

Morphological Studies of *Stomoxys* spp. (Diptera: Muscidae) in Central Thailand

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ABSTRACT

Morphological characteristics of *Stomoxys* spp. were studied and recorded for the first time in Thailand. Specimens were collected in central Thailand at Nakhon Pathom, Kanchanaburi and Saraburi Province, using Vavoua traps and sweep net. It was found that *Stomoxys calcitrans* (L.) was the most commonly abundant species, followed by *Stomoxys sitiens* Rondani, *Stomoxys indica* Picard and *Stomoxys bengalensis* Picard. External morphological characteristics and male genitalia of each species were described and illustrated.

Key words: *Stomoxys calcitrans* (L.), *Stomoxys sitiens* Rondani, *Stomoxys indica* Picard, *Stomoxys bengalensis* Picard, morphology, male genitalia

INTRODUCTION

Stomoxiine flies (Diptera: Muscidae) are about the same size as the house fly, but can be easily distinguished by the mouthparts used to pierce the skin and imbibe blood. The thorax is grey with four longitudinal dark stripes. The stable fly has a broader abdomen than the house fly and there is a checkerboard of dark spots on the second and third segments of the abdomen. They are often found breeding in outdoor silage, decayed hay and piled manure mixed with bedding.

Stomoxys fly is an economically important pest of cattle. Both males and females are blood-sucking flies that attack domestic, wild animals, and sometimes human beings across the world (Wall and Shearer, 1997). High level density of flies can lead to significant reductions in weight gains of livestock and milk production (Bruce and

Decker, 1958; Campbell *et al.*, 2001). *Stomoxys* flies are an important nuisance, causing irritation at the area of the bite. *Stomoxys calcitrans* (L.) has been found to be a vector of *Trypanosoma evansi* (agent of surra), *Trypanosoma brucei* and *Trypanosoma vivax* (agent of nagana). Equine infectious anaemia may also be transmitted by these flies. *Stomoxys* can also serve as an intermediate host for *Habronema* spp. worm larvae.

At present, knowledge about stable fly is very limited, even though they are cosmopolitan livestock pest and attacking up to 30 different species including mammals, birds, reptiles and even amphibians (Hafez and Gammal-Eddin, 1959). The knowledge on morphology and biology is a rarity, only few information on biology and effects of some juvenile hormone on *S. calcitrans* was first studied and reported in Thailand by

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Ketavan and Kanjanamungsuk (1987). The objectives of this study were to survey the *Stomoxys* species found in central Thailand and to compare the morphological differences among the *Stomoxys* species.

MATERIALS AND METHODS

Specimen collection area

Stomoxys flies were collected from the beef and dairy cattle shelters at three locations in central Thailand i.e. Suwanvajokkasikit Animal Research and Development Institute (SARDI), Kasetsart University, Kamphaengsaen Campus, Ban Yang District, Nakhon Pathom Province; Thai-Denish dairy cattle farm, Moak Lek District, Saraburi Province and private dairy farm, Kanchanaburi Province (Figure 1).

Collection method

Adult flies were captured using Vavoua traps (Laveissiere and Grebaut, 1990; Mihok *et al.*, 1995) (Figure 2) placed near the cattle shelters. Specimens were also obtained by sweep net around the shelters of cattle. The number of flies, sex and timing of capture were recorded. All flies were killed by freezing in the freezer and preserved in the screw-top bottles with 95% ethanol for further investigation. Samples of *Stomoxys* flies were identified to species level using identification key developed by Zumpt (1973). Specimens were examined with the aid of dissecting microscope.

Morphological studies

The principles morphological characteristics of each species, i.e. thoracic pattern, wings, dorso-abdominal pattern and legs were described, measured and illustrated based on Zumpt (1973). The male genitalia were dissected and mounted as described by Krantz (1975). The male genitalia of flies species was illustrated and photographed by digital camera attached to microscope. The program Studio Quick Start

Version 8 was used for photography. Average length and width of genitalia were also measured by Motic Images Plus 2.0.



Figure 1 Collection sites for *Stomoxysine* fly in central Thailand at Nakhon Pathom, Kanchanaburi and Saraburi Province.



Figure 2 Vavoua trap for *Stomoxysine* fly collection.

