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PRELIMINARY SURVEY OF THE NATURAL ENEMIES OF MOSQUITOES IN THAILAND

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Abstract

Surveys to obtain noninsect predators and insect predators as natural enemies of mosquitoes (Diptera: Culicidae) were conducted at ten inland localities in Thailand. Twenty species of noninsect predators and fourteen species of insect predators are reported. The most abundant and consistently recorded species were three species of fish (Tilapia nilotica, Trichopsis vittatus *and* Dermogenys pusillus) *and two species of reptiles,* Hemidactylus frenatus *and* Platyrus platyrus. *These species have not been reported in the literature as good natural enemies of mosquitoes in Thailand prior to this research.*

Introduction

Insecticide resistance-and non-selectivity have posed new problems in the fight against mosquitoes as vectors of human diseases. These problems can be countered by integrated pest management (IPM) measures. These measures provide the careful timing and placement of insecticide applications to avoid prejudicing the existing natural limitation factors, and provide also for the exploitation of biological control and environmental manipulation. Such an approach necessitates a detailed knowledge of the ecology of vectors and their natural enemies[1-3].

Conservation of mosquito natural enemies is an important criterion in developing pest management programs. To do this effectively, their major predators must be largely known so that these specimens can be conserved or manipulated to ensure their presence and/or encourage their predatory action against populations of human disease vectors. With the objective of locating potential biological control agents for species of mosquito genera *Aedes, Culex* and *Anopheles* in Thailand, survey of their predators has been conducted since 1975 at 10 different locations except the southern part of Thailand. This report provides preliminary information on the noninsect and insect predators of mosquito hosts and degrees of importance.

Materials and Methods

Collections were made at the locations shown in Fig. 1. More numerous collections were made in Bangkok where the base laboratory was located. Adults and larvae of *Aedes aegypti* and *Culex quinquefasciatus* and occasionally other species, with their predators were collected at several sites within each location. Detailed collection site data were recorded. Predators from each site were kept separate and transported to Bangkok for correct identification at the Museum of Zoology, Chulalongkorn University[4,5], Division of Entomology and Zoology, Thailand Department of Agriculture, and some of them were sent to the Smithsonian Institution, United States of America for precise identification.

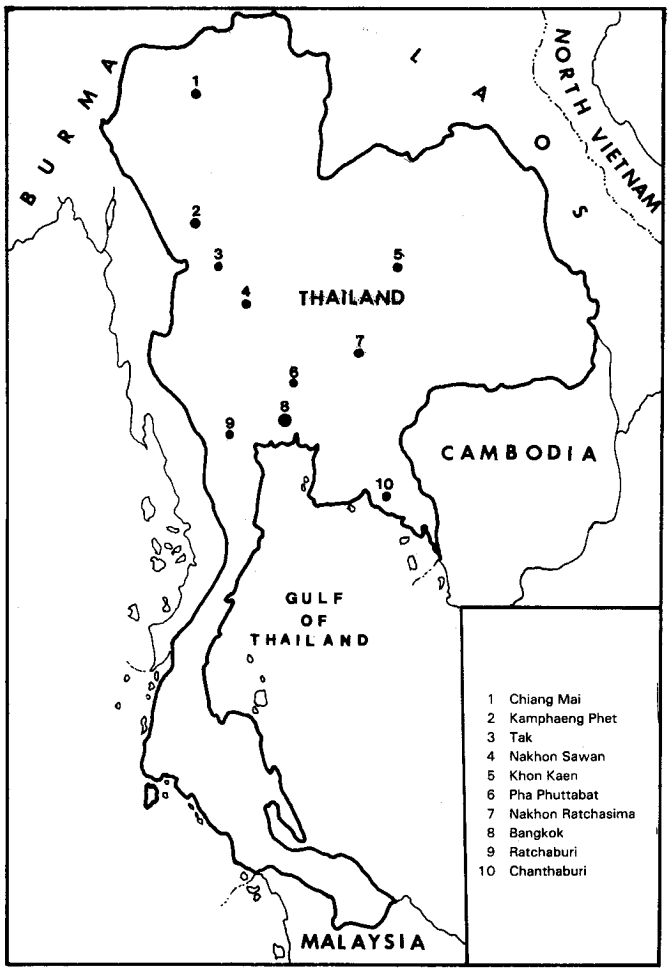

Figure 1. Selected locations in Thailand where, *Aedes aegypti* and *Culex quinquefasciatus* (= *fatigans*) surveys of and their predators were conducted.

