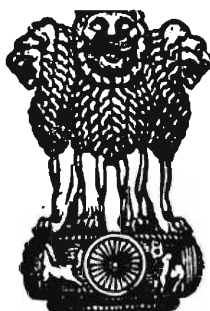


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	Pages
Taxonomy, zoogeography and phylogeny of the Genus <i>Cryptotermes</i> (Isoptera : Kalotermitidae) from the Oriental Region By O. B. Chhotani	1—81



सत्यमेव जयते

Edited by the Director, Zoological Survey of India

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TAXONOMY, ZOOGEOGRAPHY AND PHYLOGENY OF THE
GENUS *CRYPTOTERMES* (ISOPTERA : KALOTERMITIDAE)
FROM THE ORIENTAL REGION

By

O. B. CHHOTANI

Zoological Survey of India, Calcutta.

(With 30 Text-figures and 10 Tables)

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I—INTRODUCTION

(a) *General*

Kalotermitidae is a primitive family of termites and consists of essentially wood-inhabiting forms. It is thus of great economic importance. The species of the family excavate irregular, longitudinal galleries in branches of trees and logs of wood, structural timbers, etc.; generally dead wood is attacked, but occasionally the infection spreads to the adjoining living portions of the wood. They do not have any connection with soil nor do they construct any termitaria.

The species of the genus *Cryptotermes* are serious pests of structural timbers in buildings, furniture, etc., and are essentially coastal termites. Due to their habit of infesting wooden articles and structures, many of these species have become distributed, through artificial agencies, along the coasts of many countries.

Roonwal and Sen-Sarma (1960) have recently revised the oriental species of the genera *Kalotermes* and *Neotermes* of the family Kalotermitidae. The present work includes the revision of the oriental *Cryptotermes* and here I have described in detail and illustrated all the species (including a new species, *Cryptotermes roonwali*) so far recorded from this region. The types of the most of the species and those of the several of the synonyms, were examined. The zoogeography and the phylogeny of the genus is also discussed. The following 10 species are dealt with:—*brevis* (Walker); *cynocephalus* Light; *declivis* Tsai and Chen; *domesticus* (Haviland); *dudleyi* Banks; *havilandi* (Sjöstedt); *perforans* Kemner; *roonwali* sp. n.; *sumatrensis* Kemner; and *thailandis* Ahmad.

Many of the species have been described under various names; the synonymy of each species, therefore, for convenient reference and to avoid confusion, is arranged under the subheadings of different names by which a particular species has been referred to in the literature. The subheadings are arranged alphabetically and the references under each are in chronological order.

(b) *Acknowledgments*

I am very grateful to Dr. M. L. Roonwal, formerly Director, Zoological Survey of India, for his expert guidance during the course of my studies and to Dr. A. P. Kapur, for his keen interest in my work on termites and encouragements.

I also acknowledge my gratitude to the following persons and authorities for kindly sending on loan the type-specimens of several species and for giving other useful information:—

- (i) Prof. Carl H. Lindroth, Head of the Zoology Department, Lund University, Lund (Sweden).
- (ii) Dr. K. Krishna, American Museum of Natural History, New York.
- (iii) Dr. Bror Hanson, Swedish Museum of Natural History, Stockholm.
- (iv) Prof. Dr. J. K. A. van Boven, Conservator of Wasmann's Collection, Naturhistorisch Museum, Maastricht (Holland).
- (v) Dr. John Smart, Curator of Insects, Museum of Zoology, Zoology Department, Cambridge University, Cambridge (England).
- (vi) Dr. P. J. Darlington, Curator of Insects, Museum of Comparative Zoology, Harvard College, Cambridge (Mass., U. S. A.)
- (vii) Dr. W. V. Harris, Officer-in-Charge, Termite Research Unit, Commonwealth Institute of Entomology, British Museum (Natural History), London.
- (viii) Director, National Museum of Victoria, Melbourne (Australia).

(ix) Dr. P. N. Chatterjee, Forest Entomologist, Forest Research Institute of India, Dehra Dun.

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(c) *Abbreviations used*

The following abbreviations have been used throughout :—

A.M.N.H., American Museum of Natural History, New York.

B.M., British Museum (Natural History), London.

coll., collected by.

det., determined by.

ex., from or out of.

F. C. No., Field collection number.

F.R.I., Forest Research Institute, Dehra Dun.

Im., imago.

Ny., nymph.

Pw., pseudoworker.

Q., queen.

S., soldier.

Sta. No., Collecting Station Number.

U.S.N.M., United States National Museum, Washington.

Z.S.I., Zoological Survey of India, Calcutta.

II—SYSTEMATIC REVISION, PHYLOGENY AND ZOOGEOGRAPHY, ETC., OF ORIENTAL
CRYPTOTERMES

1. *General Remarks, Zoogeography, etc.*

(a) *General remarks*

The genus *Cryptotermes* was first recognised by Banks 1906, to include his new species, *Cryptotermes cavifrons*, from Florida. Subsequently some authorities (Holmgren, 1910-1913; Emerson, 1925, 1928; Bathelier, 1927; Light, 1933; Snyder, 1934; Hare, 1937; and Hill, 1942) regarded *Cryptotermes* as a subgenus of *Kalotermes* (*Calotermes* of some). It is now generally recognised as a full-fledged genus of the family Kalotermitidae.

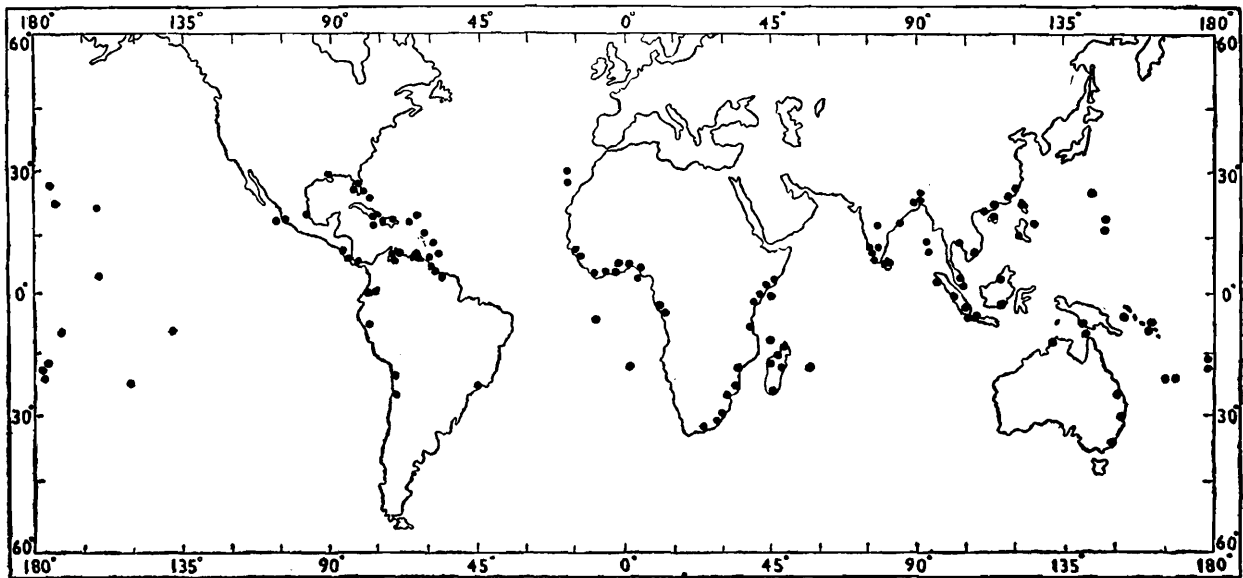
Snyder (1949) recognised 27 species in the genus and Emerson (1955) recognised 33 species (including 11 new ones) from the world. Krishna (1961) in his recent study of the Kalotermitidae has recognized only 23 species in this genus, and I have followed him in this respect. Tsai and Chen (1963) and Ahmad (1965) have described two species recently and I have further added a new species, thus bringing the total to 26.

(b) *Zoogeography and distribution* (Text-fig. 1; Table 1)

Species of genus *Cryptotermes* are essentially coastal termites except for a few records of some species found further inland (Emerson 1952; Chhotani 1963). The general range of distribution of the genus is approximately 33° N. lat. to 35° S. lat. throughout the tropics. But records of the occurrence of *Cryptotermes* are available from as far North as California and Washington, D. C. in the United States and England in Europe, which probably are cases of accidental introductions. Many of the species are cosmotropical which is mainly due to their habit of infesting wooden articles, structural timbers, etc., this makes them easily transportable through the agency of man and other artificial agencies.

The 26 species are distributed in the various zoogeographical regions as follows :—
Australian 4 (1 common with other regions), Ethiopian 5 (3 common with other regions),

Indo-Malayan 10 (5 common with other regions), Malagasy 3 (1 common with other regions), Nearctic 2 (both common with other regions), Neotropical 9 (5 common with other regions), Papuan 7 (4 common with other regions) and 1 from unknown region. The genus is well represented in the Neotropical (34.6%) and the Indo-Malayan (38.46%) regions. Due to the distribution of the same species in more than one region, some species have been described under different names from time to time, thus giving rise to several synonymies and consequent confusion in the literature.



TEXT-FIG. 1.—Map of the world, showing distribution of genus *Cryptotermes*.

(c) *Phylogenetic position*

The origin of the family Kalotermitidae seems to be from *Mastotermes*-type ancestors as is evidenced by morphology, biology and the intestinal flagellates. The imago-worker mandibles (Ahmad, 1950) of *Mastotermes darwiniensis* Froggatt, the only living species of the family Mastotermitidae, and those of the Kalotermitids are strikingly similar. The other common morphological character is the presence of spines on middle tibia of both *Mastotermes darwiniensis* Froggatt and some of the fossil and living Kalotermitids. The presence of the intestinal flagellates of the genus *Metadevescovina* in both *Mastotermes* and many of the Kalotermitids (Kirby, 1945), and the biology of both these families further confirm this origin.

The genera *Cryptotermes* and *Procryptotermes*, in both of which the median vein of the wings curves up to meet the radial sector, fall in a single group. The imago-worker mandibles (left mandible with the shortened posterior margin of 1st marginal and the elongated anterior margin of the 2nd marginal tooth and right mandible with a long posterior margin of the 2nd marginal) confirm the above grouping. The group seems to have branched out separately and *Cryptotermes* appears to be the more highly evolved of the two. Although the imago of *Cryptotermes* is similar to that of *Procryptotermes* and does not show any higher evolutionary characters, but its soldier, with highly phragmotic head and the short 3rd antennal segment, indicates that *Cryptotermes* is more highly evolved. The other closely allied genera are *Allotermes*, *Marginitermes*, *Tauritermes*, *Bicornitermes* and *Epicalotermes*.

(d) *Previous work on Oriental Cryptotermes*

The first record of a *Cryptotermes* in the Indo-Malayan Region is that of Haviland (1898) who described *C. domesticus* (his *Calotermes domesticus*) from Singapore and Sarawak (Borneo). Holmgren (1912) described *Calotermes (Cryptotermes) formosae* from Botel-Tobago (Formosa) and later (1913) recorded 3 species from the Oriental Region (*domesticus* Haviland, *formosae* Holmgren and a new species, *Calotermes (Cryptotermes) jacobsoni* from Java).

Oshima (1912, 1913, 1914) described *Calotermes* (*Cryptotermes*) *kotoensis*, *Calotermes* (*Cryptotermes*) *ogasawarensis* and *Calotermes* (*Cryptotermes*) *dentatus* from Botel Tobago Island, Ogasawarajima Island and Taihoku, Formosa, respectively, all of which are now regarded as synonyms of *C. domesticus* (Haviland).

Light (1921) described another two species from the Philippines, namely, *Cryptotermes cynocephalus* and *Planocryptotermes nocens*, the latter being now regarded as a synonym of *C. dudleyi* Banks. Later on (1924) he described *Cryptotermes campbelli* which is now regarded as a synonym of *C. domesticus* (Haviland).

Kemner (1930, 1932) described *Cryptotermes sumatrensis* from Sumatra and *C. perforans* from Ceylon, respectively. In the latter contribution he also described *Planocryptotermes primus* from Ceylon, which has now been regarded synonymous with *C. dudleyi* Banks. He further (1934) described two more new species from Java, namely, *Cryptotermes buitenzorgi* and *Cryptotermes* (*Planocryptotermes*) *javanicus* which are now regarded as synonyms of *C. cynocephalus* Light and *C. dudleyi* Banks, respectively. Snyder (1934) described a new species, *Kalotermes* (*Cryptotermes*) *bengalensis*, from India; this is now regarded as a synonym of *C. havilandi* (Sjöstedt). In his world catalogue, Snyder (1949) has recorded 7 species of *Cryptotermes* from the Indo-Malayan Region. Rattan Lal and Menon (1953) record 3 species from the Indian Region. Ahmad (1958) has given a key for identification of the Indo-Malayan *Cryptotermes*, and includes 6 species. Recently Tsai and Chen (1963) and Ahmad (1965) have described *C. declivis* from South China and *C. thailandis* from Thailand, respectively.

(e) *Distribution of Cryptotermes species in the Oriental region and their probable origin and dispersion* (Text-fig. 2)

Genus *Cryptotermes* is represented in the Oriental Region by ten species, namely, *brevis* (Walker), *cynocephalus* Light, *declivis* Tsai and Chen, *domesticus* (Haviland), *dudleyi* Banks, *havilandi* (Sjöstedt), *perforans* Kemner, *roonwali* sp. n., *sumatrensis* Kemner and *thailandis* Ahmad. Of these 10 species 5 (50 per cent: i.e., *declivis*, *perforans*, *roonwali*, *sumatrensis* and *thailandis*) are endemic to the region. *Cryptotermes declivis* Tsai and Chen has been recently described from South China, *C. perforans* is known from Ceylon, *C. roonwali* sp. n. from South India, *C. sumatrensis* from Sumatra and *C. thailandis* from Thailand. It is not unlikely that these species may be discovered in other parts of the Oriental Region and also in other zoogeographical regions since species of *Cryptotermes* are easily transportable from one place to another.

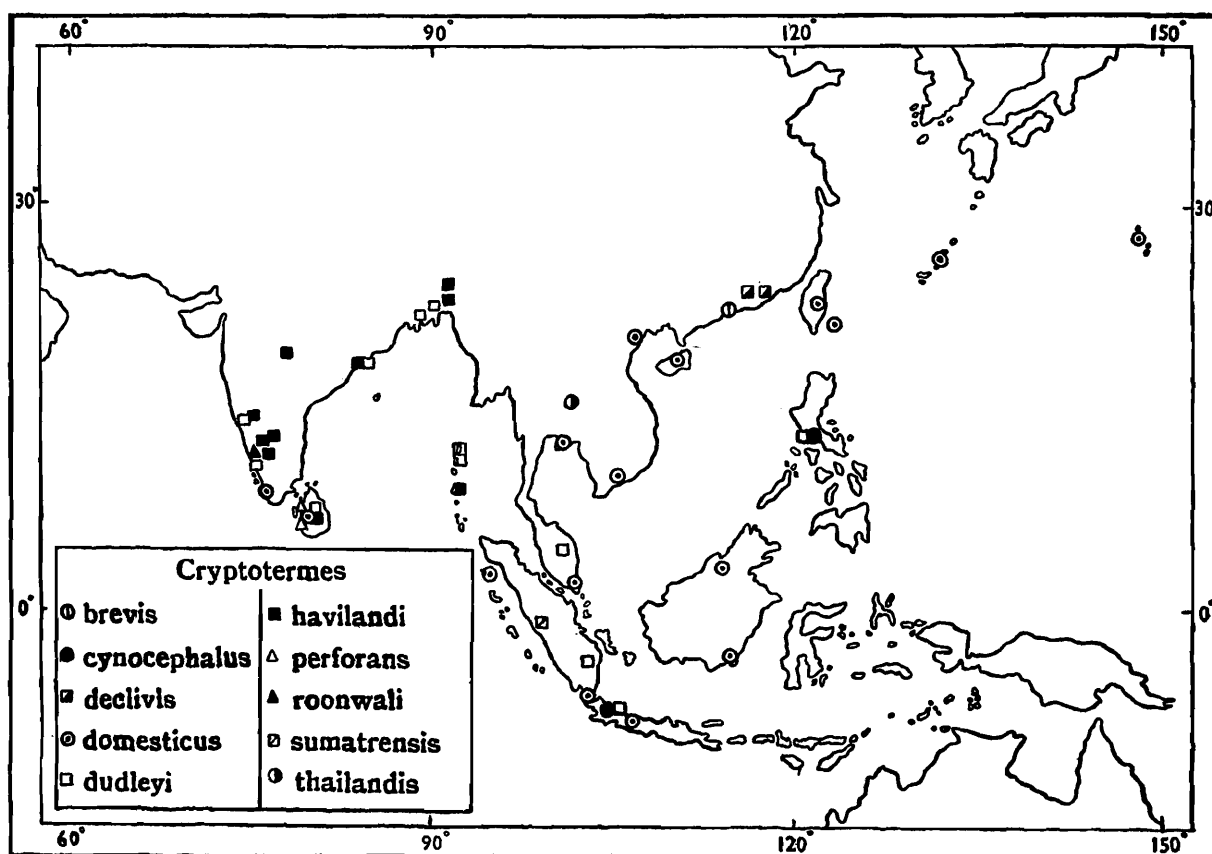
Of the non-endemic species *C. brevis* is recorded only from Hongkong in the Oriental Region, and is mainly Neotropical. *C. cynocephalus* occurs in the Philippines and Java and is also recorded from New Britain Island in the Papuan Region. *C. domesticus*, which is widely distributed in the Oriental Region (e.g., Ceylon, India, Indonesia, Formosa, Malaya, Singapore, Thailand and South China), is also commonly distributed in the Papuan Region and there is a single record of the species from the Neotropical Region (Panama).

It is difficult to say, with definiteness, as to which are the native habitats of the various species of *Cryptotermes*, and the following remarks about their place of origin and dispersion are based on the present-day distribution records only:—

The native habitat of *C. brevis* seems to be the Neotropical Region where it abounds, the single record of the species in the Oriental Region and some distribution records in the Ethiopian and Papuan regions would seem to suggest that the species was probably introduced in these regions from the Neotropical, rather than the Chinese origin as suggested by Light (1931) for *C. piceatus* which is a synonym of *C. brevis*.

The record of *C. cynocephalus* from New Britain Island seems to be a case of introduction from the Oriental Region. The native habitat of *C. domesticus* is probably the Oriental or the Papuan Region where it is common. It has been introduced to the Neotropical

Region (Panama). *C. dudleyi* Banks is quite common in the Oriental, Ethiopian and the Neotropical Regions and it is difficult to say anything definitive about its native habitat and dispersions.



TEXT-FIG. 2.—Map of the Indo-Malayan Region, showing distribution of the Indo-Malayan species of genus *Cryptotermes*.

C. havilandi is probably the only species known to occur in a semi-wild state in India and Ceylon, but the native habitat of this species seems to be the Ethiopian Region where it is common and whence it probably got dispersed to the Oriental, Malagasy and Neotropical Regions.

(f) *Note on Cryptotermes cynocephalus* Light

Cryptotermes cynocephalus was described by Light (1921) from the Philippines and was described again under a different name, *Cryptotermes buitenzorgi* n. sp., by Kemner (1934) from Java. Ahmad (1953) recorded this species from Ceylon on the basis of a collection from Colombo; I have examined these latter specimens and have found them to be identical with the types of *Cryptotermes perforans* Kemner, also from Colombo. The record of *C. cynocephalus* from Ceylon is, therefore, evidently based on wrong determination, and the species is thus known only from the Philippines, Java (Indonesia) and New Britain Island.

(g) *Note on Cryptotermes jacobsoni* Holmgren

Holmgren (1913), described *Calotermes* (*Cryptotermes*) *jacobsoni* from Java, and placed it near *C. domesticus* (Haviland) and *Calotermes* (*Cryptotermes*) *formosae* Holmgren from Formosa. Later on (1914), he recorded it from East Sumatra also. Light (1937) and Snyder (1949) regard this species as a synonym of *Cryptotermes dudleyi* Banks; this is evidently a mistake as *C. dudleyi* was described by Banks (1918) much later than *C. jacobsoni* of Holmgren (1913). I have not been able to procure the original material of *jacobsoni* for comparison and am, therefore, unable to give a definite opinion regarding its status. Krishna (1961), does not include it in his list of *Cryptotermes*.

2. Systematic Account

Genus *Cryptotermes* Banks(i) Genus *Calotermes* Hagen (in part)

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 1898. G. D. Haviland, *J. Linn. Soc. Lond.*, London, **26**, pp. 371, 373.
 1904. J. Desneux, *Genera Insectorum*, Fasc. **25**, *Termitidae*, Brussels, pp. 20-24.

(ii) Genus *Cryptotermes* Banks

1906. N. Banks, *Ent. News*, Philadelphia, **17** (9), p. 336. *Type of genus* : *Cryptotermes cavifrons* Banks.
 1919. N. Banks, *Bull. Mus. Comp. Zool. Harv. Coll.*, Cambridge (Mass.), **62** (10), p. 476.
 1920. N. Banks and T. E. Snyder, *Bull. U. S. nation. Mus.*, Washington, No. 108, pp. 7, 16, 35.
 1921. C. Fuller, *S. Afr. J. nat. Hist.*, Pretoria, **3** (1), pp. 19, 22-24, 29.
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 1924. S. F. Light, *China J. Sci. Arts*, Canton, **2** (1-4), p. 52.
 1926. Y. Sjöstedt, *K. Sv. Vet. Akad. Handl.*, Stockholm, (3) **3** (1), pp. 22, 23, 28.
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 1958. M. Ahmad, *Biologia*, Lahore, **4** (1-2), pp. 35, 36, 53.
 1960. M. L. ROONWAL & P. K. Sin-Sarma, *Contributions to the Systematics of Oriental Termites*, New Delhi, pp. 97, 98.
 1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, **122** (Art. 4), pp. 314, 315, 316, 317, 379-382, 383, 384, 385, 388 and 389.

(iii) Subgenus *Cryptotermes* Banks

1910. N. Holmgren, *Zool. Anz.*, Leipzig, **35** (9-10), p. 285.
 1911a. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **46** (6), pp. 53, 55, 58, 60, 61.
 1911b. N. Holmgren, *Zool. Anz.*, Leipzig, **37**, p. 549.
 1913. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **50** (2), pp. 37, 46.
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 1934. T. E. Snyder, *Indian For. Rec. (Ent.)*, Delhi, **20** (11), pp. 24, 27.
 1934. N. A. Kemner, *K. Sv. Vet. Akad. Handl.*, Stockholm, (3) **13** (4), p. 45. [Subgenus *Cryptotermes* s. str.]
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 1942. G. F. Hill, *Termites (Isoptera) from the Australian Region*, Melbourne, pp. 7, 65-66.
 1948. T. E. Snyder, *Our Enemy the Termite*, New York, pp. 232, 234, 235.

(iv) Genus/Subgenus *Planocryptotermes* Light

1921. S. F. Light, *Philipp. J. Sci.*, Manila, **19** (1), pp. 41-42.
 1928. A. E. Emerson, *Bull. Amer. Mus. nat. Hist.*, New York, **57** (Art. 7), p. 405.
 1930. S. F. Light, *Philipp. J. Sci.*, Manila, **42** (1), pp. 15, 16, 18.
 1934. N. A. Kemner, *K. Sv. Vet. Akad. Handl.*, Stockholm, (3) **13** (4), pp. 30, 37.

(v) Subgenus *Lobitermes* Holmgren (in part)1933. S. F. Light, *Calif. Univ. Publ. (Ent.)*, Berkeley, 6 (5), pp. 82, 101.(vi) Genus *Procryptotermes* Holmgren (in part)1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, 112, p. 36.(a) *Characters of genus Cryptotermes Banks*

IMAGO.—Head-capsule without eyes subsquarish ; sides subparallel ; posterior margin round. Epicranial sutures present. Eyes small, round or broadly oval. Ocelli oval, generally touching the eyes, sometimes separated slightly. Antennae with 13-18 segments. Clypeus subtrapezoidal ; ante- and postclypeus not clearly demarcated. Labrum broader than long. Mandibles with an apical and 2 marginal teeth ; apical finger like and long ; 1st marginal short ; anterior margin of 2nd marginal of left mandible about twice as long as the posterior margin of 1st ; posterior margin of 2nd marginal of right mandible one-and-a-half times to twice the length of molar plate. Pronotum narrower, as wide as, or slightly broader than head with eyes. Legs with 3 apical spurs on each tibia ; tarsi 4-jointed ; an arolium present in the majority of species. Wings punctate, hairy on margins and on scales ; all veins except median in hindwing arising independently ; costa, subcosta, radius and radial-sector thickly chitinised, and median and cubitus weakly chitinised ; costa bordering the anterior margin ; subcosta in forewing short, thick and meeting the costa a little outside scale, absent in hindwing ; radius in forewing fusing with costa at about one-third to middle of wing-membrane, and in hindwing at about middle or a little beyond the middle ; radial sector running upto the distal tip of wing, with 3-10 branches to the costa ; median arising independently from scale in forewing, but from radial sector outside scale in hindwing, running medially between radial sector and cubitus and curving up to meet the former beyond the middle ; cubitus running medially to distal end and with 10-15 branches to posterior margin. Abdomen long. Cerci 2-jointed.

SOLDIER.—Head-capsule generally dark brown, almost black in front ; short, thick and phragmotic ; rough in the region of frons, vertex and sides, in some species ; frontal area sharply sloping either at right angle or a little less than a right angle, sometimes overhanging ; with a thick frontal ridge between frons and vertex ; generally with 2 horn-like weak to prominent tubercles on either side—the dorsal one a projection from frons near the lateral hind corners of postclypeus, and the ventral one a prolongation of ventral genae, sometimes either of them or both absent ; frons generally incurved ; vertex behind frontal ridge somewhat depressed medially. Eyes generally present, one on either side ; unpigmented. Ocelli absent. Antennae with 11-15 segments. Clypeus subtrapezoidal, only sometimes clearly demarcated from frons. Labrum subtriangular or tongue-shaped, pointed in front. Mandibles generally short, thick and humped basally at outer margins, sometimes somewhat longish ; either weakly dentate or without dentition. Postmentum broad posteriorly. Pronotum broader than long ; as wide as or slightly narrower than head-capsule ; anterior margin concave, wavy or serrate and emarginate medially. Legs short ; apical tibial spurs 3 : 3 : 3. Tarsi 4-jointed. Abdomen elongate. Cerci 2-jointed.

PSEUDOWORKER.—Head-capsule subcircular, broader than its length to base of mandibles ; eyes present ; ocelli absent. Antennae short, with 10-15 segments ; segments either flat and broad or broadly pyriform. Postclypeus flat. Mandibles as in imago. Pronotum sub-rectangular ; anterior margin weakly to deeply concave. Legs short ; apical tibial spurs 3 : 3 : 3. Tarsi 4-jointed. Abdomen elongate ; cerci 2-jointed.

(b) *Keys for identification of the Oriental species of genus Cryptotermes*

The imago caste in *Cryptotermes* does not provide good morphological characters and unless collections are associated with soldiers they are difficult to identify on imagos alone.

No specimens of *C. declivis* Tsai and Chen and *C. thailandis* Ahmad were available to me for study and these species, therefore, are not included in these key.

(i) *Key to imagos*

The imagos of nine out of ten Oriental species are known. The specimens of *C. declivis* Tsai & Chen and *C. thailandis* Ahmad were not available to me; the other seven species are keyed as follows:—

- 1(4) Smaller species: Head-width with eyes 0.77—0.85; head length to tip of labrum 1.0—1.07, to lateral base of mandibles 0.80—0.83 mm. Distance between eye and lower margin of head small (0.11—0.13 mm.).
- 2(3) Darker and slightly larger species: Head-capsule brown to dark reddish brown. Eyes larger and ocelli smaller (maximum diameter of eyes 0.29; and of ocelli 0.08 mm.). 1. *C. cynocephalus* Light
- 3(2) Paler and slightly smaller species: Head-capsule brownish yellow. Eyes smaller and ocelli larger (maximum diameter of eyes 0.27; and of ocelli 0.10 mm.). 2. *C. perforans* Kemner
- 4(1) Larger species: Head-width 0.90—1.17; head-length to tip of labrum 1.20—1.40, to lateral base of mandibles 0.87—1.10 mm. Distance between eye and lower margin of head large (0.15—0.20 mm.).
- 5(6) Head wide (width with eyes 1.05—1.17 mm.). 3. *C. brevis* (Walker)
- 6(5) Head generally narrow (width with eyes 0.90—1.10 mm.).
- 7(8) Eyes large, maximum diameter 0.35—0.37 mm. 4. *C. sumatrensis* Kemner
- 8(7) Eyes generally small, maximum diameter 0.27—0.33 mm., rarely more (0.37 mm. in 2 examples of *C. domesticus* from the Papuan Region).
- 9(10) Ocelli farther from the antennae (minimum ocellus-antennal distance 0.17—0.19 mm.). 5. *C. dudleyi* Banks
- 10(9) Ocelli nearer the antennae (minimum ocellus-antennal distance 0.13—0.17 mm., rarely 0.17 mm.).
- 11(12) Sides of head-capsule incurved in region of eyes; eyes generally smaller (maximum diameter 0.27—0.30 mm., rarely above 0.30). 6. *C. domesticus* (Haviland)
- 12(11) Sides of head-capsule substraight in region of eyes; eyes generally larger (maximum diameter 0.30—0.34 mm.). 7. *C. havilandi* (Sjöstedt)

(ii) *Key to soldiers*

- 1(2) Head-capsule with only the ventral tubercle (*i.e.*, horn-like projection of ventral genae) prominent, the dorsal one very weak. Frontal ridge of head strongly projecting in front medially, reaching beyond base of mandibles (index Maximum length of head upto frontal ridge/Length of head to base of mandibles 1.10—1.25) and making an angle of less than 90° with mandibles. 1. *C. domesticus* (Haviland)
- 2(1) Head-capsule with both the tubercles (*i.e.*, horn-like projection of ventral genae and the projection from frons near the lateral base of postclypeus) prominent. Frontal ridge of head not projecting in front medially, laterally sometimes weakly projecting in front (index Maximum length of head upto frontal ridge/Length of head to base of mandibles 0.85—1.05), and making an angle of generally more than 90° with mandibles.
- 3(4) Head-capsule and frontal ridge strongly wrinkled and roughened. 2. *C. brevis* (Walker)
- 4(3) Head-capsule and frontal ridge smooth, vertex sometimes slightly roughened.
- 5(6) Larger species (head-length to lateral base of mandibles 1.60—1.80 mm.; maximum width of head 1.12—1.43 mm.). Mandibles longish and with prominent dentition; frontal ridge weak and strongly pushed back medially. 3. *C. dudleyi* Banks
- 6(5) Smaller species (head-length to lateral base of mandibles 0.83—1.47 mm.; maximum width of head 0.90—1.35 mm.). Mandibles short, thick and with weak dentition; frontal ridge prominent and not strongly pushed back medially.
- 7(8) Frontal ridge with a deep median cleft. 4. *C. sumatrensis* Kemner
- 8(7) Frontal ridge without a median cleft.
- 9(10) Ventral tubercle (*i.e.*, horn-like projection of ventral genae) large, a little longer than the dorsal one and visible in dorsal view of head. Head larger (length to base of mandibles 1.13—1.47 mm., maximum width 1.10—1.35 mm.). 5. *C. havilandi* (Sjöstedt)
- 10(9) Ventral tubercle small, shorter than the dorsal one and not visible dorsally. Head smaller (length to base of mandibles 0.83—1.10 mm.; maximum width 0.75—1.03 mm.).
- 11(12) Frontal ridge gradually raised in front, not ribbon-like; frons deeply concave; vertex comparatively rough. Head smaller (length to base of mandibles 0.83; maximum width 0.75—0.90 mm.). 6. *C. cynocephalus* Light
- 12(11) Frontal ridge ribbon-like; frons weakly concave; vertex comparatively smooth. Head larger (length to base of mandibles 0.97—1.17; maximum width 0.90—1.03 mm.).
- 13(14) Frontal ridge thick and prominently raised; mandibles strongly humped basally on outer margins; head-capsule thick, height of head more as compared to length and width (index Height/Length to base of mandibles 0.78—0.82; Height/Maximum width 0.82—0.88). Head smaller (length to base of mandibles 0.97—1.03; maximum width 0.90—1.00 mm.). 7. *C. perforans* Kemner
- 14(13) Frontal ridge thin, flat and weakly raised; mandibles weakly humped basally on outer margins; head-capsule thin, height of head less as compared to length and width (index Height/Length to base of mandibles 0.71—0.73; Height/Maximum width 0.78—0.80). Head larger (length to base of mandibles 1.10—1.17; maximum width 1.00—1.03 mm.). 8. *C. ruonwali* sp. n.

3. *Descriptions of Species of Cryptotermes*

1. *Cryptotermes brevis* (Walker)

(Text-figs. 3 & 4 ; and Tables 2-4)

(i) *Termes brevis* Walker

1853. F. Walker, *List Specimens Neuropterous Insects Brit. Mus.*, London, Part III, p. 524. *Im. Type-locality* : Jamaica (West Indies).

(ii) *Calotermes brevis* (Walker)

- *1853. H. A. Hagen, *Bericht Königl. preuss. Akad. Wiss.*, Berlin, p. 68.
 1858. H. Hagen, *Linn. Ent.*, Berlin, **12**, pp. 68-70, pl. 2, fig. 6 ; pl. 3, fig. 5. *Im.* Jamaica ; Cuba ; St. Thomas ; Brazil ; Mexico ; Central America ; and St. Fe de Bogota.
 *1858. H. A. Hagen, *Catal. Specimens Neuropterous Insects Brit. Mus.*, London, Part I, p. 10.
 1860. H. Hagen, *Linn. Ent.*, Berlin, **14**, p. 101.
 1904. J. Dexneux, *Genera Insect.*, Brussels, Fasc. **25**, *Termitidae*, p. 23.
 1915. J. Dexneux, *Coll. Zool. Baron Edm. de Selys Longchamps*, Fasc. **3**, pt. 3, p. 6.

(iii) *Calotermes (Cryptotermes) brevis* (Walker)

1911. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **46** (6), p. 55. America.

(iv) *Cryptotermes brevis* (Walker)

1919. N. Banks, *Bull. Mus. Comp. Zool.*, Cambridge (Mass.), **62** (10), p. 476. Dominica : St. Thomas ; Landet. Cuba : Cayamas ; Santiago de las Vegas.
 1920. N. Banks and T. E. Snyder, *Bull. U. S. nation. Mus.*, Washington, No. 108, p. 144. Dominica : St. Thomas. West Indies : Jamaica. Cuba : Santiago de las Vegas ; Cayamas. South and Central America ; Mexico ; and Key West (Florida, U.S.A.).
 1921. D. T. Fullaway, *Proc. Hawaiian ent. Soc.*, Honolulu, **4** (3), pp. 456-457. Hilo (Hawaii).
 1922. T. E. Snyder, *Proc. U. S. nation. Mus.*, Washington, **61** (Art. 20), p. 13, pl. 5, fig. 20 (wing). U. S. A. : Key West ; and Miami.
 1924. T. E. Snyder and J. Zetek, *Bull. U. S. Dept. Agric.*, Washington, No. 1232, p. 24. U. S. A. : Miami (Florida).
 1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, **3** (1), pp. 26, 27. Central America and Caribbean : Barbados Is. ; Cuba ; Dominica ; Haiti ; Jamaica ; Mexico ; Puerto Rico ; St. Thomas. U. S. A. : Florida ; Louisiana. South America : Brazil ; British Guiana ; Venezuela.
 1934. T. E. Snyder, In : *Termites and Termite Control* (Ed. C. A. Kofoid), pp. 269, 270, 272, 751. U. S. A. : Key West ; Miami ; New Orleans ; Palm Beach ; and Tampa. Also West Indies ; Mexico ; Central America ; South America ; and South Africa.
 1934. S. F. Light, In : *Termites and Termite Control* (Ed. C. A. Kofoid), pp. 137, 206-207, 208, 335, 336, 337, 338. Mexico : Eastern coastal plain ; Colima. Also West Indies ; Central America ; South America (as far South as Kartabo in British Guiana) ; and U. S. A.
 *1938. G. N. Wolcott, *Ann. Rept. P. R. agric. exp. Sta. (1936-37)*, Mayaguez, Washington, pp. 83-84. Puerto Rico.
 *1939. R. W. E. Tucker, *Barbados Agric. J.*, **8** (2) pp. 56-60. Barbados Islands.
 *1939. L. F. Martorell, *J. agric. Univ. P. R.*, San Juan, **23** (4), pp. 184-185. South America : Aragua ; and Venezuela.
 *1940. S. J. Saint, *Ann. Rep. Barbados Dept. Sci. and Agric. (1939-40)*, Bridgetown, pp. 9-10. Barbados Islands.
 *1940. H. D. Lopez-Penha, *Rev. agric. Dominican Republic*, **31** (132), p. 449. Dominica.
 1941. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (1), p. 54. Colima (Mexico) ; Puerto Rico ; Lima (Peru). Protozoa.
 *1942. K. A. Bartlett and H. K. Plank, *Ann. Rep. P. R. Agric. exp. Sta. (1941)*, Mayaguez, Washington, pp. 19-23. Puerto Rico.
 1942. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (3), p. 186. Colima (Mexico) ; Puerto Rico ; Lima (Peru). Protozoa.
 1943. A. E. Emerson and E. M. Miller, *Ent. News*, Philadelphia, **56** (8), pp. 185, 186. Florida (U.S.A.).
 *1946. G. N. Wolcott, *Bull. P. R. Agric. exp. Sta.*, Mayaguez, Washington, **68**, pp. 1-29. Puerto Rico.
 *1948. W. G. H. Coaton, *Bull. S. Africa Dept. Agric. (Ent.)*, Pretoria, No. 290, pp. 1-18. South Africa : Durban ; Ifafa Beach ; and Port Elizabeth.
 1948. T. E. Snyder, *Our Enemy the Termite*, pp. 13, 24, 63-64, 86, 188-189. Bahama Islands (Caribbean Sea) and Florida (U.S.A.).
 1949. W. G. H. Coaton, *J. ent. Soc. S. Afr.*, Pretoria, **12**, p. 16. S. Africa.
 1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112**, p. 39. U. S. A. ; West Indies ; Middle and S. America Midway Isl., thru Terr. ; Hawaii and Fanning Isl. to Marquesas Isl. ; China ; Fiji ; S. Africa.

*Not seen in original.

1949. A. E. Emerson, *2nd Rapp. Ann. I. R. S. A. C.*, Brussels, p. 158. South Africa : Durban ; Ifafa Beach ; and Port Elizabeth.
- 1950a. W. G. H. Coaton, *Bull. Union S. Africa Dept. Agric. (Ent. Series No. 30)*, Pretoria, No. 299, p. 1. South Africa.
- 1950b. W. G. H. Coaton, *J. ent. Soc. S. Afr.*, Pretoria, **13**, pp. 18-24. *Im.* and *S.* West Indies ; Southern U. S. A. ; Central and South America ; Congo ; and South Africa.
- *1951. B. Stone, *Contr. Cushman Found. Foramin. Res.*, Sharon (Mass.), **2** (4), p. 139.
1952. C. B. Keck, *Proc. Hawaiian ent. Soc.*, Honolulu, **14** (3), p. 351. Midway Island.
1953. W. V. Harris, *Proc. R. ent. Soc. Lond.*, London, (A) **28** (1-3), pp. 13-14. St. Helena ; S. Africa ; Congo ; Sierra Leone ; Nigeria.
- *1953. T. E. Snyder, *Pest Control*, Painsville, **21** (7), pp. 40-41. Peru.
1954. T. E. Snyder, *Pest Control*, Painsville, **22** (11), p. 28. Washington D.C.
1955. H. Weidner, In : *Die Termiten* (Ed. H. Schmidt), p. 48. Southern North America ; Central and South America ; West Indies ; Hawaii and Marquesas Isls., China ; Fiji Isl., South Africa ; and Canary Isl.
1957. Commonwealth Institute of Entomology, *Distribution Maps of Insect Pests*, London, Ser. A., No. 77. Africa : Najala, Freetown (Sierra Leone) ; Boma (Congo) ; Durban and Port Elizabeth (South Africa). North America : Southern Florida and New Orleans (U.S.A.). Central America and West Indies : Eastern coastal plain and Colima (Mexico) ; Guatemala ; Porto Rico ; Jamaica ; Barbados ; Hamilton (Bermuda) ; Trinidad ; Tobago ; St. Lucia Isl. ; St. Vincent Isl. ; Haiti ; Cuba ; St. Thomas (Vigrin Isls.) ; Dominica ; Nassau (Bahamas) ; St. Kitts. South America : Brazil ; British Guiana ; Antofagasta (Chile) ; Colombia ; Venezuela. Atlantic Ocean : Ascension Isl. ; St. Helena Isl. Pacific Ocean : Hawaii ; Hivaoa, Atuona (Marquesas Isls.).
- *1957. J. B. Martinez, *Montes*, Madrid, **13** (75), pp. 147-161. Atlantic Ocean : Madeira ; and Canary Islands.
- *1957. N. E. Hickin, *African World*, April 1957, p. 23. East Africa. [Is actually *C. dudleyi* Banks *vide* personal communication from Dr. W. V. Harris of B. M. (N. H.), London.]
1958. W. V. Harris, *East African Agric. J.*, Nairobi, **23** (3), pp. 163, 165, 166. Southern U. S. A. ; Central America ; West Indies ; S. America ; Hawaii, Marquesas, Ascension and St. Helena Isls. ; Sierra Leone ; Boma ; Natal and Cape Province (S. Africa).
1959. T. E. Snyder, *Amer. Midl. Natur.*, Notre Dame (Ind.), **61** (2), pp. 317, 319, 320. Venezuela : Caracas ; and Margarita Isl.
1960. E. A. McMahan, *Proc. Hawaiian ent. Soc.*, Honolulu, **17** (2), pp. 270-272.
1960. A. Suehiro, *Proc. Hawaiian ent. Soc.*, Honolulu, **17** (2), p. 291. Midway Atoll.
1961. W. V. Harris, *Termites : Their Recognition and Control*, pp. 46, 63, 119, 120, 143, 155, 159, 160, 161, 162, 163. North (Florida, Louisiana), Central (Mexico, Guatemala) and S. America (British Guiana, Brazil, Chile, Peru and Venezuela) ; Caribbean ; West Indies ; West and South Africa (Senegal, Gambia, Sierra Leone, Ghana, W. Nigeria, South-East coast of S. Africa) ; Pacific ocean (Hawaii, Fiji, and Marquesas Isls.) ; Atlantic ocean (Madeira, Ascension, and St. Helena Isls.).
1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, **122** (4), pp. 382, 391, 393, 394, 397.
- *1961. N. E. Hickin, *Timber Technol.*, **69** (2259), pp. 26-27. [Accidentally imported in England.]
1963. W. V. Harris, *Mem. Hongkong nat. Hist. Soc.*, Hongkong, No. 6, pp. 2-3, fig. 1 (S.). Hongkong.
1964. P. H. Tsai and N. S. Chen, *Acta Entom. Sinica*, Peking, **13** (1), pp. 27, 34. Hongkong ; Cuba ; Brazil ; Mexico ; North America ; Honolulu.
1967. F. J. Gay, *Bull. Commonw. Sci. Industr. Res. Org.*, Melbourne, No. 286, pp. 8-10, 17-20, 49-50. *Im.* and *S.*

(v) *Kaloterme* (*Cryptoterme*) *brevis* (Walker)

1925. A. E. Emerson, *Zoologica*, New York, **6** (4), pp. 326-329, fig. 29 (*Im.* & *S.*). *Im.* and *S.* West Indies : Jamaica. British Guiana : Georgetown ; Penal Settlement ; Kartabo. Also Mexico ; Central America ; West Indies ; Colombia ; and Brazil.
1933. S. F. Light, *Univ. Calif. Publ. (Ent.)*, Berkeley, **6**, pp. 84, 85, 103. Mexico : Colima (west coast).
1936. A. E. Emerson, *Science*, New York, **83** (2157), pp. 410-411. U. S. A. : Louisiana and Florida. S. Africa : Durban. Also West Indies ; Caribbean shores ; and British Guiana.
- *1936. S. F. Light, *Pan-Pacific Ent.*, San Francisco, **12** (3), pp. 125-126. Peru : Lima. U. S. A. : California.
1939. R. J. A. W. Lever, *Agric. J. Fiji*, **10** (3), p. 87. Fiji.