RESULTS AND DISCUSSION

Morphology of *Stomoxys* species was studied for the first time in Thailand. Stomoxiine flies collected from three localities at Nakhon Pathom, Kanchanaburi and Saraburi Province were identified by the key of Zumpt (1973). Four *Stomoxys* species, *S. calcitrans*, *Stomoxys sitiens* Rondani, *Stomoxys indica* Picard and *Stomoxys bengalensis* Picard were trapped in Nakhon Pathom, Kanchanaburi and Saraburi Province during July 2004 to June 2005. The number and sex of each species was tabulated by sex of each species (Table 1). Among the three localities, *S. calcitrans* was the most abundant and commonly found in every locality followed by *S. indica* and *S. sitiens* (Table 2). During this experiment, only one *S. bengalensis* female was captured from Nakhon Pathom Province (Table 1 and 2).

Morphology of *Stomoxys* species found at Nakhon Pathom, Kanchanaburi and Saraburi Province

The main characteristics such as head and wing are shown in Figures 3 and 4.

Measurement of frontal index of each species is presented in Table 3.

Stomoxys calcitrans

Body length: 4-7 mm, easily recognized by one marked median spot and two lateral dark round spots presented on the second and third abdominal segments (Figure 5).

Originated in the old world and cosmopolitan species, commonly found in many areas, mainly in temperate zones, is to be regarded as one of a synanthropic fly (Zumpt, 1973).

Width of frons at its narrowest point measuring $\frac{1}{3}$ or more of eye length. Thorax and abdomen dark grey and olive-brown, with distinct pattern. Wing hyaline, terminal part of r_1 not setulose. Legs dark, only bases of tibiae more or less extensively pale.

Male – Average frontal index was 0.33 ± 0.03 mm (Table 3). Frons widened slightly from the vertex. Frontal stripe black. Antennae were black-brown to nearly black, third segment is about $2\frac{1}{2}$ times as long as the second, arista with long dorsal hairs. Palpi yellow, proboscis dark reddish-brown. Thorax black with a whitish-grey

Table 1 Stomoxiine flies collected by Vavoua traps from beef and dairy cattle farms, Kasetsart University, Kamphaengsaen Campus, Nakhon Pathom Province during July 2004 to June 2005.

Species	Number of flies		
	Male	Female	Total
<i>S. calcitrans</i>	68	64	132
<i>S. sitiens</i>	23	36	59
<i>S. indica</i>	8	14	22
<i>S. bengalensis</i>	0	1	1

Table 2 Distribution of *Stomoxys* species observed at Nakhon Pathom, Kanchanaburi and Saraburi Province during July 2004 to June 2005.

Province	<i>S. calcitrans</i>	<i>S. sitiens</i>	<i>S. indica</i>	<i>S. bengalensis</i>
Nakhon Pathom	+	+	+	+
Kanchanaburi	+	-	-	-
Saraburi	+	-	+	-

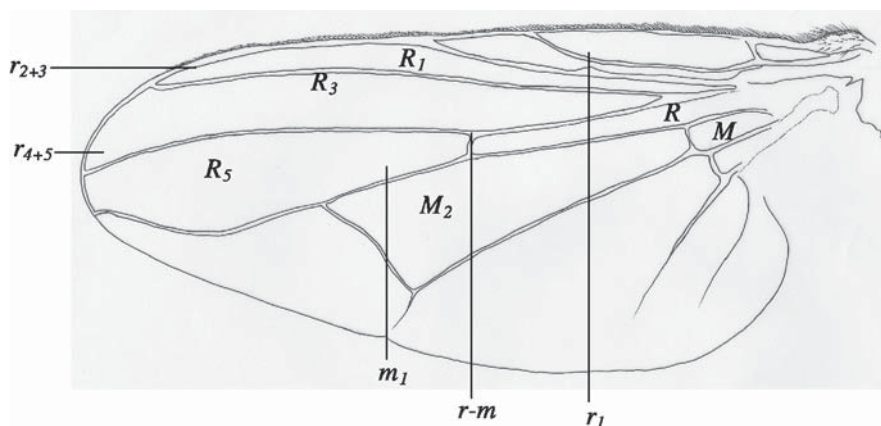


Figure 3 Wing of *S. calcitrans*; *R* = first basal cell, *R*₁ = marginal cell, *R*₃ = submarginal cell, *R*₅ = first posterior cell, *M* = second basal cell, *M*₂ = second posterior or discal cell, *r*₁ = first longitudinal vein, *r*₂₊₃ = second longitudinal vein, *r*₄₊₅ = third longitudinal vein, *m*₁ = fourth longitudinal vein (media), *r-m* = discal cross-vein.

