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HELMINTH PARASITES OF SWINE IN SOUTHEAST ASIA

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CONTENTS

SUMMARY

The nematodes, trematodes, cestodes and acanthocephalids which have been found in domestic and wild pigs in eight Southeast Asian countries are given in a host-site-parasite list. The individual helminths found in the ASEAN countries (Indonesia, Malaysia, Philippines, Singapore and Thailand) are discussed including their epidemiology, pathology and importance as zoonoses. A brief criticism is made of the literature that has been published on this subject.

INTRODUCTION

Southeast Asia can be subdivided into two broad geographical groupings: mainland Southeast Asia or the Indo-Chinese peninsula containing the countries of Burma, Thailand, Vietnam, Kampuchea, Laos and Peninsular Malaysia; and island Southeast Asia consisting of Singapore, East Malaysia, Brunei, Indonesia and the Philippines. Throughout its history the area has been exposed to many external influences and these have resulted in a wide diversity of languages, religions and cultures. However almost all of the region has a tropical climate and therefore most of the inhabitants share similar methods of food production and ways of living. Rice is the basic food. The peasant family and the village community are the mainstays of the social structure.

Pigs are the most important source of meat and in the Far East region they contribute 45% of all the protein derived from domesticated animals and poultry (Kroeske, 1972). The importance of this source is given further emphasis by the overall scarcity of animal protein in this region. The population of the Far East has the lowest daily per capita consumption of protein in the world. Pigs are also important as a source of fertiliser and their manure can be used to fertilise either the soil or the fish ponds which are plentiful in this region. In addition the use of the methane gas from pig manure as a source of energy for domestic needs is rapidly increasing. The social role of pigs is also important. In many areas the ownership of pigs has a high prestige value and pork often constitutes the main dish at feasts, festivals and other ritual gatherings. However some of the people object to pig meat on religous grounds especially in Malaysia and Indonesia.

There has been a considerable expansion in pig numbers in Southeast Asia during the past ten years. The total number of pigs has increased from approximately 20 million in 1968 to approximately 35 million in 1978. There was a threefold increase in the pig population of Vietnam and the only country where numbers decreased was Kampuchea. (FAO-WHO-OIE Animal Health Yearbooks, 1968 and 1978). The pig populations of the different countries of Southeast Asia are shown in Table I. Countries such as Malaysia and Singapore which were heavily dependant on imports in the past are now virtually self sufficient in pig based products. In addition there has been a large increase in per capita consumption of pork. In Malaysia this increased from 25 lbs to 32.5 lbs from 1957 to 1973.

In Southeast Asia pig raising systems can be divided into three main types - intensive, semi intensive and extensive.

I. Intensive Systems of Pig Production

One of the main features of the swine industry in Southeast Asia has been the rapid increase in the number of intensive units. Nowhere is this more apparent than in Singapore, which with a population of over two million people in an area of 587 square kilometres is one of the most densely populated countries in the world. As a result almost all animals including pigs are intensively raised. In order to minimise the problem of pollution by effluents from piggeries there is a government scheme at the moment requiring pig farms to congregate on one estate which consists of 800 - 1200 hectares of land. It is hoped that by 1982 this estate will house three quarters of a million pigs. There has also been a rapid increase in the number of large scale pig farms in the Philippines and Malaysia. Even in Thailand,

where there are only a few large scale piggeries, they account for about 50% of the commercial market supply.

The vast majority of intensive pig units use exotic breeds, the most popular of which are the Large White, Landrace, Middle White, Berkshire, Tamsworth, Duroc, Jersey and Hampshire. Pig breeding centres act as multiplying units selling mainly cross breds to commercial farms. An A.I. service has been introduced to certain areas such as West Malaysia but its use seems to be limited at the present time.

Intensive farms make use of balanced rations produced by commercial feedmills which in some cases are the owners of large pig units themselves. Probably the biggest problem facing intensive pig farmers in Southeast Asia is the shortage of feeds. The human population growth is very rapid in many areas so there is an ever increasing competition between man and animals for grain supplies. Many countries such as Malaysia and Singapore are heavily dependant on imports of feed such as corn, sorghum, soyabean meal, meat and bone meal and fish meal. Often these are in short supply in the world market or are expensive, so claims to self sufficiency are often more illusory than real. The continued expansion of the pig industry in Southeast Asia depends on increased local production of suitable animal feed-stuffs and the more efficient utilisation of the by products of rice, sugarcane, pineapple and other agricultural products.

Large urban centres provide the main markets for pigs produced in intensive units. In Thailand about one third of all pigs that enter into commercial circulation are consumed in Bangkok. However most pig meat in that country never enters commercial channels. The vast majority of the pig meat that is eaten in Southeast Asia is in the form of pork although in

some countries processing plants for the production of ham, bacon and sausages are starting up.

Disease is also a major problem. In spite of the efforts being made by government veterinary services, contagious diseases such as swine fever and swine plague are widespread in some areas. Thus the setting up of intensive pig units has to be accompanied by the implementation of strict disease control measures. Vaccines are available in most of the endemic areas for swine fever and swine plague. Other infectious diseases of importance are piglet diarrhoea, swine brucellosis, swine erysipelas, porcine toxoplasmosis and enzootic pneumonia.

Most of Southeast Asia has a humid climate and in many areas conditions are ideal all year round for the proliferation of parasites. Thus a wide range of helminths are found in these countries. In intensive units the high density of the pigs favours the rapid multiplication of some of these parasites. In spite of various control measures being implemented helminths seem to be a major problem in many of these units. Lim (1978) carried out a survey on 200 pig farms in Singapore and found that helminths were present on 94.5% of these units. Although only 25% of farms were not using anthelmintics she concluded that the deworming programme was inadequate in a further 60.5% because of irregularity of administration or because some of the pigs were excluded. In addition she studied the types of anthelminthics used and concluded that only 11.5% of the farms administered appropriate ones. Likewise in Malaysia Yahaya (1977) concluded that considerable losses occurred in pig units due to parasitism in spite of the fact that almost all commercial pig farmers dosed their animals at least twice in the life span of each animal.

II. Semi Intensive Systems

These systems are very variable in character and are usually used by the smaller commercial farmers. In Malaysia there are many medium sized holdings with 10 to 50 sows and these are often associated with the growing of vegetables and root crops. These and other home produced nutrients are supplemented by the purchase of pre mixed rations or individual ingredients which are then mixed by the farmers. Pigs in such units will often alternate daily between houses and pasture or in certain cases some, such as breeding pigs, will be raised outdoors while others, such as fatteners, are raised intensively in buildings.

III. Backyard Systems

In spite of the increase in large and medium scale pig farms the majority of pigs in Southeast Asia are still raised under backyard conditions. In most cases they are raised as a complementary enterprise to rice cultivation and provide additional income to farmers in times of financial hardship.

Indigenous breeds are still common in these systems although in most countries their numbers are rapidly decreasing due to the continuous upgrading programmes that are being carried out. While their level of productivity is poor most of these breeds have a high genetic potential for hardiness and prolificacy and therefore it is likely that they will have a considerable role to play in the foreseeable future as sources of crossbreds suitable for backyard systems.

In most areas backyard pigs are allowed to roam freely or are tied to a tree alongside the dwellinghouse. Sometimes they are allowed to shelter under the floor if the house is on stilts. In more advanced systems the pigs are kept in timber

pens with a thatched roof and a slatted bamboo floor or occasionally in concrete pens. Feeding is based on locally available by products such as rice bran, broken rice, the peelings of root crops and kitchen waste. These may be supplemented with herbage and water hyacinth. In some areas these wastes are cooked. For example the Dayak people of Sarawak boil roots and green leaves and pour the hot mixture over rice bran.

Many pigs from backyard producers never enter commercial marketing channels. However in some areas middlemen play an important role in marketing backyard pigs by assembling, feeding and dispatching them to the slaughterhouse. Middlemen also act as sources of credit for producers.

Diseases cause considerable losses in backyard pig enterprises. The veterinary service available is often poor or non existent and as a result vaccinations and other prophylactic or control measures are not carried out. Thus swine fever, swine plague and the other diseases already mentioned are widespread. Helminth infections are also very important. In addition to the suitable climatic factors already mentioned the local environment of most backyard pigs is very conducive to the development and uptake of helminth eggs and larvae, whether free or in paratenic hosts. Anthelminthic medication and other control measures are rarely used.

Most of the literature on the helminths of swine in Southeast Asia is concerned with recording the presence of a parasite in a particular country of region. There is often very little information on other aspects of parasitic diseases of swine such as the pathogenicity, immunology and economic importance of these agents. Even in countries such as Indonesia, where comprehensive

lists of swine helminths have been available for a long time, there seems to be little interest in gaining further insights into the nature of these organisms. However the zoonotic importance of some helminths has provided a stimulus for more detailed research. This is especially true in the cases of Taenia solium and Trichinella spiralis and to a lesser extent for Fasciolopsis buski, Echinostoma malayanum, Macracanthorhynchus hirudinaceus and the other zoonotic parasites.

In most of the countries lists have been compiled of the helminth parasites of swine. Much of the early work to determine the helminth fauna of domestic animals in Indonesia was done by H.J. Smit and B.J. Krijgsman. The latter worker drew up a comprehensive helminth list for all domestic animals (Krijgsman,1933). This was revised by Adiwinata (1955). In Malaysia a helminth list for domestic livestock was compiled by Lancaster (1957). The main sources of information used in compiling this list were the articles by Purvis (1930a and 1930b), Narayanan (1940), Orr (1938) and Euzeby (1956). In more recent times valuable contributions to this subject have been made by Griffiths (1968) and Shanta (1971). In the Philippines Tubangui (1925) compiled a parasite list for domestic animals from specimens that he identified at the University of the Philippines and from reports by other parasitologists, especially those of Schwartz. This list was revised by Tubangui himself in 1947. Shortly after this an informative survey on gastro-intestinal pig helminths was carried out by Refuerzo and Gonzales (1953). Very little information is available on the helminths of pigs in Singapore apart from the surveys of Giam and Spence (1967) and Lim (1968). It is likely that lack of research in this field accounts for the small number of helminths that have

been reported from pigs in this country. In Thailand most of the information on pig helminths was obtained by de Jesus and Waramontri (1961) who examined 2,223 carcases at the swine abattoir in Bangkok. This was among the information used by Segel et al (1968) to compile a list of the parasites of man and domestic animals in Thailand. Also included in this latter paper was a list of the parasites of man and domestic animals in Kampuchea, Laos and Vietnam.

The main purpose of this literature review is to give lists of the helminths found in swine in eight Southeast Asian countries. There is also a detailed review of the helminths found in swine in the ASEAN nations (Indonesia, Malaysia, Philippines, Singapore and Thailand). The pathogenicity and epidemiology of the various helminth diseases in these countries is reviewed in detail and, in view of its importance in this region, the zoonotic aspect of swine helminths is given considerable attention. Less attention is given to morphological and other data unless the parasite in question is confined to Southeast Asia and no details are available in the standard textbooks.

The taxonomy of Soulsby (1968) is used throughout. Where the nomenclature of a particular species is in dispute the name used by the original author(s) is included in the text and a footnote inserted as appropriate. In the discussion the name that is considered to be correct is used. Unless otherwise specified all the findings described refer to the domestic pig (Sus scrofa domestica linnaeus) and the country described in the title of each section.

HELMINTH PARASITES OF SWINE IN INDONESIA

Indonesia comprises the islands of Java, Sumatra and parts of Borneo (excluding Sabah, Sarawak and Brunei) and New Guinea (the western part, West Irian) plus associated small islands.

For a complete list of the helminths of swine in this country see Table II.

Trematodes

1. Family: Opisthorchidae

1.1. Genus: Opisthorchis R. Blanchard, 1895

Opisthorchis tenuicollis (Rud. 1819) (Syn. Opisthorchis felineus) was reported by Krijgsman (1933) who stated that the parasite occurred in the gall bladder and pancreas of infected pigs but gave no further information.

2. Family: Fasciolidae

2.1. Genus: Fasciola linnaeus, 1758

Parasites of the genus Fasciola were reported in Sulawesi and Bali by Dennig (1976) who worked in the islands as an F.A.O. expert for a period of two years.

2.2. Genus: Fasciolopsis Looss, 1899

Fasciolopsis buski (Lankester, 1857) was reported by Krijgsman (1933) who gave no other information.

