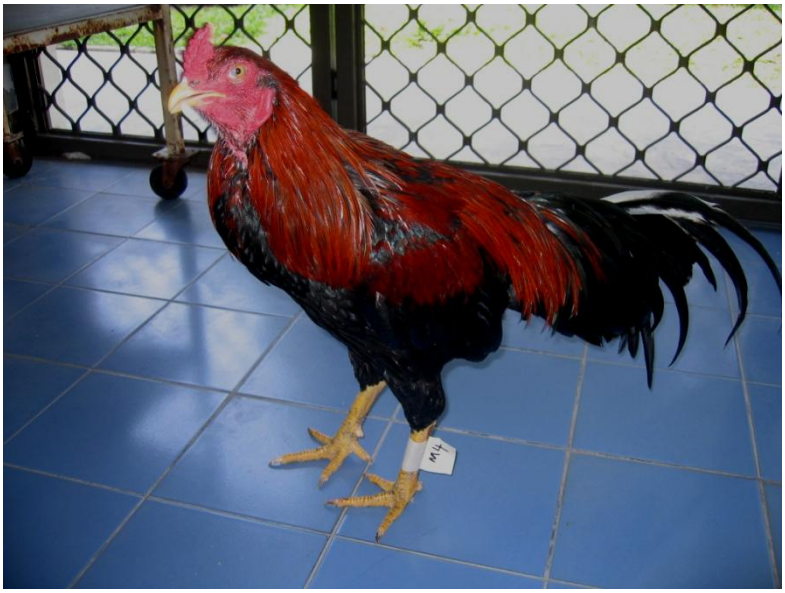
2.1 Scavenging chickens

Most of rural villagers in Malaysia rear native chickens (*Gallus domesticus*) under the free-range system. The chickens are left scavenging around the backyards during daytime and during nights, usually confined in simple coops or allowed to rest on trees. They enjoy more freedom of movement as compared to chickens reared under the intensive system, where they are crammed and may lack movement. They find their feeds from the surrounding environment that takes the forms of kitchen wastes, broken grains, worms, snails, insects, vegetation, food remnants or offals. Scavenging chicken which is also known as 'ayam kampung' is of a dual-purpose type, reared for both its meat and eggs. However, it has a low egg-laying performance and the eggs are smaller than that of commercial chicken eggs. Generally, 'ayam kampung' meat is preferred by most consumers, probably due to the specific texture and taste. Therefore, its meat is more expensive than that of broiler meat, more so, if it has not been treated with antibiotics, antihelminthics or hormones. Nowadays, there is an emerging trend of consumer awareness towards organically grown chickens, with customers increasingly willing to pay high prices for good quality meat.

2.1.1 The native chickens of Malaysia

Native chickens of Malaysia are small in size, with variable body conformations and physical characteristics. They originated from the red jungle fowl (*Gallus gallus*) of South East Asia approximately 5000 years ago through natural mating and selection (King & McLelland, 1975).

According to Food and Fertilizer Technology Center for the Asian and Pacific Region (1991), in Malaysia there are three main types of native chickens: black-red ‘ayam kampung’ (Plate 2.1), red ‘ayam kampung’ (Plate 2.2) and naked-neck ‘ayam kampung’ (Plate 2.3). The morphological characteristics of these chickens are similar in nature, however certain differences are observed with regard to the types of combs, plumage colors and plumage patterns.



a)

b)

Plate 2.1: Black-red ‘ayam kampung’

a) Male
b) Female

a)

b)

Plate 2.2: Red ‘ayam kampung’

a) Male
b) Female

a)

b)

Plate 2.3: Naked-neck ‘ayam kampung’

a) Male
b) Female

2.1.2 Anatomy of chickens commonly infected by parasites

There are nine major systems in the chicken body. These are respiratory, digestive, circulatory, skeletal, urinary, reproductive, nervous, musculature and endocrine systems, of which the digestive system being most commonly infected by parasites. Sometimes the circulatory system is also infected by parasites (Permin and Hansen, 1998 and Zamri-Saad, 2006).