and dark olive pollinosity. Mesonotum with two pairs of dark and broad longitudinal stripes, may be partly united laterally. Wing hyaline, *r*₁ with a few dorsal setae at base, *r*₄₊₅ with dorsal and ventral setae restricted to the first half or more or less reaching *r-m*, *R*₅ at its broadest point $2\frac{1}{2}$ times as wide as at apex, *m* terminally sinuous, squamae hyaline, halter yellow. Legs dark-brown to blackish with tips of femur and basal parts of tibiae yellow. Abdomen with a grey and dark-brown pollinosity, characteristic, with varied extents (Zumpt, 1973).

Female – In the female, width of frons at vertex was about half the eye-length. Frons at vertex about half of eye-length. Frontal index was 0.55 ± 0.04 mm (Table 3). Frontal stripe was black. Ovipositor with slender cerci.

Stomoxys sitchensis

Body length: 4-6 mm. Adult with two distinct lateral dark spots, more transversely elongate on the second and third abdominal segments (Figure 6).

Width of frons at the narrowest point $\frac{1}{4}$ or less of eye length. Thorax and abdomen dense

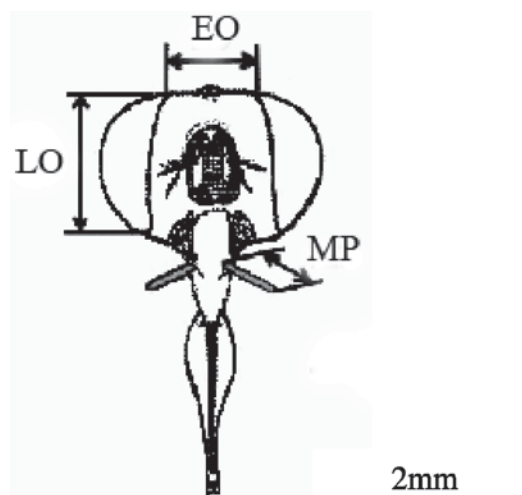


Figure 4 Head of *S. calcitrans*: frontal view (diagram) showing measurement of the frontal index (frontal index = EO/LO with *EO* = frontal space of vertex, *LO* = eye length), *MP* = maxillary palpi.

grayish or brownish, not shiny. First posterior cell of wing (*R*₅) at apex less than one half as wide as at widest point, media more strongly curved upward and sinuous terminally. Wing with the apex of media slightly proximal to apex of *r*₄₊₅. Legs

