

REVISION OF THE GENUS *GLYPTOTERMES*
FROGGATT (KALOTERMITIDAE, ISOPTERA,
INSECTA) FROM THE INDIAN REGION

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(With 14 Text-figures and 7 Tables)

CONTENTS

	PAGE
I—INTRODUCTION	110
(a) General	110
(b) Acknowledgements	110
(c) Abbreviations used	110
II—INDIAN <i>Glyptotermes</i> : SYSTEMATIC REVISION, ZOOGEOGRAPHY AND PHYLOGENY :	111
1. General Remarks, Zoogeography, etc.	111
(a) General remarks	111
(b) Zoogeography and distribution	111
(c) Phylogenetic position	113
(d) Taxonomic work on Indian <i>Glyptotermes</i>	113
(e) Distribution of <i>Glyptotermes</i> species in the Indian Region	113
(f) Note on <i>Lobitermes nigrifrons</i> Tsai & Chen	115
2. Systematic Account of <i>Glyptotermes</i>	115
(a) Characters of genus <i>Glyptotermes</i> Froggatt	116
(b) Keys for identification of Indian species of genus <i>Glyptotermes</i>	117
(i) Key to imagos	117
(ii) Key to soldiers	117
3. Descriptions of species of <i>Glyptotermes</i>	118
1. <i>Glyptotermes almorensis</i> Gardner	118
2. <i>Glyptotermes ceylonicus</i> Holmgren	128
3. <i>Glyptotermes coorgensis</i> Holmgren & Holmgren	134
4. <i>Glyptotermes dilatatus</i> (Bugnion and Popoff)	142
5. <i>Glyptotermes minutus</i> Kemner	150
6. <i>Glyptotermes nigrifrons</i> Mathur and Sen-Sarma	155
III—SUMMARY	157
IV—REFERENCES	157

I—INTRODUCTION

(a) *General*

Species of the genus *Glyptotermes* are wood termites and some of them are serious pests of rubber and tea plantations. Thus, they are of considerable economic importance.

A taxonomic revision of the oriental species of the genera *Kalotermes* and *Neotermes* has been done by Roonwal and Sen-Sarma (1960) and of that of the genus *Cryptotermes* by Chhotani (1970). Here in this paper, a taxonomic revision of the species of *Glyptotermes*, known from the Indian subregion, is undertaken and all the species so far recorded from this subregion are redescribed in detail and illustrated adequately. The imago of *G. coorgensis* Holmgren and Holmgren, so far not known, is described here for the first time. The following 6 species are dealt with:—*almorensis* Gardner, *ceylonicus* Holmgren, *coorgensis* Holmgren and Holmgren, *dilatatus* (Bugnion and Popoff), *minutus* Kemner and *nigrifrons* Mathur and Sen-Sarma. The zoogeographical distribution and the phylogenetic position of the genus have been discussed.

(b) *Acknowledgements*

The author gratefully thanks Dr. M. L. Roonwal, formerly Director, Zoological Survey of India, for his valuable guidance in this study and Dr. A. P. Kapur for his continuous interest and encouragement in his work on termites.

The author is also thankful to the following persons for sending on loan the types of some of the species and for giving other useful informations:—

- (i) Prof. A. E. Emerson, Hulletts Landing (N.Y.), U.S.A.
- (ii) Dr. W. V. Harris, officer-in-charge, Termite Research Unit, Commonwealth Institute of Entomology, British Museum (Natural History), London.
- (iii) Prof. Carl H. Lindroth, Head of Zoology Department, Lund University, Lund (Sweden).
- (iv) Dr. K. Krishna, American Museum of Natural History, New York (U.S.A.).
- (v) Dr. P. N. Chatterjee, Forest Entomologist, Forest Research Institute, Dehra Dun (India).

(c) *Abbreviations used*

<i>A.M.N.H.</i> ,	American Museum of Natural History, New York.
<i>B.M.</i> ,	British Museum (Natural History), London.
<i>coll.</i> ,	collected by.
<i>det.</i> ,	determined by.
<i>ex.</i> ,	from or out of.
<i>F.R.I.</i> ,	Forest Research Institute, Dehra Dun.
<i>Im.</i> ,	imago.
<i>Ny.</i> ,	nymph.
<i>Pw.</i> ,	pseudoworker.
<i>S.</i> ,	soldier.
<i>Sta. No.</i> ,	Collecting Station Number.
<i>Z.S.I.</i> ,	Zoological Survey of India, Calcutta.

II—INDIAN *Glyptotermes*: SYSTEMATIC REVISION, ZOOGEOGRAPHY AND PHYLOGENY

1. GENERAL REMARKS, ZOOGEOGRAPHY, ETC.

(a) *General remarks*

Froggatt (1896) erected the genus *Glyptotermes* to include his species *tuberculatus*, *iridipennis*, *brevicornis* and *eucalypti* in his subfamily Glyptotermitinae. He also included his genus *Heterotermes* in the subfamily Glyptotermitinae (p. 518) but later on, in the same publication (p. 550) he relegated that genus and the species *H. platycephalus* to the subfamily Heterotermitinae. As in case of genus *Cryptotermes*, some authorities regard *Glyptotermes* also as a subgenus of *Kalotermes* (*Calotermes* of some authors) along with some other genera of the family Kalotermitidae (Holmgren 1910, '11a, '13; Emerson, 1925, '28; Hare, 1937; Hill, 1942; Rattan Lal and Menon, 1953; etc.). At present it is recognised as a full genus of the family Kalotermitidae.

The soldiers of some species of *Glyptotermes* show great diversity of characters and were thus from time to time referred to different genera, e.g., *G. asperatus* Snyder to subgenus *Calcaritermes* of genus *Kalotermes* by Snyder (1926) when he described the species; *G. contracticornis* Snyder to subgenus *Neotermes* by Hare (1937); *G. posticus* Hagen to subgenus *Cryptotermes* by Holmgren (1911a) with some doubt; and so on. Holmgren (1911a) created the subgenus *Lobitermes* to accommodate *Calotermes lobicephalus* Silvestri (= *canellae* Müller) and *Calotermes pinangae* Haviland, both of which are now regarded as belonging to *Glyptotermes* (Snyder, 1949; Krishna, 1961).

Grasse (1949) recognised the validity of subgenus *Lobitermes* and raised it to full genus. Tsai and Chen (1963) have described a new species, *Lobitermes nigrifrons**. But Snyder (1949), Roonwal and Sen-Sarma (1960) and Krishna (1961) do not give generic status to *Lobitermes*, and I agree with the latter view.

(b) *Zoogeography and distribution* (Table 1)

Snyder (1949) recognised 45 living and one fossil species of *Glyptotermes* from the world. Krishna (1961) listed all the species included by Snyder (1949) except *Calotermes latifrons* Silvestri which he referred to genus *Proneotermes*. He also included six out of ten species of *Glyptotermes* described after Snyder (1949), thus making a total of 51 known species including a fossil one: Out of the other four, he refers *Glyptotermes longiceps* Cachan and ? *G. sordwanae* Coaton, along with several other species, to his new genus *Postelectrotermes*; and ? *G. umtatae* Coaton to genus *Kalotermes*. He does not include *G. alaotranus* Cachan in any of the Kalotermitid genera.

Mathur and Sen-Sarma (1960), Tsai and Chen (1963) and Ahmad (1965) have recently described *G. nigrifrons* from southern India, *G. chinpingensis* from southern China and *G. kachongensis* from Thailand,

* See discussion below, on *Lobitermes nigrifrons*.

respectively. Krishna and Emerson (1962) have added another 20 species from the Neotropical (8), Ethiopian (5), Papuan (5) and Indo-Malayan (2) regions. The total number of species thus known at

TABLE 1.—Distribution of species of *Glyptotermes* in various zoogeographical regions.

Region	Number of species			Present Account	
	Snyder (1949)	Emerson (1955)	Krishna (1961)	No. of described species	Percentage
Australian	5	5	5	5	6.8
Ethiopian	2	10	12 (including 6 new species)	11	15.1
Indo-Malayan	16	19	21 (including 3 new species)	23	31.5
Malagasy	1	2	2 (including 1 new species)	1	1.4
Neotropical	18	27	25 (including 8 new species)	25	34.2
Papuan	3	8	8 (including 5 new species)	8	11.0
Unknown Region	—	1	1	—	—
Total:	45	72 (including 25 new species)	74 (including 23 new species)	73	—

present from all over the world is 73 living and one fossil. The living forms are distributed in various zoogeographical regions as follows:—Australian (5 species or 6.8%); Papuan (8 or 11.0%); Indo-Malayan (23 or 31.5%); Ethiopian (11 or 15.1%); Malagasy (1 or 1.4%); and Neotropical (25 or 34.2%).

As the species of *Glyptotermes* are apparently not easily transportable by artificial means, their distribution is rather restricted. This restricted distribution and their abundance in the Neotropical (34.2%) and Indo-Malayan (31.5%) regions, provide some reasons to believe that, as suggested by Emerson (1952, 1955), the genus had its origin in either of these regions, and thence got dispersed in the late Jurassic or early Cretaceous through the Bering land bridge having a tropical climate during the Mesozoic times and to the Australian and Papuan Regions, through the former Papuan connections with the Indo-Malayan Region. An alternative is that the genus had the origin in the southern land mass, when these land masses were contiguous and thence got dispersed before they started drifting apart according to Wegener's hypothesis (Wegener 1922, van der Gracht 1928).

(c) *Phylogenetic position*

Glyptotermes falls in the group with other Kalotermitid genera which have the anterior margin of the 2nd marginal tooth of the left imago mandible, equal to the posterior margin of the 1st marginal (*i.e.*, the *Proelectrotermes-Calcaritermes* complex of Krishna, 1961). The median vein in all the genera of this complex is generally strongly chitinised except in case of the fossil genera *Proelectrotermes* and *Electrotermes* and the living genus *Kalotermes*. These fossil genera are definitely more primitive as indicated by the presence of spines on the middle tibia, a character which is in common with the probably more primitive termites of the families Mastotermitidae and some Hodotermitidae. *Glyptotermes* can be grouped with *Calcaritermes* because of the absence of the radial sector branches and in having a more compact costal area in the wings, features common to both the genera. The soldier of some of the species, however, has a phragmotic head which is comparable to the soldier head of the genera *Cryptotermes*, *Eucryptotermes*, *Calcaritermes* etc., a case of convergent evolution as suggested by Krishna (1961).

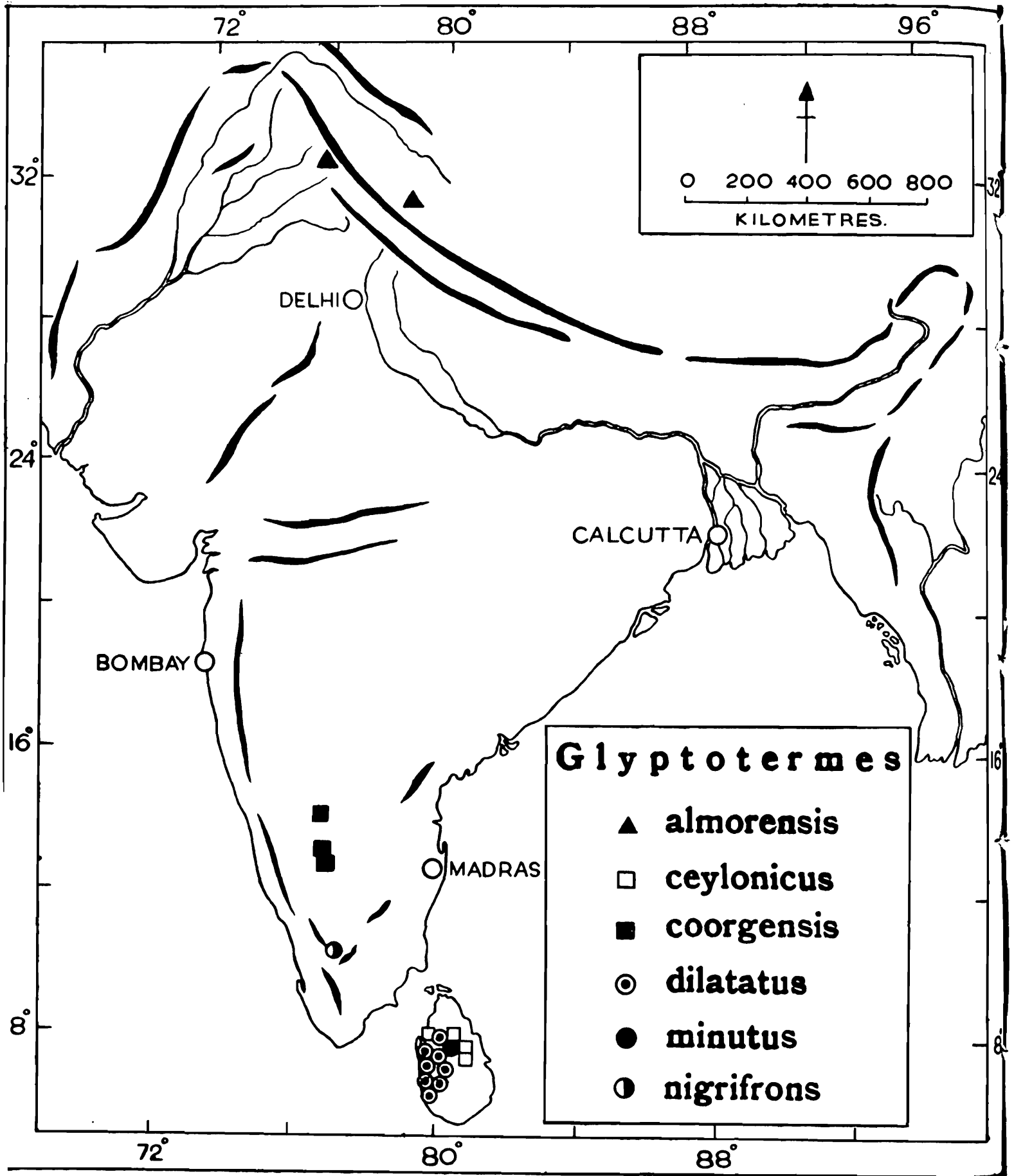
(d) *Taxonomic work on Indian Glyptotermes*

Bugnion and Popoff (1910) were the first to describe a species of *Glyptotermes* (*G. dilatatus*—their *Calotermes dilatatus*) from the Indian Region (Ambalangoda, Ceylon). Holmgren (1911*b*) described another species (*G. ceylonicus*) from Peradeniya, Ceylon, and later on (1913) revised the oriental species including these two known from Ceylon. Holmgren and Holmgren (1917) recorded the genus from the Indian mainland and described a species, *G. coorgensis*, from South India. Kemner (1932) described yet another species *G. minutus*, from Ceylon and Gardner (1944) described *G. almorensis* from Almora (Western Himalayas, India). Snyder (1949) included the Indian *Glyptotermes* in his world catalogue, and Rattan Lal and Menon (1953) have catalogued the Indian forms. Recently, Mathur and Sen-Sarma (1960) have described another species, *G. nigrifrons*, from southern India. Thus, so far only 6 species are known from the Indian region.

A considerable amount of work has been done on the biology and control of *G. dilatatus* which is a serious pest of tea in Ceylon and on *G. ceylonicus* (Holmgren). The more important works on biology, etc. which need reference here are those by Jepson (1930) and Pinto (1941).

(e) *Distribution of Glyptotermes species in the Indian region (Text-fig. 1)*

Out of the 73 world and 23 Indo-Malayan species of *Glyptotermes*, only six are known from the Indian Region (India, Ceylon, Burma, Pakistan). From the Indian mainland 3 species (*almorensis*, *coorgensis* and *nigrifrons*) are known whereas the other 3 species (*ceylonicus*, *dilatatus* and *minutus*) are known from Ceylon. There are no records of any *Glyptotermes* from either Burma or Pakistan. The species have somewhat restricted distribution. *G. ceylonicus*, *G. dilatatus* and *G. minutus* are confined to Ceylon. The single record of *G. dilatatus* from Madras, India (Rattan Lal and Menon, 1953) is based on a paper by Rau, S. A. 1936 (*Rep. Tea Dep. U.P.A.S.I.*, 1935-36, Madras), but Rau refers to an undescribed species near *G. dilatatus*, *G. almorensis* is known from



Text-fig. 1.—Map of the Indian Region showing distribution of the Indian species of genus *Glyptotermes*.

the Western Himalayas (Almora and Garhwal, Uttar Pradesh) and *coorgensis* and *nigrifrons* are from southern India.

(f) *Note on Lobitermes nigrifrons* Tsai and Chen

The genus or subgenus *Lobitermes* is now generally recognised as a synonym (in part) of genus *Glyptotermes*, and in part that of the genera *Cryptotermes* and *Calcaritermes*. Recently, Tsai and Chen (1963) described a new species, *Lobitermes nigrifrons*, from South China which they placed near *Calotermes (Lobitermes) pinangae* Haviland. The latter species has now been referred to the genus *Glyptotermes* (Snyder, 1949; Krishna, 1961). I have not been able to examine specimens of *L. nigrifrons* Tsai and Chen and am, therefore, unable to give an opinion on its status. But if it is a *Glyptotermes*, which most likely is, it requires a new name as *Glyptotermes nigrifrons* Mathur and Sen-Sarma (1960) has priority.

2. SYSTEMATIC ACCOUNT OF GLYPTOTERMES

Genus *Glyptotermes* Froggatt

(i) Genus *Calotermes* (in part)

1858. H. A. Hagen, *Linn. Ent.*, Berlin, **12** : 31-38.
 1858. H. A. Hagen, *Catal. Specimens Neuropterous Insect Coll. Brit. Mus.*, London, Part 1: 1.
 1898. G. D. Haviland, *J. Linn. Soc. Lond.*, London, **26** : 371, 373.
 1904. J. Desneux, *Genera Insect.*, Brussels, Fasc. 25, *Termitidae*: 20-24.