(vi) *Termes flavicollis* Walker (in part)

1853. F. Walker, *List Specimens Neuropterous Insects Coll. Brit. Mus.*, London, Part III, pp. 502, 503. [Wrong determination. The imago from Mr. Children's collection and the soldier only are *C. brevis*.]

(vii) *Caloterme* (*Cryptoterme*) *grassii* Silvestri (MS name)

1911. C. Janicki, *Biol. Centralbl.*, Leipzig, **31** (11), p. 321. Iquique (Chile). [Protozoa.]
1915. C. Janicki, *Z. wiss. Zool.*, Leipzig, **113**, pp. 574, 620. Iquique (Chile). [Protozoa.]

(viii) *Termes indecisus* Walker

1853. F. Walker, *List Specimens Neuropterous Insects Coll. Brit. Mus.*, London, Part III, p. 524. *Im.* Type-locality : Columbia.

(ix) *Termes lucifugus* Walker (in part)

1853. F. Walker, *List Specimens Neuropterous Insects Coll. Brit. Mus.*, London, Part III, p. 505. *Im.* [Wrong determination. Specimen from Mr. Children's collection only is *brevis*.]

(x) *Cryptotermes/Kalotermes (Cryptotermes) piceatus* Snyder

1922. T. E. Snyder, *Proc. U. S. nation. Mus.*, Washington, 61 (Art. 20), pp. 14-16. *Im.* and *S.* *Type-locality*: Honolulu (Oahu, Hawaii).
 1931. S. F. Light, *Lignan Sci. J.*, Canton, 7, pp. 583, 584, 588-589. Hongkong (China).
 1932. S. F. Light, *Bull. B. P. Bishop. Mus.*, Honolulu, No. 98, p. 84. Marquesas Isl.: Atuona, Hivaoa.
 1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, 3 (1), pp. 28,30. Hongkong; Hawaii Isl.
 1941. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, 45 (1), p. 55. Hawaii Isl. [Protozoa.]

(xi) *Cryptotermes/Kalotermes (Cryptotermes) pseudobrevis* Fuller

1921. C. Fuller, *S. Afr. J. nat. Hist.*, Pretoria, 3 (1), pp. 30-31. *Im.* and *S.* *Type-locality*: Durban (S. Africa).
 1922. E. Hegg, *Les Termites*, pp. 346, 682. South Africa: Durban.
 1925. A. E. Emerson, *Zoologica*, New York, 6 (4), p. 329.
 1926. Y. Sjöstedt, *K. Sv. Vet. Akad. Handl.*, Stockholm, 3 (1), p. 31. S. Africa: Durban.
 1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, 3 (1), p. 25. S. Africa: Natal.
 1936. S. F. Light, *Pan-Pacific Ent.*, San Francisco, 12 (3), p. 125.

(a) MATERIAL EXAMINED

(A) *Present in Z.S.I., Calcutta.*

(i) One vial, Z.S.I. Reg. No. 2957/H8, with a soldier and several pseudoworkers, P.H. Naval-Shipyard, Oahu, Hawaiian Isl., coll. *Clagg & Kinmo.*

(ii) One vial, Z.S.I. Reg. No. 2956/H8, with 3 nymphs and 2 pseudoworkers, Hawaiian Isl.

(B) *Present in F.R.I., Dehra Dun.*

(iii) One vial with 4 imagos [3 ♀♀, 1 ♂, (2 dealates)], a soldier, a nymph and a pseudoworker, Guatemala (Central America), coll. *G. Becker.*

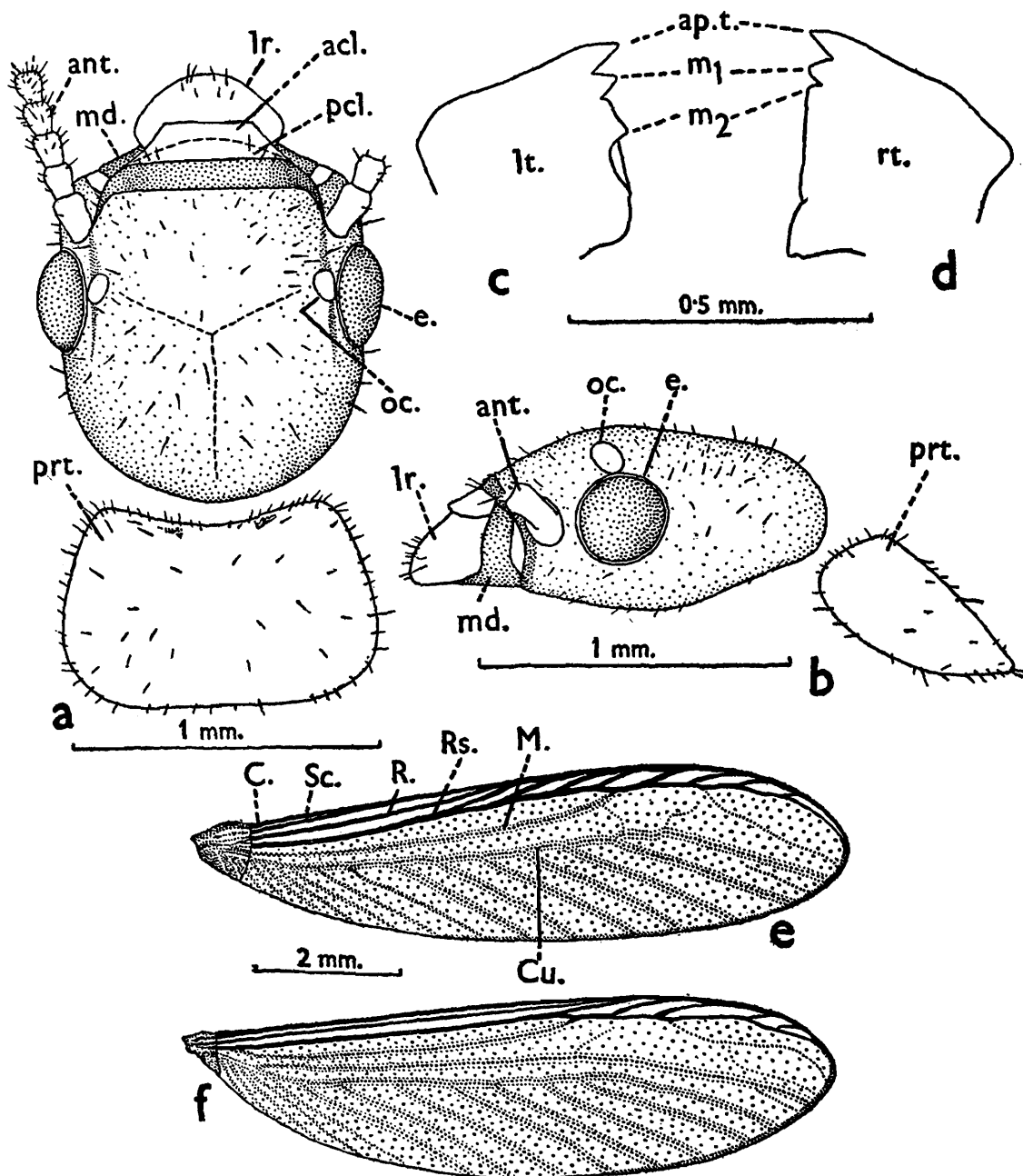
(b) DESCRIPTION

1. IMAGO (Text-fig. 3; Table 2).—

General: Head capsule yellowish to yellowish brown or reddish brown, somewhat paler anteriorly; pronotum of same colour as head; antennae, labrum and legs yellowish to pale yellowish brown; abdominal tergites slightly paler than head-capsule; sternites yellowish brown. Head, pronotum and abdomen moderately pilose; each abdominal tergite with a row of hairs on posterior margin and a few hairs on body. Total body-length with wings *c.* 10.3—12.8 mm.; without wings *c.* 5.0—7.56 mm.

Head: Head-capsule subrectangular; broader than its length to base of mandibles (length to base of mandibles 1.03—1.10; maximum width with eyes 1.05—1.17 mm.); frons somewhat sloping in front; sides subparallel; posterior margin round; epicranial sutures distinct. *Fontanelle*: Absent. *Eyes*: Two black, round, lateral eyes of medium size, one on either side; maximum diameter 0.25—0.33 mm. *Ocelli*: Two lateral, oval ocelli, one on either side, touching the eyes; maximum diameter 0.11—0.13, minimum diameter 0.10 mm. *Antennae*: With 14-18 segments; segment 3 of variable length, either shorter or longer than or equal to 2 or 4. Antennae broken in the specimens examined; 9 segments present in one specimen as follows:—Segments 1-3 weakly and the remainder fairly densely pilose; segment 1 longest and cylindrical; 2 about two-thirds the length of 1 and cylindrical; 3 subequal to 2; 4 equal to or shorter than 3; 4-9 subequal and pyriform. *Glypeus*: Subtrapezoidal; indistinctly separated into an ante- and a postclypeus. Anteclypeus apilose; with a substraight anterior margin. Postclypeus with a few hairs near posterior

margin; anterior margin weakly convex. *Labrum*: Broadly tongue-shaped; broader than long; with a few hairs on anterior margin and on body. *Mandibles*: Of typically *Cryptotermes*-type; each with an apical and two marginal teeth. Left mandible: Apical finger-like; 1st marginal subtriangular and shorter than apical; 2nd slightly shorter than 1st and with a long anterior margin. Right mandible: Apical finger-like, slightly thicker than the apical in left mandible; 1st marginal shorter than apical; 2nd shorter than 1st but with a much longer posterior margin; molar plate about half the length of posterior margin of 2nd marginal.



TEXT-FIG. 3.—*Cryptotermes brevis* (Walker). Imago. Drawings from specimens from Guatemala (Central America).

(a) Head and pronotum in dorsal view. (b) Ditto, in side view. (c) Left mandible, in dorsal view. (d) Ditto, right mandible. (e) Right forewing, in dorsal view. (f) Ditto, right hindwing.

acl., anteclypeus; ant., antenna; ap. t., apical tooth of mandibles; C., costa; Cu., cubitus; e., eye; lr., labrum; lt., left; M., median; m₁, m₂, 1st and 2nd marginal teeth of mandibles; md., mandible; oc., ocellus; pcl., postclypeus; prt., pronotum; R., radius; Rs., radial sector; rt., right; Sc., subcosta.

Thorax: Pronotum: Flat, subreniform; length about two-thirds its maximum width (maximum length 0.54—0.67; maximum width 0.94—1.20 mm.); slightly narrower to a

little broader than the head-capsule with eyes; anterior margin concave; sides round and depressed; posterior margin weakly incurved medially. *Mesonotum and metanotum*: Slightly incurved at posterior margin. *Legs*: Short and moderately hairy; forelegs shortest; hind legs longest; apical tibial spurs 3 on each leg, tibial spur formula 3:3:3. Tarsi 4-jointed; an arolium present between claws.

Wings: Pale brown; costa, subcosta, radius and radial-sector thick and strongly chitinised; median and cubitus weakly chitinised. *Forewing*: Longer than hindwing; scale also longer than that of hindwing and covering the greater part of the latter. Costa thick and bordering the anterior margin of wing; subcosta arising separately from scale and fusing with costa a little outside the wing-suture. Radius arising independently and meeting the costa a little beyond one-third of wing-membrane opposite the 1st branch of radial sector. Radial sector running parallel with and close to costa, giving 7-8 (6-9 according to Coaton, 1950) simple or forked branches to costal border; sometimes giving off a branch near the distal end which goes lower down to distal margin or fuses with the last branch of cubitus. Median arising separately from the wing-scale; running a little above the middle of wing-membrane and curving up to meet the radial sector a little before the distal one-third (at about one-fourth the length of wing from tip according to Emerson, 1925); sometimes with one to two small branches near its distal end. Cubitus arising separately and running in the middle of wing-membrane; giving off 12-15 (11-17 according to Emerson, 1925) main branches to posterior margin; some branches forked sometimes. *Hindwing*: Costa as in forewing. Subcosta absent. Radius simple, meeting the costa near the distal third and opposite 1st branch of radial sector. Radial sector with 4-5 (4-8 according to Coaton, 1950) branches to costa, otherwise as in forewing. Median arising from radial sector, otherwise as in forewing; sometimes running straight upto the distal margin of wing and not curving up to meet the radial sector. Cubitus with 12-14 (12-18 according to Coaton, 1950) branches to posterior margin, otherwise as in forewing; sometimes dividing into two near the proximal end, of which one branch running straight to distal end without giving off any branches to posterior margin (Text-fig. 3, fig. f).

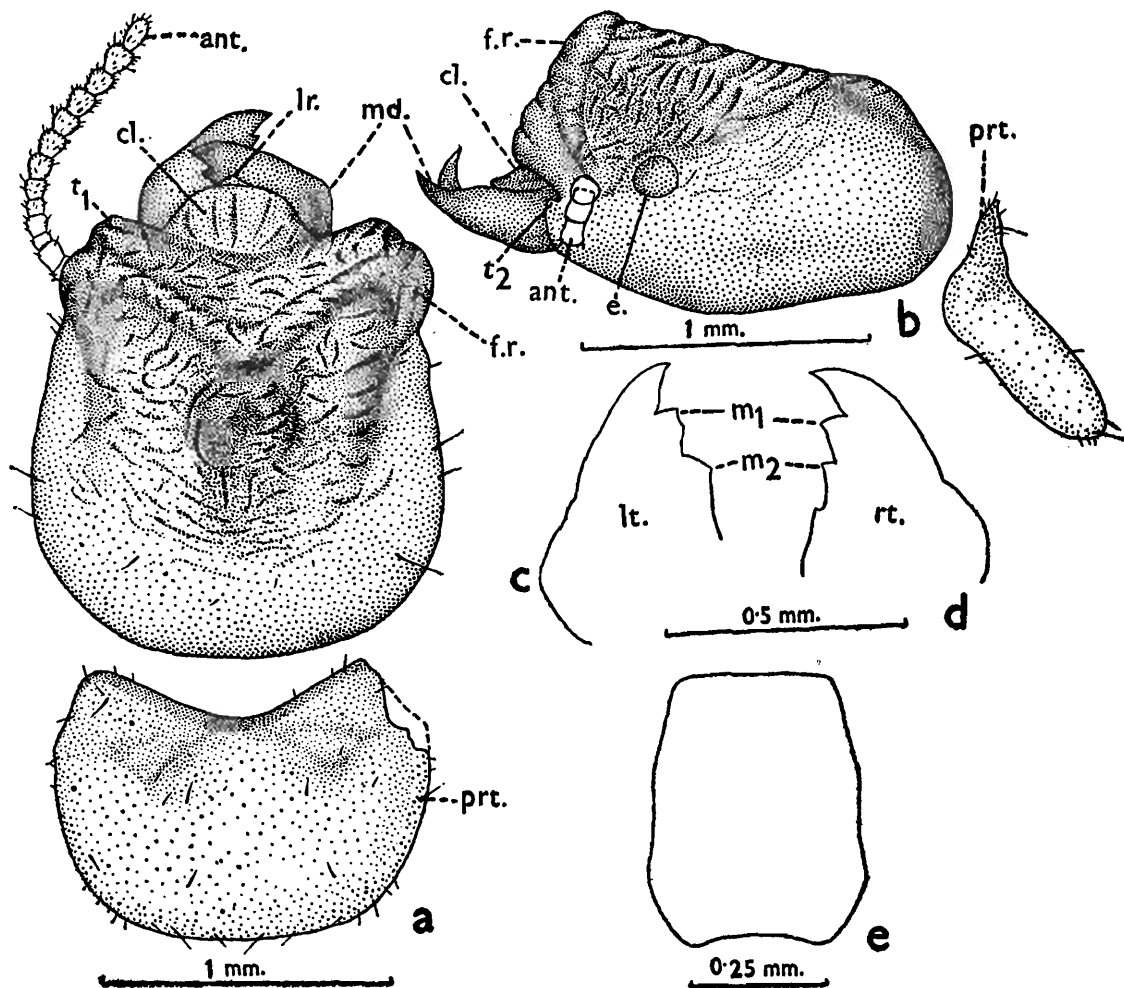
Abdomen: Oblong, hairy, each tergite with a row of hairs near posterior margin and a few hairs on body. Cerci 2-jointed, 0.1 mm. long. Styli (in males) single-jointed, 0.08 mm. long; absent in females.

2. SOLDIER (Text-fig. 4; Table 3).—

General: Head-capsule yellowish to dark brown posteriorly and getting darker in front; vertex and frons blackish; antennae, labrum, body and legs creamish white to pale brown; pronotum darker at anterior margin; eyes paler than the area of head-capsule around them; mandibles blackish. Head and body sparsely pilose. Total body-length without antennae c. 4.6—7.8 mm.

Head: Thick, stout, heavily wrinkled and roughened; slightly longer than its maximum width (length to base of mandibles 1.46—1.83; maximum width 1.25—1.54 mm.); sides incurved in the region just behind the frontal ridge and rounded posteriorly; posterior margin round; frontal ridge prominent and wrinkled, extending on the sides upto or a little beyond the base of mandibles; vertex strongly depressed in middle behind the frontal ridge; frons truncated in front, incurved and somewhat more weakly wrinkled than vertex, elevated on either side into a wrinkled ridge; dorsal tubercles short and flat, lying at base of lateral ridge of frons; ventral tubercles (*i.e.*, prolongations of ventral genae) short; Y-sutures present, either distinct or faint. *Fontanelle and ocelli* Absent. *Eyes*: Two, lateral, subcircular eyes, one on either side; about 0.17 mm. in diameter. *Antennae*: With 11-15 segments (13-14 in the 2 specimens examined). Segments 1 and 2 sparsely and the remainder moderately pilose; segment 1 longest and cylindrical; 2 longer than half of 1 and cylindrical; 3 shortest; 4-8 gradually becoming longer and pyriform; 9 to the penultimate one subequal and pyriform; the last ovate, shorter and narrower than the preceding one. *Clypeus*: Thick, black and thickly wrinkled; anteriorly rounded or straight; not differentiated into an ante- and a postclypeus in the specimens available

for study. *Labrum*: Broadly triangular or tongue-shaped; distal tip pointed or rounded; broader than long. *Mandibles*: Thick, stout and short; humped posteriorly at the outer margins; distally weakly incurved and pointed. Left mandible with 2 distinct marginal teeth. Right mandible with 2-3 distinct marginal teeth in distal two-thirds of mandible. *Postmentum*: Longer than broad; broadest in the posterior one-third; sides weakly incurved at middle; anterior margin substraight; posterior margin rounded at corners and incurved medially.



TEXT-FIG. 4.—*Cryptotermes brevis* (Walker). Soldier. Figs. (a), (b) from specimen from Guatemala (Central America); and figs. (c)—(e) from a specimen from Oahu, Hawaii Islands.

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Left mandible, in dorsal view. (d) Ditto, right mandible. (e) Postmentum, in ventral view.

ant., antenna; *cl.*, clypeus; *e.*, eye; *f.r.*, frontal ridge; *lr.*, labrum; *lt.*, left; *m₁*, *m₂*, 1st and 2nd marginal teeth of mandibles; *md.*, mandible; *prt.*, pronotum; *rt.*, right; *t₁*, *t₂*, dorsal and ventral tubercles, respectively.

Thorax: Pronotum: Subreniform; a little narrower to slightly wider than head-capsule; much broader than long (maximum length 0.62—1.07; maximum width 1.27—1.50 mm.); anterior margin with a wide, deep, median incurving; antero-lateral corners elevated; sides rounded; posterior margin weakly convex, with or without a slight median incurving. *Mesonotum*: Narrower than pronotum; with a weak median incurving at posterior margin. *Metanotum*: Narrower than pronotum and a little wider than mesonotum; posterior margin weakly incurved medially. *Legs*: Short and hairy, apical tibial spurs 3 on each tibia. Tarsi 4-jointed.

Abdomen: Oblong; sparsely pilose. Cerci 2-jointed and 0.10—0.13 mm. long. Styli absent in both the specimens examined (short, reduced, present or absent, according to Coaton, 1950).

3. PSEUDOWORKER (Table 4).—

General: Head, antennae, labrum, body and legs creamish white to pale yellow; mandibles of same colour but with dark brown toothed and outer margins. Head and body moderately hairy. Total body-length c. 3.7—6.5 mm.

Head: Head-capsule subcircular; almost as wide as or a little wider than head-length to base of mandibles; epicranial sutures present. *Fotnanelle and ocelli*: Absent. *Eyes*: Two lateral, pale greyish brown eye spots, one on either side; maximum diameter 0.13—0.17 mm. *Antennae*: With 12-15 segments; basal 2 or 3 segments sparsely and the remainder fairly, pilose; segment 1 longest, cylindrical; 2 longer than half of 1 and cylindrical; 3 onwards gradually increasing in length and becoming pyriform; the last ovate, narrower and longer than the penultimate one; segments sometimes flatly wide and not pyriform. *Clypeus labrum and mandibles*: As in imago.

Thorax: Pronotum: Subreniform; broader than long; generally narrower than but sometimes as wide as head-capsule (maximum length 0.40—0.77; maximum width 0.77—1.17 mm.); anterior margin broadly concave; sides round; posterior margin weakly convex and slightly incurved medially. *Mesonotum*: As wide as, and *metanotum* weakly broader than, pronotum. *Legs*: Short and hairy; apical tibial spur formula 3:3:3. Tarsi 4-jointed.

Abdomen: Oblong, moderately hairy. Cerci 2-jointed, 0.10—0.13 mm. long. Styli single-jointed, 0.10 mm. long.

(c) TYPE-SPECIMENS

(a) Of *Cryptotermes brevis* (Walker):

Cotypes: Two imagos, in B.M., London.

(b) Of *Termes indecisus* Walker:

An imago [=Holotype], in B.M., London.

(c) Of *Cryptotermes pseudobrevis* Fuller:

Cotypes: In Division of Entomology, Dept. of Agriculture, South Africa, Pretoria.

(d) Of *Cryptotermes piceatus* Snyder:

Type imago, in U.S.N.M., Washington.

(d) TYPE-LOCALITIES

(a) Of *Cryptotermes brevis* (Walker):

Jamaica, West Indies.

(b) Of *Termes indecisus* Walker:

Colombia.

(c) Of *Cryptotermes pseudobrevis* Fuller:

Durban, South Africa.

(d) Of *Cryptotermes piceatus* Snyder:

Honolulu (Oahu, Hawaii Islands).

(e) DISTRIBUTION

Cryptotermes brevis (Walker) is a widely distributed species and is recorded from the Indo-Malayan, Ethiopian, Neotropical, Neartic and Papuan regions, as follows:—

Africa: Congo: Boma, 5°31' S., 13°06' E. *South Africa*: Durban, 29°34' S', 30°34' E.; Ifafa Beach; and Port Elizabeth, 34°00' S., 25°21' E. *Sierra Leone*: Najala, Freetown, c. 8°19' N., 13°10' W. Also recorded from Gambia; Nigeria; and Senegal.

Asia : Hongkong, 22°96' N., 114°54' E.

Europe : England (accidentally imported).

Central America and Caribbean Sea : *Mexico* : Eastern Coastal Plain ; and Colima. *West Indies* : Jamaica (type-locality of *brevis*), 18°09' N., 77°18' W. *Cuba* : Santiago de las Vegas ; and Cayamas. *Dominica* : Landet ; and St. Thomas. Also recorded from Bahamas, Barbados, Bermuda, St. Lucia, St. Vincent and Virgin Islands ; Guatemala ; Haiti ; Puerto Rico ; St. Kitts ; Trinidad ; Tobago ; and St. Fe de Bogota.

North America : *U. S. A.* : Key West, 24°24' N., 82°09' W. ; Miami, 28°18' N., 80°12' W. ; New Orleans, 30°10' N., 90°36' W. ; Palm Beach ; Tampa, 27°35' N., 82°17' W. ; Washington D.C., 38°33' N., 77°24' W. (introduced) and California (introduced from Lima, Peru).

South America : *British Guiana* : George Town, 6°50' N., 58°10' W. ; Kartabo, 6°23' N., 58°42' W. ; and Penal settlement, 6°24' N., 58°40' W. *Chile* : Antofagasta, 23°40' S., 70°23' W. ; Iquique, 20°22' S. 70°06' W. *Peru* : Lima. *Venezuela* : Caracas, 10°18' N., 66°35' W. ; and Margarita Is., 11°30' N., 63°55' W. Also recorded from Aragua ; Brazil ; and Colombia.

Pacific Ocean : Hawaii Islands : Hilo, 19°43' N., 155°10' W. ; Honolulu, 22°00' N., 156°00' W. ; and Oahu, 21°25' N., 158°00' W. Midway Is., 28°10' N., 177°00' W. Marquesas Islands : Atuona, Hivaoa, 9°15' S., 139°00' W. Also Fiji Is., 18°00' S., 177°00' E. ; and Fanning Is.

Atlantic Ocean : Ascension Is., 7°33' S., 14°00' W. ; Canary Is., 28°00' N., 16°00' W. ; Madeira Is., 32°33' N., 16°23' W. ; and St. Helena Is., 15°34' S., 6°00' W.

(f) COMPARISON

The imago of *Cryptotermes brevis* (Walker) is separable from that of the other oriental species by its generally larger size (head-width with eyes 1.05—1.17 vs. 0.77—1.10 mm.).

The soldier can be easily differentiated from that of the other species by its heavily wrinkled and roughened head.

2. *Cryptotermes cynocephalus* Light

(Text-figs. 5 & 6 ; and Tables 2 & 3)

(i) *Cryptotermes buitenzorgi* Kemner

1934. N. A. Kemner, *K. Sv. Vet. Akad. Handl.*, Stockholm, (3) 13 (3), pp. 45-47. *Im., S. & Pw. Type-locality* : Buitenzorg (=Bogor), Java, Indonesia.

(ii) *Cryptotermes cynocephalus* Light

1921. S. F. Light, *Philipp. J. Sci.*, Manila, 19 (1), pp. 36-41, pl. 2, figs. 1 & 2 (S.). *Im., S., Pw. & Ny. Type-locality* : Manila (Philippines).

1928. F. X. Williams, *Philipp. J. Sci.*, Manila, 35 (1), p. 65. Philippines.

1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, 3 (1), p. 29. Philippines.

1941. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, 45 (1), p. 66. Buitenzorg (=Bogor), Java, Indonesia. [Protozoa.,

1942. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, 45 (3), p. 191, Buitenzorg (=Bogor), Java, Indonesia.

1949. T. E. Snyder, *Smiths. misc. coll.*, Washington, 112, p. 40. Philippines ; Java. [Spells wrongly as *cynocephalus*.]

1953. M. Ahmad, *Spolia Zeylan.*, Colombo, 27 (1), p. 35. *Ceylon* : Colombo. [Wrong determination. Specimens examined by me and on comparison with types of *C. perforans* Kemner, were found to be identical. Also *vide infra* "Remarks".]

1958. M. Ahmad, *Biologia*, Lahore, 4 (1 & 2), pp. 53, 56. keys.

1960. L. G. E. Kalshoven, *Acta Tropica*, Basel, 17 (3), pp. 265, 267, 269, 271 Java ; S. E. Borneo.

1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, 122 (4), p. 382.

1967. F. J. Gay, *Bull. Commonw. Sci. Industr. Res. Org.*, Melbourne, No. 286, pp. 10, 20, 50-53.

(iii) *Calotermes (Cryptotermes) cynocephalus* Light

1942. G. F. Hill, *Termites (Isopt.) Austr. Reg.*, pp. 75-76. Rabaul (New Britain Island, Pacific Ocean).

(iv) *Cryptotermes (Cryptotermes) cynocephalus* Light

1937. S. F. Light, *Pan-Pacific Ent.*, San Francisco, 13 (1-2), pp. 16-17, 21-22.

(a) MATERIAL EXAMINED

Present in F.R.I., Dehra Dun.

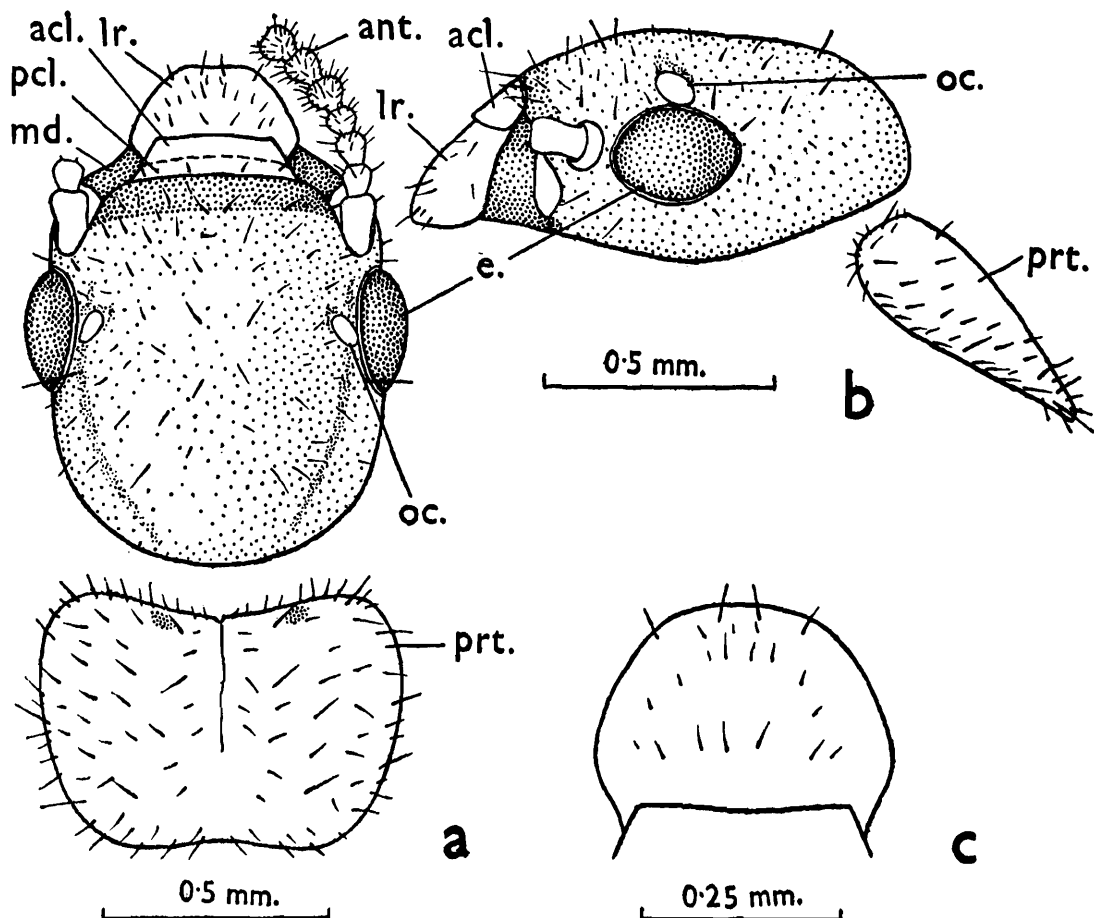
A vial (F. R. I. No. M. C. 19091/3) with a soldier and an imago (♂ dealate), *det.* Emerson Buitenzorg (=Bogor), Java, coll. *H. Kirby* (T. 4537), 20.vii.1935.

(b) DESCRIPTION

1. IMAGO (Text-fig. 5; Table 2).—

General: Head-capsule brown to dark reddish brown; antennae, labrum and legs pale yellowish brown; thorax, wing-scales and tergites reddish brown; sternites paler than tergites, and somewhat paler medially. Head and thorax moderately hairy; tergites and sternites with a few hairs near posterior margin. Total body-length with wings *c.* 8.3—9.0; without wings *c.* 3.85—5.00 mm.

Head: Oval; head-capsule subrectangular; length to base of mandibles subequal to width with eyes (length to tip of labrum 1.00—1.07; length to base of mandibles 0.83; and



TEXT-FIG. 5.—*Cryptotermes cynocephalus* Light. Imago. Drawings from a specimen from Buitenzorg (=Bogor), Java, Indonesia.

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Labrum, in dorsal view.
acl., anteclypeus; *ant.*, antenna; *e.*, eye; *lr.*, labrum; *md.*, mandible; *oc.*, ocellus; *pcl.*, postclypeus; *prt.*, pronotum.

width including eyes 0.77—0.85 mm.); epicranial sutures not clear; sides subparallel; posterior margin round. *Fontanelle*: Absent. *Eyes*: Two medium sized, compound, black, subovoid eyes, one on either side; maximum diameter 0.29 mm. *Ocelli*: Two oval, lateral, small ocelli, one on either side; maximum diameter 0.08 mm. *Antennae*: Broken in the single specimen available; only 7 segments of right antenna present; segment 1 long and cylindrical; 2 cylindrical, shorter than 1; 3 subequal to 2; 4-7 gradually increasing in size. According to Light (1921) "Antennae more than twice as long as width of head, 13 to 15 segments, first segment large and cylindrical, second smaller and cylindrical, third smallest, thickly abconic, fourth to sixth gradually increasing in size, thicker than third, and with rounded distal ends, eighth to thirteenth (when 14) increasingly long and with thicker distal ends, last as long as thirteenth but narrow and oval in shape; antennae with scattered larger hairs and a dense coat of short straight hairs." *Clypeus*: Weakly differentiated into an ante- and a postclypeus. Anteclypeus subtrapezoidal; anterior margin straight. Postclypeus short with round anterior margin. *Labrum*: Broadly tongue-shaped; with two pairs of long hairs along the round anterior margin, and some hairs on body; broader than long (length 0.27 and width 0.35 mm.). *Mandibles*: Not examined in the single specimen available for study.

Thorax: Pronotum: Flat, slightly narrower than head with eyes and much broader than long (head-width 0.77—0.85; pronotum width 0.67—0.80; pronotum length 0.45—0.57 mm.); sides weakly rounded; anterior margin concave; posterior margin weakly depressed medially. *Mesonotum and metanotum*: With weakly incurved posterior margins, at middle. *Legs*: Short, hairy; femora somewhat swollen; apical tibial spur formula 3 : 3 : 3. Tarsi 4-jointed; arolium present.

Wings: Broken in the specimen examined, only wing-scales present. Forewing scales shield-like, 0.7 mm. long; covering the hindwing scales completely. Hindwing scales triangular, 0.23 mm. long.

The following is Light's (1921, pp. 37-38) description of wings:—

"Wings slender, cloudy gray, iridescent; median and cubitus very slightly chitinized except at base in some specimens, costa and radius sector heavily chitinized, gray-brown; all veins and branches as well as areas between the veins marked by papilla-like projections; base of anterior wing twice the width of base of posterior wing; forewing with radius sector and median separate at base; radius sector sends five distinct branches, and one or more small branches to the costa; median joins radius sector beyond middle of wing usually near to origin of third branch of radius sector; cubitus with eleven to thirteen branches; hind wing with six or seven branches uniting radius sector and costa, inner three large; median and radius sector usually united for a short distance at their bases; median joins radius sector distally between points of origin of second and third branches of latter (in one specimen median runs to end of wing!); cubitus with about eleven branches which tend to be more subdivided than those of forewing; cubitus of both wings bends slightly toward radius sector near level of junction of median and radius sector; a few indefinite cross veins unite cubitus and radius sector beyond junction of latter with median."

Abdomen: Oblong, hairy at posterior margins of tergites and sternites. Cerci 2-jointed; 0.1 mm. long. Styli (in males) 1-jointed, finger-like; 0.1 mm. long.

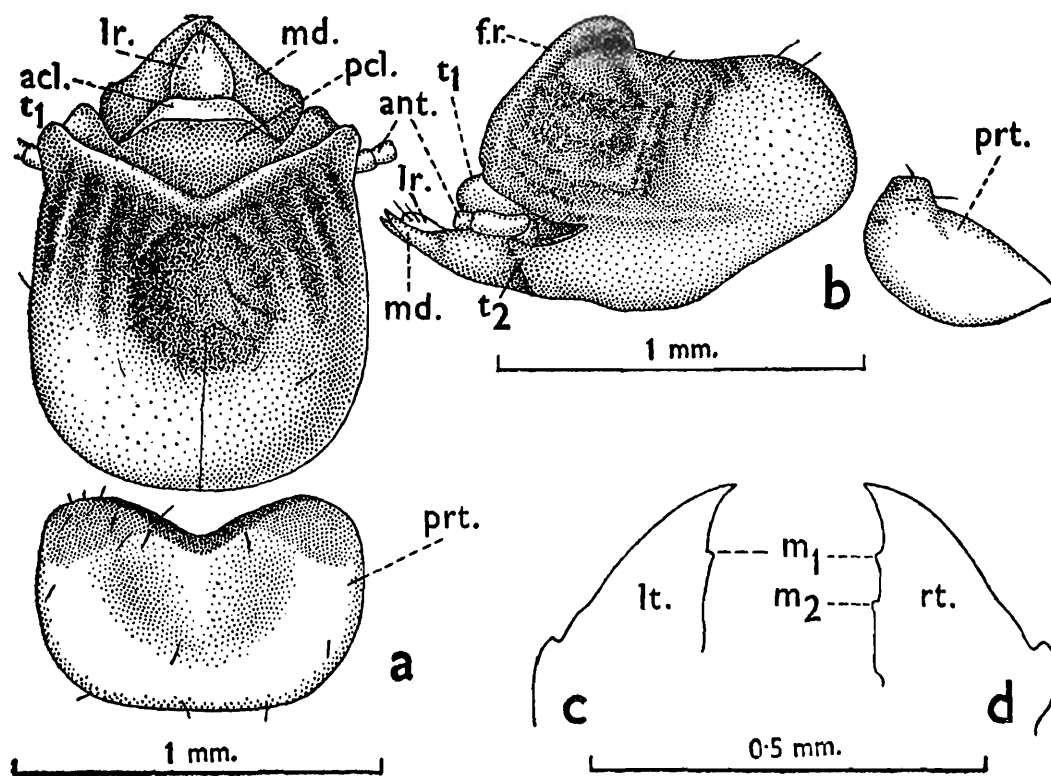
2. SOLDIER (Text-fig. 6; Table 3).—

General: Head-capsule mostly black, somewhat blackish brown posteriorly; antennae, labrum, legs and body pale brownish white; mandibles black proximally and blackish brown distally; pronotum pale brown, somewhat darker near anterior margin. Head, thorax and abdomen sparsely pilose. Total body-length c. 3.25—3.70 mm.

Head: Head-capsule short and thick; length with mandibles 1.20; length to lateral base of mandibles 0.83; and maximum width 0.75—0.90 mm.; frontal ridge prominent greatly elevated, not ribbon-like; two knob-like tubercles present on either side, one above

the antennal socket and the other below it ; the longitudinal epicranial suture present as a depressed line ; frons deeply concave, incurved under the frontal ridge ; vertex medially depressed behind the frontal ridge ; and weakly wrinkled. *Fontanelle and ocelli* : Absent. *Eyes* : Eye spots present *vide* Light 1921, pl. 2, fig. 1, but not distinct in specimen from Buitenzorg (Java). *Antennae* : Broken in the specimen examined, basal 2 segments present : 1 large, cylindrical ; 2 little longer than half of 1 and cylindrical. [According to Light (1921) "antennæ of from 9 to 12 segments, longer than the head depth ; third segment smaller than the second and more heavily chitinized".] *Glypeus* : Hardly separable from frons. *Anteclypeus* a thin, narrow, apilose, hyaline strip. *Postclypeus* pilose, and of same colour as frons ; hardly separable from frons. *Labrum* : Triangularly tongue-shaped ; length 0.13 mm., maximum width 0.17 mm. *Mandibles* : Short, thick and broad basally ; narrowly pointed apically ; with a prominent hump above the condyle on outer margins ; right with two and left with one, short marginal teeth. *Postmentum* : Short and broad posteriorly ; narrower anteriorly ; posterior margin round.