The organs of the digestive system of chicken include the beak, mouth, tongue, esophagus, crop, proventriculus, gizzard, intestines, caeca, rectum and cloaca. Since chickens have no teeth, their digestive systems have to break down feeds without chewing. Chickens sort and peck feeds with their beaks, then swallow relatively small pieces of feed. The tongue and pharynx transport and swallow the food which has been lubricated by the secretions of the oral glands. The mouth is connected to a thin-walled tube called esophagus. The lower portion of the esophagus forms a pouch called crop. It functions as a temporary storage site for food. From the crop, the food reaches the proventriculus, where some protein digestive enzymes are produced. The food then passes into the gizzard or the muscular stomach, which undergoes rhythmic contractions. It acts as the grinding plates which grind the feed into a smooth paste. It is effectively assisted by the presence of small stones which grain-eating birds frequently ingest. The lower portion of the gizzard is connected to the duodenum which is the first portion of the small intestine. It forms a characteristic "U"-shaped loop which is held by the pancreas. The lower portion of the duodenum is the small intestine where nutrients are absorbed. There are two long caeca situated at the junction of the small and large intestines. Microbial fermentation takes place in the caeca and help break down the undigested food

passing through the intestine. The large intestine connects the small intestine and cloaca, the terminal part of the intestinal tract (Sturkie, 1976).

Liver, an organ associated with digestion, is located in the front portion of the body cavity. The function of liver is to produce digestive fluids as well as filter toxic waste from the blood. The digestive fluid produced in liver is stored in the gall bladder which is a greenish pouch attached to the liver (Ede, 1964).

The circulatory system consists of the blood, blood vessels and four chambered heart which are two atria and two ventricles. Blood consists of plasma, red blood cell (erythrocytes), white blood cells (leukocytes) and other chemical constituents such as proteins and lipids. The red blood cells of chickens are oval shaped and nucleated. This system provides transportation of various products such as nutrients, gases, liquid wastes, hormones and water to all parts of the avian body (Wallace, 1971).

The sensory organs such as eyes are also commonly infected by parasites. There are two main eyelids, with a very thin membrane translucent third eyelid called the nictitating membrane, being located in the front corner of each eye. It is capable of covering the eyeball with a very fast movement to provide protection to that organ. For example, the predilection site for *Oxyspirura mansoni* is located under the nictitating membranes in the conjunctiva sacs (Permin and Hansen, 1998).

2.2 Parasitism

Ectoparasites are parasites that live on the skin of the host or not within the body of the host, while endoparasites live within the body of the host.

Endoparasites can be divided into two main groups, the protozoa and the helminths. Protozoa are unicellular organisms in which the body consists of the cytoplasm with at least one nucleus. They are divided into five major groups; flagellata, amebida, ciliophora, sporozoa and cnidosporidia. Most of the protozoan parasites of avians are flagellates (trypanosomes) and sporozoans (Eimeria and Plasmodium). Certain protozoan parasites, such as *Plasmodium* sp. (which causes avian malaria) invade the blood of the chickens. The parasites are transmitted by vectors which are the mosquitoes *Mansonia* spp., *Aedes* spp., *Culex* spp. and *Armigeres* spp. (Permin and Hansen, 1998). Coccidiosis is caused by protozoans from the genus *Eimeria*. The oocysts of *Eimeria* are expelled with the faeces and sporulate in a few days. Infection is initiated when the sporulated oocysts are ingested by the chickens. The sporozoites are then released and subsequently enter the intestinal epithelial cells and grow (Soulsby, 1968).

The term ‘helminth’ was popularly applied to worm-like creatures which are of interest as parasites of vertebrates that belong to four different phyla of the animals kingdom, the Platyhelminthes (flatworm), the Nemathelminthes (roundworm), the Acanthocephala (spiny-headed worm) and the Annelida (the segmented worms).

The Platyhelminthes or the common name of flatworms, are flattened dorso-ventrally, with no body packing tissue. Most of the flatworms are hermaphroditic and the digestive system may or may not be present. If present, the system appears to be in the

simplest form and there is no anus. The flatworms are divided into three classes; the Tuberllaria, the trematode and the cestode. The Tuberllaria are basically free-living aquatic animals with ciliated bodies while the others are entirely parasitic (Bowman *et al.*, 2003).

