Kobe J. Med. Sci., Vol. 65, No. 4, pp. E118-E123, 2019

Prevalence of Parasitic Contamination of Cockroaches Collected from Fresh Markets in Chachoengsao Province, Thailand

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Received 12 September 2019/ Accepted 28 October 2019

Key words: Prevalence, Parasites, Contamination, Cockroaches, Thailand

Cockroaches are the greatest potential mechanical vector of various pathogenic microorganisms. This study aimed to determine the prevalence and species type of human pathogenic parasite infestations on the external body surface of the cockroaches. A total of 450 cockroaches collected from three fresh markets were identified in three species belonging to *Periplaneta americana, Periplaneta brunnea* and *Periplaneta australasiae*. Helminth and protozoan species were identified by using a direct wet smear technique and modified acid-fast staining technique. The overall prevalence rate of parasitic infestation on the external body surface of cockroaches was 46.4% (209/450). The number of cockroaches infested with protozoa was 44.7% (99/209) and helminths was 44.0% (92/209), while 8.6% (18/209) were infested by both protozoan and helminth parasites. A total of 272 parasite specimens belonging to 16 species were found: ten species of protozoan were identified as *Cryptosporidium* spp. (15.4%), *Entamoeba histolytica*/*E. dispar* (8.5%), *Cyclospora* spp. (7.0%), *Blastocystis hominis* (6.6%), *Cystoisospora belli* (6.6%), *Endolimax nana* (4.0%), *Entamoeba coli* (2.2%), *Chilomastix mesnili* (1.5%), *Balantidium coli* (1.1%) and *Iodamoeba butschlii* (1.1%); six species of helminths included *Toxocara* spp. (8.5%), *Trichuris trichiura* (6.3%), *Ascaris lumbricoides* (5.9%), *Taenia* spp. (5.1%), *Strongyloides stercoralis* (4.4%), and hookworm (2.2%). Unidentified species of the helminths were isolated, namely nematode larva (9.9%) and helminth eggs (3.7%). Our results show that the cockroaches collected from fresh markets are potential mechanical vectors of several protozoan and helminth species.

INTRODUCTION

Cockroaches are an important public health pest in urban areas and can cause significant health problems for humans. They are the greatest potential mechanical vector of various pathogenic microorganisms (fungi, bacteria, viruses, and parasites) (1), some of which cause serious diseases in humans and domestic animals. The high prevalence of human pathogens carried by the cockroach has been reported in many countries. These reports show the difference between prevalence rates for the various species of pathogens isolated from cockroaches in each geographical location of the study. In addition, a cockroach can produce important indoor allergens that are a common cause of human asthma (1,2). There exist about 4,000 living species of cockroaches in the world, but only few species are considered pests by humans (3). Most cockroaches are found in the urban communities of the countries located in tropical and subtropical climates.

In Thailand about twelve species of cockroach are found in urban communities (4,5). There are five species which were found to be the most frequent pests in human dwellings, including: the American cockroach (*Periplaneta americana*), the German cockroach (*Blattella germanica*), the Brown-banded cockroach (*Supella longipalpa*), the Australian cockroach (*Periplaneta australasiae*) and the brown cockroach (*Periplaneta brunnea*) (1). They can live in a wide range of habitats, especially in warm, dark, and moist places with abundant organic food. The market is one of the most suitable habitats for cockroaches (6), as they are usually found in great abundance in very dirty place such as the sewage pipes and drains of markets. The cockroaches had the opportunity to become contaminated with several species of pathogenic microorganisms from the market environment, and can also transport these pathogens on their body surfaces from one place to another. In Thailand, only one study has reported the prevalence of pathogenic parasites isolated from the cockroaches in Samutprakarn Province (6), but no studies reported on the fresh markets of Chachoengsao Province. Therefore, this study aimed to determine the prevalence and species type of human pathogenic parasite infestations on the external body surfaces of the cockroaches from the fresh markets of Mueang Chachoengsao District, Chachoengsao Province, Thailand.