3. Family: Echinostomatidae

3.1. Genus: Echinostoma Rudolphi 1809

Echinostoma malayanum Leiper 1911, though common in pigs in other parts of Southeast Asia has not been reported in this species in Indonesia. However it has been reported in an Indonesian boy in Sumatra (Bonne, 1941).

4. Family: Schistosomatidae

4.1. Genus: Schistosoma Weinland, 1858

Wild pigs act as reservoir hosts for Schistosoma japonicum (Katsurada, 1904) in Indonesia according to Wiroreno (1975). He found this parasite only in the Lindu valley, central Sulawesi. The infection rate in man was found to be 57% in one of the villages surveyed. Other reservoirs were wild deer, dogs, civet cats, cows and rats. The intermediate host was the mollusc Oncomelania hupensis lindoensis.

Cestodes

1. Family: Taeniidae

1.1. Genus: Taenia Linnaeus, 1758

Taenia solium Linnaeus, 1758 is common in in certain parts of Indonesia such as Bali, Northern Sumatra, Java and West Irian. The adult stage was first reported in a woman from West Kalimantan (Bonne, 1940). Tumada and Margono (1973) found a 9% prevalence of Taenia eggs in 170 hospital patients from the Wissel lakes area of West Irian. Adult worms expelled by these patients were Taenia solium and the authors stated that cysticerci were common in pork in the area. Simanjuntak et al (1977) examined 548 stools from the inhabitants of three villages in Bali and found 11 (2%) positive for Taenia eggs. Four proglottids were also recovered. Two of these were Taenia solium and two were Taenia saginata. Cysticerci recovered from the muscles of pigs during post mortem examinations at a slaughterhouse on the island were identified as Cysticercus cellulosae. Previously the presence of this metacestode had been reported from Bali in 1920 according to Simanjuntak et al (1977). The presence of the parasite was also reported from the island by Ressang and Umboh (1962)

and a government veterinary bulletin (Anonymous, 1974-1977 as cited by Simanjuntak et al, 1977) reported the presence of cysticercosis in pigs and cattle in Bali and North Sumatra throughout 1974-1977.

Tumada and Margono (1973) stated that cysticerci were common in pork in West Irian. The main purpose of their paper was to report the diagnosis of 13 cases of cysticercosis at a hospital in this area during a six month period in 1972-1973. Prior to this the diagnosis of cysticercosis in man was rare and between 1950 and 1971 only six cases were reported (Hausman et al, 1950; Lie Kian Joe et al, 1955; Soebroto et al, 1960; Adnjana and Djozopranato, 1961; and Hadidjaja et al, 1971). After 1973 further cases were reported by Gde Ngoerah (1975), Tjahjadi et al (1978) and also in 1978 Giri reported six cases from Surabaya in Eastern Java which occurred between 1963 and 1977. He stated that there were three possible sources of infection with cysticerci in man - hetero infection, external auto-infection and internal auto-infection. Tjahjadi et al (1978) found no adult tapeworms at autopsy and stated that it was probable in this case that the disease was contracted due to hetero infection, with food contaminated with Taenia eggs as the most likely source. Tumada and Margono (1973) on the other hand recovered a number of Taenia solium specimens from their patients and in these cases either internal or external auto-infection was the most likely mode of transmission.

Simanjuntak et al (1977) in their survey in Bali tried to determine socio-ecologic factors associated with taeniasis and cysticercosis. In the villages they studied they found that toilet facilities were lacking and defaecation was often indiscriminate. Hygiene was poor throughout the island. Most people owned pigs and in one of the three villages surveyed 79% of the pig owners permitted their pigs to roam freely. A

favourite native dish (lawar) consisting of minced spiced meat and was often eaten uncooked.

Cysticercus tenuicollis has also been reported (Krijgsman, 1933). He stated that it was found in the abdominal cavity.

1.2 Genus: Echinococcus Rudolphi, 1801

The larval stages of Echinococcus granulosus (Batsch, 1786) were recovered from the liver, lungs and other organs according to Krijgsman (1933). Ressang and Umboh (1962) stated that hydatidosis constituted only a minor problem as a zoonosis because most of the Indonesian people were Islamic in religion.

2. Family: Diphyllobothridae

2.1 Genus: Diphyllobothrium Cobbold, 1858

The plerocercoid larval stage of Diphyllobothrium raillieti (syn. Sparganum raillieti) was reported from the mesentary by Krijgsman (1933). The validity of this species is not very clear as it is not recorded in any of the textbooks in common use at the present time. However the synonym suggests that this species is identical with Spirometra raillieti (Ratz, 1913) Wardle et al., 1947. Yamaguti (1959) stated that the sparganum of this parasite was recovered from hogs in Hungary and Serbia and that the adult occurred in dogs.

Nematodes

1. Family: Ascaridae Baird, 1853

1.1. Genus: Ascaris Linnaeus, 1758

The presence of Ascaris lumbricoides Linnaeus 1758 (sic)* has been recorded by Krijgsman (1933), Adiwinata (1955),

*Footnote:- In the past the Ascarid species of man and the pig were believed to be identical and both were given the name Ascaris lumbricoides. However it has been shown that cross infection between the two forms is rare and this together with minor morphological differences has led most parasitologists to the conclusion that the two forms should be considered as distinct species. The name Ascaris suum is used for the Ascarid species of the pig while Ascaris lumbricoides is reserved for the human species. A.suum can sometimes infect children.

Seidel (1957) and Dennig (1976).

2. Family: Rhabditidae Oerley, 1880

2.1 Genus: Strongyloides Grassi, 1879

A member of the genus Strongyloides was associated with an outbreak of overt disease in suckling piglets and weight loss in four month old pigs on a farm in Indonesia by Seidel (1957). To determine the exact species involved he carried out host specificity experiments. Transmission was successful in rabbits and guinea pigs but the author was unable to infect sheep and dogs with the infective filariform larvae. From these results he concluded that the nematodes were of the species Strongyloides ransomi Schwartz & Alicata, 1930. The author also carried out observations on the development of the free living stages of the parasite. He found that the free living adults produced only one generation of larvae which developed to the infective filariform stage. These did not possess a sheath and the author concluded that they were very susceptible to dessication. The author also noted that no males were present in many of the free living cultures.

3. Family: Trichonematidae Witenberg, 1925

3.1 Genus: Bourgelatia Railliet Henry & Bauche, 1919

Specimens belonging to the species Bourgelatia diducta Railliet Henry & Bauche, 1919 were collected in Java by Smit and Notosoediro (1927).

3.2 Genus: Oesophagostomum Molin, 1861

Krijgsman (1933) reported that Oesophagostomum dentatum (Rudolphi, 1803) occurred. Specimens belonging to this genus were also found during autopsy by Seidel (1957).

4. Family: Stephanuridae Travassos & Vogelsang, 1933

Genus: Stephanurus Diesing, 1839

Stephanurus dentatus Diesing, 1839 was reported to have been recovered from the ureter by Krijgsman (1933).

5. Family: Ancylostomatidae Looss, 1905

5.1 Genus: Globocephalus Molin, 1861

Two members of the genus Globocephalus have been reported. The presence of Globocephalus longemucronatus Molin 1861 was recorded by Krijgsman (1933). Smit and Notosodiro (1927) described a new species of Globocephalus in pigs which they called Globocephalus amucronatus. A detailed description of this parasite was given by Smit and Ihle (1928). They stated that the male was 5mm long and 220-235 microns wide and that the female was 6-7mm long and 375-410 microns wide. This species could be differentiated from other members of the genus on the basis of its copulatory bursa and the position of the genital opening in the female. This was situated nearer to the posterior end of the body as compared to other members of the genus.

6. Family: Metastrongylidae Leiper, 1908

6.1 Genus: Metastrongylus Molin, 1861

The FAO-WHO-OIE Animal Health Yearbook (1961) states that there was a low sporadic incidence of metastrongylosis. According to Krijgsman (1933) and Adiwinata (1955) Metastrongylus apri (Gmelin, 1790) (syn. Metastrongylus elongatus) was the only member of the genus to occur.

7. Family: Thelaziidae Railliet, 1916

7.1 Genus: Ascarops v. Beneden, 1873 (syn. Arduenna)

Ascarops strongylina (Rudolphi, 1819) was first

reported from Indonesia by Smit and Notosodiro (1931). They recovered specimens from a four month old piglet. Two years later Ascarops dentata (von Linstow, 1904) was reported by Krijgsman (1933).

8. Family: Gnathostomatidae Railliet, 1895

8.1 Genus: Gnathostoma Owen, 1836

Gnathostoma hispidum Fedtchenko, 1872 was reported for the first time by Kraneveld and Douwes (1940) after being recovered from a wild pig (Sus scrofa milleri).

9. Family: Filariidae Claus, 1885

9.1 Genus: Filaria Mueller, 1787

Filaria bauchei Railliet & Henry, 1911 (= F. hellemansi Smit, 1922) was reported from the bronchioles by Krijgsman (1933).

10. Family: Setariidae Skrjabin & Schikhobalova, 1945

10.1 Genus: Setaria Viborg, 1795

Setaria bernardi Railliet & Henry, 1911 (syn. Setaria congolensis Railliet & Henry, 1911) was reported from the abdominal cavity by Krijgsman (1933).

11. Family: Trichinellidae Ward, 1907

11.1 Genus: Trichinella Railliet, 1895

According to Dissamarn and Aranyakanada (1960)the first case of trichinosis was found in swine at a slaughter house at Medan, Sumatra in December 1929. During the period 1930-1939, 32,026 pig carcases were examined at Batakland, Sumatra and 745 (2.3%) were found to be infected with Trichinella spiralis (Owen, 1833) (syn. Trichina spiralis). In his paper Holz (1962) gave the prevalence of the parasite in dogs during the years 1932 to 1939

inclusive. Between 1100 and 2500 dogs were examined each year and the prevalence varied from 1.30 to 2.86. However in more recent times the importance of the disease seems to have decreased. Steele et al (1976) during their visit to Indonesia in 1970 found that no one had any knowledge of the presence of Trichinella spiralis in Indonesia at that time. The FAO-WHO-OIE Animal Health Yearbook (1976) stated that trichinosis was suspected but not confirmed.

12. Family: Trichuridae Railliet, 1915 (Trichocephalidae Baird, 1853)

12.1 Genus: Trichuris Roederer, 1761

Trichuris trichiura (Linnaeus, 1771) (sic)* was reported from the intestine by Krijgsman (1933). In his paper on Strongyloides ransomi Seidel (1957) also mentioned that he recovered Trichuris during a post mortem examination on three piglets.

Acanthocephala

1. Family: Oligacanthorhynchidae Meyer, 1931

1.1 Genus: Macracanthorhynchus Travassos, 1916

Macracanthorhynchus hirudinoceus (Pallas, 1781) (syn. Echinorhynchus gigas) was reported from a wild pig (Sus scrofa milleri) by Krijgsman (1933) and Kraneveld and Douwes (1940).

*Footnote:- As was customary at that time Krijgsman called his specimen Trichuris trichiura. However Soulsby (1968) stated that there was no evidence to show that the Trichuris species of man and pigs were interchangeable. At the present time most parasitologists consider the two forms to be distinct species. The pig parasite has been given the name Trichuris suis (Schrank, 1788) and the name Trichuris trichiura is now reserved for the human species.

The Federation of Malaysia came into being in 1963 as a sovereign state within the Commonwealth. It consists of East Malaysia which is comprised of the states of Sabah (formerly North Borneo) and Sarawak and Peninsular Malaysia which was formerly known as Malaya.

For a complete list of swine helminths see Table II.

Trematodes

1. Family: Dicrocoelidae

1.1. Genus: Dicrocoelium Dujarden, 1845

The FAO-WHO-OIE Animal Health Yearbook (1961) records the presence of Dicrocoelium dendriticum (Rudolphi, 1819) Looss, 1899 (Syn. D. lanceolatum) in wild pigs in North Borneo. Other species also seem to act as hosts. According to Sandosham and Noordin Bin Keling (1967) various dicrocoelid worms occur in ruminants in Malaysia and they cited Dunn and Bolton (1963) as having found eggs of an unknown dicrocoelid trematode in the faeces of a Malayan aborigine.

