

THE TERMITE (INSECTA: ISOPTERA) FAUNA OF PASOH FOREST RESERVE, MALAYSIA

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DEDICATION. - In memory of the late Dr Tho Yow Pong. He left us with an indispensable body of work on the termites of Southeast Asia.

ABSTRACT. - Pasoh Forest Reserve, in Peninsular Malaysia, is one of the most intensively studied forest sites in Southeast Asia. Despite previous studies on termites, some of which have involved considerable collecting effort, no adequate species checklist of the termite fauna of Pasoh has ever been provided. To advance our knowledge of the fauna, termites were sampled at Pasoh in 1994 using a standardised transect method, resulting in 52 species being collected. This paper presents the first consolidated species checklist for Pasoh, based on the 1994 collection plus additional species compiled from published records. A total of 80 species is now known from Pasoh. A breakdown of the taxonomic and functional composition is presented. *Bulbitermes makhamensis* is shown to be a junior synonym of *B. prabhae*.

KEYWORDS. - Kalotermitidae, Rhinotermitidae, Termitidae, species composition.

INTRODUCTION

Pasoh Forest Reserve, in Peninsular Malaysia, is arguably the most intensively studied area of forest on the mainland of Southeast Asia. Between 1970 and 1978 the International Biological Programme and the University of Malaya coordinated a series of large research projects designed to investigate the ecology of the forest at Pasoh (Lee, 1995). In 1985, under the management of the Forest Research Institute of Malaysia, a 50 hectare permanent research plot was set up to allow the trees to be catalogued and forest dynamics to be monitored (Manokaran et al., 1990). These initiatives, and numerous smaller projects, have produced a wealth of knowledge about the flora and fauna of the forest. As a result, Pasoh Forest

Reserve is now a valuable scientific resource, as well as being an important regional example of primary lowland forest.

There is a large but scattered literature concerning the termite fauna of Pasoh. Morimoto (1976) listed 12 species, while Tho's (1982) locality records indicate that he identified 26 species from Pasoh. However, the most intensive work on the termite fauna was the ecological research conducted by Abe and Matsumoto (see Abe, 1979; Abe & Matsumoto, 1979; Matsumoto & Abe, 1979), during which they collected a total of 57 species (Abe, 1978). Unfortunately, only 7 of these were identified to named species, while the remainder consisted of numbered morphospecies, identified only to genus. There are many differences, even at the generic level, between Abe's (1978) list and the records of Tho (1982) and Morimoto (1976). These discrepancies indicate that the labour intensive fieldwork of Abe and Matsumoto failed to collect at least 6 species which have been recorded from Pasoh. Despite all these studies, a definitive species checklist, compiled from all the previous data on the termites of Pasoh, has never been published. As a consequence, the only indication of the taxonomic structure of Pasoh's termite assemblage is the number of species per subfamily offered by Collins (1984), based on Abe's (1978) incomplete species list.

Given the central ecological role of termites in tropical forest systems (see Wood & Sands, 1978; Collins, 1983; Eggleton et al., 1996) it is important to understand the taxonomic and functional composition of termite assemblages. This paper presents the results of an examination of termites collected at Pasoh in 1994 using a standardised transect sampling protocol. Within this material a total of 52 species are recognised. In addition, we have attempted to locate all published records of termites from Pasoh, and where these identifications are considered reliable, to incorporate them into one consolidated species checklist. This consolidated list is then used to produce a breakdown of the species composition of the termite assemblage at Pasoh Forest Reserve. The aim of this paper is to provide the most accurate list to date of the termite fauna of Pasoh. A detailed analysis comparing the termite assemblage at Pasoh with other forest sites where the standardised transect sampling protocol has been used will be published elsewhere.

MATERIALS AND METHODS

Study Site. - Pasoh Forest Reserve (2°59' N, 102°18' E) is located in the state of Negeri Sembilan, and varies in altitude from 90 - 150 m above sea level. The reserve consists of a core area of 600 ha of primary lowland mixed dipterocarp forest (the floristics are described by Kochummen et al., 1990; Manokaran et al., 1992), surrounded by 2450 ha of secondary forest (Lee, 1995). The mean annual rainfall is about 2000 mm (Kochummen et al., 1990), with two wet seasons, one usually in November, and the other during April-May, while the dry seasons can have up to 26 rainless days per month (Soepadmo, 1978). In the Holdridge Life Zone system this habitat is classified as tropical moist forest (Holdridge et al., 1971).

