

A Systematic Key to Termites of Thailand

Yupaporn Sornnuwat¹, Charunee Vongkaluang¹ and Yoko Takematsu²

ABSTRACT

A new systematic key to genera of Thailand's termites based on soldier characteristics was developed from four thousand three hundred collections recorded across the country. A total 37 genera in 4 families and 10 subfamilies was described. Further taxonomic studies to species level and their distribution were also conducted. Historic and current lists of species were included.

Key word: termite, systematic key, soldier caste, geographical distribution

INTRODUCTION

Termites are widely distributed in tropical and subtropical regions. The number of species and their biomass are especially large in tropical zone (Krishna and Weesner, 1969; 1970; Pearce, 1999). Thailand is located within tropical climatic zone with various types of forest ecosystem that is suitable for termite growth and development and termite nests can easily be found everywhere in the forest, farmland, rural shelters or even in city buildings. However, little is known about termite fauna of Thailand.

The first publication of the monograph of termites of Thailand by Holmgren (1913) reported only 5 species, *Bifiditermes indicus* (Holmgren), *Glyptotermes domesticus* (Havilandi), *Coptotermes havilandi* (Holmgren), *Macrotermes carbonarius* (Hagen) and *Odontotermes formosanus* (Shiraki). *Macrotermes annandalei* was later on added to termite list of Thailand (Snyder, 1949). Ahmad (1965) published excellent monograph described 74 species of termites belonging to 29 genera which had been used as reference key literature until now. Morimoto (1973)

listed 90 species in his manuscript on termite from Thailand. Forty-eight species reported were the results of the survey made by him and his colleagues. Intanai (1987) reported 25 species from rubber plantation of Chanthaburi and Trat provinces. From records mentioned altogether up to 92 species of termite have been recorded from Thailand.

Research on other aspects apart from termite taxonomy in Thailand included termite diversity, abundance, biomass, behavior and their function in various ecosystem (Watanabe *et al.*, 1984; Abe and Inoue, 1993; Sugio, 1995; Watson and Gay, 1997; Davies, 1997; Inoue *et al.*, 2001; Klangkaew *et al.*, 2002; Takematsu *et al.*, 2003; Vongkaluang *et al.* 2003; Sornnuwat *et al.*, 2003). None of these works has given any descriptive guide for termite identification.

With the progress of research concerning the roles of termite in the ecosystem of human life, benefit and detriment produced by termites has to be well understood. Since there are many species of termite in Thailand, attempt should be made to distinguish beneficial species from the destructive ones by making survey, collect termite specimen,

¹ Royal Forest Department, Bangkok 10900, Thailand.

² Department of Agriculture, Faculty of Biological and Environmental Sciences, Yamaguchi University, Japan.

study the morphological characteristics necessary for identification and publish new list of termite of Thailand which will be beneficial for further studies on termites.

Survey and collection of termite specimens in Thailand have been carried out continuously for 25 years. The numbers of termite specimen collected from 1992-2004 deposits in the termite collection of Royal Forest Department are accounted for more than 4,300 vials. These specimens were collected under the Biodiversity Project of Royal Forest Department, the Plant Genetics Conservation Project under the Royal Initiative of Her Royal Highness Maha Chakri Sirindhorn, the KU-JST Termite Bio-recycle Project and the Cooperative Research on Termite Ecology of the late Dr. Takuya Abe, the most well known termite ecologist from Kyoto University.

In this study, the external morphological characteristics of soldier caste of the specimen were observed and classified into genera and species based on the systematic keys of Ahmad (1958), (1965); Krishna, 1965; Morimoto, 1973; Thapa, 1981 and Tho, 1992. A new systematic key to genera was compiled and proposed for comprehensive key to termite of Thailand.

The information provided in this study on regional distribution of the genera also avail new reference for further study on termite in Thailand in addition to scientific benefit in the field of termite taxonomy.

MATERIALS AND METHODS

Termite specimens were collected from 53 provinces both on the mainland and on the island of Andaman Sea and Gulf of Thailand together with collections from forest plantations, community forests, rubber plantations, fruit orchards, agricultural fields, residential villages and city cites. Over 4,300 specimens were collected and preserved in 80% ethyl-alcohol. Voucher

specimens are deposited at the Royal Forest Department Termite Collection.

Detail of locations and name of collected sites are given in Figure 1.

Method of taxonomic study

The study was based primarily on termite specimens in the collection of Royal Forest Department, Bangkok Thailand.

Over 4,300 samples of termite were used in the studies. Termites were identified using external morphology of soldier caste. The major characteristics used to distinguish termite genera were the shape and size of head, fontanelle, labrum, clypeus, mandible and pronotum. In addition to mandible characteristics, the position of teeth and number of antennae articles were also used.

Measurements were generally taken in alcohol-preserved specimens without dissected out or flatted on the petri-dish. While measuring, the body was kept as flat as possible and measured under a binocular stereo microscope with the aid of ocular micrometer. All measurements were recorded in millimeters.

General features of soldier and taxonomic measurements used in this study were illustrated in Figure 2 (Roonwal, 1969), Figure 3 (Tho, 1992), Figure 4 (Pearce, 1999) and Figure 5 (Roonwal, 1969).

FURTHER TAXONOMIC STUDY

Based on more than 4,300 specimens, further taxonomic studies to species level were made together with their regional distribution. The summary of the study and their geographic distribution appear in Table 1. Variation of head shape and size of soldier for quick reference are shown in Figure 6. Table 2 shows termite species of Thailand reported from 1913-2004.