2. Family: Fasciolidae

2.1 Genus: Fasciolopsis Looss, 1899

Fasciolopsis buski (Lankester, 1857) has been recorded during surgery or post mortem in human intestines on a few occasions (Sandosham and Noordin Bin Keling, 1967). However there is no mention of its occurrence in pigs. The above authors state that the water caltrop, Tropa natans and T. bicornis and the water chestnut, Eliocharis tuberosa are not grown extensively in Malaysia as pig food. Imported water plants from Hong Kong and China where

the parasite has a high prevalence have been examined for metacercariae but none have been found and the chances of transmitting infection by means of these foods is further decreased by the fact that the skin is often sliced off before they are sold in Malaysia.

3. Family: Echinostomatidae

3.1 Genus: Echinostoma Rudolphi, 1809

Echinostoma malayanum Leiper, 1911 is common in pigs in Malaysia and is also a parasite of man and other animals. Leiper (1911) first reported the parasite from the small intestine of an Indian labourer in Malaysia. Later it was found in an Indian girl in Kuala Lumpur by Lie Kian Joe and Virik (1963). This trematode has also been found in man in Indonesia (Bonne, 1941), Thailand (Leiper, 1915) and on the Sino-Tibetan frontier (Faust, 1949). Lie Kian Joe (1963b) recovered Echinostoma malayanum from the intestines of 37 of 1302 pigs examined at the slaughter house in Kuala Lumpur, an incidence of 2.8%. The number of parasites in infected animals varied from one to more than one thousand. Rats and house schrew were found infected in large numbers in the neighbourhood of ponds and disused mining pools. The author was able to experimentally infect two dogs, one cat and two monkeys but was unable to infect birds. Lie Kian Joe also studied the life cycle. The first intermediate host, 'a fresh water snail of the species Indoplanorbis exustus' was found in ponds, pools and in small water collections but was not found in running water. He stated that infected faeces of pigs and other animals draining into these pools serve as sources of Echinostoma eggs. After penetration the miracidia develop into sporocysts, mother and daughter rediae and cercariae. The cercariae develop into metacercariae in the same snail or in other fresh water snails such as

Pila scutata, Mons., Lymnaea rubignosa Mich., and Gyraulus convexiusculus Hut. Various species of frogs have also been found to harbour metacercariae according to Lie Kian Joe & Owyang (1962). The pigs are infected by swallowing the second intermediate hosts which are usually attached to the water hyacinth (Eichhornia crassipes) and other water plants grown in these stagnant pools and commonly used for pig food. Although pigs are important hosts of E. malayanum the author showed that the parasite can be maintained in their absence by rats and house schrews. He suggested that man became infected by eating inadequately cooked Pila snails.

In another paper Lie Kian Joe (1963a) gave a detailed description of the morphology of Echinostoma malayanum. The worms measured 6.8-8.5 x 2.1-2.5mm or 7.4-9.0 x 1.9-3.0mm depending on whether they were fixed in hot formalin or acetic acid. The maximum width was usually located in the middle of the worm but it could also be located towards the acetabulum or towards the posterior extremity. The author said that this species can be differentiated from other members of the family on the basis of

1. the arrangement and number of the collar spines
2. the distribution of the body spines
3. the deeply lobed testis
4. the large cirrus sac which usually extends somewhat beyond the acetabulum
5. the distribution of the vitellaria with the anterior margin at the level of the acetabulum
6. the relative broad size of the body.

Although some differences were observed between the parasites of the various hosts the author believed that they all belonged to the same species and he succeeded in transferring

the pig strain into white rats. He further stated that Echinostoma malayanum was identical to a species described as Artyfechinostomum sufrartyfex Lane, 1915. The parasite was obtained from humans and pigs in India.

According to Griffiths (1968) it is not known if Echistoma malayanum is pathogenic for pigs.

4. Family: Psilostomatidae

4.1. Genus: Testifrondosa

Testifrondosa cristata Bhalerao, 1924 was recorded by Narayanan (1940). No further information was given. The original finding by Bhalerao (1924) was from the small intestine of a pig in Rangoon (Burma) and the parasite has also been recovered from the intestine of a buffalo in India (Sharma and Sahai, 1977). Shanta (1971) stated that this parasite was very rarely found in pigs in Malaysia.

Cestodes

1. Family: Taeniidae

1.1 Genus: Taenia Linnaeus, 1758

According to the FAO-WHO-OIE Animal Health Yearbook (1976) Cysticercus cellulosae is not present in Malaysia. However Sandosham and Noordin bin Keling (1967) stated that Cysticercus cellulosae was commonly observed in Malayan abattoirs before the second world war. They cite the Director of Veterinary Research as reporting that of 744,379 pigs slaughtered in Malaya in 1937 1,235 carcases were totally condemned because of Cysticercus cellulosae. However all except nine of these pigs had been imported from areas such as Bali and Indo-China where there was a high prevalence of the disease. As the swine industry in Malaysia developed and the country became self sufficient in pork the incidence

dropped dramatically and the authors say that the parasite was rare in 1967. The reason they give for the low prevalence is the systematic examination of carcases in the abattoir and the thorough cooking of pork by the Malaysian people. Taenia saginata Goeze, 1782, is also very rare in Malaysia.

1.2 Genus: Echinococcus Rudolphi, 1801

Euzeby (1957) recorded the presence of the larval stages of Echinococcus granulosus (Batsch, 1786) in pigs. According to Sandosham and Noordin Bin Keling (1967) hydatid cysts have also been found in immigrant workers but the adult has not been recorded in dogs.

Nematodes

1. Family: Ascaridae Baird, 1853

1.1 Genus: Ascaris Linnaeus, 1758

There is very little literature available on Ascaris suum Goeze, 1782. However Euzeby (1957) stated that this helminth was the most widely distributed and the most serious parasite of swine and that it could occur in 100% of animals in some parts of Malaya. A U.S. Naval Medical Research Unit expedition to North Borneo in 1960 reported the presence of Ascaris lumbricoides Linnaeus, 1758 (sic) in domestic pigs in this area (Myers and Kuntz, 1969). In the 1971 Annual Report of the Department of Agriculture of the State of Sabah it was stated that ascarids in pigs were a problem particularly in backyard pigs and on farms where the standard of animal husbandry was not satisfactory.

2. Family: Trichonematidae Witenberg, 1925

2.1 Genus: Oesophagostomum Molin, 1861

Oesophagostomum dentatum (Rudolphi, 1803) was first reported by Purvis (1930a) from post mortems that he

carried out in the locality of Alor Star. Subsequently it was recorded by Narayanan (1940) and by Euzeby (1957) who said that the parasite was widely distributed in Malaya but that it did not cause severe lesions.

The U.S. Naval Medical Research Unit expedition to North Borneo in 1960 recovered Oesophagostomum longicaudum Goodey, 1925 (Myers and Kuntz, 1969).

3. Family: Stephanuridae Travassos & Vogelsang, 1933

3.1 Genus: Stephanurus Diesing, 1839.

According to Lancaster (1957) Stephanurus dentatus Diesing, 1839 was first reported from Malaya by Purvis (1930b) and later by Adams (1933), Orr (1938), Narayanan (1940), Marsh (1940) and Euzeby (1957). There is some disagreement over the importance of this parasite. At an F.A.O. meeting held in Singapore in 1963 the Malaysian delegate stated that Stephanurus was rare in Malaysia but was known to occur in Sabah (F.A.O., 1963). However Euzeby (1957) stated that the parasite had a wide distribution and that the prevalence could be as high as 100% in some areas. He further stated that although it did not often produce clinical signs it was of great economic importance and caused a lot of condemnation of kidneys.

Marsh (1940) was in agreement with Euzeby and stated that stephanuriasis was probably the most serious helminth pest affecting swine in Malaya. In his survey pig urine specimens from several agricultural stations of the veterinary department of Malaya were examined and observations were also carried out at the larger Malayan abattoirs. He noted that the incidence and the degree of infestation was more marked in the case of European breeds and their cross breds than in the indigenous pigs and that the same

degree of infestation caused the imported breeds more distress. However the disease did not occur in pigs at the agricultural station in the Cameron highlands even though the original stock used to populate the station came from the lowlands and were known to have been infected with the parasite. This station is situated at an altitude of 4,750 feet above sea level and has an average minimum temperature of 56°F. Presumably this is sufficiently low to prevent the development of the parasite during its extra-host stages.

4. Family: Ancylostomatidae Looss, 1905

4.1 Genus: Globocephalus Molin, 1861

The presence of this genus in Malaysia was first recorded by Purvis (1930a) who recovered the parasite from the locality of Alor Star. The occurrence of the species Globocephalus urosubulatus (Alessandrini, 1909) was reported by Adams (1933), and later confirmed by Narayanan (1940) and Euzeby (1957). The latter author also recorded the presence of Globocephalus samoensis (Lane, 1922). He said that members of this genus had a high prevalence but they did not seem to be very pathogenic.

5. Family: Trichostrongylidae Leiper, 1912

5.1 Genus: Hyostrongylus Hall, 1921

The presence of Hyostrongylus rubidus (Hassall & Stiles, 1892) was reported by Griffiths (1968) who encountered the parasite in a herd in West Malaysia. He stated that further studies might reveal that this parasite is more common in the Far East than was generally supposed. However Shanta (1971) stated that this parasite was found only very occasionally and did not seem to constitute a problem.

6. Family: Metastrongylidae Leiper, 1908

6.1 Genus: Metastrongylus Molin, 1861

Metastrongylus apri (Gmelin, 1790) (syn. M. elongatus) has been recorded in Malaysia by Orr (1938), Narayanan (1940) and by Euzeby (1957). Metastrongylus salmi Gedoelst, 1923 was recorded by Purvis (1931a), Adams (1933) and Euzeby (1957). Metastrongylus pudendotectus (Wostok, 1905) (syn. M. brevivaginatus, Choerostrongylus pudendotectus) was recorded by Purvis (1931a).

The FAO-WHO-OIE Animal Health Yearbook (1961) stated that verminous pneumonia in pigs is widespread throughout North Borneo. Euzeby (1957) considered members of this genus to be important pathogens in Malaya and stated that many of the lungs that he examined demonstrated oedematous inflammation. Yahaya (1977) stated that over a five year (1971-1975) period at the Malacca Municipal abattoir 203,598 (78.9%) out of a total of 258,136 lungs examined were found to harbour Metastrongylus species.

7. Family: Thelaziidae Railliet, 1916

7.1 Genus: Ascarops v Benedin, 1873 (syn. Arduenna)

Ascarops dentata (von Linstow, 1904) was reported from the stomachs of pigs in Malaya by Orr (1938). Two years later Ascarops strongylina (Rudolphi, 1819) was reported by Narayanan (1940).

7.2 Genus: Physocephalus Diesing, 1861

Physocephalus sexalatus (Molin, 1860) has been recorded by a number of workers (Orr, 1938; Narayanan, 1940; Euzeby, 1957). Shanta (1971) stated that members of this genus and those parasites belonging to the genus Ascarops produced a

catarrhal gastritis with the formation of pseudo-membranes when they were present in large numbers and occasionally ulcers were formed. He further stated that Physocephalus spp were more common in pigs than Ascarops spp.

8. Family: Gnathostomatidae Railliet, 1895

8.1 Genus: Gnathostoma Owen, 1836

Gnathostoma hispidum Fedtchenko, 1872 was recorded by Narayanan (1940). Euzeby (1957) stated that this species occurred rarely in Malaya.

Sandosham (1954) reported the collection of a male and a female specimen of Gnathostoma doloresi Tubangui, 1925 from a pig in Singapore which had been bred in Malaya. This parasite is normally found in the stomach but these specimens were obtained from the liver. The male was 24.5 mm long and 1.3 mm wide whereas the female was 27 mm long by 1.6mm wide. The head bulb was armed with ten rows of backwardly curved hooks. Spines were present on the body. The left spicule of the male was 2.68 mm long and the proximal half was provided with a membranous expansion. The right spicule was 0.645 mm long. Two of the four pairs of large caudal papillae were pre-anal in position.

Shanta (1971) stated that gnathostomes were only seen very occasionally and did not appear to be a problem.