Thorax : Pronotum : Flat, anterior margin somewhat raised ; slightly narrower than head-width (head-width 0.90 ; pronotum width 0.87 mm. ; index Pronotum width/Head-width 0.97) ; length a little less than two-thirds of its width, index Length/Width 0.61 ; sides somewhat rounded ; anterior margin deeply and broadly notched ; posterior margin substraight. *Mesonotum and metanotum* : Narrower than pronotum ; the latter slightly broader than the former ; weakly incurved at posterior margins. *Legs* : Short, thick and pilose ; apical tibial spur formula 3 : 3 : 3. Tarsi 4-jointed.



TEXT-FIG. 6.—*Cryptotermes cynocephalus* Light. Soldier. Drawings from a specimen from Buitenzorg (=Bogor) Java, Indonesia.

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Left mandible, in dorsal view. (d) Ditto, right mandible.

acl., anteclypeus ; *ant.*, antenna ; *f. r.*, frontal ridge ; *lr.*, labrum ; *lt.*, left ; *m₁*, *m₂*, 1st and 2nd marginal teeth of mandibles ; *md.*, mandible ; *pcl.*, postclypeus ; *prt.*, pronotum ; *rt.*, right ; *t₁*, *t₂*, dorsal and ventral tubercles, respectively.

Abdomen : Oblong, pilose, Cerci 2-jointed, 0.10 mm. long. styli absent in the specimen examined.

3. PSEUDOWORKER.—

Not available for study but according to Light (1921, p. 39) "Workers" and nymphs.— "Small and slender. Considerably smaller than those of *Planocryptotermes nocens* g. et sp. nov. which they otherwise resemble."

(c) TYPE-SPECIMENS

(a) Of *Cryptotermes cynocephalus* Light :

Holotype was not selected by Light (1921) ; according to him [types and] the cotypes are as follows :—

"Types : Adults, soldier, larva, and nymph, No. 25 in type collection. Soldier, larva, and nymph from No. 67 of general collection, dealated adult, No. 433 of general collection, winged adult from No. 443 of general collection." [Out of "No. 67" above, 1 soldier and 3 nymphs (cotypes) present in American Museum of Natural History, New York (U. S. A.).

"Cotypes.—No. 67 (*del Rosario*), Manila ; No. 433 (*Light*), Manila ; No. 443 (*Gamboa*), Manila ; No. 448 (*Aguila*), Manila, in general collection."

(b) Of *Cryptotermes buitenzorgi* Kemner :

Cotypes : (i) Imago, soldier and nymph, in American Museum of Natural History, New York. (ii) In Zoologiska Institutet, Lund Universitet, Lund (Sweden).

(d) TYPE-LOCALITIES

(a) Of *Cryptotermes cynocephalus* Light :

Manila (Philippines).

(b) Of *Cryptotermes buitenzorgi* Kemner :

Buitenzorg (=Bogor), Java, Indonesia.

(e) DISTRIBUTION

Cryptotermes cynocephalus is known from the Philippines, Indonesia and New Britain (Pacific Ocean), as follows :—

Asia : Philippines : Manila (type locality), 14°58' N., 121°00' E. Indonesia : Buitenzorg (=Bogor) (Java), c. 7°00' S., 107°00' E. and South-East Borneo.

Pacific Ocean : Rabaul, 4°00' S., 152°00' E. (New Britain Is.).

(f) COMPARISON

Cryptotermes cynocephalus Light is closest to *C. perforans* Kemner. For differences, see under that species.

(g) REMARKS

Ahmad (1953) reported the introduction of *C. cynocephalus* in Ceylon, on the basis of a collection from Colombo. I have re-examined these specimens and compared them with the lectotype of *C. perforans* Kemner, also from Colombo, and find them to be unseparable from the latter. Ahmad's record for Ceylon should, therefore, be taken as invalid.

3. *Cryptotermes declivis* Tsai and Chen

(Text-figs. 7 & 8)

(i) *Cryptotermes declivis* Tsai & Chen

1963. (May). P. H. Tsai and N. S. Chen, *Acta ent. Sinica*, Peking, **12** (2), pp. 168-169, 196, text-fig. 1(S.), text-fig. 2 (Im.); *Im.* and *S.* *Type-localities*. : Chaochou, Taishan of Kwangtung Province; Kinchengchiang (Kwangshi Province); and Yunhsiao (Fukien Province).

1964. P. H. Tsai and N. S. Chen, *Acta ent. Sinica*, Peking, **13** (1), pp. 27, 34. Yunhsiao (Fukien); Taishan Lung Kang Tsui, Chaochou (Kwangtung); and Kinchengchiang (Kwangshi).

(ii) *Cryptotermes domesticus* Tsai (nec Haviland)—Wrong determination.

*1956. P. H. Tsai, *Syst. Ent.*, **1**, pp. 153-154. Tainsum.

(a) MATERIAL

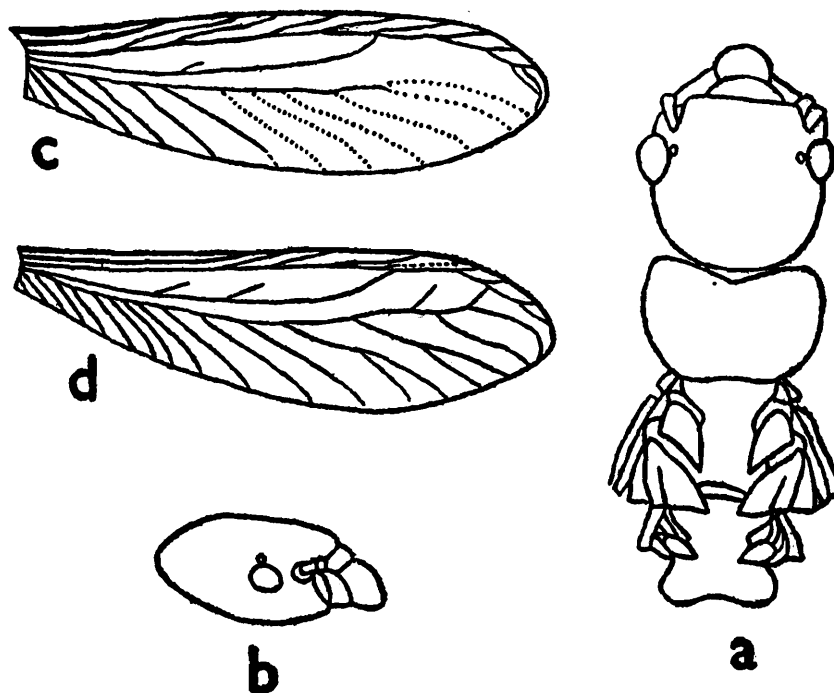
The material of this species, recently described by Tsai and Chen 1963 (*Acta ent. Sinica*, **12** (2), pp. 168-169, 196), was not available to me for this study.

(b) DESCRIPTION

As no material of this species was available to me for study, the English translation of the original description (in Chinese) of imago and soldier is, therefore, given here.

1. IMAGO (Text-fig. 7).—

“Head reddish brown. Antennae, maxillary palpi, labial palpi and labrum hairy, brownish yellow. Thorax, abdomen and legs (partly) dark brown. Tibia and tarsi light yellow. Wings yellowish brown.



TEXT-FIG. 7.—*Cryptotermes declivis* Tsai & Chen. Imago. Drawings reproduced from Tsai, P. H. and Chen, N. S. 1963. (*Acta ent. Sinica*, **12**, p. 169).

(a) Head and thorax, in dorsal view. (b) Head, in side view. (c) Right forewing, in dorsal view. (d) Ditto, hindwing. (Median vein in the hindwing is shown to arise from cubitus it is either an abnormality or a mistake.)

*Not seen in original.

“Head subrectangular, sides parallel, posterior margin arc-shaped. Compound eyes small and oval. Ocelli oval, lying above the compound eyes, quite near the eyes, not touching. Postclypeus short, horizontal, inlaid, not clearly demarcated from frons, not swollen, anterior margin straight. Anteclypeus trapezoidal. Antennae with 14-16 segments; length of 2, 3, 4 segments equal or 2, 3 equal and 4 slightly shorter, comparatively.

“Pronotum as wide as head, anterior margin incurved as a whole, posterior margin slightly concave. The forewing and hindwing scales unequal. Forewing scales overlying hindwing scales. Wing-membrane punctate. The veins of forewing: Sc very short; R extending upto 1/3 of wing-length; Rs extending upto tip of wing, with about 7 short branches to anterior margin; M coming out independently from scale, proximally near Cu but extending upto 2/4-3/4 of wing-length and bending up to meet Rs, with faint branches connected with Rs and Cu; Cu with more than 10 branches, the branches darker proximally near the wing-base, paler distally. Veins of hindwing almost similar to those of forewing, M*not coming out of scale independently but arising from Cu, separation very near the scale.

“Total length	8.50	8.80
Length of body excluding wings	5.20	5.80
Length of forewing	7.00	6.80
Length of head upto tip of labrum	1.36	1.40
Width of head with eyes	1.09	1.13
Length of compound eyes	0.27	0.31
Length of ocelli	0.09	0.08
Width of ocelli	0.06	0.05
Distance between compound eyes and ocelli	0.02	0.02
Length of pronotum	0.61	0.65
Width of pronotum	1.04	1.13
Length of tibia of hindleg	0.88	0.93”

2. SOLDIER (Text-fig. 8).—

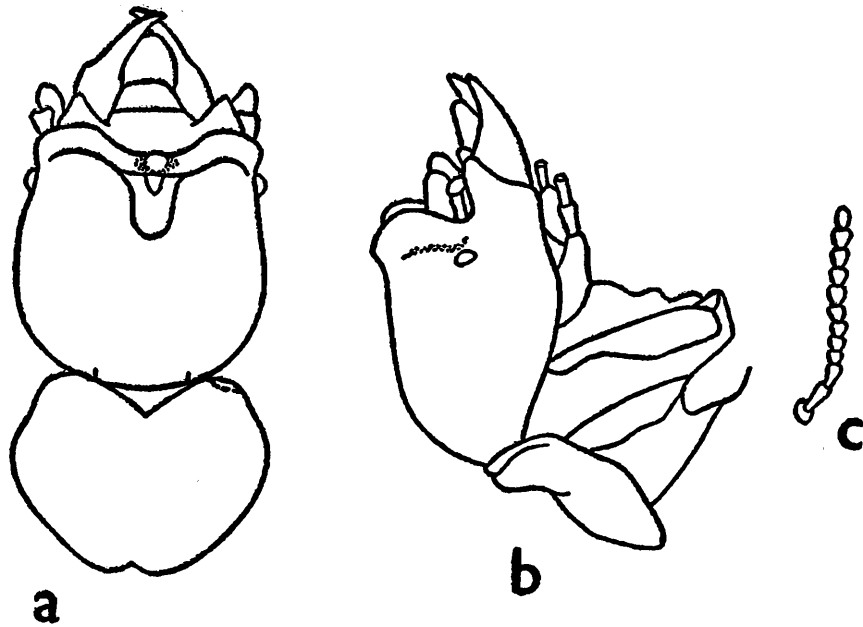
“Mandibles and frons black. Occiput dark red. Antennae, palpi, thorax and abdomen light yellow.

“Head short and thick, squarish as viewed from behind. Frons not perpendicularly inclined, forming an oblique plane in front, with mandibles making an angle larger than 90°; the plane uneven. Two sides of this plane and upper portion forming projected ridge, the ridge depressed at upper middle portion of the plane thus forming left and right parts. Other portions of head smooth, not prominently rugose, only vertex (head-top) with a big, shallow depression. Antennal fossae situated laterally at base of above mentioned plane. Large protuberances projecting in front, each at ventral and dorsal side of antennal fossae; the ventral flat and the dorsal conical, almost equal in size. Labrum rectangular posteriorly, sides converging anteriorly to form a triangle. Antenna with 11-15 segments. Eyes lateral, lying behind the antennal fossae. Mandibles short, small and flat. Left mandible with two big and thick teeth in the middle, the first tooth slightly inclined in front, the second inclined inwards. Right mandible with two teeth inclining in front, their position a little posterior to the position of teeth on left mandible.

“Pronotum almost as wide as head; the anterior margin with a big wedge-shaped cut, sides triangular or subcircular on either side of this cut, projecting in front, and elevated to lie on the back of head; the posterior margin slightly concave medially.

*Median vein in hindwing of termites arises generally from the radial-sector. In figure also, the median in the hindwing, is shown to be arising out of cubitus. This evidently, is either an abnormality or a mistake on the part of the authors.

“Abdomen long. Legs very short.



TEXT-FIG. 8.—*Cryptotermes declivis* Tsai & Chen. Soldier. Drawings reproduced from Tsai, P. H. and Chen, N. S. 1963 (*Acta ent. Sinica*, 12, p. 168).

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Antenna.

“Total length	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	5.11	5.11	5.55
Length of head including mandibles	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	1.81	2.00	1.93
Length of head excluding mandibles	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	1.38	1.52	1.45
Length of head upto frons	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	0.97	1.13	1.09
Width of head	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	1.22	1.40	1.32
Height of head (excluding postmentum)	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	0.90	1.00	0.90
Length of pronotum	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	0.70	0.80	0.72
Width of pronotum	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	1.20	1.38	1.34
Length of tibia of hindleg	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	.. .. .	0.80	0.80	0.88

(c) TYPE-SPECIMENS

The authors, Tsai and Chen (1963) did not specifically select any holotype and paratypes. The type-material (=cotypes) is, however, deposited in the Institute of Zoology, Academia Sinica, Peking.

(d) TYPE-LOCALITIES AND DISTRIBUTION

No specific type-locality is mentioned by the authors. The species is, however, described from southern China, as follows :—

South China : Chaochou (Kwangtung); Kinchengchiang (Kwangsi); and Yunhsiao (Fukien).

(e) COMPARISON

As I could not have access to the specimens of *Cryptotermes declivis*, I give below the differences from *C. havilandi* (Sjöstedt) to which it is closest, on the basis of the original description of *declivis*. These differences are very minor and the species are not easily separable.

Imago : (i) Head reddish brown (*vs.* pale brown to brown in *haviglandi*). (ii) Head a little wider (Head width with eyes 1.09—1.13 *vs.* 0.93—1.07 mm.)

Soldier : Length of head-capsule with mandibles 1.81—2.00 mm. *vs.* 1.50—1.80 mm. in *haviglandi*.

4. *Cryptotermes domesticus* (Haviland)

(Text-figs. 9-12 ; and Tables 2-4)

(i) *Calotermes* (*Cryptotermes*) *buxtoni* Hill

Some material from Thursday Island (*det.* G. F. Hill) was examined *vide* "Material" below.

1926. G. F. Hill, *Entomologist*, London, **59** (762), p. 298. *Im.* and *S.* *Type-locality* : Apia (Upolu Isl.), Samoan Islands.
 1927. G. F. Hill, Isoptera, Family Termitidae. In : *Insects of Samoa*, pt. VII. Fasc. 1, pp. 9-13, text-figs. 10-12 (*Im.*), 13-14 (*S.*). *Im.* and *S.* Apia (Upolu Isl.).
 1933. G. F. Hill, *Proc. roy. Soc. Viat.*, Melbourne, **46** (1), pp. 44-45. Fiji and Thursday Isls. Also : Tutuila Isl. (Samoa) and Vavau Isl. (Tonga group).
 1942. G. F. Hill, *Termites (Isoptera) from the Australian Region*, pp. 7, 11, 70-72, fig. 29 (*S.*). *Im.* & *S.* Fanning ; Marquesas Flint ; Society ; Austral ; and Oeno Isls. ; Apia (Samoa) ; Tulagi (Solomon Isls.) ; Rabaul (New Britain Isl.) ; 30 miles S.E. of port Moresby (Papua) ; Suva (Fiji Isls.) ; Thursday Isl. ; Guam (Marianas Isls.).

(ii) *Cryptotermes*/*Calotermes* (*Cryptotermes*) *campbelli* Light

1924. S. F. Light, *China J. Sci. Arts*, Shanghai, **2** (1-4), pp. 57-60. *Q.* and *S.* *Type-locality* : Kachek, Hainan Isl. (off China).
 1931. S. F. Light, *Lingnan Sci. J.*, Canton, **7** (1929), pp. 583, 584, 586-588. Hainan and Kwangtung (China).
 1942. G. F. Hill, *Termites (Isoptera) from the Australian Region*, p. 70.

(iii) *Calotermes* (*Cryptotermes*) *dentatus* Oshima

- 1914a. M. Oshima, *Zool. Anz.*, Leipzig, **44** (7), pp. 289-291, fig. 1. (*S.* mandibles). *Im.* and *S.* *Type-locality* : Taihoku, Formosa.
 *1914b. M. Oshima, *4th Off. Rep. Termites*, Taihoku, p. 2, pl. 1, fig. 1, pl. 2, figs. 8-9. Formosa.

(iv) *Calotermes domesticus* (Haviland)

1896. G. D. Haviland and D. Sharp, *Trans. ent. Soc. Lond.*, London, **44**, pp. 591-594. Singapore. [Biology only.]
 1898. G. D. Haviland, *J. Linn. Soc. Lond.*, London, **26** (169), p. 374, pl. 23, figs. 3-4 (*S.*), 5-6 (*Im.*). *Im.* and *S.* *Type-localities* ; Singapore and Sarawak (Borneo). Also see under "type-locality" below. *Types examined*.
 1904. J. Desneux, *Genera Insectorum*, Brussels, Fasc. **25**, p. 23.
 1912. N. Holmgren, *Ent. Mitt.*, Berlin, **1** (9), p. 280. "Anping (?)."
 1913. E. E. Green, *Spol. Zeyl.*, Colombo, **9**, p. 8. Peradeniya (Ceylon).
 1914. E. Bugnion, *Bull. Mus. nation. Hist. Nat.*, Paris, **20**, p. 176. Peradeniya (Ceylon).
 1934. V. Margabandhu, *J. Bombay nat. Hist. Soc.*, Bombay, **37** (3), p. 702. Peradeniya (Ceylon).

(v) *Calotermes* (*Cryptotermes*) *domesticus* (Haviland)

- 1911a. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **46** (6), p. 55, pl. 4, fig. 9 (*S.*).
 1911b. N. Holmgren, *Zool. Anz.*, Leipzig, **37**, p. 550.
 1913a. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **50** (2), pp. 46-47, pl. 1, fig. 16 (*S.*). *Im.* and *S.* Singapore ; Sarawak ; and Bangkok (Thailand).
 1913b. N. Holmgren, *Tijdsch. Ent.*, The Hague, **56** (1-2), pp. 13, 15. Deli (Sumatra) ; Krakatau.
 1927. J. Bathelier, *Faun. Colon. Franc.*, Paris, **1**, pp. 128-129, 183-184. Singapore ; Sarawak ; Bangkok (Thailand) ; Saigon and Tonkin (Vietnam).
 1929. F. P. Jepson, *Bull. Dept. Agric. Ceylon*, Colombo, No. 85, pp. 7, 9.
 1942. G. F. Hill, *Termites (Isoptera) from the Australian Region*, p. 70.

(vi) *Cryptotermes domesticus* (Haviland)

1923. M. Oshima, *Cap. Zool.*, The Hague, **2** (3), p. 5. *Im.* Simalur, Sinabang (Sumatra).
 1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, **3** (1), pp. 28, 29, 35. Ceylon ; India ; Indo-China ; Java ; Krakatau Isl. ; Malaya ; Siam ; Simalur.
 1937. S. F. Light, *Pan-Pacific Entom.*, San Francisco, **13** (1-2), pp. 17, 22.

*Not seen in original.

1941. C. F. C. Beeson, *Ecol. & Control Forest Insects, India, etc.*, p. 540. Ceylon ; Malaya.
 1941. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (1), p. 57. Fanning Isl. (Pacific Oc.).
 1942. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (3), p. 191. Singapore.
 1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112**, pp. 40-41. India ; China ; Formosa ; Thailand ; Malay Arch. Sumatra ; Sarawak (Borneo) ; Krakatau, Marianas, Guam, Papua, New Britain, Solomon, Fiji, Samoa, Fanning, Flint, Society, Australian, Marquesas and Oeno Isls.
 1957. W. V. Harris, *Malayan Nat. J.*, Kuala Lumpur, **2**, pp. 22, 25, 27.
 1958. W. V. Harris, *East Afr. agric. J.*, Nairobi, **23** (3), p. 166. South China ; Siam ; Formosa ; Malaya ; Indonesia and many island groups in the Pacific from the Solomons to Fiji and Marianas.
 1958. W. V. Harris and E. S. Brown, *Bull. ent. Res.*, London, **49**, (4), pp. 737, 739, 740, 741-742. Honiara (Guadacanal) and Gizo (western group) in Solomon Islands.
 1958. M. Ahmad, *Biologia, Lahore*, **4** (1 & 2), pp. 54, 55. Keys.
 1960. L. G. E. Kalshoven, *Acta Tropica*, Basel, **17** (3), p. 264. Java ; S. E. Borneo.
 1961. K. Krishna, *Bull. Amer. Mus. Nat. Hist.*, New York, **122** (4), p. 382.
 1961. W. V. Harris, *Termites : Their Recognition and Control*, pp. 46, 63, 68, 143, 155, 160, 161. Formosa ; Siam ; Malaya ; Indonesia ; Solomon Isls. ; Fiji Isls. ; Samoa Isls. ; Ceylon ; and Panama.
 1963. W. V. Harris, *Mem. Hongkong nat. Hist. Soc.*, Hongkong, No. 6, p. 2. Kwangtung Prov. and Hainan Isl., China. [Authorship of species wrongly assigned to Holmgren.]
 1964. P. H. Tsai and N. S. Chen, *Acta Entom. Sinica*, Peking, **13** (1), pp. 27, 34. Hainan and Yunnan (China) ; Formosa ; Indonesia ; Thailand ; Singapore ; Kuan Isl.
 1965. M. Ahmad, *Bull. Amer. Mus. nat. Hist.*, New York, **131** (Art. 1), pp. 14, 16-17. *Im.*, *S.*
 1966. W. V. Harris, *Proc. Linn. Soc. Lond.*, London, **177**, (1), p. 12. Singapore ; Sarawak.
 1967. F. J. Gay, *Bull. Commonw. Sci. Indust. Res. Org.*, Melbourne, No. 286, pp. 10, 20-21, 53-54.

(vii) *Kalotermes (Cryptotermes) domesticus* (Haviland)

1934. T. E. Snyder, *Indian For. Rec.*, Delhi, **20** (11), p. 5. Trivandrum (Kerala, India).
 1953. Rattan Lal and R. D. Menon, *Catalog. Indian Insects*, Pt. 27, *Isoptera*, Delhi, p. 10. Singapore ; Sarawak (Borneo) ; and Ceylon.

(viii) *Cryptotermes (Cryptotermes) domesticus* (Haviland)

1934. N. A. Kemner, *K. Sv. Vet. Akad. Handl.*, Stockholm, (3) **13** (4), p. 46.

(ix) *Calotermes (Procryptotermes) domesticus* (Haviland)

1910. N. Holmgren, *Trans. Linn. Soc. Lond.*, London, (2) **14**, p. 136.

(x) *Calotermes (Cryptotermes) formosae* Holmgren

1911. N. Holmgren, *Zool. Anz.*, Leipzig, **37**, p. 550. [No description].
 1912. N. Holmgren, *Annot. Zool. Jap.*, Tokyo, **8**, pp. 119-120. *Im.* and *S.* *Type-locality* : Botel Tobago (Formosa).
 1913. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **50** (2), pp. 47-48, fig. 5 (*S.* mandibles), pl. 1, fig. 17 (*S.*). *Im.* *S.* and *Pw.* Botel Tobago (Formosa).

(xi) *Calotermes (Cryptotermes) gulosus* Hill

1927. G. F. Hill, *Mem. nation. Mus. Melb.*, Melbourne, No. 7, pp. 11-13, pl. 1, figs. 5-11 (*Im.* & *S.*) ; pl. 5, fig. 151 (wing) ; pl. 8, fig. 152 (wing). *Im.*, *Q.* and *S.* *Type-locality** : 30 miles S. E. from Port Moresby (New Guinea). Types examined.
 1927. G. F. Hill, *Insects of Samoa*, Part VII, Fasc. 1, p. 12.
 1933. G. F. Hill, *Proc. roy. Soc. Vict.*, Melbourne, (*N. S.*), **46** (1), p. 45.

(xii) *Cryptotermes/Kalotermes (Cryptotermes) hermsi* Kirby

1925. H. Kirby, *Calif. Univ. Publ. (Zool.)*, Berkeley, **26**, pp. 437-441. *Im.* and *S.* *Type-locality* ; Fanning Isl. (Pacific Ocean).
 1932a. S. F. Light, *Bull. Bishop Mus.*, Honolulu, **98**, pp. 83-84. Marquesas Isls. : Atuona (Hivaoa Isl.) and Hanahevane valley (Tahuata Isl.).
 1932b. S. F. Light, *Bull. Bishop Mus.*, Honolulu, **98**, pp. 171, 172, 176. Marquesas Isls. ; Atuona (Hivaoa Isl.) ; and Hanahevane valley (Tahuata Is.). Keys and collection records.
 1936. S. F. Light and E. C. Zimmerman, *Occ. Papers Bishop Mus.*, Honolulu, **12** (12), pp. 11, 12. Oeno Isl. ; Austral Isls. ; Society Isls. ; Flint Isl.
 1941. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (1), p. 57. Fanning Isl. (Pacific Ocean).

*The holotype soldier and the morphotype imagos of *Calotermes (Cryptotermes) gulosus* Hill, are from Kaile (Papua). Also see under "Material" below. These two localities (*i.e.*, Kaile (Papua) and 30 miles S. E. of Port Moresby), probably mean the same place.

1942. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (3), p. 190. Fanning Isl. (Pacific Ocean).
 1946. S. F. Light, *Bull. Bishop Mus.*, Honolulu, No. 189, p. 9. Guam (Pacific Ocean). Also Fanning, Washington; Marquesas, Tahiti, Austral, Oeno, and Flint Islands.

(xiii) *Calotermes/Calotermes (Cryptotermes) kotoensis* Oshima

- †1912. M. Oshima, *3rd Official Rept. Termites*, Taihoku, p. 56, pl. 2, figs. 3, 4, 17 & 18.
 1913. M. Oshima, *Philipp. J. Sci.*, Manila, (D) **8** (4), pp. 274, 275; fig. 1 (*S.* mandibles) (explanation of figure misprinted as *Coptotermes kotoensis*). Botel Tobago Island (Formosa) and Loo-Choo Archipelago.
 †1914. M. Oshima, *4th Official Rept. Termites*, Taihoku, p. 1.
 1915. S. Hozawa, *J. Coll. Sci. Tokyo Imp. Univ.*, Tokyo, **35** (Art. 7), pp. 51-61, text-figs. 11 (*Im.*), 12 (*S.*) and 13 (*Pw.*); pl. 2, figs. 9 (*Im.*) and 10 (*S.*). *Im.*, *Ny.*, *S.* and *Pw.* Formosa. Japanese Arch.: Ishagakijima, Loo-Choo; and Bonin Isl.
 1942. G. F. Hill, *Termites (Isoptera) from the Australian Region*, p. 70.

(xiv) *Cryptotermes lignarius* Kemner (MS name)

1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, **3** (1), p. 85. Ceylon: Hakgala.
 1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112**, p. 345.

(xv) *Calotermes (Cryptotermes) ogasawarensis* Oshima

1913. M. Oshima, *Philipp. J. Sci.*, Manila, (D) **8**(4), pp. 274-276, fig. 2 (*S.* mandibles) (explanation misprinted as *Coptotermes ogasawarensis*). *Im.* and *S.* *Type-locality*: Ogasawarajima or Bonin Isl. (Japanese Archipelago).
 1914. M. Oshima *Zool. Anz.*, Leipzig, **44** (7), pp. 291-292, fig. 3 (*S.* mandibles). *Im.* and *S.* Ogasawarajima (or Bonin Isl.), Japan.

(xvi) *Calotermes (Cryptotermes) repentinus* Hill

- 1927a. G. F. Hill, *Mem. nation. Mus. Melb.*, Melbourne, No. 7, pp. 13-14, pl. 1, fig. 13 (*Im.*). *Im.* *Type-locality*: Rabaul (New Britain). Also Toma (New Britain). Types examined.
 1927b. G. F. Hill, *Insects of Samoa*, Part VII, Fasc. 1, p. 13.
 1933. G. F. Hill, *Proc. roy. Soc. Vict.*, Melbourne, (*N. S.*), **46** (1), p. 45.

(xvii) *Cryptotermes tectus* Kemner (MS name)

1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, **3** (1), p. 85. Ceylon: Colombo.
 1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112**, p. 345.

(a) MATERIAL EXAMINED

(A) Present in University Museum of Zoology, Cambridge (England).

(i) One vial with 14 imagos (6 alates, 8 dealates), 3 soldiers, 6 nymphs, 1 pseudoworker, and a few loose wings. No. "376" Sarawak (Borneo).

(B) Present in Z. S. I., Calcutta.

(ii) One vial, Z. S. I. Reg. No. 2625/H8, with 2 imagos (dealates), 1 soldier and 2 nymphs, Colombo (Ceylon), ex "frame of an oil painting"

(iii) One vial, Z. S. I. Reg. No. 9901/18, with 2 imagos and several pseudoworkers, Trivandrum (Kerala State, India), *det.* F. Silvestri, ex "mango-wood boat model"

(C) Present in F. R. I., Dehra Dun.

(iv) One vial, F. R. I. No. M.C. 19092/1, with 2 imagos (dealates), 1 soldier, 1 nymph and two loose wings, Thursday Isl. (N. Australia), *det.* G. F. Hill as "*Calotermes (Cryptotermes) buxtoni*"

(v) One vial with an incompletely chitinised imago and 1 pseudoworker, Formosa, ex Shiraki Coll., "*Calotermes kotoensis*" *det.*

(D) Present in A. M. N. H., New York (All *det.* G. F. Hill as "*Calotermes (Cryptotermes) buxtoni* Hill").

† Not seen in original

(vi) One vial with a soldier (holotype of *Calotermes (Cryptotermes) gulosus* Hill), 2 imagos (1 ♂, 1 ♀; morphotypes of *gulosus* Hill) and 5 loose wings, Kaile (Papua) [probably same as "30 miles S. E. of Port Moresby", *vide* above], coll. *G. F. Hill*, 22.vii.22.

(vii) One vial with an imago (type of *Calotermes (Cryptotermes) repentinus* Hill), Rabaul, New Britain, June, 1922.

(viii) One vial with 13 soldiers, Rabaul, New Britain, coll. *J. L. Froggatt*, 5.?.31, No. 1159/N.Br.

(ix) One vial with 1 soldier, 1 imago, 1 nymph and several pseudoworkers, Tubagi, Solomon Isls., coll. *R. A. Lever* (6952), 17.xi.1936, "from leg of table".

(x) One vial with 1 soldier, 3 imagos, and several nymphs, Thursday Isl., N. Australia, "25.x. c.c. 227"

(xi) One vial with 4 soldiers and several imagos, nymphs and pseudoworkers, Thursday Isl., "7 : II", coll. *G. F. Hill* (No. 1412):

(xii) One vial with 1 soldier and several imagos, nymphs and pseudoworkers, Thursday Island, Oct. 1922, coll. *G. F. Hill*.

(E) Present in *Zoologiska Institutet, Lund University, Lund (Sweden)*.

(xiii) One vial with an imago (dealate), 2 soldiers, several nymphs and pseudoworkers and a few loose wings, Colombó (Ceylon), 13.x.1928, ex. "Venesta board", *det.* N.A. Kemner "*Cryptotermes tectus* n. sp." (MS name).

(xiv) One vial with an imago (dealate) and a loose hindwing,* Hakgala (Ceylon), coll. *F.P. Jepson*, 25.iv.1917, "at light at night", *det.* N.A. Kemner "*Cryptotermes lignarius* n. sp." (M.S. name).

(b) DESCRIPTION

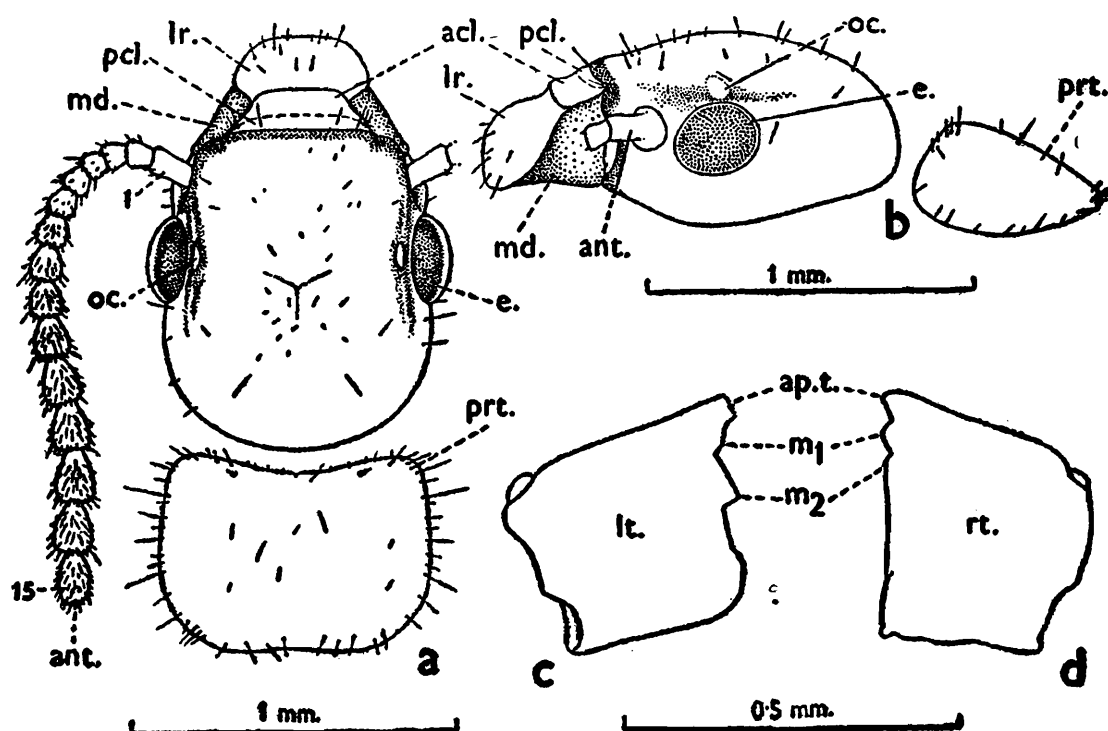
Types examined.

1. IMAGO (Text-fig. 9 ; Table 2).—

General : Head-capsule ochraceous or pale yellow to pale brown, somewhat paler anteriorly ; antennae, labrum, legs and body paler than head-capsule ; mandibles yellowish to pale brown with dark brown toothed margins. Head and body moderately pilose. Total body-length with wings c. 7.5-10.0 mm. ; without wings 4.5-6.9 mm.

Head : Oval ; length to tip of labrum 1.23-1.37 mm., width with eyes 0.90-1.10 mm. Head-capsule subrectangular, rounded posteriorly ; sides subparallel, somewhat incurved in region of eyes ; length to base of mandibles subequal to width with eyes *Fontanelle* : Absent. *Eyes* : Two lateral, black, compound, oval eyes, one on either side ; maximum diameter 0.23-0.37 mm. *Ocelli* : Two lateral, transparent, small ocelli, one on either side ; maximum diameter 0.09-0.13 mm. ; either touching the eyes or separated just by a thin line. *Antennae* : With 14-17 segments ; segments 1 and 2 sparsely, and remainder moderately, pilose ; segments 1 and 2 cylindrical, the latter approximately half of 1 ; 3 pyriform, subequal to or slightly shorter than 2 ; 4 shortest ; 5 to the penultimate one pyriform and gradually increasing in length ; the last ovate and shorter than the penultimate one. *Glypeus* : Subtrapezoidal. *Anteclypeus* apilose ; weakly incurved at anterior margin. *Postclypeus* hardly differentiated from the anteclypeus ; weakly pilose. *Labrum* : Broader than long ; rounded at anterior margin ; pilose near tip and on body. *Mandibles* : Of typically *Cryptotermes*-type. Left mandible with a finger-like apical and 2 marginal teeth ; 1st marginal short ; 2nd triangular, larger than 1st and widely separated from it. Right mandible also with a finger-like apical and 2 marginal teeth ; 1st marginal short, triangular ; 2nd smaller than 1st, lying at its base and with the hind margin about twice the length of molar plate.

* The loose wing is exceptionally long (10.0 mm. without scale) ; otherwise the imago (dealate) has all the characters of *C. domesticus* (Heslind).



TEXT-FIG. 9.—*Cryptotermes domesticus* (Haviland). Imago. Figs. (a), (b) from lectomorphotype imago; and (c), (d) from a paralectomorphotype dealatè imago from same lot. Sarawak, Borneo.

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Left mandible, in dorsal view. (d), Ditto, right mandible.

acl., anteclypeus; *ant.*, antenna; *ap. t.*, apical tooth of mandibles; *e.*, eye; *lr.*, labrum; *lt.*, left; *m₁*, *m₂* 1st and 2nd marginal teeth of mandibles; *md.*, mandible; *oc.*, ocellus; *pcl.*, postclypeus; *prt.*, pronotum; *rt.*, right.

Thorax : Pronotum : Flat, subreniform; generally narrower, but sometimes subequal to or broader than, head with eyes; much broader than long (maximum length 0.57-0.77; maximum width 0.73-1.25 mm.); sides substraight to weakly convex; anterior margin weakly concave; posterior margin substraight to weakly rounded, sometimes slightly incurved medially. **Mesonotum and metanotum :** Posterior margin weakly incurved medially. **Legs :** Pilose; fore-legs shortest; hind-legs longest; apical tibial spur formula 3 : 3 : 3. Tarsi 4-jointed; arolium present between claws.

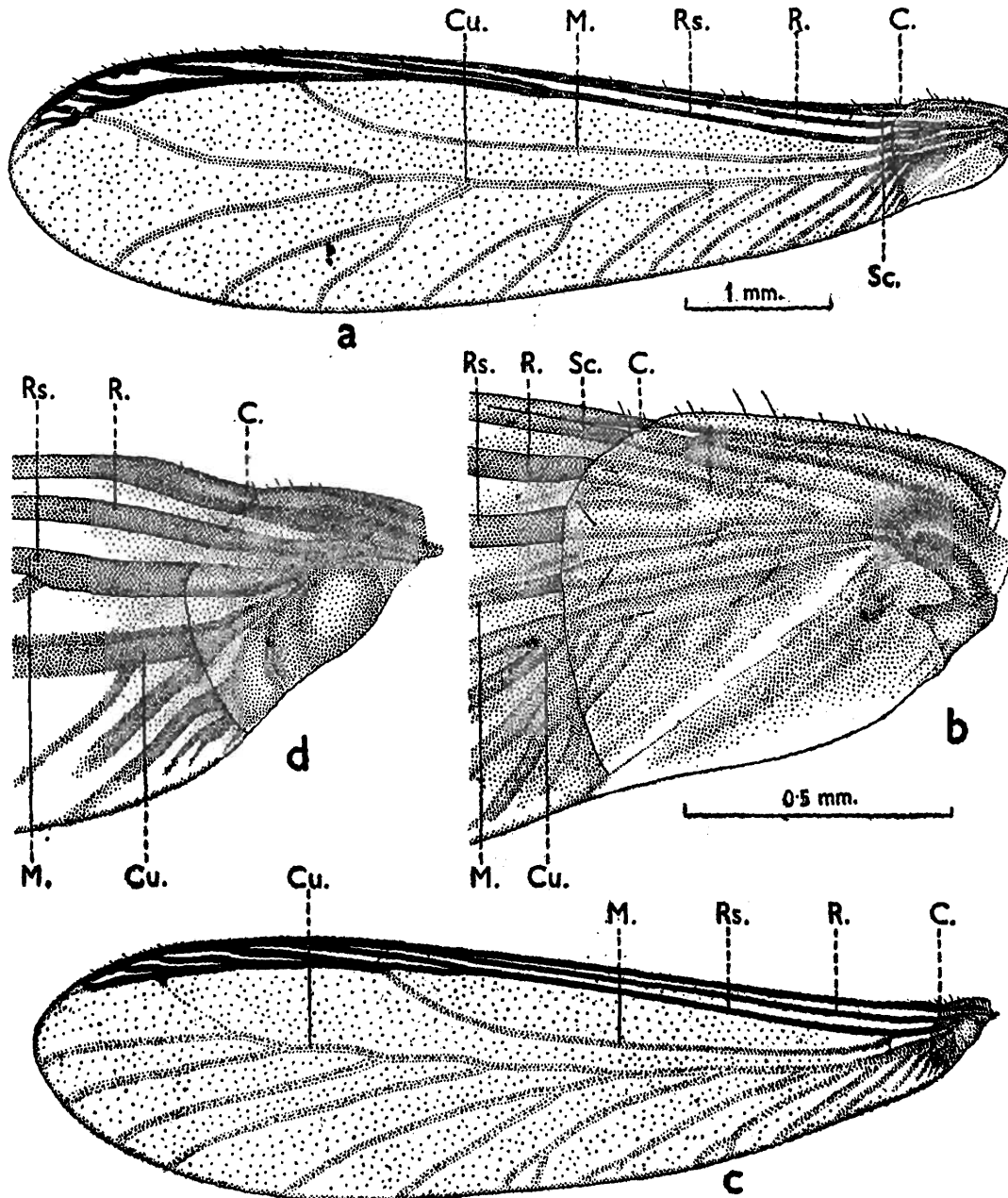
Wings (Text-fig. 10) : Transparent, pale yellow. Costa, subcosta, radius and radial sector thick and strongly chitinous; median and cubitus thin. **Forewing :** Longer than hindwing; basal scale shield-like. Costa thick, running along entire length of wing membrane. Subcosta short, arising independently from scale and meeting the costa just outside the scale. Radius short and thick, meeting the costa at about one-fourth to one-third the length of wing-membrane. Radial sector thick, arising independently from scale; running parallel with costa and giving 6-10 branches to the latter; first bifurcation at about one-third to approximately middle of wing-membrane. Median thin, arising independently from basal scale, curving up and meeting the radial sector at about middle to distal one-third of wing. Cubitus thin, with 11-13 branches to posterior margin. **Hindwing :** Shorter than forewing; scale also shorter than forewing scale, covered completely by the latter. Costa as in forewing; subcosta absent; radius as in forewing, meeting the costa at about middle of wing-membrane. Radial sector as in forewing, with 4-6 branches to costa. Median arising from radial sector a little outside the scale, curving up and meeting the radial sector at about the middle to the distal one-third. Cubitus as in forewing, with 10-11 branches to posterior margin.