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MATERIALS AND METHODS

Study area

This study was carried out from February 2018 to April 2018 in three fresh markets including FM1 **(**13°40′30″N and 101°03′56″E**),** FM2 **(**13°41′26″N and 101°04′41″E**)** and FM3 **(**13°41′32″N and 101°04′50″E**)** located in Mueang Chachoengsao District, Chachoengsao Province, in central Thailand. They are about 80 kilometers east of Bangkok Metropolis, the capital city. The total land cover of this district is approximately 378 square kilometers. (Figure 1)

Sample Collection

A total of four hundred and fifty cockroaches were caught alive by using sterile hand gloves from each fresh market (between 8.00 pm and 12.00 am). Each cockroach was separated into a clean plastic container and then transported to the parasitology laboratory at the Department of Public Health, Faculty of Science and Technology, Rajabhat Rajanagarindra University, for identification and parasitological analysis.

Identification of Cockroaches and Parasitological Analysis

Once collected, the cockroaches were killed individually by freezing at 0°C for 10 minutes (6). All cockroaches collected were examined under the dissecting microscope and identified by using standard taxonomic keys (7). After identification, each cockroach was placed in a centrifuge tube containing 5 mL of 0.85% normal saline solution. The tube was shaken vigorously for 30 minutes in order to detach any adherent parasites on the external body surface. After removal of the cockroach, the solution was centrifuged at 2000 rpm for 5 minutes. After centrifugation, the supernatant was decanted while the sediment was stained with 1% Lugol's iodine solution and observed under a light microscope for the detection of protozoa and helminths. The oocysts of coccidian species were identified following the modified acid-fast staining method.

Statistical Analysis

The data obtained from these surveys were analyzed using Statistical Package for Social Sciences for Windows (SPSS) version 23. Descriptive statistics were used to analyze the frequencies of occurrence and percentage of parasites isolated from the external body surfaces of the cockroaches.

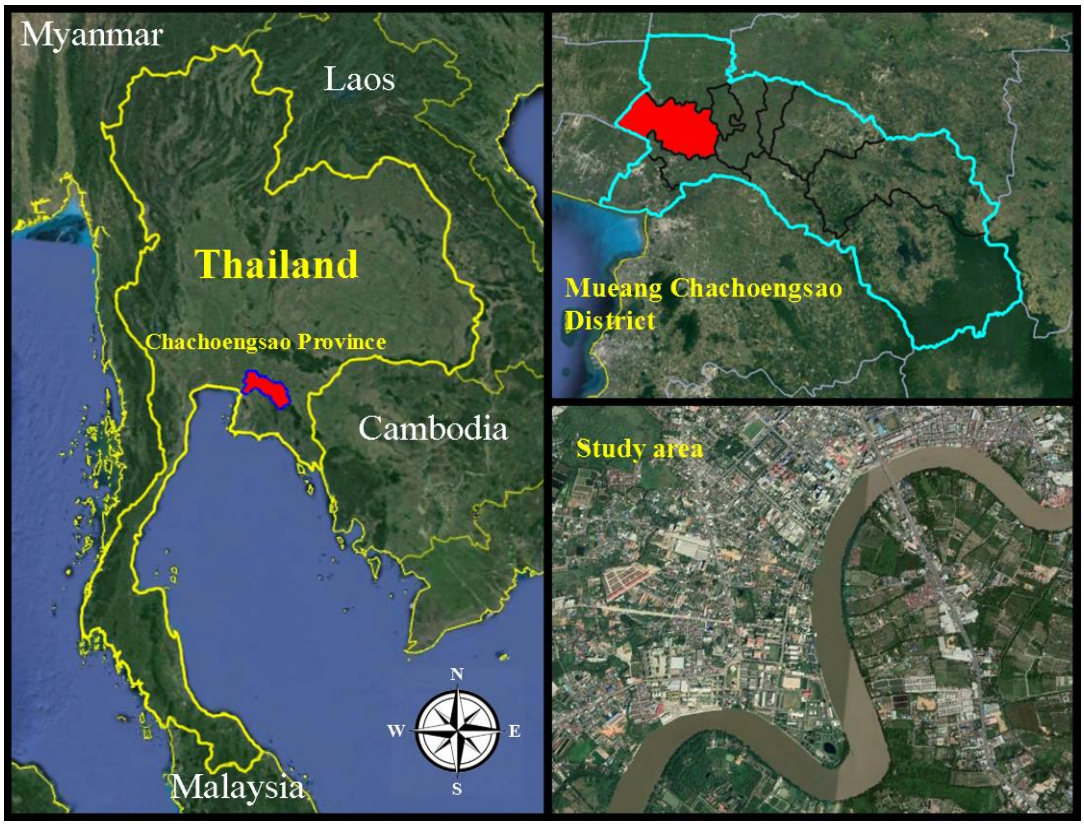

Figure 1. Map showing of study area in Mueang Chachoengsao District, Chachoengsao Province, in central Thailand.