9. Family: Filariidae Cobbold, 1864

9.1 Genus: Onchocerca Diesing, 1841

There are two reports of the occurrence of this genus. The first was by Ramachandran and Tan Boon Eng (1967) who recovered microfilariae from a carcinomatous lesion and also from normal areas of a pig's skin. These microfilariae were unsheathed and had a pointed tail. The nuclear column did not

reach the tip of the tail. They measured about 300-340 μ in length by 8-15μ in width. On the basis of this morphology and the site these parasites were held to belong to the genus Onchocerca. No adults were recovered and no microfilariae were seen in peripheral blood films.

The second report was by Bain et al (1977) who collected adult worms and microfilariae from the tendons and subcutaneous connective tissues of the metatarsal region of a wild boar (Sus scrofa jubatus, Miller). These could be differentiated from other species of the genus Onchocerca by means of the female cuticle, which showed straight ridges that overlapped in the lateral fields and by the relatively thick microfilariae (length 228-247 and width 6-7 μ). Thus the authors concluded that these parasites constituted a new species which they called Onchocerca detwittei.

10. Family: Setariidae Skryjabin & Schikhobalova, 1945

10.1 Genus: Setaria Viborg, 1795

Five female and three male worms which were obtained from the peritoneal cavity of a wild boar shot in Kelantan, Pahang (Sus scrofa jubatus Miller) were considered by Sandosham (1954) to belong to the genus Setaria and to constitute a new species which he called Setaria thomasi. He described the main features of this species as follows

"The body is filiform tapering towards the posterior extremity, which is twisted into a loose spiral especially in the females. The anterior end is rounded, the mouth being surrounded by a thick oval chitinous "peribuccal ring". Four median cephalic papillae and a pair of smaller lateral papillae are seen. Cuticular striations are not evident and the cervical papillae are not seen".

Sandosham further stated that the males measured from 48 to 57 mm in length and 0.4 mm in maximum thickness and that the females measured from 54 to 95 mm in length and 0.6 mm in maximum width. This species could be distinguished from other members of the genus by the number and the arrangement of the caudal papillae in the male. Fourteen pairs of papillae were present, seven pairs being pre-cloacal in position.

Bain and Shoho (1978) collected one immature female specimen of Setaria thomasi from the peritoneal cavity of a wild boar in the same region as those collected by Sandosham. After examining this parasite they confirmed the validity of the species.

11. Family: Trichinellidae Ward, 1907

11.1 Genus: Trichinella Railliet, 1895

There is disagreement as to the prevalence of Trichinella spiralis (Owen, 1833) (syn. Trichina spiralis). According to the FAO-WHO-OIE Animal Health Yearbook (1961) the parasite was widespread at that time. The Annual Report of the Medical Department cited by Sandosham and Noordin Bin Keling (1967) stated that 177 cases occurred in humans in 1958. However these authors stated that these reports were false and occurred because someone confused the term trichinosis with trichuriasis. They further stated that only one authentic human case has been recorded in Malaysia by Young (1927) and that the person involved was not a native of Malaya. Examinations of the diaphragms of several hundred wild rodents were carried out by one of the authors but all were negative.

12. Family: Trichuridae Railliet, 1915

12.1 Genus: Trichuris Roederer, 1761

Euzeby (1957) recorded the presence of

Trichuris trichiura (Linnaeus, 1771) (sic) in the caecum of pigs during post mortems at the Veterinary Research at Ipoh. Shanta (1971) stated that Trichuris suis (Schrank, 1788) was widespread in West Malaysia and that heavy infections with the parasite were known to occur.

Acanthocephala

1. Family: Oligacanthorhynchidae Meyer, 1931

1.1 Genus: Macracanthorhynchus Travassos, 1916

Macracanthorhynchus hirudinaceus (Pallas,1781) has been reported by Orr (1938) and by Narayanan (1940). However according to Griffiths (1968) the incidence is very low compared to other Asian countries. Shanta (1971) stated that infections with the parasite were not considered to be a serious problem.

HELMINTH PARASITES OF SWINE IN THE PHILIPPINES

The Philippines is an archipelago consisting of more than 7,000 islands. It can be subdivided into three main regions. Luzon in the north covers an area of 40,815 square miles and is the largest island in the archipelago. In the centre of the country is the Visayas region which consists of numerous smaller islands including Samar, Leyte, Bohol, Cebu, Negros and Panay. To the south of these lies the island of Mindanao. This is only slightly smaller than Luzon and covers an area of 36,906 square miles.

For a complete list of swine helminths in this country see Table II.

Trematodes

1. Family: Fasciolidae

1.1 Genus: Fasciola Linnaeus, 1758

Although fascioliasis is widely prevalent in cattle and buffaloes in the Philippines only one record of its occurrence in pigs could be found. According to Steele et al (1973) Fasciola eggs were recovered from the faeces of one of seven pigs in a survey carried out on the island of Negros.

1.2 Genus: Fasciolopsis Looss, 1899

Fasciolopsis buski (Lankester, 1857) has been recorded from man in the Philippines by Schwartz (1925a) who found eggs of this parasite in the stools of several Chinese in the Sulu Archipelago. However Arambulo (1974) said that indigenous infections of either man or animals have not been recorded and that this parasite has not established a nidus in the Philippines.

2. Family: Troglotrematidae

2.1 Genus: Paragonimus Braun

Paragonimus westermanii (Kerbert, 1878), the "lung fluke", is endemic in certain parts of the Philippines such as the provinces of Leyte and Sorsogan. However the role played by pigs in this zoonotic disease has not been established. Musgrave (1907) was the first to report this parasite from the Philippines. As well as giving details of clinical and post mortem observations on 17 human cases he also stated that one out of 32 cats examined was found to be infected with the parasite. In a survey carried out in Sorsogan province by Yogore et al (1958) it was found that the mollusc Brotia asperata was the first intermediate host in that area and that the crustacean Parathelphusa (Barythelphusa) grapsoides was the second. Although the crustacean host occurred commonly and had a high level of infection the prevalence of the parasite in man in the area was low (0.7%) possibly because crabs were usually thoroughly cooked before they were served. However the low incidence in humans meant that other animals must act as reservoir hosts for the parasite. The author found four of six cats that he examined positive for P. westermanii infection and he suggested that these were important reservoirs. Unfortunately no pigs were surveyed. However Arambulo (1974) said that pigs together with cats, dogs and field rats served as reservoir hosts in endemic parts of the Philippines.

3. Family: Schistosomatidae

3.1 Genus: Schistosoma Weinland, 1858

Schistosoma japonicum (Katsurada, 1904) is a very important parasite of man in the Philippines. The first human case was reported by Wooley (1906). At the present time

schistosomiasis is endemic in parts of the provinces of Sorsogan and Mindoro in Luzon; Samar, Leyte and Bohol in the Visayas and all of the provinces of Mindanao except Oriental Misamis (Arambulo, 1974). The frontiers of endemicity of the disease are limited by the distribution of the intermediate host, Oncomelania quadrasi. This in turn is dependant on ecological factors such as the presence of continuous rainfall and high levels of dissolved O_2 in the water.

There have been a number of studies on the role of domesticated animals in the perpetuation of this parasite. Tubangui (1947) found pigs and dogs to be infected on the island of Mindoro. Magath and Mathieson (1946) said that pigs were important reservoirs of S. japonicum because villages in the rural parts of the Philippines were usually located on the edges of swamps or near small streams. These easily became polluted with infected faecal material from pigs and man.

Pesigan et al (1958) set up infections in a variety of experimental animals and showed that there were no strain differences between the parasites of man, dogs, pigs, cattle and rats. These workers also tried to determine the importance of the different hosts as disseminators of the parasite in the municipality of Palo, Leyte. Pigs constituted the largest single group of domesticated animals kept by the people in this area. However the prevalence rate of S. japonicum infection at 13.3% was low compared to the figures for man, dogs, cattle and rats though higher than for buffaloes and goats. The mean daily egg output per infected pig at 481 was very low. The hatchibility of Schistosoma eggs passed out by pigs at 31.9% was higher than for dogs, rats and buffaloes but was lower than the figures obtained

for man, cattle and goats. The relative transmission potential for the different hosts was calculated based on the factors just mentioned and this was expressed as a percentage of the total role played by all the hosts involved. The following figures were obtained which demonstrate that pigs were relatively unimportant as reservoirs for human infection.

Man	75%		
Dog	14.4%	Pig	1.5%
Cow	5.7%	Buffalo	1.2%
Rat	1.5%	Goat	0.4%

Cestodes

1. Family: Taeniidae

1.1 Genus: Taenia Linnaeus, 1758

Taeniasis is an important zoonotic disease in the Philippines. It was first reported in man by Strong (1901) and in the following years by a large number of authors including Garrison (1907, 1908). Garrison et al (1909), Rissler and Gomez (1910), Chamberlain et al (1910), Willets (1911, 1914), Crowell and Hammock (1913), Garcia (1917) and Schwartz and Tubangui (1922). It was Garrison (1907) who established that both T. solium and T. saginata were present. However recent information shows that T. solium is rare in man. Arambulo (1967) noted that according to records at the Philippine General Hospital only one case of T. solium is observed every two years out of approximately 1,000 patients admitted for parasitological conditions. Only a few other reports of human cases of taeniasis due to T. solium infection in recent times exist (Chanco, 1960; Cabrera, 1965).

The first published data on cysticercosis in pigs was that of Schwartz and Tubangui (1922) who stated that

the prevalence at the Manila slaughterhouse for the years 1914 to 1920 exclusive of 1916 ranged from 1.0 to 1.5%. De Jesus (1932a) gave information on the prevalence of cysticercosis from the same abattoir for the years 1925-1929. He said that the true prevalence in the area was much higher than the range of values recorded (0.724-1.377) because many of the pigs infected with cysticerci were detected by the owners by means of tongue palpation and were then sent to abattoirs where meat inspection was not carried out. He estimated that the true prevalence of cysticercosis in pigs was in the range of 2.895-4.447%. He said that there were a number of reasons for this including indiscriminate disposal of human faeces, the free ranging nature of swine raising, unscrupulous butchers who disguised and sold infected meat cheaply and the practice of eating improperly cooked pork. The prevalence given by Refuerzo and Albis (1947) for cysticercosis among 3,361,580 pigs examined over a 25 year period in the Manila city abattoir was 0.97%.

However in more recent surveys the prevalence of cysticercosis in pork has dropped significantly. Arambulo (1967) reported that C. cellulosae had a prevalence rate of 0.04% in pigs slaughtered at the Manila abattoir during the year 1967. Arambulo et al (1969) found a prevalence of 0.0175% for C. cellulosae among a total of 610,177 pigs slaughtered at the Manila abattoir from January to December 1968. They found the prevalence to be highest among pigs slaughtered in December (0.0476%) and lowest in those slaughtered in September (0.002%). The ages of the infected pigs varied from one month to three years with a mode of 7-8 months. As regards geographic distribution the disease was highest in Masbate with 26.1% of the infected animals coming from this region.

As early as 1908 Garrison stated that T. saginata seemed to be much more prevalent than T. solium in man although the records from meat inspection by the Bureau of Animal Industry showed a much higher percentage of cysticercosis in hogs than in cattle. In fact there are only two documented reports of cysticercosis in cattle by Schwartz and Tubangui (1922) in two cattle imported from Indo-China and by Refuerzo and Albis (1947) who reported a case in an indigenous Red Sindhi cow. Arambulo et al (1976) studied information collected from 20 selected provinces, cities and municipalities over a five year period (1970-1975) which recorded 8 cases of cysticerci in buffaloes and 13 cases in cattle. The authors considered these reports to be of dubious value. In spite of the low prevalence of the larval stages in cattle T. saginata is very prevalent in some areas. Cabrera (1973) recorded a prevalence of 10.26% for this parasite among humans in an endemic focus in Leyte. In their study from this area Arambulo et al (1976) recovered T. saginata parasites from 88% of 66 confirmed cases of taeniasis that had been treated with bithional. No T. solium parasites were recovered. However none of the cattle or buffalo carcases examined from the area were infected with Cysticercus bovis cysts and beef was rarely eaten by the people. On the other hand cysticerci were common in pork and the consumption of raw pork was widely practiced in the area. Some 11% of the infected persons claimed to have eaten pork with cysticerci. To determine if pigs were intermediate hosts for T. saginata the authors examined over a thousand cysticerci from 50 pig carcases and found that all had scoleces typical of T. solium. T. solium was recovered from one human and from a monkey

artificially infected with C. cellulosae cysts, showing that the scolex did not lose its hooks in man. Because of these results and because cattle and buffalo calves and goats (sic!) failed to develop cysticerci after being artificially infected with eggs from gravid segments voided by the human carriers the authors suggested that taeniasis in this area was possibly due to a Taenia species other than T. saginata with a direct life cycle or one involving fish which were commonly eaten raw in this area.