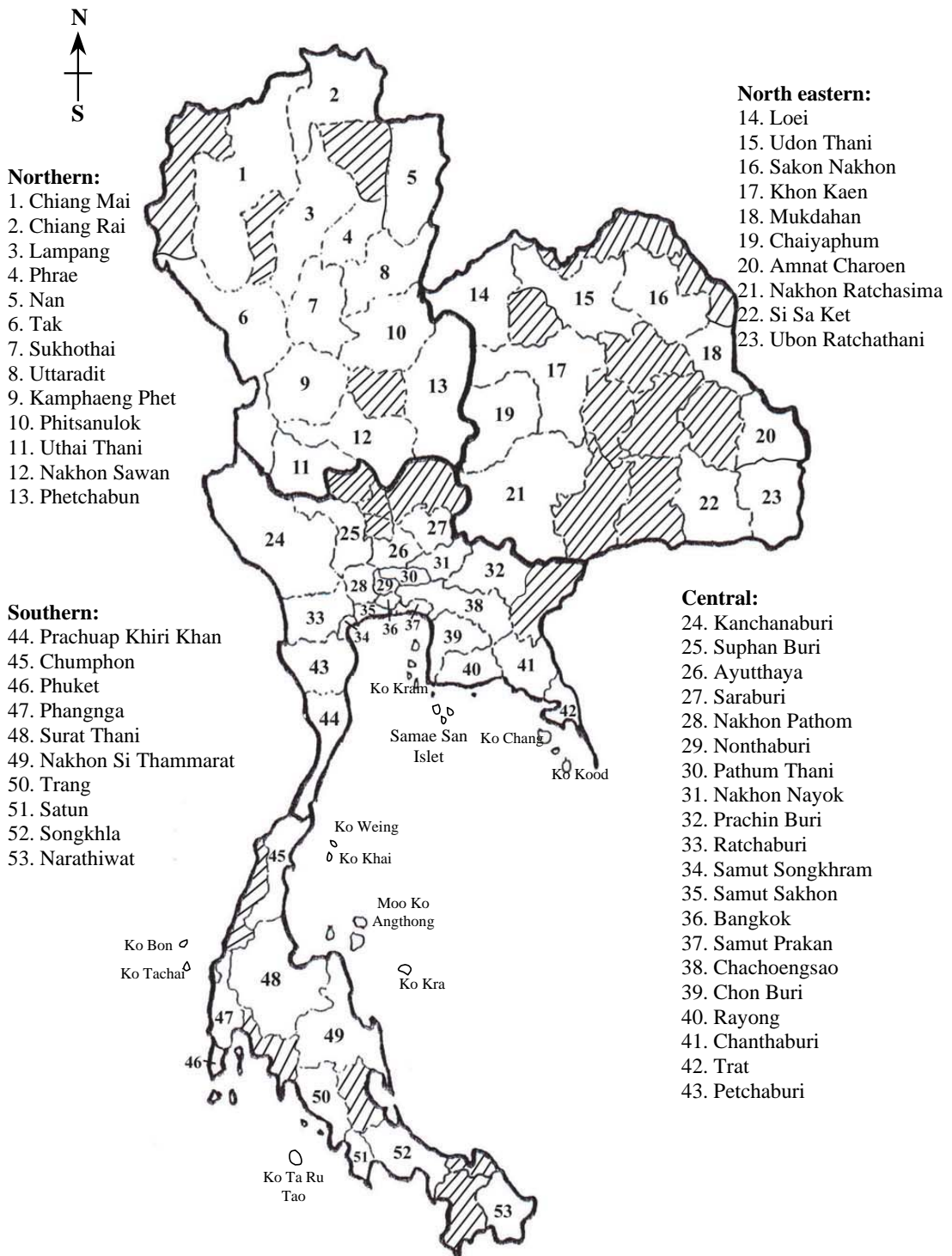


Figure 1 Map of Thailand : Localities of collecting termite specimens.

Provinces surveyed

▨ Provinces did not cover in the survey

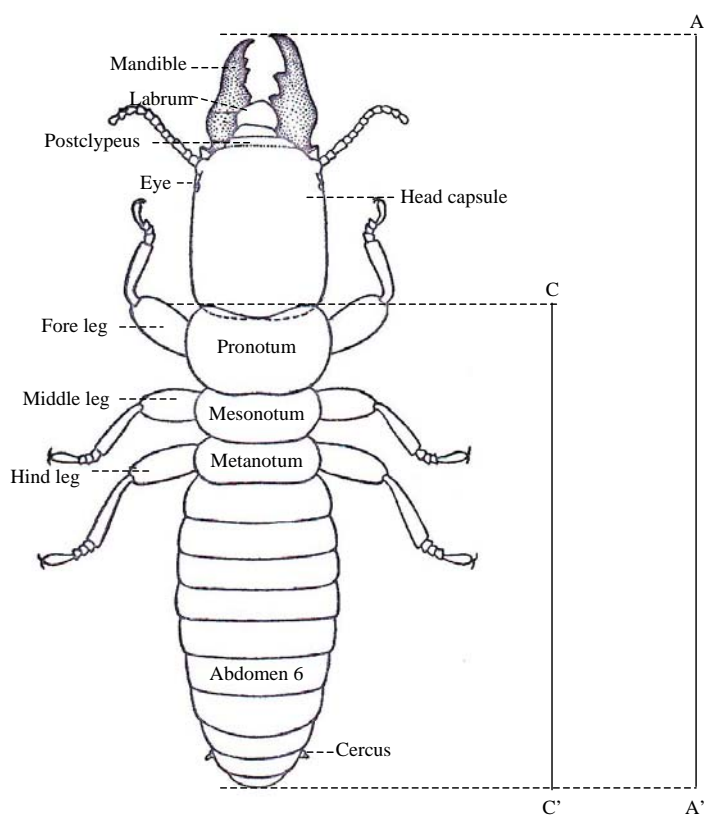


Figure 2 General features of soldier and dorsal view of total body and measurement of *Bifiditermes beelsoni* (Gardner)

- a) Total body –length (line AA')
 - b) Body-length without head (line CC')
- (Roonwall, 1969)

CONCLUSIONS

1. Morphological identification of soldier caste resulted in 178 species 37 genera 10 subfamilies and 4 families.
2. Current records of termite species from Thailand have been 199 species 39 genera 10 subfamilies and 4 families.
3. Termopsidae is a new record of termite family from Thailand.
4. Eleven new records of termite genera are *Archotermopsis* (1 sp.), *Neotermes* (6 sp.), *Incisitermes* (2 sp.), *Parrhinotermes* (1 sp.), *Reticulitermes* (3 sp.), *Synhamitermes* (1 sp.),

Prohamitermes (1 sp.), *Homallotermes* (2 sp.), *Angulitermes* (4 sp.), *Longipeditermes* (1 sp.) and *Lacessititermes* (4 sp.).

5. Two termite genera; *Archotermopsis* and *Reticulitermes* normally recorded from the temperate region was first recorded in Thailand.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the Royal Forest Department (RDF), Japan Science and Technology Corporation (JST), The Institute of Physical and Chemical Research (RIKEN), and Kasetsart University (KU) for technical and