Evaluation of the effectiveness of natural enemies was measured by the degree of success of mosquito control or establishment of the natural enemies. For instance, in the laboratory, control of mosquitoes by achieving more than 90% killed, as shown by bioassay, was denoted as major; 90–50% as minor; and <50% as uncertain, respectively. In the field these levels of control were measured by the degree of establishment of imported species or population density of native natural enemies. For instance, *Tilapia nilotica* (an imported species) occurring as permamently established was called major; substantially established as minor; and partially established as uncertain.

Results and Discussion

Twenty noninsect predators and fourteen insect predators were found in association with various mosquito species. Detailed collection site data are available to interested investigators (Table 1 and 2). For each predator listed in Table 1 and 2, the following parameters are designated: (1) prey stage, the mosquitoes life stage preyed upon; (2) importance, the relative importance as a mortality factor of mosquitoes as intimated by the author; observation, where the predation was observed; and location; a list of the locations as numbered in the map, Fig. 1[6-14].

TABLE 1. NONINSECT PREDATORS OF THE MOSQUITOES, WITH INFORMATION ON THE ROLE OF EACH PREDATOR

Predator	Host species	Host stage	Importance	Lab or field study	Location
AMPHIBIA					
Anura (Slientia)					
Bufonidae					
Bufo melanosticus	*Culex guinquefasciatus*	Adult	Major	Both	1–10
(คางคก)	*Aedes aegypti*	Adult	Major	Lab	
	Ae. albopictus	Adult	Major	Lab	
Ranidae					
Rana tigrina	*Cx. quinquefasciatus*	Larval	Minor	Both	1–10
(กบ)	*Ae. aegypti*	Adult	Minor	Lab	
	Ae. albopictus	Adult	Minor	Lab	
	An. dirus	Adult	Minor	Lab	

TABLE 1. *(cont.)*

Predator	Host species	Host Stage	Importance	Lab or field study	Location
Oxyglossis lima	*Cx. quinquefasciatus*	Adult	Minor	Lab	8–10
(เขียด)	*Ae. aegypti*	Adult	Minor	Lab	
	Ae. albopictus	Adult	Minor	Lab	
	An. dirus	Adult	Minor	Lab	
Reptilia					
Squamata					
Geckkonidae					
Gekko gecko	*Cx. quinquefasciatus*	Adult	Minor	Both	8–10
(ตุ๊กแก)					
Hemidactylus	*Cx. quinquefasciatus*	Adult	Major	Both	1–10
frenatus	*Ae. albopictus*	Adult	Major	Lab	
(จิ้งจก)	*Ae. aegypti*	Adult	Major	Lab	
	An. dirus	Adult	Major	Lab	
Platyrus platyrus	*Cx. quinquefasciatus*	Adult	Major	Both	1–10
	Ae. aegypti	Adult	Major	Lab	
	An. dirus	Adult	Major	Lab	
Agamidae					
Acanthosaura capra	*Ae. albopictus*	Abult	Uncertain	Field	8
(กิ้งก่า)	*An. dirus*	Adult	Uncertain	Field	
Calotes emma	*Cx. quinquefasciatus*	Adult	Uncertain	Field	8–10
	Ae. aegypti	Adult	Uncertain	Field	
	Ae. albopictus	Adult	Uncertain	Field	
	An. dirus	Adult	Uncertain	Field	
	Armigeres subalbatus	Adult	Uncertain	Field	
Liolepis belliana	*Ae. albopictus*	Adult	Uncertain	Field	1,2,3,5,10
(แย้)	*An. dirus*	Adult	Uncertain	Field	
Scincidae					
Lygosoma quadrapes	*Cx. quinquefasciatus*	Adult	Uncertain	Field	1–10
(จิ้งเหลน)	*Ae. aegypti*	Adult	Uncertain	Field	
	Ar. subalbatus	Adult	Uncertain	Field	
Aabuya sp.	*Ae. albopictus*	Adult	Uncertain	Field	10
	An. dirus	Adult	Uncertain	Field	