Cysticercus tenuicollis was recorded from the abdominal cavity of a pig in Pampanga province by Schwartz (1925b).

1.2 Genus: Echinococcus Rudolphi, 1801

The FAO-WHO-OIE Animal Health Yearbook (1961) stated that there was a low sporadic incidence of hydatidosis in pigs in the Philippines. However more recent editions do not mention the presence ofthis parasite in pigs.

Nematodes

1. Family: Ascaridae Biard, 1853

1.1 Genus: Ascaris Linnaeus, 1758

Ascaris lumbricoides Linnaeus 1758 (sic) was first reported by Schwartz (1922) who found the parasite in seven of 29 pigs that he examined at the University of the Philippines with burdens ranging from 1 to 34. The author also observed some ascarid parasites in the abattoir in Manila. Tubangui (1947) stated that A. lumbricoides (sic) was widely distributed. Refuerzo and Gonzales (1953) examined the small intestines of 201 pigs in the Manila abattoir and found that the prevalence of A. lumbricoides (sic) was 47.26% with an average worm burden in infected animals of 3.38 parasites. There is no

up to date information on the prevalence of this parasite but given that husbandry practices have changed very little among backyard raisers in the past 40 years it is likely that A. suum is still widely distributed in pigs raised under these conditions.

2. Family: Strongyloididae (Litwood & McIntosh, 1934)

2.1 Genus: Strongyloides Grassi, 1879

The members of this genus have been reported. Strongyloides suis (Lutz, 1885) von Linstow, 1905 (syn. Strongyloides papillosus) was reported from Manila by Tubangui (1947). Strongyloides ransomi Schwartz & Alicata, 1930 was recorded by Refuerzo and Gonzales (1953) who found this parasite in 15 of the 201 small intestines that they examined, a prevalence of 7.40%.

3. Family: Trichonematidae Witenberg, 1925

3.1 Genus: Oesophagostomum Molin, 1861

Oesophagostomum longicaudum Goodey, 1925 was first reported by Schwartz (1926). In 1953 Refuerzo and Gonzales found that 16 out of 180 large intestines were infected with this parasite, a prevalence of 8.88%. An average of 14.37 parasites per infected pig was recorded.

Oesophagostomum dentatum (Rudolphi, 1803) was reported by Schwartz (1925b) who observed both larval and adult forms of the parasite in the large intestine of most of the pigs that he examined. Refuerzo and Gonzales (1953) found a prevalence of 43.22% in their survey with the worm burden averaging 74.29. They observed that the dorsal ray of the copulatory bursa showed some variations between individual parasites and in a few individuals the branches of the dorsal rays were asymmetrical, one branch being bipartite and the other tripartite.

4. Family: Stephanuridae Travassos & Vogelsang, 1933

4.1 Genus: Stephanurus Diesing, 1839

In terms of direct economic losses Stephanurus dentatus Diesing, 1839 is one of the most important parasites of domesticated animals in the Philippines. It was the first parasite of the pigs to be reported there by Boynton in 1913 who associated it with disease in a group of imported pigs. During the same year Newcomb examined 2,000 pigs at an abattoir in Manila and found 50% of them infected with S. dentatus. Schwartz (1925b) found the parasite to be quite common in pigs in Los Banos and Manila and it appeared to him that native pigs were less likely to be heavily infected than imported breeds. In a slaughterhouse survey carried out by de Jesus (1935) on pigs coming from the provinces of Batangas and Laguna 602 out of 941 carcases examined were found to be infected, a prevalence of 63.98%. Peneyra and Naui (1965) examined 500 carcases and found a prevalence of 48% for S. dentatus. However in contrast to earlier reports they found that the prevalence was much higher in native rather than in imported pigs. For example the prevalence rate for the Landrace breed was only 29% as compared to 78% for native pigs. They suggested that this was due to improved husbandry practices for the imported group. Arambulo et al (1968a) examined the carcases of 8,289 pigs which were mainly foreign breeds and found 28.85% of these infected with S. dentatus. They noted that the prevalence was lower than in earlier surveys and they related this to improved local husbandry practices and effective disease control measures.

There have been a number of reports on the

pathogenicity of the parasite. Boynton (1913) stated that infection was associated with posterior paralysis in some cases. However de Jesus (1935) stated that paralysis of the hind quarters was not common even in sows with heavy levels of infestation. From his observations he concluded that heavy burdens of S. dentatus could cause mortalities in both mature and young pigs. However in general pigs between 3 and 5 months of age were more severely affected than older pigs. Even moderately infected animals in this age group became stunted, cachectic, emaciated and had a poor appetite, tucked up abdomen and an arched back. In mature pigs such symptoms were often not manifested even when the level of infection was heavy. In contrast to the findings of other workers this author stated that the urine of the 3-5 month old pigs that he examined was often positive for Stephanurus eggs.

Most workers found the livers to be much more severely affected than the kidneys. This was because pigs were often slaughtered before the parasite reached the latter organs. Peneyra and Naui (1965) found that severely infected livers were very much enlarged, had rounded edges, a grayish colour and were firm in consistency. Nodules with or without parasites and varying in size were common, especially in the portal areas. In severe cases they were scattered over the entire surface of the liver. Arambulo et al (1968a) stated that most of the livers that they observed from Stephanurus positive pigs were condemned and that great financial losses were incurred as a result of this.

In infections involving the renal region Peneyra and Naui (1965) stated that nodules were commonly observed

in the wall of the pelvis and ureter and in the peri renal fat. The kidneys were enlarged with irregular surfaces showing white spots.

5. Family: Ancylostomatidae Looss, 1905

5.1 Genus: Necator, Stiles 1903

Necator americanus (Stiles, 1902) has a wide distribution according to Tubangui (1947) and occurs in both man and pigs. However it is more prevalent in the southern islands because of the more even yearly distribution of rainfall in these areas (Tubangui et al, 1935).

5.2 Genus: Globocephalus Molin, 1861

Globocephalus longemucronatus Molin, 1861 was first reported from the Philippines by Tubangui (1925). The presence of this parasite was confirmed by Wehr (1930) who also identified two other pig parasites belonging to this genus from specimens sent to him by Tubangui. There were Globocephalus samoensis (Lane, 1922) and Globocephalus urosubulatus (Alessandrini, 1909). Refuerzo and Gonzales (1953) stated that none of these parasites were seen in their survey.

6. Family: Trichostrongylidae Leiper, 1912

6.1 Genus: Metastrongylus Hall, 1921

Hyostrongylus rubidus (Hassall & Stiles, 1892) is very prevalent. According to Schwartz (1925b) this parasite was commonly encountered in autopsies in Los Banos, Laguna. Refuerzo and Gonzales (1953) obtained a prevalence rate of 23.63% for this parasite in their survey which involved the examination of 165 pig stomachs, with an average of 52.94 worms. In the survey by Tongson et al (1971) the prevalence was 23.2%

making it the second most common stomach worm they encountered. They stated that local climatic factors might be the reason that it was not the most common stomach worm as is the case in many temperate countries. H. rubidus is very susceptible to dessication and exposure to dryness for a short time will kill the larvae.

As regards the pathogenicity of this parasite Schwartz (1925b) said that its presence in the stomach of a pig was often associated with catarrhal inflammation of the mucosa and sometimes extensive ulceration. However these lesions were not invariably present. Tongson et al (1971) found shallow "erosions" in the stomachs of infected animals and the mucous membrane was covered by a layer of thick tenacious clear mucous, particularly in the fundic and pyloric regions. At times the whole of the stomach lining was covered by ulcerations.

7. Family: Metastrongylidae Leiper, 1909

7.1 Genus: Metastrongylus Molin 1861

Lungworms are very common and three members of the genus Metastrongylus are present. The presence of this genus was first noted by Boynton (1913). In 1924 Tubangui reported the occurrence of Metastrongylus apri (Gmelin, 1790) in pigs and a year later the presence of Metastrongylus salmi Gedoelst, 1923 was recorded by Schwartz (1925c). Soller (1966) reported a lungworm prevalence of 52% based on the examination of 5,000 lungs. He claimed that this was highest among native and cross bred pigs being 55% and 54% respectively. In their study Arambulo et al (1967a) examined the lungs of 10,000 pigs of which 3,826 were positive for Metastrongylus.

In another study Arambulo et al (1967b)

determined the prevalence of the different species of Metastrongylus. M. apri was by far the most common species encountered occurring as a pure infection in 73.3% of the 1000 infected lungs examined as opposed to figures of 5.9% for M. salmi and 3.2% for Metastrongylus pudendotectus (Wostok, 1905). Mixed infections were also present. This was the first time that M. pudendotectus was reported from the Philippines. In another survey carried out by Arambulo et al (1968b) this parasite was present in 27 of the 200 infected lungs examined. The authors stated that this parasite was probably introduced into the Philippines through the importation of pigs from the U.S.A.

A number of papers have been published on the intermediate hosts of M. apri in the Philippines. Refuerzo and Reyes (1959) after examining earthworms from lungworm infected piggeries said that three species harboured Metastrongylus larvae. Of these Lampito mauritii appeared to be a more suitable intermediate host for these parasites than Pheretima bahli and Pheretima elongata as gauged by the percentage of each species infected and the number of larvae in the infected worms. In 1967 Reyes and Refuerzo reported the occurrence of three further species which served as intermediate hosts for Metastrongylus - Pheretima houlleti, Perionyx excavatus and Nematogenia panamaensis. The first two species seemed to be highly susceptible with N. panamaensis being slightly less susceptible. Reyes (1968) reported on a 10 year study in which earthworms from 24 piggeries in different parts of the Philippines were collected and examined for Metastrongylus larvae. Sixteen species were recovered and in addition to the six species already mentioned members of two further genera (Drawida and Plionogaster) were found to harbour Metastrongylus larvae. The distribution of the different species of earthworms varied considerably. Some species such as Pheretima

elongata were found in a large number of piggeries whereas others such as Perionyx excavatus were found in only one.

Arambulo et al (1967a) described the lesions that they encountered in infected lungs. The posterior part of the diaphragmatic lobe was most commonly infected and the most common lesions observed were irregular pale areas of emphysema alternating with hard and elevated grayish areas of consolidation. On incising the areas of consolidation numerous worms were seen clogging the bronchioles. Generally, affected areas were sharply demarcated from the normal portions of lung. The authors stated that Metastrongylus infections caused a high rate of lung condemnation and considerable financial loss.

8. Family: Thelaziidae Railliet, 1916

8.1 Genus: Ascarops v. Benedin, 1873 (syn. Arduenna)

Ascarops strongylina (Rudolphi, 1819) was initially reported by Tubangui (1925) and Schwartz (1925b). In their survey involving 165 stomachs in 1953 Refuerzo and Gonzales found that A. strongylina was the most common parasite that they encountered with a prevalence of 67.26% and an average worm burden of 43.95 parasites. Likewise in 1971 Tongson et al found this parasite to be very prevalent occurring as a pure or mixed infection in over 45% of the stomachs examined. They found pronounced necrosis and ulceration of the gastric mucosa in pigs harbouring the parasite and in some cases the worms penetrated deeply into the stomach wall.

8.2 Genus: Physocephalus Diesing, 1861

Physocephalus sexalatus (Molin, 1861) was reported by Tubangui (1925) who found this parasite at Los Banos, Laguna. The parasite had a prevalence rate of 41.2% in the survey

of Refuerzo and Gonzales (1953) and there was an average worm burden of 18.57 parasites in the infected stomachs. Tongson et al (1971) also recorded P. sexalatus during their survey. The parasite had an incidence of 3.0% and occurred either as a pure or mixed infection with other stomach worms.