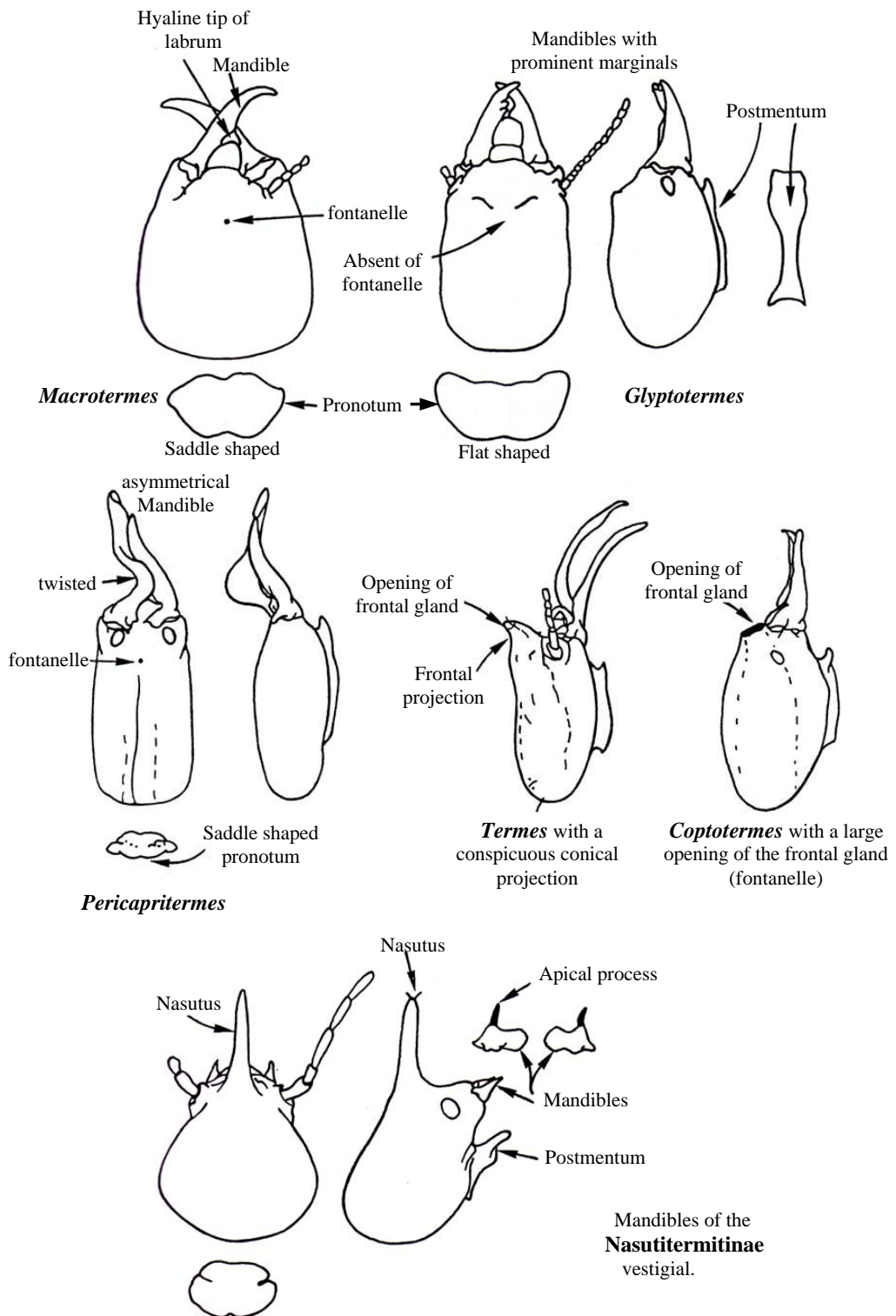


Figure 3 Major characteristics of soldier head necessary for identification (Tho, 1992).

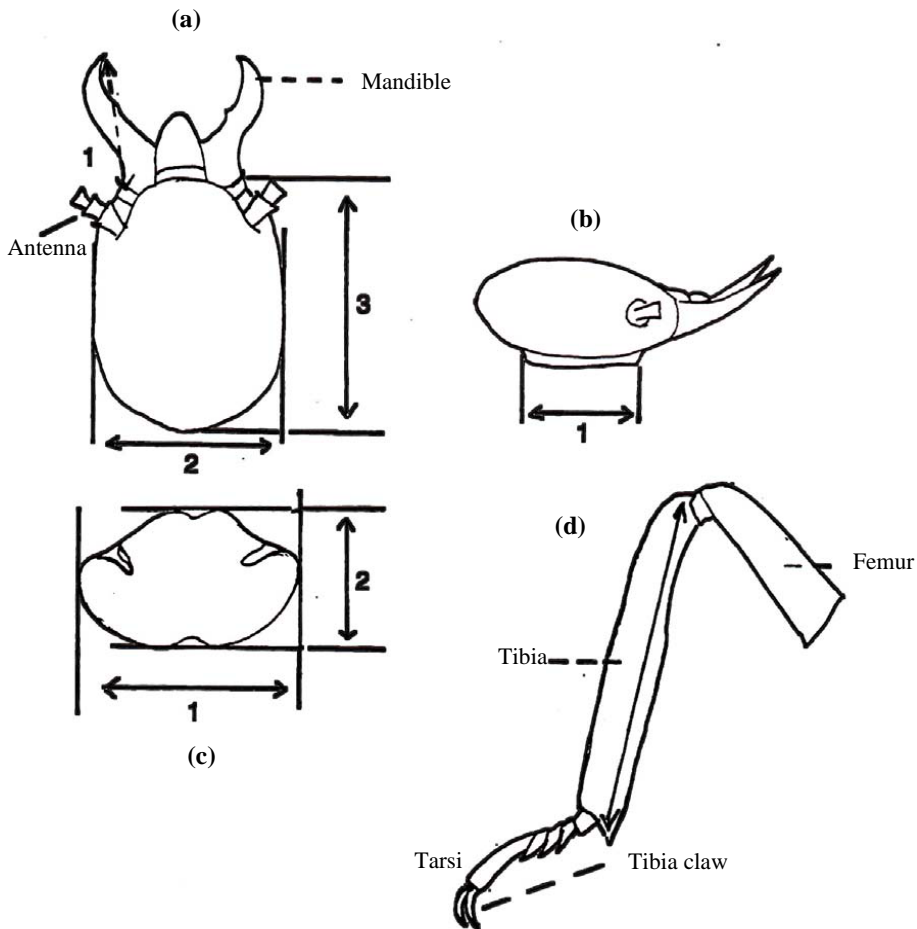


Figure 4 Taxonomic measurements of termite.

- a) Soldier head, length of left mandible, width of head, length of head.
- b) Length of postmentum.
- c) width of pronotum, length of pronotum.
- d) Length of tibia.

(Pearce, 1999)

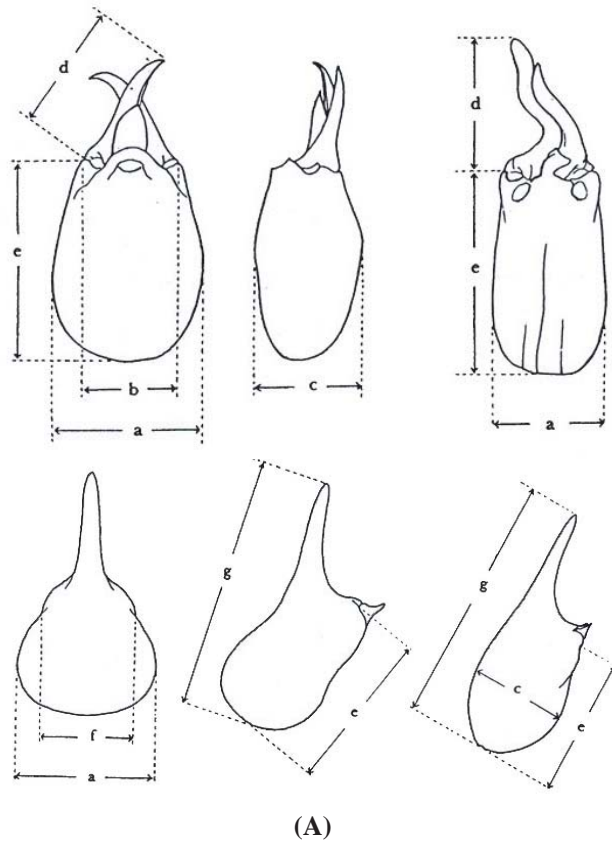
financial assistance which facilitate the completion of this study.