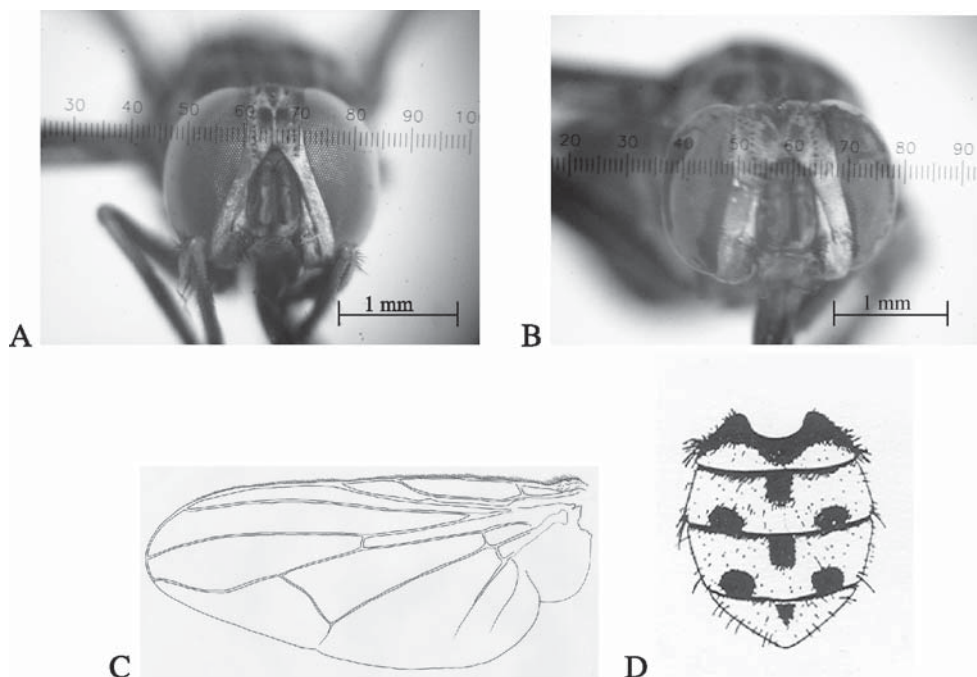


Figure 5 *Stomoxys calcitrans*; A-B) Male and female head, anterior view; C) Wing; D) Dorsal abdominal pattern.

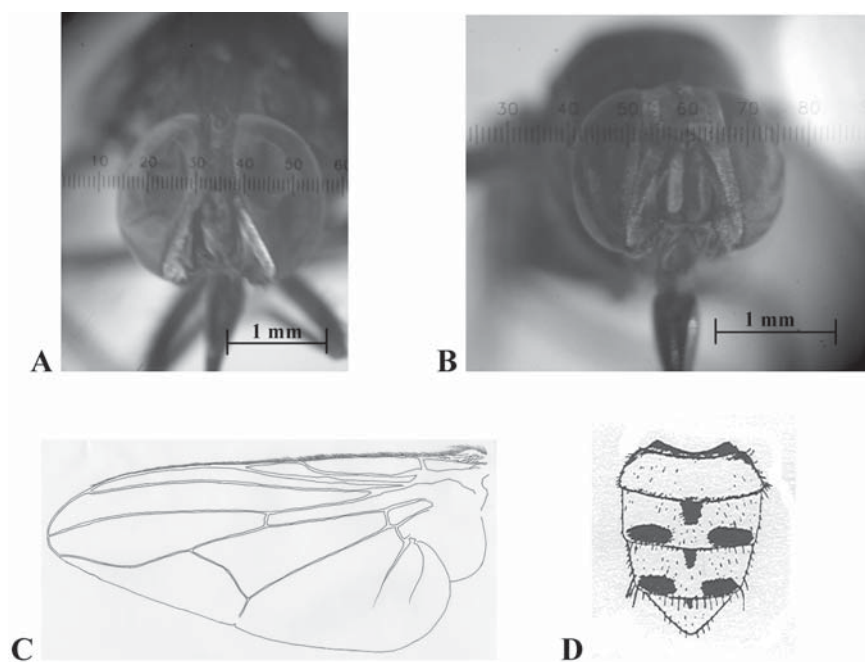


Figure 6 *Stomoxys sitiens*; A-B) Male and female head, anterior view; C) Wing; D) Dorsal abdominal pattern.

dark colored, tibiae more or less extensively yellow with dark-brown or blackish tarsi. Hind-femur with relatively short ventral hairs. Abdomen with distinct spots or transverse bands.

Male – Frons at the narrowest point about $\frac{1}{5}$ of eye-length. Frontal index 0.19 ± 0.02 mm (Table 3). Frontal stripe black. Antennae dark-brown to blackish, third antennal segment about 3 times as long as the second, arista with long dorsal hairs. Palpi yellow, proboscis dark reddish-brown. Thorax black, with a dense grey and olive pollinosity. Mesonotum with four longitudinal black stripes. Wing with r_1 dorsally bare, except for a few setae near the humeral cross-vein, r_{4+5} with dorsal and ventral setae along up to half of its length or more to $r-m$, apex of media slightly proximad to apex of r_{4+5} . Squamae hyaline, halter yellow. Legs dark-brown to blackish with tips of femora and basal parts of tibiae yellow. Abdomen

with grey and olive-brown pattern reminiscent of *S. calcitrans*, but the lateral spots more transversely elongate (Zumpt, 1973).