Trematodes are parasitic flatworms with soft-bodies, commonly oval or leaf-shaped and furnished with suckers for adhering to their hosts. Trematodes are divided into two groups; Monogenea and Digenea. The Monogenea are parasitic externally, usually in the excretory bladder or on the gills of aquatic vertebrates and need only one host to complete their life cycle. On the other hand, Digenea has a complicated life cycle which involves two or more host species. The cestode, commonly known as tapeworm, consists of chains (strobila) of segments with a scolex (head) which serves as an organ of adhesion. The segments, known as proglottids, are connected internally by the musculature nerve trunks and also excretory tube. The cestodes are hermaphroditic with both male and female reproductive organs present in each proglottid (Bhatia *et al.,* 2004).

The nematodes or roundworms typically are unsegmented worms of cylindrical shape and tapering more or less at the posterior and anterior ends. The nematode is encased in a tough and impermeable transparent cuticle which is marked externally by fine transverse striations. Sexes are separate which differ in size and differences between them can be seen at the posterior ends (Soulsby, 1968).

Acanthocephala or spiny-headed worms are parasitic with an unsegmented body. The body consists of a posterior trunk and an anterior presoma, consisting of spiny proboscis and unspined neck. The sexes are separate; the males are smaller in size when

compared to the females. The life cycle involves intermediate hosts which are usually arthropods or small crustaceans (Pandey *et al.*, 1992).

The ectoparasites, Arthropods are divided into two main classes. The Arachnida (arachnids) includes the order Acarina (ticks and mites) and the Insecta includes the order Phthiraptera (lice), Hemiptera (bugs), Siphonaptera (fleas) and Diptera (flies and mosquitoes).

The Acarina is divided into four suborders: Mesostigmata, Ixodoidea, Trombidiformes and Sarcoptiformes. Mesostigmata refers to the fact that a single pair of stigmata is lateral and outside the coxae of the legs. Species of the suborder Mesostigmata is divided into two portions, an anterior gnathosoma (mouthparts) and a posterior idiosoma. *Dermanyssus* sp. and *Ornithonyssus* sp. are the ectoparasites of chickens that belong to this suborder (Bhatia *et al.* 2004).

The suborder Ixodoidea is classed in two families, Ixodidae (hard ticks) and Argasidae (soft ticks). *Haemaphysalis* sp. is an example of a hard tick which belongs to the family Ixodidae. Ticks of this family possess a hard chitinous shield or scutum that almost completely covers the dorsal surface of the male but only the anterior portion of it in the larva, nymph and female. The Argasidae on the other hand, are distinguished by having the body covered by a leathery cuticle, marked by numerous tubercles or granulations, and sometimes small circular discs, but no plates or shields. *Argas persicus*, commonly named the fowl tick, is an ectoparasite belonging to the family Argasidae (Soulsby, 1968).

Chigger mites or harvest mites are parasitic larvae which belong to the suborder Trombidiformes. They are parasitic on various animals and man, while the nymphs and adults are free-living and feed either on invertebrates or plants.

The suborder Sarcoptiformes is characterized by the legs which are frequently grouped in two pairs on either side in the nymph, as well as the adult, and they end in suckers, claws or hairs. *Pterolichus obtusus* are parasitic mites of chickens which belong to this suborder (Atyeo and Gaud, 1992).

The ectoparasite of the class Insecta includes the order Phthiraptera (lice), Siphonaptera (fleas), Hemiptera (bugs) and Diptera (flies and mosquitoes). Species of the order Phthiraptera are small, wingless and have dorso-ventrally flattened bodies. This order is divided into two suborders, Anoplura (sucking lice) and Mallophaga (chewing lice). The Anoplura has mouthparts adapted for sucking the tissue fluids and the blood of the host. The Mallophaga (chewing lice) on the other hand, have mouthparts adapted for chewing which refers to the fact that many species of this suborder feed on the epithelial debris on the skin of the host, or on the feathers of the birds. Most of the ectoparasites of chickens belong to this suborder. Examples are *Menopon gallinae*, *Goniocotes gallinae* and *Lipeurus caponis* (Bhatia *et al.*, 2004).

Species of the order Siphonaptera or fleas are wingless insects, with laterally compressed bodies to facilitate gliding between the hairs or feathers of the hosts. The head is broadly joined to the thorax and the abdomen has ten segments. The legs are very long, powerful and adapted to leaping (Soulsby, 1968).