9. Family: Gnathostomatidae Railliet, 1895

9.1 Genus: Gnathostoma Owen, 1836

Gnathostoma doloresi was first reported by Tubangui in 1925 who recovered four mature female specimens from a pig slaughtered at Los Banos, Laguna. He said that this species differed from Gnathostoma hispidum Fedtchenko, 1872 in the size and the appearance of the eggs, which were provided with a polar cap at each end. Miyazaki (1968) stated that another difference between the two species was the shape of the cuticular spines. Refuerzo and Gonzales (1953) found only a single male G. doloresi specimen in the 165 pig stomachs that they examined. Tongson et al (1971) recorded a prevalence of 2.3% in their survey. They stated that the reason the prevalence was low was because pigs rarely ate raw fish or frogs, which serve as intermediate hosts for the parasite. The authors also stated that the head of the worms and a portion of the body were firmly embedded in the stomach wall.

G. hispidum was reported by Schwartz (1925b). However only a single specimen was recovered from the infected pig. There have been no reports of this parasite since then and Tongson et al thought that the original report may have been erroneous.

10. Family: Trichinellidae Ward, 1907

10.1 Genus: Trichinella Railliet, 1895

There has been one report of Trichinella

spiralis (Owen, 1833) by Orange (1966) but this report may have been erroneous. Other surveys which have been carried out in pigs and rats have all produced negative results. (Tubangui, 1931; de Jesus, 1932b; Manuel and Cruz, 1963; Tacal and Pabello, 1965; Villenueva et al, 1966; Arambulo et al, 1970 and 1971 and Steele et al, 1973). Manuel and Cruz (1963) stated that the chances of getting the disease from outside were remote because pigs were only imported from countries with low levels of infection and were used for upgrading local stock rather than for meat. However Arambulo et al (1971) stated that Garduno and Dominador (1959) reported two cases of suspected trichinosis in Philippine army personnel. The two people infected had a history of eating dog meat. Arambulo et al suggested that studies should be carried out on sylvatic animals and other carnivores to determine if these were reservoirs. However there has been no further reports of infection from this source.

11. Family: Trichuridae Railliet, 1915

11.1 Genus: Trichuris Roederer, 1761 (syn. Trichocephalus)

Trichuris trichiura (Linnaeus, 1771) (sic)

was commonly found in Manila and Los Banos by Schwartz (1925b). However this parasite was found in only three of 180 large intestines examined by Refuerzo and Gonzales (1953), a prevalence of 1.65%. However the number of parasites per infected organ at 167.33 was higher than for any of the other helminths that they encountered.

Acanthocephala

1. Family: Oligacanthorhynchidae Meyer, 1931

1.1 Genus: Macracanthorhynchus Travassos, 1916

Macracanthorhynchus hirudinaceus (Pallas, 1781)

has been reported from pigs and man in the Philippines. It was first observed by Schwartz (1925b) who recovered a single specimen from the intestine of a wild boar (Sus philippinensis) trapped at Los Banos, Laguna. Tubangui (1947) stated that the parasite was widespread among pigs. Refuerzo and Gonzales (1953) recorded an incidence of 4.97% for M. hirudinaceus and the average number of worms in the infected intestines was 1.5. In a survey conducted by Arambulo and Blanea (1972) 39 out of 12,962 pigs were found to harbour the parasite. The worm burden varied from 1 to 30. No exotic breeds or their cross breds were found to be infected and the reason put forward for this was that these types of pigs would not usually be seeking food by scavenging and rooting and therefore were less likely to come in contact with the intermediate host. According to the authors the most widespread host was Phyllophaga rugosa commonly known as the May beetle.

In some parts of the Philippines beetles are a native delicacy and so M. hirudinaceus is a potential human health hazard. According to Arambulo and Blanea (1972) only two human cases were recorded by the Institute of Public Health at the University of the Philippines between 1960 and 1970 and one of these was a false infection. They said that a possible reason for the low incidence in humans might be that the parasites were destroyed during preparation of the beetles for human consumption, as they were usually deep fried.

HELMINTH PARASITES OF SWINE IN SINGAPORE

The island of Singapore lies at the southern tip of the Malaysian peninsula. It merged briefly with Malaya, Sabah and Sarawak in 1963 to form the Federation of Malaysia but withdrew from this within a short time to become an independant territory.

For a list of the helminths of swine in this country see Table II.

Cestodes

1. Family: Taeniidae

1.1 Genus: Taenia Linnaeus, 1758

The FAO-WHO-OIE Animal Health Yearbook (1978) stated that Cysticercus cellulosae was not found. This may be due to the fact that almost all pigs are intensively raised in Singapore.

Nematodes

1. Family: Ascaridae Baird, 1853

1.1 Genus: Ascaris Linnaeus 1758

Ascaris lumbricoides Linnaeus, 1758 (sic) was thought to be common by Giam and Spence (1967) even though it was not seen in the pig carcases they examined. They said that there had been a recent reduction in the prevalence of the parasite due to the increased use of piperazine and the rearing of pigs on concrete floors. These authors were reporting on the results of post mortems carried out at the veterinary laboratory in Singapore during its first year of operation in 1965. A total of 83 pigs were examined during the year and thirteen had parasites. Lim (1978) carried out faecal examinations for parasite eggs on 200 pig farms in Singapore and found that 35.5% of these farms had

pigs which were positive for ascarid eggs.

2. Family: Strongyloides Chitwood & McIntosh, 1934

2.1 Genus: Strongyloides Grassi, 1879

Strongyloides ransomi Schwartz & Alicata, 1930 was identified by Chew (1972) who associated the parasite with a severe outbreak of post weaning enteritis in a group of 36 pigs. The clinical signs observed were a severe mucoid diarrhoea and emaciation. Faecal smears were heavily positive for Strongyloides eggs. In one sample a count of 53,800 e.p.g. was recorded. Eight pigs died and a post mortem examination was carried out in one. Thickening of the duodenum and a severe enteritis involving the jejunum, ileum and the large intestine was observed. The intestinal contents were blood stained and had a thick mucoid consistency. Patches of pneumonia were found in all of the lobes of the lungs. S. ransomi adult female parasites were recovered from the duodenum, jejunum and ileum. Haemolytic Esherichia coli organisms were also isolated from these areas as well as from the lungs. After treatment with two doses of oral thiabendazole the diarrhoea was arrested and there was a dramatic drop in the faecal egg counts from the remaining 28 piglets. From this response the author concluded that the clinical signs were mainly due to the heavy infection with S. ransomi. However he also stated that infections with this parasite could predispose pigs to E. coli infections.

S. ramsomi seems to have a high prevalence in Singapore as indicated by the survey by Lim (1978) who recovered Strongyloides ova from the faeces of pigs in 80% of the farms that she visited.

3. Family: Trichonematidae Witenberg, 1925

3.1 Genus: Oesophagostomum Molin, 1861

Helminths of the genus Oesophagostomum were

recovered from a sow by Giam and Spence (1967). They also stated that eggs resembling those of Oesophagostomum sp. were isolated from weaned pigs with chronic diarrhoea. Strongyle eggs were recorded from 67% of the farms that Lim (1978) surveyed. She stated that in Singapore strongyle ova from pigs belonged exclusively to the genus Oesophagostomum. However the earlier recovery of Hyostrongylus rubidus parasites from pigs in this country by Griffiths (1968) would seem to contradict this view.

4. Family: Stephanuridae Travassos & Vogelsang, 1933

4.1 Genus: Stephanurus Diesing, 1839

Stephanurus dentatus Diesing, 1839 was considered to have caused the deaths of two sows and a boar examined at the veterinary laboratory in Singapore by Giam and Spence (1967). It was also seen as an incidental finding during post mortem examinations of other pigs. Corynebacterium pyogenes was the bacterial agent that was most consistently isolated from the abscesses which were associated with this parasite.

5. Family: Trichostrongylidae Leiper, 1912

5.1 Genus: Hyostrongylus Hall, 1921

Hyostrongylus rubidus (Hassall &Stiles, 1892) specimens were recovered by Griffiths (1968). However no further information was given.

6. Family: Metastrongylidae Leiper, 1908

6.1 Metastrongylus Molin, 1861

Helminths belonging to the genus Metastrongylus were recovered from the lungs of a one month old pig and an adult boar by Giam and Spence (1967). In her survey Lim (1978) recovered Metastrongylus eggs from 3.5% of the 200 pig farms that she visited.

7. Trichuridae: Railliet, 1915 (Trichocephalidae Baird, 1853)

7.1 Genus: Trichuris Roederer, 1761 (syn. Trichocephalus)

Trichuris suis (Schrank, 1788) was recovered from the large intestine of a two month old pig by Giam and Spence (1967). Trichuris ova were isolated from 44% of the farms surveyed by Lim (1978).

HELMINTH PARASITES OF SWINE IN THAILAND

Thailand lies in the centre of mainland Southeast Asia and shares common borders with Malaysia in the south, Burma in the west and northwest, Laos in the northeast and east and Kampuchea in the southeast. There is rich delta country in the south and centre, where most of the population lives and where most of the rice is grown. Much of northern and eastern Thailand cannot be used to any considerable extent for agriculture because of the mountainous character of the terrain.

For a full list of the helminths of swine in this country see Table II.

Trematodes

1. Family: Fasciolidae

1.1 Genus: Fasciolopsis Looss, 1899

Fasciolopsis buski (Lankester, 1857) is an important parasitic disease of man and pigs in those areas of central Thailand where water plants such as the water caltrop (Tropa bicornis) and the water hyacinth (Eichhornia speciosa) are commonly used for food. The parasite was first reported from man by Goddard (1918) and later reports include those of Daengsvang and Mangalasmaya (1941) and Sadum and Maiphoom (1953). The parasite was reported from pigs by de Jesus and Waramontri (1961) who found 1.61% of the 2,223 pig carcases that they examined in an abattoir in Bangkok to be infected. These pigs came from the middle regions of Thailand and were found to suffer from moderate to heavy infections.

Manning and Ratanarat (1970) tried to gain further knowledge on the importance of animal reservoirs of F. buski.

They found that the parasite only occurred in the provinces of Angthong, Ayuthaya and Suphanburi in areas where annual flood waters covered the ground for several months each year. Prevalences of 5.2%, 39.3% and 12.1% respectively were recorded for F. buski in man in these provinces. The authors estimated that one fifth of the total population of 500,000 in this endemic area were infected at any one time. Of the animals examined only pigs were found to be infected and only in the same provinces as human infections. In three villages where both man and pigs were surveyed there was a close correlation between the prevalence of the parasite in the two populations. However pigs had lighter infections than man, averaging only two worms per infected animal as opposed to an average worm burden of 18 in infected people. In one of these villages 72% of 454 people and 63% of 143 pigs were found to be infected with F. buski.

Manning and Ratanarat suggested that contamination by human faeces took place in areas where there was little or no dry ground and people defaecated directly into the standing water beneath their houses. Because of the presence of a lot of organic matter these areas were very suitable for the molluscan intermediate hosts which were found to be Segmentina trochoideus and Segmentina hemisphaerula. Many water plants were cultivated near the houses and were used as human and animal food thus allowing ingestion of the metacercariae by the final host. It was felt that pigs were also important reservoirs of infection. These were often kept in pens near the dwellinghouses and their faeces could also easily contaminate the water in which the intermediate host lived. Thus it was felt that pigs could maintain the parasite in the human population even if sanitary

disposal of human waste was possible. The most likely source of infection for the pigs themselves was the water hyacinth (Eichhornia speciosa) which was eaten almost exclusively by livestock.

2. Family: Echinostomatidae

2.1 Genus: Echinostomum Rudolphi, 1809

Echinostoma malayanum Leiper, 1911 was reported from man in Chiengmai province in Thailand by Leiper (1915). More recently human cases have been reported by Bhaibulaya et al (1964). However there have been no reports of the occurrence of this parasite in pigs in Thailand.

3. Family: Paramphistomatidae

3.1 Genus: Gastrodiscoides, 1913

Gastrodiscoides hominis (Lewis & McConnell 1876) Leiper, 1913 (= Gastrodiscus hominis (Lewis & McConnell, 1876) (Fischoeder, 1902)) was found in the large intestine of five of the pigs examined by de Jesus and Waramontri (1961). The infected animals had light infections and came from the middle region of Thailand.