(ii) Genus *Glyptotermes*

1896. W. W. Froggatt, *Proc. Linn. Soc. N.S.W.*, Sydney, **21** (4): 518, 543. (Type. by subsequent designation.) *Type of genus: Glyptotermes tuberculatus* Froggatt.
 *1905. W. W. Froggatt, *Agr. Gaz. N.S.W.*, Sydney, **16** : 17, 23, 24.
 *1915. W. W. Froggatt, *Bull. Dep. Agric. N.S.W.*, Sydney, No. 60: 25.
 1924. T. E. Snyder, *Proc. U.S. nation. Mus.*, Washington, **64** (Art. 6): 109.
 1926. Y. Sjöstedt, *K. Sv. Vet. Akad. Handl.*, Stockholm, (3) **3** (1): 22, 23, 42. [In part]
 1930. S. F. Light, *Philipp. J. Sci.*, Manila, **42** (1): 15, 16, 18.
 1934. N. A. Kemner, *K. Sv. Vet. Akad. Handl.*, Stockholm, **13** (4): 30, 38.
 1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, **3** (1): 85.
 1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112** : 45, 359.
 1949. P. Cachan, *Mem. Inst. Sci. Madagascar*, Tenanarive, (A) **3** (2): 180, 185, 190, 208, [In part].
 1949. P. P. Grassé, *Traite de Zoologie*, Paris, **9** : 531.
 1950. M. Ahmad, *Bull. Amer. Mus. nat. Hist.*, New York, **95** (Art. 2): 44, 50.
 1952. A. E. Emerson, *Bull. Amer. Mus. nat. Hist.*, New York, **99** (Art. 3): 218-219.
 1955. H. Weidner, In: Schmidt's *Die Termiten*: 46, 48, 68.
 1955. A. E. Emerson, *Fieldiana (Zool.)*, Chicago, **37** : 468, 473, 476-478, 492, 507, 508.
 1958. M. Ahmad, *Biologia*, Lahore, **4** (1-2): 35, 36.
 1960. M. L. Roonwal and P. K. Sen-Sarma, *Contrib. Syst. Orient. Termites*, New Delhi : 97, 98.
 1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, **122** (Art. 4): 343-348.
 1961. W. V. Harris, *Termites: Their Recogn. & Cont.*, London, p. 47.

* Not seen in original.

(iii) Subgenus *Glyptotermes*

- 1910a. N. Holmgren, *Zool. Anz.*, Leipzig, **35** : 285. [Mentions *G. borneensis* as the type-species].
 1910b. N. Holmgren, *Trans. Linn. Soc. Lond. (Zool.)*, London, (2) **14** (8), Pt. 1: 140.
 1911. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **46** (6): 53, 55, 56, 58-61. [Mentions *G. borneensis* Havil. as type-species].
 1913. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **50** (2): 37, 49
 1925. T. E. Snyder, *J. Washington Acad. Sci.*, Washington, **15** (7): 152, 157-158.
 1925. A. E. Emerson, *Zoologica*, New York, **6** (4): 313, 331.
 1928. A. E. Emerson, *Bull. Amer. Mus. nat. Hist.*, New York, **57** (Art. 7): 405, 412, 418.
 1933. T. E. Snyder, *Proc. ent. Soc. Wash.*, Washington, **35** (5): 67.
 1934. T. E. Snyder, *Indian For. Rec. (Ent.)*, Delhi, **20** (11): 24, 27.
 1937. L. Hare, *Ann. ent. Soc. Amer.*, Columbus (Ohio), **37** (3): 461, 474, 475.
 1942. G. F. Hill, *Termites (Isop.) Austr. Region*: 7, 85.
 1963. Rattan Lal and Menon, R. D., *Catalog. Indian Insects*, Part 27, *Isoptera*, Delhi: 8, 11-12.

(iv) Genus/subgenus *Lobitermes* Holmgren

1911. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **46** (6): 53, 56, 59-61.
 1913. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **50** (2): 37, 59.
 1924. T. E. Snyder, *Proc. U.S. nation. Mus.*, Washington, **24** (Art. 6): 9-10.
 1925. T. E. Snyder, *J. Wash. Acad. Sci.*, Washington, **15** (7): 152, 158.
 1925. A. E. Emerson, *Zoologica*, New York, **6** (4): 337.
 1928. A. E. Emerson, *Bull. Amer. Mus. nat. Hist.*, New York, **57** (Art. 7): 406.
 1933. S. F. Light, *Calif. Univ. Publ. (Ent.)*, Berkeley, **6** (5): 82, 101.
 1933. T. E. Snyder, *Proc. ent. Soc. Wash.*, Washington, **35** (5): 67.
 1949. P. P. Grassé, *Traite de Zoologie*, Paris, **9** : 531.

(a) Characters of genus *Glyptotermes* Froggatt

IMAGO: Head-capsule quadrate or subcircular, sides without eyes weakly convex or somewhat straight; posterior margin round; epicranial sutures present. Fontanelle absent. Eyes broadly oval and moderately large. Ocelli oval, either touching, or away from the eyes. Antennae with 11-17 segments. Clypeus flat, trapezoidal not very distinctly separated into an ante- and a postclypeus. Labrum broadly tongue-shaped; broader than long. Mandibles each with an apical and 2 marginal teeth; apical finger-like; anterior margin of 2nd marginal tooth of left mandible equal to posterior margin of 1st marginal; posterior margin of 2nd marginal of right mandible only slightly longer than molar plate. Pronotum narrower than, or as wide as, head with eyes. Legs with 3 apical spurs on each tibia. Tarsi 4-jointed; an arolium always present. Wings smoky brown, strongly punctate; all veins, except median in hindwing, arising independently from scale. Costa, subcosta, radius and median strongly, and cubitus weakly, chitinised. Costa bordering the anterior margin; subcosta in forewing short and fusing with costa just outside scale, and absent in hindwing; radius short fusing with costa a little away from scale; radial sector running parallel with costa upto the distal tip of wing-membrane; median running parallel with and close to radial sector, and arising independently from scale in forewing but from radial sector in hindwing; cubitus running medially, with branches to posterior margin. Abdomen long. Cerci 2-jointed and short.

SOLDIER: Head-capsule generally subrectangular, cylindrical; sometimes phragmotic, with frons sloping in front almost vertically as in *Cryptotermes* and concave in some species, either weakly or distinctly

bilobed in front, with a U- or V-shaped depression in between; epicranial sutures present. Fontanelle absent. Eyes present, one on either side, unpigmented. Ocelli minute, translucent, dot-like, present near the extremity of lateral sutures of head, one on either side; sometimes not distinct. Antennae with 10–15 segments. Clypeus divided into an ante- and a postclypeus; postclypeus distinctly or weakly separated from frons. Labrum tongue-shaped. Mandibles prominently dentate, basally either humped or plain on outer margin; generally thick and stout. Postmentum long, club-shaped. Pronotum either narrower than or, as wide as or slightly wider than, head-capsule. Legs with 3 apical tibial spurs on each tibia. Tarsi 4-jointed. Abdomen elongate. Cerci 2-jointed, short.

PSEUDOWORKER: Head-capsule subcircular, broader than its length to base of mandibles; eyes rudimentary, unpigmented; ocelli absent. Antennae with 9–12 segments. Mandibles as in imago. Pronotum either narrower than, or as wide as, or wider than, head-capsule. Legs short, apical tibial spurs 3:3:3; tarsi 4-jointed. Abdomen elongate; cerci 2-jointed and short.

(b) *Keys for identification of Indian species of genus Glyptotermes*

(i) *Key to imagos*

Out of six species of *Glyptotermes* occurring in the Indian Region, imagos of only five are known, and are keyed below:—

- 1(4). Larger species: Head-width with eyes over 1 mm. (*c.* 1.03–1.30 mm.).
- 2(3). Darker species, head-capsule yellowish brown to brown; Y-suture distinct.
 - .. 1. *G. ceylonicus* Holmgren
- 3(2). Paler species, head-capsule brownish yellow; Y-suture indistinct.
 - .. 2. *G. dilatatus* (Bugnion & Popoff)
- 4(1). Smaller species: Head-width with eyes under 1 mm. (*c.* 0.85–0.97 mm.).
- 5(6). Ocelli small and directed vertically when viewed laterally, diameter: (maximum 0.07, minimum 0.05 mm.).
 - .. 3. *G. coorgensis* Holmg. & Holmg.
- 6(5). Ocelli large and directed antero-laterally, diameter: (maximum 0.09, minimum 0.07–0.09 mm.).
- 7(8). Head-width with eyes 0.85 mm.; eyes separated from basal margin of head-capsule by a distance of *c.* 0.13 mm.
 4. *G. minutus* Kemner.
- 8(7). Head-width with eyes 0.90–0.97 mm.; eyes separated from basal margin of head-capsule by a distance of *c.* 0.17 mm.
 5. *G. almoresis* Gardner

(ii) *Key to soldiers*

- 1(4). Larger species: Head-length to lateral base of mandibles 2.0–3.01 mm.; maximum head-width 1.27–1.67 mm.
- 2(3). Mandibles short, thick and stout; left mandible with 2 thick marginal teeth; Mandible-Head Index (Left mandible length/Head-length to base of mandibles) smaller, *c.* 0.34–0.36. Head longer and wider (head-length to base of mandibles 2.62–3.01; maximum head-width 1.50–1.67 mm.).
 1. *G. ceylonicus* Holmgren
- 3(2). Mandibles long and thin; left mandible with 4 prominent marginal teeth; Mandible-Head Index (Left mandible length/Head-length to base of mandibles) larger, *c.* 0.47–0.50. Head smaller and narrower (head-length to base of mandibles 2.0–2.23; maximum head-width 1.27–1.35 mm.).
 2. *G. dilatatus* (Bugnion & Popoff)

- 4(1). Smaller species: Head-length to lateral base of mandibles 1.29–1.73 mm.; maximum head-width 0.90–1.20 mm.
- 5(6). Antero-lateral corners of head-capsule sharply pointed in front.
 3. *G. coorgensis* Holmg. & Holmg.
 .. 4. *G. nigrifrons* Mathur & Sen-Sarma
- 6(5). Antero-lateral corners of head-capsule rounded in front.
- 7(8). Head-capsule narrower (maximum width 0.90 mm.). Y-suture distinct.
 ... 5. *G. minutus* Kemner
- 8(7). Head-capsule wider (maximum width 1.06–1.13 mm.). Y-suture faint, lateral arms indistinct.
 6. *G. almorensis* Gardner

3. DESCRIPTIONS OF SPECIES OF GLYPTOTERMES

1. *Glyptotermes almorensis* Gardner

(Text-figs. 2–5; and Tables 2–4)

(i) *Kalotermes* (*Glyptotermes*) *almorensis* Gardner

1944. J. C. M. Gardner, *Indian J. Ent.*, New Delhi, **6**: 104–105. *Im.* and *S.* Fig. 1 (*S.* mandibles). *Type-locality*: Bajwar (Almora District, Uttar Pradesh, India). Types examined.
1953. Rattan Lal and Menon, R. D. *Cal. Indian Insects*, Part 27, *Isoptera*, p. 12, India: Bajwara (= Bajwar), Almora Dist., U.P.

(ii) *Glyptotermes almorensis* Gardner

1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112**: 45, India.
1953. M. L. Roonwal and G. D. Pant, *Indian For. Leaflet (Ent.)*, Delhi, No. 121 (3): 44. *India*: Uttar Pradesh: Bajwar; Paithani-Jakh (Garhwal).
1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, **122** (Art. 4): 347.
1962. R. N. Mathur and R. S. Thapa, *Indian For. Leaflet (Ent.)*, Delhi, No. 167: 9. *India*: Uttar Pradesh: Bajwar; Paithani-Jakh (Garhwal).

(a) *Material Examined*

(A) *Present in F.R.I., Dehra Dun*: (i) A vial (F.R.I. Nos. M.C. 17357/1, t. 3365, j. 115), with a soldier, an imago (alate) and several pseudoworkers, *cotypes*, Bajwar, Almora Dist. (Uttar Pradesh, India), coll. J.C.M. Gardner, June 1937, ex "dead *Rhododendron*"

(B) *Present in Z.S.I., Calcutta*: (ii) A vial (Z.S.I. No. 3729/H8), with 4 imagos (alates), 2 soldiers and 2 pseudoworkers, Jakh Kandar Syun, Paithani (Garhwal, U.P., India), coll. B. Singh, June 1941, ex "dead and hard stump of *Rhododendron arboreum*"

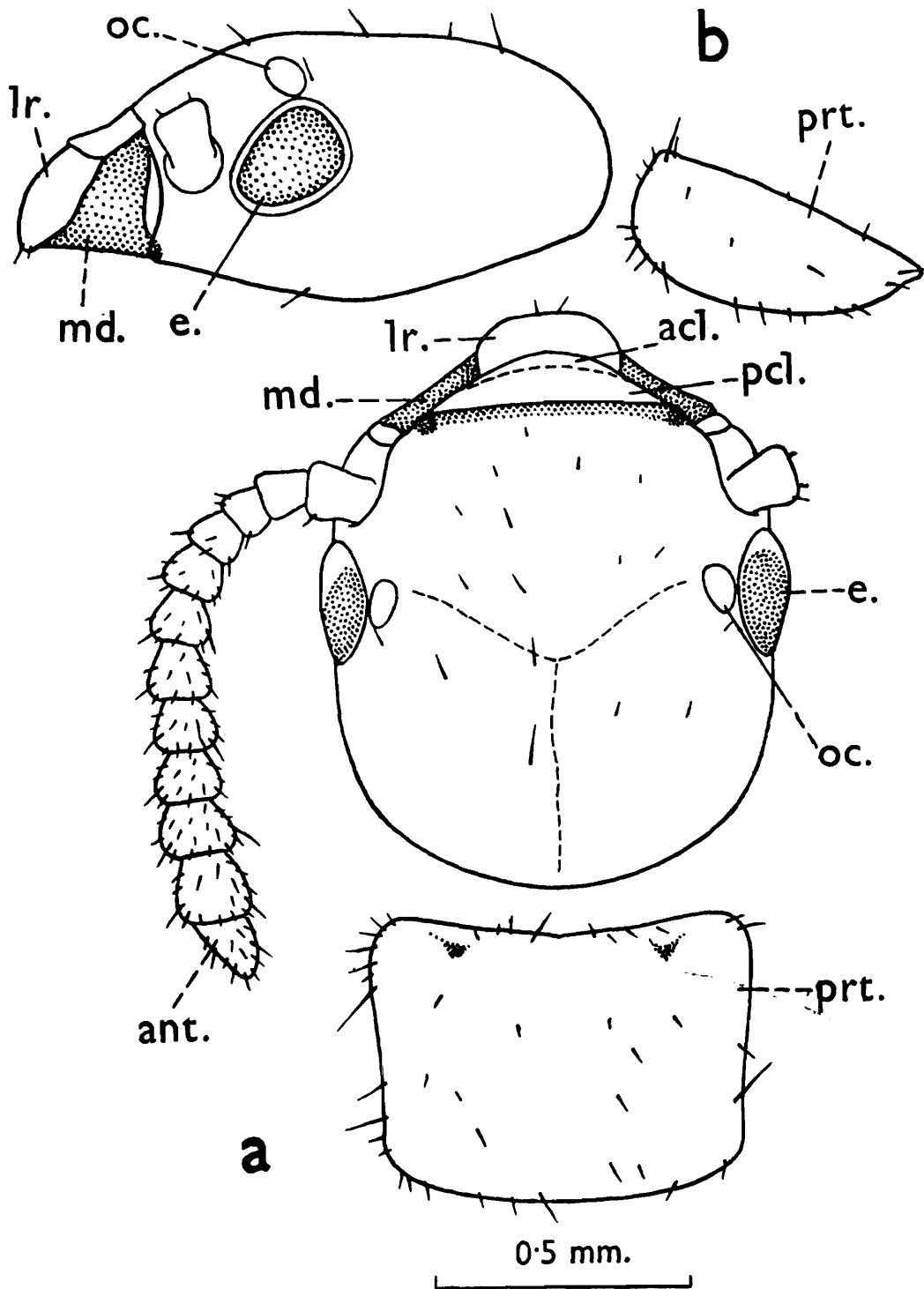
(b) *Description*

Types examined:

1. IMAGO (Text-figs. 2 & 3; Table 2).—

General: Head-capsule, pronotum and abdominal tergites castaneous brown; first 4 or 5 abdominal tergites darker; sternites paler; coxae and femora dark brown; labrum antennae, tibiae and tarsi pale brown;

mandibles brown with dark brown teeth; wings dark brown. The imago in the type collection has become paler, probably due to age.



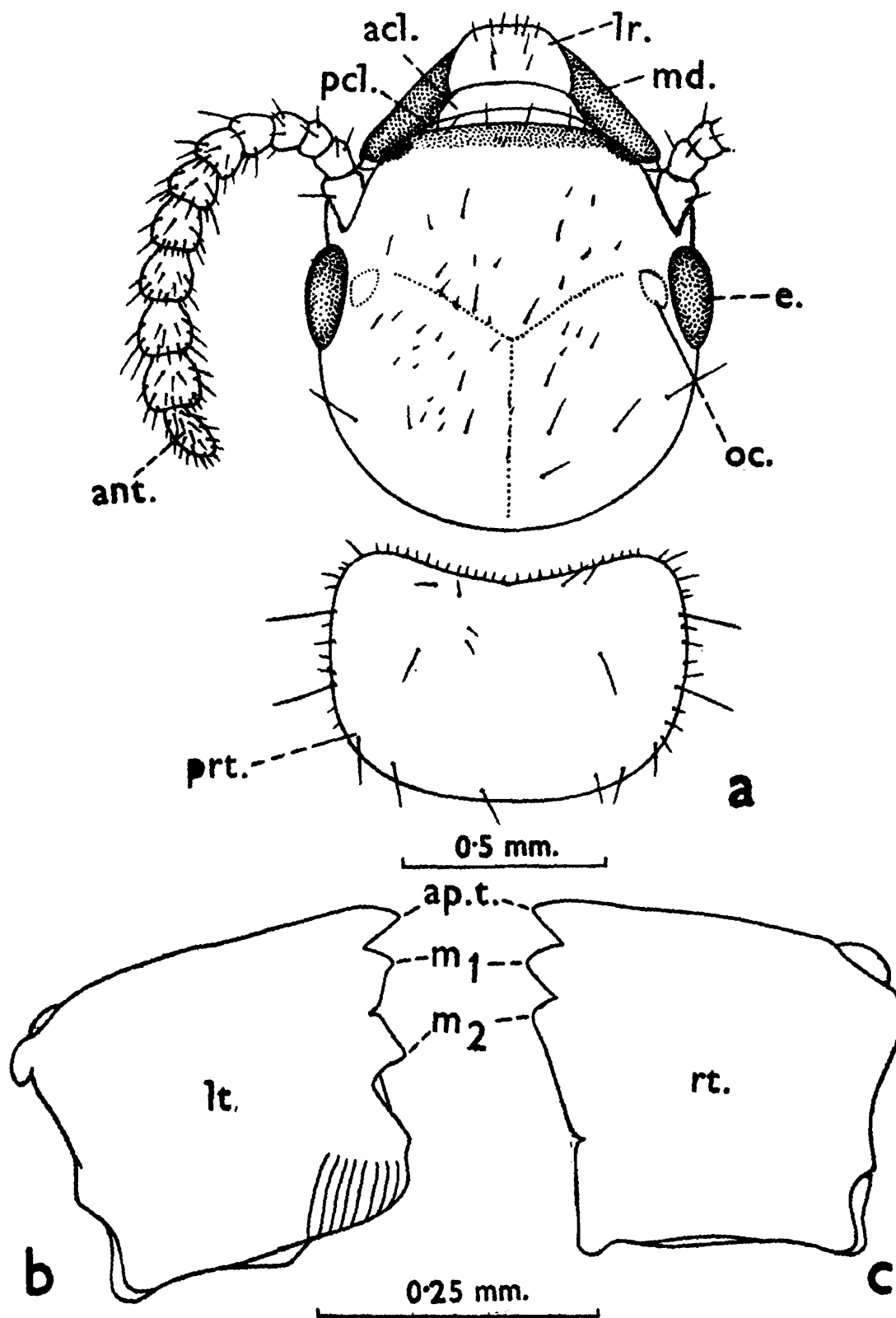
Text-fig. 2.—*Glyptotermes almorensis* Gardner. Imago. Paralectotype, from Bajwar (U.P., India).