Species of the order hemiptera have mouthparts adapted for piercing and sucking. The parasites are long, flat-bodied, elongate oval in shape and attack man and animal to suck blood. The wings are vestigial. The first pair of wings called hemelyptra has the basal portion thickened and leathery while the terminal portion is sharply demarcated and membranous. The second pair of wings is membranous and folds under the others, when at rest. Bed bugs (*Cimex lectularius*) belong to this order (Bowman *et al.*, 2003).

All insects belong to the order Diptera, also known as the "true flies". They are characterized by having only a single pair of membranous wings at the mesothorax and the mouthpart is adapted for sucking. The Diptera is a large order that is divided into three small groups (suborders), Nematocera (black flies), Brachycera (horse flies and deer flies) and Cyclorrhapha (stable flies and horn flies). Some Diptera larvae called maggots, burrow into the flesh of animals and cause a condition known as myiasis. Many species of adult flies are bloodsuckers and are among the most important parasites of both humans and livestock (Soulsby, 1968).

2.3 Parasitic infections of chickens

Infections of parasites may vary. It may involve a simple route of entry when eggs are deposited at one place and remain there until ingested by the next host, or in some cases, it may involve the infective larvae in the body cavity of the intermediate host, where infection is accomplished by ingesting the intermediate host. Nevertheless, infections also occur frequently when insects such as mosquitoes, ticks, mites and fleas, which serve as the vectors for some protozoans and filarial nematodes, transfer sporozoites from the salivary glands to the bloodstream of the new host.

Apparently, transmission of parasites happen when infective eggs or larvae are ingested by the new host. This route of entry involves species of parasites with a direct life-cycle which spend all of the time in only one host. The oocysts or eggs are passed with the faeces of the host and develop in the environment, reaching the infective stage with the right temperature and humidity. The sporulated oocysts or the eggs containing the infective larvae are ingested through contaminated water, feeds or soils. Upon ingestion, the eggs hatch in the alimentary tract of the host. For example, chickens become infected with *Eimeria* spp. or *A. galli* by ingesting sporulated oocysts of *Eimeria* spp. or infective eggs of *A. galli*.

It should be pointed out that some parasitic infections are induced by ingesting intermediate hosts such as earthworms, grasshoppers, cockroaches, beetles, pillbugs or snails (Cram, 1937; Vellayan *et al.,* 1994). Intermediate hosts fulfill a number of functions in the life cycle of a parasite. They provide a suitable milieu for part of the parasite's development. Parasites with an indirect life-cycle spend part of their lives in an intermediate hosts before encountering the host. For instance, *Gongylonema ingluvicola*

and *Dispharynx nasuta* completed their life-cycles with beetles or cockroaches as intermediate hosts. The eggs are passed with the faeces and swallowed by the intermediate host. The eggs hatch and develop into infective stage in the body cavity of the intermediate host. Infection occurs when the intermediate host containing the infective larvae is eaten (Permin and Hansen, 1998).

Of the major helminth groups, two, the filarial nematodes and some of the protozoans such as *Plasmodium* spp., possess different routes of infection. Transmission of these blood parasites are affected by a blood sucking vector, usually an arthropod such as mosquitoes. Transmission occurs when the vector bites a new host and the infective stages are injected from the salivary glands. In all other sporozoa in the blood, the stages infective to the vector are the gametocytes. In the filarial worms, the larvae or microfilariae enter the bloodstream or the tissue lymph and these are simply taken up by species of mosquitoes or fleas which act as the intermediate hosts. In the intermediate hosts, the larvae develop to the infective stage larvae, passed into the body cavity and reach the proboscis of the arthropod. Infection occurs when the intermediate host bites a new host and the infective stages are injected from the salivary glands (Permin and Hansen, 1998).

In general, ectoparasites such as lice may be transferred from animal to animal by attachment to flies (phoresy). Both biting and sucking lice have been collected from house flies and horn flies moving from animal to animal (Williams *et al.*, 1985). Lice populations on fowl are common on barnyard flocks where old and young birds are free to range together. These mixed populations allow for easy transfer of lice to hosts with low resistance. Since all stages of lice, as far as is known, feed on the same materials, and

egg laying and moulting from one instar to the next occurs on the same host, invasion of other host species becomes largely irrelevant to them. Transfer from one host to another of the same species may then occur during aggregation of hosts in the nest as during feeding or in copulation.