Abdomen : Oblong, hairy. Cerci 2-jointed, c. 0.08-0.10 mm. long. Styli (in males) single-jointed, 0.07 mm. long.

2. SOLDIER (Text-figs. 11 & 12 ; Table 3).—

General : Head-capsule black, slightly paler (dark castaneous) posteriorly ; antennae, labrum, legs and body yellowish to pale brown ; pronotum darker near anterior margin ; mandibles black. Head and body sparsely hairy. Total body-length *c.* 4-6 mm.

Head : Head-capsule subrectangular, thick and truncated in front ; length to base of mandibles 1.20-1.30 mm. ; maximum width 1.13-1.29 mm. ; with a prominently projecting,



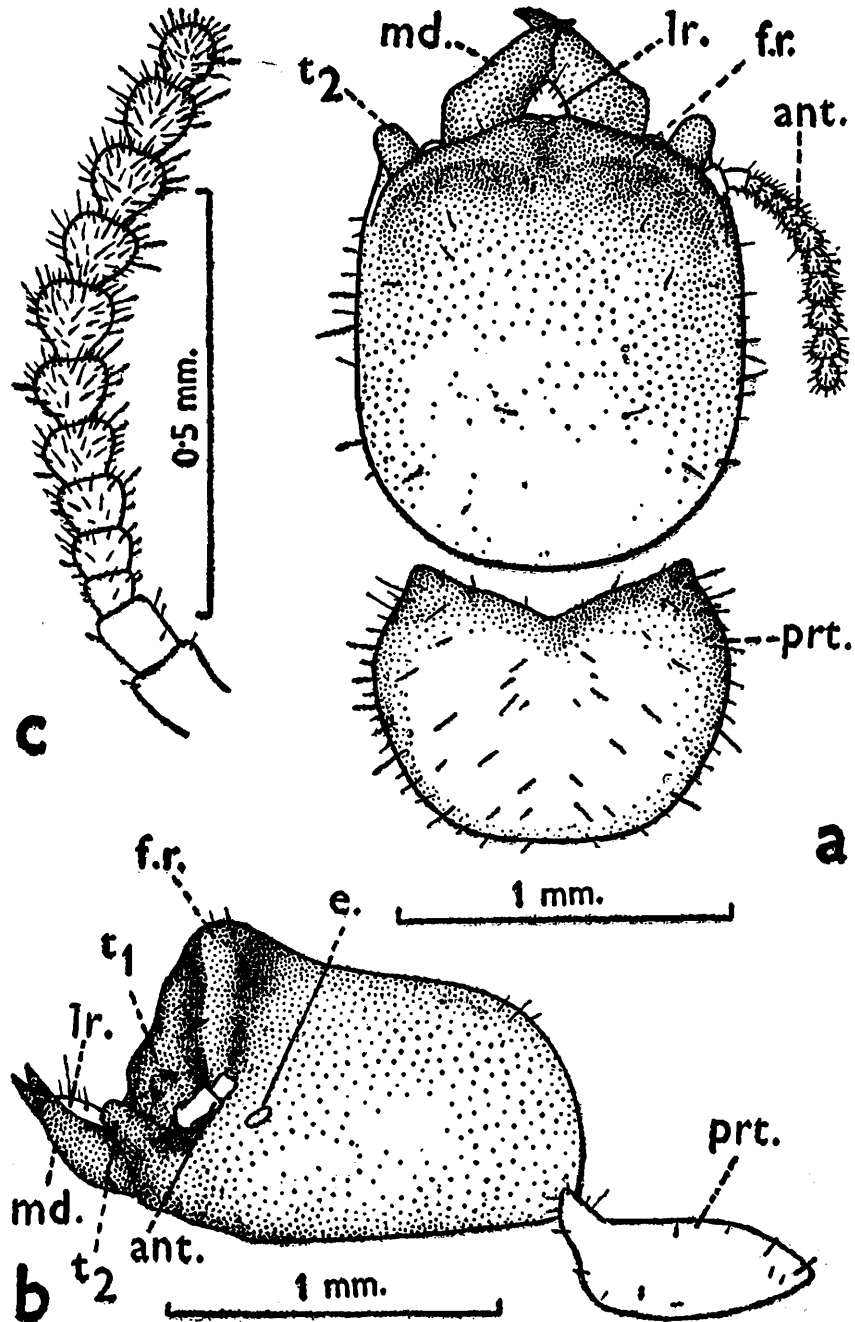
TEXT-FIG. 10.—*Cryptotermes domesticus* (Haviland). Wings. From paralectomorphotype specimen. Sarawak, Borneo.

(a) Forewing, in dorsal view. (b) Proximal portion of forewing, enlarged. (c) Hindwing, in dorsal view. (d) Proximal portion of hindwing, enlarged.

C., costa ; Cu., cubitus ; M., median ; R., radius ; Rs., radial sector ; Sc., subcosta.

knob-like tubercle on either side, arising from ventral genae just below the antennal sockets, and a weak swelling on either side of postclypeus arising from frons a little above the antennae in place of the dorsal tubercles ; frontal ridge prominent, weakly to strongly notched anteriorly in middle and strongly projecting in front from about the base of mandibles to approximately middle of mandibles (index Maximum head-length upto ridge/Head-length to base

of mandibles 1.10-1.25). Frons truncated, forming a right angle or a smaller angle with the mandibles. *Fontanelle and ocelli* : Absent. *Eyes* : Two small, suboval eye spots, one on either side ; maximum diameter 0.10-0.17 mm. *Antennae* : With 11-14 segments ; segments 1 and 2 sparsely and the remainder moderately densely pilose ; segment 1 longest, cylindrical ; 2 a little longer than half of 1 ; 3 narrower, in length either shortest or a little longer than



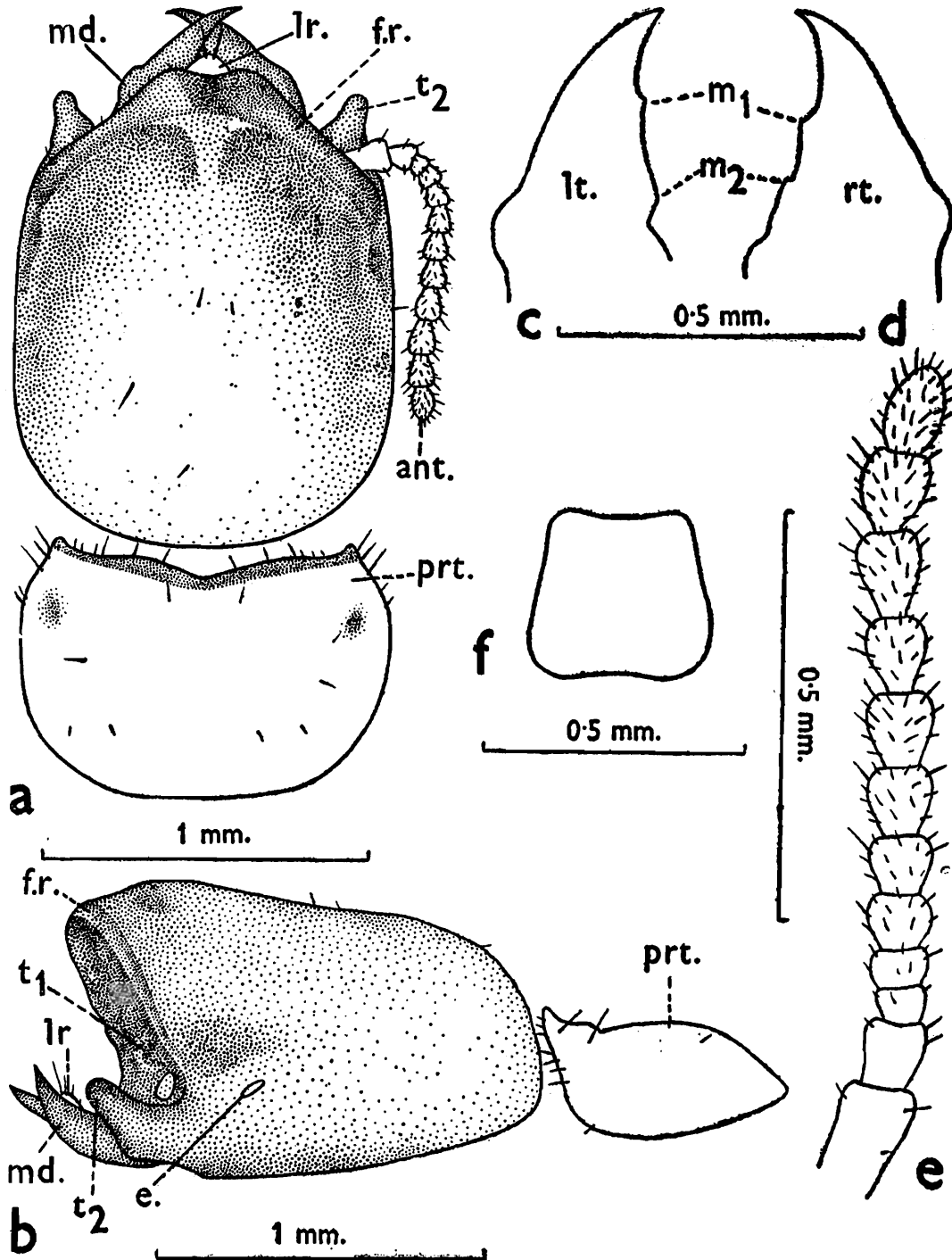
TEXT-FIG. 11.—*Cryptotermes domesticus* (Haviland). Soldier. Lectotype. Sarawak, Borneo.

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Right antenna, in dorsal view.

ant., antenna ; *e.*, eye ; *f.r.*, frontal ridge ; *lr.*, labrum ; *md.*, mandible ; *prt.*, pronotum ; *t₁*, *t₂*, dorsal and ventral tubercles respectively.

or subequal to 4 ; 5 to the penultimate one gradually increasing in length and becoming pyriform ; the last oval, shorter and narrower than the penultimate one. *Clypeus* : Anteclypeus a thin, narrow subtrapezoidal strip of same colour as labrum. Postclypeus narrow, subrectangular, separated from frons by a thin groove ; of same colour as frons. *Labrum* : Subtriangular to broadly tongue-shaped ; broader than long (length 0.12-0.24, maximum width at base 0.17-0.30 mm.) ; with a pair of bristle-like hairs at anterior end. *Mandibles* : Short, thick and triangular ; sharply pointed at tips, and with a prominent hump on the

outer margin just above the outer basal condyle ; teeth on inner margin present or absent, when present very weak. Left mandible generally with 2 weak marginal teeth. Right mandible also generally with 2 small marginal teeth located in middle-third. *Postmentum* : Short, squarish, somewhat broader posteriorly ; anterior and posterior margins weakly incurved.



TEXT-FIG. 12.—*Cryptotermes domesticus* (Haviland). Soldier. Specimens from Colombo, Ceylon.

- (a) Head and pronotum, in dorsal view (Note difference in shape of frontal ridge and pronotum from that in lectotype, Text-figure 11). (b) Head and pronotum, in side view. (c) Left mandible, in dorsal view. (d) Ditto, right mandible. (e) Right antenna, in dorsal view. (f) Postmentum, in ventral view.
ant., antenna ; *e.*, eye ; *lr.*, labrum ; *lt.*, left ; *m₁*, *m₂*, 1st and 2nd marginal teeth of mandibles ; *md.*, mandible ; *prt.*, pronotum ; *rt.*, right ; *t₁*, *t₂*, dorsal and ventral tubercles, respectively.

Thorax : Pronotum : Flat, weakly raised near anterior margin ; generally narrower than, and sometimes subequal to, head-width ; length sometimes less but generally over two-thirds

of width (maximum length 0.53-0.87, maximum width 1.01-1.30 mm. ; index Length/Width 0.64-0.74) ; anterior margin concave, medially notched, laterally somewhat projecting in front ; sides rounded ; posterior margin weakly convex. *Mesonotum* : Narrower than pronotum, with a weakly convex posterior margin. *Metanotum* : Narrower than pronotum but broader than mesonotum ; posterior margin weakly convex. *Legs* : Short, hairy ; fore-legs shortest ; hind-legs longest ; apical tibial spur formula 3 : 3 : 3. Tarsi 4-jointed.

Abdomen : Oblong, hairy. Cerci 2-jointed, *c.* 0.10 mm. long. styli either present or absent ; when present, single-jointed, *c.* 0.03-0.05 mm. long.

3. PSEUDOWORKER (Table 4).—

General : Head-capsule whitish to yellow ; antennae, thorax, legs and body paler. Head and body fairly pilose. Total body-length *c.* 4.4-7.0 mm.

Head : Head oval ; head-capsule subcircular (length to base of mandibles 0.90-1.07 ; maximum width 0.98-1.10 mm.). *Fontanelle and ocelli* : Absent. *Eyes* : Two lateral eyespots present ; 0.10-0.17 mm. in diameter. *Antennae* : With 11-16 segments ; segments 1 and 2 sparsely, and the remainder fairly, pilose ; segment 1 longest, cylindrical ; 2 a little longer than half of 1 and cylindrical ; 3-6 ring-like ; 7 to the penultimate one pyriform, gradually increasing in length ; the last ovate, shorter than the penultimate one. *Clypeus* : Subtrapezoidal, not distinctly separated into an ante- and a postclypeus. *Labrum* : Broadly tongue-shaped ; broadest in middle ; with a few hairs near anterior margin and on body. *Mandibles* : Of typically *Cryptotermes*-type.

Thorax : *Pronotum* : Flat, subreniform ; narrower to broader than head-capsule ; broader than long (length 0.38-0.63 ; maximum width 0.70-1.30 mm.) ; anterior margin concave ; posterior margin weakly rounded, substraight medially. *Legs* : Short, hairy ; apical tibial spur formula 3 : 3 : 3 ; tarsi 4-jointed.

Abdomen : Oblong, hairy. Cerci 2-jointed, *c.* 0.08-0.09 mm. long. Styli single-jointed, *c.* 0.07-0.08 mm. long.

(c) TYPE-SPECIMENS

(a) Of *Cryptotermes domesticus* (Haviland) :

Lectotypes selected as follows :—

(i) Present in University Museum of Zoology, Cambridge (England) : *Lectotype* : Soldier, with right middle and hindlegs broken. *Lectomorphotypes* : An imago and a pseudoworker. *Paralectotypes* and *paralectomorphotypes* : 1 paralectotype soldier and 4 paralectomorphotype imagos.

(ii) In Z. S. I., Calcutta : *Paralectotype* and *paralectomorphotype* : One paralectotype soldier and one paralectomorphotype imago.

(iii) In A. M. N. H., New York : *Cotypes* : An imago, a soldier and a nymph.

(b) Of *Cryptotermes bustoni* Hill :

Cotypes : (i) A winged adult and a soldier, in B. M., London. (ii) 2 winged adults in A.M.N.H., New York.

(c) Of *Cryptotermes campbelli* Light :

Cotypes : A soldier and a nymph in A.M.N.H., New York.

(d) Of *Calotermes (Cryptotermes) dentatus* Oshima :

Location, etc. not known.

(e) Of *Calotermes (Cryptotermes) formosae* Holmgren :

Cotypes : Imagos, soldiers and nymphs in Naturhistorisches Museum, Vienna, (*vide* Holmgren, 1912, *Annot. Zool. Jap.*, Tokyo, 8, p. 120).

(f) Of *Calotermes (Cryptotermes) gulosus* Hill :

(i) *Holotype and morphotype* : A soldier (holotype) and 2 imagos (morphotypes), in A.M.N.H., New York.

(ii) *Paratypes* : In National Museum of Victoria, Melbourne : 3 examples, in a tube, *vide* letter from Museum dated 12th May, 1964.

(g) Of *Cryptotermes hermsi* Kirby :

Type (=Holotype) : A winged adult male, in U.S.N.M., Washington.

Cotypes (=Paratypes) : An imago and a soldier, in A.M.N.H., New York. Also in author's private collection, in California Academy of Sciences, San Francisco and in Department of Zoology, University of California, Berkeley, *vide* Kirby 1925:

(h) Of *Calotermes (Cryptotermes) kotoensis* Oshima :

Cotypes : In Institute of Science, Govt. of Formosa, (*vide* Oshima, 1913, *Philipp. J. Sci.*, (D) 8 (4), p. 274).

(i) Of *Calotermes (Cryptotermes) ogasawarensis* Oshima :

Location, etc., not known.

(j) Of *Calotermes (Cryptotermes) repentinus* Hill :

Holotype : An imago, in A.M.N.H., New York.

(The species was described by Hill, 1927, from 2 alate imagos. The other example is not traceable (*vide* letter from National Museum of Victoria, Melbourne, dated 12th May, 1964).

(d) TYPE-LOCALITY

(a) Of *Cryptotermes domesticus* (Haviland) :

Haviland's (1898) material came from Singapore and Sarawak. As the lectotype, selected here is from Sarawak, this may now be considered as the type-locality.

(b) Of *Calotermes (Cryptotermes) buxtoni* Hill :

Apia (Upolu Isl., Samoa Isls., South Pacific).

(c) Of *Cryptotermes campbelli* Light :

Kachek, Hainan Isl. (China).

(d) Of *Calotermes (Cryptotermes) dentatus* Oshima :

Taihoku (Formosa).

(e) Of *Calotermes (Cryptotermes) formosae* Holmgren :

Botel Tobago Island (Formosa).

(f) Of *Calotermes (Cryptotermes) gulosus* Hill :

30 miles S. E. from Port Moresby [=Kaile] (New Guinea).

(g) Of *Cryptotermes hermsi* Kirby :

Fanning Isl. (Marianas Isls., N. Pacific).

(h) Of *Calotermes (Cryptotermes) kotoensis* Oshima :

Botel Tobago (Formosa).

(i) Of *Calotermes (Cryptotermes) ogasawarensis* Oshima :

Ogasawarajima or Bonin Isl. (Japanese Archipelago).

(j) Of *Calotermes (Cryptotermes) repentinus* Hill :

Rabaul (New Britain, S. Pacific).

(e) DISTRIBUTION

Cryptotermes domesticus is a very widely distributed species and is known from the Indo-Malayan, Papuan and Neotropical regions, as follows:—

Asia : *Ceylon* : Colombo, 6°50' N., 79°55' E. ; Hakgala, 6°55' N., 80°48' E. ; Peradeniya, 7°16' N., 80°37' E. *China* : Kachek, Hainan Isl. ; Kwangtung and Yunnan Provinces. *Formosa* : Botel Tobago ; Taihoku. *India* : Trivandrum, 8°27' N., 77°43' E. *Borneo* : Sarawak (type-locality). Also S. E. Borneo ; Karakatau Isl. ; Sinabang (Simalur) ; Java and Sumatra (Deli). *Japan* : Ishagakijima (Loo-Choo Isls.) ; Ogasawarjima (= Bonin Isl.), 27°30' N., 141°00' E. Singapore, 1°17' N., 103°51' E. *Thailand* : Bangkok, 6°50' N., 79°55' E. *Vietnam* : Saigon ; Tonkin. “Anping ?”

Pacific Ocean : *North Pacific* : Marianas Islands : Guam, c. 11°40' N., 146°0' W. ; Fanning Isl., 4°0' N., 159°15' W. ; and Washington Isl. *South Pacific* (New Guinea) : 30 miles S. E. of Port Moresby [=Kaile] ; New Britain Isl. : Rabaul, 4°00' S., 152°00' E. and Toma ; Fiji Isl. : Suva, c. 18°06' S., 178°30' E. ; Oneo Isl. ; Samoan Isls. : Apia (Upolu Isl., 13°50' S., 171°50' W.) and Tutuila ; Flint Island (c. 11°30' S., 153°30' W.) ; Society, Austral and Thursday (10°40' S., 142°10' E.) Islands ; Marquesas Islands : Atuona (Hivaoa Isl.) ; and Hanahevene valley (Tahuata Isl.) ; Solomon Isls. : Honiara (Guadacanal), 9°40' S., 160°0' E. ; and Gizo (Western Group), 8°0' S., 157°30' E. ; Tubagi ; and Vavau Island (Tonga Group).

Central America : Panama, 9°0' N., 79°20' W.

(f) COMPARISON

The imago of *Cryptotermes domesticus* is very close to that of *C. dudleyi* and *C. havilandi*. It is separable from them as follows:—

From *C. dudleyi* : (i) Eyes generally smaller (maximum diameter 0.27-0.30 (rarely above 0.30) vs. 0.30-0.33 mm.). (ii) Ocelli nearer the antennae, minimum ocellus-antennal distance 0.13-0.16 vs. 0.17-0.19 mm.

From *C. havilandi* : (i) Head-capsule somewhat incurved in the region of eyes vs. sub-straight. (ii) Eyes smaller 0.27-0.30 (rarely above 0.30) vs. 0.30-0.34 mm.

The soldier of this species is separable from all the other oriental species in having only the ventral tubercle of head prominent, the dorsal one being very weak (vs. both the tubercles prominent in other species). The frontal ridge of head is also strongly projecting in front medially vs. pushed back medially or sometimes projecting in front laterally, in the other species.

5. *Cryptotermes dudleyi* Banks

(Text-figs. 13 & 14 ; and Tables 4-6)

(i) *Cryptotermes dudleyi* Banks

1918. N. Banks, *Bull. Amer. Mus. nat. Hist.*, New York, **38** (Art. 17), pp. 660-661, pl. 51, fig. 3 (S.). *Im.* and *S.* *Type-locality* : Panama (Central America). Types examined.
1925. T. E. Snyder, *J. Agric. Res.*, Washington, **29** (7), p. 179. Panama.
1926. T. E. Snyder, *J. Wash. Acad. Sci.*, Washington, **16** (1), p. 27. Costa Rica.
1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, **3** (1), p. 25. Panama.
1941. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (1), pp. 33, 57. Peradeniya (Ceylon). Balboa ; and Barro Colorado Isl. (Panama, Central America). Protozoa.
1942. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (3), pp. 182, 191. Tanga (Tanganyika). Ancon ; and Balboa (Panama, Central America). Protozoa.
1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112**, pp. 41-42. Costa Rica ; and Panama (Central America) ; Colombia (S. America) ; Ceylon ; Philippines ; Sumatra ; Java ; New Guinea ; N. Australia (Northern Territory) ; Thursday Isl.
1951. W. V. Harris, *Proc. R. ent. Soc. Lond.*, London, **20** (1-2), p. 25. Tanga (Tanganyika).
1953. M. L. Koonwal & G. D. Pant, *Indian For. Leafl. Delhi*, No. 121 (pt. 3), p. 42. Ceylon. Cannanore (Kerala State, India).

1955. G. U. Chaudhry, *Pakistan J. Forest.*, **5** (1), p. 40. Khulna (E Pakistan).
1956. M. L. Roonwal & P. K. Sen-Sarma, *Indian J. Agric. Sci.*, New Delhi, **26** (1), pp. 3-4. Barkuda Island, Chilka Lake (Orissa, India).
1957. P. K. Sen-Sarma and R. N. Mathur, *Curr. Sci.*, Bangalore, **26** (12), p. 399. J Plot, 30 miles N-E of Nankhana Range Headquarters and Jhingakhali, Sundarbans (West Bengal, India).
1958. W. V. Harris, *E. Afr. agric. J.*, Nairobi, **23** (3), p. 165. Fig. 1 (S.), fig. 2 (Im.). From Malindi in Kenya to Mikindani in S. Tanganyika; Zanzibar Isl.; Java; Sumatra; New Guinea; small islands off north. coast of Australia; Ceylon; and Central America.
1958. M. Ahmad, *Biologia*, Lahore, **4** (1-2), pp. 54, 55. Keys.
1960. L. G.E. Kalshoven, *Acta Tropica*, Basel, **17** (3), p. 265. Java; S. E. Borneo.
1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, **122** (4), p. 382.
1961. W. V. Harris, *Termites: Their Recognition and Control*, p. 63. Central America to Colombia and Trinidad, S. E. Asia; N. Australia; Ceylon; and East African coast.
1967. F.J. Gay, *Bull. Commonw. Sci. Industr. Res. Org.*, Melbourne, No. 286, pp. 10-11, 21-22, 54-56. Im. and S.

(ii) *Kalotermes (Cryptotermes) dudleyi* Banks

1934. T. E. Snyder, *Proc. biol. Soc. Wash.*, Washington, **47**, p. 97.
1936. A. E. Emerson, *Science*, New York, **83** (2157), p. 411.
1937. L. Hare, *Ann. ent. Soc. Amer.*, Columbus (Ohio), **30**, pp. 467, 480.

(iii) *Cryptotermes (Planocryptotermes) dudleyi* Banks

1937. S. F. Light, *Pan-Pacific Ent.*, San Francisco, **13** (1-2), pp. 17-18.

(iv) *Cryptotermes (Planocryptotermes) javanicus* Kemner

1934. N. A. Kemner, *K. Sv. Vet. Akad. Handl.*, Stockholm, (3) **13** (3), pp. 47-49, fig. 6 (S.). Im., S. and Pw. Type-locality: Buitenzorg (= Bogor) (Java, Indonesia).

(v) *Planocryptotermes/Cryptotermes (Planocryptotermes)/Kalotermes (Cryptotermes) nocens* Light

1921. S. F. Light, *Philipp. J. Sci.*, Manila, **19** (1), pp. 42, 43-47, pl. 2, figs. 3 & 4, pls. 5 & 6. Im., S., Ny. and larva, Type-locality: Manila (Philippines).
1928. F. X. William, *Philipp. J. Sci.*, Manila, **35** (1), p. 65. Los Banos (Philippines).
1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, **3** (1), p. 29. Philippines.
1937. S. F. Light, *Pan-Pacific Ent.*, San Francisco, **13** (1-2), pp. 15, 16. Peradeniya (Ceylon); and Kedorugdjati (Java, Indonesia).
1942. G. F. Hill, *Termites (Isoptera) from the Australian Region*, pp. 76-77, fig. 32 (S.) Im. and S. Manila (Philippines); Darwin (North Terr., Australia); Thursday Island; and New Guinea.

(vi) *Cryptotermes (Planocryptotermes)/Kalotermes (Planocryptotermes)/Planocryptotermes primus* Kemner

1932. N. A. Kemner, *Ent. Tidskr.*, Stockholm, **53** (2-3), pp. 151-153, fig. 8 (S.). Im. and S. Type-locality: Ceylon. Types examined.
1936. Anonymous, *Trop. Agric.*, Peradeniya, **86**, p. 345.
1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, **3**, p. 85. Ceylon.
1953. Rattan Lal and R. D. Menon, *Catalog. Indian Insects*, Part 27, *Isoptera*, Delhi, p. 11. Ceylon.

(vii) *Kalotermes (Cryptotermes)/Cryptotermes secundus* Hill

1925. G. F. Hill, *Proc. roy. Soc. Victoria*, Melbourne, (N. S.), **37** (2), pp. 215-216, pl. 23, fig. 16 (S.). S. Type-locality: Darwin (North. Terr., Australia).
1933. G. F. Hill, *Proc. roy. Soc. Victoria*, Melbourne, (N. S.), **46** (1), p. 45. Darwin (North. Terr., Australia).
1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, **3** (1), p. 30. North. Terr., Australia.

(viii) *Cryptotermes/Kalotermes (Cryptotermes) thompsonae* Snyder

1922. T. E. Snyder, *Proc. U. S. nation. Mus.*, Washington, **61** (Art. 20), pp. 16-18, pl. 2, figs. 4-9. Im. and S. Type-locality: Ancon, (Canal Zone, Panama).
1923. H. F. Dietz and T. E. Snyder, *J. agric. Res.*, Washington, **26** (7), pp. 281, 284. Ancon (Canal Zone, Panama).
1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, **3** (1), p. 25. Panama.

(ix) *Cryptotermes* n. sp. (= *C. melloi* Cheriau & Margabandhu, MS name)

1944. M. C. Cheriau and V. Margabandhu, *Proc. 31st Indian Sci. Congr.*, Calcutta, (Abstracts), **31**, pp. 80-81. Goa (India). [Is specimen with MS name *Cryptotermes melloi* C. & M., vide below, 'Material (ii)'].

(x) *Cryptotermes* sp. (= *C. dudleyi*)1942. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, 45 (3), p. 191. Telawa (Java).

(a) MATERIAL EXAMINED

(A) Present in A.M.N.H., New York.

(i) One vial with 9 imagos (alates and dealates), 3 soldiers, 7 pseudoworkers and several loose wings, *paratypes* from type-colony, Panama (C. America), coll. J. Beaumont.

(B) Present in Z.S.I., Calcutta.

(ii) One vial, Z.S.I. No. 1139/H8, with a soldier (*holotype* of "*Cryptotermes melloi* Cherian and Marghabandhu", MS name), Nova Goa (Panjim), Western Coast, India, coll. Froilano de Mello.(iii) One vial, Z.S.I. No. 3726/H8, with a soldier, Cannanore (Kerala, India), coll. B. M. Bhatia, June, 1941, ex. "Red pine"; *det.* J.C.M. Gardner "*Planocryptotermes primus* Kemner"

(iv) One vial, Z.S.I. No. 3573/H8, with an imago, Ross Island, South Andamans, India, coll. C. Paiva, 24.iii.1911.

(v) One vial, Z.S.I. No. 3574/H8, with 4 soldiers and several pseudoworkers, Maya Bunder, North Andaman Isl., India, coll. K. K. Tiwari (F.C. No. 373), 28.ii.1959.

(C) Present in F.R.I., Dehra Dun.

(vi) One vial, F.R.I. No. M.C. 17451/1, with an imago (badly preserved) in spirit, *paratype* (but labelled *cotype*), Panama (C. America), coll. J. Beaumont.

(vii) One vial, F.R.I. No. M.C. 17451/2, with an imago, a soldier (without mandibles) and 2 nymphs in spirit, Balboa, Canal Zone, Panama, coll. J. Zetek, 14.v.1935.

(D) Present in Zoologiska Institutet, Lund University, Lund (Sweden). (All *det.* N. A. Kemner as "*Planocryptotermes primus* Kemner, n. sp.")

(viii) One vial with 3 imagos, 1 soldier (damaged) and several pseudoworkers, Peradeniya (Ceylon), coll. F. P. Jepson and M.P.D. Pinto, (7303), 16.v.1930. ex. "building wood-work"

(ix) One vial with 4 imagos, 2 soldiers and 1 nymph, Kadugannawa (Ceylon), coll. F. P. Jepson, (7367), 3. iii. 1931. ex. "building wood-work"

(x) One vial, with a soldier and 3 pseudoworkers, Kandy (Ceylon), coll. F. P. Jepson, (7295), 1.v.1930, ex. "building wood-work"

(b) DESCRIPTION

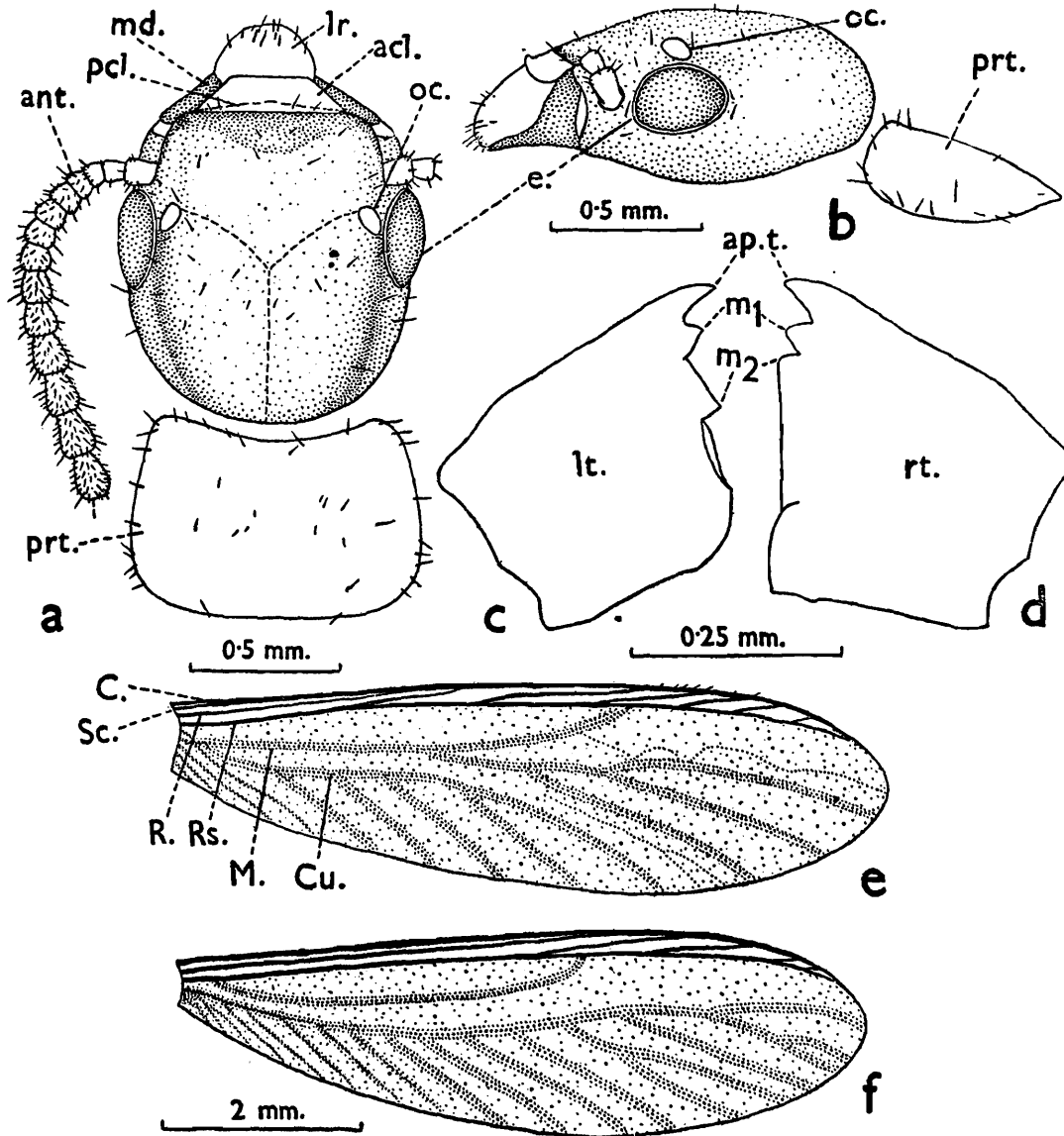
Types examined.

1. IMAGO. (Text-fig. 13 ; Table 5).—

General : Head-capsule pale reddish yellow or yellowish brown to pale brown, somewhat paler in front ; clypeus, labrum antennae and legs yellow; mandibles pale brown with dark brown toothed margins ; thorax, wing-scales and abdominal tergites somewhat paler than head-capsule; wing-membrane with a pale brownish tinge; sternites paler than tergites. Head and body moderately pilose. Total body-length with wings c. 8.5—10.1, without wings c. 4.6—6.0 mm.

Head : Suboval; length upto tip of labrum 1.30—1.37 mm.; head-capsule subrectangular; including eyes equal to or broader than its length to base of mandibles (maximum width with eyes 0.97—1.13; length to lateral base of mandibles 0.97—1.03 mm.); head-sutures faint; sides substraight; posteriorm argin round. *Fontanelle* : Absent. *Eyes* : Two black,

suboval (broader anteriorly), moderately swollen, lateral eyes, one on either side ; maximum diameter 0.30—0.33 mm.; situated at a distance of about half their diameter (0.13—0.17 mm.) from the side base of head. *Ocelli* : Two suboval, translucent, lateral ocelli, one on either side in between the eyes ; generally touching the inner margin of eye, sometimes separated by a thin line; maximum diameter 0.10—0.13; minimum diameter 0.07—0.10 mm. *Antennae* : With 16-18 segments; fairly pilose; segment 1 longest, cylindrical; 2 little longer than half of one and cylindrical; 3 generally shortest, sometimes subequal to 2 or 4; 5 to the penultimate one gradually increasing in length and becoming pyriform; last segment ovate



TEXT-FIG. 13.—*Cryptotermes dudleyi* Banks. Imago. Paratype from Panama (Central America).

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Left mandible, in dorsal view. (d) Ditto, right mandible. (e) Right forewing, in dorsal view. (f) Ditto, hindwing.

acl., anteclypeus ; *ant.*, antenna ; *ap. t.*, apical tooth of mandibles ; *C.*, costa ; *Cu.*, cubitus ; *e.*, eye ; *lr.*, labrum ; *lt.*, left ; *M.*, median ; *m₁*, *m₂*, 1st and 2nd marginal teeth of mandibles ; *md.*, mandible ; *oc.*, ocellus ; *pcl.*, postclypeus ; *prt.*, pronotum ; *R.*, radius ; *Rs.*, radial sector ; *rt.*, right ; *Sc.*, subcosta.

and subequal to the penultimate one. *Clypeus* : Subtrapezoidal, weakly divided into an ante- and a postclypeus. Anteclypeus apilose; with straight anterior margin. Postclypeus a little darker and pilose; with weakly convex anterior margin. *Labrum* : Broader than long; broadest in middle; anterior margin round. *Mandibles* : Squarish, each with an apical and 2 marginal teeth. Left mandible : Apical finger-like; 1st marginal shorter than apical; 2nd marginal a little larger than 1st, directed backwards and with a long anterior margin

Right mandible : Apical finger-like but thicker than the corresponding one in left mandible ; 1st marginal short; 2nd smaller than 1st; situated just at base of 1st and with the posterior margin about one-and-half times the length of molar plate.

Thorax : Pronotum : Flat, subreniform; broader than long, but narrower than head-capsule with eyes (width 0.80—1.03 ; length 0.60—0.70 mm.); anterior margin weakly concave; sides weakly convex; posterior margin weakly convex, sometimes slightly incurved medially. *Legs* : Short, hairy; apical tibial spurs 3 on each leg ; tarsi 4-jointed; arolium present.

Wings : Thin, membranous; with a slight brownish tinge; punctate and with a few short hairs on anterior margin. Costa, subcosta, radius and radial sector thick, strongly chitinous and brownish; median and cubitus weak and thin. *Forewing* : Scale large, triangular, shield-like. Costa running along entire anterior margin of wing. Subcosta short, separated from costa by a thin line and fusing with it just outside scale. Radius well separated and thick; fusing with costa a little beyond one-fourth to about one-third of wing-membrane. Radial-sector running parallel with costa along the entire length of wing-membrane and giving off 5-8 branches to costa; first bifurcation at about one-fourth of wing-membrane. Median arising independently from scale and curving upwards to meet radial sector in between its 2 and 3 or 3 and 4 or 4 and 5 branches to costa, beyond the middle of wing-membrane. [In a right forewing (paratype) median giving off a branch from approximately its middle, which runs towards distal margin and gives 3 further branches]. Cubitus running medially along entire length of wing and giving off 11-13 branches to posterior margin. *Hindwing* : Scale short, triangular and completely overlapped by forewing-scale. Costa as in forewing. Subcosta absent. Radius meeting the costa at about middle or beyond the middle of wing-membrane, otherwise as in forewing. Radial sector also as in forewing but with only four branches to costa, 3rd branch sometimes subdivided; first bifurcation near the middle of wing-membrane. Median arising from radial sector a little outside the scale and fusing with the latter beyond the middle of wing-membrane in between 1 and 2 or 2 and 3 branches of radial sector. Cubitus with 11-13 branches to posterior margin.

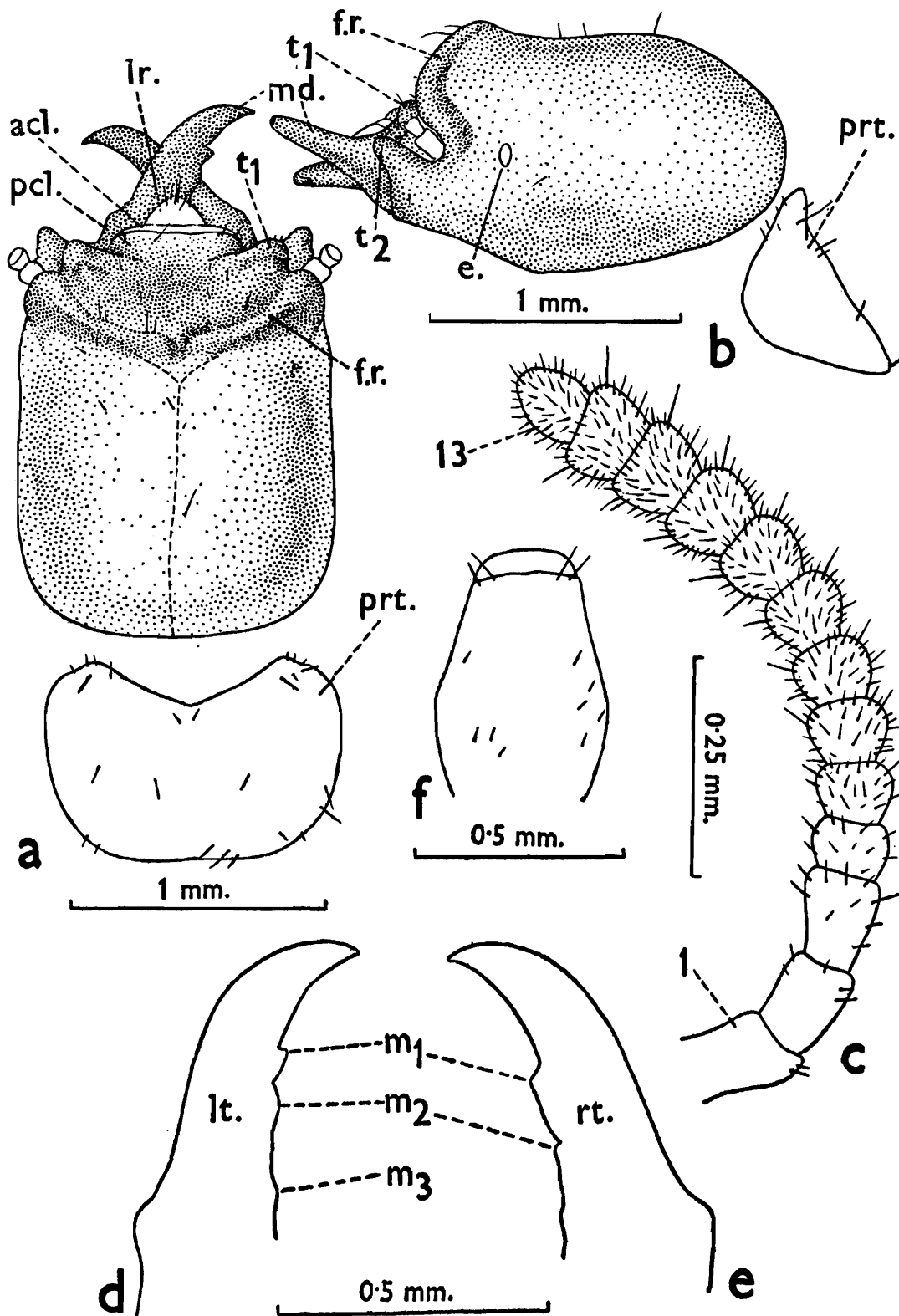
Abdomen : Oblong, hairy; cerci present, 2-jointed, 0.13 mm. long. Styli (in males) single-jointed, 0.10 mm. long.