The standardized transect sampling method. - Three transects were run, plus a little casual collecting, during November 1994. All sampling was conducted within about 100 m of the 50 ha permanent plot. Transects followed the protocol given by Davies (1997), Eggleton et al. (1997), and Jones et al. (in press). Transects 100 m long and 2 m wide, were divided into 20 equal sections. Each section, 5 m x 2 m in area, was sampled by two people for 30 minutes (a total of one hour of collecting per section). Within each section, the following microhabitats were searched: surface soil to 5 cm depth; accumulations of humus at the base

of trees; the inside of dead logs, tree stumps, branches and twigs; the soil within and beneath very rotten logs; all subterranean nests, mounds, carton sheeting and runways on vegetation, and arboreal nests up to a height of 2 m above ground level.

Identification of material. - A total of 161 series of termites was collected during the fieldwork. These will be deposited at the Forest Research Institute of Malaysia (Kepong), and The Natural History Museum, London (BMNH). Species were identified using relevant taxonomic publications, and with reference to the collections at the BMNH. Specimens were also compared with the extensive Darwin Initiative termite collection from Danum Valley (southeast Sabah), and material from the Maliau Basin (south central Sabah). Identification of workers was aided by examining the mandibles (Ahmad, 1950) and gut structure (Johnson, 1979).

The dimensions of key morphological characters are provided for those species which fall outside the size range given in their published descriptions (hl = head length; hw = head width; lm = left mandible; rm = right mandible; measurements in mm). All other named species fall within the stated limits. Morphospecies lettering (sp. A, B, C etc.) follows on alphabetically from those assigned to species from Danum Valley (Eggleton et al., 1997) and the Maliau Basin (Jones et al., in press). Species are the same as those from Danum or Maliau only where indicated. Several genera are in need of taxonomic revision necessitating the use of open nomenclature in this paper.

Functional groups. - Genera were assigned to one of five functional groups based on known feeding habits (see Collins, 1984; Eggleton et al., 1996; Eggleton et al., 1997; Jones et al., in press) the shape of the molar plates of the worker mandibles (Deligne, 1966) and worker gut content analyses (Sleaford et al., 1996). The five functional groups are;

1. Soil-feeding: termites that feed on humus and mineral soil.
2. Wood-feeding: termites that feed on dead wood at any stage of decay but excluding those that feed on extremely decayed and friable wood.
3. Soil/wood-feeding: termites that feed on extremely decayed wood that has lost its structure and has become soil-like. This is synonymous with the term "intermediate feeders", as used by De Souza & Brown (1994).
4. Litter-feeding: termites that feed on leaf-litter and small items of woody trash. Many species of Macrotermitinae will consume litter in certain circumstances (Lepage et al., 1993) but there is little quantitative data on how Southeast Asian species divide their diet between litter and wood. Leaf-litter forms a large proportion of the diet of *Macrotermes carbonarius*, while *M. malaccensis* and *M. gilvus* also consume some litter (Matsumoto & Abe, 1979; Tho, 1978). At least one species of *Odontotermes* in Southeast Asia has been observed consuming litter (Jones, 1996) but it is uncertain if the same is true of any of the species recorded from Pasoh. *Longipeditermes longipes* consumes leaf litter, as well as rotting wood (Matsumoto & Abe, 1979; Hoare & Jones, in press).
5. Lichen-feeding: *Hospitalitermes* and *Grallatotermes* are the only two genera known to feed on lichens and other free living non-vascular plants which they graze from the surface of tree trunks (Collins, 1979; Jones & Gathorne-Hardy, 1995; Roisin & Pasteels, 1996).

Compilation of a consolidated species checklist. - A consolidated species checklist for the Pasoh Forest Reserve is presented. This is based on the termites collected during the November 1994 fieldwork (hereafter referred to as the 1994 collection) plus additional species previously

recorded from Pasoh. However, because previous collections have not been examined, it has not been possible to cross-reference and match material with the 1994 collection. Therefore, when considering previous records for inclusion in the consolidated checklist, the following assumptions were made;

- 1) that named species were based on accurate taxonomic identification, and
- 2) that morphospecies were separated accurately to valid species by those authors.