The authors are in great debt to the information, recommendation and encouragement given by the late Professor Dr. Takuya Abe of Kyoto University and would like to dedicate this study in memory of him.

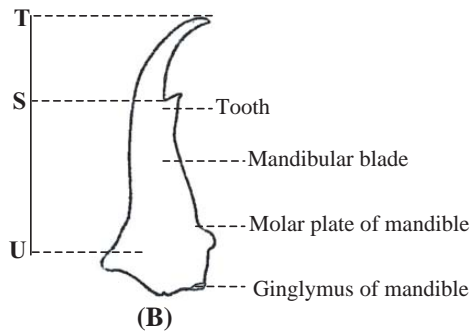
Sincere thanks extends to the administrators and staff of the National Park, Wildlife and Plant Conservation Department, The Plant Genetics

Conservation Project under the Royal Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn and the Navy Special War-Fare Group of Royal Thai Navy for the jointed field works within the conservation areas on the mainland and island.

Deeply thanks goes to Dr. Tetsushi Inoue, Miss Sajit Chutibhapakorn and all members of the termite diversity project involving in this survey and study.



(A)



(B)

Figure 5 (A) Measurements used in quantifying the soldier head size:

- a) maximum width of head, b) width of head at base of mandible, c) height of head, d) length of left mandible, e) length of head to base of mandible, f) width of head at point of constriction, g) length of head to tip of nasutus.

(Tho, 1992)

(B) Left mandible of soldier of *Odontotermes obesus* (Rambur):

- a) Tooth distance from distal tip of mandible (line ST)
- b) Tooth distance from mandibular base (line SU).

(Roonwall, 1969)

KEY TO GENERA OF TERMITE OF THAILAND

Soldier

1.	Head without fontanelle	2
-	Head with fontanelle	6
2.	Antennae more than 22 segments	<i>Archotermopsis</i>
-	Antennae less than 20 segments	3
3.	Head long or weakly phragmotic	4
-	Head short and strongly phragmotic	<i>Cryptotermes</i>
4.	Third segment of antennae elongated like club shape; antero-lateral margin of pronotum deeply concave	<i>Incisitermes</i>
-	Third segment of antennae not elongate like club shape	5
5.	Forehead steeply sloping, with antero-lateral lobes; antennae with less than 15 segments	<i>Glyptotermes</i>
-	Forehead gently sloping, without antero-lateral lobes; antennae with 15 or more segments	<i>Neotermes</i>
6.	Pronotum flat	7
-	Pronotum saddle shaped	11
7.	Mandibles saber-shaped, without any marginal teeth	8
-	Mandibles with prominent marginal teeth	10
8.	Fontanelle very wide and close to clypeus	<i>Coptotermes</i>
-	Fontanelle small, circular, placed much behind clypeus	9
9.	Head elongate oval with a groove running forward from the fontanelle	<i>Prorhinotermes</i>
-	Head rectangular, parallel sided	<i>Reticulitermes</i>
10.	Soldiers monomorphic; labrum prominent; mandibles with leaf shape marginal teeth	<i>Parrhinotermes</i>
-	Soldier dimorphic	<i>Schedorhinotermes</i>
11.	Mandibles well developed, functional; head not produce into a nasutus	12
-	Mandibles degenerate, non-functional; head produced into a nasutus (nasutiforms)	31
12.	Mandibles symmetrical, curved at tips, used for biting	13
-	Mandibles slightly to strongly asymmetrical, used for snapping or for both snapping and biting	25
13.	Left mandible without teeth but cutting edge crenulated basally	14
-	Left mandible with one or two teeth or cutting edge serrated	19
14.	Labrum with hyaline tip; meso and metanotum greatly expanded laterally; soldiers distinctly dimorphic	<i>Macrotermes</i>
-	Labrum without hyaline tip; meso and metanotum not greatly expanded laterally; soldiers monomorphic	15
15.	Head rectangular	<i>Microcerotermes</i>
-	Head round	16
16.	Mandible with crenulation	17
-	Mandible without crenulation	18

17.	Mandibles long, strongly curve	<i>Prohamitermes</i>
-	Mandibles short, weakly curve	<i>Hypotermes</i>
18.	Mandibles weakly curved apically; head oval	<i>Microtermes</i>
-	Mandibles strongly curved apically; head as nearly broad as long	<i>Ancistrotermes</i>
19.	Right mandible with distinct teeth	20
-	Right mandible with minute or without teeth	<i>Odontotermes</i>
20.	Clypeus distinctly bilobed; head longer than wide; tooth of left mandible laterally directed	<i>Amitermes</i>
-	Clypeus not bilobed	21
21.	Head round or globular; mandibles long, strongly curve downward	<i>Globitermes</i>
-	Head shot parallel-sided	22
22.	Mandibles long, saber shaped, slightly curved apically	<i>Synhamitermes</i>
-	Mandibles short; stoutly built, not very strongly curved apically	23
23.	Pronotum very strongly saddle shaped, anterior lobe longer than posterior lobe; head hypognathous, covered with dense coat of thin short hairs; tarsi three-segmented	<i>Indotermes</i>
-	Pronotum not very strongly saddle shaped, anterior lobe not longer than posterior lobe	24
24.	Mandibles with large broad tooth	<i>Speculitermes</i>
-	Mandibles with small, pointed tooth	<i>Euhamitermes</i>
25.	Head with frontal projection	26
-	Head without frontal projection	28
26.	Mandibles slightly asymmetrical	27
-	Mandibles strongly asymmetrical, left mandible twisted; right mandibles blade-like	<i>Mirocapritermes</i>
27.	Labrum shallowly cut; lateral sides almost straight; base of the antenna with a ridge; mandibles long and slender, rodlike, bent downward	<i>Termes</i>
-	Labrum deeply cut; lateral sides convex; base of the antenna without ridge; mandibles anteriorly directed	<i>Angulitermes</i>
28.	Antennae with 13 segments; head distinctly narrowed anteriorly; mandibles with tip not bent in form of hook	<i>Homallotermes</i>
-	Antennae with 14 segments; mandibles slightly to strongly asymmetrical	29
29.	Antero-lateral corners of head rounded without projections	30
-	Antero-lateral corners of head with pointed projections below antennal sockets with its lateral corners produced into long needle-like projections; anterior margin of labrum deeply concave	<i>Dicuspiditermes</i>
30.	Labrum with anterior margin straight; anterolateral corners very short; tip of left mandible broad, not strongly bent	<i>Pericapritermes</i>
-	Labrum with anterior margin concave; its anterolateral corners long; tip of left mandible narrow, bent in form of hook	<i>Procapritermes</i>