4. Family: Schistosomatidae

4.1 Genus: Schistosoma Weinland, 1858

In an area of south Thailand where a focus of human infection, believed to be Schistosoma japonicum (Katsurada, 1904), was discovered, surveys were carried out on a number of species that could act as reservoir hosts. Between March 1960 and February 1963, 94 pigs were surveyed for S. japonicum eggs but all were negative. Other potential hosts examined including buffaloes, cattle, dogs, pigs and rats were also negative for S. japonicum, although seven of the buffaloes were positive for an unidentified

schistosome species (Kruatrachue and Harinasuta, 1964). These findings were in marked contrast to those of Pesigan et al (1958) in the Philippines. The Thai authors suggested that in their country a distinct strain of S. japonicum or even a different species might be present.

Cestodes

1. Family: Taeniidae

1.1 Genus: Taenia Linnaeus, 1758

Cysticercus cellulosae was found to have an incidence of 2.789% in the masseter muscle of pigs in the study by de Jesus and Waramontri (1961). The infected animals came from the middle region of Thailand and the level of infections were moderate to heavy. Patharangura and Chaiyaporn (1973) reported an increase in the number of cases of Taenia solium Linnaeus, 1758 being recorded at the Siriraj hospital in Thailand. Between 1923 and 1957 only six cases of T. solium infection were recorded. However between March 1971 and September 1972 14 cases were identified at the same hospital. The authors mentioned that a dish known as "Nam" containing partially cooked pork was popular in Thailand. They stated that another possible reason for the increased number of cases of T. solium recorded was the growing enthusiasm of people for submitting parasite specimens. However they concluded that the pork tapeworm was still seldom reported in man in Thailand while Cysticercus cellulose was relatively common in pigs.

Cadigan et al (1967) reported that they had recovered an adult T. solium parasite from a white handed gibbon which was fed several pieces of "measly pork" and they

suggested that the gibbon might be a suitable model for testing new therapeutic agents for taeniasis in man.

Cysticercus tenuicollis was found to have an incidence of 2.519% in pigs in the survey by de Jesus and Waramontri (1961). Light infections wwre found in the visceral organs and the infected pigs came from the middle and northeast regions of Thailand.

1.2 Genus: Echinococcus Rudolphi, 1801.

In the study by de Jesus and Waramontri (1961) a large unilocular sterile hydatid was found in the omentum of one out of the 2,223 pig carcases examined, an incidence of 0.044%. The cyst measured 9.6 cm in its smallest diameter and 13 cms in its largest diameter. The positive pig came from the middle region of Thailand. According to the authors hydatidosis has also been reported to occur in buffaloes in this country.

Nematodes

1. Family: Ascaridae Baird, 1853

1.1 Genus: Ascaris Linnaeus, 1758

Ascaris lumbricoides Linnaeus, 1758 (sic) was recorded in Thailand by Dissamarn and Goff (1960) and de Jesus and Waramontri (1961). The latter authors found that 14.439% of the pigs that they examined in the Bangkok abattoir were infected with A. lumbricoides. The positive animals came from the middle and northeast regions of Thailand. The authors suggested that because of age resistance in the pigs that they examined, the prevalence would be higher in younger pigs.

2. Family: Trichonematidae Witenberg, 1925

2.1 Genus: Bourgelatia Railliet Henry & Bauche, 1919

A few specimens of Bourgelatia diducta

Railliet Henry & Bauche, 1919 were found by de Jesus and Waramontri (1961) in Chandi village in Nakhom, Srithammaraj province. This species seems to have a low prevalence in Thailand.

2.2 Oesophagostomum Molin, 1861

Oesophagostomum dentatum (Rudolphi, 1803) was found to have a prevalence of 5.0% in the survey by de Jesus and Waramontri (1961). The pigs came from the middle region of Thailand and suffered from light to moderate infections.

Oesophagostomum longicaudum Goodey, 1925 was found during an autopsy in one pig from a large piggery in Nakorn Pathom by the same workers. They stated that the parasite seemed to have a very low incidence in Thailand.

3. Family: Stephanuridae Travassos & Vogelsang, 1933

3.1 Genus: Stephanurus Diesing, 1839

Stephanurus dentatus Diesing, 1839 was found to have a prevalence of 2.0% in the survey by de Jesus and Waramontri (1961). The infected pigs came from the middle region of Thailand and suffered from light infections.

4. Family: Metastrongylidae, Leiper, 1908

4.1 Genus: Metastrongylus, Molin, 1861

Metastrongylus apri (Gmelin, 1790) had an incidence of 0.629% in the survey by de Jesus and Waramontri (1961). The infected pigs came from the middle and northeast regions of Thailand and had moderate to heavy infections.

Metastrongylus salmi Gedoelst, 1923 was reported by Segel et al (1968). No further information was given.

5. Family: Thelaziidae Railliet, 1916

5.1 Genus: Ascarops v. Beneden 1873 (syn. Arduenna)

Ascarops strongylina (Rudolphi, 1819) was

found to have a prevalence of 2.204% in the survey by de Jesus and Waramontri (1961). The infected pigs came from the northeast region of Thailand and had moderate to heavy parasite burdens.

6. Family: Gnathostomatide Railliet, 1895

6.1 Genus: Gnathostoma Owen, 1836

Gnathostoma doloresi Tubangu, 1925 was reported by Dissamarn et al (1966). 33 out of 1,568 pigs slaughtered in the Bangkok abattoir were found to be infected with this parasite. It was determined that Mesocyclops leukarti was the intermediate host for G. doloresi in Thailand.

Gnathostoma hispidum Fedtchenko, 1872 was reported from Thailand by Dissamarn et al (1966). They found one of the 1,568 pigs that they examined to be infected with this parasite at the Bangkok abattoir and they stated that incidences of 1.67% and 2.74% had been recorded for this parasite in two abattoirs in southern Thailand. Experimentally it was found that Mesocyclops leukarti was an intermediate host and that there was a prepatent period of seven months after the cyclops was fed to a pig. Fresh water fish (Anabas spp. and Opicephalus striatus) and an albino rat were infected after being fed fully developed larvae in cyclops. In these second intermediate hosts the larvae developed more fully and were bigger than those found in the first intermediate host.

The study of Daengsvang (1972) gave further information on the incidence, life cycle and morphology of G. hispidum. He examined the stomachs of 847 pigs in the Bangkok abattoir and in four abattoirs in southern Thailand and recorded an incidence of 2.4% with an average worm burden in infected animals of 2.6. All the worms were found with their

heads penetrating into the ulcerated mucosa.

As regards the life cycle this author found that at a temperature of 29-30°C and a pH of 6.8 to 7.2 the ova became embryonated in 3-10 days and most hatched on day 13 after embryonation. The larvae had a viability period of approximately five days when kept under these conditions. After ingestion by cyclops (Mesocyclops leukarti and Cyclops varicans Sars) the first stage larvae developed to the infective third stage in approximately ten days. When these larvae were fed to fresh water fish, amphibia, reptiles or rodents advanced third stage larvae were seen developing in various organs of all groups except the reptiles. When these advanced third stage larvae were fed to other fresh water fish, amphibia or rodents larvae similar in size and morphology to those fed were found in various organs of all groups. Thus these vertebrates could also act as paratenic hosts for the worm.

Likewise the author showed that primates (monkeys of the Macaca irus species were used) could act as paratenic hosts when they ingested advanced third stage larvae from infected vertebrates but no development occurred when cyclops containing early third stage larvae were ingested by these animals. It was shown that pigs could become infected through ingesting either early third stage or advanced third stage larvae. The author found larval stages in the liver of pigs showing that some migration occurred before the parasite developed to maturity in the stomach.

A detailed description of the morphology of G. hispidum was given by Daengsvang (1972). Fresh worms had a characteristic reddish appearance in the space between the oesophagus and the body wall. The average size of the males was

19.7 x 1.7mm and 26.2 x 2.3mm for the females. At the anterior end immediately behind the disc shaped cephalic bulb the body circumference assumed a conical shape. Immediately behind this the diameter decreased and then increased again so that the maximum width of the parasite was located in the posterior half of the body. The caudal part of the body became smaller and rather cylindrical with a slightly tapering rounded posterior end. The cephalic bulb had 9-12 rows of cephalic hooklets. Almost all of these were equal in size except for those in the first and last rows which were smaller. The body cuticle was entirely covered with many transverse rows of cuticular spines of different sizes and shapes and densely arranged in a regular manner. This and the other features mentioned could be used to differentiate this species from Gnathostoma spinigerum and Gnathostoma doloresi.

G. spinigerum Owen, 1836 was reported to occur in pigs in Thailand by Segel et al (1968). No further information was given.

7. Family: Trichinellidae Ward, 1967

7.1 Genus: Trichinella Railliet, 1885

Until 1962 only one case of Trichinella spiralis (Owen, 1833) had been reported from Thailand. This was in a European living in the north of the country (Holck, 1963). Between May 1956 and June 1957 3,092 pig diaphragms were examined for the parasite at one of the municipal slaughterhouses in Bangkok and all were negative (Dissamarn and Aranyakanada, 1960). In the survey by de Jesus and Waramontri (1961) 2,223 pig carcases were examined for T. spiralis and again all were negative. However in June 1962 an outbreak of trichinosis was reported from Mae Hong Son province in northern Thailand which involved 56 people,

11 of whom died (Holck, 1963). Since then ten more outbreaks have been reported up to 1978. (See Table III.) According to Khamboonruang and Nateewatana (1975) many other outbreaks have not been recorded. However all recorded outbreaks were confined to one part of northern Thailand.

There have been four sources of infection in the outbreaks recorded. These were hilltribe pigs, a wild boar, a jackal and a black bear. Hilltribe pigs are the native pigs of northern Thailand. They are similar to domestic pigs but they are allowed to forage on the mountains; hence they are more like wild animals in their habits and some of them have been crossed with wild boars. They are consumed by the hilltribe people with any surplus being sold to the Thai people who live on the plains. (Dissamarn and Chai-anan, 1970), (Khamboonruang et al, 1978).

There is a high incidence of trichinosis in these pigs. Eight of the 11 outbreaks reported in man have been due to hilltribe pigs. In a survey carried out in the provinces of Chiangmai, Prae and Nan it was found that 8 out of 70 hilltribe pigs examined were infected with T. spiralis. The number of larvae in 100 grams of diaphragm muscle ranged from 7 to 5,570 (Dissamarn and Chai-Ananda, 1965). In spite of the high prevalence of the parasite in these pigs outbreaks in these areas are rare because the pork is usually well cooked. Villagers in lowland areas on the other hand eat pork with chili peppers (lab) or sometimes the pork is fermented for several days in cooked banana leaves (nam). Thus some of the trichinosis outbreaks have occurred in lowland people who have purchased hilltribe pigs and prepared them in these ways. As already stated lowland pigs are seldom infected with Trichinella spiralis.

In addition to the surveys already mentioned, Khamboonruang et al (1978) examined 7,598 pig diaphragms at the provincial abattoir in Chiangmai province and found that only one diaphragm harboured Trichinella larvae. The authors also gave the results of a survey conducted by the Ministry of Agriculture between 1967 and 1969 in northern Thailand. 18 of 117,126 pig diaphragms were positive. All of these pigs were traced to hill-tribe areas. The number of larvae ranged from 2 to 800 per gram of muscle.

In the third outbreak in March 1964 a wild boar which had been hunted and killed was the source of infection. Dissamarn and Chai-anan (1970) reported that a few samples of wild boar muscle had been examined but all were negative. Very little is known about the prevalence of T. spiralis in jackals and black bears, each of which caused one outbreak of trichinosis in northern Thailand. Rats also seem to be important reservoirs in hilltribe areas. In the survey of Dissamarn and Chai-Ananda (1965) there was an 8.33% incidence of infection in the rat (Rattus rattus) in the hilltribe village of Prae. However as with pigs infection in rats seems to be confined to hilltribe areas. In a survey carried out in the city of Chiangmai by Khamboonruang et al (1978) none of the 1070 rodents examined were infected with T. spiralis. According to Doege et al (1969) the reservoir state is maintained in animals by feeding on carcases of other trichinous wild life or through the consumption of Trichinella infected improperly cooked kitchen waste of man.

As regards the pathogenicity of the disease in man Suriyanon and Klunklin (1972) stated that the severity depended on the numbers of parasites ingested in the uncooked meat

and was not related to age, sex or race. To control trichinosis in Thailand the following measures were employed by the Department of Livestock in Thailand (Anon, 1966).