(a) Head and pronotum, in dorsal view (sides of pronotum pressed down).
(b) Ditto, in side view.

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

Head and body sparsely hairy. Total body-length with wings *c.* 7.2–8.1, without wings *c.* 4.2–5.4 mm.

Head: Length of head-capsule generally equal to width (with eyes) sometimes a little less (length to base of mandibles 0.90–0.97;



Text-fig. 3.—*Glyptotermes almorensis* Gardner. Imago. Paithani (U.P., India).

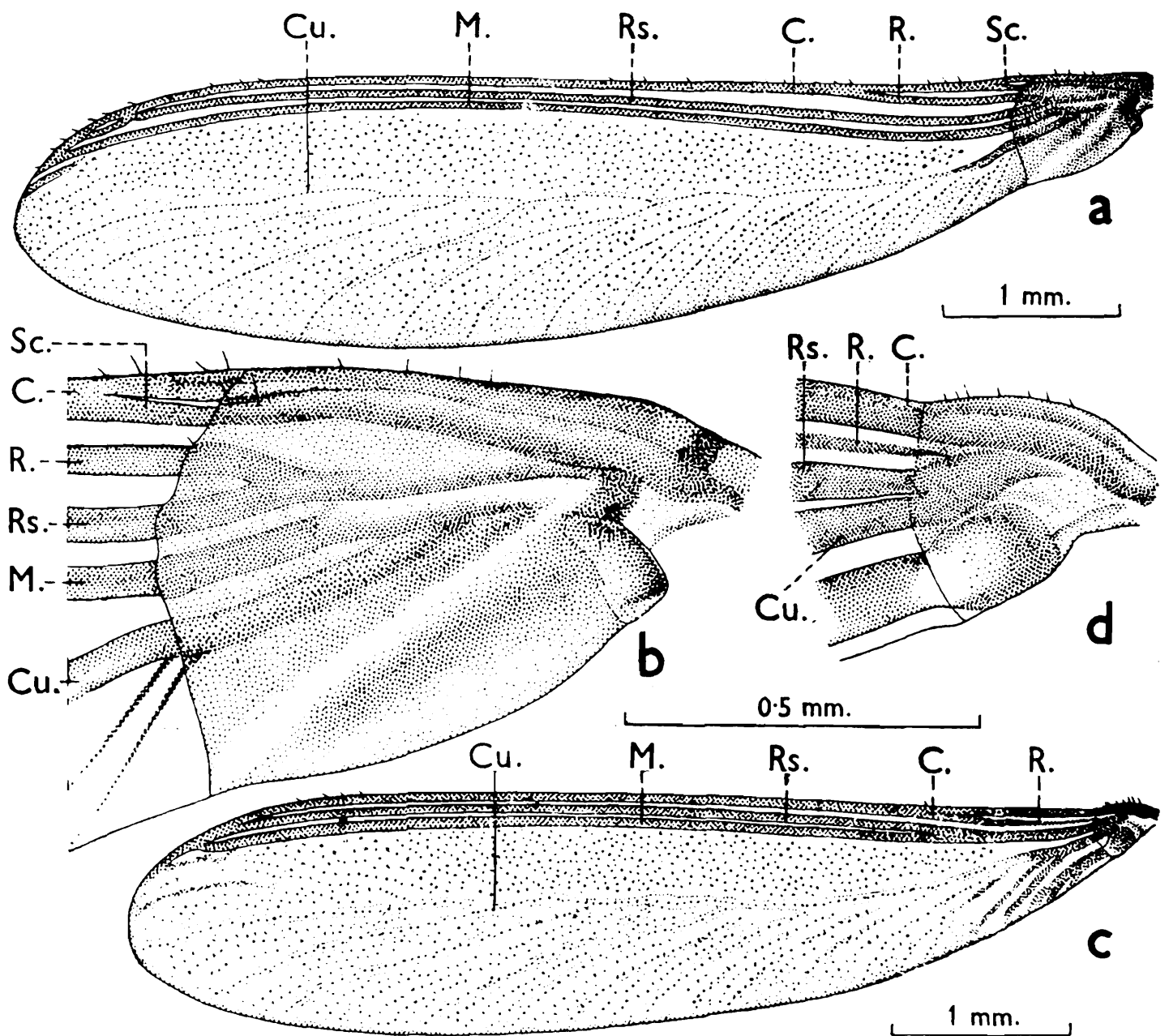
(a) Head and pronotum, in dorsal view (pronotum in actual shape, *in situ*). (b) Left mandible, in dorsal view. (c) Ditto, right mandible. acl., anteclypeus; ant., antenna; ap.t., apical tooth of mandibles; e., eye; lr., labrum; lt., left; m₁, m₂; 1st and 2nd marginal teeth of mandibles; md., mandible; oc., ocellus; pcl., postclypeus; prt., pronotum; rt., right.

TABLE 2.—Measurements (in mm.) of *Glyptotermes almorensis* Gardner and *G. coorgensis* Holmgren & Holmgren. Imago.
ex., examples.

Body-parts	<i>G. almorensis</i> Range (5 ex.)	<i>G. coorgensis</i> Range (2 ex.)
1. Total body-length <i>with</i> wings (excluding antennae), <i>c.</i>	7.2 —8.1	—
2. Total body-length <i>without</i> wings, (excluding antennae), <i>c.</i>	4.4 —5.4	4.2 —4.6
3. Length of head to tip of labrum	1.13—1.30	1.07
4. Length of head to lateral base of mandibles	0.90—0.97	0.87—0.90
5. Maximum width of head (with eyes)	0.90—0.97	0.87—0.93
6. Maximum height of head	0.50—0.53	0.53
7. Maximum length of labrum	0.17—0.25	0.23
8. Maximum width of labrum	0.30—0.33	0.33
9. Maximum diameter of compound eye (with ocular sclerite)	0.23—0.25	0.25
10. Maximum diameter of lateral ocellus	0.09	0.07
11. Minimum diameter of lateral ocellus	0.09	0.05
12. Minimum ocellus-antennal distance	0.15—0.17	0.15
13. Minimum eye-ocellus distance	0.015 (in one ex. only)	—
14. Minimum eye-antennal distance	0.03—0.04	0.03
15. Minimum distance of eye from lateral base of head	0.17	0.15
16. Maximum length of pronotum	0.53—0.60	0.57
17. Maximum width of pronotum	0.77—0.83	0.80—0.83
18. Length of forewing with scale	5.70—6.30	—
19. Length of forewing scale	0.67—0.80	0.77—0.86
20. Length of hindwing with scale	5.40—5.80	—
21. Length of hindwing scale	0.30—0.33	0.33

width with eyes also 0.90–0.97 mm.); sides without eyes substraight; posterior margin round. *Frontanella*: Absent. *Eyes*: Two lateral, small, suboval, black, faceted eyes, one on either side; maximum diameter with ocular sclerite 0.23–0.25; minimum diameter 0.20–0.21 mm.; situated at a distance of 0.17 mm. from the lateral base of head-capsule. *Ocelli*: Two medium-sized, oval, translucent ocelli, one on either side, somewhat directed in front; generally touching the eye of its side, sometimes slightly separated; separated from the antennae by a distance of *c.* 0.15–0.17 mm. *Antennae*: With 12 segments; basally sparsely and distally fairly pilose; segment 1 cylindrical; 2 longer than half of 1 and slightly longer than 3; 4 to the penultimate segments gradually increasing in length, large and broadly pyriform; last ovate, pointed apically and narrower than the penultimate one. *Clypeus*: Subtrapezoidal; anterior margin weakly convex to round, sides weakly incurved; indistinctly divided into an ante- and a post-clypeus. *Labrum*: Broader than long; anterior margin round; with a few hairs near anterior margin.

Mandibles: Subsquarish. Left mandible with an apical and two marginal teeth; apical finger-like; 1st marginal shorter but thicker than apical; 2nd marginal subequal to 1st and with anterior margin equal to the posterior margin of 1st. Right mandible also with an apical and two marginal teeth; apical finger-like, a little stronger than the corresponding one in left mandible; 1st marginal subtriangular, subequal to but stronger than apical; 2nd marginal short, with the posterior margin a little longer than molar plate.



Text-fig. 4.—*Glyptotermes almorensis* Gardner. Wings. From a specimen from Paithani (U.P., India).

(a) Forewing, in dorsal view. (b) Ditto, proximal portion enlarged. (c) Hindwing, in dorsal view. (d) Ditto, proximal portion, enlarged.

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

Thorax: Pronotum: Subrectangular; narrower than headcapsule and broader than long; maximum length 0.53–0.60; maximum width 0.77–0.83 mm.; with short and long bristles on all margins and a few on body; anterior margin weakly concave; sides round (in the lectomorphotype, (Text-fig. 2a), the sides appear substraight in dorsal view due to the dehydration and pressing down of sides); posterior margin substraight; both antero-lateral and postero-lateral corners rounded, anterior ones narrower. *Legs:* Short and hairy; apical tibial spurs 3: 3: 3. Tarsi 4-jointed; arolium present.

Wings (Text-fig. 4): Dark brown; membrane covered with prominent granules. *Forewing:* A little longer than hindwing; scale also longer and covering the hindwing scale. All veins arising independently from scale. Costa, subcosta, radius, radial sector and median strongly chitinised and thick, cubitus generally weak somewhat prominent near the scale. Costa bordering the anterior margin and running upto distal end. Subcosta minute, fusing with costa just outside the scale. Radius short, arising separately and joining the costa at about one-sixth the length of wing-membrane from scale. Radial sector arising separately from scale (but from a common stalk, with radius inside the scale); curving up a little and then running parallel with costa upto the distal tip; without any branches to costal border. Median also curving up and running close to and parallel with radial sector. Cubitus running medially and with 11–14 branches to posterior margin; cross-veins between cubitus and median sometimes present. *Hindwing:* Costa, radius and radial sector as in forewing. Subcosta lacking. Median arising from the radial sector at about one-fourth to one-sixth of wing-membrane from the scale, and running close to, and parallel with the radial sector upto the distal end. Cubitus as in forewing, with 12–13 branches to posterior margin; cross-veins between cubitus and median sometimes present.

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

2. SOLDIER (Text-fig. 5; Tables 3).—

General: Head-capsule reddish brown, paler posteriorly and dark reddish brown anteriorly; antennae, labrum, legs and abdomen pale yellowish brown; the last tergite darker (testaceous, *vide* Gardner 1944); mandibles black. Head and body sparsely pilose with longish bristles. In the soldier in the type collection (now selected as Lectotype) the head is generally paler and the hairs haven't fallen off probably due to faulty preservation. Total body-length *c.* 4.8–5.7 mm.

Head: Head-capsule subrectangular, flat; longer than broad, length about one-and-a-half times the width (length to lateral base of mandibles 1.43–1.73; maximum width 1.06–1.13 mm.); frons sloping in front and weakly depressed medially; lateral protuberences on frons absent or weakly developed; sides substraight; posterior margin round; Y-suture faintly marked, median arm weak, lateral arms indistinct; genae round not sharply projected in front. *Fontanelle:* Absent. *Eyes:* Two lateral, oval, unpigmented eyes, one on either side; flush with head surface; situated at a distance of their short diameter from the

TABLE 3.—Measurements in mm.) etc., of *Glyptotermes almorensis* Gardner; *G. ceylonicus* Holmgren and *G. corogensis* Holmgren & Holmgren. Soldier.

ex., examples.

Body-parts	<i>G. almorensis</i>		<i>G. ceylonicus</i>	<i>G. corogensis</i>
	Range (5 ex.)	Lectotype	Range (5 ex.)	Range (9 ex.)
1. Total body-length (excluding antennae) c.	4.8-5.7	5.7	6.5-10.4	4.8-5.8
2. Length of head to lateral base of mandibles	1.43-1.73	1.73	2.67-3.00	1.33-1.70
3. Maximum width of head	1.07-1.13	1.13	1.50-1.67	1.00-1.20
4. Maximum height of head	0.87-0.93	0.90	1.37-1.40	0.80-1.00
5. Head Index I (Width/Length)	0.65-0.75	0.65	0.56-0.60	0.65-0.75
6. Head Index II (Height/Width)	0.80-0.87	0.80	0.84-0.91	0.79-0.87
7. Head Index III (Height/Length)	0.52-0.60	0.52	0.47-0.51	0.53-0.61
8. Maximum length of labrum	0.20-0.25	0.23	0.32-0.47	0.13-0.23
9. Maximum width of labrum	0.27-0.30	0.30	0.33-0.43	0.27-0.30
10. Length of mandibles (from upper base of condyle to tip):				
(a) Left mandible	0.67-0.77	0.77	0.90-1.00	0.63-0.77
(b) Right mandible	0.70-0.77 (2 ex.)	0.77	0.90-1.00	0.63-0.77
11. Head-mandible length Index (Left mandible-length/Head-length to base of mandibles)	0.45-0.47	0.45	0.33-0.36	0.43-0.48
12. Minimum median length of postmentum	0.90-1.10	1.10	1.90-2.33	0.83-1.17
13. Maximum width of postmentum	0.40-0.43	0.40	0.50-0.60	0.35-0.44
14. Width of postmentum at anterior end	0.27-0.30	0.27	0.33-0.40	0.21-0.30
15. Width of postmentum at waist	0.20-0.21	0.23	0.23	0.19-0.27
16. Postmentum-contraction Index (i.e., Width at waist/Maximum width)	0.47-0.57	0.57	0.38-0.46	0.48-0.62
17. Maximum length of pronotum	0.60-0.63	0.63	0.73-0.97	0.50-0.60
18. Maximum width of pronotum	1.03-1.07	1.07	1.33-1.67	0.87-1.03
19. Pronotum-head Index (Pronotum-width/Head-width)	0.94-0.96	0.94	0.87-1.00	0.86-1.00
20. Pronotum Index (Length/Width)	0.58	0.58	0.55-0.60	0.55-0.61
21. Maximum width of mesonotum	0.80-0.93	0.93	1.33-1.60	0.80-0.97
22. Maximum width of metanotum	0.83-0.90 (2 ex.)	—	1.33-1.67	0.87-0.97

antennal socket. *Ocelli*: Indistinct. *Antennae*: With 11–12 segments; segments 1 and 2 sparsely and the remainder fairly, pilose; segment 1 longest, cylindrical; 2 cylindrical, about one-half of 1; 3 shorter than 2, subequal to or slightly longer than 4; sometimes subdivided; 4 to the penultimate one broadly pyriform and subequal; the last ovate and narrower than the penultimate one. *Clypeus*: Subtrapezoidal; divided into an ante- and a postclypeus. Anteclypeus a thin, pale, apilose strip. Postclypeus pilose; demarcated from frons by a thin, weak groove. *Labrum*: Broadly tongue-shaped and slightly wider than long; anterior margin rounded. *Mandibles*: Short, stout and strongly hooked apically; length a little less than half of head-capsule. Left mandible with 3 marginal teeth; marginals 1 and 2 close together and situated in distal third of mandible; marginal 3 larger and situated in middle-third. Right mandible with 2 marginal teeth in middle-third of mandible. *Postmentum*: Long, club-shaped; widest at about anterior one-third; sides gradually narrowing behind into a narrow waist at posterior one-third and widening again posteriorly; in front of widest point, sides weakly narrowed; anterior margin substraight; posterior margin concave, bulged medially.

Thorax: Pronotum: Subrectangular; slightly narrower than head-capsule (as wide as head, according to Gardner 1944); much broader than long (maximum length 0.60–0.63; maximum width 1.03–1.07 mm.); anterior margin weakly concave and slightly notched in middle; sides substraight and narrowed posteriorly; posterior margin nearly straight; antero-lateral corners narrower than postero-lateral corners. *Mesonotum*: Narrower than pronotum; posterior margin straight. *Metanotum*: As wide as, or a little wider than, mesonotum; posterior margin straight. *Legs*: Short and hairy; apical tibial spurs 3:3:3. Tarsi 4-jointed.

Abdomen: Oblong, hairy; the last tergite somewhat darker than, the rest. Cerci 2-jointed.

3. PSEUDOWORKER (Table 4).—

General: Head-capsule pale brown; antennae, labrum and body paler than head. Mandibles pale brown with dark brown toothed margins. Head and body sparsely pilose. Total body-length *c.* 4.5–5.0 mm.