31.	Head constricted behind antennae sockets	32
-	Head not constricted behind antennae sockets	35
32.	Legs and antennae greatly elongated; hind femora as long as or longer than abdomen	33
-	Legs and antennae not unusually long; head not produced behind, not depressed at base of nasus	<i>Bulbitermes</i>
33.	Third antennae segment moderately long and shorter than or subequal to fourth; soldiers generally with distinct color forms	<i>Lacessititermes</i>
-	Third antennae segment very long much longer than fourth	34
34.	Soldier monomorphic; head not greatly produced behind	<i>Hospitalitermes</i>
-	Head triangular, greatly produced behind; soldiers distinct dimorphism; legs paler than the body	<i>Longipeditermes</i>
35.	Nasutus with minute projection at base on each side; head covered with minute hairs; mandibles without apical projection	<i>Aciculitermes</i>
-	Nasutus without projection at base	36
36.	Antennal articles long, apical projection of mandible with minute tooth; dorsal profile of head weakly concave; rostrum long	<i>Havilanditermes</i>
-	Antennal articles short, apical projection of mandible without tooth; dorsal profile of head straight	<i>Nasutitermes</i>

Table 1 List of termite genera and their geographical distribution.

No.	Termite genera (No. of species)	Geographic area ¹			
		N	NE	C	S
1	F Kalotermitidae				
1.1	SF. Kalotermitinae				
1	<i>Cryptotermes</i> (3 sp.)	X	X	X	X
2	<i>Glyptotermes</i> (7 sp.)	X	X	X	X
3	<i>Neotermes</i> (6 sp.)	X	X	X	X
4	<i>Incisitermes</i> (2 sp.)	-	X	-	X
2	F Termopsidae				
2.1	SF Termopsinae				
5	<i>Archotermopsis</i> (1 sp.)	X	-	-	-
3	F. Rhinotermitidae				
3.1	SF. Rhinotermitinae				
6	<i>Schedorhinotermes</i> (4 sp.)	X	X	X	X
7	<i>Parrhinotermes</i> (1 sp.)	-	-	-	X
3.2	SF. Prorhinotermitinae				
8	<i>Prorhinotermes</i> (2 sp.)	X	-	X	X
3.3	SF. Heterotermitinae				
9	<i>Reticulitermes</i> (3 sp.)	X	X	-	-

Table 1 (cont.) List of termite genera and their geographical distribution.

No.	Termite genera (No. of species)	Geographic area ¹			
		N	NE	C	S
3.4 SF. Coptotermitinae					
10	<i>Coptotermes</i> (5 sp.)	X	X	X	X
4 F. Termitidae					
4.1 4.1 SF. Macrotermitinae					
11	<i>Macrotermes</i> (6 sp.)	X	X	X	X
12	<i>Microtermes</i> (3 sp.)	X	X	X	X
13	<i>Ancistrotermes</i> (2 sp.)	X	X	X	X
14	<i>Hypotermes</i> (4 sp.)	X	X	X	X
15	<i>Odontotermes</i> (31 sp.)	X	X	X	X
4.2 SF. Termitinae					
16	<i>Amitermes</i> (2 sp.)	-	X	X	X
17	<i>Microcerotermes</i> (6 sp.)	X	X	X	X
18	<i>Globitermes</i> (1 sp.)	X	X	X	X
19	<i>Synhamitermes</i> (1 sp.)	-	X	-	-
20	<i>Prohamitermes</i> (1 sp.)	-	-	X	X
21	<i>Termes</i> (4 sp.)	X	X	X	X
22	<i>Dicuspitermes</i> (3 sp.)	X	X	X	X
23	<i>Pericapritermes</i> (8 sp.)	X	X	X	X
24	<i>Procapritermes</i> (9 sp.)	X	X	X	X
25	<i>Mirocapritermes</i> (4 sp.)	X	X	X	-
26	<i>Homallotermes</i> (2 sp.)	-	-	-	X
27	<i>Angulitermes</i> (4 sp.)	-	X	X	-
4.3 SF. Apicotermitinae					
28	<i>Indotermes</i> (1 sp.)	X	-	-	-
29	<i>Euhamitermes</i> (7 sp.)	X	X	X	-
30	<i>Speculitermes</i> (3 sp.)	X	X	X	X
4.4 SF. Nasutitermitinae					
31	<i>Nasutitermes</i> (17 sp.)	X	X	X	X
32	<i>Bulbitermes</i> (11 sp.)	X	X	X	X
33	<i>Hospitalitermes</i> (6 sp.)	X	X	X	X
34	<i>Aciculitermes</i> (2 sp.)	X	X	-	X
35	<i>Havilanditermes</i> (1 sp.)	X	X	-	X
36	<i>Longipeditermes</i> (1 sp.)	-	-	-	X
37	<i>Lacessititermes</i> (4 sp.)	-	-	X	X