Morphospecies were only added to the consolidated checklist if they were considered to represent extra species, i.e. in addition to the named species already recorded for that genus. For example, Abe (1978) listed three morphospecies of *Schedorhinotermes* from Pasoh, while four named species have been recorded; two in the 1994 collection, and two different species by Morimoto (1976). Abe's three morphospecies have not been added to the consolidated checklist on the assumption that they may be the same as three of the named species already on the list. However, in the case of *Odontotermes*, the 1994 collection contains five named species and one morphospecies, while Abe (1978) listed seven morphospecies. Therefore, one morphospecies from Abe's list must be added to the consolidated list on the assumption that Abe's other six species could be the same as the six species in the 1994 collection. This conservative assessment procedure was considered in the light of taxonomic revisions, and discussed below under the relevant genus when necessary.

TAXONOMIC AND IDENTIFICATION NOTES

The consolidated species checklist for Pasoh, based on the 1994 collection plus additional species previously recorded from Pasoh, is given in Table 1, with the source of records indicated. Where records were ambiguous, the decision to reject or include is explained below. Character measurements are included below when they extend the limit of the published size range.

FAMILY RHINOTERMITIDAE LIGHT, 1921 SUBFAMILY RHINOTERMITINAE FROGGATT, 1896

Parrhinotermes. - *Parrhinotermes minor* is slightly larger than Thapa's (1981) size range, which he described from five soldiers (one soldier from Pasoh: hl = 0.85; hw = 0.75; lm = 0.50; rm = 0.51).

FAMILY TERMITIDAE LIGHT, 1921 SUBFAMILY MACROTERTITINAE KEMNER, 1934

Macrotermes. - *Macrotermes carbonarius*, *M. gilvus* and *M. malaccensis* were all found at Pasoh by Abe (1978), and Tho (1982). However, a fourth species was recorded by Tho (1982), which he considered to be a new species. The figures and size range do not appear to fit any of the three new species of *Macrotermes* described by Thapa (1981) from material collected in Sabah.

Odontotermes. - Separation and identification of *Odontotermes* species using the soldier caste has been based mainly on head capsule size and the position of the tooth on the left mandible.

However, as Tho (1992) makes clear, because of their morphological similarity and variation in size, positive identifications may not always be possible until the genus is revised. The soldier size ranges of the *Odontotermes* species in the 1994 collection are provided below because they frequently fall slightly outside the ranges given by Holmgren (1913), Ahmad (1965) and Thapa (1981).

Odontotermes denticulatus: hl = 1.40 - 1.64; hw = 1.20 - 1.38; n = 33 from three colonies. Two soldiers from one colony of *O. grandiceps*: hl = 2.48 & 2.59; hw = 2.10 & 2.16. One soldier of *O. longignathus*: hl = 2.89; hw = 2.40. Two soldiers of *O. oblongatus* from separate colonies: hl = 2.02 & 2.05; hw = 1.34 & 1.40. Soldiers of *O. sarawakensis*: hl = 1.19 - 1.28; hw = 0.99 - 1.08; n = 20 from five colonies.

Hypotermes. - Abe (1978) recorded one unidentified species of *Hypotermes* from Pasoh. Within Peninsular Malaysia, *H. xenotermitis* (Wasmann) is known from Perlis in the north of the country, and Tho (1982) recorded a possible second species from Kepong, in the south.

Ancistrotermes. - Akhtar & Hussain (1980) transferred *Microtermes pakistanicus* to the genus *Ancistrotermes* based on their study of the armature of the enteric valve, antennal segmentation, and the fact that the soldier caste is dimorphic in size. Soldiers and workers of *A. pakistanicus* from the 1994 collection differ slightly in the size ranges given by Tho (1982, under the name *Microtermes*). Major soldiers: hl = 1.00 - 1.04; hw = 1.02 - 1.06; n = 9 from five colonies. Minor soldiers: hl = 0.80 - 0.88; hw = 0.82 - 0.88; n = 35 from six colonies. Major worker: hw = 1.03 - 1.26; n = 37 from four colonies. Minor worker: hw = 0.82 - 0.91; n = 40 from five colonies.