TABLE 1. *(cont.)*

Predator	Host species	Host Stage	Importance	Lab or field study	Location
PISCES					
Poecilidae					
Poecillia reticulata	*Cx. quinquefasciatus*	Larval	Major	Both	1,8 -10
(ปลาหางนกยูง)	*Ae. aegypti*	Larval, pupal	Major	Lab	1,8 -10
	An. dirus	Larval, pupal	Uncertain	Lab	
Gambusia affinis	*Cs. quinquefasciatus*	Larval, pupal	Major	Both	8
(ปลากินยุง)	*Ae. aegypti*	Larval, pupal	Major	Lab	
	An. dirus	Larval, pupal	Uncertain	Lab	
Anabantidae					
Betta splendens	*Cx. quinquefasciatus*	pupal	Major	Both	1-10
(ปลากัด)	*Ae. aegypti*	Larval, pupal	Major	Lab	
Trichopsos vittatus	*Cx. quinquefasciatus*	Larval, pupal	Major	Both	1-10
(ปลากริม)	*Ae. aegypti*	Larval, pupal	Major	Lab	
Cyprinodontidae					
Aplocheilus panchax	*Cx. quinquefasciatus*	Larval	Major	Lab	8-10
(ปลาหัวตะกั่ว)	*Ae. aegypti*	Larval	Major	Lab	
Heriramphidae	*An. dirus*	Larval	Major	Both	
Dermogenys pusillus	*An. dirus*	Larval	Major	Lab	8-10
(ปลาเข็ม)	*Cx. quinquefasciatus*	Larval	Major	Lab	
Cichlidae					
Tilapia nilotica	*Cx. quinquefasciatus*	Larval, pupal	Major	Lab	1-10
(ปลานิล)	*Ae. aegypti*				
	Ae. aegypti	Larval, pupal	Major	Lab	

TABLE 1. *(cont.)*

Predator	Host species	Host stage	Importance	Lab or field study	Location
	An. dirus	Larval, pupal	Major	Both	
COELENTERATA					
Hydra littoralis	*Ae. aegypti*	Larval	Minor	Both	8
(ไฮดรา)	*Cx. quinquefasciatus*	Larval	Minor	Both	
PLATYHEL-MINTHES					
Planaria tigrina (พลานาเรีย)	*Cx. quinquefasciatus*	Larval	Minor	Both	8
ARTHROPODA					
Crustacea					
Limnocythere sp.	*Ae. aegypti*	Larval	Uncertain	Lab	8
(ออสตราคอด)	*Cx. quinquefasciatus*	Larval	Uncertain	Lab	

TABLE 2. INSECT PREDATORS OF THE MOSQUITOES, WITH INFORMATION ON THE ROLE OF EACH PREDATOR.

Predator	Host species	Host stage	Importance	Lab or field study	Locations
Odonata					
Libellulidae					
Crocothemis servillia	*Cx. quinquefasciatus*	Larval, pupal	Minor	Both	8-10
(แมลงปอ)	*Ae. aegypti*	Larval	Minor	Lab	
Coenagrionidae					
Coeoneura sp.	*Cx. quinquefasciatus*	Larval, pupal	Minor	Both	8-10
(แมลงปอเข็ม)	*Ae. aegypti*	Larval	Minor	Lab	
Hemiptera					
Belostomatidae					
Lethocerus indicus	*Cx. quinquefasciatus*	Larval	Uncertain	Both	1-10
(แมลงดานา)					