On the other hand, mites spend most of their time off the host and the eggs are laid off the host. They are most commonly found where the slatted floor and the nest provide ample places for hiding and protection. The adult mites each feed on a bird. They can survive off the host for a week or more, and this ability enhances the chances for transmission. Therefore, infestation can be spread not only by direct contact between birds, but also through contact with infested litter. Besides, wild birds or domestic birds are the major means of mite dissemination. Also, mites can be carried by wild birds and rodents (Axtell and Arends, 1990).

2.4 The prevalence of parasite infections in scavenging chickens in Malaysia

2.4.1 Endoparasites

Studies on parasites of Malaysian poultry had been reported by many researchers (Lancaster, 1957; Omar and Lim, 1968; Mustaffa-Babjee, 1980; Shanta, 1982; Mustaffa-Babjee, 1984; Sani *et al.,* 1986; Lee *et al.,* 1991). The first check list of helminths in domestic livestock, including poultry in Malaya was made by Lancaster (1957). A similar listing was made by Mustaffa-Babjee (1980), Shanta (1982) and Mustaffa-Babjee (1984). The last known check-list on parasites of domestic animals in Malaysia was prepared by Lee *et al.* (1991). This list included records of ectoparasites which are arthropods (Table 2.1). Based on previous studies, the nematodes recovered from the necropsies of indigenous fowls were *Heterakis gallinae*, *Capillaria* sp., *A. galli*, *Capillaria annulata*, *Syngamus trachea*, *Tetrameres fissispina*, *G. ingluvicola* and *O. mansoni* (Sani *et al.*, 1986). In addition, *Stronglyloides avium* and *Heterakis beramporia* had also been observed in the fowl (Shanta, 1982). Meanwhile, *Raillientina tetragona, Amoebotaenia sphenoides, Raillietina cesticillus, Choanotaenia infundibulum, Cotugnia digonopora* and *Davainea prolottina* were the cestodes recovered in *Gallus gallus domesticus* (Shanta, 1982; Sani *et al.,* 1986).

There had been several studies reported on trematodes in fowls. Shanta *et al.* (1971) recovered *Echinostoma lindoense* in rectums of broilers. Meanwhile, Shanta (1962) reported *E. revolutum* from the caecum and rectum of a fowl. Meanwhile, Vattanodorn *et al.* (1984) recorded *E. revolutum*, *Heterophyes* sp. and *Prosthogonimus sp.* from the small intestine of chickens obtained from an aborigine village. Cheah *et al.*

(1986) revealed for the first time the presence of the trematode, *Postharmostomum gallinum* from caeca of birds.

Omar (1968) made some observations on four species of blood protozoans (haemoprotozoans) in domestic chickens, namely *P. gallinaceum*, *P. juxtanucleare*, *Leucocytozoon caulleryi* and *L. sabrazesi*. Also, Sani *et al.* (1986) reported the presence of *Trypanosoma* sp. in domestic fowls from Selangor.

However, most of parasite studies of poultry were not from Penang Island, and studies on the prevalence and significance of helminths in poultry in Penang Island seems limited. The only two reports on the prevalence of parasites in poultry from Penang Island were that of Khairul and Khamis (1978) and Rahman *et al.* (2009). Khairul and Khamis (1978) revealed the occurrence of helminthic parasites from 100 intestines of chickens reared under different conditions in Penang. A total of eight different species were recovered, comprising of three species of nematodes and five species of cestodes with only 50% of the examined intestines parasitized. The most common species recovered was *A. galli* (35%) while *A. sphenoides* and *Hymenolepis* sp. were the least common species recovered. The study by Rahman *et al.* (2009) reported on the prevalence of helminthic parasites in 60 rural scavenging chickens in Penang Island. Eight different helminth species were recovered comprising of four nematodes and four cestodes. Nematodes recovered included *A. galli*, *Capillaria* spp., *H. gallinarum* and *S. avium* while the principal cestode species encountered were *R. echinobothrida*, *R. tetragona*, *R. cesticillus* and *Hymenolepis carioca*. The highest mean worm burden was recorded for the cestode, *R. echinobothrida* while the lowest was the nematode, *A. galli*.