SUBFAMILY APICOTERMITINAE GRASSÉ & NOIROT, 1954

Euhamitermes. - The 1994 collection contains a single series of *Euhamitermes* workers. Holmgren originally described *E. hamatus* from Singapore and Malacca (Holmgren, 1912, 1913). The description was based on the soldier caste and no description of the worker was provided. However, the worker mandibles of the specimens in the 1994 collection are very close to those of the Indian species of *Euhamitermes* (Roonwal & Chhotani, 1965).

SUBFAMILY TERMITINAE SJÖSTEDT (MODIFIED)

Labritermes. - Two series of *Labritermes emersoni* were collected, and their size range falls outside that given in the original description by Krishna & Adams (1982) (Pasoh: hl = 1.05 - 1.11; hw = 0.66 - 0.71; n = 13 from two colonies).

Microcerotermes. - Tho (1982) recorded *Microcerotermes dubius* and *M. havilandi* from Pasoh, while Abe (1978) listed four morphospecies, two of which have been added to the consolidated list. Morimoto (1976) identified *M. annadalei* Silvestri and *M. paracelebensis* Ahmad from Kuala Pilah, which is located approximately 20 km south of Pasoh. These latter two species may be two of Abe's morphospecies.

CAPRITERMES GROUP (SUBFAMILY TERMITINAE)

Mirocapritermes. - *Mirocapritermes connectens* Holmgren was collected in 1994 and previously by Morimoto (1976, misspelt as *Microcapritermes*). Abe (1978) recorded one unidentified species.

Procapritermes. - Four species of *Procapritermes* were recognized in the 1994 collection. Of these, *P.* sp. B is the same as *P.* sp. B from Danum (Eggleton et al., 1997), and *P. ?neosetiger* is very close to Tho's (1982) *Procapritermes* sp. A.

Procapritermes proved to be a problematic genus when compiling the consolidated checklist. This is because Ahmad & Akhtar (1981) transferred nine species of *Procapritermes* into closely related genera in the *Capritermes* group. Abe (1978) recorded six morphospecies which he assigned to *Procapritermes*. However, as no descriptions were given it is now uncertain to which genus each belongs, and therefore Abe's six morphospecies have been disregarded.

Kemneritermes. - One series of *Kemneritermes* sp. A was found in the 1994 collection. The workers have similar mandibles and enteric valve structure to that described by Ahmad & Akhtar (1981), and the single soldier is close in shape and size to *K. sarawakensis* Ahmad & Akhtar. The soldier of *K.* sp. A appears to be very similar to Tho's (1982) description of *Procapritermes* sp. F.

Coxocapritermes. - The 1994 collection contains two species of *Coxocapritermes*. The enteric valve and mandibles of the workers, and the soldiers (with enlarged fore coxae) match the generic description given by Ahmad & Akhtar (1981). *Coxocapritermes* sp. A is similar to *C. orientalis* Ahmad & Akhtar, although the soldiers are larger (Pasoh soldier: hl = 2.72 - 3.15; hw = 1.72 - 1.86; rm = 2.86 - 3.10; n = 11 from three colonies). *C.* sp. B is very close to a species recorded from Pasoh by Tho (1982), which he identified as *Procapritermes angustignathus* (Holmgren) (and misspelt as *angustignathus*).

Pericapritermes. - The genus *Pericapritermes* is easily identified from the kidney-shaped swelling in the P1 of the worker gut, which can be readily observed through the abdominal wall in ventral view. The 1994 collection contains five species, of which, *P.* sp. C is represented only by workers. *Pericapritermes* sp. C may be the same as *P.* sp. A described by Tho (1982) as the workers' head-width size ranges overlap. *Pericapritermes* sp. D from the 1994 collection, appears to be the same as *P.* sp. D described by Tho (1982).

SUBFAMILY NASUTITERMITINAE HARE, 1937

Nasutitermes. - Five species were recognised in the 1994 collection, and a sixth named species was identified by Morimoto (1976). Abe (1978) listed five morphospecies, so these were ignored. It is unknown how many species Tho (1982) found in Pasoh because locality records were not provided for this genus. The upper limit on the size range of *Nasutitermes neoparvus* soldiers in the 1994 collection is slightly larger than that given in Thapa's (1981) description (Pasoh soldier: hl = 1.18 - 1.29; hw = 0.63 - 0.74; n = 15 from four colonies).