¹ N = Northern NE = North eastern C = Central S = Southern

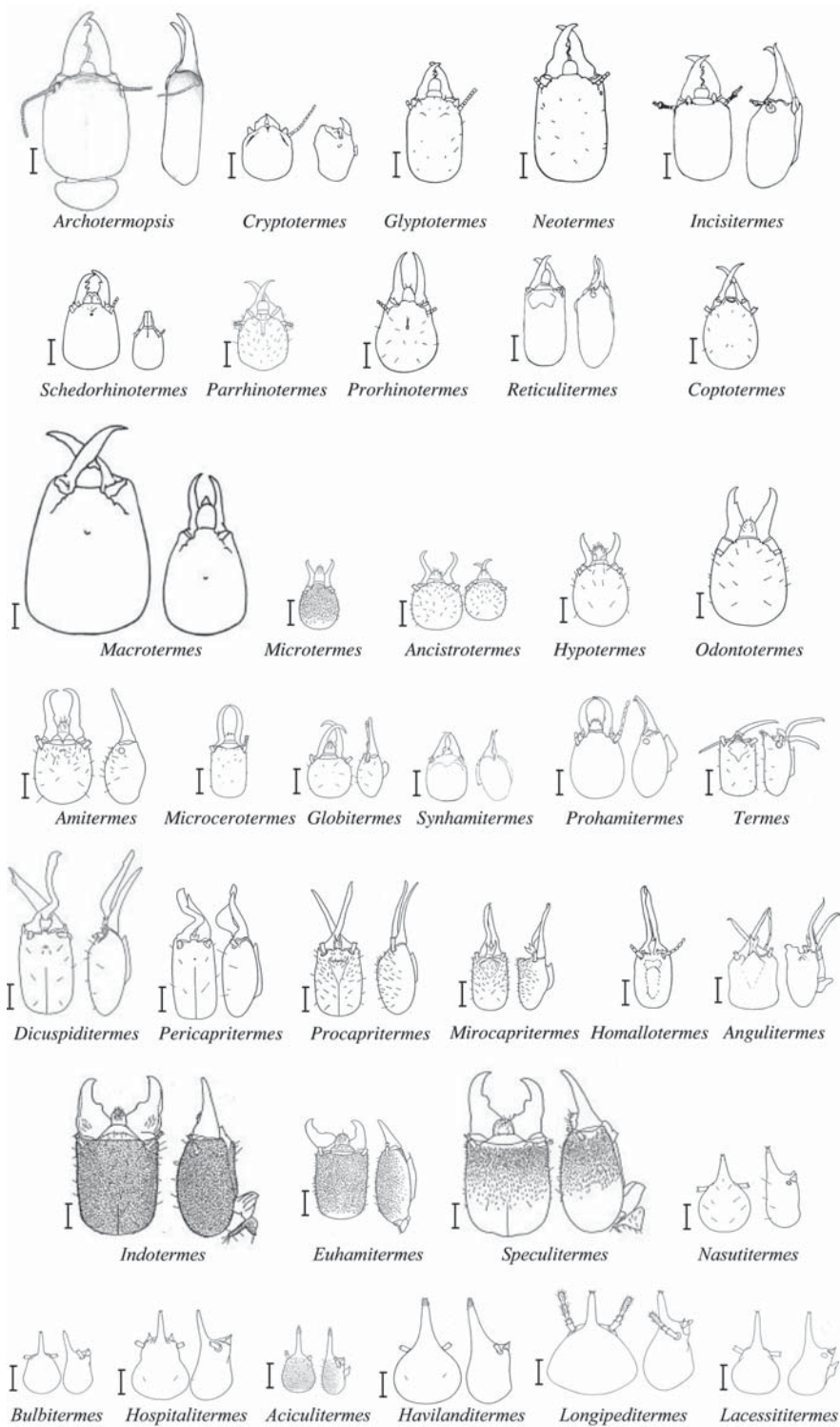


Figure 6 Variation of head shape and size of soldier caste; $\bar{\text{I}} = 0.5$ mm. (length of head to tip of mandible or nasus).

Table 2 Termite species of Thailand reported from 1913-2004.

No.	Termite species	References					Present study (2004)
		Holmgren (1913)	Snyder (1949)	Ahmad (1965)	Morimoto (1973)	Intanai (1987)	
1 F. Kalotermitidae							
1.1 SF. Kalotermitinae							
1	<i>Cryptotermes thailandis</i>			X			X
2	<i>Cryptotermes domesticus</i>	X	X	X			
3	<i>Cryptotermes bengalensis</i>				X		
4	<i>Cryptotermes</i> sp. 1						X
5	<i>Cryptotermes</i> sp. 2						X
6	<i>Glyptotermes brevicaudatus</i>			X		X	X
7	<i>Glyptotermes pinangae</i>			X			X
8	<i>Glyptotermes kachongensis</i>			X			
9	<i>Glyptotermes thailandis</i>				X		X
10	<i>Glyptotermes</i> sp.				X		
11	<i>Glyptotermes</i> sp. 1						X
12	<i>Glyptotermes</i> sp. 2						X
13	<i>Glyptotermes</i> sp. 3						X
14	<i>Glyptotermes</i> sp. 4						X
15	<i>Neotermes</i> sp. 1						X
16	<i>Neotermes</i> sp. 2						X
17	<i>Neotermes</i> sp. 3						X
18	<i>Neotermes</i> sp. 4						X
19	<i>Neotermes</i> sp. 5						X
20	<i>Neotermes</i> sp. 6						X
21	<i>Bifiditermes indicus</i>	X	X	X			
22	<i>Incisitermes</i> sp. 1						X
23	<i>Incisitermes</i> sp. 2						X
24	<i>Postelectrotermes tongyaii</i>			X			
2 F Termopsidae							
2.1 SF Termopsinae							
25	<i>Archotermopsis</i> sp. 1						X
3 F. Rhinotermitidae							
3.1 SF. Rhinotermitinae							
26	<i>Schedorhinotermes medioobscurus</i>			X	X	X	X
27	<i>Schedorhinotermes rectangularis</i>			X	X	X	X
28	<i>Schedorhinotermes sarawakensis</i>			X	X		X
29	<i>Schedorhinotermes</i> sp. 1						X
30	<i>Parrhinotermes</i> sp. 1						X

Table 2 (cont.) Termite species of Thailand reported from 1913-2004.

No.	Termite species	References					Present study (2004)
		Holmgren (1913)	Snyder (1949)	Ahmad (1965)	Morimoto (1973)	Intanai (1987)	
3.2 SF. Prorhinotermitinae							
31	<i>Prorhinotermes tibiaoensisiformis</i>			X			X
32	<i>Prorhinotermes</i> sp. 1						X
3.3 SF. Heterotermitinae							
33	<i>Reticulitermes khaoyaiensis</i>						X
34	<i>Reticulitermes</i> sp. 1						X
35	<i>Reticulitermes</i> sp. 2						X
3.4 SF. Coptotermitinae							
36	<i>Coptotermes gestroi</i>			X	X	X	X
37	<i>Coptotermes havilandi</i>	X	X	X	X		X
38	<i>Coptotermes premrasmii</i>			X			X
39	<i>Coptotermes curvignathus</i>			X	X	X	X
40	<i>Coptotermes kalshoveni</i>			X			
41	<i>Coptotermes</i> sp. 1						X
4 F. Termitidae							
4.1 4.1 SF. Macrotermitinae							
42	<i>Macrotermes carbonarius</i>	X	X	X	X	X	X
43	<i>Macrotermes chaigloni</i>			X			X
44	<i>Macrotermes annandalei</i>		X	X	X	X	X
45	<i>Macrotermes maesodensis</i>			X		X	X
46	<i>Macrotermes gilvus</i>			X	X	X	X
47	<i>Macrotermes malaccensis</i>			X	X	X	X
48	<i>Microtermes obesi</i>			X	X	X	X
49	<i>Microtermes</i> sp. 1						X
50	<i>Microtermes</i> sp. 2						X
51	<i>Ancistrotermes pakistanicus</i>			X	X	X	X
52	<i>Ancistrotermes</i> sp. 1						X
53	<i>Hypotermes makhamensis</i>			X			X
54	<i>Hypotermes xenotermitis</i>			X	X	X	X
55	<i>Hypotermes obculiceps</i>					X	
56	<i>Hypotermes</i> sp. 1						X
57	<i>Hypotermes</i> sp. 2						X
58	<i>Odontotermes hainanensis</i>				X		
59	<i>Odontotermes paraoblongatus</i>			X	X		
60	<i>Odontotermes javanicus</i>				X		
61	<i>Odontotermes sarawakensis</i>			X			X

Table 2 (cont.) Termite species of Thailand reported from 1913-2004.