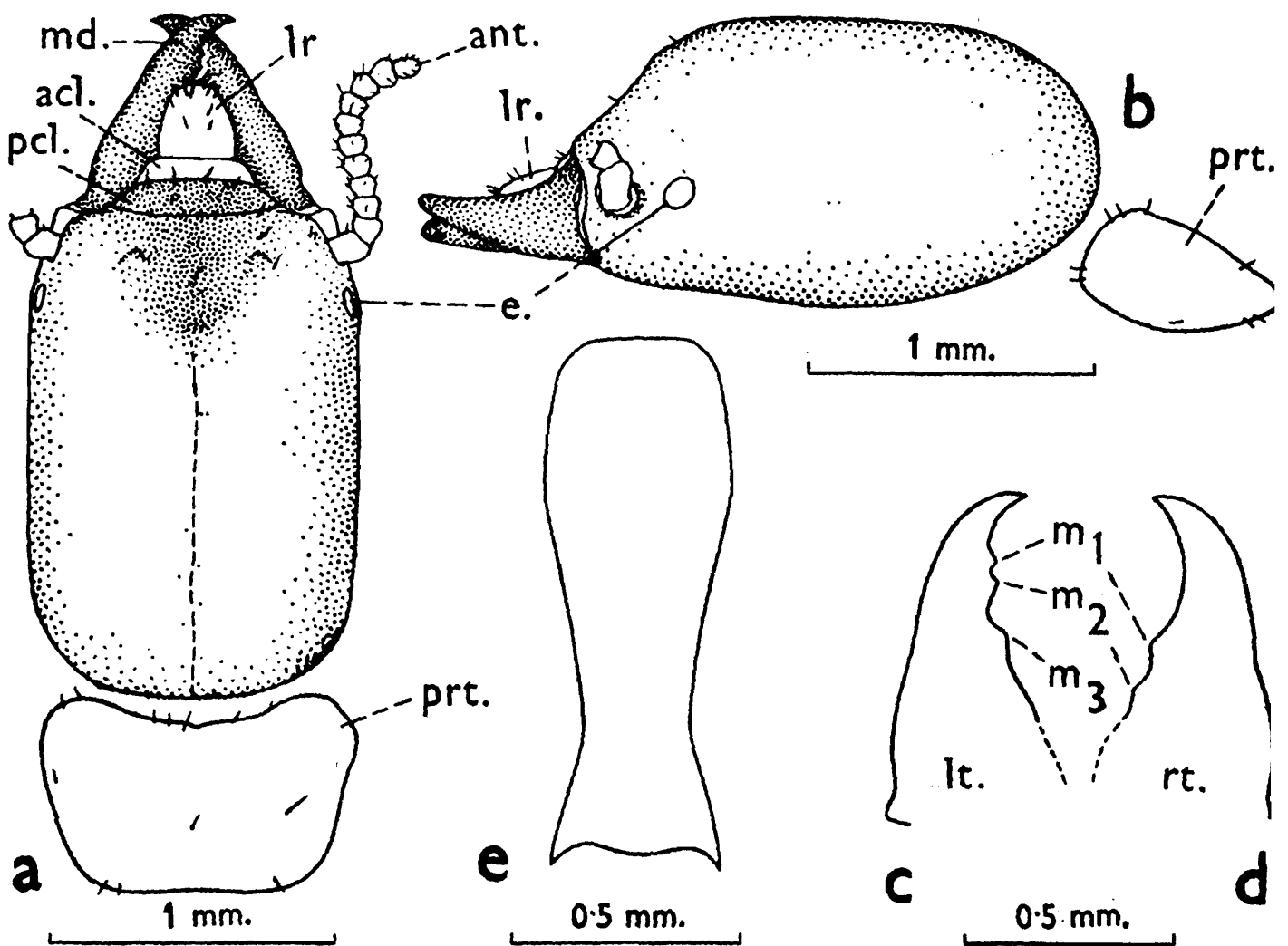
Head: Head-capsule subcircular; almost as wide as length to lateral base of mandibles (length to lateral base of mandibles 1.00; maximum width 0.93–1.03 mm.). *Fontanelle and ocelli*: Absent. *Eyes*: Two lateral unpigmented eyes, one on either side; flush with head-surface. *Antennae*: With 10–11 segments; segment 1 long, cylindrical; 2 a little longer than half of 1, cylindrical; 3 short; 4 to the penultimate one broadly pyriform and gradually increasing in length; the last ovate, narrower and shorter than the penultimate one. *Clypeus, labrum and mandibles*: As in imago.

Thorax: Pronotum: Almost as wide as, or slightly narrower than, head-capsule; broader than long (maximum length 0.57; maximum

width 0.90–1.00 mm.); anterior margin concave; posterior margin substraight. *Legs*: As in soldier.

Abdomen: Oblong, sparsely pilose. Cerci 2-segmented, 0.07 mm. long (broken in most of the specimens examined). Styli also broken in the specimens examined.

(c) *Type-specimens*:—Gardner (1944) neither selected the holotype nor gave any repository of the types. Out of the cotypes present in



Text-fig. 5.—*Glyptotermes almorensis* Gardner. Soldier. Lectotype, from Bajwar (U.P., India).

- (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.

acl., anteclypeus; *ant.*, antenna; *e.*, eye; *lr.*, labrum, *lt.*, left; *m₁–m₃*, 1st to 3rd marginal teeth of mandibles; *md.*, mandible; *pcl.*, postclypeus; *prt.*, pronotum; *rt.*, right,

TABLE 4.—Measurements (in mm.) of *Glyptotermes almorensis* Gardner, *G. ceylonicus* Holmgren and *G. coorgensis* Holmgren & Holmgren. Pseudoworker.

ex., examples.

Body-parts	<i>G. almorensis</i>	<i>G. ceylonicus</i>	<i>G. coorgensis</i>
	Range (5 ex.)	(1 ex.)	Range (10 ex.)
1. Total body-length (excluding antennae) <i>c.</i>	4.5 —5.0	8.60	4.9 —6.2
2. Length of head to tip of labrum	1.17—1.37	1.83	1.17—1.33
3. Length of head to lateral base of mandibles	1.00	1.40	0.90—1.07
4. Maximum width of head	0.93—1.03	1.50	0.93—1.10
5. Maximum height of head	0.50—0.60	0.97	0.57—0.67
6. Maximum length of labrum	0.20—0.30	0.47	0.20—0.33
7. Maximum width of labrum	0.33—0.40	0.43	0.33—0.40
8. Maximum length of pronotum	0.57	0.90	0.53—0.70
9. Maximum width of pronotum	0.90—1.00	1.60	0.83—1.00

the F.R.I., Dehra Dun, *vide* "Material (i)" above, I have selected the lectotype and paralectotypes as follows:—

Lectotype: A soldier, in a vial.

Paralectotypes: An imago and several pseudoworkers, in a vial.

Cotypes are also present in B.M., London and with Prof. Emerson (now in A.M.N.H., New York) *vide* Roonwal and Pant (1953, p. 44).

(*d*) *Type-locality*:—Bajwar, Almora District (Uttar Pradesh, India), *c.* 31° 30' N., 75° 55' E.

(*e*) *Distribution*: India: *Uttar Pradesh*: Bajwar (type-locality), Almora District; and Paithani, 30° 05' N., 78° 55' E., Garhwal District.

(*f*) *Comparison*.—*Glyptotermes almorensis* is close to *G. coorgensis* Holmg. & Holmg. and *G. minutus* Kemner, and is separable from them as follows:—

1. From *G. coorgensis*:

Imago: (i) Slightly paler species. (ii) Head-capsule somewhat larger (length to base of mandibles 0.90–0.97 *vs.* 0.87–0.90 mm.; maximum width 0.90–0.97 *vs.* 0.87–0.93). (iii) Ocelli larger and directed anteriorly in lateral view *vs.* smaller and directed vertically (maximum diameter 0.09 *vs.* 0.07 mm.).

Soldier: (i) Antero-lateral corners of head-capsule at base of mandibles, rounded (*vs.* sharply projected). (ii) Head sutures indistinct (*vs.* distinct). (iii) Inner margin of left mandible between marginal

teeth 2 and 3 roundly concave (*vs.* incurved with a deep notch). (iv) Mandibles without a basal hump on outer margin (*vs.* with a weak to prominent hump).

2. From *G. minutus*:

Imago: (i) Generally larger (length to tip of labrum 1.13–1.30 *vs.* 0.99; length to base of mandibles 0.90–0.97 *vs.* 0.85; pronotum length 0.53–0.60 *vs.* 0.49; and pronotum width 0.77–0.83 *vs.* 0.76 mm.). (ii) Head-sutures distinct *vs.* indistinct. (iii) Eyes separated from antennae by a distance of 0.03–0.04 mm. *vs.* 0.015 mm.; and from basal margin of head by 0.17 *vs.* 0.13 mm.

Soldier: (i) Head-capsule wider (maximum width 1.06–1.13 *vs.* 0.90 mm. (index Width/Length 0.65–0.75 *vs.* 0.60). (ii) Head-sutures indistinct *vs.* distinct. (iii) Postmentum waist short and broad *vs.* long and narrow (Postmentum-Contraction Index *i.e.*, Width at waist/Maximum width 0.47–0.57 *vs.* 0.46).

2. *Glyptotermes ceylonicus* Holmgren

(Text-figs. 6 & 7; Tables 3 & 4)

(i) *Calotermes (Glyptotermes) ceylonicus* Holmgren

- 1911a. N. Holmgren, In: Escherich's *Termitenleben auf Ceylon*,: 187, 189, *Im. Type-locality*: Peradeniya (Ceylon).
 1911b. N. Holmgren, *Zool. Anz.*, Leipzig, **37** (26): 551. [= *C. dilatatus*].
 1913a. N. Holmgren, *Spol. Zeylan.*, Colombo, **8** (32): 277, 279–280. *Im.* and *S.* Ceylon: Peradeniya.
 1913b. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **50** (2): 49, 50, 55–56, fig. 10 (*S. mandibles*), pl. 1, fig. 12 (*S.*), *Im.* and *S.* Ceylon.
 1913. E. E. Green, *Spol. Zeylan.*, Colombo, **9** (33): 8. Ceylon: Peradeniya.
 1925. O. John, *Treubia*, Batavia, **6** (3-4): 380. Ceylon: Peradeniya.
 1930. F. P. Jepson, *Trop. Agric.*, Peradeniya, **75** (3 & 4): 149, 151, 155, 1 pl. Ceylon: Elpitiya; Hewaheta; Peradeniya.
 1931. F. P. Jepson, *Adm. Rep. Dir. Agric. Ceylon*, Colombo, 1930: 72, 73. Ceylon: Hewaheta Dist.; Chilaw; Peradeniya.
 1934. V. Margabandhu, *J. Bombay nat. Hist. Soc.*, Bombay, **37** (3): 702. Ceylon: Peradeniya.

(ii) *Calotermes ceylonicus* Holmgren

1922. E. Hegh, *Les Termites*, Brussels, p. 48. Ceylon.

(iii) *Glyptotermes ceylonicus* Holmgren

1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, **3** (1): 86. Ceylon: Hewaheta; Passara; Peradeniya.
 1941. C. F. C. Beeson, *Ecology & Control Forest Insects, etc.*: 541.
 1942. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (2): 116. Protozoa.
 1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112**: 47. Ceylon.
 1953. M. L. Roonwal and G. D. Pant, *Indian For. Leaf. (Ent.)*, Delhi, No. 121 (3): 44. Ceylon: Kurunegala.
 1958. M. Ahmad, *Biologia*, Lahore, **4** (1-2): 47, 50. Keys.
 1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, **122**, (Art. 4): 347.
 1962. R. N. Mathur and R. S. Thapa, *Indian For. Leaf. (Ent.)*, Delhi, No. 167: 9. Ceylon: Kurunegala; Peradeniya.

(iv) *Kalotermes (Glyptotermes) ceylonicus* Holmgren

1953. Rattan Lal and Menon, R. D., *Catalogue Indian Insects*, Part 27—*Isoptera*: 12–13. Ceylon. Also see for other references on biology of this species.

(v) *Glyptotermes ceylonicus* var. *cylindricus* Kemner (MS name).

1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, **3** (1): 87. Ceylon: Elpitiya.

1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112**: 346. Ceylon: Elpitiya.

1962. R. N. Mathur and R. S. Thapa, *Indian For. Leaflet. (Ent.)*, Delhi, No. 167: 9. Ceylon: Elpitiya; Talgaswella.

(a) *Material Examined*

(A) *Present in Z.S.I., Calcutta*: (i) A vial with 2 soldiers, Kurunegala, Ceylon, *F.R.I. coll.*, 24.xii.1934, ex "*Cutocarpus integrifolia*"

(B) *Present in Zoologiska Institute, Lund University, Lund*: (ii) A vial with 2 soldiers, 2 nymphs and 1 pseudoworker, Talgaswella, Elpitiya, Ceylon, coll. *F.P. Jepson* (No. 6489), 20.viii.1925, ex "dead *Heavea*" *Det.* N. Kemner "*Calotermes (Glyptotermes) ceylonicus* var. *cylindricus*" (MS name). (iii) A vial with 1 soldier, Ceylon, coll. *F.P. Jepson*, 20.viii.1925, ex "Kemner's Coll."

(b) *Description*

1. IMAGO.—

Imagos were not available to me. I, therefore, give below the English translation of the original description:

"IMAGO¹) Head pale brown, paler in front [Yellowish brown to brown, *vide* Holmgren 1913]. Pronotum paler than head. Abdomen brownish above, paler below, legs rust yellow. Wings iridescent, with brownish anterior veins.

"Pilosity of head and thorax very thin.

"Head thick, almost quadrately oval. Facetted eyes and ocelli small, the latter separated from the eyes by their diameter or a little more [touching the eyes *vide* Holmgren 1913]. Clypeus short. Antenna 14-segmented (?) [13-segmented *vide* Holmgren 1913], distinctly thickened distally. Segment 2 almost as long as 3.

"Pronotum as wide as head posteriorly [narrower than head *vide* Holmgren 1913], anterior corners rectangular [acutely rounded *vide* Holmgren 1913], posterior corners strongly rounded, posterior margin hardly sinuate. Pronotum somewhat longer than half the width. Wings moderately long, narrow, marked, weakly iridescent. Subcosta not visible. Radius joined with anterior margin before the middle of wing. Radial sector single. Median outside running near the radial sector. Transverse branches absent. Cubitus only basally strongly marked, with generally 13 [10–12 *vide* Holmgren 1913] branches which stand thick basally."

¹) Description from a dried example."

The following measurements of imago are from Holmgren 1911*b* (original description), Holmgren (1913, *Spolia Zeyl.*, **8** (32), p. 279; and 1913, *K. Sv. Vet. Akad. Handl.*, **50** (2), p. 55):—

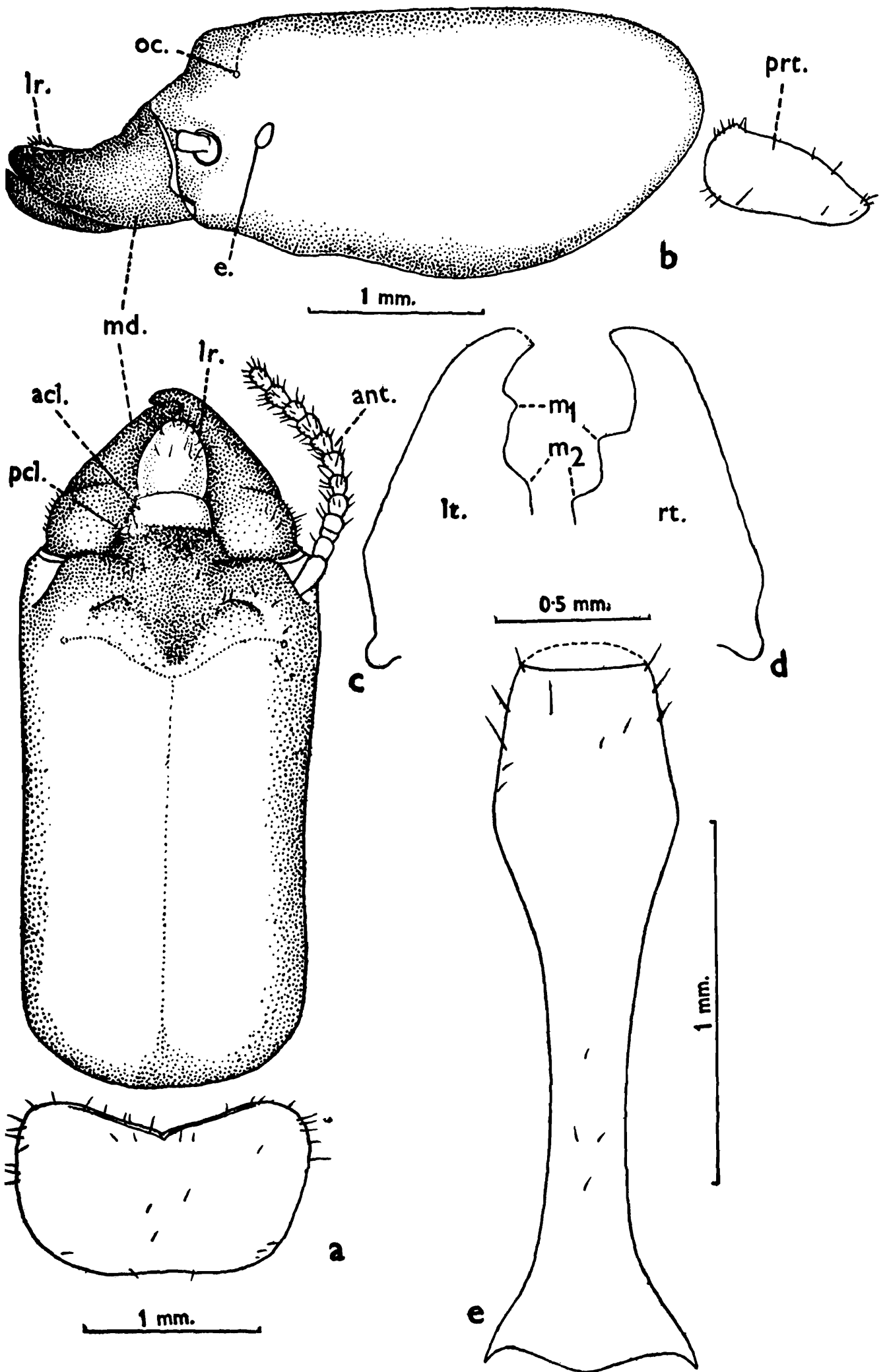
1. Length with wings	8.5 – 11.0 mm.
2. Length without wings	4.7 – 6.0 „
3. Length of head	1.33– 1.52 „
4. Width of head	1.15– 1.30 „
5. Length of pronotum	0.52– 0.72 „
6. Width of pronotum	0.96– 1.22 „
7. Length of forewing	7.3 „

2. SOLDIER (Text-fig. 6; Table 3).—

General: Head-capsule pale brownish yellow, frons reddish brown; mandibles black, reddish brown at base; labrum and antennae pale yellow to pale reddish yellow; body and legs straw yellow. Head sparsely and body moderately hairy. Total body-length *c.* 6.5–10.4 mm.