2. SOLDIER (Text-fig. 14; Table 6).—

General : Head-capsule yellowish to dark brown, anteriorly almost blackish; frontal ridge and frons darker ; mandibles dark reddish brown to black; antennae, labrum, legs and body yellowish to pale brown, anterior margin of pronotum darker. Head and body sparsely pilose. Total body-length c. 4.3—6.1 mm.

Head : Head-capsule subrectangular, longer than broad (length to base of mandibles 1.60—1.80; maximum width 1.12—1.43 mm.); with 2 lateral knob-like tubercles on either side, one above and the other below the antennal socket; frontal ridge fairly prominent, weakly raised and pushed backwards; frons weakly concave and inclined at more than the right angle with mandibles; dorsum weakly depressed just behind frontal ridge in middle; Y-sutures present. *Fontanelle and ocelli* : Absent. *Eyes* : Two lateral eye-spots present just behind the antennal sockets; 0.13—0.20 mm. long. *Antennae* : 11-14 segmented. Segments 1 and 2 cylindrical, the latter smaller and narrower than the former; 3 subequal to or shorter than 2, sometimes subdivided by a round furrow in middle; 4 shortest; 4 to the penultimate one gradually increasing in length and thickly pyriform; last ovate, subequal to or longer than the penultimate one. *Clypeus* : Anteclypeus a thin, narrow, apilose, yellowish strip. Postclypeus of same colour as frons and hardly separable from it; pilose; anterior margin weakly concave and slightly projected in front medially. *Labrum* : Subtriangular; broad basally; broader than long; with a few hairs near tip and on body. *Mandibles* : Thinner and longer than in other *Cryptotermes* from this region and with weak humps just above the outer condyles; apices pointed and somewhat incurved. Left mandible

with 2-3 marginal teeth; 1st marginal large, triangular; 2nd and 3rd marginals short. Right mandible with 2 marginal teeth in middle of mandible, variably prominent (short in paratypes and in specimens from Cannanore (India), but large in specimens from the Andaman



TEXT-FIG. 14.—*Cryptotermes dudleyi* Banks. Soldier. Paratype from Panama (Central America).

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Right antenna, in dorsal view. (d) Left mandible, in dorsal view. (e) Ditto, right mandible. (f) Postmentum, in ventral view.
acl., anteclypeus; *e.*, eye; *f.r.*, frontal ridge; *lr.*, labrum; *lt.*, left; *m₁-m₃*, 1st to 3rd marginal teeth of mandibles; *md.*, mandible; *pcl.*, postclypeus; *prt.*, pronotum; *rt.*, right; *t₁*, *t₂*, dorsal and ventral tubercles, respectively.

Islands); 1st situated lower than the corresponding one in left mandible. *Postmentum*: Short; longer than broad; widest behind the middle; from the widest points sides weakly narrowing both anteriorly and posteriorly; anterior margin weakly convex or substraight; posterior margin, concave, with a weak median bulge.

Thorax : Pronotum: Flat, weakly raised anteriorly; broader than long (length 0.58—0.93; width 1.00—1.33 mm.); narrower than head-capsule (index Pronotum-width/Head-width 0.88—0.95); anterior margin deeply and broadly concave sometimes serrate; sides round or substraight; posterior margin weakly convex, with a weak impression of median incurving. *Mesonotum*: Narrower than pronotum; posterior margin convex, slightly incurved in middle. *Metanotum*: Narrower to a little broader than pronotum; with a substraight posterior margin. *Legs*: Short, hairy; apical tibial spurs 3 on each leg. Tarsi 4-jointed.

Abdomen: Oblong, hairy. Cerci 2-jointed, 0.07 mm. long. Styli either present or absent; when present single-jointed and c. 0.10 mm. long.

3. PSEUDOWORKER (Table 4).—

General: Head-capsule yellow to pale yellowish brown; labrum, antennae, thorax, legs and abdomen paler than head; mandibles yellowish with dark brown toothed margins. Head and body moderately pilose. Total body-length (without antennae) c. 3.7—6.3 mm.

Head: Head-capsule subcircular; length to base of mandibles 1.00—1.10; maximum width 1.07—1.17 mm.; side and posterior margins round. *Fontanelle and ocelli*: Absent. *Eyes*: Two lateral, pale brown eye spots, one on either side; 0.13—0.17 mm. in diameter. *Antennae*: With 11-15 segments; fairly pilose; segment 1 longest, cylindrical; 2 narrower and shorter than 1, cylindrical; 3-7 short and ring-like; 8 to the penultimate one gradually becoming pyriform and increasing in length; last oval and shorter than the penultimate one. *Clypeus*: Subtrapezoidal. Anteclypeus apilose; with substraight anterior margin. Postclypeus pilose, with only 3-4 short hairs; anterior margin weakly convex. *Labrum*: Broader than long; anterior margin round; with a few short hairs near anterior margin and on body. *Mandibles*: Of typically *Cryptotermes*-type.

Thorax : Pronotum: Flat, subreniform; broader than long (maximum width 0.80—1.06; maximum length 0.50—0.60 mm.); narrower than head-capsule; anterior margin concave and medially notched; sides weakly convex; posterior margin weakly convex and with a slight median depression. *Legs*: Short and hairy; apical tibial spurs 3 on each leg. Tarsi 4-jointed.

Abdomen: Oblong; moderately hairy. Cerci 2-jointed, 0.10—0.12 mm. long. Styli (when present) single-jointed, 0.1 mm. long.

(c) TYPE-SPECIMENS

(a) Of *Cryptotermes dudleyi* Banks :

Holotype: Soldier, deposited in Museum Comparative Zoology, Cambridge (Mass., U.S.A.) is not traceable now, *vide* information (dated 28th July, 1964) received from Dr. P. J. Darlington, Curator of Insects at the Museum.

Paratypes: (i) In A.M.N.H., New York, *vide* "Material (i)", *supra*. (ii) An imago (labelled cotype), in F.R.I., Dehra Dun *vide* "Material (vi)", *supra*.

(b) Of *Cryptotermes (Planocryptotermes) javanicus* Kemner :

In Zoologiska Institutet, Lund University, Lund Sweden.

(c) Of *Planocryptotermes nocens* Light :

An imago, a soldier and 3 nymphs in A.M.N.H., New York.

(d) Of *Cryptotermes (Planocryptotermes) primus* Kemner :

In Zoologiska Institutet, Lund University, Lund.

- (e) Of *Calotermes (Cryptotermes) secundus* Hill :
Type soldier. In National Museum of Victoria, Melbourne.
- (f) Of *Cryptotermes thompsonae* Snyder :
Type imago, in U.S.N.M., Washington.

(d) TYPE-LOCALITIES

- (a) Of *Cryptotermes dudleyi* Banks :
Panama (Central America).
- (b) Of *Cryptotermes (Planocryptotermes) javanicus* Kemner :
Buitenzorg (=Bogor) (Java, Indonesia).
- (c) Of *Planocryptotermes nocens* Light :
Manila (Philippines).
- (d) Of *Cryptotermes (Planocryptotermes) primus* Kemner :
Ceylon.
- (e) Of *Calotermes (Cryptotermes) secundus* Hill :
Darwin (Northern Territory, Australia).
- (f) Of *Cryptotermes thompsonae* Snyder :
Ancon, Canal Zone (Panama, Central America).

(e) DISTRIBUTION

Cryptotermes dudleyi Banks is a widely distributed species in Neotropical, Oriental, Ethiopian, Papuan and Australian Regions, as follows :—

Africa : *Tanganyika* : Tanga, 5°10' S., 39°12' E.: Along eastern coast-line from Mogadishu (2°10' N., 44°50' E.) to Ravuma River (c. 11°0' S., 38°0' E.). Zanzibar Island, 6°48' N., 39°16' E. (Indian Ocean).

Asia : *Ceylon* : Peradeniya, 7°16' N., 80°37' E.; Kadugannawa, 7°15' N., 80°32' E.; and Kandy, 7°18' N., 80°40' E. *India* : Kerala State : Cannanore (western coast), 11°31' N., 75°15' E.; Orissa State : Barkuda Island (Chilka Lake, eastern coast), 19°45' N., 85°12' E.; West Bengal : J. Plot 30 miles N-E of Nankhana Range Headquarters and Jhingakhali in Sunderbans, c. 21°18' N., 90°0' E.; Goa : Nova Goa, 15°27' N., 73°47' E. (=Panjim, western coast); Andaman Islands : Maya Bunder, 12°52' N., 92°57' E.; and Ross Island, 11°40' N., 92°46' E. *Indonesia* : Java : Buitenzorg (=Bogor), 7°00' S., 107°00' E.; Gunung Gedeh; Telawa and Kedorngdjati. E. Sumatra : Bahsoembo; Tandjong Slammat. South East Borneo. *Malaya*. *Pakistan (East)* : Khulna, 22°30' N., 75°15' E. *Philippines* : Manila, 14°58' N., 121°0' E.; Los Banos.

Australia : Darwin (North. Terr.), 12°12' S., 131°0' E.; Thursday Island, 10°24' S., 142°6' E.; and New Guinea (Pacific Ocean).

Central America and Caribbean Sea : *Panama* : Canal zone : Ancon; Balboa, c. 8°59' N., 79°34' W.; Barro Colorado Isl.; Panama, 9°0' N., 79°12' W. (type-locality). Costa Rica; and Trinidad, 10°40' N., 61°30' W.

South America : *Colombia*.

(f) COMPARISON

Cryptotermes dudleyi Banks is close to *C. domesticus* (Haviland) and *C. havilandi* (Sjöstedt) and is separable as follows :—

From *C. domesticus* : *Imago* : See under that species.

Soldier : (i) Larger species (head-length to base of mandibles 1.60—1.80 *vs.* 1.20—1.30 mm.). (ii) Mandibles thin and long *vs.* short and thick. (iii) Head-capsule with both tubercles prominent *vs.* with only the ventral tubercle prominent, dorsal one very weak. (iv) Frontal ridge greatly pushed back medially *vs.* projected in front.

From *C. havilandi* : *Imago* : Hardly separable except that the ocelli are somewhat broader (minimum diameter 0.07—0.10 *vs.* 0.05—0.07 mm.) and widely separated from antennae (minimum ocellus-antennal distance 0.17—0.19 *vs.* 0.13—0.17, rarely 0.17 mm.).

Soldier : (i) Head-capsule larger (length to tip of labrum 2.03—2.43 *vs.* 1.50—1.80 and length to lateral base of mandibles 1.60—1.80 *vs.* 1.15—1.47 mm.). (ii) Mandibles thin and long *vs.* short and thick (length 0.67—0.83 *vs.* 0.44—0.60 mm.). (iii) Frontal ridge greatly pushed back *vs.* less so. (iv) Postmentum long and narrow *vs.* short and broad.

6. *Cryptotermes havilandi* (Sjöstedt)

(Text-figs. 15-20; and Tables 5, 6 & 10)

(i) *Cryptotermes angulatus* Kemner (MS name)

1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, 3 (1), p. 83. Ceylon : Balangoda.

(ii) *Kalotermes (Cryptotermes)/Cryptotermes bengalensis* Snyder

1934. T. E. Snyder, *Indian For. Rec.*, Delhi, 20 (11), pp. 4-6. *Im.* and *S.* *Type-locality* : Sunderbans, Bengal (sea forest). Types examined.

1941. C. F. C. Besson, *Ecol. & Cont. Forest Insects, etc.*, p. 540.

1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, 112, p. 42. Bengal, India.

*1952. M. Ahmad, *Proc. 4th Pak. Sci. Conf.*, Peshawar, Pt. III, p. 71.

1953. M. L. Roonwal and G. D. Pant, *Indian Forest Leaflet*, Delhi, No. 121 (pt. 3), p. 42. India : Assam : Lakhimpur, Jokhai Reserve ; Bengal : Sundarbans. E. Pakistan : Dacca.

1953. Rattan Lal and R. D. Menon, *Catalog. Indian Insects*, Part 27—*Isoptera*, p. 10. Sundarbans, Bengal.

1955. G. U. Chaudhry, *Pakistan J. Forest.*, Abbottabad, 5 (1), p. 40. Sundarbans (East Bengal, Pakistan).

1958. M. Ahmad, *Biologia*, Lahore, 4 (1 & 2), p. 54. [Foot note].

1962. M. L. Roonwal and O. B. Chhotani, *Proc. nation. Inst. Sci. India*, New Delhi, (B) 28 (4), pp. 300-301, text-figs. 3 (*Im.*), 4 (*S.*). *Im.* and *S.* India : Jokai Reserve Forest (Assam); Sunderbans (W. Bengal). E. Pakistan : Dacca.

(iii) *Cryptotermes brachygnathus* Kemner (MS name)

1931. J. C. Hutson, *Adm. Rep. Dir. Agric. Ceylon* (1930), Colombo, p. 73. Ceylon : Puttalam. [Mentions as a species of subgenus *Glyptotermes*.]

1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, 3 (1), p. 83. Ceylon : Talawila.]

1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, 112, p. 345.

(iv) *Cryptotermes ceylonicus* Kemner (MS name)

1931. J. C. Hutson, *Adm. Rep. Dir. Agric. Ceylon* (1930), Colombo, p. 74.

1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, 3 (1), p. 83. Ceylon : Chilaw; Paiyagala near Kalutara; Peradeniya.

1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, 112, p. 345.

(v) *Calotermes domesticus* Sjöstedt (*Nom. preoccupied*)

1897. Y. Sjöstedt, *Ent. Tidskr.*, Stockholm, 18, p. 212. *Im. Type-localities* : Fernando Po; Boma (Cameroons, Congo). Types examined.

(vi) *Calotermes Havilandi* Sjöstedt

1900. Y. Sjöstedt, *K. Sv. Vet. Akad. Handl.*, Stockholm, 34 (4), pp. 37, 43-45, 218, 220, Pl. 1, figs. c₁, c₂, c₃ (*Im.* and wings). *Im.* Africa : Victoria (Nigeria); Fernando Po; Boma (Congo).

1904. Y. Sjöstedt, *K. Sv. Vet. Akad. Handl.*, Stockholm, 38, pp. 9, 18, 111, 113, 119. Fernando Po; Congo; Cameroons.

1910. E. Wasmann, *Wiss. Ergeb.*, Stuttgart, 3, p. 120. Anjouan (Comoren Isl.).

1911. N. Holmgren, *Zool. Anz.*, Leipzig, 37, pp. 549, 550.

1914. Y. Sjöstedt, *Ark. Zool.*, Uppsala, 8 (27), p. 6. Fenerive (Madagascar).

1922. E. Hegg, *Les Termites*, Brussels, pp. 70, 208.

*Not seen in original.

(vii) *Calotermes (Cryptotermes) Havilandi* (Sjöstedt)

1911. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **46**, p. 55. Africa.
 1922. E. Hegg, *Les Termites*, Brussels, pp. 345, 682. Cameroons; Fernando Po; Ivory Coast; Congo; Nigeria. Comoros Isl.; Madagascar.

(viii) *Cryptotermes Havilandi/havilandi* (Sjöstedt)

- 1914a. F. Silvestri, *Boll. Lab. Zool. Portici*, Portici, **9**, pp. 5, 6-7, fig. 1 (S.). Nigeria: Olokomji; Ibadan. Gold Coast Aburi.
 *1914b. F. Silvestri, *Ann. Scu. sup. Agric. Portici*, Napoli, **12**, pp. 477, 478, 479, fig. 1 (S.).
 *1917. B. Grassi, *Mem. R. Accad. Lincei*, (5) **12**, pp. 334, 335.
 *1921. C. Fuller, *S. Afr. J. nat. Hist.*, Pretoria, **3**, pp. 29, 30, 31.
 1922. E. Hegg, *Les Termites*, Brussels, pp. 603, 604.
 1923. L. R. Cleveland, *Amer. J. Hyg.*, Baltimore, **3** (4), pp. 447, 452, 459. Chile; Nigeria.
 1926. Y. Sjöstedt, *K. Sv. Vet. Akad. Handl.*, Stockholm, **3** (1), pp. 28, 29-30. Africa: Aburi (Gold Coast); Olokemeji, Ibadan and Victoria (Nigeria); Fernando Po; Boma (Congo); Mombasa (Kenya).
 1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, **3** (1), pp. 24, 25. Congo; Cameroons; Fernando Po; Gold Coast; Kenya; Nigeria; Madagascar; Mauritius.
 *1935. C. L. Cox and H. A. Porter, *Notes on Termites and Anti-termite Work*, p. 7. (Kaduna Publ. Works Dept., Nigeria).
 *1936. P. P. Grassé, *Rev. Pathol. Végét. Ent. Agric. Fr.*, Paris, **23**, p. 8.
 *1938. W. V. Harris, *Ent. Leaflet. Dep. Agric. Tanganyika*, Dar-es-Salaam, No. 16, pp. 7, 8. [Annual Report of the Entomologist for the year 1937.]
 *1941. W. V. Harris, *E. Afr. Agric. J.*, Nairobi, **8**, p. 202.
 1941. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (1), p. 39. Nigeria.
 1942. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (3), p. 206. Near Bremersdorp (Swaziland). Beira; and Lorenzo Marques (Mozambique). [Protozoa.]
 *1943. W. V. Harris, *E. Afr. Agric. J.*, Nairobi, **8**, pp. 147-148.
 1948. W. G. H. Coaton, *Bull. Dep. Agric. S. Africa.*, Pretoria, No. 290, p. 1. New Zululand.
 1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112**, p. 42. Senegal; Ivory Coast; Gold Coast; Nigeria; Cameroons; Fernando Po; Congo; E. Africa; Comoro Island; Madagascar; West Indies.
 *1950. W. V. Harris, *E. Afr. Agric. J.*, Nairobi, **16** (1), p. 3.
 1950. W. G. H. Coaton, *J. ent. Soc. S. Africa*, Pretoria, **13**, pp. 12-17, 29, 30. Africa: Dukuduku Forest, St. Lucia; Mkuzi Reserve; Lower Mkuzi Drift and Maputa (North Zululand, S. Africa); Aburi (Gold Coast); Olokemeji, Ibadan and Victoria (Nigeria); Fernando Po; Boma (Congo); Mombasa (Kenya).
 1951. W. V. Harris, *Proc. R. ent. Soc. Lond.*, London, (B) **20**, p. 25. Dar-es-Salaam (Tanganyika).
 *1952. I. F. de Mello, *Arq. Biol.*, Sao Paulo, **36** (310), pp. 1, 3.
 *1952. M. Ahmad, *Proc. 4th Pak. Sci. Conf.*, Peshawar, Pt. 3, p. 71.
 1955. L. I. Moszkowski, *Mem. Inst. Sci. Madagascar*, Tananarive, (E) **6**, pp. 15-29, fig. 1 (Im.), figs. 2 & 3 (S.). Im. and S. Africa: Cameroons; Nigeria; Senegal; Kenya; Tanganyika; Congo; Portuguese East Africa; Swaziland; South Africa; Comoros Isl.; Madagascar; Surinam; Ivory Coast; Gold Coast. Asia: India. South America: Brazil; British Guiana. Atlantic Ocean: West Indies.
 1955. W. G. H. Coaton, *J. ent. Soc. S. Afr.*, Pretoria, **18** (2), pp. 124-127. Africa: Fernando Po; Nigeria: Olokemeji; Ibadan; Victoria, Gold Coast: Aburi, Senegal: Thies; Dakar and Rufisque; Ivory Coast; Congo: Mukim-bungu; Boma; Leopoldville; Kenya: Mombasa; Tanganyika: Dar-es-Salaam; Madagascar: Fenerive; Comoro Islands; Union of S. Africa: Zululand: Dukuduku Forest; Mkuzi Reserve, Lower Mkuzi Drift, Maputa; Atlantic Ocean: West Indies: Trinidad and Tobago.
 1958. W. V. Harris, *E. Afr. Agric. J.*, Nairobi, **23** (3), p. 165. West African Coast line from Ivory Coast to Congo.
 1958. M. Ahmad, *Biologia*, Lahore, **4** (1 & 2), pp. 54, 56. Keys.
 1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, **122** (4), p. 382.
 1961. W. V. Harris, *Termites: Their Recognition and Control*, pp. 63, 155, 161, 162. Eastern Africa from Kenya to Zululand; Madagascar; Western Africa from Senegal to Cameroons; Bengal (India); Trinidad (West Indies); British Guiana and Brazil.
 1962. W. Wilkinson, *Bull. ent. Res.*, London, **53** (2), pp. 265-286, 2 pls.
 1963. O. B. Chhotani, *J. Bombay nat. Hist. Soc.*, Bombay, **60** (1), pp. 287-288, 1 pl. India: Mandla (M.P.); and Jokhai Reserve Forest (Assam).
 1965. M. Ahmad, *Bull. Amer. Mus. nat. Hist.*, New York, **131** (Art. 1), p. 16. (Foot note).
 1967. F. J. Gay, *Bull. Common. Sci. Indust. Res. Org.*, Melbourne, No. 286, pp. 11, 22-24, 56-58.

(ix) *Calotermes/Cryptotermes havilandi parasita* Wasmann

1910. E. Wasmann, *Wiss. Ergeb.*, Stuttgart, **3**, p. 120. Im. Type-localities: Europa Island (Mozambique Channel, Indian Ocean) and Mauritius Island. The type imagos of *C. h. parasita* from Europa Island, were examined and compared with the lectotype of *C. havilandi* (Sjöstedt). Both were found to be identical. The Mauritius specimens are not identical with the lectotype of *C. havilandi*, and are *C. pallidus* (Ramb.) (Snyder 1949, p. 43).
 1911. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **46** (6), p. 55. Africa.

1911. N. Holmgren, *Zool. Anz.*, Leipzig, **37** (26), pp. 549, 550.
 1922. E. Hegh, *Les Termites*, Brussels, pp. 95, 345, 682. Mauritius Isl. [Wrongly spelt as *parasitica*].
 1926. Y. Sjöstedt, *K. Sv. Vet. Akad. Handl.*, Stockholm, **3** (1), pp. 28, 30. Anjouan (Comoren Is.); Fenerive (Madagascar).
 1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, **3** (1), p. 24. Madagascar; Mauritius.
 1949. P. Cachan, *Mem. Inst. Sci. Madog.*, Tananarive, (A) **3**, pp. 187, 214-216. Fenerive and Beloha (Madagascar); Anjouan (Comoren Is.).
 1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112**, p. 43. Indian Ocean : Europa; Comoro and Madagascar Isls [Wrongly mentioned as *parasitus*].

(x) *Calotermes lamanianus* Sjöstedt

1911. Y. Sjöstedt, *Ent. Tidsk.*, Stockholm, **32** (3), pp. 137-139. *Im.*, *S.* and *Larva*. *Type-locality* : Mukimbungu (Congo). [Types misplaced *vide infra* "Type-specimens".]
 1922. E. Hegh, *Les Termites*, pp. 346, 683. Mukimbungu (Congo).
 1926. Y. Sjöstedt, *K. Sv. Vet. Akad. Handl.*, Stockholm, **3** (1), pp. 28-29, pl. 1, figs. N1—N4 (*S.*). *S.* Mukimbungu (Congo); Thies (Senegal).
 1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, **3** (1), p. 24. Gambia.
 *1936. P. P. Grassé, *Rev. Pathol. Végét. Ent. Agric. Fr.*, Paris, **23**, pp. 6, 7. Ivory Coast : Abidjan; Grand Basam; and Bingerville. Senegal : Thies; Dakar; and Rufisque.
 1937. P. P. Grassé, *Ann. Soc. Ent. Fr.*, Paris, **106**, pp. 6-8. *Im.* and *S.* La Me, Bingerville (Ivory Coast).

(xi) *Cryptotermes* sp. (Adamson)

- *1940. A. M. Adamson, *Trop. Agric.*, Trinidad, **17**, pp. 12, 13. Trinidad : Speyside (Tobago).

(xii) *Cryptotermes* sp. (Kirby)

1941. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45**, (1), pp. 39, 47, 57. Tanganyika; Kenya.
 1942. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45**, (3), pp. 182, 191, 200, 214. Madagascar; Mauritius; Tanganyika; Kenya.

(xiii) *Cryptotermes* sp. (Emerson)

1952. A. E. Emerson, *Bull. Amer. Mus. nat. Hist.*, New York, **99**, p. 218.

(xiv) *Cryptotermes* n. sp. (Kirby)

1941. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (1), p. 67. Madagascar : Manantantely near Fort Dauphin.

Note on *Cryptotermes senegalensis* Silvestri 1914 (*Boll. Lab. Zool. Gen. Agr. Portici*, Portici, **9**, pp. 3, 7-8).—This was treated as synonym of *C. havilandi* (Sjöstedt) by Snyder (1949, p. 42) and Moszkowski (1955, pp. 17, 18). Krishna 1961 (*Bull. Amer. Mus. Nat. Hist.*, New York, **122**, p. 382) considers it a distinct species. I had no access to the type-specimens and am, therefore, not certain of its position. Accordingly, I follow the latest revision of Krishna.

(a) MATERIAL EXAMINED

(A) Present in *Naturhistoriska Riksmuseum, Stockholm.*

(i) One vial with a lectotype imago ♂ (partly damaged—antennae, left wings and right hindwing damaged or absent) and 2 paralectotype imagos (also damaged), in spirit, Fernando Po, coll. Buchholz, Jan. 1873, det. Y. Sjöstedt, with the 4 labels reading as follows:—(1) Riksmuseets Entomologiska Afdelning, Termitidae, Africanae, *Calotermes Havilandi* Sjöst. N : 0 11, Jan. 1873, colleg. Buchholz Determ. *Yngve Sjöstedt*. (2) N : 37 Genus *Cryptotermes*. (3) 131. (4) Riksmuseum Stockholm.

(B) Present in *Z.S.I., Calcutta.*

(ii) A vial with an imago and a soldier, Taveta Forest (Kenya, Africa), coll. H. Kirby, 23.x.1934, det. A. Emerson.

(iii) A vial with an imago (dealate), a soldier and a pseudoworker, Jokai Reserve Forest, Lakhimpur (Assam, India), coll. C. F. C. Beeson, 8.i.1936, ex "unknown wood", det. J. C. M. Gardner "*C. bengalensis* Snyder."

(iv) 9 vials with imagos, soldiers and pseudoworkers, Madhya Pradesh, Mysore and Orissa States, India, coll. O. B. Chhotani, as follows. The denominator in Collection No

*Not seen in original.

denotes date of collection :—01/2.11.59, Z.S.I. Sta. No. 12, Mandla (M.P.), ex "*Ficus bengalensis* Linn." Ditto (imagos only, emergence in laboratory colony, June, 1960). 015/9.11.62, Z.S.I. Sta. No. 2, Dharwar (Mysore St.) ex "dead portion of a *Ficus* sp." 01/10.11.62, Z.S.I. Sta. No. 8, Chickmagalur (Mysore St.), ex "dead portion of a mango tree". 016/11.11.62, Z.S.I. Sta. No. 12, Chickmagalur (Mysore St.), ex "dead portion of an unknown tree" 01/15.11.62, Z.S.I. St. No. 17a, Tallagatpura (Bangalore Dist., Mysore St.), ex "dead portion of an unknown tree". 010/18.11.62, Z.S.I. St. No. 20, Megalapura (Mysore Dist., Mysore St.), ex "dead standing tree" 024/21.11.62, Z.S.I. Sta. No. 22, Anekad Forest Range, 15 miles from Mercara on road to Mysore (Mysore St.), ex "dead portion of *Ficus religiosa* Linn." 05/5.7.61. Barkuda Island, Chilka Lake (Orissa St.), ex "dead wood of *Ficus* sp."

(v) 3 vials with imagos, soldiers and pseudoworkers, Little Andamans, Bay of Bengal (India), coll. *A. Daniel*, as follows :—F.C. No. 140, Z.S.I. Sta. No. 2, 2 km. inside the forest of Laitora (7 miles North of Tokoibuea), 14.ii.1961, ex "dead tree". F.C. No. 398, Z.S.I. Sta. No. 4, Taibalowe, 16 km. East of Ingoie, 22.ii.1961, ex "dead log in ground". F.C. No. 437, Z.S.I. Sta. No. 4, Otirubera Korale, 17 km. West of Ingoie, 22.ii.1961, ex "dead tree"

(C) Present in Zoologiska Institutet, Lund University, Lund (Sweden).

(vi) A vial with a soldier, 4 nymphs and 4 pseudoworkers, Talawila near Puttalam (Ceylon), coll. *M.P.D. Pinto*, 26.vii.1929 (7204), ex "*Mimusops hexandra*" Det. N. A. Kemner "*Cryptotermes brachygnathus* n. sp." (MS name).

(vii) A vial with an imago, 3 soldiers and several nymphs and pseudoworkers, Balangoda (Ceylon), coll. *F. P. Jepson* (7366), 2. iii. 1931. Det. N. A. Kemner "*Cryptotermes angulatus* n. sp." (MS name).

(viii) A vial with 2 soldiers and several pseudoworkers, Peradeniya (Ceylon), coll. *F. P. Jepson* (7166), 15. iii. 1929, ex "*Ficus altissima*" Det. N. A. Kemner "*Cryptotermes ceylonicus* n. sp." (MS name).

(D) Present in F. R. I., Dehra Dun, India.

(ix) A vial with an imago (partly damaged) and several nymphs, cotypes of *Kalotermes* (*Cryptotermes*) *bengalensis* Snyder, F.R.I. Nos. T2304; J. 115; M.C. 14683/2, Sundarbans (Bengal), *C. F. G. Beeso* coll., 12. ii. 1915, ex "*Erythrina indica*" det. T. E. Snyder "*Kalotermes* (*Cryptotermes*) *bengalensis*"

(x) A vial with a soldier and 2 imagos (dealate), F. R. I. Nos. R. R. D. No. 935, M. C. No. 19985/1). Tea Research Institute (Coll. No. 232), Peradeniya, Ceylon, 1939, det. P. Sen-Sarma "*Cryptotermes ceylonicus* MS name", ex "tea"

(E) Present in Naturhistorisches Museum, Maastricht (Holland).

*(xi) 3 imagos (one without head), 3 nymphs and a pseudoworker, on card, types of *Calotermes Havilandi parasita* Wasm., Europa Island, coll. *A. Voeltzkow*, 1903-4. With the following 4 labels. (1) *Calotermes Havilandi parasita* Wasm. Type. (2) Insel Europa Voelskow 1903-04. (3) v 22 a. (4) bei *Calotermes europae*.

(b) DESCRIPTION

Types examined.

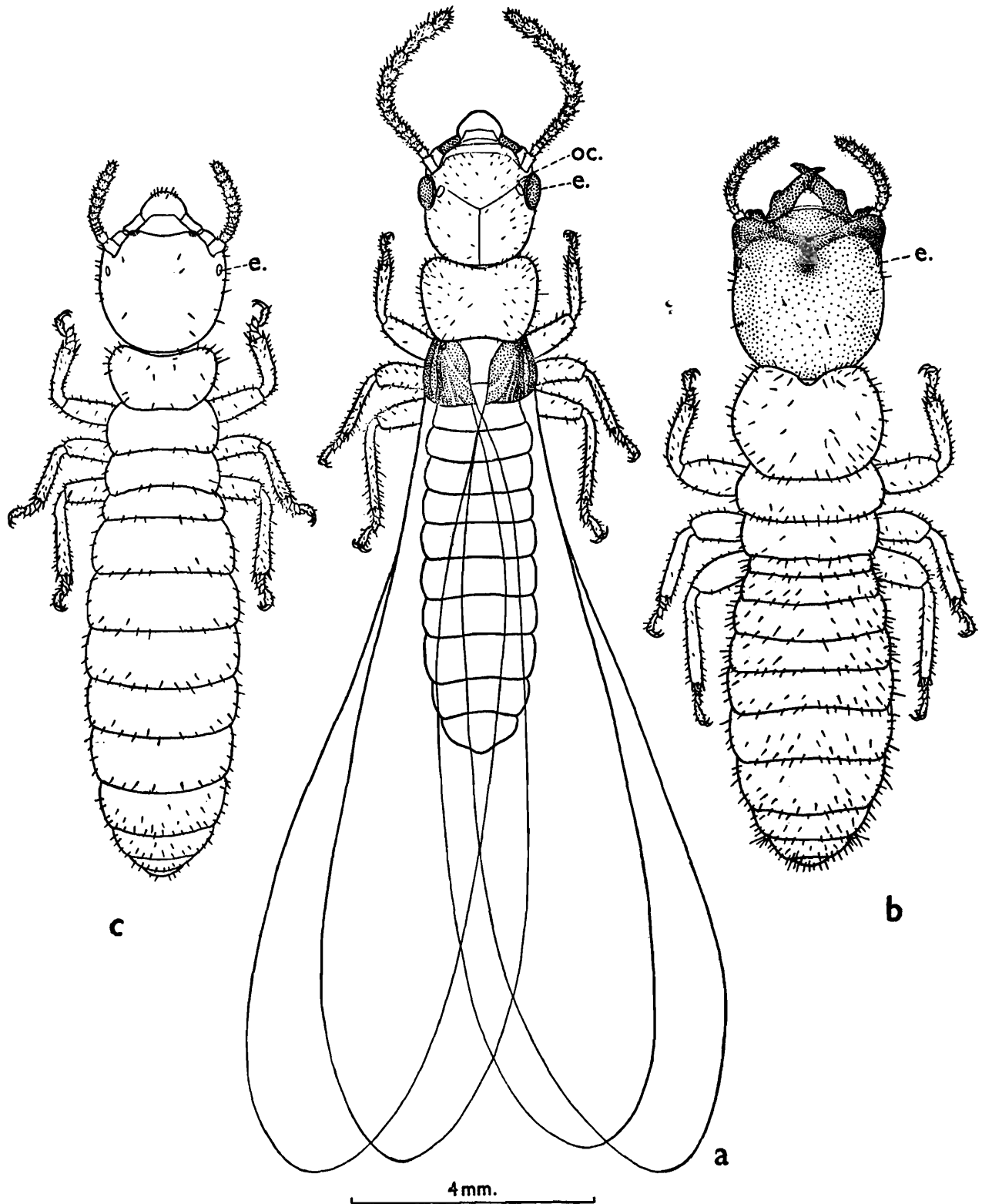
1. IMAGO (Text-figs. 15-18 & 20; Table 5).—

General : Head-capsule pale brown to brown, somewhat paler anteriorly; labrum and antennae yellowish to pale brown, paler than head-capsule; mandibles pale brown with dark brown toothed margins; body a little paler than head-capsule. Head and body fairly

*Along with this material were received 2 imagos, on card, from Mauritius Island, coll. *Voeltzkow*, 1903-04, and labelled as "*Calotermes havilandi parasita*". These specimens were found to belong to a different species on comparison with the lectotype of *C. havilandi* Sjöstedt. They are probably *C. pallidus* as mentioned by Snyder 1949, p. 43.

densely pilose. Total body-length with wings (excluding antennae) c. 8.0—10.1 mm., without wings 4.7—6.3 mm.

Head: Oval, 1.2—1.4 mm. long (upto the tip of labrum). Head-capsule subrectangular; length upto base of mandibles 0.87—1.03 mm.; width (with eyes) 0.90—1.07 mm.; dorsum with faint epicranial Y-sutures (not distinct in lectotype). *Fontanelle*: Absent. *Eyes*:



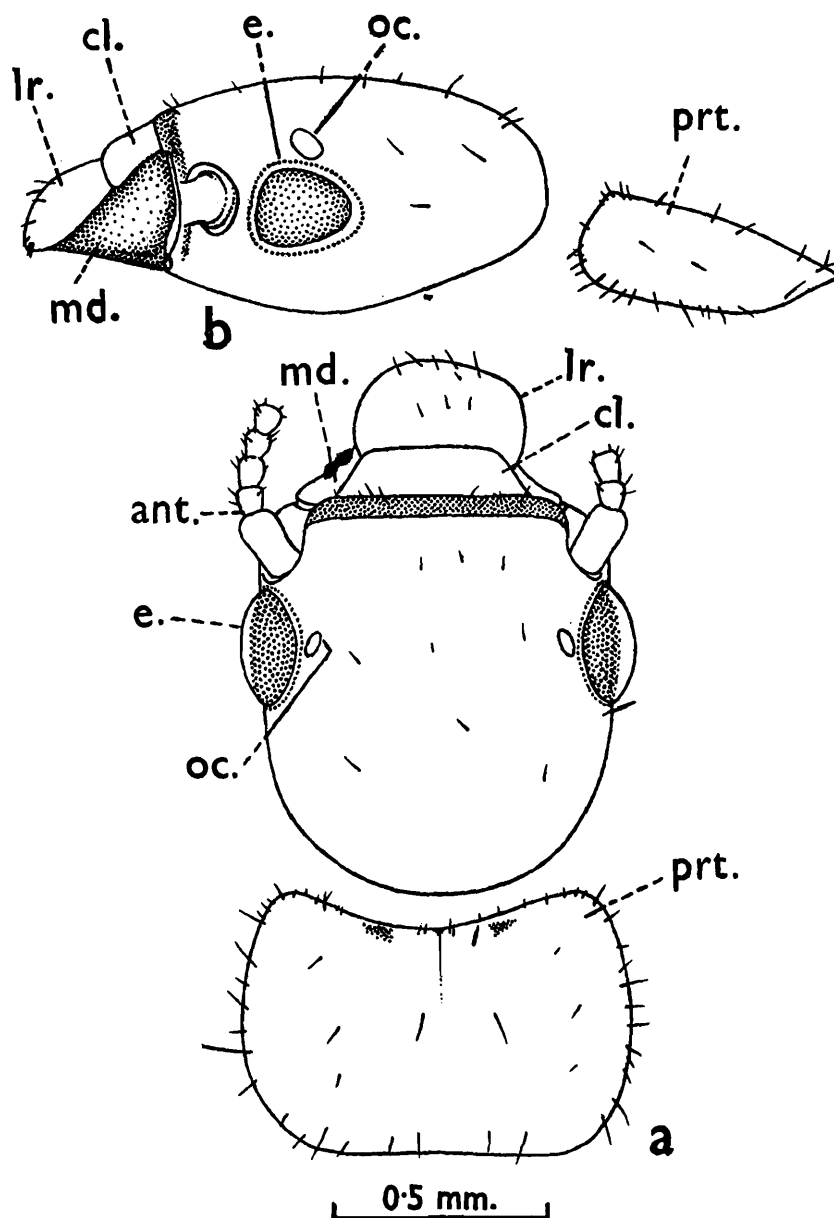
TEXT-FIG. 15.—*Cryptotermes havilandi* (Sjöstedt). Specimens from Mandla (Madhya Pradesh, India).

(a) Imago, in dorsal view. (b) Ditto, Soldier. (c) Ditto, pseudoworker.

e., eye; oc., ocellus.