RESULTS

A total of 450 cockroaches were collected from three fresh markets including FM1, FM2 and FM3 in Chachoengsao Province. The numbers of cockroaches collected from each fresh market were 150 samples, and these cockroaches were identified in only three species belonging to the genus *Periplaneta* spp., namely the American cockroach (*Periplaneta americana*), the brown cockroach (*Periplaneta brunnea*) and the Australian cockroach (*Periplaneta australasiae*). The prevalence rates of *P. americana*, *P. brunnea* and *P. australasiae* were 84.4% (380/450), 12.9% (58/450) and 2.7% (12/450), respectively. The overall prevalence rate of parasitic infestation on the external body surfaces of the cockroaches was 46.4% (209/450). The fresh market with the highest prevalence rate of parasitic infestation on cockroaches was FM3 with 62.0% (93/150), followed by FM1 with 44.0% (66/150) and FM2 with 33.3% (50/150). *P. americana* had the highest prevalence rate of parasitic infestation with 91.4% (191/209), followed by *P. brunnea* with 8.1% (17/209) and *P. australasiae* with 0.5% (1/209) (Table I). Among all cockroaches infested with parasites, the numbers of cockroaches infested with only protozoa was 44.7% (99/209) and only helminths was 44.0% (92/209), while 8.6% (18/209) were infested by both protozoan and helminth parasites (Table II). Sixteen species of medically important parasites were isolated from cockroaches; ten species were identified as protozoa and the other six species were helminths (Figure 2). The protozoan parasite infestations on the external body surfaces of the cockroaches were identified as *Cryptosporidium* spp. (15.4%, 42/272), *Entamoeba histolytica/E. dispar* (8.5%, 23/272), *Cyclospora* spp. (7.0%, 19/272), *Blastocystis hominis* (6.6%, 18/272), *Cystoisospora belli* (6.6%, 18/272), *Endolimax nana* (4.0%, 11/272), *Entamoeba coli* (2.2%, 6/272), *Chilomastix mesnili* (1.5%, 4/272), *Balantidium coli* (1.1%, 3/272) and *Iodamoeba butschlii* (1.1%, 3/272). The helminth parasite infestations on the external body surfaces of the cockroaches included *Toxocara* spp. (8.5%, 23/272), *Trichuris trichiura* (6.3%, 17/272), *Ascaris lumbricoides* (5.9%, 16/272), *Taenia* spp. (5.1%, 14/272), *Strongyloides stercoralis* (4.4%, 12/272), and hookworm (2.2%, 6/272). Unidentified species of helminth were isolated from the body surfaces, including nematode larva (9.9%, 27/272) and helminth eggs (3.7%, 10/272) (Figure 2).

Table I. Prevalence of parasitic infestation of cockroaches collected from the three fresh markets.

Location	Cockroach species						Total	
	P. americana		*P. brunnea*		*P. australasiae*			
	No. of examined (%)	No. of infested (%)	No. of examined (%)	No. of infested (%)	No. of examined (%)	No. of infested (%)	No. of examined (%)	No. of infested (%)
FM1	127(84.7)	56(44.1)	21(14.0)	10(47.6)	2(1.3)	0(0.0)	150(100)	66 (44.0)
FM2	119(79.3)	46(38.7)	22(14.7)	3(13.6)	9(6.0)	1(11.1)	150(100)	50 (33.3)
FM3	134(89.3)	89(66.4)	15(10.0)	4(26.7)	1(0.7)	0(0.0)	150(100)	93 (62.0)
Total	380(84.4)	191(50.3)	58(12.9)	17(29.3)	12(2.7)	1(8.3)	450(100)	209 (46.4)

Table II. Types and number of parasites isolated from the external body surfaces of cockroaches.