Bulbitermes. - *Bulbitermes germanus* was matched with a vial of material from Malacca determined by Holmgren (BMNH 1894-231). However, this species is difficult to separate

from *B. sarawakensis* and *B. singaporiensis* (see Tho, 1992). The key given by Morimoto (1973) is not adequate and the group is in need of revision since the limits of variation of many soldier characters are uncertain. *Bulbitermes* sp. A falls within the limits of *B. sp. A* collected from Danum (Eggleton et al., 1997) and the Maliau Basin (Jones et al., in press). *Bulbitermes* sp. A shows considerable variation in soldier head capsule size and shape, however, and may conceal a complex of very similar species.

The 1994 collection contains three series of *Bulbitermes prabhae*, a species originally described from Burma (Krishna, 1965). Later the same year, a very similar species, *B. makhamensis*, was described from Thailand by Ahmad (1965, p. 84) on the basis that the soldier head "is larger and lighter in colour and the head bulges more laterally below the middle" than *B. prabhae*. An examination of the Pasoh material and several tubes of material held at the BMNH, plus published size ranges (Table 2) clearly shows that *B. prabhae* soldiers are highly variable in size. It is apparent from the description of *B. makhamensis*, and a paratype soldier held at the BMNH, that *B. makhamensis* falls within the natural variation of size, shape and colour of *B. prabhae*. We therefore consider *B. makhamensis* to be a junior synonym of *B. prabhae*. The type locality details of *B. makhamensis* are identical to those for a series of *B. prabhae* also collected by Ahmad (1965), suggesting that he may have inadvertently removed larger individuals from the same colony and described them as a new species. It should be noted that the number of antennal articles on four paratype soldiers of *B. prabhae* (BMNH 1966-482) varied from 13 to 15, although Krishna (1965, p. 27) stated that the soldiers have 14 articles. The morphospecies *Bulbitermes* sp. C from Pasoh, described by Tho (1982) may be *B. prabhae*, and therefore Tho's record has not been included in the consolidated checklist.

Hospitalitermes. - The 1994 collection contains three species of *Hospitalitermes*; *H. medioflavus* and two unnamed morphospecies. Tho (1982) identified *H. hospitalis* and *H. umbrinus* from Pasoh, while Abe (1978) listed two morphospecies. Matsumoto (1976) recorded *H. flaviventris* but this name was not used in any of Matsumoto or Abe's subsequent publications on Pasoh, suggesting there was uncertainty in the identity of this species. There are at least 18 described species in the genus (Tho, 1992) but many can only be separated on subtle differences in colour and head shape of the soldier caste. However, it is not always certain how consistent these characters are within each species, and there is a pressing need to revise this genus (using soldier and worker characters) and to use a standard colour chart when redescribing species. In the absence of confident identifications we have only included the three species from the 1994 collection in the consolidated list.

Lacessititermes. - *Lacessititermes* sp. D from the 1994 collection appears to be the same as *L. sp. D* found in the Maliau Basin (Jones et al., in press). Abe listed two morphospecies, one of which was figured (Abe, 1978, Fig. 3) as building an arboreal carton nest with conical projections on the exterior surface. Tho (1982, Fig. 153) and John (1925, Figs. 19 and 21) clearly indicate that such a nest structure is characteristic of *L. laborator*, and so this specific name has been added to the consolidated list.

SUBULITERMES GROUP (NASUTITERMITINAE)

Four genera in the *Subulitermes* group have been recorded from Pasoh. *Leucopitermes leucops* is slightly larger than the size given by Ahmad (1968) and Thapa (1981) in their descriptions (Pasoh soldier: hl = 1.36 - 1.48; hw = 0.70 - 0.76; n = 15 from two colonies). Morimoto

(1976) described a new species, *L. paraleucops*. *Subuloiditermes* sp. A is the same as *S.* sp. A from Danum Valley (Eggleton et al., 1997).

TAXONOMIC AND FUNCTIONAL COMPOSITION

The taxonomic composition of the termite assemblage at Pasoh Forest Reserve, based on the consolidated checklist (Table 1) which comprises 80 species, is shown in Fig. 1a. The lower termites (Kalotermitidae and Rhinotermitidae) represent 15% of the assemblage, while the four subfamilies of the higher termites (Termitidae) make up the rest. The Nasutitermitinae and Termitinae are the dominant groups, each with roughly one third of the recorded species. The Macrotermitinae (the fungus-growing termites) make up 16% of species.