Head: Head-capsule subrectangular; frons sloping in front; dorso-lateral protuberances of frons quite prominent; much longer than broad (length to base of mandibles 2.62–3.01; maximum width 1.50–1.67 mm.); sides subparallel; posterior margin round; Y-suture present. *Fontanelle:* Absent. *Eyes:* Two lateral, translucent, suboval eyes; situated a little behind the antennae. *Ocelli:* Two lateral, dot-like, translucent ocelli, one on either side, at the end of the lateral arms of Y-suture. *Antennae:* With 12 segments; moderately pilose; segment 1 longest and cylindrical; 2 about half of 1 or a little longer, and cylindrical; 3 shortest; 4–11 pear-shaped; the last shorter and narrower than the penultimate one. *Clypeus:* Divided into an ante- and a post-clypeus. Anteclypeus apilose; either a thin or moderately long, rectangular, translucent strip. Postclypeus pilose, demarcated from frons only at lateral corners. *Labrum:* Broadly tongue-shaped; anterior margin broad; slightly longer than broad and extending beyond the middle of mandibles. *Mandibles:* Thick and stout, distally broadly narrowed. Left mandible with 2 large, broad marginal teeth; 1st marginal a little above one-fourth of mandible (in one example very near the distal tip); 2nd marginal broader and larger than 1st and located in middle of mandible length. [In the figure given by Holmgren 1913, fig. 10, the 2nd marginal is shown just below the 1st. Dentition of left mandible is apparently very variable.] Right mandible with 2 marginal teeth in the middle of mandible-length. *Postmentum:* Long and club-shaped; with a few hairs anteriorly and in middle of waist; widest at about anterior one-fourth; anteriorly the sides weakly narrowed; posteriorly the sides strongly narrowing into a long waist and again widening out abruptly near posterior margin; anterior margin substraight or weakly convex; posterior margin medially projected.

Thorax: Pronotum: Flat, subrectangular, either narrower, or as wide as head (maximum length 0.65–0.97; maximum width 1.33–1.67 mm.); anterior margin concave and with a minute, median notch; sides round and faintly narrowed posteriorly; posterior margin convex, either



Text-fig. 6.—*Glyptotermes ceylonicus* Holmgren. Soldier. Elpitiya (Ceylon).
 (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.
acl., anteclypeus; *ant.*, antenna; *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.

notched or incurved medially; antero-lateral corners narrower than postero-lateral corners. *Mesonotum*: Narrower than pronotum and weakly incurved at posterior margin. *Metanotum*: As wide as, or narrower than, pronotum and weakly incurved at posterior margin. *Legs*: Short and stout; apical tibial spurs 3 on each leg. *Tarsi* 4-jointed.

Abdomen: Oblong; moderately pilose. *Cerci* 2-jointed, 0.17–0.20 mm. long. *Styli* single-jointed, 0.10 mm. long.

3. PSEUDOWORKER (Text-fig. 7; Table 4).—

General: Head-capsule pale yellow; antennae, labrum, body and legs pale straw yellow; mandibles yellowish brown with dark brown toothed margins. Head and body moderately hairy. Total body-length *c.* 8.6 mm.

Head: Head-capsule subcircular, a little broader than long (maximum width 1.50; length to base of mandibles 1.40 mm.); head sutures not clear. *Fontanelle*: Absent. *Eyes*: Two lateral, compound, colourless eye-spots present, one on either side. *Ocelli*: Absent. *Antennae*: Broken in the specimen examined; only 8 segments present; segment 1 longest, cylindrical; 2 a little shorter than 1 and cylindrical; 3 shortest; 4–8 gradually increasing in length and broadly pyriform. *Clypeus*: Flat; trapezoidal; not clearly divided into an ante- and a postclypeus; with a few hairs near posterior margin. *Labrum*: Broadly tongue-shaped; longer than broad; with a few hairs near anterior margin and on body; anterior margin truncate. *Mandibles*: Of typically *Glyptotermes*-type.

Thorax: Pronotum: Flat, subrectangular; wider than head-capsule; much wider than long (maximum length 0.90; maximum width 1.60 mm.); anterior margin concave with a faint median notch; sides round; posterior margin with a broad median notch. *Legs*: Short and stout; apical tibial spurs 3 on each leg. *Tarsi* 4-jointed.

Abdomen: Oblong, moderately hairy. *Cerci* 2-jointed, 0.17 mm. long. *Styli* single-jointed, 0.10 mm. long.

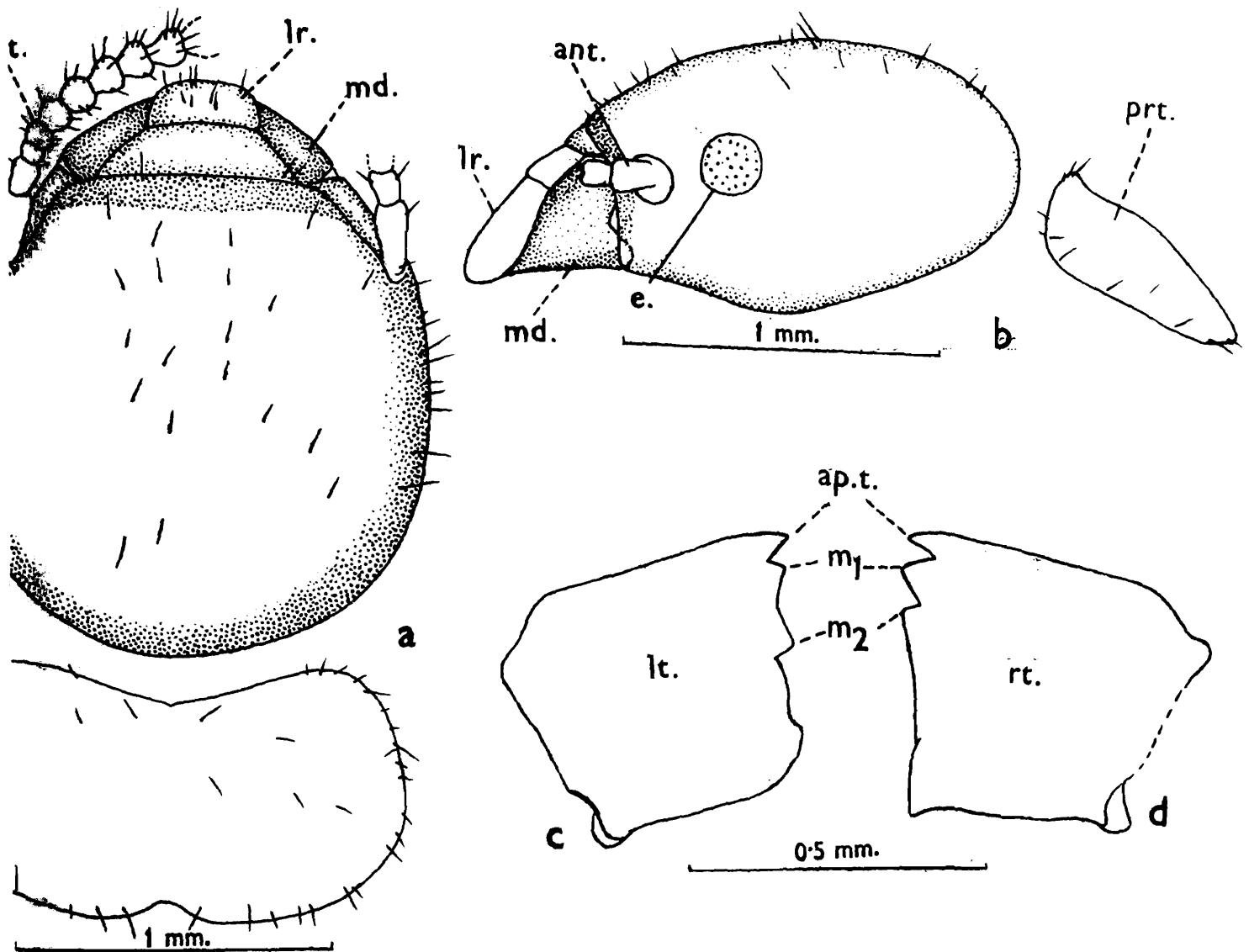
(c) *Type-specimens*.—The species was described by Holmgren (1911b) from a single dry imago which thus becomes the holotype; it is stated to be present in Vienna Museum.

(d) *Type-Localities*.—Peradeniya (Ceylon).

(e) *Distribution*.—The species is confined to Ceylon and has been recorded as follows:—

Chilaw, 7°34' N., 79°48' E.; Hewaheta; Elpitiya, 6°16' N., 80°09' E.; Kurunegala, 7°28' N., 80°23' E.; Passara, 6°57' N., 81°09' E.; Peradeniya, 7°16' N., 80°37' E.

(f) *Comparison*—*Glyptotermes ceylonicus* Holmgren along with *G. dilatatus* (Bugn. & Popoff) can be separated from all the other Indian species by their larger size. *G. ceylonicus* is close to *G. dilatatus* (Bugn. & Popoff),



Text-fig. 7.—*Glyptotermes ceylonicus* Holmgren. Pseudoworker. Elpitiya (Ceylon).

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

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; *notum*; *rt.*, right.

G. borneensis (Haviland) and *G. buttelreepeni* Holmg. but can be separated from them as follows:—

From G. dilatatus

Imago: (i) Darker (*vs.* paler). (ii) Sagittal-sutures distinct (*vs.* undistinct). (iii) Antero-lateral corners of pronotum narrowly round (*vs.* broadly rounded).

Soldier: (i) Head-capsule thicker, stouter and larger (length to lateral base of mandibles 2.62–3.01 *vs.* 2.00–2.33 mm.; maximum width 1.50–1.67 *vs.* 1.27–1.35 mm.). (ii) Mandibles thicker and shorter (length 0.90–1.00 *vs.* 1.03–1.13 mm.). (iii) Left mandible with two marginal teeth (*vs.* with four teeth). (iv) Labrum extending beyond the middle of mandibles (*vs.* not beyond middle). (v) Anteriorly, the genae with round and flat anterior margins (*vs.* projected in front). (vi) Anterior broad portion of postmentum simple (*vs.* bilobed). (vii) Anterior margin of pronotum angularly concave (*vs.* roundly concave)

2 *From G. borneensis*

Imago: (i) Antenna with 13 segments, segment 3 subequal to 2 (*vs.* with 11–12 segments, segment 3 shorter than 2). (ii) Pronotum narrower than head (*vs.* broader)

Soldier: (i) Head-capsule thicker and larger (length to lateral base of mandibles 2.62–3.01 *vs.* 2.32–2.47 mm.). (ii) Mandibles shorter and thicker, with 2 marginal teeth (*vs.* longer and thinner, with 4 marginal teeth)

3 *From G. buttel-reepeni*

Imago: (i) Paler and smaller (head width 1.15–1.30 *vs.* 1.44–1.47 mm.; pronotum width 0.96–1.22 *vs.* 1.37 mm.). (ii) Antenna with 13 segments (*vs.* 11–12 segments). (iii) Wings shorter (forewing length 7.3 *vs.* 9.5 mm.).

Soldier: (i) Head-capsule longer and narrower (length to base of mandibles 2.62–3.01 *vs.* 2.66 mm.; maximum width 1.50–1.67 *vs.* 1.75 mm.); index Width/Length 0.56–0.60 *vs.* 0.66. (ii) Mandibles shorter and thicker (*vs.* comparatively longer and thinner).

3. **Glyptotermes coorgensis** Holmgren & Holmgren

(Text-figs. 8–10; Tables 2–4)

(i) *Calotermes* (*Glyptotermes*) *coorgensis* H. & H.

1917. K. Holmgren and N. Holmgren, *Mem. Dep. Agric. India*, Calcutta, 5 (3). 139–140, 1 fig. (*S.* mandibles). *S. Type-locality*: Sidapur, Coorg (Mysore State, India)

1934. V. Margabandhu, *J. Bombay nat. Hist. Soc.*, Bombay, 37 (3): 702. *India*. Sidapur (Coorg, Mysore State)

(ii) *Glyptotermes coorgensis* H. & H

1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, 112: 49 *India*.
 1958. G. D. Bhasin, M. L. Roonwal and S. Singh, *Indian For. Bull. (Ent.)*, (N.S.) Delhi, No. 171 (2): 99.
 1958. M. Ahmad, *Biologia*, Lahore, 4 (1 & 2): 52. Keys.
 1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, 122, (Art. 4): 347
 1962. R. N. Mathur and R. S. Thapa, *Indian For. Leaflet. (Ent.)*, Delhi, No. 167 10. *India*: Sidapur (Coorg, Mysore State)

(iii) *Kalotermes (Glyptotermes) coorgensis* H. & H

1953. Rattan Lal and Menon, R. D., *Cat. Indian Insects*, Part 27, *Isoptera*, p. 13 *India*: Sidapur (Coorg, Mysore State)

(a) *Material Examined*

Present in Z.S.I., Calcutta. (i) A vial with 2 imagos (dealate), 3 soldiers and several pseudoworkers, Anekad Forest Range, Coorg (Mysore State, India), coll. O. B. Chhotani, 21.xi.1962, ex "dead portion of a *Ficus religiosa* Linn. tree"

(ii) A vial with 5 soldiers, and several pseudoworkers and nymphs, ex "dead log of an unknown wood lying on ground"; other data as in (i) above.

(iii) A vial with a soldier and several pseudoworkers, Z.S.I. Coll Sta. No. 13, Janserigoda, Bababudin Hills (Chickmagalur District, Mysore State, India), coll. O. B. Chhotani, 12.xi.1962, ex "a dead silver oak tree"

b) *Description*

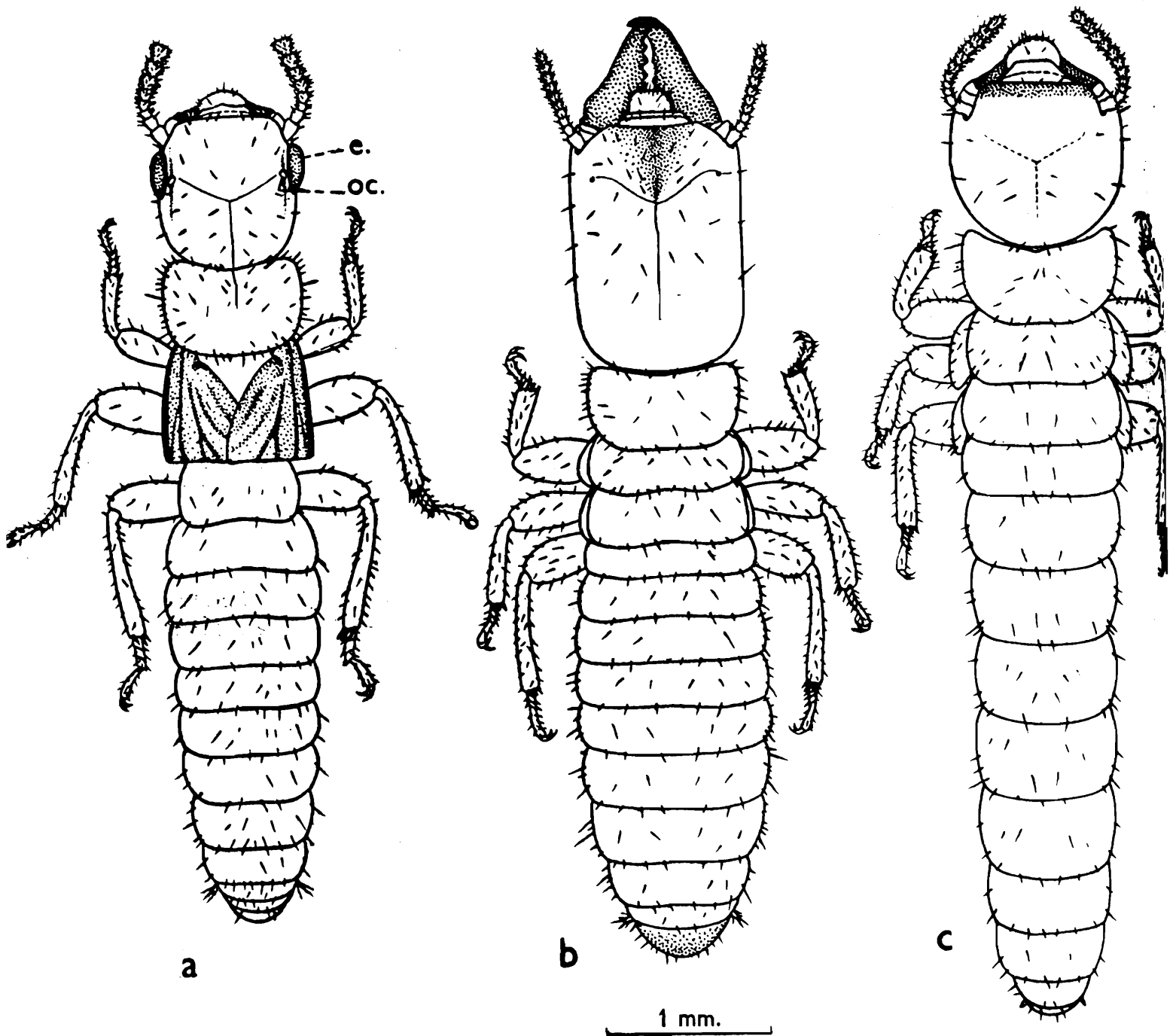
IMAGO (Text-figs. 8 & 9; Table 2).

The hitherto unknown imago caste of this species is described here for the first time.

General: Head-capsule dark castaneous brown; thorax, wing-scales and abdomen a little paler; abdominal sternites paler than targites, basal 4 sternites yellowish medially; labrum and legs brownish; antennae a little darker than labrum and legs; antennal segments paler distally; mandibles brownish, with dark brown toothed margins. Head and body fairly pilose with short and long hairs. Total body-length without wings *c.* 4.2–4.6 mm.

Head: Head-capsule subsquarish; as wide as or slightly wider than length to base of mandibles; maximum width with eyes 0.87–0.93; length to base of mandibles 0.87–0.90 mm.; sides substraight; posterior margin round; Y-suture present *Fontanelle*. Absent. *Eyes:* Two

lateral, oval, black, faceted eyes; one on either side; maximum diameter 0.25; minimum diameter 0.20–0.21 mm.; separated from the lower margin of head-capsule by a distance of 0.15 mm. *Ocelli*: Two small, oval, translucent ocelli one on either side, and touching the eye of its side; directed vertically when viewed laterally. Diameter: maximum 0.07, minimum 0.05 mm. *Antennae*: Incomplete in both



Text-fig. 8.—*Glyptotermes coorgensis* Holmgren and Holmgren.