Types of parasites	No. of cockroaches infested (%)	No. of parasites isolated
Only helminths	92 (44.0)	98
Only protozoa	99 (47.4)	131
Both	18 (8.6)	43
Total	209 (100)	272

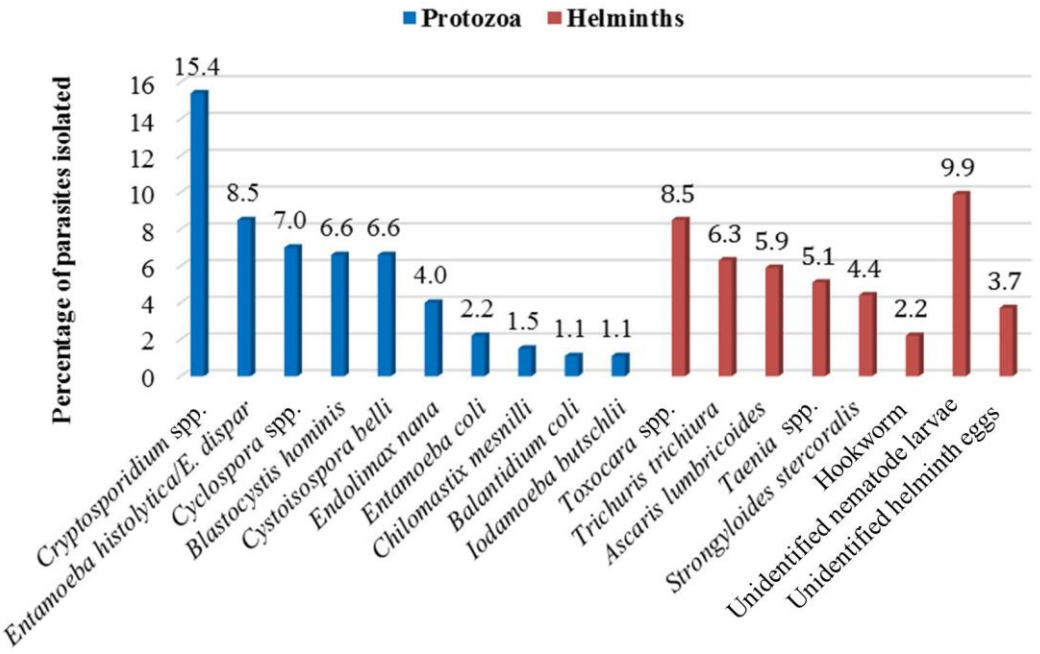

Figure 2. Parasite species and the percentage of parasites isolated from the external body surfaces of cockroaches.

DISCUSSION

In this present study, the three cockroach species of infestation in fresh markets were identified as *P. americana*, *P. brunnea* and *P. australasiae*. These findings conflict with the results of a previous research study reporting on the open-air shopping markets of Samutprakarn Province in Thailand which found only two species of cockroach as *P. americana* and *P. brunnea* (6). The most common cockroach species found was *P. americana*, agreeing with several studies reporting similar findings from markets and housing areas in Thailand (5,6,8), Malaysia (9), Nigeria (10), and Cameroon (11). However, this study in contrast with the other studies also revealed that *Blattella germanica* (German cockroach) was the most predominant species collected from residential units, offices, and hospitals from Iran (12), indoor households from Ethiopia (13), and from hospitals, shopping malls/stores, institutes and residential areas from Pakistan (14). The differences in the infestations of the two cockroach species may be due to both *P. americana* and *B. germanica* preferring to live in different suitable places which can support these species in their growth and reproduction. *P. americana* can frequently be found in sewers and basements, particularly around sewage pipes and drains, whereas *B. germanica* can usually be found in kitchens and food storage areas (14).

The overall prevalence rate (46.4%) of parasitic infestation isolated from the external body surfaces of cockroaches in fresh markets remains significant, although the results were lower than in previous studies conducted in the open-air shopping markets of Samutprakarn Province (54.1 %) in Thailand (6). Furthermore, the rate was also lower than that reported from the external body surfaces of cockroaches collected from food stalls and restaurants from Malaysia (57.9%) (9), and dwelling places from Nigeria (89.2%) (15), but was higher than that previously reported from indoor households in Ethiopia (10.95%) (13). The findings from our study demonstrated that the prevalence rate was lower than previously reported results in other studies from external body surfaces and gut contents of cockroaches, which were collected in households from Ethiopia (75.62%) (13), Nigeria (96.4%) (10), and Cameroon (47.39%) (11). The differences in prevalence rates of parasitic infestation on cockroaches reported from several countries may be due to a variety of factors such as different geographical conditions, temperatures, rainfall, relative humidity, and the different environment sanitation standards of each location area. In our study, the prevalence rate of parasitic infestation of cockroaches was found to be lower than the results of previous authors, but this might be the result of not conducting the study to evaluate the parasites isolated in the gut of the cockroaches.