The functional composition, based on the consolidated checklist, is shown in Fig. 1b. Over half the recorded species in the Pasoh assemblage are wood-feeders (54%), while species that feed on both wood and leaf-litter represent another 5%. The soil-feeders make up 31%. Termites that feed on highly decayed soil-like wood represent 6% of the total recorded species, and lichen-feeders account for only 4%. It has been postulated that soil-feeding has arisen possibly five times within the Isoptera (Bignell & Eggleton, 1995). Four of these soil-feeding clades are represented at Pasoh; the *Capritermes* group (Termitinae) represent 19% of the recorded assemblage while the *Subulitermes* group (Nasutitermitinae) another 10%. The other two clades are represented by one species each, *Labritermes emersoni* (from the *Foraminitermes* group), and *Euhamitermes* sp. (Apicotermitinae). The fifth clade, the *Cubitermes* group, is African in its distribution.

DISCUSSION

As it has not been possible to examine previous Pasoh collections, the consolidated checklist in Table 1 gives an accurate representation of all collections made to date only insofar as the material has been correctly identified. Tendencies among earlier taxonomists to “split” or “lump” species when identifying Pasoh material will have over- or underestimated the richness of their collections. Furthermore, the consolidated list may be an underestimate

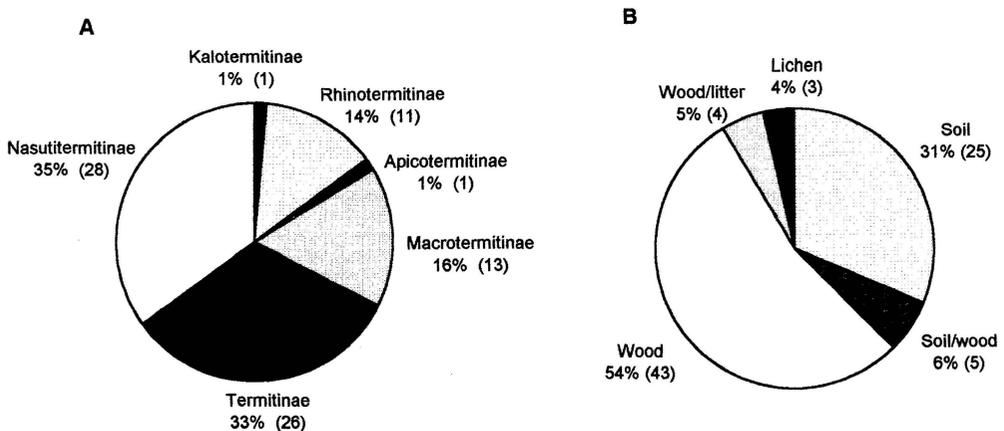


Fig. 1. Species composition of the known termite assemblage at Pasoh Forest Reserve, based on the 80 species listed in Table 1. Taxonomic composition (A), and functional composition (B). The number of species per group is given in parenthesis.

Table 1. Consolidated checklist of the 80 termite species recorded from Pasoh Forest Reserve, Peninsular Malaysia. The list is based on the 52 species identified in the 1994 collection plus previous published records. Decisions to include or reject records are discussed in the text. Species were assigned to one of five functional groups; wood-feeders (W), soil-feeders (S), Soil/wood-feeders (S/W), litter-feeders (L), and lichen-feeders (M). Sources; J = Jones & Brendell, this paper (the 1994 collection); T = Tho, 1982; A = Abe (1978) and Abe & Matsumoto (1979); M = Morimoto, 1976.