Specimens from Anekad Forest Range, Coorg (Mysore State, India).

(a) Imago (dealate), in dorsal view. (b) Soldier, in dorsal view.
(c) Pseudoworker, in dorsal view.

e., eye; oc., ocellus.

examples (maximum 9 segments present); segments 1 and 2 sparsely, and the remainder fairly, pilose; segment 1 longest, cylindrical; 2 about half of 1 in length and cylindrical; 3 slightly shorter than 2; 4 onwards gradually increasing in size and pyriform. *Clypeus*: Subtrapezoidal; indistinctly divided into an ante- and a postclypeus. Anteclypeus apilose; anterior margin weakly projected in front medially. Postclypeus with a few hairs near posterior margin; anterior margin weakly convex. *Labrum*. Broader than long; with a few hairs near anterior margin and on body. *Mandibles*: Of typically *Glyptotermes*-type. Left mandible with an apical and two marginal teeth; apical finger-like; 1st marginal shorter than apical; 2nd subequal to 1st; posterior margin of 1st and anterior margin of 2nd subequal. Right mandible also with an apical and 2 marginal teeth; apical as in left mandible; 1st marginal short and triangular; 2nd shorter than 1st and with a long posterior margin.

Thorax: Pronotum: Subrectangular; anterior region paler; narrower than head with eyes; much broader than long (maximum length 0.57; maximum width 0.80–0.83 mm.); antero-lateral corners narrower than postero-lateral ones; anterior margin weakly concave; margin of sides weakly convex; posterior margin substraight. *Mesonotum and metanotum*: Weakly incurved at posterior margin. *Legs*: Short, hairy; apical tibial spur formula 3:3:3. Tarsi 4-jointed; an arolium present between claws. *Wing-scales*: Forewing scale large, shield-like, 0.77–0.80 mm. long. Hindwing scales short, triangular, and completely covered by forewing scales; 0.33 mm. long.

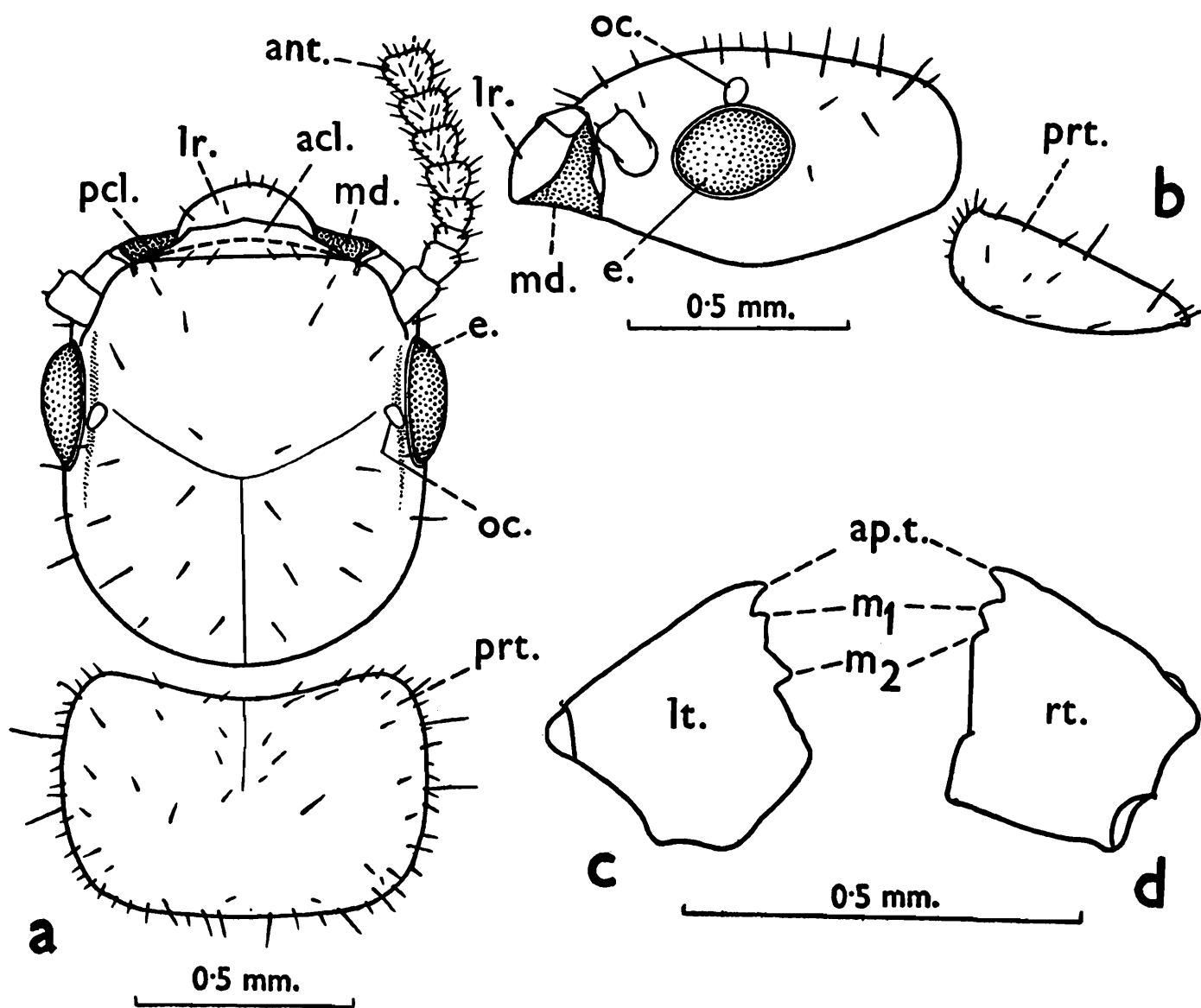
Abdomen: Oblong; hairy, with a few long and many short hairs near posterior margin of each tergum, and a few long hairs anteriorly. Cerci 2-jointed, *c.* 0.10 mm. long, hairy. Styli present in male, minute, one-jointed, 0.07 mm. long.

2. SOLDIER (Text-figs. 8 & 10; Table 3).—

General: Head-capsule reddish yellow; anteriorly reddish brown, posteriorly somewhat paler; mandibles blackish brown; antennae yellow to pale brown; labrum pale brown; thorax and abdomen creamish yellow to pale brown or pale reddish yellow, pronotum somewhat darker; legs yellow; last abdominal tergite weakly to strongly more chitinised than the preceding ones. Head and body sparsely pilose. Total body-length *c.* 4.2–6.0 mm.

Head: Head-capsule subrectangular; longer than broad; length to lateral base of mandibles 1.29–1.70; maximum width 0.99–1.20 mm. frons bilobed, sloping in front at an angle of *c.* 45° and depressed medially; sides substraight; posterior margin round; Y-sutures present, distinct; antero-lateral corners of head-capsule sharply projected in front near the base of mandibles. *Fontanelle*: Absent. *Eyes*: Two lateral, oval, unpigmented eye-spots present, *c.* 0.08–0.13 mm. long. *Ocelli*: Two

lateral, minute, dot-like ocelli present, one on either side at the end of lateral arms of Y-suture. *Antennae*: With 9–11 segments; segments 1 and 2 sparsely, and the remainder fairly, pilose; segment 1 longest, cylindrical; 2 about half of 1 and cylindrical; 3 variable, either shortest or subequal to or longer than 2, sometimes subdivided into two; 4 to the penultimate one gradually increasing in size and pyriform; the last ovate, shorter and narrower than the penultimate one. *Clypeus*: Subtrapezoidal; divided into an ante- and a postclypeus. Anteclypeus pale brown, apilose, strip-like; either very short or as long as postclypeus. Postclypeus of same colour as frons, and pilose; separated

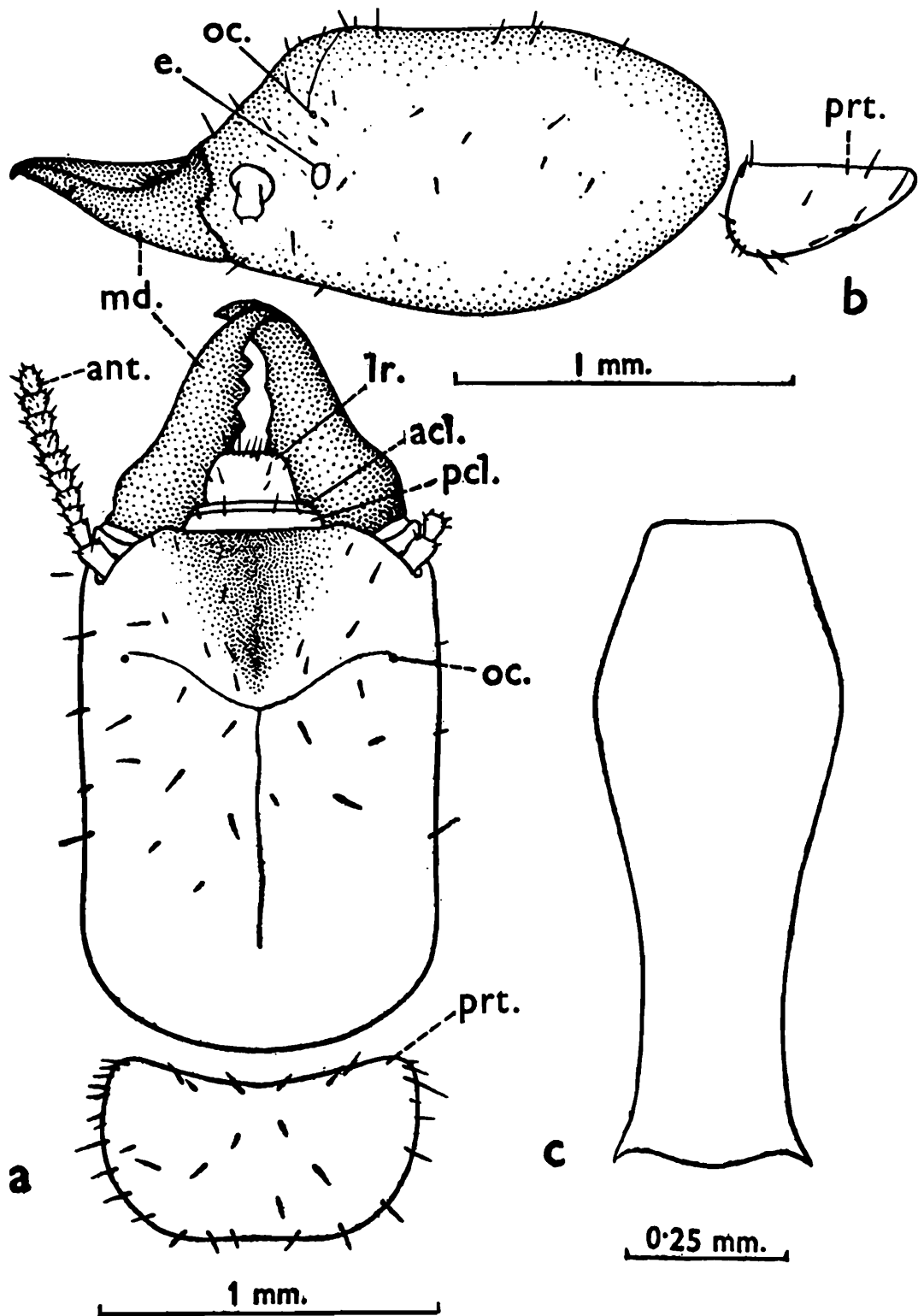


Text-fig. 9.—*Glyptotermes coorgensis* Holmgren and Holmgren. Imago. Anekad Forest Range, Coorg (Mysore State, India).

(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.

from frons by a thin groove. *Labrum*: Broadly tongue-shaped; wider than long; anterior margin truncated or weakly rounded; with several hairs near tip and a few on body. *Mandibles*: Thick and short; shorter



Text-fig. 10.—*Glyptotermes coorgensis* Holmgren and Holmgren.

Soldier. Anekad Forest Range, Coorg (Mysore State, India).

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

(c) Postmentum, in ventral view.

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

than half the length of head to base of mandibles; outer margin concave in basal third and with a weak to prominent hump further down. Left mandible with 3 marginal teeth; 1st and 2nd marginals close together; 3rd widely separated and larger; margin between the 2nd and 3rd incurved and notched. Right mandible with two small marginal teeth in middle third. *Postmentum*: Long, club-shaped; maximum width at about distal one-third; waist long; anterior margin substraight to weakly convex; posterior margin concave, medially convexly projected.

Thorax: Pronotum: Transversely subrectangular; narrower than head-capsule; much wider than long; maximum length 0.46–0.60; maximum width 0.87–1.06 mm.; anterior margin concave; sides weakly convex and narrowing posteriorly; posterior margin weakly convex, sometime slightly incurved medially; antero-lateral corners narrower than postero-lateral corners. *Mesonotum*: Slightly narrower than pronotum; posterior margin weakly incurved medially. *Metanotum*: As wide as pronotum; posterior margin weakly invaginated. Epimerson of meso- and metanota swollen. *Legs*: Short, hairy; apical tibial spur formula 3: 3: 3. Tarsi 4-jointed.

Abdomen: Oblong; hairy; 10th tergite slightly to somewhat strongly, sclerotised. Cerci short, 2-segmented; 0.08–0.10 mm. long. Styli single-segmented, short, finger-like; 0.07 mm. long; sometimes absent.

3. PSEUDOWORKER (Text-fig. 8; Table 4).—

General: Head-capsule pale yellow to pale reddish yellow; antennae and legs paler than head; labrum pale brown; mandibles brownish yellow with dark brown toothed margins; thorax creamish white to pale brown, pronotum slightly more chitinised; abdomen creamish white but appearing pale pink to pale grey because of intestinal contents showing through the partly transparent tergites and sternites. Head and body fairly pilose. Total body-length *c.* 4.9–6.2 mm.

Head: Head-capsule subcircular; either as wide as or slightly wider than its length to base of mandibles (length upto base of mandibles 0.90–1.07; maximum width of head 0.93–1.10 mm.). *Fontanelle and Ocelli*: Absent. *Eyes*: Two lateral, unpigmented eyes present; sometimes not discernible. *Antennae*: With 10–11 segments; segments 1 and 2 as in soldier; 3 in 10 segmented antennae subequal to 2 and sometimes subdivided, in 11 segmented antennae shortest; 4- to the penultimate one gradually increasing in size and broadly pyriform; the last ovate, narrower and shorter than the penultimate one. *Glypeus, labrum and mandibles*: As in imago.

Thorax: Pronotum: Subrectangular; broader than long (maximum length 0.53–0.70; maximum width 0.83–1.00 mm.); narrower than head; anterior margin concave; sides weakly convex and narrowed posteriorly; hind margin weakly convex and slightly incurved medially. *Legs*: As in soldier.

Abdomen: Oblong, fairly pilose. Cerci 2-jointed, 0.10–0.13 mm. long. Styli single-jointed, short and finger-like; *c.* 0.07–0.10 mm. long.

(*c*) *Type-specimens*.—No holotype was selected by Holmgren and Holmgren (1917). The cotypes are present as follows:

(i) One soldier and several nymphs in Emerson Collection, now at A.M.N.H., New York. (ii) One pseudoworker, in F.R.I., Dehra Dun.

No cotypes apparently are present in the Holmgren Collection at the Naturhistoriska Riksmuseet, Stockholm (*vide* information received dated the 28th April, 1965 from that Museum, but they may still be found if the Holmgren Collection, which was poorly labelled by Holmgren, is examined in detail.

(*d*) *Type-locality*.—Sidapur, Coorg (Mysore State, India).

(*e*) *Distribution*.—INDIA: *Mysore State*: Anekad Forest Range, Coorg, *c.* 12°20' N., 75°50' E.; Janserigoda (Bababudin Hills, Chickmagalur Dist.), 13°30' N., 75°45' E. and Sidapur (type-locality), 12°15' N., 75°50' E.

(*f*) *Comparison*.—*Glyptotermes coorgensis* is close to *G. almorensis* Gardner, *G. brevicaudatus* (Haviland) and *G. minutus* Kemner, and is separable from these species as follows:—

1. *From G. almorensis*:

See under that species.

2. *From G. brevicaudatus*:

Imago: (i) Smaller in size and darker in colour *vs.* larger and paler (head-width 0.87–0.93 *vs.* 1.0–1.03 mm.; length to tip of labrum 1.07 *vs.* 1.22–1.29 mm.; pronotal width 0.80–0.83 *vs.* 0.91 mm.). (ii) Ocelli smaller, diameter: maximum 0.07 *vs.* 0.10 mm.; minimum 0.05 *vs.* 0.07 mm.).

Soldier: Soldier of one size-category (*vs.* of two categories, *e.g.* major and minor); *G. coorgensis* is close to the minor soldier of *brevicaudatus* but differs from it as follows:—(i) Left mandible with 3 prominent teeth (*vs.* with weak dentition). (ii) Margin between teeth of left mandible notched (*vs.* roundly concave). (iii) Right mandible with 2 teeth (*vs.* one tooth).

3. *From G. minutus*:

Imago: Somewhat larger (head-width with eyes 0.87–0.93 *vs.* 0.85; head-length to tip of labrum 1.07 *vs.* 0.99; length to base of mandibles 0.87–0.90 *vs.* 0.80; pronotal width 0.80–0.83 *vs.* 0.73 mm.). (ii) Sides of head-capsule without eyes substraight (*vs.* weakly convex and narrowed behind). (iii) Ocelli smaller and vertically directed when viewed laterally (*vs.* larger and directed antero-laterally (diameter: maximum 0.07 *vs.* 0.09, minimum 0.05 *vs.* 0.07 mm.)).

Soldier: (i) Antero-lateral corners of head-capsule pointed in front (*vs.* rounded). (ii) Head-capsule wider absolutely and in comparison to length to base of mandibles (maximum width 0.99–1.20 *vs.* 0.90 mm.; index Width/Length to base of mandibles 0.65–0.75 *vs.* 0.60). (iii) Mandibles thicker apically and with different dentition. (iv) Post-mentum behind the region of maximum width gradually narrowing *vs.* sharply narrowing and less contracted at waist (Contraction Index, Width at waist/Maximum width, 0.48–0.62 *vs.* 0.46).