Female – Head with a broad frons. Frontal index 0.45 ± 0.02 mm (Table 3). Frontal stripe black.

Stomoxys indica

Body length: 4-6 mm. Abdomen grey to olive-brown with distinct spots or transverse stretch bands.

Width of frons at the narrowest point $\frac{1}{4}$ or less of eye length. First posterior cell of wing (R_5) at apex one half as wide as at widest point with slightly curved upward media. Legs yellow-brown to dark-brown, fore-metatarsus simple, without rows of erect hairs.

Male – Male frontal index 0.13 ± 0.02 mm (Table 3). Third antennal segment light color.

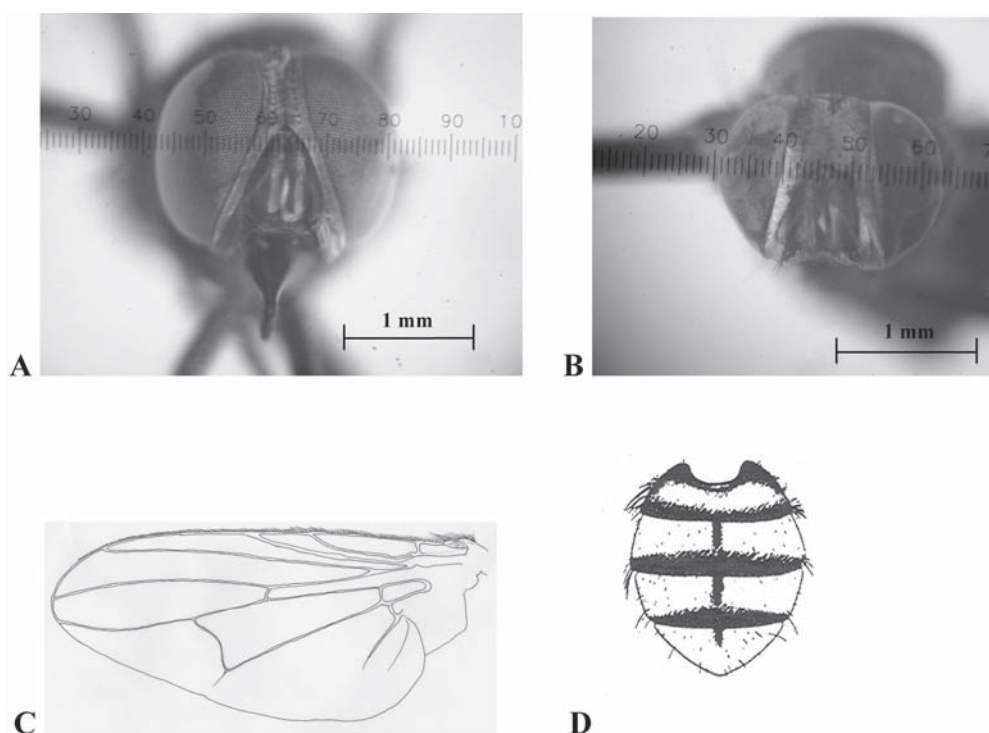


Figure 7 *Stomoxys indica*; A-B) Male and female head, anterior view; C) Wing; D) Dorsal abdominal pattern.

Wing-vein r_{4+5} with dorsal and ventral setae reaching more or less to $r-m$ (Zumt, 1973). The majority of specimens with the femur blackish or dark-brown, only the apices being yellowish.

Female – The female frontal index is 0.44 ± 0.03 mm (Table 3).

Stomoxys bengalensis

Body length: 6.5-7.5 mm.

Width of frons at the narrowest point $\frac{1}{4}$ or less of eye length. Wing with the apex of media almost directly under apex of r_{4+5} . First posterior cell of wing (R_5) at apex less than one half as wide as at widest point, media more strongly curved upward and sinuous terminally. Legs dark colored, tibiae more or less extensively yellow, tarsi dark-brown or blackish. Fore-metatarsus simple, without rows of erect hairs. The hind-femur with long ventral hairs. Thorax and abdomen with dense grayish or brownish, not shiny. Abdomen with distinct spots or dark transverse bands and narrow median vittae, this pattern more or less reduced.