Meanwhile, the most prevalent nematodes were *H. gallinae* while the most prevalent cestodes were *R. tetragona* and *R. echinobothrida*.

2.4.2 Ectoparasites

There had been few studies on ectoparasites of chickens in Malaysia (Amin-Babjee and Ragavan, 1985; Sani *et al.*, 1986; Amin-Babjee and Lee, 1994; Wu, 1994). Examination of the chickens revealed four species of lice; *M. gallinae, L. caponis, Goniodes dissimilis* and *G. gallinae*; and one species of mites, *Megninia cubitalis*.

A check-list of arthropods in domestic animals in Malaysia was prepared by Lee *et al.* (1991). They reported five species of mites, three species of ticks, five species of lice and two species of flies (Table 2.1).

The last known study on ectoparasites of chickens was conducted by Amin-Babjee *et al.* (1997). This study reported on the prevalence and degree of ectoparasite infestation in 158 local village chickens in Selangor. Ten species of ectoparasites were identified, including one tick, *Haemaphysalis wellingtoni*; two mites, *Neoschongastia gallinarum* and *M. cubitalis*; seven lice, *Cuclotogaster heterographus, G. gallinae, G. dissimilis, Goniodes gigas, L. caponis, Menacanthus straminues* and *M. gallinae*. All examined chickens were found to be infested with ectoparasites. The tick, *H. wellingtoni* was the most common ectoparasite. Most of the chickens were infested with three to five species of ectoparasites.

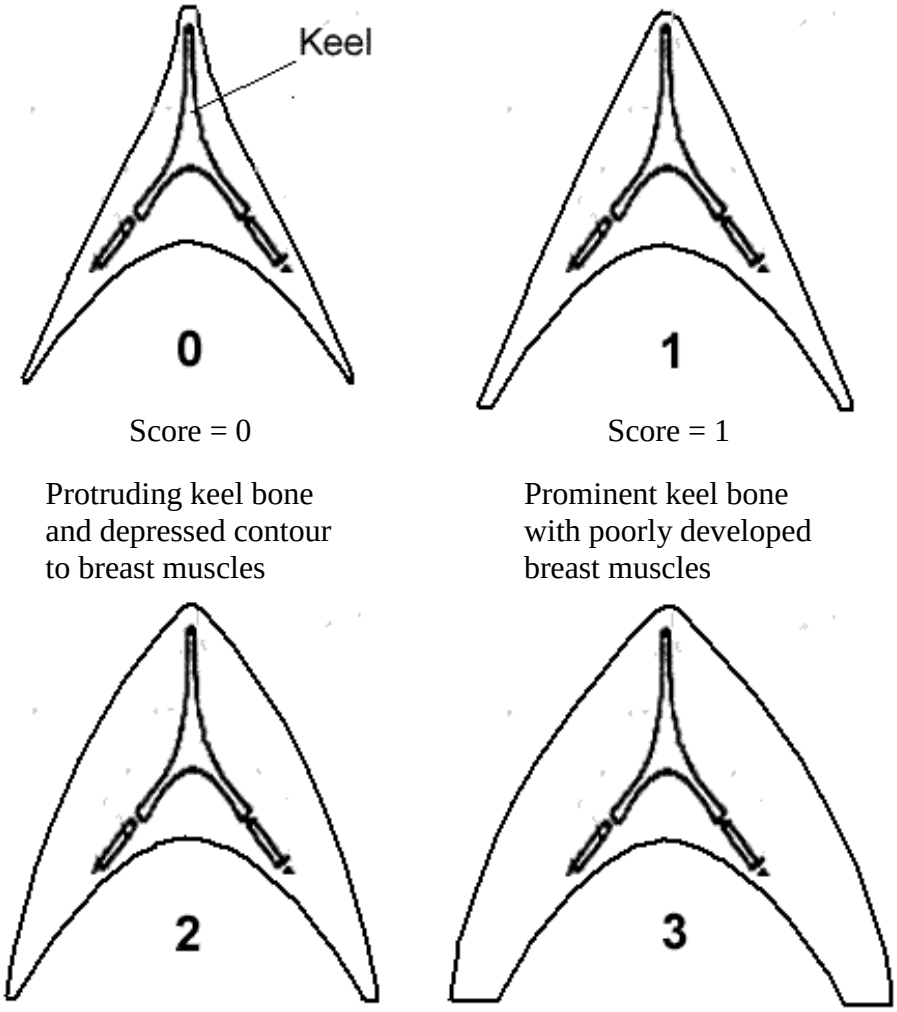
Table 2.1: Check list of protozoans, helminths and arthropods in poultry by Lee *et al.* (1991).