4. *Glyptotermes dilatatus* (Bugnion & Popoff)

(Text-figs. 11 & 12; Tables 5–7)

(i) *Calotermes dilatatus* Bugnion & Popoff

1910. E. Bugnion and N. Popoff, *Mem. Soc. Zool. Fr.*, Paris, **23** : 137–143, text-fig. 13 (S.), pl. 4, S., *Ny.* and *Larva*. *Type-locality*: Ambalangoda (Ceylon).
 1911. N. Holmgren, *Zool. Anz.*, Leipzig, **37** (26): 551.
 1922. E. Hegg, *Les Termites*, Brussels: 46, 48. Ceylon.
 1926. N. A. Kemner, *Bull. ent. Res.*, London, **16** : 383–384. *Im.* and *S.* Ceylon: Ambalangoda; Elpitiya; Ingiriya; and Ratnapura.
 1926. F. P. Jepson, *Trop. Agric.*, Peradeniya, **67** : 73, 77, 78, 2 pls.
 1929. F. P. Jepson, *Trop. Agric.*, Peradeniya, **72** : 308–310.

(ii) *Calotermes (Glyptotermes) dilatatus* (Bugnion & Popoff)

1911. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **46** (6): 56, pl. 4, fig. 22 (S.).
 1913a. N. Holmgren, *Spolia Zeylan.*, Colombo, **8** (32): 278. *Im.* Ceylon : Peradeniya.
 1913b. N. Holmgren, *K. Sv. Vet. Akad. Handl.*, Stockholm, **50** (2): 56–57, fig. 11 (S. mandibles), pl. 1, fig. 10 (S.). *Im.* (dealate), *S.* and *Pw.* Ceylon.
 1913. E. E. Green, *Spolia Zeylan.*, Colombo, **9** (33): 8. Ceylon: Ambalangoda; Avisawella; Kegalla; Ratanapura; and Udugama.
 1914. N. Holmgren, *Zool. Jb. (Syst.)*, Jena, **36** (2-3): 234–235. *Im.* and *S.* Ceylon: Peradeniya.
 1914. E. Bugnion, *Bull. Hist. nat. Paris*, Paris, **20** (4): 176–177, pl. 4, figs. 1–4. Ceylon: Ambalangoda.
 1925. O. John, *Treubia*, Batavia, **6** (3-4): 380. Ceylon.
 1930a. F. P. Jepson, *Trop. Agric.*, Peradeniya, **75** (3 & 4), pp. 144–147, 155, 3 pls. Ceylon: Ambalangoda; Avissawella; Balangoda, Chilaw; Deniyaya; Elpitiya; Galaha; Galle; Gampola; Horana; Ingiriya; Kadugannawa; Katugastota; Kegalle; Kiriella; Matugama; Opanake; Pelmadulla; Peradeniya; Ratnapura; Udugama; Yatiyantota.
 1930b. F. P. Jepson, *Trop. Agric.*, Peradeniya, **75** (3 & 4): 191–195. Ceylon: Kandy District, but mainly in low country districts.
 1934. V. Margabandhu, *J. Bombay nat. Hist. Soc.*, Bombay, **37** (3): 702.

(iii) *Glyptotermes dilatatus* (Bugnion & Popoff)

1932. J. C. Hutson, *Adm. Rep. Dir. Agric. Ceylon*, Colombo, 1931 : 114–115. Ceylon: Galle and Yatiyantota Districts.
 1937. S. F. Light, *Pan-Pacific Ent.*, San Francisco, **13** (1 & 2): 15, 16–17. Peradeniya (Ceylon).
 1941. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (1): 33, 66. Ceylon. Protozoa.
 1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, **3** (1): 87. Ceylon: Ambalangoda; Kelani Valley.
 1942. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (3): 182, 191. Ceylon. Protozoa.

1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112** : 47. Ceylon.
 1953. M. L. Roonwal and G. D. Pant, *Indian For. Leaflet. (Ent.)*, Delhi, No. 121 (3) : 44. Ceylon.
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 1958. G. D. Bhasin, M. L. Roonwal and B. Singh, *Indian For. Bull. (Ent.)*, Delhi, (N.S.), No. 171 (2) : 63, 95, 99.
 1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, **122**, (Art. 4) : 347.
 1962. R. N. Mathur and R. S. Thapa, *Indian For. Leaflet. (Ent.)*, Delhi, No. 167 : 10. Ceylon: Peradeniya.

(iv) *Kalotermes (Glyptotermes) dilatatus* (Bugnion & Popoff)

1953. Rattan Lal and Menon, R. D., *Cat. Indian Insects*, Part 27, *Isoptera* : 13-14. Ceylon. India: Madras.* [Authorship wrongly assigned to Bugnion. Also see this for more references on biology of the species].

(a) *Material Examined*

(A) *Present in Z.S.I., Calcutta*: (i) A vial (Z.S.I. Reg. No. 3741/19) with a soldier and a few nymphs and pseudoworkers, Ambalangoda (Ceylon), donor E. E. Green. (ii) A vial, Z.S.I. Reg. No. 4130/19 with a pseudoworker, Ambalangoda, Ceylon.

(B) *Present in F.R.I., Dehra Dun*: (iii) A vial (F.R.I. Nos. M.C. 17444/2, T 3431, J. 115) with 3 imagos, 3 soldiers and a few nymphs and pseudoworkers, Ceylon. (iv) A slide with wings, from the above material.

(b) *Description*

1. IMAGO (Text-fig. 11; Table 5).—

General: Head-capsule brownish yellow; antennae, labrum, legs and body paler; mandibles brown with dark brown toothed margins. Head and body sparsely pilose. Total body-length with wings *c.* 10.0–10.5 mm., without wings *c.* 4.3–6.0 mm.

Head: Head-capsule subcircular; broader than its length to base of mandibles (maximum width with eyes 1.03–1.32; length to base of mandibles 1.0–1.17 mm.); sides without eyes weakly convex, strongly rounded at postero-lateral corners; posterior margin round. *Fontanelle*: Absent. *Eyes*: Two lateral, subcircular, medium-sized, compound eyes, one on either side; diameter: maximum 0.30–0.40, minimum 0.24–0.37 mm., separated from lower margin of head by about half its short diameter (two-thirds its short diameter according to Light, 1937). *Ocelli*: Two lateral, oval, translucent ocelli, one on either side, only slightly separated from or touching the eye of its side; diameter: maxi-

* Recorded from Madras on the basis of a paper by Rau, S. A. 1936. (*Rep. Tea Dep. U.P.A.S.I.*, 1935-36, Madras, pp. 35-45), but Rau refers, in this paper, to an undescribed species near *G. dilatatus*.

mum 0.13–0.15, minimum 0.10 mm., minimum eye-ocellus distance (when separated) 0.03 mm. *Antennae*: With 13–15 segments; sparsely pilose; segment 1 longest, cylindrical; 2 short, cylindrical; 3 longer than or equal to either 2 or 4 (in an incomplete antenna 3 shorter than 2 or 4); 4 to the penultimate one pyriform and gradually increasing in size; the last ovate, shorter than the penultimate one. *Clypeus*: Subtrapezoidal. Anteclypeus hyaline, strip-like, apilose; anterior margin straight. Postclypeus pale yellow with 1 or 2 hairs near posterior

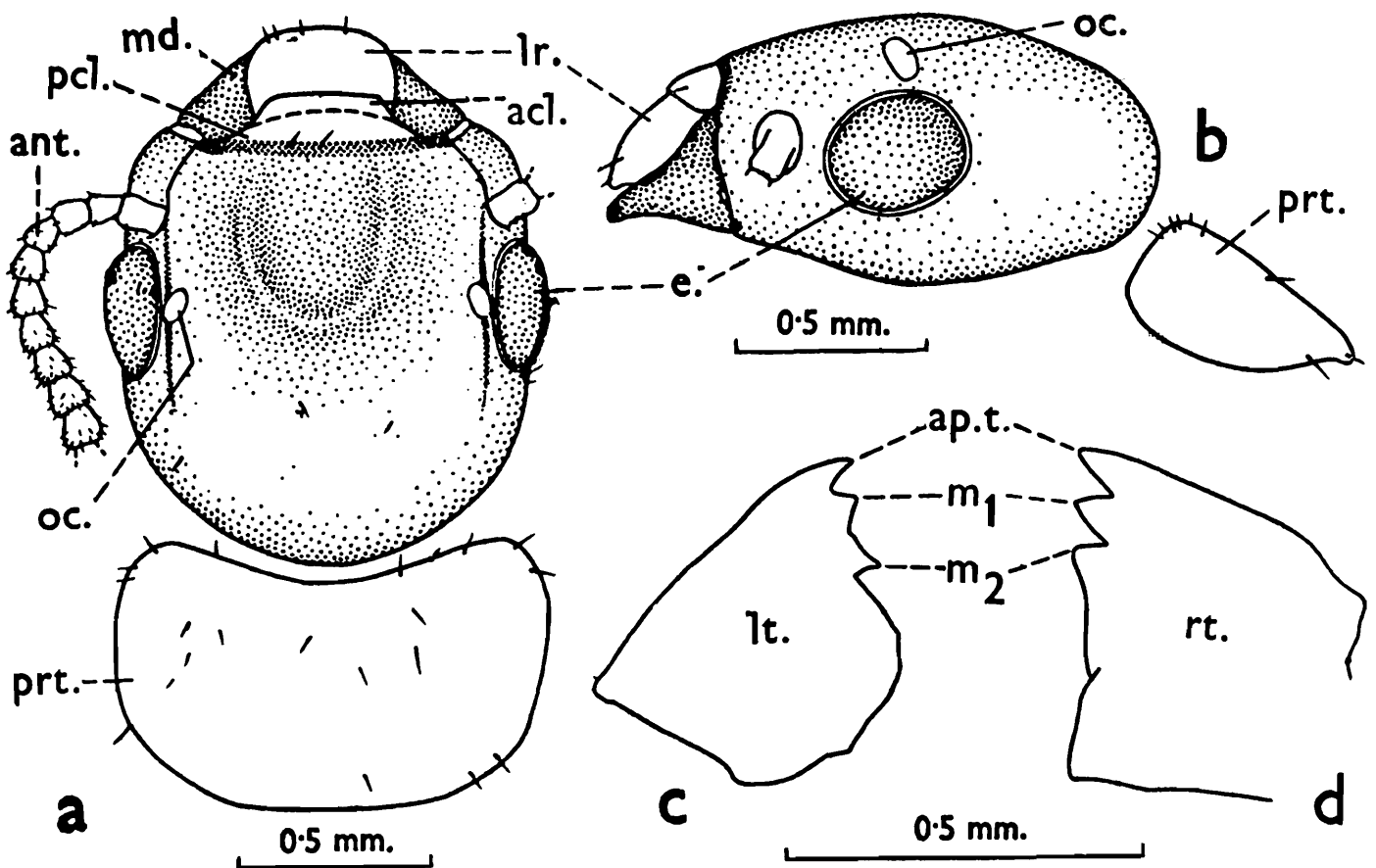
TABLE 5.—Measurements (in mm.) of *Glyptotermes dilatatus* (Bugnion & Popoff) and *G. minutus* Kemner. Imago.

Body-parts	<i>ex.</i> , examples.	
	<i>G. dilatatus</i> Range (2 ex.)	<i>G. minutus</i> (flex., Lecto- morphotype)
1. Total body-length <i>without</i> wings, (excluding antennae), <i>c.</i>	4.3 —4.7	—
2. Length of head to tip of labrum	1.23—1.40	0.99
3. Length of head to lateral base of mandibles	1.00—1.17	0.80
4. Maximum width of head (with eyes)	1.03—1.20	0.85
5. Maximum height of head	0.67—0.77	0.47
6. Maximum length of labrum	0.30	0.20
7. Maximum width of labrum	0.37—0.43	0.29
8. Maximum diameter of compound eye (with ocular sclerite)	0.37—0.40	0.25
9. Maximum diameter of lateral ocellus	0.13 (1 ex.)	0.09
10. Minimum diameter of lateral ocellus	0.10	0.07
11. Minimum ocellus-antennal distance	0.20—0.23	0.15
12. Minimum eye-ocellus distance	0.02	touching
13. Minimum eye-antennal distance	0.03 (1 ex.)	0.015
14. Minimum distance of eye from lateral base of head	0.13—0.17	0.13
15. Maximum length of pronotum	0.70	0.49
16. Maximum width of pronotum	1.00—1.13	0.73
17. Length of forewing scale	0.80 (1 ex.)	0.66
18. Length of hindwing scale	0.33	0.27

margin; anterior margin weakly convex. *Labrum*: Broader than long; anterior margin round; with a few hairs anteriorly. *Mandibles*: Sub-squarish. Left mandible with an apical and 2 marginal teeth; apical finger-like; 1st marginal shorter than apical; posterior margin of 1st marginal subequal to anterior margin of 2nd marginal; 2nd equal to 1st. Right mandible also with an apical and 2 marginal teeth; apical finger-like; 1st marginal triangular and only slightly shorter than apical; 2nd marginal short, posterior margin a little longer than molar plate.

Thorax: Pronotum: Narrower than or as wide as head with eyes; much broader than long (maximum length 0.59–0.70, maximum width 1.0–1.32 mm.); anterior margin concave, without a median notch; sides weakly convex; posterior margin also weakly convex and without a median emargination or incurving. **Mesonotum and metanotum:** With weakly convex to substraight posterior margin. **Legs:** Short, thick and pilose; apical tibial spur formula 3:3:3. Tarsi 4-jointed. Arolium present.

Wings: Costa, subcosta, radius, radial sector and median prominent and strongly chitinised; cubitus weakly chitinised and faint, proximally somewhat more chitinised and distinct. **Forewing:** All veins arising independently from the scale. Costa running along anterior margin upto distal end and with a row of hairs along the



Text-fig. 11.—*Glyptotermes dilatatus* (Bugnion & Popoff).

Imago. From Ceylon. (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.

margin. Subcosta short and fusing with costa just outside the scale. Radius also short and meeting the costa between one-fifth to one-third of wing-membrane. Radial sector running all along upto distal tip and parallel with costa; without any branches to latter. Median arising separately, slightly curving up anteriorly and running parallel to and close to radial sector. Cubitus running medially; with only 3-4 proximal branches prominent, others not clear in the material examined by me (according to Kemner (1926), with numerous but rather vague branches); and with a few faint cross-veins between median and cubitus in distal half of wing-membrane. *Hindwing*: Costa and radial sector as in forewing; subcosta absent. Radius as in forewing but fusing with costa at about one-seventh of wing-membrane. Median arising from radial sector near the point of fusion of radius and costa (in basal one-eighth, according to Light, 1937) and running parallel with and close to radial sector upto the distal tip. Cubitus as in forewing.

Abdomen: Oblong, sparsely pilose. Cerci 2-jointed, 0.10 mm. long. Styli (in male) short, single-jointed, 0.10 mm. long.

2. SOLDIER (Text-fig. 12; Table 6).—

General: Head-capsule yellowish brown to brownish red, anteriorly somewhat darker; labrum, thorax and body straw yellow to yellowish brown; mandibles black, basally dark brown. Head and body sparsely pilose. Total body-length 5.9-8.0 mm.

Head: Head-capsule cylindrical, much longer than broad (length to lateral base of mandibles 2.0-2.33; maximum width 1.27-1.37 mm.); frons sloping in front, bilobed and depressed medially; with 2 prominent protuberances, one on either side situated at base of the sloping frons; sides substraight; posterior margin round; Y-sutures present. *Eyes*: Two small, oval, unpigmented eyes, one on either side; flush with head-surface and faint; situated a little behind the antennal sockets; maximum diameter 0.13 mm. *Ocelli*: Two small, point-like, one on either side, near the end of lateral sutures. *Antennae*: With 11-13 segments; sparsely pilose; segment 1 longest, cylindrical and strongly chitinised; 2 shorter and cylindrical; 3 slightly longer or shorter than 2; 4 to the penultimate one pyriform and gradually increasing in length; the last ovate, shorter than the penultimate one. *Clypeus*: Divided into an ante- and a postclypeus. Anteclypeus thin, strip-like, apilose. Postclypeus of same colour as frons and not clearly differentiated from it, weakly pilose. *Labrum*: Broadly tongue-shaped to dome-shaped; either longer or shorter than wide. *Mandibles*: Long and strong. Left mandible with 4 marginal teeth of variable size. Right mandible with 2 large, medial marginal teeth. *Postmentum*: Long and club-shaped; club weakly bilobed; broadest at about anterior one-fifth; sides gradually narrowing behind into a long narrow waist and again widening out a little near posterior margin; posterior margin medially bulged.