Male genitalia of *Stomoxys* species

The different sclerites of genitalia or hypopygium of each species were examined and illustrated. According to Zumt (1973), the lateral sclerite was divided into two parts, pregonite and postgonite (Figure 8). In this study, the horned sclerites were clearly distinguished among the three species. The various sclerotized plates were also different in shape among *S. calcitrans*, *S. sitiens* and *S. indica* (Figure 9).

The average sizes of male genitalia of flies were observed. The width of horned sclerite was determined and the length of hypopygium was measured. The size of male genitalia of *Stomoxys* species are shown in Table 4, genitalia of *S. calcitrans* is the biggest, followed by *S. sitiens* and *S. indica*.

During this experiment, *S. calcitrans* was the most commonly collected fly species among *Stomoxys* species. As a synanthropic fly, *S. calcitrans* has a world wide distribution, not only in the tropical parts of the Old World and in the

Table 3 Some morphological characteristics of *Stomoxys* species found in central Thailand at Nakhon Pathom, Kanchanaburi and Saraburi Province.

Morphological characteristics	<i>S. calcitrans</i>		<i>S. sitiens</i>		<i>S. indica</i>	
	Male (n = 49)	Female (n = 43)	Male (n = 12)	Female (n = 11)	Male (n = 3)	Female (n = 3)
Frontal index (mm)	0.33 ± 0.03	0.55 ± 0.04	0.19 ± 0.02	0.45 ± 0.02	0.13 ± 0.02	0.44 ± 0.03
Eye length (mm)	1.51 ± 0.10	1.50 ± 0.10	1.59 ± 0.10	1.48 ± 0.13	1.30 ± 0.00	1.22 ± 0.08
Frontal space (mm)	0.49 ± 0.04	0.82 ± 0.08	0.30 ± 0.04	0.66 ± 0.06	0.17 ± 0.03	0.53 ± 0.03
Number of longitudinal stripe on thorax	4 lines		4 lines		4 lines	
Abdominal pattern	2 lateral dark round spot on the 2 nd and 3 rd segment		2 lateral dark oval shape spot on the 2 nd and 3 rd segment		1 dark long stripe on the 2 nd and 3 rd segment	
Body length (mm)	4-7		4-6		4-6	

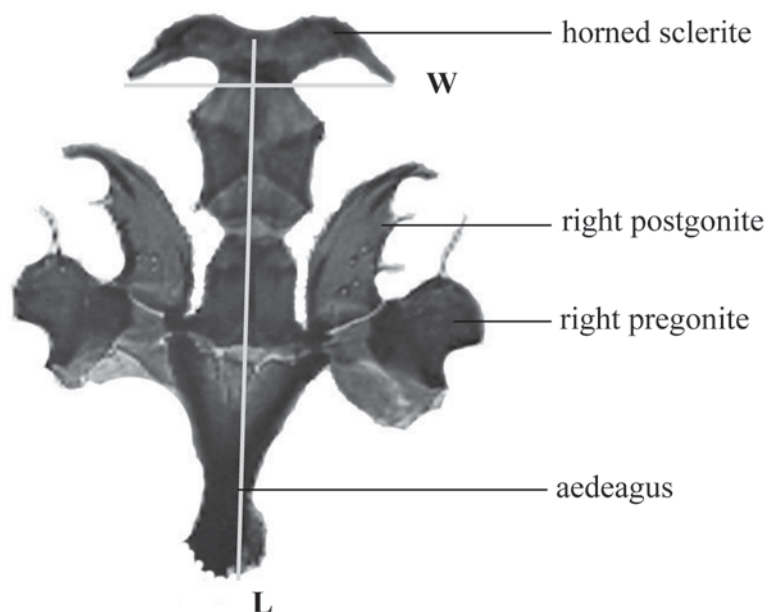


Figure 8 Male genitalia of *S. calcitrans*; W = width of horned sclerite and L = the length of genitalia.