Two black, medium sized, somewhat oval, lateral eyes, one on either side; maximum diameter 0.30—0.34 mm. *Ocelli*: Two lateral, oval ocelli, one on either side, either touching the eyes

or separated from them by a thin line; long diameter 0.07—0.18 mm. *Antennae* : With 13-17 (generally 15-17) segments. In 15-segmented antennae, segment 1 long, cylindrical; 2 a little longer than half of 1, and cylindrical; 3 pear-shaped, shorter than 2; 4 shortest, 5 to the penultimate one pear-shaped and gradually increasing in size; last ovate, longer than the penultimate one. In 16-segmented antennae, segments 3 and 4 subequal, and the last shorter than the penultimate one; otherwise as in 15-segmented antennae. In 17-segmented



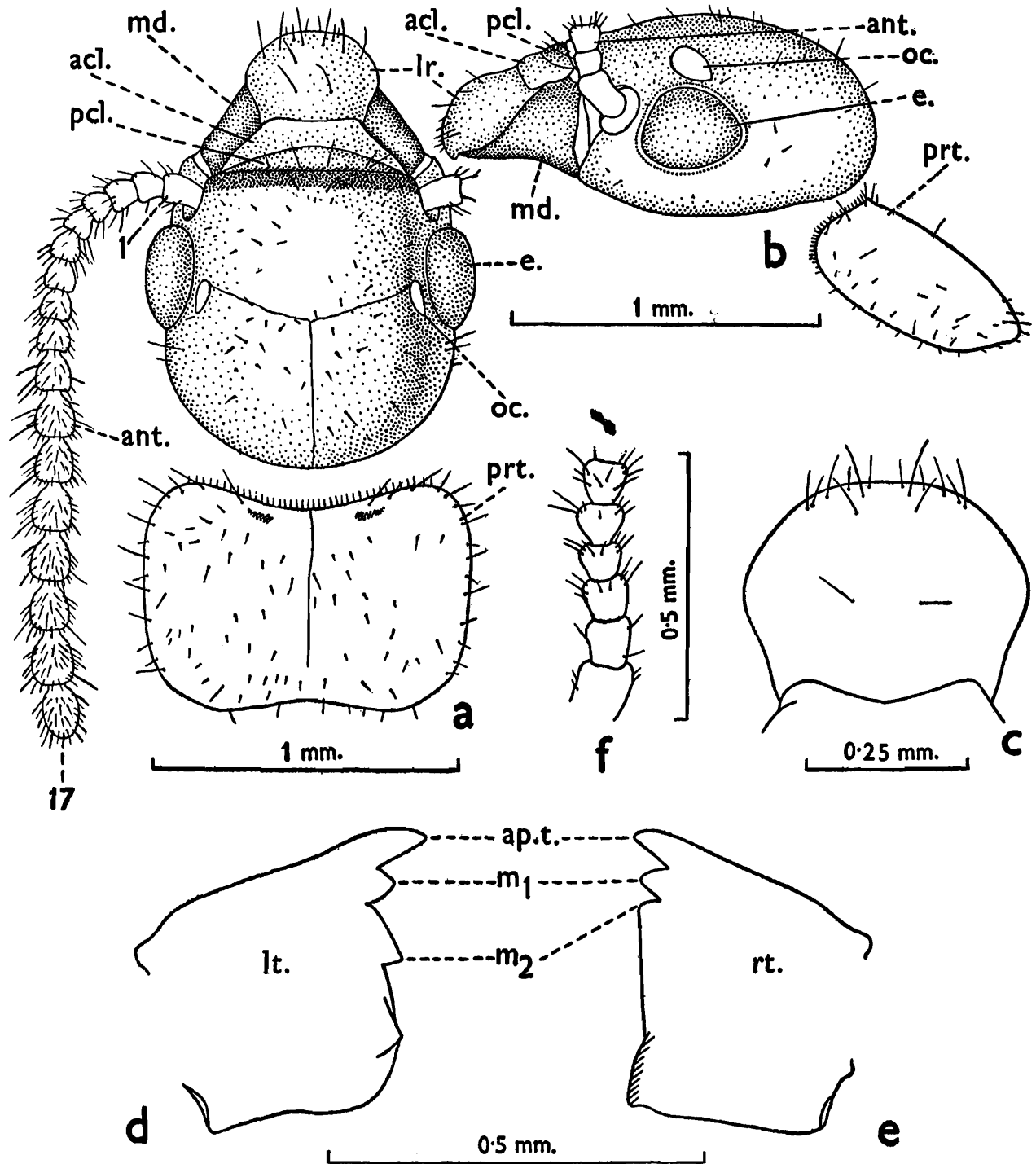
TEXT-FIG. 16.—*Cryptotermes havilandi* (Sjöstedt). Imago. Lectotype from Fernando Po.

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view.

ant., antenna; *cl.*, clypeus; *e.*, eye; *lr.*, labrum; *md.*, mandible; *oc.*, ocellus; *prt.*, pronotum.

antennae, segment 4 shortest and the last shorter than the penultimate one; otherwise as in 15-segmented antennae. *Glypeus* : Divided into an ante- and a postclypeus (the latter sometimes hardly differentiated, as in lectotype). Anteclypeus hyaline, subtrapezoidal, apilose. Postclypeus crescent shaped, pilose. *Labrum* : Broadly tongue-shaped; with a number of hairs near tip and a few on body. *Mandibles* : Subsquamish, each mandible with an apical and two marginal teeth. *Left Mandible* : Apical finger-like; 1st marginal shorter than apical; 2nd larger than 1st and separated from latter by a long anterior margin. *Right Mandible* : Apical finger-like, a little shorter than the corresponding one on left mandible; 1st marginal shorter than apical; 2nd short, lying at base of 1st and with a long posterior margin.

Thorax: Pronotum: Transverse, depressed at sides; generally narrower, but sometimes as wide as or a little wider than, head with eyes; length approximately three-fourths of width (maximum length 0.46—0.77; maximum width 0.80—1.10 mm.); anterior margin concave; posterior margin weakly incurved. *Legs:* Short and pilose; forelegs shortest; hindlegs longest; apical tibial spur formula 3 : 3 : 3; tarsi 4-jointed; arolium present.



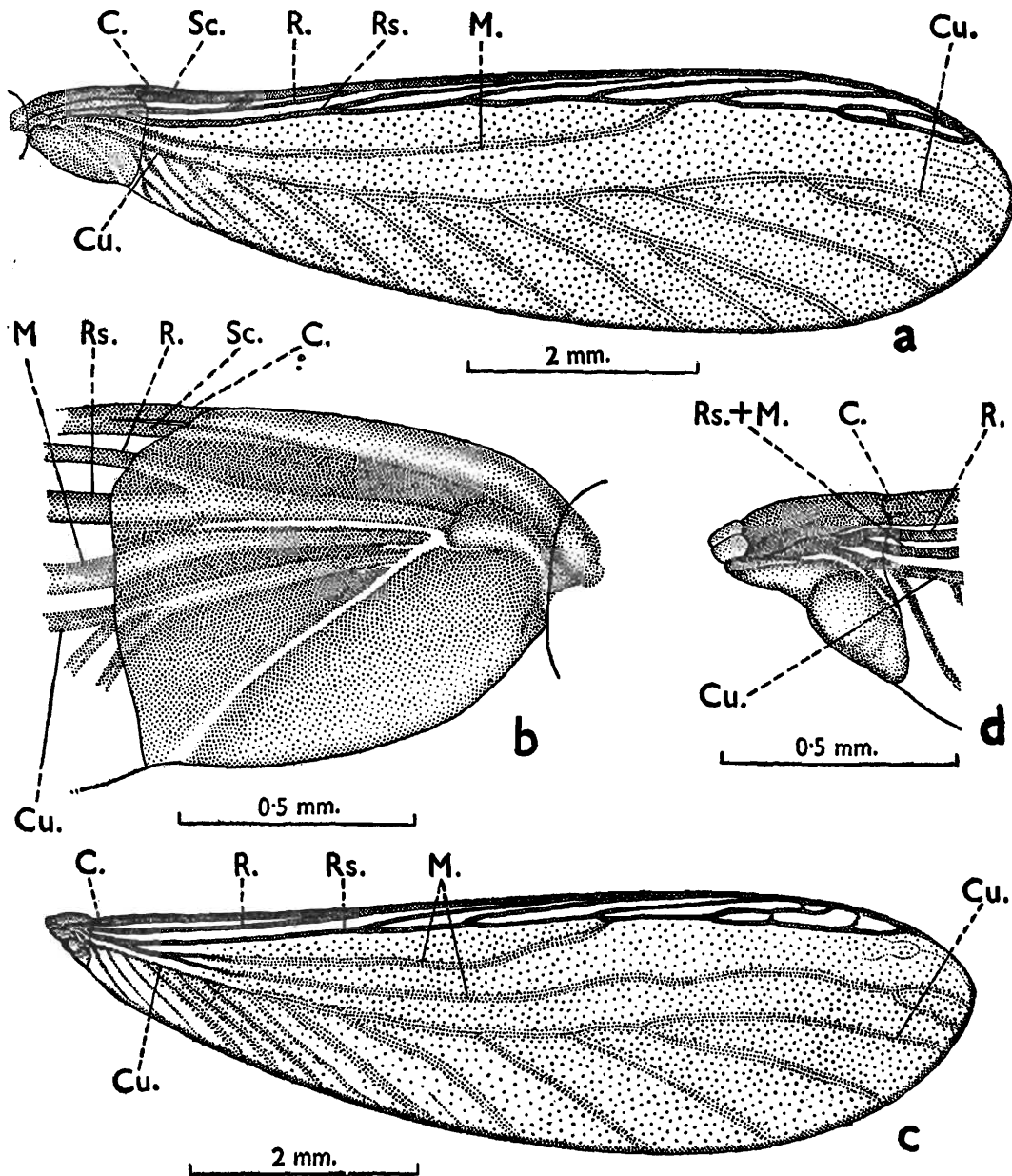
TEXT-FIG. 17.—*Cryptotermes havilandi* (Sjöstedt). Imago. Taveta Forest (Kenya, Africa).

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Labrum, in dorsal view. (d) Left mandible, in dorsal view. (e) Ditto, right mandible. (f) Proximal 6 segments of antenna, enlarged.

acl., anteclypeus; *ant.*, antenna; *ap. t.*, apical tooth of mandibles; *e.*, eye; *lr.*, labrum; *lt.*, left; *m₁*, *m₂*, 1st and 2nd marginal teeth of mandibles; *md.*, mandible; *oc.*, ocellus; *pcl.*, postclypeus; *prt.*, pronotum; *rt.*, right.

Wings (Text-fig. 18): Hyaline, weakly tinged brown. Costa, subcosta, radius and radial-sector brownish and strongly chitinised; median and cubitus faint and weakly chitinised. *Forewing:* Scales large, shield-like, covering the hindwing scales entirely or partly. All

veins arising from the scale independently. Costa running along the anterior margin entirely. Subcosta short, separated from costa by a line and fusing with the latter just outside the scale. Radius fusing with costa just beyond the 1st branch of radial sector at about one-fourth of wing-length (in a specimen from Taveta Forest, Kenya, Africa, radial giving a small branch to costa in the right forewing, text-fig. 18, fig. a) Radial sector running parallel with and



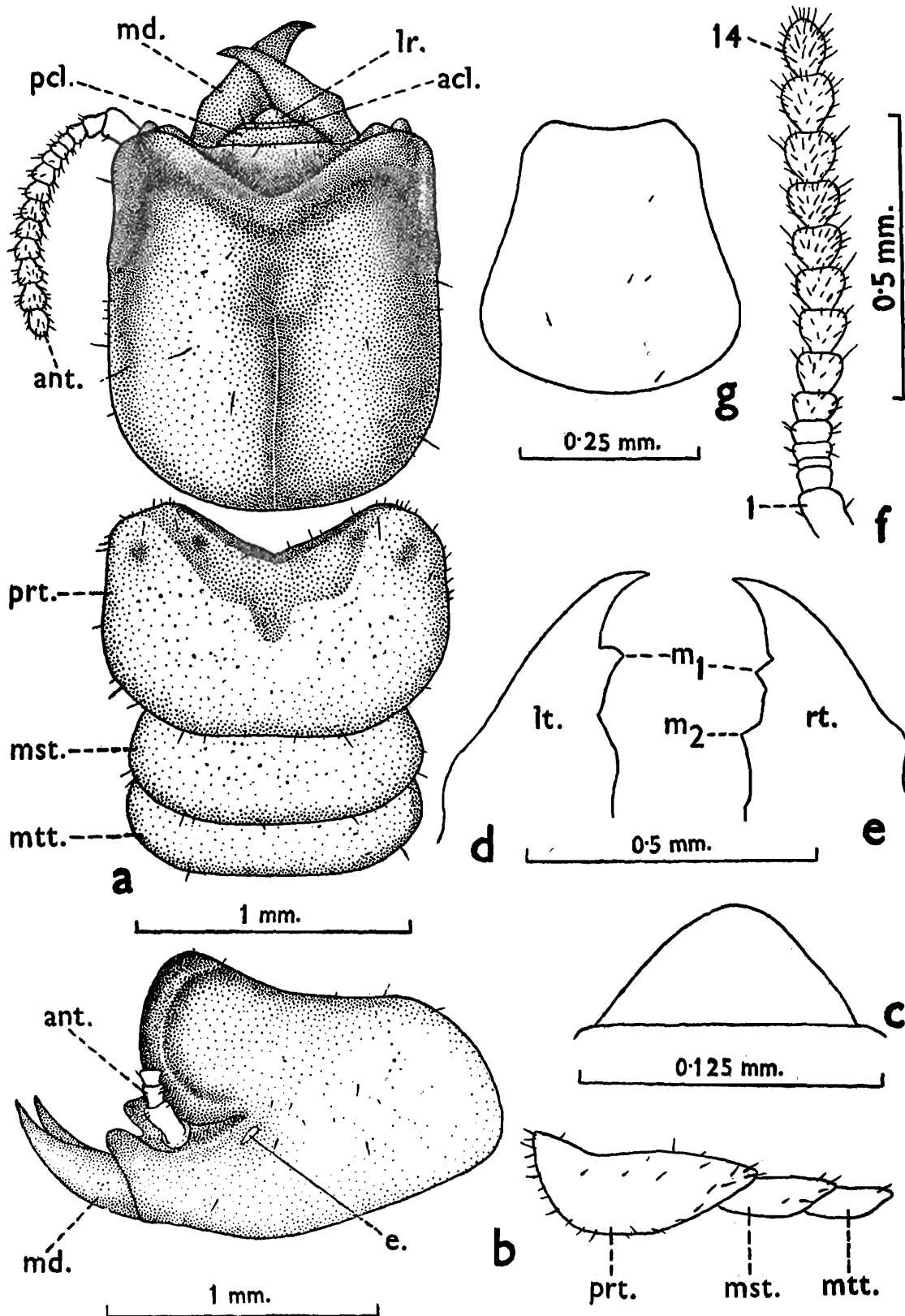
TEXT-FIG. 18.—*Cryptotermes havilandi* (Sjöstedt). Wings. From specimen from Taveta Forest (Kenya, Africa).

(a) Right forewing, in dorsal view. (b) Left forewing, proximal portion enlarged. (c) Right hindwing, in dorsal view. (d) Ditto, proximal portion enlarged.

C., costa; Cu., cubitus; M., Median; R., radius; Rs., radial sector; Sc., subcosta.

nearer to costa upto the distal end and giving 5-7 branches to the latter. Median arising independently from the scale; curving up and meeting the radial sector generally between the 3rd and 4th, or sometimes between the 4th and 5th, branches of the latter to costa, at approximately the distal onethird. Cubitus running medially and with 10-14 main branches to the posterior margin. *Hindwing*: Scale short, triangular. Costa as in forewing. Subcosta absent. Radius as in forewing. Radial sector as in forewing, with 3-6 branches to costa. Median arising from radial sector near the proximal end and curving up to meet it again between its 2nd and 3rd branches to the costa, at a distance of three-fifths or a little more, of the length of wing. (In specimen from Taveta Forest, Kenya, it bifurcates just after

coming out of radial sector, the upper branch curving up to meet the radial sector and the lower one running, parallel with and nearer to cubitus throughout the entire wing-length, to the distal margin, text-fig. 18, fig. c.). Cubitus as in forewing, with 13-15 main branches to posterior margin.



TEXT-FIG. 19.—*Cryptotermes havilandi* (Sjöstedt). Soldier. Taveta Forest (Kenya, Africa).

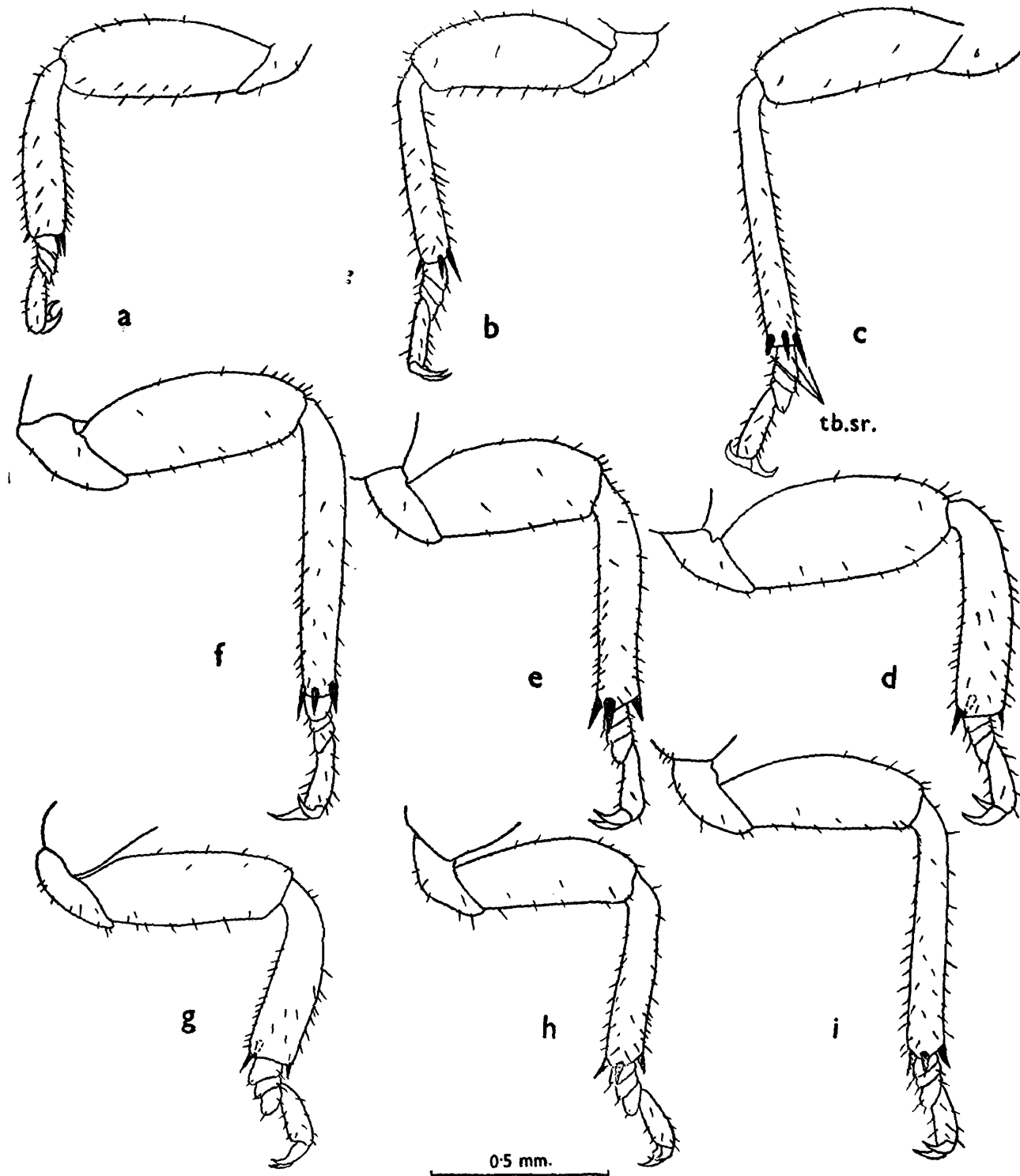
(a) Head and thorax, in dorsal view. (b) Ditto, in side view. (c) Labrum, in dorsal view. (d) Left mandible, in dorsal view. (e) Ditto, right mandible. (f) Left antenna, in dorsal view. (g) Postmentum, in ventral view.

acl., anteclypeus; ant., antenna; e., eye; lr., labrum; lt., left; m_1 , m_2 , 1st and 2nd marginal teeth of mandibles; md., mandible; mst., mesonotum; mtt., metanotum; pcl., postclypeus; prt., pronotum; rt., right.

Abdomen: Elongate, fairly densely pilose. Cerci minute, 2-jointed, 0.05—0.07 mm. long. Styli (in males) short and single-jointed.

2. SOLDIER (Text-figs. 15, 19 & 20; Table 6).—

General: Head-capsule black, dark reddish to dark brown posteriorly; mandibles black; labrum and antennae yellowish to pale brown; thorax, body and legs pale yellow to pale



TEXT-FIG. 20.—*Cryptotermes havilandi* (Sjöstedt). Drawings from specimens from Mandla, Madhya Pradesh, India.

(a)-(c) Fore- middle- and hindlegs respectively, of imago. (d)-(f) Ditto, soldier. (g)-(i) Ditto, pseudoworker.

tb. sr., tibial spur.

yellowish brown. Head sparsely and body moderately pilose. Total body-length *c.* 3.6—6.3 mm.

Head: Head-capsule subrectangular, short and thick (length to base of mandibles 1.13—1.47; maximum width 1.10—1.35 mm.); truncated in front; frontal ridge variably prominent, overhanging the frons, lying generally a little behind the lateral base of mandibles or at level of mandibles, anterior margin of ridge weakly to fairly prominently concave; frons sharply inclined and concave; vertex with a median depression just behind the frontal ridge; with 2 knob-like tubercles, on either side, one arising from frons just above the antennal sockets and the other a prolongation of genae just below the antennal sockets; epicranial sutures present, transverse sutures not distinct. *Fontanelle and ocelli*: Absent. *Eyes*: Two lateral, oval, eye spots, a little paler than surrounding area, present; 0.07—0.17 mm. long. *Antennae*: With 11-15 segments; proximal 3 or 4 segments sparsely, and others fairly densely, pilose; segment 1 cylindrical and longest; 2 also cylindrical and a little longer than half of 1; 3 either short and ring-like or subequal to 2, sometimes subdivided; 4 and 5 ring-like and short; 6 to the penultimate one pyriform and gradually increasing in length; last ovate, shorter and narrower than the penultimate one. [In a specimen from Mandla (M.P.), left antenna with only 8 segments; segments 1 and 2 as in normal antennae; 3 equal to 2; 4 shortest; 5 exceptionally large and pyriform; 6 smaller than 5; 7 also very large, longer than 5; 8 (last) subequal to 1 and narrowly projected in front]. *Clypeus*: Divided into an ante- and a postclypeus; separated from frons by a transverse, thin groove. Anteclypeus a thin, narrow, pale strip. Postclypeus subtrapezoidal, weakly pilose and of same colour as frons. *Labrum*: Subtriangular; broadest at base; either apilose or with a pair of hairs at tip. *Mandibles*: Short and stout; with a prominent hump a little above the base on outer margin; tips sharply pointed and incurved. Left mandible with 2 marginal teeth; 1st marginal weak to fairly prominent; 2nd small, sometimes absent. Right mandible also with 2 weak to fairly prominent marginal teeth. *Postmentum*: Short; broad posteriorly and narrowing in front; anterior margin substraight to weakly concave; posterior margin round.

Thorax: Pronotum: A little narrower to somewhat broader than head-capsule; maximum width of pronotum 0.90—1.42 mm.; length little more than half to about three-fourths of width (index Length/Width 0.58—0.78); sides rounded to somewhat straight; posterior margin weakly convex or substraight; anterior margin deeply and broadly concave. *Mesonotum and metanotum*: Narrower than pronotum; posterior margin weakly convex. *Legs*: Short, thick and hairy; femora swollen; apical tibial spur formula 3 : 3 : 3. *Tarsi* 4-jointed.

Abdomen: Oblong; moderately pilose. *Cerci* 2-jointed, 0.07—0.1 mm. long. *Styli* either present or absent; when present, single-jointed, *c.* 0.07 mm. long.

3. PSEUDOWORKER (Text-figs. 15 & 20; Table 10).—

General: Head-capsule, antennae, labrum and clypeus pale yellow; mandibles pale yellow with dark brown toothed margins; thorax, legs and body white to pale yellow; abdomen sometimes pale pink. Head and body sparsely hairy. Total body-length (without antennae) *c.* 5.3—6.0 mm.

Head: Oval, length to tip of labrum 1.30—1.43 mm.; head-capsule subcircular (length to base of mandibles 1.0—1.10; maximum width 1.07—1.20 mm.); frons weakly depressed medially. *Fontanelle and ocelli*: Absent. *Eyes*: Two lateral, flat, eyes, one on either side. *Antennae*: With 12-14 segments; segments 1 and 2 as in soldier; 3-8 or 9 (sometimes 3-6) ring-like and broader than long; the remainder upto the penultimate one broadly pyriform; last ovate and narrower than the penultimate one. *Clypeus*: Subtrapezoidal; not clearly differentiated into an ante- and a postclypeus. Anteclypeus apilose, substraight to weakly concave anteriorly. Postclypeus pilose; anterior margin round. *Labrum and mandibles*: As in imago.

Thorax: Pronotum: Flat; a little narrower than head-capsule (maximum width 0.97—1.00 mm.; maximum length 0.53—0.66 mm.). *Legs*: As in soldier.

Abdomen: Oblong; sparsely pilose. Cerci 2-jointed, 0.07 mm. long. Styli (when present) single-jointed, c. 0.07—0.10 mm. long.

(c) TYPE-SPECIMENS

(a) Of *C. havilandi* (Sjöstedt):

Holotype was not selected by Y. Sjöstedt 1897. *Lectotype** (*vide* "Material (i)" above), one imago, selected from material from Fernando Po, and labelled as such by A. E. Emerson, 1957; in Naturhistoriska Riksmuseum, Stockholm.

*Paralectotypes**: 2 imagos in Naturhistoriska Riksmuseum, Stockholm, "Material (i)" above.

Cotypes: (i) In A. M. N. H., New York, 1 imago from Fernando Po. (ii) In Zoologisches Museum, Hamburg (West Germany) imagos from Boma, Congo. (iii) In Museum Greifswald (East Germany).

(b) Of *Kalotermes (Cryptotermes) bengalensis* Snyder :

Cotypes and comorphotypes: (i) In B. M., London. (ii) In F. R. I., Dehra Dun. (iii) In U. S. N. M., Washington (Catol. No. 50162). (iv) In A. M. N. H., New York.

(c) Of *Calotermes havilandi parasita* Wasmann:

(i) In Wasmann's Collection, Naturhistorisches Museum, Maastricht (Holland). Specimen from Europa Island only, *vide* "Material (xi)" above. (ii) In A. M. N. H., New York.

(d) Of *Calotermes lamanianus* Sjöstedt :

In a communication from Naturhistoriska Riksmuseum, Stockholm, Sweden, it has been informed that types of *C. lamanianus* have probably been misplaced.

(d) TYPE-LOCALITY

(a) Of *C. havilandi* (Sjöstedt)* :

Fernando Po, Atlantic Ocean, Africa.

(b) Of *Kalotermes (Cryptotermes) bengalensis* Snyder :

Sunderbans (Bengal).

(c) Of *Calotermes havilandi parasita* Wasmann :

Europa Island (Mozambique Channel).

(d) Of *Calotermes lamanianus* (Sjöstedt) :

Mukimbungu (Congo, Africa).

(e) DISTRIBUTION

It is a very widely distributed species and is known from the Oriental, Ethiopian, Neotropical and Malagasy Regions, as follows:—

Africa: *Congo*: Boma, 5°48' S., 13°6' E.; Mukimbungu, 5°05' S., 14°02' E.; Sona Mpungu, 5°30' S., 13°55' E. *Gambia. Gold Coast*: Aburi, 5°54' N., 0°09' W. *Ivory Coast*: Abidjan, 5°22' N., 3°59' W.; Bingerville, 5°22' N., 3°52' W.; Grand-Basam, 5°13' N., 3°44' W. *Kenya*:

*Professor Emerson selected the lectotype and paralectotypes of this species in the year 1957; this being the first record of the same since these designations have not been published by him so far.

**Cryptotermes havilandi* Sjöstedt was described by Y. Sjöstedt (1897) as *Calotermes domesticus* n. sp. from Fernando Po and Boma (Cameroons, Congo). Later on, Sjöstedt (1900) recorded this species from Victoria (Cameroons), and in 1926 from Aburi (Gold Coast); Olokemeji and Ibadan (Nigeria); Victoria (Cameroons); Fernando Po; Boma (Congo) and Mombasa (Kenya), and mentioned Victoria as the type-locality (*typi*). The species was originally described from Fernando Po and Boma, therefore, one of these localities should be regarded as the type-locality, and as the lectotype is from Fernando Po (Ruehholz, 1873), this should be taken as the type-locality and not Victoria (Cameroons) as mentioned by Sjöstedt (1926), Coaton (1950, 1955) and Moszkowski (1955).

Mombasa, 4°0' S., 39°40' E.; Near Mombasa, 4°0' S., 39°40' E.; Taveta Forest, 3°20' S., 37°42' E. *Mozambique*: Lourenco Marques, Delagoa Bay, 25°57' S., 32°35' E.; Beira, 19°50' S., 34°52' E. *Nigeria*: Ijora Lagos, 6°31' N., 3°21' E.; Ikoyi Lagos; Ibadan, 7°28' N., 3°56' E.; Lagos, 6°31' N., 3°21' E.; Olokemeji, 7°25' N., 3°34' E.; Port Harcourt, 4°04' N., 7°07' E.; Victoria, 4°0' N., 9°12' E. *Swaziland*: 13 miles from Bremersdorp toward Gollel, 26°39' S., 31°29' E.; 16 miles from Bremersdorp toward Gollel, 26°42' S., 31°31' E.; 20 miles from Bremersdorp toward Gollel, 26°45' S., 31°22' E.; 39 miles from Bremersdorp toward Gollel, 26°59' S., 31°41' E. *South Africa*: Jesser Point, Zululand, 27°34' S., 32°40' E.; 9 miles South of Empangeni, 28°53' S., 31°59' E.; Mkuzi Drift, Mkuzi River near Mkuzi, 27°38' S., 32°0' E.; 1 mile South of Mkuzi. *Tanganyika*: Amani, Road to Darema, 5°8' S., 38°36' E.; Dar-es-Salaam, 6°47' S., 39°15' E.; Zanzibar Island, 5°30' S., 39°13' E.; Amani (Usambara), 5°8' S., 38°36' E.; Tanga (Usambara), 5°7' S., 39°7' E.

Asia : *Ceylon*: Balangoda, 6°40' N., 80°45' E.; Chilaw, 7°35' N., 79°55' E.; Paiyagala near Kalutara, 6°30' N., 79°59' E.; Peradeniya, 7°16' N., 80°37' E.; Puttalam, 8°0' N., 79°49' E.; and Talawila nr. Puttalam, 8°08' N., 79°42' E. *India*: Mysore State: Anekad Forest Range, c. 12°25' N., 75°57' E.; Chickmagalur, 13°15' N., 75°45' E.; Dharwar, 15°27' N., 75°5' E.; Megalapura nr. Mysore, 12°20' N., 76°30' E.; Tallagatpur nr. Bangalore, c. 12°50' N., 77°50' E. *Madhya Pradesh*: Mandla, 22°43' N., 80°35' E. *Assam*: Jokai Reserve Forest, Lakhimpur, 27°10' N., 95°25' E. *Orissa*: Barkuda Island, Chilka Lake, 19°45' N., 85°12' E. *Bengal*; Sundarbans. *Andaman Islands* (Bay of Bengal): 2 km. inside the Forest of Laitora (7 km. North of Tokoibuea), Little Andamans, 10°50' N., 92°34' E.; Taibalowe, 16 km. East of Ingoi, Little Andamans, 10°31' N., 92°31' E. and Otirubera Korale, 17 km. West of Ingoi, Little Andamans, 10°33' N., 92°26' E. *East Pakistan*: Dacca, 23°30' N., 90°30' E.

Atlantic Ocean : Fernando Po, 3°30' N., 8°40' E. (type-locality).

Indian Ocean : Comoros Islands (11°24'—11°56' S., 43°11'—43°29' E.) : Anjouan. *Madagascar Is.*: Ambongomaranitra (106 km. from Maevatanana toward Majunga), 16°20' S., 46°50' E.; Grand Lac (15 km. North of Majunga), 15°36' S., 46°21' E.; Manantantely, 24°50' S., 46°50' E.; Marohoga (20 km. East of Majunga), 15°46' S., 46°28' E.; 5 km. North of Majunga, 15°41' S., 46°21' E.; 20 km. North—East of Maevatanana, 16°48' S., 46°55' E.; 11 km. East of Mahabo, 20°26' S., 44°58' E.; 8 km. South of Mahabo, 20°31' S., 44°52' E.; 33 km. South-West of Mandabe, 21°15' S., 44°42' E.; 34 km. South-West of Mandabe, 21°15' S., 44°41' E.; Fenerive, 17°17' S., 49°25' E. *Europa Island* (Mozambique Channel).

Central America and Caribbean Sea: *West Indies*: Speyside, Tobago, 11°25' N., 60°30' W. Trinidad: Maracas valley, 10°42' N., 61°24' W.; San Juan, 10°40' N., 61°27' W.; St. Augustine, 10°40' N., 61°15' W.; St. Joseph, 10°39' N., 61°25' W.; Port of Spain, 10°40' N., 61°31' W.

South America: *British Guiana*: Kartabo (Bartica District), 6°23' N., 58°42' W. *Brazil*: Santos (Sao Paulo), 23°59' S., 46°24' W. *Chile*. *Dutch Guiana*: Paramaribo (Surinam), 5°50' N., 55°17' W.

(f) COMPARISON

Cryptotermes havilandi (Sjöstedt) is a very variable species. It is however, close to *C. domesticus* and *C. dudleyi*; the differences from these two species are given under them.

7. *Cryptotermes perforans* Kemner

(Text-figs. 21-24; and Tables 7, 8 & 10)

(i) *Cryptotermes cynocephalus* Light [Wrong determination]

1953. M. Ahmad, *Spolia Zeylan.*, Colombo, 27 (1), p. 35. Ceylon. [Specimens examined by me and found to be identical with the lectotype of *C. perforans* Kemner—also vide "Remarks" above under *C. cynocephalus*.]

(ii) *Cryptotermes perforans* Kemner

1932. N. A. Kemner, *Ent. Tidskr.*, Stockholm, 53 (2-3), pp. 153-155. *Im.* and *S.* Type-locality: Colombo (Ceylon). Types examined.

1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, 3, p. 83. Ceylon: Talawila near Puttalam, and also common below 2000 ft. above sea-level.
1949. T. E. Snyder, *Smiths. misc. coll.*, Washington, 112, p. 43. Ceylon.
1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, 122(Art. 4), p. 382.
1962. R. N. Mathur and R. S. Thapa, *Indian For. Leaf. (Ent.)*, Delhi, No. 167, p. 8. India: Beliapatam (Kerala). Ceylon: Golaka (Galaha *vide* material). [Specimens from Galaha only. Beliapatam specimens are *C. roonwali*, sp. n. *vide infra*.]

(iii) *Kalotermes (Cryptotermes) perforans* Kemner

1953. Rattan Lal and R. D. Menon, *Catalogue Indian Insects*, Part 27, *Isoptera*, Delhi, pp. 10-11. Ceylon.

(iv) *Cryptotermes perforatus* Kemner

1937. S. F. Light, *Pan-Pacific Ent.*, San Francisco, 13 (1-2), p. 22. [Wrong spellings for *perforans*.]

(v) *Cryptotermes* near *perforans* Kemner

1953. M. L. Roonwal and G. D. Pant, *Indian For. Leaf. (Ent.)*, Delhi, No. 121 (Pt. 3), p. 42. India: Baliapatam (N. Malabar). [These specimens were determined as "*Cryptotermes* near *perforans* Kemner" but are a new species; *C. roonwali* sp. n., *infra*.]

(vi) *Calotermes (Glyptotermes) perforans* Kemner

1931. J. C. Hutson, *Adm. Rep. Dir. Agric. Ceylon*, Colombo, 1930, p. 73. Ceylon: Puttalam. [Wrongly mentioned as a species of subgenus *Glyptotermes*.]

(a) MATERIAL EXAMINED

(A) Present in Zoologiska Institutet, Lund University, Lund.

(i) A vial with a lectotype soldier, a lectomorphotype imago (with 2 loose wings) (selected A. Emerson, 1957); and a pseudoworker, from type-colony, Colombo (Ceylon), coll. F. P. Jepson, (7181), 7. v. 1929, *det.* N. A. Kemner.

(B) Present in Z.S.I., Calcutta.

(ii) A vial (Z. S. I. Reg. No. 2624/H8) with 2 soldiers, 6 pseudoworkers and 4 nymphs, Colombo (Ceylon), 26.ix.1928, "from wood of a sewing machine" *Det.* M. Ahmad "*Cryptotermes cynocephalus* Light", but is actually *C. perforans*.

(C) Present in F. R. I., Dehra Dun.

(iii) A vial (F. R. I. Nos. R. R. D. 935, M. C. 18874/3) with 2 soldiers and several pseudoworkers, Tea Research Institute, (Coll. No. S. 26) Galaha (Ceylon), 1939, ex "Factory timber"

(b) DESCRIPTION

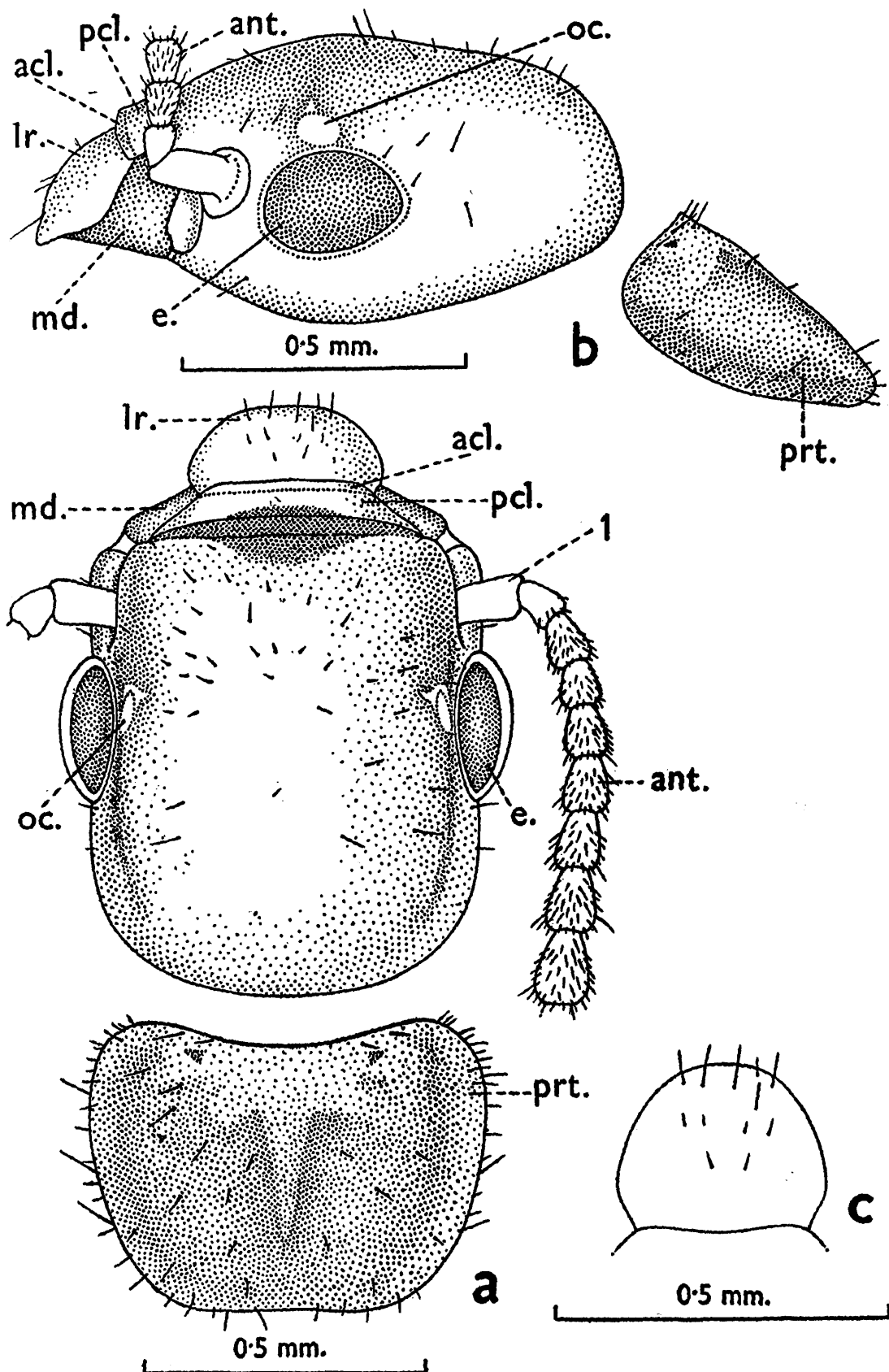
Types examined.

1. IMAGO (Text-figs. 21—22; Table 7).—

General: Head, thorax and abdominal tergites pale brownish yellow; antennae, labrum and legs pale yellow; mandibles yellow with brown margins; anteclypeus hyaline; sternites paler than tergites. Head and body sparsely pilose. Total body-length with wings 7.0—7.69; without wings 4.52—4.95 mm.

Head: Head oval; head-capsule subsquarish, almost as long as width with eyes (length to base of mandibles 0.80; width with eyes 0.77—0.81 mm.); sides subparallel; frons weakly depressed medially; posterior margin round. *Fontanelle*: Absent. *Eyes*: Two lateral, black, compound eyes, one on either side; oval, somewhat narrowing posteriorly; maximum diameter 0.27 mm. *Ocelli*: Two lateral, hyaline, oval ocelli, one on either side; maximum diameter 0.10 mm.; touching the ocular sclerite. *Antennae*: Broken in the specimen (lectomorphotype) examined; only 9 segments present; segments 1 and 2 very stily and the remainder

fairly densely pilose; segment 1 longest, cylindrical; 2 shorter than 1 and cylindrical; 3 longer than either 2 or 4; 4-9 gradually increasing in length and pyriform. [According to Kemner (1932), antennae with 13-14 segments. In 13-segmented antennae, 3rd segment large,



TEXT-FIG. 21.—*Cryptotermes perforans* Kemner. Imago. Lectomorphotype from Colombo, Ceylon.