1. The slaughter of all pigs in an area where trichinosis was detected with compensation being paid by the government
2. The destruction of reservoirs, especially rats, by all available means
3. The education of people on the dangers of the disease
4. The restriction of the movement of pigs from mountains to lowlands
5. A recommendation to carry out post mortem examinations on pig carcases for T. spiralis using a trichinoscope in every provincial abattoir in northern Thailand
6. The periodic examination of foodstuffs made with raw or fermented pork in the plains of the endemic provinces of northern Thailand

8. Family: Trichiuridae Railliet, 1915 (Trichocephalidae, Biard, 1853)

8.1 Genus: Trichuris Roederer, 1761 (syn. Trichocephalus)

Trichuris trichiura (Linnaeus, 1771) (sic)

had an incidence of 0.044% in the survey by de Jesus and Waramontri (1961). The animals had a light infection and came from the middle regions of Thailand In their report on the use of piperazine compounds on swine in Thailand Dissamarn and Goff (1960) also stated that they found Trichuris eggs in the faeces of pigs that they examined. The compounds that they were testing had little or no effect on these parasites.

Acanthocephala

1. Family: Oligacanthorhynchidae Meyer, 1931

1.1 Genus: Macracanthorhynchus Travassos, 1916

Macracanthorhynchus hirudinaceus (Pallas, 1781) has been reported from pigs and man in Thailand. An incidence of 2.204% was recorded from pigs in the survey by de Jesus and Waramontri (1961). The animals had a light infection and came from the middle and northeast regions of Thailand. However Chaisrisongkram (1973) in a survey of 1000 pigs in Ratchburi province in the central plains of Thailand failed to record the presence of this parasite. Two human cases of Macracanthorhynchus hirudinaceus infection were recorded in Thailand up to 1974. The first was by Pradatsundarasar and Pechranond (1965) who recovered a female acanthocephalan belonging to this species from the small intestine of a thirty two year old Thai woman in Bangkok. Six ulcers were seen close together in the jejunum. Attached to one of these ulcers was the parasite with its proboscis buried deeply in the mucosa. The other case was reported by Chaiyaporn (1967) and Kliks et al (1974). One specimen of the parasite was recovered from the ileum of a 26 year old male at a hospital in northern Thailand. Although no natural intermediate hosts of M. hirudinaceus have been recorded in Thailand various species of adult beetles and grubs which have been found to act as intermediate hosts in other countries are consumed by man. These include members of the genera Anomala and Cetonia. (Kliks et al, 1974).

HELMINTH INFECTIONS OF SWINE IN KAMPUCHEA, LAOS AND VIETNAM

For a list of the parasites of swine in these countries see Table II. The source of this information is Segel et al (1968).

DISCUSSION AND CONCLUSIONS

A wide range of parasites have been found in pigs in Southeast Asia. Without doubt this is a reflection on the management systems used for raising these animals. In the backyard systems, which are still very common in all countries in the area except Singapore, conditions are often ideal for the development of the extra host stages of the parasites and intermediate hosts such as earthworms beetles, cyclops and snails are commonly encountered by pigs. However there are considerable variations in the distribution of the individual helminths in the region. Some such as Ascaris suum, Trichuris suis, Metastrongylus spp and Stephanurus dentatus are found throughout the region. Other helminths have well defined geographical limitations. This may be due to the environmental sensitivity of these parasites or their intermediate hosts or due to complex life cycles which can only be completed under specialised conditions. Thus Schistosoma japonicum is confined to areas where factors such as a high and evenly distributed annual rainfall allows the molluscan intermediate host Oncomelania to develop and multiply. With Trichinella spiralis infection on the other hand management practices are important and nidi of infection are maintained in areas such as northern Thailand where pigs are raised in a semi feral manner and have access to the carrion of other wild animals and vice versa. The use of particular types of feeds for pigs is sometimes also important in allowing life cycles to be completed. For example Fasciolopsis buski and Echinostoma malayanum are common in pigs in those parts of Thailand and Malaysia respectively where water plants are used as pig feed.

The zoonotic implications of pig helminths in South east Asia

are considerable. Helminths reported from pigs in this region that are commonly capable of infecting man include

Dicrocoelium dendriticum
Opisthorchis tenuicollis
Fasciolopsis buski
Echinostoma malayanum
Paragonimus westermanii
Gastrodiscoides hominis
Schistosoma japonicum
Taenia solium
Echinococcus granulosus
Necator americanus
Gnathostoma spinigerum
Macracanthorhynchus hirudinaceus

Of these Taenia solium is the most widespread. This parasite is common in the Philippines, Thailand and certain parts of Indonesia but seems to occur only rarely in Singapore and Malaysia. While the intensive management used for raising pigs may be partly responsible for the virtual absence of the parasite in Singapore it would seem that the main reason for the differences in prevalence is the cooking practices employed by the inhabitants of the various countries. Many people in the Philippines Indonesia and Thailand prefer uncooked or partially cooked pork whereas people in Malaysia and Singapore usually cook pork thoroughly. Trichinosis is of considerable importance in Thailand but the situation is somewhat confused as regards the prevalence of the parasite in other countries. The importance of the other helminths as zoonoses seems to be comparatively minor with the possible exception of Fasciolopsis buski in Thailand.

There is very little information available on the direct economic effects of pig helminths in Southeast Asia. Yahaya (1977) gave some information on losses due to treatment costs and abattoir condemnations in Peninsular Malaysia. He stated that virtually all

of the pigs raised intensively were treated with anthelminthics. Assuming that three quarters of the 732,975 (1972 census) of the pigs in that part of the country were raised intensively he calculated that the total annual treatment costs for helminths were in the region of 193,000.00 Malaysian Ringgit ($) (£1 sterling = $ 4.9 approx.). However in spite of this there were still considerable losses at abattoirs due to the condemnation of livers, intestines, stomachs, lungs and kidneys. At one abattoir 78.9% of the 258,136 lungs examined over a five year period were condemned because of metastrongylosis. The author estimated that the total annual loss in Peninsular Malaysia due to condemnation of parts of pig carcases in abattoirs because of parasitism was in the region os $ 490,000. No mention was made of losses due to mortalities and decreased productivity.

From the work of Yahaya (1977) and Lim (1978) it would seem that while anthelminthics are in common use they are not being used very effectively to control parasitic diseases in pigs. Thus it would seem that an important task of the veterinary services of these countries is to encourage the proper use of anthelminthics by farmers with respect to the types of drug that are used and the routine of administration. Probably of greater importance however is to encourage better hygienic measures on farms. Most of the intensive units use concrete pig pens which can be easily cleaned. Thus it should be relatively easy to greatly reduce the prevalence of parasites such as lung worms and those stomach worms, which require earthworms, beetles or cyclops as intermediate hosts. Control measures are more difficult to implement in backyard units. The best approach would seem

to be to encourage the confinement of pigs in slatted wooden houses. These are already widely used in some areas and can be erected fairly cheaply from local materials such as bamboo.

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APPENDIX

TABLE I

Pig populations in the Countries of Southeast Asia

(In Thousands)

	1968	1978
Brunei	7	14
Indonesia	3,180	4,358
Kampuchea, Dem	1,078	919
Laos	1,000	1,447
Malaysia (Peninsular)	605	1,192
Malaysia (Sabah)	147	106
Malaysia (Sarawak)	225	146
Philippines	5,500	9,700
Singapore	402	1,071
Thailand	4,300	4,300
Vietnam	3,300	11,500
Burma	1,300	1,500

References FAO-WHO-OIE Animal Health Yearbooks 1968 and 1978

TABLE II

Helminths Reported from Swine in Eight Southeast Asian Countries

SITE	PARASITE	COUNTRY							
		INDONESIA	MALAYSIA	PHILIPPINES	SINGAPORE	THAILAND	KAMPUCHEA	LAOS	VIETNAM
STOMACH	NEMATODES								
	Hyostrongylus rubidus		X	X	X				
	Ascarops dentata	X	X				X		X
	Ascarops strongylina	X	X	X		X	X		X
	Simondsia paradoxa								X
	Physocephalus sexalatus		X	X					X
	Gnathostoma hispidum	X	X	X		X	X		X
	Gnathostoma doloresi		X	X		X			X
	Gnathostoma spinigerum					X			
INTESTINE	TREMATODES								
	Fasciolopsis buski	X				X	X		X
	Echinostoma malayanum		X						
	Euparyphium sp.						X		
	Gastrodiscoides hominis					X	X		X
	Gastrodiscus aegypticus								X
	Testifrondosa cristata		X						
	NEMATODES								
	Ascaris suum	X	X	X	X	X	X		X
	Strongyloides sp.						X		
	Strongyloides suis			X					X
	Strongyloides ransomi	X		X	X				
	Oesophagostomum sp.				X				
	Oesophagostomum dentatum	X	X	X		X	X		X
	Oesophagostomum longicaudum		X	X		X			
	Trichonema aegypticum						X		
	Trichonema longibursatum						X		
	Bourgelatia diducta	X				X			X
	Necator americanus			X					
	Globocephalus longemucronatus	X		X					
	Globocephalus samoensis		X	X			X		
	Globocephalus urosubulatus		X	X			X		
	Globocephalus amucronatus	X							
	Trichinella spiralis	X		X		X			
	Trichuris suis	X	X	X	X	X	X		X
	ACANTHOCEPHALA								
	Macracanthorhynchus hirudinaceus	X	X	X		X			X

TABLE II (contd)

SITE	PARASITE	COUNTRY							
		INDONESIA	MALAYSIA	PHILIPPINES	SINGAPORE	THAILAND	KAMPUCHEA	LAOS	VIETNAM
LIVER	TREMATODES								
	Dicrocoelium dendriticum		X						
	Fasciola sp.	X		X					
	Fasciola hepatica								X
	Opisthorchis tenuicollis	X							
	CESTODES								
	Cysticercus tenuicollis					X			X
	Hydatid Cyst	X	X	X		X			X
CIRCULATORY SYSTEM	TREMATODES								
	Schistosoma japonicum	X		X					
UROGENITAL SYSTEM	NEMATODES								
	Stephanurus dentatus	X	X	X	X	X			X
RESPIRATORY SYSTEM	TREMATODES								
	Paragonimus westermanii			X					
	CESTODES								
	Hydatid cysts	X	X	X		X			X
	NEMATODES								
	Dictyocaulus khawi								X
	Metastrongylus apri	X	X	X		X	X		X
	Metastrongylus salmi		X	X		X			X
	Metastrongylus pudendotectus		X	X					X
	Metastrongylus sp.				X				
	Filaria bauchei	X							X
SKIN AND SUB CUTANEOUS TISSUE	NEMATODES								
	Onchocerca detwittei		X						
MUSCLES AND TENDONS	CESTODES								
	Cysticercus cellulosae	X	X	X		X	X	X	X
	Diphyllobothrium mansoni (Sparganum mansoni)								X
	NEMATODES								
	Trichinella spiralis	X		X		X			

TABLE II (contd)

SITE	PARASITE	COUNTRY							
		INDONESIA	MALAYSIA	PHILIPPINES	SINGAPORE	THAILAND	KAMPUCHEA	LAOS	VIETNAM
SEROUS CAVITIES	CESTODES								
	Cysticercus tenuicollis	X		X					
	Diphyllobothrium raillieti (Sparganum raillieti)	X							X
	NEMATODES								
	Filaria labiato-papillosa								X
	Setaria bernardi	X							X
	Setaria thomasi		X						

TABLE III

Epidemics of trichinosis in North Thailand

reported since 1962

Date	District and Province		No. of Patients	No. of Deaths	Source of infection
June 1962	Mae Sa Riang	Mae Hong Son	56	11	Hilltribe pig
April 1963	Prow	Chiang Mai	80	22	Hilltribe pig
March 1964	Fang	Chiang Mai	258	15	Wild boar
February 1966	Muang	Chiang Mai	30	-	Hilltribe pig
August 1967	Fang	Chiang Mai	16	-	Jackal
August 1967	Mae Tang	Chiang Mai	65	-	Black bear
October 1967	Tung Chang	Nan	33	-	Hilltribe pig
May 1968	Tung Chang	Nan	80	-	Hilltribe pig
January 1971	Toeng	Chiang Rai	27	3	Hilltribe pig
February 1971	Pai	Mae Hong Son	119	3	Hilltribe pig
April 1973	Mae Sruay	Chiang Rai	31	1	Hilltribe pig

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