Results showed that the cockroaches were found to be infested with protozoan and helminth parasites similar to those reported by several authors (7,10,11,13,15), but contradicting previous findings that found no infestation of protozoan parasites on the external body surfaces of cockroaches collected from Malaysia (9). In our study, a total of sixteen species of human parasites were isolated from cockroach specimens; comprising ten species of protozoa and six species of helminths. The six species of protozoan parasites, responsible for intestinal infectious disease and causing diarrhea in humans, were *B. coli* (balantidiasis), *B. hominis* (blastocystiasis),

Cryptosporidium spp. (cryptosporidiosis), *C. belli* (cystoisosporiasis), *Cyclospora* spp. (cyclosporiasis), and *E. histolytica* (amoebiasis). The other species of nonpathogenic protozoa, which inhabit the intestinal tract of humans, included *E. nana*, *E. coli*, *C. mesnili*, and *I. butschlii*. The five species of helminth parasites, which cause human intestinal helminthiasis, included *T. trichiura* (trichuriasis), *A. lumbricoides* (ascariasis), *Taenia* spp. (taeniasis), *S. stercoralis* (strongyloidiasis), and hookworm (hookworm disease). In humans, only one species of helminth parasites, *Toxocara* spp. can cause toxocariasis when the larvae invade multiple tissues and manifest as visceral and ocular larva migrans, respectively. In the present investigation, the prevalence of parasitic contamination in cockroaches may provide a useful index of environmental sanitation management in fresh markets and for risk evaluation of parasitic infectious disease in local communities.

The findings from our study demonstrated that cockroaches are possible carriers of human parasites in this environment. Moreover, our studies found unidentified species which were isolated from their external body surface, namely nematode larva and helminth eggs, which are morphologically indistinguishable species. These unidentified pathogens may have the potential for zoonosis into serious human health or other host species. The most common protozoan found was *Cryptosporidium* spp. which agrees with previous studies in Thailand (6), but contrasts with the previous reports which did not find this species in similar studies (9,11,13,15). *Toxocara* spp. was the predominant helminth species identified and isolated, as this finding differed from several other results where *Toxocara* spp. infestation was not found (6,9,10,13,15). These differences may be caused by the environmental contamination with dog and cat feces in the study area, and this may be a possible important source of human toxocariasis. Previous studies of the environmental contamination with *Toxocara* eggs were reported in the range of 6.0% to 19.0% from Thailand (16-18).

Cockroaches are the potential mechanical vector of various pathogenic protozoan and helminth parasites. The authors demonstrate that the prevalence rate of parasitic infestation on the external body surface of cockroaches was 46.4% (209/450), with protozoa accounting for 44.7% (99/209), helminths for 44.0% (92/209), and both protozoa and helminths for 8.6% (18/209), respectively. The results provide initial baseline data on the prevalence and species diversity of medically important parasites isolated from cockroaches living in fresh markets. Moreover, this study may contribute to the efforts in reducing the risk of waterborne and foodborne transmission of parasites. Consumption of food and water contaminated by cockroaches may lead to many infectious diseases caused by parasitic protozoa and helminths. From a public health perspective, the use of integrated vector management approaches, such as the combination of environmental sanitation management, waste management, and the safe use of insecticides in fresh markets, are essential for the control of cockroach populations, including the prevention of pathogens transmitted to humans by vectors.

ACKNOWLEDGEMENTS

The authors acknowledge and thank all staff of the Department of Public Health, Faculty of Science and Technology, Rajabhat Rajanagarindra University for their help and cooperation during this project. The authors also acknowledge and thank the public health students involved in the collection of samples in the field. This work was supported by the Institute of Research and Development, Rajabhat Rajanagarindra University, Thailand. None of the authors has any conflicts of interest.

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