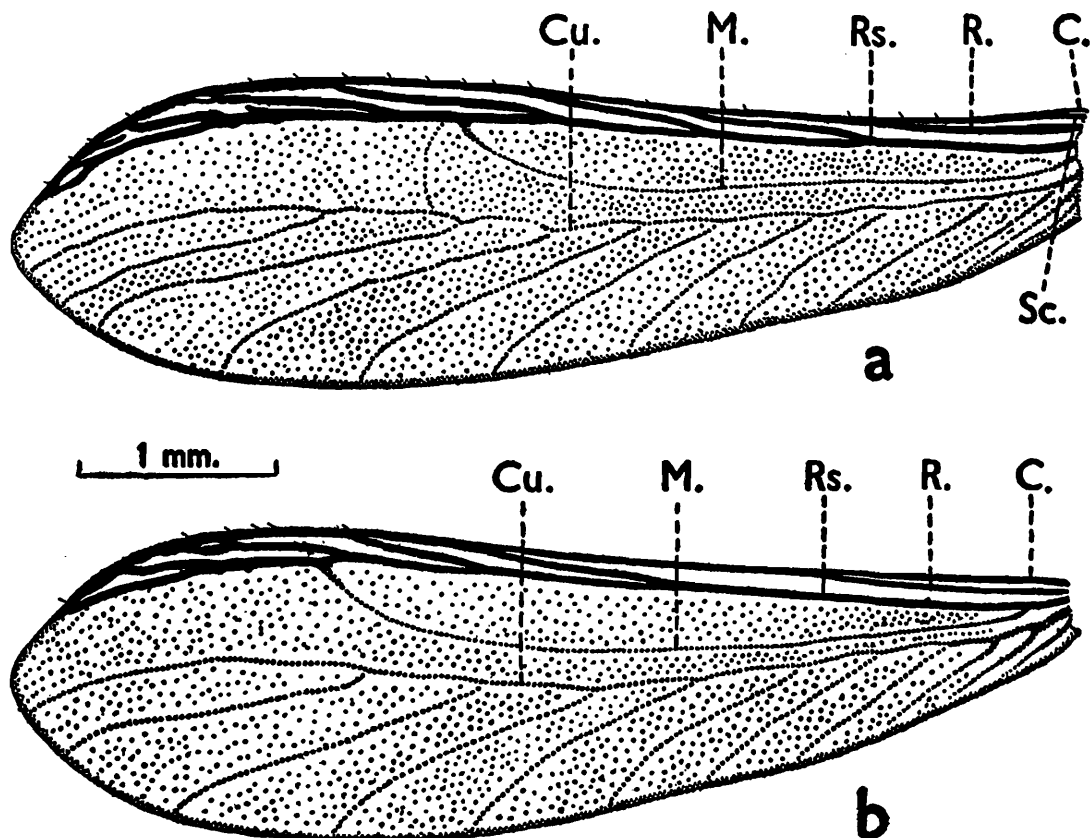
(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Labrum, in dorsal view.

acl., anteclypeus; ant., antenna; e., eye; lr., labrum; md., mandible; oc., ocellus; pcl., postclypeus; prt. pronotum.

longer and a little thicker than the 4th. In 14-segmented antennae, 3rd segment as long as but narrower than 4th. From 8 onwards, segments longer and about twice the width.] *Clypeus*: Subtrapezoidal; demarcation into ante- and postclypeus not clear. *Labrum*: Broadly tongue-shaped; broader than long; broadest in middle; anterior margin round; with a few hairs on anterior margin and on body. *Mandibles*: Not examined in the single (lectomorphotype) specimen available for study.

Thorax: Pronotum: Flat, subreniform; narrower than head with eyes (pronotum width 0.70—0.72; head width with eyes 0.77—0.81 mm.); broader than long (length 0.46—0.50 mm.; width 0.70—0.72 mm.); anterior margin weakly concave; sides weakly convex and slightly narrowed behind; posterior margin weakly incurved medially.

Wings (Text-fig. 22): Transparent, weakly tinged brownish, punctate; costa, radius and radial sector heavily chitinoid and thick; median and cubitus thin and weakly chitinoid. *Forewing*: Scales triangular, shield-like, covering about half of hindwing scales; anterior margin with a few short hairs along the entire length. Costa thick, running along the entire length of anterior margin of wing. Subcosta fused with costa, separated at the proximal end by a thin line. Radius coming out separately from the scale and fusing with costa a little before one-fifth of the wing-membrane. Radial sector also arising independently, running parallel to costa along the entire length of wing-membrane and giving 6 branches to costa; first branching at about one-fifth of the wing-membrane. Median arising independently from the scale, running a little above the middle of wing-membrane and curving up to meet the radial sector at about three-fifths of the wing-membrane. Cubitus running medially along the length of wing-membrane, with 12 branches to the posterior margin. *Hindwing*: Scale small, triangular, costal margin with fewer hairs. Costa as in forewing. Subcosta absent. Radius as in forewing but meeting the costa a little before one-fourth of wing-membrane. Radial sector as in forewing but with only 4 branches to costa, first branching at about two-fifths of wing-membrane. Median arising from radial sector outside the scale, running



TEXT-FIG. 22.—*Cryptotermes perforans* Kemner. Wings. From lectomorphotype imago from Colombo, Ceylon. (a) Left forewing, in dorsal view. (b) Ditto, left hindwing. C., costa; Cu., cubitus; M., Median; R., radius; Rs., radial sector; Sc., subcosta.

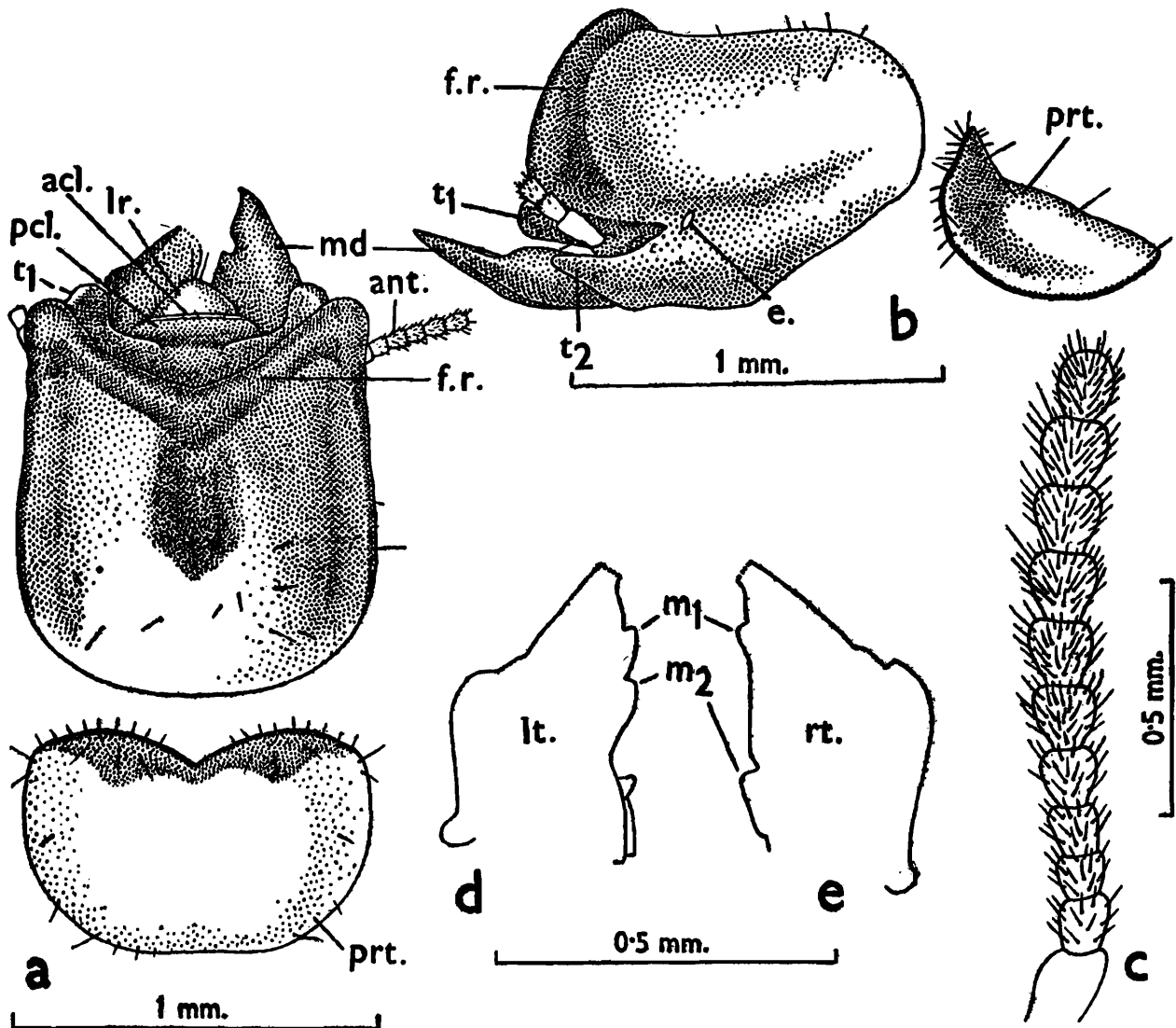
medially and curving up to meet radial sector again at about distal third of wing-membrane. Cubitus as in forewing but with 11 branches to posterior margin.

Abdomen : Long, hairy. Cerci 2-jointed, 0.1 mm. long. Styli 1-jointed, 0.07 mm. long.

2. SOLDIER (Text-fig. 23 ; Table 8).—

General : Head-capsule black, blackish brown posteriorly ; antennae, labrum, legs and body pale brown ; pronotum dark brown at anterior margin ; mandibles black, somewhat reddish black distally. Head sparsely, and body fairly, pilose. Total body-length c. 2.9-4.3 mm.

Head : Head-capsule thick and short (length with mandibles 1.23-1.34 ; length to lateral base of mandibles 0.97-1.03 ; and maximum width 0.88-1.00 mm.) ; truncated in front and forming an angle of more than 90° with the mandibles ; frontal ridge prominent, a



TEXT-FIG. 23.—*Cryptotermes perforans* Kemner. Soldier. Figures (a), (b) from lectotype soldier from Colombo Ceylon ; and figs. (c)-(e) also from a specimen from Colombo.

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Right antenna, in dorsal view. (d) Left mandible, in dorsal view. (e) Ditto, right mandible.

acl., anteclypeus ; *ant.*, antenna ; *e.*, eye ; *f. r.*, frontal ridge ; *lr.*, labrum ; *lt.*, left ; *m₁, m₂*, 1st and 2nd marginal teeth of mandibles ; *md.*, mandible ; *pcl.*, postclypeus ; *prt.*, pronotum ; *rt.*, right ; *t₁, t₂*, dorsal and ventral tubercles, respectively.

little elevated and forming a ribbon-like band ; two knob-like tubercles present on either side, a thick one lying a little above the antennal sockets on inner side of the lateral margin of frontal ridge and the other narrow, pointed, arising from the genae and lying below the

antennal sockets ; frons incurved under the frontal ridge ; vertex with a median depression just behind the frontal ridge ; sides substraight ; posterior margin round. *Fontanelle and ocelli* : Absent. *Eyes* : Two small, oval, slightly paler (than the head capsule) eye-spots present, one on either side ; maximum diameter 0.07 mm. *Antennae* : With 10-11 segments ; segments 1 and 2 sparsely and the remainder fairly pilose ; segment 1 longest, cylindrical ; 2 about one-half of 1 and cylindrical ; 3 either subequal to or shorter than 2 (11-segmented antennae), sometimes subdivided (10-segmented antennae) ; 4 onwards, segments gradually increasing in length and pyriform ; last ovate and narrower than the penultimate one. *Clypeus* : Anteclypeus, thin hyaline, line-like ; apilose. Postclypeus subrectangular ; of same colour as frons and not clearly separated from it ; weakly pilose. *Labrum* : Subtriangular ; wider than long and widest basally ; with a few bristles near the tip. *Mandibles* : Short and thick ; with a prominent hump on outer margin a little above the condyle ; each mandible with 2 small marginal teeth. *Postmentum* : Short and broad ; broadest basally and narrowing anteriorly ; anterior margin substraight or weakly convex ; posterior margin substraight.

Thorax : *Pronotum* : Flat, with slightly raised anterior margin ; broader than long and either as wide as or a little narrower than head-capsule (head-width 0.88-1.00 ; pronotum length 0.60-0.63, width 0.88-0.93 mm.) ; anterior margin convex with a deep and broad median notch ; sides weakly convex ; posterior margin weakly convex, substraight medially. In one example from Colombo (*vide* "Material (ii)" above) left anterior corner of pronotum wavy. *Mesonotum and metanotum* : Narrower than pronotum and with weakly incurved posterior margin. *Legs* : Short and hairy ; apical tibial spur formula 3 : 3 : 3. *Tarsi* 4-jointed.

Abdomen : Oblong, hairy. *Cerci and styli* broken in the specimens examined.

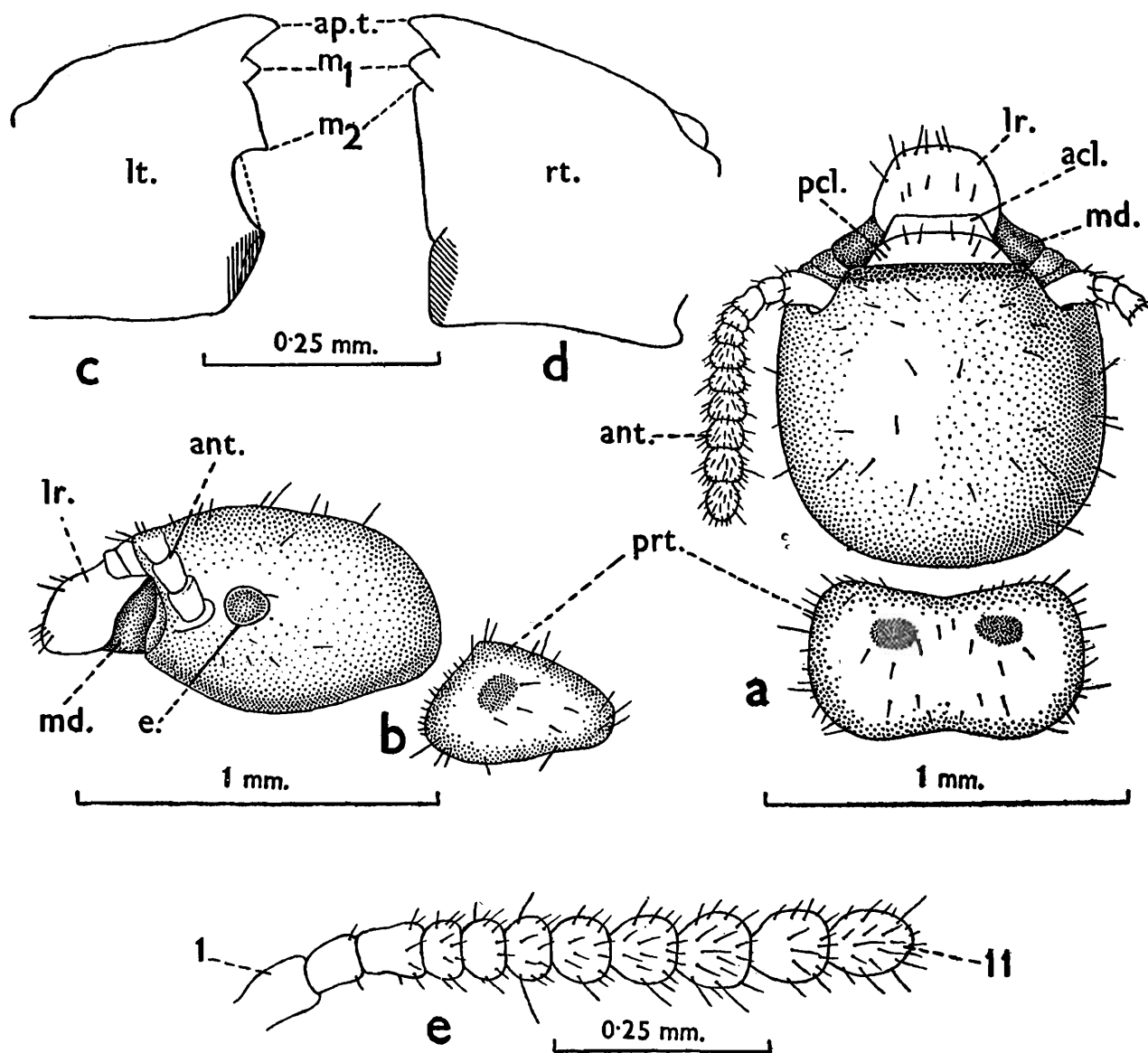
3. PSEUDOWORKER (Text-fig. 24 ; Table 10).—

General : Head-capsule yellowish to pale brown, somewhat paler anteriorly ; labrum, antennae, and legs pale dull brown. Head and body moderately pilose. Total body-length c. 3.8-4.4 mm.

Head : Head-capsule subcircular ; broader than its length to base of mandibles (length to base of mandibles 0.77-0.83 ; maximum width 0.85-0.90 mm.). *Fontanelle and ocelli* : Absent. *Eyes* : Two lateral eyes of same colour as head-capsule present, one on either side ; diameter 0.13-0.17 mm., flush with head-surface. *Antennae* : With 11-13 segments ; segments 1 and 2 cylindrical, the latter shorter than the former ; 3 long and subequal to 2 or ring-like and short ; 4-5 or 6 ring-like ; 6 or 7 to the penultimate one broadly pyriform and increasing in length ; last ovate and narrower than the penultimate one. *Clypeus* : Subtrapezoidal. Anteclypeus apilose, strip-like. Postclypeus pilose, weakly convex at anterior margin. *Labrum* : Broader than long ; anterior margin rounded ; pilose near anterior margin and on body. *Mandibles* : Subsquamish, each with an apical and 2 marginal teeth. Left mandible : Apical finger-like and long ; 1st marginal short and triangular ; 2nd larger than 1st and pointing downwards, with a long anterior margin. Right mandible : Apical finger-like, shorter than its corresponding one in left mandible ; 1st marginal triangular, larger and stouter than the corresponding one in left mandible ; 2nd short, situated at the base of 1st, posterior margin a little less than twice the length of molar plate.

Thorax : *Pronotum* : Subrectangularly flat ; narrower than head-capsule (head-width 0.85-0.90, pronotum width 0.73-0.83 mm.) ; length a little more than half of width ; sides somewhat rounded ; anterior margin concave ; posterior margin weakly convex or weakly incurved medially. *Legs* : Short, thick and pilose. Apical tibial spur formula 3 : 3 : 3. *Tarsi* 4-jointed.

Abdomen : Oblong ; moderately pilose. *Cerci* 2-jointed, 0.07-0.10 mm. long. *Styli* 1-jointed, finger-like, 0.07-0.10 mm. long.



TEXT-FIG. 24.—*Cryptotermes perforans* Kemner. Pseudoworker. Colombo, Ceylon. (a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Left mandible, in dorsal view. (d) Ditto, right mandible. (e) Left antenna, in dorsal view.

acl., anteclypeus; *ant.*, antenna; *ap. t.*, apical tooth of mandibles; *e.*, eye; *lr.*, labrum; *lt.*, left; *m₁*, *m₂*, 1st, and 2nd marginal teeth of mandibles; *md.*, mandible; *pcl.*, postclypeus; *prt.*, pronotum; *rt.*, right.

(c) TYPE-SPECIMENS

No holotype was selected by Kemner, 1932. *Lectotype and Lectomorphotype**: A lectotype soldier and a lectomorphotype imago (selected A.E. Emerson, 1957) are present in Zoologiska Institutet, Lund University, Lund, and were examined by me.

(d) TYPE-LOCALITY

Colombo (Ceylon).

(e) DISTRIBUTION

Ceylon: Colombo, 6°56' N., 79°56' E.; Galaha, 7°12' N., 80°40' E.; and Talawila near Puttalan, 8°08' N., 79°42' E. Common upto 2000 ft. above sea level.

*Professor Emerson selected the lectotype and lectomorphotype of this species in the year 1957; this being the first record of same since these designations have not been published by him so far,

(f) COMPARISON

Cryptotermes perforans Kemner is close to *C. cynocephalus* Light, and to *C. roonwali* sp. n. from India (*vide* below). It is separable from these species as follows :—

From *C. cynocephalus* : *Imago* : (i) Paler species (head-capsule brownish yellow *vs.* brown to dark reddish brown). (ii) Eyes smaller (maximum diameter 0.27 *vs.* 0.29 mm.). (iii) Ocelli larger (maximum diameter 0.10 *vs.* 0.08 mm.). *Soldier* : (i) Frontal ridge ribbon-like *vs.* gradually raised in front. (ii) Frons less concave and vertex smooth (*vs.* rather rough). (iii) Head larger (length to base of mandibles 0.97-1.03 *vs.* 0.83 mm.; width 0.88-1.00 *vs.* 0.75-0.80 mm.).

From *C. roonwali* sp. n. : See under that species, *infra*.

8. *Cryptotermes roonwali* sp. n.

(Text-figs. 25 & 26 ; and Tables 9 & 10)

(a) MATERIAL EXAMINED*

(A) *Present in Z. S. I., Calcutta.*

(i) A vial (Z. S. I. Reg. No. 3728/H8) with a soldier and 2 pseudoworkers, Beliapatam (N. Malabar, Kerala State, India), coll. A. H. Khan, 23. viii. 1941, ex "*Vateria indica* sawn scantlings "

(B) *Present in F. R. I., Dehra Dun.*

(ii) Same source as (i) above; 6 soldiers and several pseudoworkers. T. 3646, J. 115; S. E.'s No. 5071, M. C. No. 18874/1.

(b) DESCRIPTION

1. IMAGO.—Not known.

2. SOLDIER (Text-fig. 25 ; Table 9).—

General : Head-capsule blackish brown posteriorly and blackish anteriorly ; antennae, labrum and body pale yellowish brown ; pronotum brown at anterior margin ; mandibles blackish brown, black posteriorly. Head and body sparsely pilose. Total body-length c. 4.0-4.7 mm.

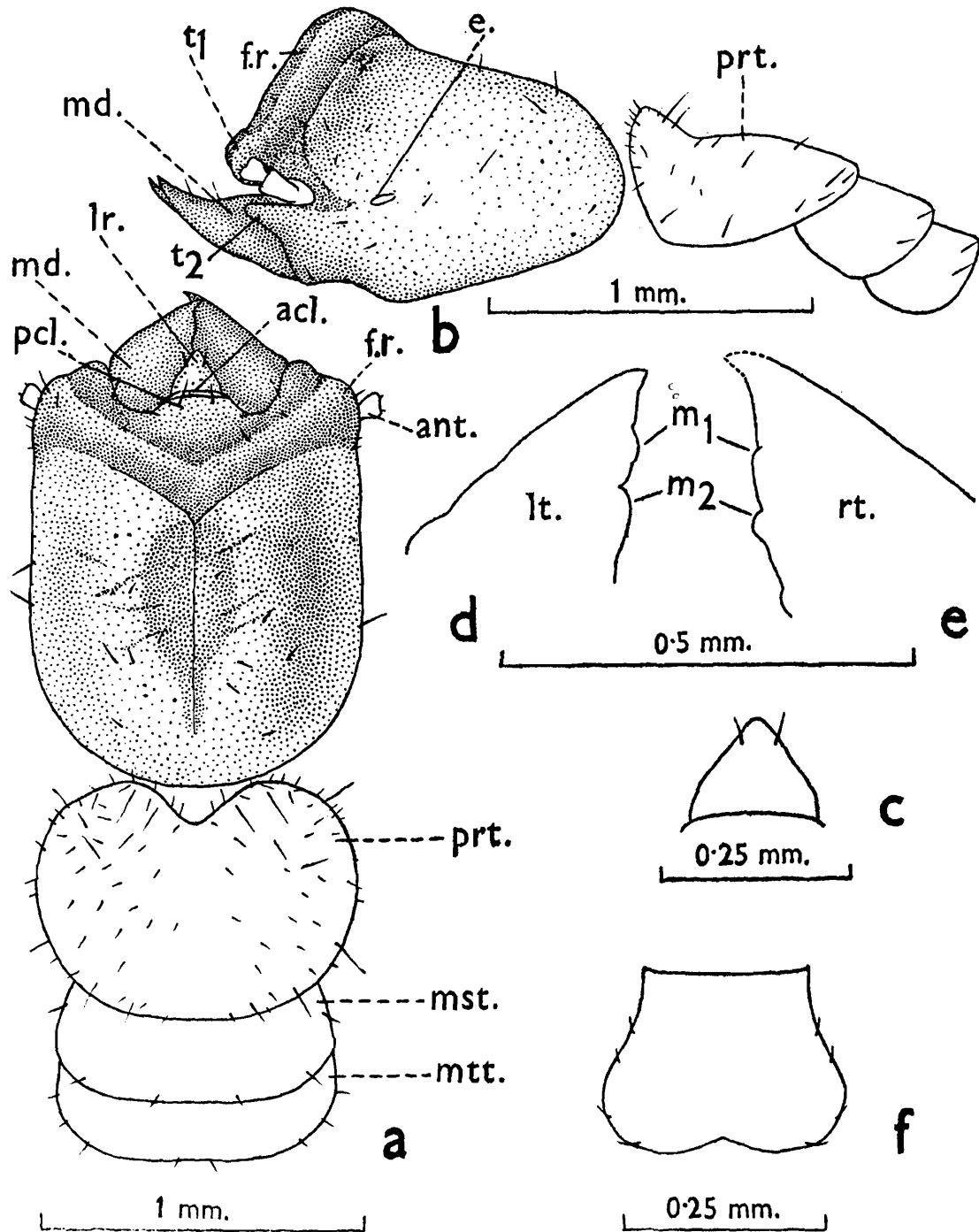
Head : Head-capsule subrectangular and thick ; longer than broad (length with mandibles 1.40-1.43, length to base of mandibles 1.10—1.17 ; maximum width 1.0—1.03 mm.; index Maximum width/Length to lateral base of mandibles 0.88—0.91) ; with a weakly raised frontal ridge ; in front inclining sharply at an angle of more than a right angle with mandibles ; frons concave ; vertex somewhat depressed in middle behind the frontal ridge ; sides subparallel ; Y-suture present ; posterior margin round. *Fontanelle and ocelli* : Absent. *Eyes* : Two suboval, lateral eye-spots present, one on either side just behind antennal sockets ; slightly paler than surrounding area. *Antennae* : Broken in the specimens examined, only basal two segments present. Segment 1 long, cylindrical ; 2 about one-half of 1 and cylindrical. *Clypeus* : Anteclypeus pale yellow, narrow and apilose. Postclypeus of same colour as frons and hardly demarcated from it ; pilose. *Labrum* : Subtriangular, broad basally ; broader than long ; with a pair of small bristles at tip. *Mandibles* : Short,

*These specimens are mentioned in the literatures as follows :—

1953. *Cryptotermes* near *perforans*, M. L. Roonwal and G.D. Pant, *Indian For. Leaflet. (Ent.)*, Delhi, No. 121 (3), p. 42. Baliapatam, N. Malabar (Kerala, India).

1962. *Cryptotermes perforans*, Mathur, R. N., and Thapa, R. S., *Indian For. Leaflet. (Ent.)*, No. 167, p. 8. Specimens from Behapatam only are *C. roonwali* sp. n.

thick and triangular; pointed apically; basal hump on outer margin weak. Each mandible with 2 small rudimentary marginal teeth. *Postmentum*: Short and swollen; posteriorly broadly rounded laterally; posterior margin round with a sharp notch in middle; anterior margin weakly incurved.



TEXT-FIG. 25.-*Cryptotermes roonwali* sp. n. Soldier. Paratype from Beliapatam (N. Malabar, Kerala State India).

(a) Head and thorax, in dorsal view. (b) Ditto, in side view. (c) Labrum, in dorsal view. (d) Left mandible, in dorsal view. (e) Ditto, right mandible. (f) Postmentum, in ventral view.

acl., anteclypeus; *ant.*, antenna; *e.*, eye; *f.r.*, frontal ridge; *lr.*, labrum; *lt.*, left; *m₁*, *m₂*, 1st and 2nd marginal teeth of mandibles; *md.*, mandible; *mst.*, mesonotum; *mtt.*, metanotum; *pcl.*, postclypeus; *prt.*, pronotum; *rt.*, right; *t₁*, *t₂*, dorsal and ventral tubercles respectively.

Thorax: *Pronotum*: Flat, slightly raised at anterior margin; broader than long (maximum length 0.66-0.70; maximum width 1.00-1.02 mm.); almost as wide as head-capsule; anterior margin convex with a broad, deep, median notch; sides rounded; posterior margin rounded without a notch at middle. *Mesonotum*: Narrower than pronotum; with a sub-

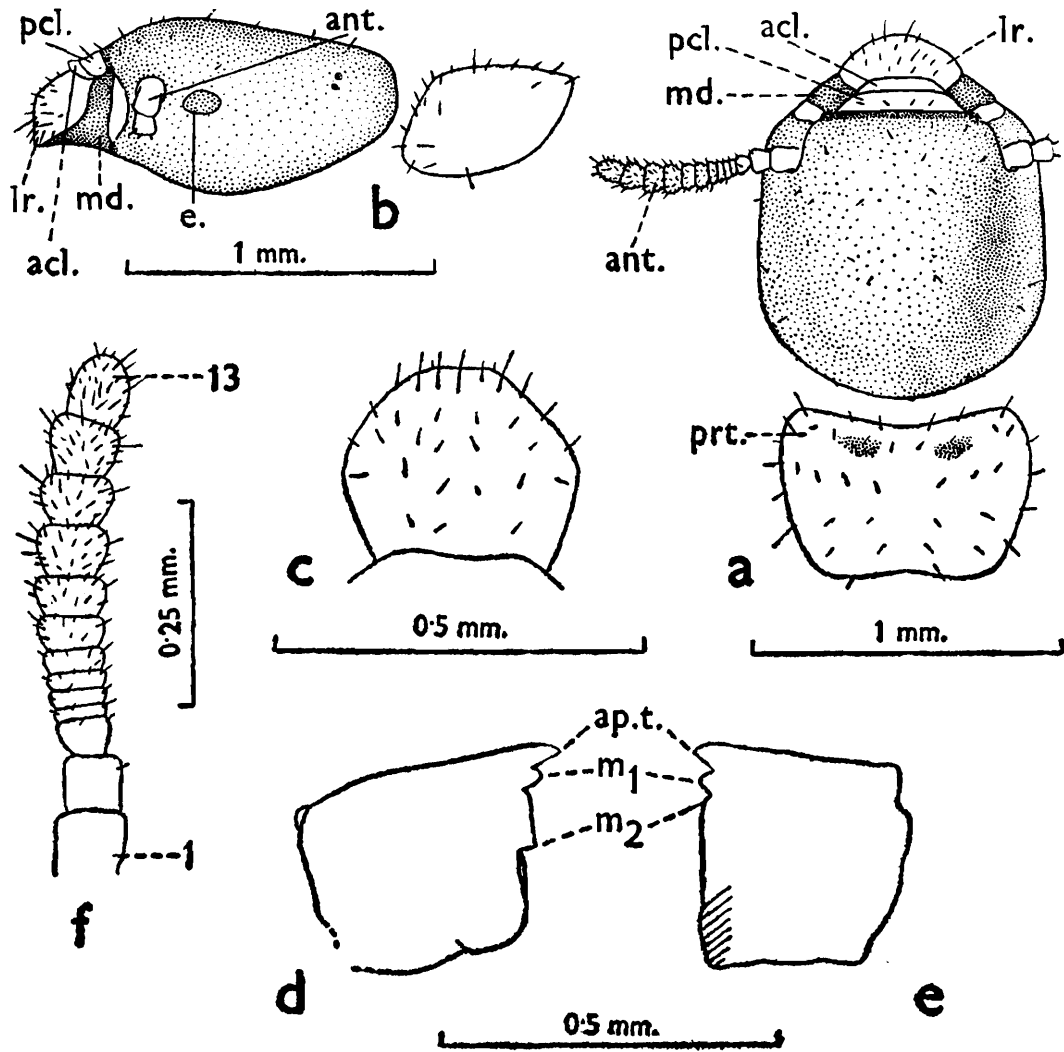
convex posterior margin. *Metanotum* : As broad as, or a little broader than mesonotum ; posterior margin subconvex. *Legs* : Short and thick, pilose ; apical tibial spur formula 3 : 3 : 3. Tarsi 4-jointed.

Abdomen : Oblong, sparsely hairy. Cerci short, 2-jointed, 0.08 mm. long. Styli either present or absent, when present single-jointed, 0.05 mm. long.

3. PSEUDOWORKER (Text-fig. 26 ; Table 10).—

General : Head-capsule yellowish brown ; antennae, labrum, legs and body pale yellow ; mandibles yellow with brownish outer and toothed margins. Head and body sparsely pilose. Total body-length c. 3.9-5.2 mm.

Head : Head-capsule subsquarish ; almost as broad as head to base of mandibles ; sides substraight, weakly narrowed in front ; posterior margin round. *Fontanelle and ocelli* ; Absent. *Eyes* : Two lateral, broadly oval eye spots ; flush with head surface and hardly



TEXT-FIG. 26.—*Cryptotermes roonwali* sp. n. Pseudoworker. Paramorphotype from Beliapatam (N. Malabar, Kerala State, India).

(a) Head and pronotum, in dorsal view. (b) Ditto, side view. (c) Labrum, in dorsal view. (d) Left mandible, in dorsal view. (e) Ditto, right mandible. (f) Left antenna, in dorsal view.

acl., anteclypeus ; *ant.*, antenna ; *ap. t.*, apical tooth of mandibles ; *e.*, eye ; *lr.*, labrum ; *m₁*, *m₂*, 1st and 2nd marginal teeth of mandibles ; *md.*, mandible ; *prt.*, pronotum.

discernible. *Antennae* : With 12-13 segments ; segments 1 and 2 cylindrical ; 2 narrower and a little shorter than 1 ; 3 shorter than 2 ; 4-7 ring-like and short ; 8 to penultimate gradually increasing in length and becoming broadly pyriform ; last ovate, narrower and

slightly longer or shorter than the penultimate one. *Clypeus*: Subtrapezoidal. Anteclypeus a thin, narrow, apilose strip. Postclypeus pilose; subconvex anteriorly. *Labrum*: Broadly tongue-shaped; broader than long; fairly pilose near anterior margin and on body. *Mandibles*: Subsquarish. Left mandible with an apical and two marginal teeth; apical finger-like, longest; 1st marginal much smaller than apical; 2nd marginal small, directed backwards, with a long anterior margin. Right mandible also with an apical and two marginal teeth; apical finger-like, but thicker than the corresponding one in left mandible; 1st marginal small; 2nd shorter than 1, with posterior margin about one and half times the length of molar plate.

Thorax: Pronotum: Flat, subrectangular; narrower than head-capsule (pronotum width 0.80-0.87; head-width 0.87-0.90 mm.); anterior margin weakly concave; sides rounded and weakly narrowing behind; posterior margin weakly incurved medially. *Legs*: Short, thick and pilose; apical tibial spur formula 3: 3: 3.

Abdomen: Oblong, hairy. Cerci 2-jointed, 0.07 mm. long. Styli (when present) finger-like, 1-jointed, 0.07 mm. long.

(c) TYPE-SPECIMENS

Holotype and morphotype: A holotype soldier and a morphotype pseudoworker *vide* "Material (ii)" above, Beliapatam (North Malabar, Kerala State), coll. A. H. Khan, 23. viii. 1941, deposited in F. R. I., Dehra Dun.

Paratypes and paramorphotypes: Deposited as follows:—(i) One soldier (paratype) and 2 pseudoworkers (paramorphotypes), in Z. S.I., Calcutta, *vide* "Material (i)" above, Z. S.I. Reg. No. 4667/H8. (ii) 4 soldiers and 10 pseudoworkers in F. R. I., Dehra Dun, *vide* "Material (ii)" above. (iii) 1 soldier and 2 pseudoworkers *vide* "Material (ii)" above, with Prof. A. E. Emerson, U.S.A.

(d) TYPE-LOCALITY AND DISTRIBUTION

Type-locality: Beliapatam (N. Malabar, Kerala State, India), 11°55' N., 75°24' E. Known only from the type-locality.

(e) COMPARISON

Cryptotermes roonwali sp. n. is close to *C. perforans* Kemner, but is separable as follows:—

Soldier: (i) Somewhat larger (length of head to tip of mandibles 1.40—1.43 *vs.* 1.23—1.34 mm.; to lateral base of mandibles 1.10—1.17 *vs.* 0.97—1.03 mm.; maximum width 1.00—1.03 *vs.* 0.88—1.00 mm.). (ii) Head-capsule thinner (index Height/Length 0.71—0.73 *vs.* 0.78—0.80; index Height/Width 0.78—0.80 *vs.* 0.82—0.88). (iii) Frontal ridge thin and flat (*vs.* thick and somewhat raised). (iv) Mandibles, compared to head-length, shorter (index Left mandible length/Head-length to lateral base of mandibles 0.29—0.34 *vs.* 0.34—0.36).

9. *Cryptotermes sumatrensis* Kemner

(Text-figs. 27 & 28; Tables 7, 8 & 10)

Cryptotermes sumatrensis Kemner

1930. N. A. Kemner, *Tijdschr. Ent.*, Amsterdam, 73 (3—4), pp. 301—305, figs. 1—8. *Im., S. & Pw.* Type-locality: Fort de Kock, Sumatra. Lectotypes examined.
1933. F. P. Jepson, *Ceylon J. Sci.*, Colombo, 3 (1), p. 29. Sumatra.
1934. N. A. Kemner, *K. Sv. Vet. Akad. Handl.*, Stockholm, (3) 13 (4), p. 46. Text-fig. 5, fig. 4. Only figure.
1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, 112, p. 41. Sumatra.
1958. M. Ahmad, *Biologia*, Lahore, 4 (1—2), pp. 54, 55. Keys.
1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, 122 (Art. 4), p. 382.

(a) MATERIAL EXAMINED

Present in Zoologiska Institutet, Lund University, Lund.

One vial with 1 alate ♀, 3 dealates (2 ♀♀ and 1 ♂), 2 soldiers (1 immature), several pseudo-workers, and a few loose wings, Fort de Kock, Sumatra, 920 m. alt., coll. *E. Jacobson*, 1924, "from galleries made in dead branches" Paralectotypes (selected A. E. Emerson).

(b) DESCRIPTION

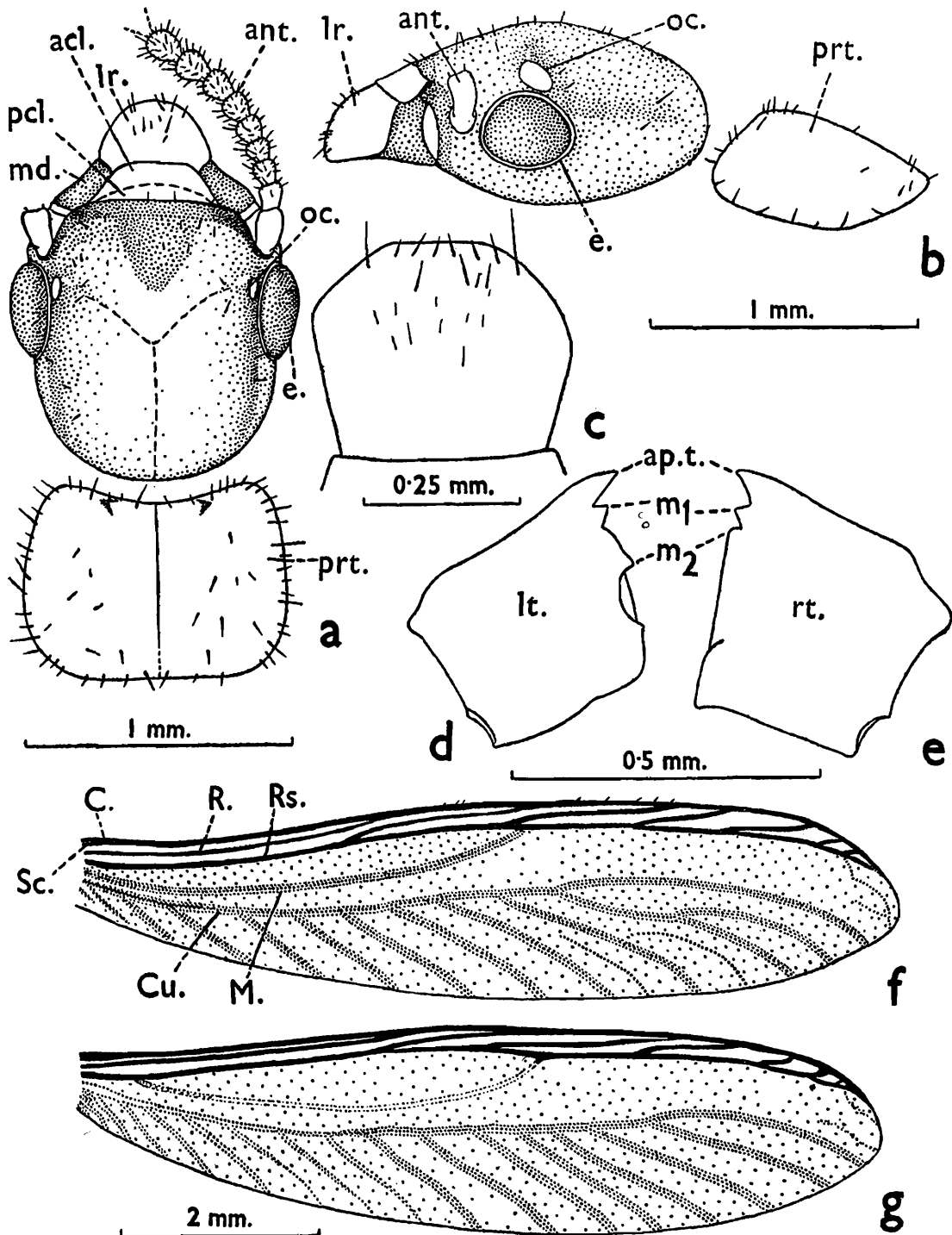
1. IMAGO (Text-fig. 27; Table 7).—

General : Head-capsule brownish yellow to brown, somewhat paler anteriorly ; antennae and labrum brownish yellow ; mandibles dark brown, brownish basally ; thorax, legs and body brown, paler than head-capsule ; wing-membranes transparent ; wing-scales transparent brown. Head and body moderately pilose. Total body-length with wings c. 9.8—11.00 mm.; without wings c. 5.0—6.4 mm.

Head : Head-capsule subsquaish ; sides without eyes subparallel ; frons somewhat depressed medially ; width with eyes more than the length to base of mandibles (length to lateral base of mandibles 0.97—1.00 ; width with eyes 1.07—1.10 mm.) ; epicranial sutures faint ; posterior margin round. *Fontanelle* : Absent. *Eyes* : Two lateral, black, faceted eyes, one on either side ; broadly oval, narrower posteriorly ; maximum diameter 0.35—0.37, minimum diameter 0.30 mm. *Ocelli* : Two, lateral, oval, translucent ocelli, one on either side ; touching the eyes ; maximum diameter 0.10—0.11, minimum diameter 0.07—0.08 mm. *Antennae* : Broken in the specimens available for study ; maximum 13 segments present in one of the specimens as follows :—Segment 1 longest, cylindrical ; 2 longer than half of 1, cylindrical ; 3 subequal to or slightly shorter than 2, pyriform ; 4 either subequal to or shorter than 3 ; 4 to 13 gradually increasing in length and pyriform. According to Kemner (1930) : antennae 15-segmented ; segments 2 and 3 slightly longer but narrower than 4. *Clypeus* : Subtrapezoidal, not clearly differentiated into an ante- and a postclypeus. *Labrum* : Broadly tongue-shaped ; broader than long ; maximum width a little below the middle. *Mandibles* : Not examined in the specimens.