No.	Termite species	References					Present study (2004)
		Holmgren (1913)	Snyder (1949)	Ahmad (1965)	Morimoto (1973)	Intanai (1987)	
62	<i>Odontotermes proformosanus</i>			X	X	X	X
63	<i>Odontotermes longignathus</i>			X	X		X
64	<i>Odontotermes feae</i>			X	X	X	X
65	<i>Odontotermes prodives</i>						X
66	<i>Odontotermes maesodensis</i>			X		X	X
67	<i>Odontotermes oblongathus</i>			X			X
68	<i>Odontotermes takensis</i>			X			X
69	<i>Odontotermes formosanus</i>	X	X	X	X	X	X
70	<i>Odontotermes djampeensis</i>						X
71	<i>Odontotermes</i> sp.				X		
72	<i>Odontotermes</i> sp. 1						X
73	<i>Odontotermes</i> sp. 2						X
74	<i>Odontotermes</i> sp. 3						X
75	<i>Odontotermes</i> sp. 4						X
76	<i>Odontotermes</i> sp. 5						X
77	<i>Odontotermes</i> sp. 6						X
78	<i>Odontotermes</i> sp. 7						X
79	<i>Odontotermes</i> sp. 8						X
80	<i>Odontotermes</i> sp. 9						X
81	<i>Odontotermes</i> sp. 10						X
82	<i>Odontotermes</i> sp. 11						X
83	<i>Odontotermes</i> sp. 12						X
84	<i>Odontotermes</i> sp. 13						X
85	<i>Odontotermes</i> sp. 14						X
86	<i>Odontotermes</i> sp. 15						X
87	<i>Odontotermes</i> sp. 16						X
88	<i>Odontotermes</i> sp. 17						X
89	<i>Odontotermes</i> sp. 18						X
90	<i>Odontotermes</i> sp. 19						X
91	<i>Odontotermes</i> sp. 20						X
92	<i>Odontotermes</i> sp. 21						X
4.2 SF. Termitinae							
93	<i>Amitermes dentatus</i>			X			X
94	<i>Amitermes longignathus</i>			X			X
95	<i>Microcerotermes crassus</i>			X	X	X	X
96	<i>Microcerotermes distans</i>				X		X

Table 2 (cont.) Termite species of Thailand reported from 1913-2004.

No.	Termite species	References					Present study (2004)
		Holmgren (1913)	Snyder (1949)	Ahmad (1965)	Morimoto (1973)	Intanai (1987)	
97	<i>Microcerotermes annandalei</i>			X	X		X
98	<i>Microcerotermes minutus</i>			X			X
99	<i>Microcerotermes paracelebensis</i>			X	X		X
100	<i>Microcerotermes</i> sp. 1						X
101	<i>Globitermes sulphureus</i>			X	X	X	X
102	<i>Synhamitermes</i> sp. 1						X
103	<i>Prohamitermes mirabilis</i>						X
104	<i>Termes cosmis</i>			X		X	X
105	<i>Termes propinquus</i>			X	X		X
106	<i>Termes huayangensis</i>			X			X
107	<i>Termes major</i>				X		X
108	<i>Dicuspiditermes garthwaitei</i>			X			X
109	<i>Dicuspiditermes makhamensis</i>			X	X	X	X
110	<i>Dicuspiditermes</i> sp. 1						X
111	<i>Pericapritermes semarangi</i>			X	X		X
112	<i>Pericapritermes latignathus</i>			X	X		X
113	<i>Pericapritermes nitobei</i>			X			
114	<i>Pericapritermes</i> sp. 1						X
115	<i>Pericapritermes</i> sp. 2						X
116	<i>Pericapritermes</i> sp. 3						X
117	<i>Pericapritermes</i> sp. 4						X
118	<i>Pericapritermes</i> sp. 5						X
119	<i>Pericapritermes</i> sp. 6						X
120	<i>Procapritermes parasilvaticus</i>			X			X
121	<i>Procapritermes prosetiger</i>			X			X
122	<i>Procapritermes longignathus</i>			X			X
123	<i>Procapritermes</i> sp. 1						X
124	<i>Procapritermes</i> sp. 2						X
125	<i>Procapritermes</i> sp. 3						X
126	<i>Procapritermes</i> sp. 4						X
127	<i>Procapritermes</i> sp. 5						X
128	<i>Procapritermes</i> sp. 6						X
129	<i>Mirocapritermes concaveus</i>			X			X
130	<i>Mirocapritermes latignathus</i>			X			X
131	<i>Mirocapritermes prewensis</i>			X			
132	<i>Mirocapritermes connectens</i>			X			

Table 2 (cont.) Termite species of Thailand reported from 1913-2004.

No.	Termite species	References					Present study (2004)
		Holmgren (1913)	Snyder (1949)	Ahmad (1965)	Morimoto (1973)	Intanai (1987)	
133	<i>Mirocapritermes</i> sp. 1						X
134	<i>Mirocapritermes</i> sp. 2						X
135	<i>Homallotermes</i> sp. 1						X
136	<i>Homallotermes</i> sp. 2						X
137	<i>Angulitermes</i> sp. 1						X
138	<i>Angulitermes</i> sp. 2						X
139	<i>Angulitermes</i> sp. 3						X
140	<i>Angulitermes</i> sp. 4						X
4.3 SF. Apicotermitinae							
141	<i>Indotermes thailandis</i>			X			X
142	<i>Euhamitermes hamatus</i>			X			X
143	<i>Euhamitermes</i> sp. 1						X
144	<i>Euhamitermes</i> sp. 2						X
145	<i>Euhamitermes</i> sp. 3						X
146	<i>Euhamitermes</i> sp. 4						X
147	<i>Euhamitermes</i> sp. 5						X
148	<i>Euhamitermes</i> sp. 6						X
149	<i>Speculitermes macrodentatus</i>			X			X
150	<i>Speculitermes rongrensis</i>				X		X
151	<i>Spculitermes</i> sp. 1						X
4.4 SF. Nasutitermitinae							
152	<i>Nasutitermes johoricus</i>			X			X
153	<i>Nasutitermes matangensisformis</i>			X		X	X
154	<i>Nasutitermes fuscipennis</i>			X			X
155	<i>Nasutitermes dimorphus</i>			X	X		X
156	<i>Nasutitermes matangensis</i>				X		X
157	<i>Nasutitermes tungsalangensis</i>			X			X
158	<i>Nasutitermes brachynasutus</i>				X		X
159	<i>Nasutitermes profuscipennis</i>					X	
160	<i>Nasutitermes preparvus</i>			X	X		X
161	<i>Nasutitermes havilandi</i>				X		X
162	<i>Nasutitermes</i> sp. 1						X
163	<i>Nasutitermes</i> sp. 2						X
164	<i>Nasutitermes</i> sp. 3						X
165	<i>Nasutitermes</i> sp. 4						X
166	<i>Nasutitermes</i> sp. 5						X

Table 2 (cont.) Termite species of Thailand reported from 1913-2004.