Species	Feeding Group	Source
KALOTERMITIDAE		
<i>Cryptotermes thalindis</i> Ahmad, 1965	W	M
RHINOTERMITIDAE		
<i>Coptotermes curvignathus</i> Holmgren, 1913	W	T
<i>Coptotermes</i> sp. 2	W	A
<i>Termitogeton planus</i> (Haviland, 1898)	W	T
<i>Parrhinotermes buttelreepeni</i> Holmgren, 1913	W	T
<i>Parrhinotermes minor</i> Thapa, 1981	W	J
<i>Parrhinotermes pygmaeus</i> John, 1925	W	J
<i>Parrhinotermes</i> sp. A	W	J
<i>Schedorhinotermes javanicus</i> Kemner, 1934	W	J
<i>Schedorhinotermes tarakanensis</i> (Oshima, 1914)	W	J
<i>Schedorhinotermes malaccensis</i> (Holmgren, 1913)	W	M
<i>Schedorhinotermes sarawakensis</i> (Holmgren, 1913)	W	M
TERMITIDAE		
Macrotermitinae		
<i>Macrotermes carbonarius</i> (Hagen, 1858)	WL	J, A, T
<i>Macrotermes gilvus</i> (Hagen, 1858)	WL	J, A, T
<i>Macrotermes malaccensis</i> (Haviland, 1898)	WL	J, M, A, T
<i>Macrotermes</i> sp. 4	W	T
<i>Odontotermes denticulatus</i> Holmgren, 1913	W	J
<i>Odontotermes grandiceps</i> Holmgren, 1912	W	J
<i>Odontotermes longignathus</i> Holmgren, 1914	W	J
<i>Odontotermes oblongatus</i> Holmgren, 1913	W	J
<i>Odontotermes sarawakensis</i> Holmgren, 1913	W	J, M
<i>Odontotermes</i> sp. D	W	J
<i>Odontotermes</i> sp. 7	W	A
<i>Ancistrotermes pakistanicus</i> (Ahmad, 1955)	W	J, T
<i>Hypotermes</i> sp.	W	A
Apicotermitinae		
<i>Euhamitermes</i> sp.	S	J
Termitinae		
<i>Prohamitermes mirabilis</i> (Haviland, 1898)	S/W	J, T
<i>Labritermes emersoni</i> Krishna & Adams, 1982	S	J
<i>Amitermes dentatus</i> (Haviland, 1898)	W	A
<i>Microcerotermes dubius</i> (Haviland, 1898)	W	J, T
<i>Microcerotermes havilandi</i> Holmgren, 1913	W	T
<i>Microcerotermes</i> sp. 3	W	A
<i>Microcerotermes</i> sp. 4	W	A
<i>Termes comis</i> Haviland, 1898	S/W	T
<i>Termes rostratus</i> Haviland, 1898	S/W	T
<i>Termes propinquus</i> (Holmgren, 1914)	S/W	M
<i>Homalotermes foraminifer</i> (Haviland, 1898)	S/W	A, T
<i>Mirocapritermes connectens</i> Holmgren, 1913	S	J, M
<i>Procapritermes ?neosetiger</i> Thapa, 1981	S	J
<i>Procapritermes setiger</i> (Haviland, 1898)	S	J, T
<i>Procapritermes</i> sp. B	S	J
<i>Procapritermes</i> sp. E	S	J
<i>Kemneritermes</i> sp. A	S	J
<i>Coxocapritermes</i> sp. A	S	J

Species	Feeding Group	Source
<i>Coxocapritermes</i> sp. B	S	J
<i>Pericapritermes dolichocephalus</i> (John, 1925)	S	J
<i>Pericapritermes mohri</i> (Kemner, 1934)	S	M
<i>Pericapritermes nitobei</i> (Shiraki, 1909)	S	J
<i>Pericapritermes semarangi</i> (Holmgren, 1913)	S	J
<i>Pericapritermes</i> sp. C	S	J
<i>Pericapritermes</i> sp. D	S	J
<i>Dicuspiditermes nemorosus</i> (Haviland, 1898)	S	J, M, A, T
Nasutitermitinae		
<i>Havilanditermes atripennis</i> (Haviland, 1898)	W	J
<i>Havilanditermes</i> sp. 2	W	A
<i>Nasutitermes longinasus</i> (Holmgren, 1913)	W	J
<i>Nasutitermes matangensisformis</i> (Holmgren, 1913)	W	J
<i>Nasutitermes matangensis</i> (Haviland, 1898)	W	J
<i>Nasutitermes neoparvus</i> Thapa, 1981	W	J
<i>Nasutitermes tungsalangensis</i> Ahmad, 1965	W	M
<i>Nasutitermes</i> sp. C	W	J
<i>Bulbitermes germanus</i> (Haviland, 1989)	W	J, T
<i>Bulbitermes parapusillus</i> Ahmad, 1965	W	M
<i>Bulbitermes perpusillus</i> (John, 1925)	W	T
<i>Bulbitermes prabhae</i> Krishna, 1965	W	J
<i>Bulbitermes singaporiensis</i> (Haviland, 1898)	W	T
<i>Bulbitermes</i> sp. A	W	J
<i>Lacessititermes laborator</i> (Haviland, 1898)	W	A
<i>Lacessititermes</i> sp. D	W	J
<i>Hospitalitermes medioflavus</i> (Holmgren, 1913)	M	J
<i>Hospitalitermes</i> sp. E	M	J
<i>Hospitalitermes</i> sp. F	M	J
<i>Longipeditermes longipes</i> (Haviland, 1898)	LW	J, A, T
<i>Leucopitermes leucops</i> (Holmgren, 1914)	S	J
<i>Leucopitermes paraleucops</i> Morimoto, 1976	S	M
<i>Oriensubulitermes inanis</i> (Haviland, 1898)	S	J
<i>Oriensubulitermes</i> sp. 2	S	A
<i>Oriensubulitermes</i> sp. 3	S	A
<i>Proaciculitermes</i> sp. D	S	J
<i>Subuloiditermes</i> sp. A	S	J
<i>Subuloiditermes</i> sp. B	S	J