Thorax : *Pronotum* : Subrectangular ; broader than long (maximum length 0.63—0.70 ; maximum width 0.97—1.02 mm.) ; slightly narrower than head with eyes ; sides weakly convex and somewhat widening behind ; anterior margin concave ; posterior margin substraight ; postero-lateral corners broader than antero-lateral corners. *Legs* : Short and hairy ; apical tibial spur formula 3 : 3 : 3. Tarsi 4-jointed ; arolium present.

Wings : Transparent. Costa, radius and radial sector strongly chitinous and thick ; median and cubitus thin. Forewing scales longer than the hindwing scales and partly covering them. *Forewing* : Forewings longer than hindwings ; scales large, shield-like. Costa thick and running along anterior margin, with a few short hairs. Subcosta short, arising separately from costa, running close to the latter and fusing with it a little outside the scale. Radius arising separately from scale, running close to costa for some distance and then fusing with it a little before the middle of wing-membrane. Radial sector also arising separately from the scale and running parallel with and nearer to the costa upto the distal margin ; on way giving 6—7 branches to the costa ; 1st branch arising a little before the junction of radius and costa. Median thin and arising separately from scale ; running close to cubitus for some distance and then curving up to meet the radial sector a little outside the middle of wing-membrane and that of the origin of the 2nd branch of radial sector. Cubitus also arising separately from the scale, running in middle of wing-membrane and giving 12—14 branches to hind margin. *Hindwing* : Costa and radius as in forewing. Subcosta absent. Radial sector also as in forewing but with 3—5 branches to costal border. Median arising from radial sector in wing-membrane a little outside the scale, otherwise as in forewing. Cubitus as in forewing and with 14 branches to hind margin.



TEXT-FIG. 27.—*Cryptotermes sumatrensis* Kemner. Imago and pseudoworker, Paralectotypes from Fort de Kock, Sumatra. Figs. (a)-(c) and (f)-(g) imago ; (d)-(e) pseudoworker.

(a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Labrum, in dorsal view. (d) Left mandible, in dorsal view. (e) Ditto, right mandible. (f) Right forewing, in dorsal view. (g) Ditto, hindwing.

acl., anteclypeus ; *ant.*, antenna ; *ap. t.*, apical tooth of mandibles ; *C.*, costa ; *Cu.*, cubitus ; *e.*, eye ; *lr.*, labrum ; *lt.*, left ; *M.*, median ; *m₁*, *m₂*, 1st and 2nd marginal teeth of mandibles ; *md.*, mandible ; *oc.*, ocellus ; *pcl.*, postclypeus ; *prt.*, pronotum ; *R.*, radius ; *Rs.*, radial sector ; *rt.*, right ; *Sc.*, subcosta.

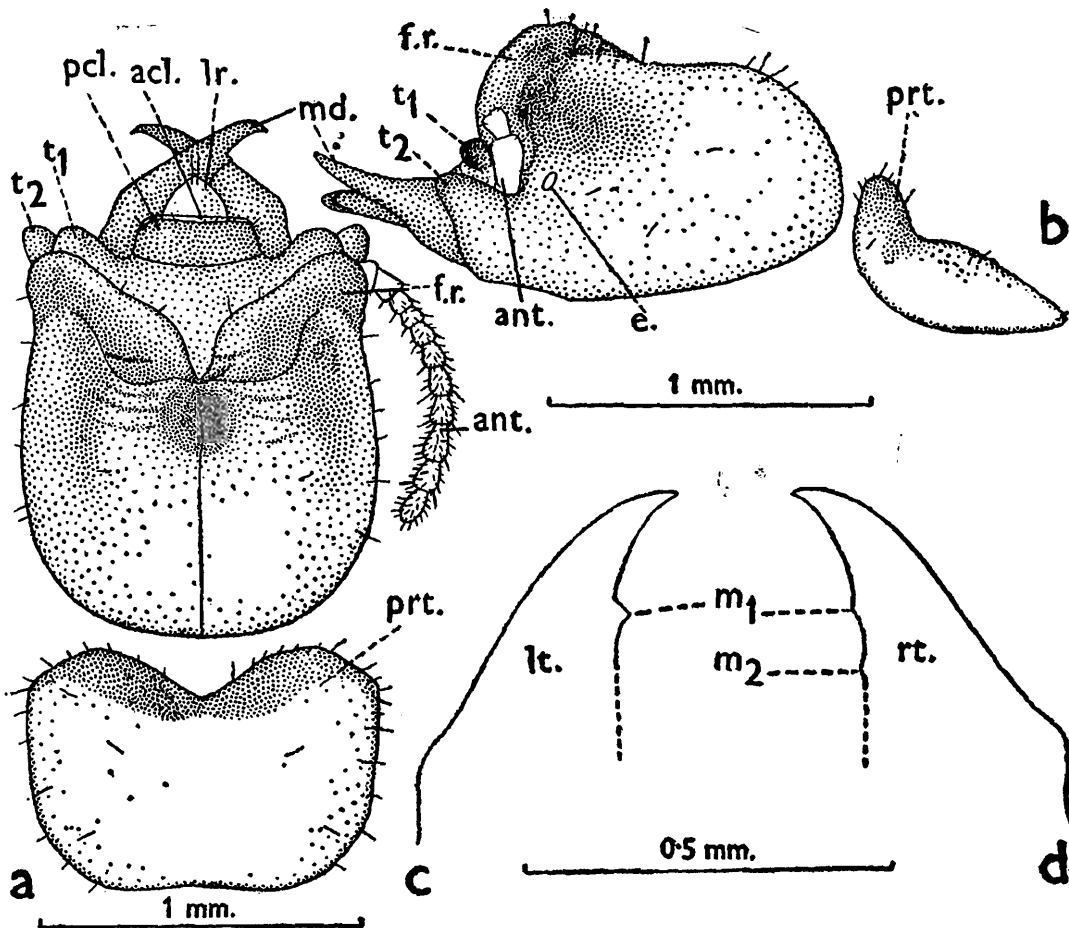
Abdomen : Oblong, hairy. Cerci 2-segmented, 0.1 mm. long. Styli present in males, single-jointed, 0.07 mm. long.

2. SOLDIER (Text-fig. 28 ; Table 8.)—

General : Head-capsule reddish brown, somewhat paler posteriorly ; frons and frontal ridge dark brown ; mandibles dark reddish brown ; antennæ, labrum, legs and body pale

yellow; pronotum pale yellow, pale brown at anterior margin. According to Kemner 1930, anterior half of head black, brownish yellow posteriorly; mandibles blackish; antennae and palpi pale yellowish brown. Head sparsely and body moderately pilose. Total body-length *c.* 3.5–4.8 mm.

Head: Head-capsule thick and stout; subrectangular; longer than broad (length to base of mandibles 1.20; maximum width 1.10 mm.); frons sharply descending in front at an angle of little more than right angle with mandibles; frons incurved; frontal ridge very thick and prominent; medially very thick and deeply cut at an acute angle; somewhat overhanging the frons; vertex with a deep median and 2 shallow lateral depressions, one on either side, just behind the frontal ridge; with 2 thick tubercles on either side, one a little above the antennal sockets arising from the frons and the other a prolongation of ventral genae below the antennal sockets; sides substraight; posterior margin rounded.



TEXT-FIG. 28.—*Cryptotermes sumatrensis* Kemner. Soldier. Paralectotype from Fort de Kock, Sumatra. (a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Left mandible, in dorsal view. (d) Ditto, right mandible.

acl., anteclypeus; *ant.*, antenna; *e.*, eye; *f.r.*, frontal ridge; *lr.*, labrum; *lt.*, left; *m₁*, *m₂*, 1st and 2nd marginal teeth of mandibles; *md.*, mandible; *pcl.*, postclypeus; *prt.*, pronotum; *rt.*, right; *t₁*, *t₂*, dorsal and ventral tubercles, respectively.

Fontanelle: Absent. *Eyes*: Two lateral, somewhat pale, oval eye-spots present, one on either side; 0.07 mm. long. *Ocelli*: Absent. *Antennae*: With 11–12 segments; segments 1 and 2 sparsely and the remainder fairly densely pilose; segment 1 longest, cylindrical; 2 longer than half of 1 and cylindrical; 3 a little shorter and narrower than 2; 4 shortest; 5 to the penultimate one gradually becoming pyriform and increasing in length; last ovate, shorter and narrower than the penultimate one. *Clypeus*: Anteclypeus thin, pale, strip-like. Postclypeus subrectangular and weakly separated from frons by a thin line. *Labrum*: Triangularly tongue-shaped; broader than long; with a pair of small bristles at anterior end. *Mandibles*: Thick and short; less than half of the length of head-

capsule ; with a hump on the outer margin near base. Left mandible with a marginal tooth at about the distal one-third. Proximal half not examined ; according to Kemner (1930, p. 304) with 2 shallow indentations. Right mandible with 2 small, marginal teeth in middle. *Postmentum* : Short ; broadly rectangular ; broader than long ; anterior margin weakly concave ; posterior margin and sides weakly convex.

Thorax : *Pronotum* : Subrectangular and weakly raised at the anterior end ; broader than long and somewhat narrower than head-capsule ; (maximum length 0.63—0.70 ; maximum width 0.99—1.03 mm.) ; anterior margin with a deep, obtuse emargination ; sides substraight weakly narrowed behind and broadly rounded at posterior corners ; posterior margin round, slightly incurved in middle. *Mesonotum* : Narrower than pronotum ; posterior margin convex and substraight medially. *Metanotum* : Narrower than pronotum and as wide as mesonotum ; posterior margin weakly incurved medially. *Legs* : Short and hairy ; apical tibial spur formula 3 : 3 : 3. Tarsi 4-segmented.

Abdomen : Oblong, hairy. Cerci 2-jointed, 0.10 mm. long. Styli single-jointed, 0.07 mm. long.

3. PSEUDOWORKER (Table 10).—

General : Head-capsule yellow ; antennae, labrum, thorax, legs and body pale yellow ; mandibles pale yellow with dark brown toothed margins. Head and body moderately pilose. Total body-length c. 3.8—5.2 mm.

Head : Head-capsule subcircular ; broader than its length to base of mandibles ; epicranial sutures present. *Fontanelle and ocelli* : Absent. *Eyes* : Not distinct. *Antennae* : With 10—11 segments ; segment 1 longest, cylindrical ; 2 shorter than 1 and cylindrical ; 3—6 generally ring-like and broad ; 7—9 or 10 broadly pyriform ; last (10th or 11th) ovate, narrower than the penultimate one. *Glypeus* : Subtrapezoidal, not clearly differentiated into an ante- and a postclypeus. *Labrum* : Broader than long, dome-shaped. *Mandibles* : Of typically *Cryptotermes*-type. Left mandible with an apical and 2 marginal teeth ; apical long, finger-like ; 1st marginal shorter than apical, posterior margin slightly longer than anterior margin ; 2nd marginal short, with a long anterior margin. Right mandible also with an apical and 2 marginal teeth ; apical as in left mandible but somewhat thicker ; 1st marginal shorter than apical ; 2nd shorter than 1st, with a long posterior margin of about one and a half times the length of molar plate.

Thorax : *Pronotum* : Subrectangular ; broader than long and narrower than head-capsule ; with a pair of light brown spots near anterior margin ; anterior margin broadly concave ; sides weakly convex and narrowing behind ; posterior margin convex, incurved medially. *Mesonotum* as wide as, and *metanotum* broader than, pronotum. *Legs* : Short and hairy ; apical tibial spur formula 3 : 3 : 3. Tarsi 4-jointed.

Abdomen : Oblong, hairy. Cerci 2-jointed, 0.10 mm. long. Styli single-jointed, 0.08-0.10 mm. long.

(c) TYPE-SPECIMENS

No holotype was designated by Kemner (1930). According to him the types are deposited in Entomological Department of the Swedish Reichsmuseum, Stockholm, and the cotypes in Jacobson's Collection in Zoologisches Museum, Amsterdam, and in his (Kemner's) collection *i.e.*, in the collection of the Zoologiska Institutet, Lund University, Lund. I have examined the cotypes kindly loaned by the Lund University ; these are now labelled as *paralectotypes** (selected A. E. Emerson).

(d) TYPE-LOCALITY AND DISTRIBUTION

Fort de Kock, Sumatra. (Approximately 50 miles North of Padang). Known only from the type-locality.

*Professor Emerson selected these paralectotypes ; this is the first record of the same since these designations have not been published by him so far.

(e) COMPARISON

The imago of *Cryptotermes sumatrensis* can be separated from all the other oriental species in having larger eyes (maximum diameter 0.35—0.37 vs. 0.27—0.34 mm. in others).

The soldier can be separated from all the other oriental species in having the thick and wide frontal ridge with a deep median cleft (vs. no such cleft in others).

10. *Cryptotermes thailandis* Ahmad

(Text-figs. 29 & 30)

Cryptotermes thailandis Ahmad

1965. M. Ahmad, *Bull. Amer. Mus. nat. Hist.*, New York, 131 (Art. 1), pp. 14, 15—16, figs. 8 and 9. *Im. & S. Type-locality* : Klang Dong, Thailand.

(a) MATERIAL

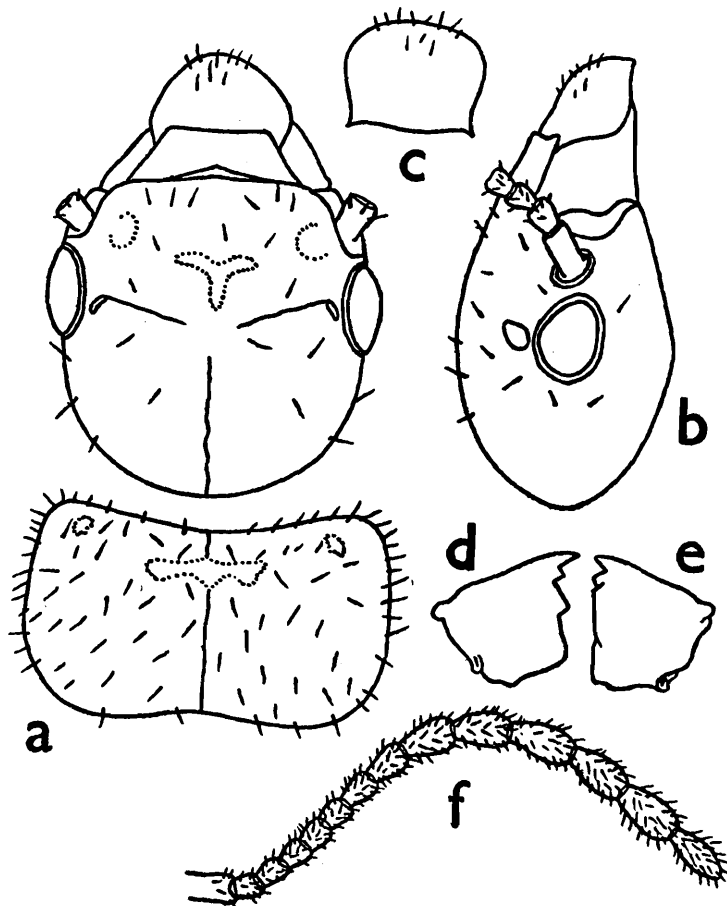
The material of this, recently described, species was not available to me for study.

(b) DESCRIPTION

As the material of this species was not available to me, I give below the original description of Ahmad (1965).

1. IMAGO (Text-fig. 29).—

“Head reddish brown ; anteclypeus yellowish ; labrum light brownish yellow ; mandibles brownish yellow, teeth reddish brown ; antennae brownish yellow ; pronotum slightly

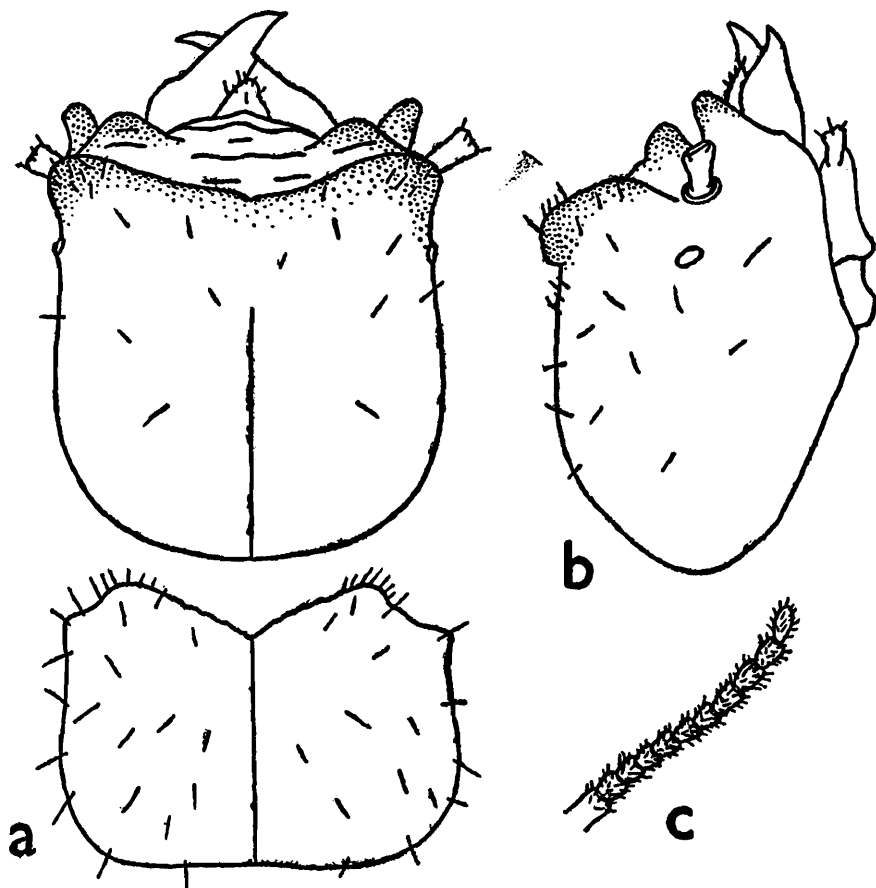


TEXT-FIG. 29.—*Cryptotermes thailandis* Ahmad. Imago. Figures reproduced from Ahmad, 1965, fig. 8. (a) Head and pronotum, in dorsal view. (b) Head, in side view. (c) Labrum, in dorsal view. (d) Left mandible, in dorsal view. (e) Ditto. Right mandible. (f) Antenna.

darker than head, with a T-shaped marking. Wings light smoky brown. Head sparsely hairy; pronotum with scattered, short and long bristles on anterolateral and lateral margins and on disc. Head posterior to eyes semicircular; Y suture with median arm distinct, rest indistinct. Eyes moderately bulging, shaped as shown in figure 8 [Text-fig. 29]. Ocellus small, oval, almost touching the eye. Anteclypeus trapezoid. Labrum broad, dome shaped; sides converging posteriorly. Left mandible with posterior cutting edge of first marginal tooth distinctly shorter than anterior cutting edge of second marginal tooth; right mandible with posterior cutting edge of second marginal tooth longer than molar plate. Antennae with 14–15 articles; in specimen with 14 articles, the second as long as third, fourth a little shorter than second. Pronotum slightly broader than head, more than one and a half times as long as broad; anterior margin shallowly concave; lateral margins weakly convex; posterior margin depressed in middle; anterolateral corners broadly rounded”

2. SOLDIER (Text-fig. 30).—

“Head reddish brown in posterior region, becoming darker anteriorly; forehead almost black; labrum yellow; pronotum light yellowish brown, with darker patches on disc; legs pale; abdominal tergites pale brown. Head scantily hairy, anterolateral corners with a few short bristles; pronotum with short bristles along anterior margin, long, scattered bristles on disc. Head strongly phragmotic, short, thick, about as long as wide; Y suture present, but not distinct; frontal phalanx (ridge) prominent, concave, without any notch in middle; profile of front nearly vertical, not overhanging; two lobelike projections



TEXT-FIG. 30.—*Cryptotermes thailandis* Ahmad. Soldier. Drawings reproduced from Ahmad, 1965, fig. 9. (a) Head and pronotum, in dorsal view. (b) Head, in side view. (c) Antenna.

at base of antenna, one above and one below. Eyes whitish, oval; 0.10 mm. long and 0.03 mm. wide. Mandibles short, with distinct basal humps; teeth rudimentary. Labrum short, broadly rounded apically. Antennae short, with 11 articles; basal three articles more strongly sclerotized than the rest, second almost as long as third, fourth shortest. Pronotum as broad as head, slightly longer than half of its width; anterior margin broadly

V-shaped, finely serrated ; anterolateral lobes notched ; lateral margins moderately convex, depressed behind anterolateral corners ; posterior margin almost straight.

“MEASUREMENTS (IN MM.) : Measurements of two imagoes, morphotype and paramorphotype, respectively : Length of head to tip of labrum, 1.19, 1.26 ; length of head to side base of mandibles, 0.96, 0.98 ; width of head, 0.93, 0.96 ; long diameter of eye, 0.27, 0.30 ; short diameter of eye, 0.21, 0.23 ; eye from lower margin of head, 0.18, 0.19 ; length of ocellus, 0.09, 0.10 ; width of ocellus, 0.08, 0.08 ; length of pronotum, 0.57, 0.61 ; width of pronotum, 1.02, 1.02.

“Holotype soldier : Length of head to side base of mandibles, 1.30 ; width of head, 1.26 ; length of left mandible, 0.64 ; length of pronotum, 0.68 ; width of pronotum, 1.26.”

(c) TYPE-SPECIMENS

Holotype : Soldier, in author's collection, in the Department of Zoology, University of the Panjab, Lahore, Pakistan.

Morphotype and paramorphotype : Two imagos, also in the author's collections as above.

(d) TYPE-LOCALITY AND DISTRIBUTION

Type-locality : Klang Dong, Thailand, 14°38' N., 101°16'E. Known only from the type-locality.

(e) COMPARISON

This species is very close to *C. havilandi* (Sjöstedt) and the distinguishing characters are not very prominent. In imago the eyes are little smaller and the ocelli slightly wider, 0.27—0.30 vs. 0.30—0.34 and 0.08 vs. 0.05—0.07, respectively. The soldier, as far as the measurements, comes within the range of the measurements of *C. havilandi*. It has, however, a somewhat more rectangular pronotum with straighter side margins. Ahmad (1965) has differentiated *thailandis* from *bengalensis* (syn. of *havilandi*) on the basis of unincised frontal ridge also, but this character is variable and cannot be used for separating the two species.

III—SUMMARY

1. The species of the genus *Cryptotermes*, rather all the Kalotermitid species, are essentially wood-inhabiting forms, and are, therefore, of great economic importance.

2. The *Cryptotermes* are easily transportable through artificial agencies, thus many species generally occur in more than one zoogeographical regions. Due to this reason, same species are described under various names, thus creating a lot of confusion in literature and consequently a number of synonym names.

3. The present work deals with the taxonomic revision of the oriental species of this genus.

4. The generic characters of the genus and keys based on imagos and soldiers, for separation of the oriental species, are given.

5. Zoogeography, the phylogenetic position of the genus and the distribution and dispersion of the species are discussed in detail.

6. Detailed descriptions of the ten oriental species (including a new one from India) of the genus are given. All the species are adequately illustrated, the figures are drawn from actual specimens and from the type specimens in whichever case available.

7. The following species are dealt with :—*Cryptotermes brevis* (Walker), *C. cynocephalus* Light, *C. declivis* Tsai and Chen, *C. domesticus* (Haviland), *C. dudleyi* Banks, *C. havilandi*

(Sjöstedt), *C. perforans* Kemner, *C. roonwali* n. sp., *C. sumatrensis* Kemner and *C. thailandis* Ahmad.

8. Types of the following species were available and examined for this study:—*Cryptotermes domesticus* (Haviland), *C. dudleyi* Banks, *C. havilandi* (Sjöstedt), *C. perforans* Kemner and *C. sumatrensis* Kemner. Lectotypes of *C. domesticus* (Haviland) are designated.

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 TABLE 1.—Geographical distribution of genus *Cryptotermes* in various zoogeographical regions.

Zoogeographical Region	No. of species known from the region	No. of species endemic to the region	Percentage of endemicity	No. of species common with other region
Australian	4	3	75	1
Ethiopian	5	2	40	3
Indo-Malayan	10	5	50	5
Malagasy	3	2	66.6	1
Nearctic	2	Nil	—	2
Neotropical	0	1	44.4	5
Papuan	7	3	42.8	4
Unknown	1	—	—	—

TABLE 2.—Measurements (in mm.) of *Cryptotermes brevis* (Walker); *C. cynocephalus* Light and *C. domesticus* (Haviland). Imago.

ex.(s) : example(s).

Body-parts	<i>C. brevis</i> Range (3 exs.)	<i>C. cynocephalus</i> Range (1 ex.)	<i>C. domesticus</i> Range (7—17 exs.)
1. Total body-length <i>with</i> wings (excluding antennae) c.	10.05 (1 ex.)	—	7.90—9.17 (7 exs.)
2. Total body-length <i>without</i> wings (excluding antennae) c.	5.0—5.67	3.82	4.50—6.87
3. Length of head to tip of labrum	1.30—1.33	1.07	1.23—1.37
4. Length of head to lateral base of mandibles	1.0—1.10	0.83	0.90—1.00
5. Maximum width of head (with eyes)	1.10—1.13	0.83	0.90—1.10
6. Maximum height of head	0.60—0.63	0.50	0.50—0.60
7. Maximum length of labrum	0.30—0.37 (2 exs.)	0.27	0.27—0.37
8. Maximum width of labrum	0.43—0.50 (2 exs.)	0.35	0.37—0.50
9. Maximum diameter of compound eye (with ocular sclerite)	0.30—0.33	0.29	0.27—0.37
10. Maximum diameter of lateral ocellus	0.11—0.13	0.08	0.09—0.13
11. Minimum diameter of lateral ocellus	0.09—0.10	0.06	0.07—0.10
12. Minimum ocellus—antennal distance	0.15	0.13	0.13—0.16
13. Minimum eye-antennal distance	0.02—0.03	0.015	0.015—0.03
14. Minimum distance of eye from lateral base of head	0.15	0.13	0.15—0.17
15. Maximum length of pronotum	0.63—0.67	0.57	0.57—0.77
16. Maximum width of pronotum	1.03—1.17	0.80	0.73—1.10
17. Length of forewing with scale	—	—	6.43—7.20 (8 exs.)
18. Length of forewing scale	0.87—1.00	0.70	0.80—1.00
19. Length of hindwing with scale	—	—	6.00—6.80 (8 exs.)
20. Length of hindwing scale	0.40—0.43	0.23	0.30—0.40

TABLE 3.—Measurements (in mm.) etc. of *Cryptotermes brevis* (Walker); *C. cynocephalus* Light and *C. domesticus* (Haviland). Soldier.

ex.(s) : example(s).

Body-parts	<i>C. brevis</i> Range (2 exs.)	<i>C. cynocephalus</i> Range (1 ex.)	<i>C. domesticus</i> Range (14 exs.)	Lectotype
1. Total body-length (excluding antennae) c. . . .	5.2—6.2	3.7	4.0—6.0	5.20
2. Length of head to tip of mandibles	1.90—2.50	1.20	1.63—1.80	1.70
3. Length of head to lateral base of mandibles . .	1.50—1.57	0.83	1.20—1.30	1.25
4. Maximum length of head upto frontal ridge	1.43—1.63	0.87	1.30—1.60	1.37
5. Median length of head upto frontal ridge	1.27—1.40	0.80	1.27—1.53	1.33
6. Maximum width of head	1.40—1.50	0.90	1.13—1.30	1.17
7. Maximum height of head	1.03—1.10	0.80	0.87—1.00	0.90
8. Head Index I (Width/Length to base of mandibles)	0.93—0.95	1.10	0.90—1.02	0.90
9. Head Index II (Height/Width)	0.73—0.74	0.89	0.74—0.83	0.77
10. Head Index III (Height/Length to the base of mandibles)	0.68—0.70	0.96	0.69—0.8	0.69
11. Head-Index IV (Maximum length upto frontal ridge/Length to base of mandibles)	0.95—1.04	1.05	1.10—1.25	1.10
12. Maximum length of labrum	0.07 (1 ex.)	0.13	0.12—0.20	0.1
13. Maximum width of labrum	0.17 (1 ex.)	0.17	0.17—0.30	0.23
14. Length of mandibles (from upper base of condyle to tip):				
(a) Left mandible	0.53—0.57	0.37	0.50—0.60	0.57
(b) Right mandible	0.53—0.57	0.37	0.50—0.60	0.57
15. Head-mandibular length Index (Left mandible-length/Head-length to base of mandibles)	0.35—0.36	0.44	0.41—0.47	0.44
16. Maximum length of pronotum	0.87—1.07	0.53	0.73—0.87	0.77
17. Maximum width of pronotum	1.27—1.53	0.87	1.07—1.27	1.07
18. Pronotum-head Index (Pronotum-width/Head-width)	0.97—1.02	0.96	0.91—1.00	0.91
19. Pronotum Index (Length/Width)	0.68—0.70	0.61	0.64—0.74	0.72
20. Maximum width of mesonotum	1.10—1.17	0.67	0.87—1.07	0.90
21. Maximum width of metanotum	1.17—1.23	0.70	0.93—1.13	0.97

TABLE 4.—Measurements (in mm.) of *Cryptotermes brevis* (Walker); *C. domesticus* (Haviland) and *C. dudleyi* Banks. Pseudoworker.*ex.(s)* : example(s).

Body-parts	<i>C. brevis</i> Range (4 exs.)	<i>C. domesticus</i> Range (5 exs.)	<i>C. dudleyi</i> Range (8 exs.)
1. Total body-length (excluding antennae) c.	3.7—6.5	4.4—5.1	3.7—5.9
2. Length of head to tip of labrum	1.20—1.53	1.20—1.40	1.30—1.43
3. Length of head to lateral base of mandibles	0.97—1.20	0.90—1.07	1.00—1.10
4. Maximum width of head	1.03—1.27	1.00—1.07	1.07—1.17
5. Maximum height of head	0.60—0.67	0.60—0.73	0.60—0.70
6. Maximum diameter of eye	0.13—0.17	0.10—0.17	0.13—0.17
7. Maximum length of labrum	0.30—0.40	0.30—0.37	0.30—0.37
8. Maximum width of labrum	0.37—0.60	0.38—0.46	0.40—0.43
9. Maximum length of pronotum	0.40—0.77	0.38—0.57	0.50—0.60
10. Maximum width of pronotum	0.77—1.17	0.70—0.90	0.80—1.00

TABLE 5.—Measurements (in mm.) of *Cryptotermes dudleyi* Banks and *C. havilandi* (Sjöstedt). Imago.
ex.(s) : example(s).

Body-parts	<i>C. dudleyi</i> Range (12 exs.)	<i>C. havilandi</i> Range (14 exs.)	Lectotype
1. Total body-length <i>with</i> wings (excluding antennae)c.	8.50—9.33 (2 exs.)	8.00—8.83 (5 exs.)	8.00 (to tip of right forewing)
2. Total body-length <i>without</i> wings (excluding antennae) c.	4.55—6.00	4.70—6.33	5.20
3. Length of head to tip of labrum	1.30—1.37	1.20—1.40	1.20
4. Length of head to lateral base of mandibles	1.00—1.03	0.87—1.03	0.90
5. Maximum width of head (with eyes)	0.97—1.07	0.90—1.07	0.93
6. Maximum height of head	0.55—0.63	0.53—0.63	0.53
7. Maximum length of labrum	0.23—0.33	0.23—0.40	0.27
8. Maximum width of labrum	0.37—0.50	0.33—0.40	0.37
9. Maximum diameter of compound eye (with ocular sclerite)	0.30—0.33	0.30—0.34	0.30
10. Maximum diameter of lateral ocellus	0.10—0.13	0.09—0.13	0.09
11. Minimum diameter of lateral ocellus	0.07—0.10	0.05—0.07	0.05
12. Minimum ocellus-antennal distance	0.17—0.19	0.13—0.17	0.15
13. Minimum eye-antennal distance	0.02—0.03	0.015—0.018	0.015
14. Minimum distance of eye from lateral base of head	0.13—0.17	0.15—0.20	0.17
15. Maximum length of pronotum	0.62—0.77	0.60—0.77	0.60
16. Maximum width of pronotum	0.80—1.03	0.80—1.10	0.90
17. Length of forewing with scale	7.00—7.50 (5 exs.)	6.48—8.40 (4 exs.)	6.48
18. Length of forewing scale	0.83—0.90	0.70—1.00	0.87
19. Length of hindwing with scale	6.25—6.75 (5 exs.)	6.30—7.67 (3 exs.)	Broken
20. Length of hindwing scale	0.33—0.40	0.30—0.37	0.30

TABLE 6.—Measurements (in mm.) etc., of *Cryptotermes dudleyi* Banks and *C. havilandi* (Sjöstedt). Soldier.
ex.(s) : example(s).

Body-parts	<i>C. dudleyi</i> Range (10 exs.)	<i>C. havilandi</i> Range (25 exs.)
1. Total body-length (excluding antennae) c.. .. .	4.3—5.8	3.8—6.2
2. Length of head to tip of mandibles	2.03—2.43	1.50—1.80
3. Length of head to lateral base of mandibles	1.60—1.80	1.13—1.47
4. Maximum length of head upto frontal ridge	1.50—1.60	1.10—1.33
5. Median length of head upto frontal ridge	1.27—1.40	0.90—1.20
6. Maximum width of head	1.27—1.40	1.08—1.35
7. Maximum height of head	1.00—1.10	0.80—1.03
8. Head Index I (Width/Length to base of mandibles)	0.76—0.82	0.92—1.04
9. Head Index II (Height/Width)	0.75—0.80	0.73—0.83
10. Head Index III (Height/Length to base of mandibles)	0.60—0.64	0.71—0.81
11. Head-Index IV (Maximum length upto frontal ridge/Length to base of mandibles)	0.90—0.94	0.85—1.00
12. Maximum length of labrum	0.13—0.23	0.10—0.19
13. Maximum width of labrum	0.27—0.33	0.20—0.27
14. Length of mandibles (from upper base of condyle to tip):		
(a) Left mandible	0.67—0.83	0.44—0.60
(b) Right mandible	0.67—0.83	0.44—0.60
15. Head-mandibular length Index (Left mandible-length/Head-length to base of mandibles)	0.40—0.48	0.36—0.46
16. Maximum length of pronotum	0.77—0.97	0.70—0.90
17. Maximum width of pronotum	1.13—1.33	1.00—1.30
18. Pronotum-head Index (Pronotum-width/Head-width)	0.87—0.95	0.82—1.00
19. Pronotum Index (Length/Width)	0.66—0.78	0.58—0.78
20. Maximum width of mesonotum	1.07—1.27	0.90—1.20
21. Maximum width of metanotum	1.03—1.30	0.97—1.23

TABLE 7.—Measurements (in mm.) of *Cryptoterмес perforans* Kemner and *C. sumatrensis* Kemner. Imago.
ex.(s) : example(s).

Body-parts	<i>C. perforans</i> (Lectomorphotype)	<i>C. sumatrensis</i> Range (4 exs.) Paralectotypes
1. Total body-length <i>with</i> wings (excluding antennae), <i>c.</i>	—	9.80 (1 ex.)
2. Total body-length <i>without</i> wings (excluding antennae), <i>c.</i>	4.95	5.30—6.37
3. Length of head to tip of labrum	1.00	1.27—1.37
4. Length of head to lateral base of mandibles	0.80	0.97—1.00
5. Maximum width of head (with eyes)	0.77	1.07—1.10
6. Maximum height of head	0.47	0.60—0.63
7. Maximum length of labrum	0.23	0.30—0.33
8. Maximum width of labrum	0.30	0.40—0.47
9. Maximum diameter of compound eye (with ocular sclerite)	0.27	0.35—0.37
10. Maximum diameter of lateral ocellus	0.10	0.10—0.13
11. Minimum diameter of lateral ocellus	0.05	0.08—0.10
12. Minimum ocellus-antennal distance	0.11	0.15—0.17
13. Minimum eye-antennal distance	0.03	0.015
14. Minimum distance of eye from lateral base of head	0.11	0.15—0.17
15. Maximum length of pronotum	0.50	0.67—0.70
16. Maximum width of pronotum,	0.70	0.97—1.03
17. Length of forewing with scale	6.15	8.85 (1 ex.)
18. Length of forewing scale	0.66	0.97—1.10
19. Length of hindwing with scale	5.45	7.65 (1 ex.)
20. Length of hindwing scale	0.27	0.40

TABLE 8.—Measurements (in mm.) etc., of *Cryptotermes perforans* Kemner and *C. sumatrensis* Kemner. Soldier.

ex.(s) : example(s).

Body-parts	<i>C. perforans</i> Range (4-5 exs.)	Lectotype	<i>C. sumatrensis</i> Paralectotype (1 ex.)
1. Total body-length (excluding antennae), c.	3.3—4.3	3.60	4.8
2. Length of head to tip of mandibles	1.27—1.33	1.33	1.60
3. Length of head to lateral base of mandibles	0.97—1.03	0.97	1.20
4. Maximum length of head upto frontal ridge	1.00—1.03	1.03	1.17
5. Median length of head upto frontal ridge	0.83—0.87	0.87	0.90
6. Maximum width of head	0.90—1.00	0.97	1.10
7. Maximum height of head	0.80—0.83	0.83	0.87
8. Head Index I (Width/Length to base of mandibles)	0.93—1.00	1.00	0.91
9. Head Index II (Height/Width)	0.82—0.88	0.85	0.79
10. Head Index III (Height/Length to base of mandibles)	0.78—0.82	0.80	0.72
11. Head-Index IV (Maximum length upto frontal ridge/Length to base of mandibles)	0.97—1.06	1.06	0.98
12. Maximum length of labrum	0.07—0.13	0.08	0.10
13. Maximum width of labrum	0.17—0.19	0.17	0.22
14. Length of mandibles (from upper base of condyle to tip) :			
(a) Left mandible	0.33—0.35	Broken	0.53
(b) Right mandible	0.30—0.35	0.30	0.50
15. Head-mandibular length Index (Left mandible-length/Head-length to base of mandibles)	0.32—0.36	—	0.44
16. Maximum length of pronotum	0.60—0.63	0.63	0.70
17. Maximum width of pronotum	0.90—0.93	0.90	1.03
18. Pronotum-head Index (Pronotum-width/Head-width)	0.90—1.00	0.93	0.94
19. Pronotum Index (Length/Width)	0.65—0.70	0.70	0.68
20. Maximum width of mesonotum	0.73—0.80	0.73	0.90
21. Maximum width of metanotum	0.80—0.85	0.80	0.90

TABLE 9.—Measurements (in mm.), etc., of *Cryptotermes roonwali* sp. n. Soldier.
ex(s) : example(s).

Body-parts	<i>C. roonwali</i> sp. n.	
	Range (6 exs.)	Holotype
1. Total body-length (excluding antennae), c.	4.0—4.7	4.4
2. Length of head to tip of mandibles	1.40—1.43	1.40
3. Length of head to lateral base of mandibles	1.10—1.17	1.10
4. Maximum length of head upto frontal ridge	1.13—1.17	1.17
5. Median length of head upto frontal ridge	0.93—1.03	0.97
6. Maximum width of head	1.00—1.03	1.00
7. Maximum height of head	0.78—0.83	0.78
8. Head Index I (Width/Length to base of mandibles)	0.88—0.91	0.91
9. Head Index II (Height/Width)	0.78—0.80	0.78
10. Head Index III (Height/Length to base of mandibles)	0.71—0.73	0.71
11. Head-Index IV (Maximum length upto frontal ridge/Length to base of mandibles)	1.00—1.06	1.06
12. Maximum length of labrum	0.08—0.13	0.11
13. Maximum width of labrum	0.13—0.20	0.18
14. Length of mandibles (from upper base of condyle to tip) :		
(a) Left mandible	0.31—0.37	0.31
(b) Right mandible	0.31—0.37	0.31
15. Head-mandibular length Index (Left mandible-length/Head-Length to base of mandibles)	0.29—0.34	0.29
16. Maximum length of pronotum	0.66—0.70	0.66
17. Maximum width of pronotum	1.00—1.02	1.00
18. Pronotum-head Index (Pronotum-width/Head-width)	0.97—1.03	1.06
19. Pronotum Index (Length/Width)	0.66—0.70	0.66
20. Maximum width of mesonotum	0.80—0.87	0.80
21. Maximum width of metanotum	0.87—0.93	0.87

TABLE 10.—Measurements (in mm.) of *Cryptotermes havilandi* (Sjöstedt) ; *C. perforans* Kemner ; *C. roonwali* sp. n. ; and *C. sumatrensis* Kemner. Pseudoworker.*ex(s)* : example(s).

Body-parts	<i>C. havilandi</i> Range (5 exs.)	<i>C. perforans</i> Range (6 exs.)	<i>C. roonwali</i> Range (5 exs.)	<i>C. sumatrensis</i> Range (5 exs.)
1. Total body-length (excluding antennae) c.	4.4 —6.0	3.8 —4.4	4.3 —5.2	4.1 —5.2
2. Length of head to tip of labrum	1.30—1.43	1.00—1.10	1.13—1.23	1.10—1.23
3. Length of head to lateral base of mandibles ..	1.00—1.10	0.77—0.83	0.87—0.90	0.87—1.00
4. Maximum width of head	1.10—1.20	0.85—0.90	0.87—0.90	0.93—1.00
5. Maximum height of head	0.53—0.66	0.48—0.53	0.53—0.57	0.53—0.63
6. Maximum diameter of eye	0.13—0.15	0.13—0.17	0.10—0.13	—
7. Maximum length of labrum	0.33—0.40	0.21—0.30	0.27—0.30	0.27—0.35
8. Maximum width of labrum	0.40—0.50	0.33—0.40	0.33—0.37	0.40—0.47
9. Maximum length of pronotum	0.53—0.66	0.40—0.43	0.47—0.53	0.33—0.47
10. Maximum width of pronotum	0.97—1.00	0.73—0.83	0.80—0.87	0.70—0.80

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