No.	Termite species	References					Present study (2004)
		Holmgren (1913)	Snyder (1949)	Ahmad (1965)	Morimoto (1973)	Intanai (1987)	
167	<i>Nasutitermes</i> sp. 6						X
168	<i>Nasutitermes</i> sp. 7						X
169	<i>Nasutitermes</i> sp. 8						X
170	<i>Bulbitermes parapusillus</i>			X	X		X
171	<i>Bulbitermes laticephalus</i>			X	X		X
172	<i>Bulbitermes prabhae</i>			X			X
173	<i>Bulbitermes makhamensis</i>			X			X
174	<i>Bulbitermes deltocephalus</i>				X		
175	<i>Bulbitermes germanus</i>				X		
176	<i>Bulbitermes</i> sp. 1						X
177	<i>Bulbitermes</i> sp. 2						X
178	<i>Bulbitermes</i> sp. 3						X
179	<i>Bulbitermes</i> sp. 4						X
180	<i>Bulbitermes</i> sp. 5						X
181	<i>Bulbitermes</i> sp. 6						X
182	<i>Bulbitermes</i> sp. 7						X
183	<i>Hospitalitermes birmanicus</i>				X		
184	<i>Hospitalitermes ataramensis</i>			X		X	X
185	<i>Hospitalitermes jepsoni</i>			X			X
186	<i>Hospitalitermes medioflavus</i>				X		
187	<i>Hospitalitermes asahinai</i>				X		
188	<i>Hospitalitermes bicolor</i>						X
189	<i>Hospitalitermes</i> sp. 1						X
190	<i>Hospitalitermes</i> sp. 2						X
191	<i>Hospitalitermes</i> sp. 3						X
192	<i>Aciculitermes maymyoensis</i>			X			X
193	<i>Aciculitermes</i> sp. 1						X
194	<i>Havilanditermes proatripennis</i>			X	X		X
195	<i>Longipeditermes longipes</i>						X
196	<i>Lacessititermes</i> sp. 1						X
197	<i>Lacessititermes</i> sp. 2						X
198	<i>Lacessititermes</i> sp. 3						X
199	<i>Lacessititermes</i> sp. 4						X

LITERATURE CITED

- Abe, T. and T. Inoue. 1993. Fauna and nesting habits of termites in peat swamp forest and rubber plantation at Narathiwat, Southern Thailand- preliminary report. **Island Studies in Okinawa** 11: 43-54.
- Ahmad, M. 1958. Key to the Indomalayan Termites. **Biologia** 4: 1988.
- Ahmad, M. 1965. Termites (Isoptera) of Thailand. **Bulletin of the American Museum of National History** 131: 3-113.
- Davies, R. G. 1997. Termite species richness in fire-prone and fire-protected dry deciduous dipterocarp forest in Doi Suthep-Pui National Park, northern Thailand. **J. Trop. Ecol.** 13: 153-160.
- Holmgren, N. 1913. "Termitenstudien. 4 Versuch Einer Systematischen Monographic der Termiten der orientalischen Region" K. Svenska Netensk. **Handl.** 50: 2(1-276).
- Inoue, T., Y. Takematsu, F. Hyodo, A. Sugimoto, A. Yamada, C. Klangkaew, N. Kirtibutr and T. Abe. 2001. The abundance and biomass of subterranean termites (Isoptera) in a dry evergreen forest of northeast Thailand. **Sociobiology** 37(1): 41-52.
- Intanai, I. 1987. **Taxonomic Studies and Some of Their Ecological Factors of Termites in Chanthaburi and Trat Province.** M.S. Thesis, Chulalongkorn University, Bangkok.
- Klangkaew, C., T. Inoue, T. Abe. Y. Takematsu, T. Kudo, N. Noparatnaraporn and N. Kirtibutr. 2002. The diversity and abundance of termites (Isoptera) in the urban area of Bangkok, Thailand. **Sociobiology** 39(3): 485-493.
- Krishna, M. 1965. Termites (Isoptera) of Burma. **American Museum Novitates** 2210: 1-34.
- Krishna, K. and F.M. Weesner. 1969. **Biology of Termites. Vol. I.** Academic Press. Inc., New York. 598 p.
- _____. 1970. **Biology of Termites. Vol. II.** Academic Press. Inc., New York. 643 p.
- Morimoto, K. 1973. Termite from Thailand. **Bull. Government Forest Explain Station** 257: 57-80.
- Pearce, M. J. 1999. **Termites: Biology and Pest Management.** CAB international, London. 172 p.
- Roonwall, M.L. 1969. Measurement of termites (Isoptera) for taxonomic purposes. **J. Zool. Soc. India** 21(1): 9-66.
- Snyder, T. E. 1949. Catalog of the termites (Isoptera) of the world. **Smithsonian Mus. Coll.** 112: 1-490.
- Sornnuwat, Y., K. Charoenkrung, S. Chutibhapakorn and C. Vongkaluang. 2003. Termite Survey in Secondary Dry Dipterocarp Forest at Srinakarin Dam National Park, Kanchanaburi Province, Western Thailand, pp. 517-522. **In Proceedings of The 2nd International Conference on Medicinal Mushroom and the International Conference Biodiversity and Bioactive Compounds.** 17-19 July 2003, Pattaya, Thailand.
- Sugio, K. 1995. Trunk trail foraging of the fungus-growing termite *Macrotermes carbonarius* (Hagen) in Southeastern Thailand. **Tropic.** 4: 211-222.
- Takemastue, Y., T. Inoue, F. Hyodo, A. Sugimoto, N. Kirtebutr and T. Abe. 2003. Diversity of Nest Types in *Microcerotermes crassus* (Termitinae, Termitidae, Isoptera) in a Dry Evergreen Forest of Thailand. **Sociology** 42(3): 587-596.
- Thapa, R. S. 1981. **Termites of Sabah.** Sabah Forest Record Number 12. 374 p.
- Tho, Y. P. 1992. **Termites of Peninsula Malaysia.** Malaysia Forest Records No.36. 224p.
- Vongkaluang, C., Y. Sornnuwat, K. Charoenkrung, S. Chutibhapakorn and Y. Takematsu. 2003. Survey and Study on Ecology and Diversity of Termites in Three Forest Types of Chanthaburi Province, Eastern Thailand, pp.

- 523-528. *In* **Proceedings of The 2nd International Conference on Medicinal Mushroom and the International Conference Biodiversity and Bioactive Compounds**. 17-19 July 2003, Pattaya, Thailand.
- Watanabe, H. H. Takeda, S. Ruaysoongnern. 1984. Termites of northeastern Thailand with special reference to changes in species composition due to shift cultivation. **Mem. Coll. Agric., Kyoto Univ.** 125 : 45-57.
- Watsan, J.A.L. and F.J. Gay. 1997. Isoptera, pp. 9-26 *In* N. Kirtibutr and T. Abe (eds.). **Biology and Ecology of Termites**. Kasetsart University, Bangkok.