PROTOZOA		
Aegyptianella pullorum	*Eimeria necatrix*	*Plasmodium gallinaceum*
Eimeria acervulina	*Eimeria tenella*	*Plasmodium juxtanucleare*
Eimeria brunetti	*Leucocytozoon caulleryi*	*Plasmodium lophurae*
Eimeria maxima	*Leucocytozoon sabrazesi*	*Plasmodium relictum*
Eimeria mitis	*Plasmodium circumflexum*	*Trypanosoma* spp.
TREMATODES		
Echinostoma lindoense	*Philophthalmus gralli*	*Prosthogonimus pellucidus*
Echinostoma revolutum	*Procerovum* spp.	*Tanaisia zarudnyi vietnamensis*
Echinostoma recurvatum	*Prostharmostomum gallinum*	*Trichobilharzia brevis* (duck)
Heterophyes spp.	*Prothogonimus ovatus*	
CESTODES		
Amoebotaenia sphenoides	*Hymenolepis cantaniana*	*Raillietina tetragona*
Choanotaenia infundibulum	*Hymenolepis carioca*	*Raillietina cesticillus*
Cotugnia digonopora	*Hymenolepis exigua*	*Raillietina rangoonica*
Davainea proglottina	*Raillietina acanthovagina*	*Raillietina volzi*
Fimbriaria fasciolaris	*Raillietina southwelli*	
Hymenolepis anatine (duck)	*Raillietina echinobothrida*	
NEMATODES		
Acuaria spp.	*Capillaria obsignata*	*Gongylonema ingluvicola*
Ascaridia galli	*Strongyloides avium*	*Heterakis beramporia*
Capillaria anatis	*Tetrameres fissispina*	*Heterakis gallinarum*
Capillaria annulata	*Cheilospirura hamulosa*	*Oxspirura mansoni*
Capillaria caudinflata	*Cardiofilaria nilesi*	*Syngamus trachea*
Capillaria longicollis	*Dispharynx nasuta*	
ACANTHOCEPHALA		
Mediorhynchus gallinarum		
ARTHROPODS		
Mites	*Dermanyssus gallinae*	*Megninia cubitalis*
	Eutrombicula hirsti	*Ornithonyssus bursa*
	Lyponysous bursa	
Ticks	*Haemaphysalis bispinosa*	
	Haemaphysalis doenitzi	
	Haemaphysalis wellingtoni	
Lice	*Goniocotes gallinae*	*Lipeurus caponis*
	Goniodes dissimilis	*Menopon gallinae*
	Goniodes gigas	
Flies	*Chrysomya bezziana*	
	Pseudolynchia canariensis	

2.5 The state of nutrition (body condition) in relation to parasite infection in chickens

There is little literature reporting on the state of nutrition or body condition in relation to parasite infection. It is assumed that animals in poor condition might have been more susceptible to parasite infections and has a greater number of parasites. Alternatively, parasites could have been the cause of the low body condition. It is impossible to establish the cause and effect since there was weak evidence and the lack of information. Studies on the correlation between body condition and parasitic load of birds have been carried out by several researchers (Permin *et al.,* 1997; Barton and Houston, 2001; Rahman *et al.,* 2009; Msoffe, 2010).

Gregory and Robins (1998) developed four body condition scores for layer hens by palpating the keel and breast muscles (Figure 2.1). It showed that as the condition score increases, empty body, fat, and muscle weights and fat percentage in the empty body increased. It can be estimated that the lowest condition scores particularly have poor breast muscle development. This method is practical in assessing the bird's fat and body reserves based on the body condition scoring system.



Source: A body condition scoring system for layer hens (Gregory and Robins, 1998)

Figure 2.1: Cross-sections of breast muscles and ventral abdominal cavity for the four body condition scores.