because only those morphospecies which exceeded the number of named species in each genus were included.

Two soldierless genera, *Protohamitermes* and *Orientotermes*, occur in Southeast Asia (Ahmad, 1976), as well as some genera in which soldiers are very rare (e.g. *Euhamitermes*). It is, therefore, not uncommon to collect series, particularly from soil samples, that contain only workers, or series of mixed species. It is important to emphasise the need to correctly sort and identify the worker caste if accurate estimates of species richness are to be recorded.

It is probable that given greater sampling effort at Pasoh, more species will be uncovered (e.g. searching dry wood from the canopy is likely to turn up additional species of kalotermitids). By comparison, 93 species have now been recorded from the Danum Valley area (Homathevi pers. com.), the most intensively sampled forest system in Southeast Asia. Therefore, we suggest that the 80 species in Table 1 are a conservative total for the termite diversity of Pasoh Forest Reserve.

Table 2. Measurements of head length and head width (in mm) of *Bulbitermes prabhae* and *B. makhamensis*, from sites in Thailand, Burma, Vietnam and Peninsular Malaysia. *Bulbitermes makhamensis* is now proposed as a junior synonym of *B. prabhae* (see text for justification). Asterisk indicates that material was not examined but measurements are from the description.

	Head length	Head width	number of soldiers
<i>B. prabhae</i> Krishna			
Holotype; Maymyo, Burma (Krishna, 1965)*	1.89	1.10	1
Paratype; Maymyo, Burma (Krishna, 1965)*	1.67 - 1.94	0.92 - 1.17	30 from two colonies
Paratype; Maymyo, Burma (BMNH 1966-482)	1.76 - 1.88	0.97 - 1.07	4 from the type colony
Paratype; Pa-an, Burma (Krishna, 1965)*	1.56 - 1.79	0.79 - 1.00	20 from one colony
Several sites in Thailand (Ahmad, 1965)*	1.37 - 1.76	0.59 - 1.09	22 from several colonies
Bangkok, Thailand (BMNH 1966-391)	1.66 - 1.74	0.92 - 1.08	3 from one colony
Bangkok, Thailand (BMNH 1928-343)	1.69 - 1.79	1.02 - 1.10	10 from one colony
Tung Sa-Lang, Thailand (BMNH 1972-489)	1.78 - 1.80	1.04 - 1.05	2 from one colony
Cau Du, Vietnam (BMNH 1966-465)	1.34 - 1.50	0.78 - 0.89	7 from one colony
Pasoh, Malaysia (collected November 1994)	1.48 - 1.72	0.74 - 0.98	27 from three colonies
<i>B. makhamensis</i> Ahmad			
Holotype; Makham, Thailand (Ahmad, 1965)*	1.80	1.20	1
Type colony; Makham, Thailand (Ahmad, 1965)*	1.75 - 1.95	1.15 - 1.25	10 from the type colony
Paratype; Makham, Thailand (BMNH 1972-489)	1.64	0.93	1 from the type colony

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