TABLE 2. *(cont.)*

Predator	Host species	Host stage	Importance	Lab or field study	Locations
Sphaerodema rusticum	*Cx. quinquefasciatus*	Larval	Uncertain	Field	8–9
Dyplonychus sp.	*Cx. quinquefasciatus*	Larval	Major	Both	8–9
(แมลงดาสวน)	*Ae. aegypti*	Larval	Major	Both	
	An. dirus	Larval	Major	Lab.	
Naucoridae					
Naucoris sp.	*Cx. quinquefasciatus*	Larval	Uncertain	Both	8–9
(มวนตะพาบ)	*Ae. aegypti*	Larval	Uncertain	Lab.	
Nepidae					
Ranatra filiformis	*Cx. quinquefasciatus*	Larval	Minor	Lab	8–9
(มวนแมลงป่อง)	*Ae. aegypti*	Larval	Minor	Lab	
R. varipes	*Cx. quinquefasciatus*	Larval	Minor	Lab	8–9
(มวนแมลงป่อง)	*Ae. aegypti*	Larval	Minor	Lab	
Notonectidae					
Anisops sardae	*Cx. quinquefasciatus*	Larval	Minor	Lab	8–9
(มวนวน)	*Ae. aegypti*	Larval	Minor	Lab	
A. bouveri	*Cx. quinquefasciatus*	Larval	Minor	Both	8–9
	Ae. aegypti	Larval	Minor	Lab	
Enithares templetoni	*Cx. quinquefasciatus*	Larval	Minor	Lab	
(มวนวนยักษ์)	*Ae. aegypti*	Larval	Minor	Lab	
Enithares sp.	*Cx. quinquefasciatus*	Larval	Major	Lab	2
	Ae. aegypti	Larval	Major	Lab	
	An. dirus	Larval	Major	Lab	
Diptera:Culicidae					
Toxorhynchites splendens	*Ae. aegypti*	Larval	Minor	Both	8–10
Toxorhynchites sp. (ยุงแม่ไก่)	*Ae. aegypti*	Larval	Minor	Both	8–10

The most abundant and consistently recorded species were: *Bufo melanosticus, Hemidactylus frenatus, Poecillia reticulata, Trichopsis vittatus, Tilapia nilotica, Crocothemis servillia, Diplonychus* sp., *Ranatra varipes, Anisops bouveri* and *Toxorhynchites splendens.* These species were found at almost every location observed, and many of them are of major importance, depending on the results of bioassay in the laboratory and the degree of establishment. The giant water bug, *Lethocerus indicus* was found in almost every province in Thailand, and occurred in large numbers during the rainy season. The immature stages of giant water bugs can feed on mosquito larvae, but when they become larger, they change to feed on other larger aquatic insects. Most of insect predators of mosquitoes occurred mainly during the rainy season, and were very difficult to find in the dry season. *Enithares* sp. at Kamphaeng Phet province provides a clear example[15].

Three species of fish *(Trichopsis vittatus, Tilapia nilotica* and *Dermogenys pusillus)* and two species of reptiles *(Hemidactylus frenatus* and *Platyrus platyrus)* have not been reported in the literature as natural enemies of mosquitoes prior to this research[4,5]. These species were found in every season in Thailand and were found to be of major importance as natural enemies of mosquitoes.

These data indicate that mosquito populations in Thailand are exposed to a diverse group of predators and should be evaluated for possible development as biological control agents. The frequency and ease with which they can be found suggests that some of them may play an important role in natural population control.

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บทคัดย่อ

งานวิจัยสำรวจศัตรูธรรมชาติของยุง *(Diptera : Culicidae)* ซึ่งเป็นตัวห้ำที่มิใช่แมลง และแมลงตัวห้ำได้กระทำในท้องที่ 10 แห่งในประเทศไทย จากการสำรวจพบว่ามีตัวห้ำที่มิใช่แมลง 20 ชนิด (species) และแมลงตัวห้ำ 14 ชนิดที่สามารถกินยุงในระยะต่าง ๆ ได้ นอกจากนั้นพบว่าศัตรูธรรมชาติที่มีจำนวนมากและพบอยู่เสมอคือ ปลา 3 ชนิด (ปลานิล, ปลากริม และปลาเข็ม) และจิ้งจกบ้าน 2 ชนิด ศัตรูธรรมชาติดังกล่าวนี้ไม่เคยมีรายงานในที่ใดมาก่อนว่าเป็นศัตรูธรรมชาติที่ดีของยุงในประเทศไทย