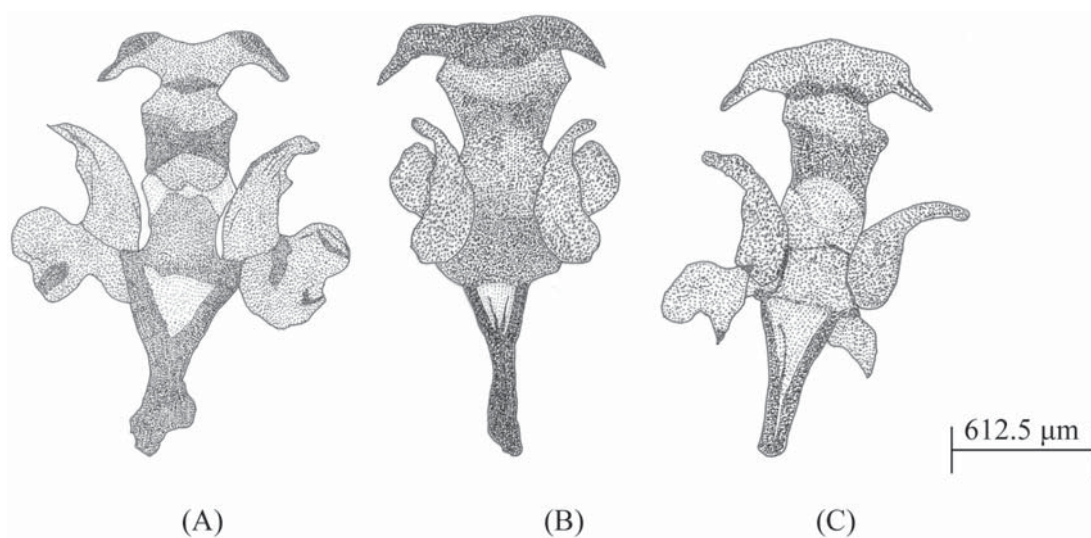


Figure 9 Male genitalia of (A) *S. calcitrans*; (B) *S. sitiens* and (C) *S. indica* collected in central Thailand at Kanchanaburi, Nakhon Pathom and Saraburi Province, respectively.

Table 4 Average size of male genitalia of *Stomoxys* spp. collected in central Thailand at Nakhon Pathom, Kanchanaburi and Saraburi Province during July 2004 to June 2005.

	<i>S. calcitrans</i> (n = 4)	<i>S. sitiens</i> (n = 4)	<i>S. indica</i> (n = 4)
Average width of horned sclerite (mm)	171±7.42	166±11.39	143±2.16
Average of length of hypopygium (mm)	360±5.32	342±34.81	282±7.66

Oriental region. *Stomoxys calcitrans* was the only one Stomoxyine fly ever recorded to be found in Thailand as pest of cattle and swine (Ketavan and Kanjanamungsuk, 1987). Distribution of *S. sitiens* has been found in high number in the Ethiopian geographical region, especially in Egypt and in the Oriental region. *Stomoxys indica* is also quite common in the Oriental region (Zumpt, 1973). However, during this investigation the number of *S. sitiens* was significantly greater than that of *S. indica* at the three localities in central Thailand. *Stomoxys sitiens* is separated from *S. calcitrans* by the wing-venation and dorsal abdominal pattern.

Stomoxys bengalensis is related to *S. calcitrans* and can be distinguished by having a narrower frons in both sexes and the abdominal pattern. *Stomoxys bengalensis* is evidently a rare species in the Oriental region with few records even by Zumpt (1973). During this investigation, only one female fly of *S. bengalensis* was trapped at Nakhon Pathom Province and was reported for the first time in Thailand.

The frontal index of Stomoxyine flies of our investigation was slightly different from the previous studied. According to Zumpt (1973), the frontal index of *S. calcitrans*, *S. sitiens*, *S. indica* and *S. bengalensis* were 0.37-0.40, 0.5-0.6; 0.18-0.23, 0.42-0.45; 0.11-0.16, 0.37, 0.43; 0.20-0.26 and 0.44 mm for male and female, respectively.

The result from this study revealed that four species of Stomoxyine flies were relatively similar. However, the differences can be observed from dorsal abdominal pattern and male genitalia as presented in this paper. Male genitalia as well as other morphological taxonomic characters should be further studied. This knowledge will be useful for fly identification, which will raise awareness for future investigation on the control of disease transmitted by these flies.

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