Thorax: Pronotum: Flat, narrower to wider than head-capsule and much wider than long (maximum width 1.10-1.41; maximum length

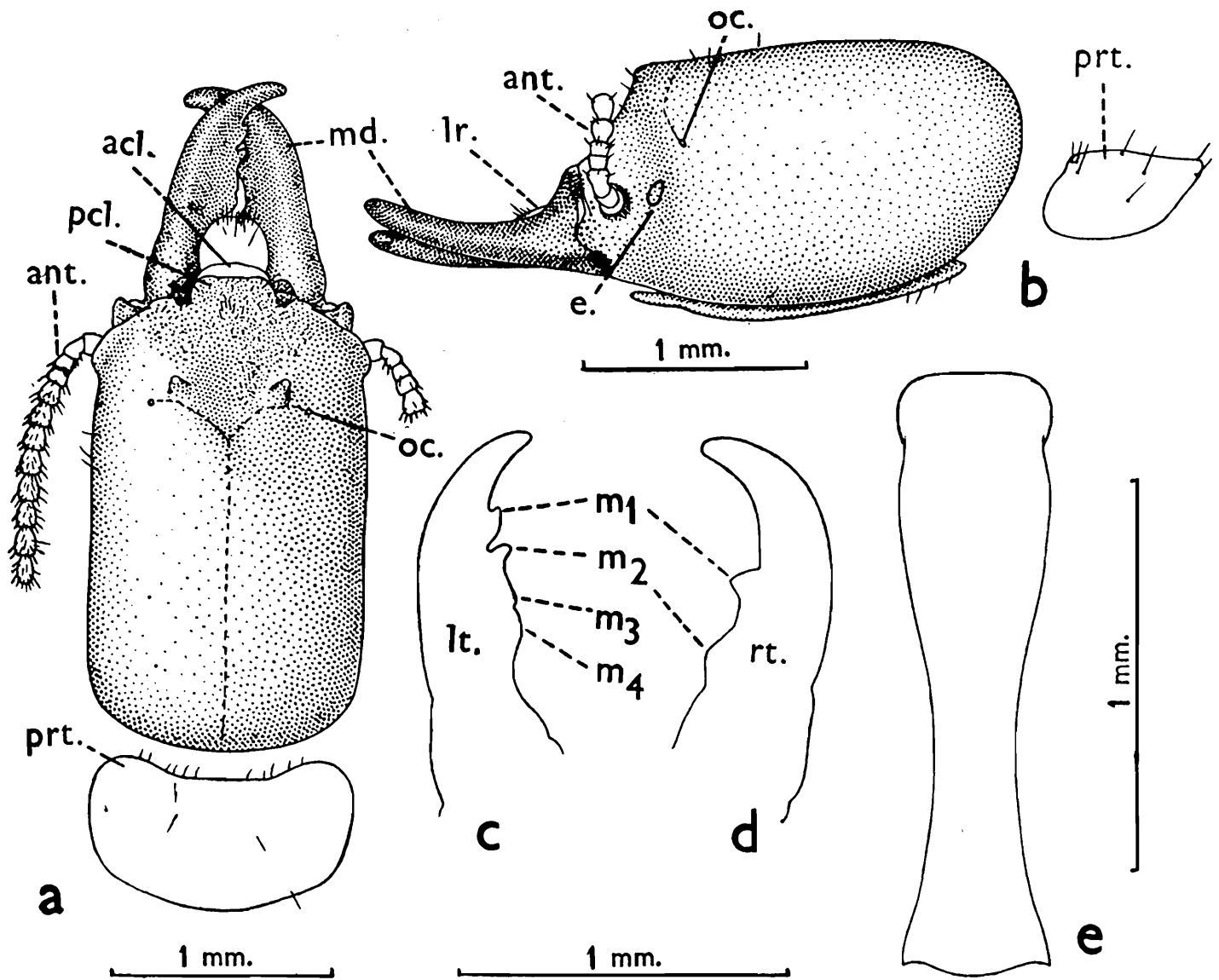
TABLE 6.—Measurements (in mm.) etc., of *Glyptotermes dilatatus* (Bugnion & Popoff); *G. minutus* Kemner and *G. nigrifrons* Mathur and Sen-Sarma. Soldier.

ex., examples.

Body-parts	<i>G. dilatatus</i> Range (4 ex.)	<i>G. minutus</i> Lectotype	<i>G. nigrifrons</i> Range (2 ex., paratype)
1. Total body-length (excluding antenna) <i>c.</i>	6.7 (1 ex.)	5.07	4.7 —6.6
2. Length of head to lateral base of mandibles	2.03—2.33	1.50	1.43—1.50
3. Maximum width of head	1.30—1.37	0.90	1.00—1.03
4. Maximum height of head	1.10—1.20	0.83	0.80—0.87
5. Head Index I (width/length)	0.59—0.64	0.60	0.69—0.70
6. Head Index II (height/width)	0.83—0.90	0.92	0.80—0.84
7. Head Index III (height/length)	0.50—0.57	0.55	0.56—0.58
8. Maximum length of labrum	0.20—0.37	0.17	0.21—0.25
9. Maximum width of labrum	0.33—0.37	0.23	0.27—0.30
10. Length of mandibles (from upper base of condyle to tip):			
(a) Left mandible	1.03—1.13	0.63	0.70
(b) Right mandible	1.07—1.13	0.58	0.70
11. Head-mandibular length Index (Left mandible-length/Head-length to base of mandibles)	0.47—0.50	0.42	0.47—0.49
12. Minimum median length of postmentum	1.50—1.60	1.07	0.90—1.07
13. Maximum width of postmentum	0.40—0.50	0.37	0.37—0.40
14. Width of postmentum at anterior end	0.30—0.37	0.23	0.27
15. Width of postmentum at waist	0.20—0.23	0.17	0.20
16. Postmentum-contraction Index (<i>i.e.</i> , Width at base/Maximum width)	0.46—0.50	0.46	0.50—0.54
17. Maximum length of pronotum	0.73—0.77 (3 ex.)	0.60	0.50—0.57
18. Maximum width of pronotum	1.17—1.23 (3 ex.)	0.93	0.87—1.00
19. Pronotum-head Index (pronotum-width/Head-width)	0.85—0.94 (3 ex.)	1.03	0.87—0.97
20. Pronotum Index (length/width)	0.61—0.62 (3 ex.)	0.64	0.57
21. Maximum width of mesonotum	1.10—1.13 (2 ex.)	0.87	0.77—0.83
22. Maximum width of metanotum	1.03—1.13 (2 ex.)	0.93	0.80—0.87

0.65–0.77 mm.); anterior margin concave, without a median notch; sides rounded and a little narrowed behind; posterior margin convex, without a notch. *Mesonotum and metanotum*: Narrower than pronotum and without median emargination at posterior margin. *Legs*: Short, pilose; apical tibial spur formula 3:3:3. Tarsi 4-jointed.

Abdomen: Oblong, sparsely pilose. Cerci 2-jointed, 0.13 mm. long. Styli 1-jointed, 0.10 mm. long.



Text-fig. 12.—*Glyptotermes dilatatus* (Bugnion & Popoff).

Soldier. Ambalangoda, Ceylon.

- (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.

acl., anteclypeus; *ant.*, antenna; *e.*, eye; *lr.*, labrum; *lt.*, left; *m*₁–*m*₄, 1st to 4th marginal teeth of mandibles; *md.*, mandible; *oc.*, ocellus; *pcl.*, postclypeus; *prt.*, pronotum; *rt.*, right,

3. PSEUDOWORKER (Table 7).—

General: Head-capsule straw yellow; antennae, thorax, legs and abdomen paler; mandibles yellowish with dark brown toothed margins. Head and body sparsely pilose. Total body-length 4.0–5.8 mm.

TABLE 7.—Measurements (in mm.) of Pseudoworker of *Glyptotermes dilatatus* (Bugnion & Popoff) and nymph of *G. minutus* Kemner.

ex., examples.

Body-parts	<i>G. dilatatus</i> Range (4 ex.)	<i>G. minutus</i> (1 ex.)
1. Total body-length (excluding antennae) <i>c.</i>	5.2 —5.8 (3 ex.)	4.0
2. Length of head to tip of labrum	1.40—1.50	0.93
3. Length of head to lateral base of mandibles	1.03—1.17	0.73
4. Maximum width of head	1.10—1.23	0.77
5. Maximum height of head	0.70—0.77	—
6. Maximum length of labrum	0.30—0.40	0.20
7. Maximum width of labrum	0.40—0.50	0.23
8. Maximum length of pronotum	0.60—0.70	0.43
9. Maximum width of pronotum	1.23—1.40	0.67

Head: Head-capsule subcircular; wider than its length to base of mandibles (maximum width 1.10–1.23 (0.65 *vide* Holmgren 1913), length to lateral base of mandibles 1.03—1.17 mm.); side convex and posterior margin rounded. *Fontanelle and Ocelli:* Absent. *Eyes:* Two lateral, oval to round eyes; flush with head-surface and of almost the same colour as head. *Antennae:* With 11–12 segments; sparsely pilose; segment 1 longest cylindrical; 2 short, cylindrical; 3 in 11-segmented antenna slightly longer than 2, in 12-segmented one, short; 4 to the penultimate one gradually increasing in length and pyriform; the last ovate, shorter and narrower than the penultimate one. *Clypeus, labrum and mandibles:* As in imago.

Thorax: Pronotum: Flat; wider than head-capsule; much broader than long (maximum width 1.23–1.44; maximum length 0.60–0.70 mm.); anterior margin concave; posterior margin weakly convex. *Legs:* As in soldier.

Abdomen: Oblong, sparsely pilose; cerci 2-jointed, 0.15 mm. long. Styli single-jointed, finger-like, 0.13 mm. long.

(*c*) *Type-specimens.*—The repository of types not known.

(*d*) *Type-locality.*—Ambalangoda (Ceylon).

(*e*) *Distribution.*—*Ceylon:* Ambalangoda, 6°14' N., 80°03' E. (type locality); Avissawella, 6°57' N., 80°13' E.; Balangoda, 6°38' N., 80°41' E.; Chilaw, 7°34' N., 79°48' E.; Deniyaya, 6°20' N., 80°34' E.;

Elpitiya, 6°16' N., 80°09' E.; Galaha, 7°12' N., 80°40' E., Galle, 6°01' N., 80°13' E.; Gampola, 7°10' N., 80°34' E.; Horana, 6°42' N., 80°04' E.; Ingiriya, 6°45' N., 80°10' E.; Kadduganawa, 7°15' N., 80°32' E.; Kandy District; Katugastota; Kegalla, 7°14' N., 80°12' E.; Kelani Valley; Kiriella; Matugama, 6°32' N., 80°06' E.; Opanake, 6°37' N., 80°38' E.; Pelmadulla, 6°37' N., 80°33' E.; Peradeniya, 7°16' N., 80°37' E.; Ratnapura, 6°41' N., 80°25' E.; Udugama, 6°13' N., 80°20' E.; and Yatiyantota, 7°03' N., 80°18' E.

(f) *Comparison*.—*Glyptotermes dilatatus* is closest to *G. ceylonicus* Holmgren. For differences see under the latter species, *supra*.

From the other Indian forms it is separable by its larger size and by the presence of the two prominent protuberances lying at base of the sloping frons.

5. *Glyptotermes minutus* Kemner

(Text-figs. 13 & 14; Tables 5 & 6)

(i) *Calotermes (Glyptotermes) minutus* Kemner (MS name).

1930. F. P. Jepson, *Tech. Rep. Dep. Agric. Ceylon*, 1929: 6.

(ii) *Glyptotermes minutus* Kemner

1932. N. A. Kemner, *Ent. Tidskr.*, Stockholm, **53**: 149–150. *Im.* and *S. Type-locality*: Ceylon. (Also see remarks under "Type-locality" below). Types examined.

1941. M. P. D. Pinto, *Indian J. Ent.*, New Delhi, **3** (1): 87–88. Peradeniya (Ceylon).

1941. H. Kirby, *Univ. Calif. Publ. (Zool.)*, Berkeley, **45** (1): 52. Ceylon. [Protozoa.]

1942. H. Kirby, *Univ. Calif. Publ. Zool.*, Berkeley, **45** (2): 121. Ceylon. [Protozoa.]

1949. T. E. Snyder, *Smiths. misc. Coll.*, Washington, **112**: 49. Ceylon.

1961. K. Krishna, *Bull. Amer. Mus. nat. Hist.*, New York, **122** (Art. 4): 347.

(iii) *Kalotermes (Glyptotermes) minutus* Kemner

1953. Rattan Lal and R. D. Menon, *Cat. Indian Insects*, Pt. 27, *Isoptera*, Delhi: 15. Ceylon.

(a) *Material Examined*

Present in Zoologiska Institutet, Lund University, Lund: One vial in spirit, with a lectotype soldier, a lectomorphotype imago ♀ (dealate, broken into 2 pieces) and a pseudoworker, Peradeniya (Ceylon), coll. *M.P.D. Pinto* (No. 7059), 22.vi.1928, *det.* N. A. Kemner.

(b) *Description*

Types examined.

1. IMAGO ♀ (Text-fig. 13; Table 5).—

General: Head-capsule, mandibles, thorax (including wing-scales) and abdomen dark brown; labrum and antennae brownish yellow; clypeus yellow; eyes black. Head and body sparsely hairy.

Head: Oval, longer than width with eyes; head-capsule subcircular; width with eyes more than length to base of mandibles (width 0.85; length 0.80 mm.); sides weakly convex and slightly narrowed posteriorly; posterior margin round. *Fontanelle*: Absent. *Eyes*: Two lateral, black, faceted, oval eyes, one on either side (diameter: maximum 0.25, minimum 0.20 mm.). *Ocelli*: Two lateral, oval ocelli, one on either side, 0.09 mm. long and 0.07 mm. wide; touching the eyes. *Antennae*: Incomplete (right antenna with 3 and left with 7 segments); segments 1 and 2 sparsely, the remainder fairly, pilose; segment 1 long; cylindrical; 2 longer than half of 1 and cylindrical; 3 subequal to 2; 4–7 subequal, broadly pyriform, longer than 3. *Glypeus*: Subtrapezoidal; indistinctly separated into an ante- and a postclypeus. Anteclypeus white, apilose, with a straight anterior margin. Postclypeus scantily pilose; anterior margin weakly convex. *Labrum*: Subsquamish, broader than long; sides weakly convex; anterior margin round, slightly incurved in middle; with 5 pairs of hairs on anterior margin and a pair on body. *Mandibles*: Not examined in the single specimen available for study.

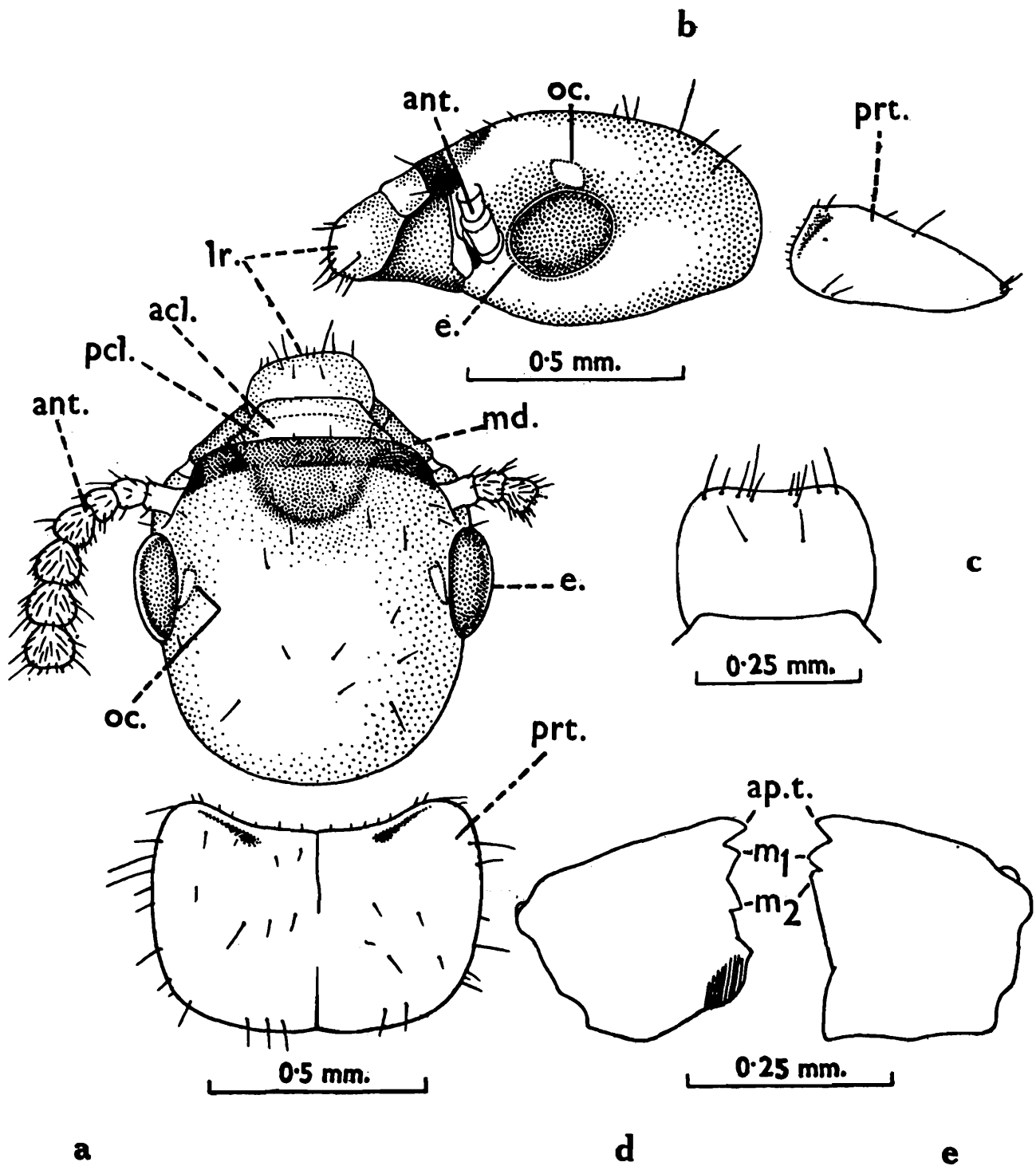
Thorax: *Pronotum*: Subrectangular; much broader than long (maximum width 0.73 (0.76 *vide* Kemner, 1932); maximum length 0.49 mm.); antero-lateral corners narrower than postero-lateral corners; anterior margin concave, weakly incised medially; sides weakly convex and narrowing behind; posterior margin convex; with a weak median notch. *Mesonotum and metanotum*: Weakly incurved medially at posterior margin. *Legs*: Broken. *Wings*: Only wingscales present. Forewing-scales large, shield-like, covering more than half of hindwing scales. Hindwing-scales short, triangular.

Abdomen: Oblong, hairy. Cerci 2-jointed, short, 0.05 mm. long and partly covered by 9th tergite. Styli absent.

2. SOLDIER (Text-fig. 14; Table 6).—

General: Head-capsule yellowish brown, reddish brown anteriorly; antennae, labrum and legs a little paler than head-capsule; mandibles black; pronotum yellowish brown, a little darker than posterior part of head, and with a darker anterior margin; body pale yellowish brown. Head and body moderately pilose. Total body-length *c.* 4.1–5.1 mm.

Head: Head-capsule rectangularly cylindrical and flat; length to base of mandibles 1.50 mm. (1.16–1.38 without mandibles *vide* Kemner, 1932); head-width 0.90 mm. (0.74–0.92 mm. *vide* Kemner, 1932) without any protuberances at the dorso-lateral corners of frons; frons sloping in front and somewhat depressed medially; rest of head uniformly high; sides parallel; posterior margin round; antero-lateral corners of head-capsule at base of mandibles round; Y-suture present. *Fontanelle*: Absent. *Eyes*: Two, small, oval eye-spots, one on either side, present; maximum diameter 0.07 mm. *Ocelli*: Minute, hardly discernible. *Antennae*: Only left antenna of the specimen complete, with 11-segments; segments 1–3 sparsely, and the remainder fairly, pilose; segment 1 longest, cylindrical; 2 about half of 1 and cylindrical; 3 shortest; 4 longer and broader than 3; 5 to the penultimate one subequal and pyriform; the last ovate and narrower than the penultimate one. [Kemner (1932, p. 150) described the antennae as follows:—Antennae short and thick,



Text-fig. 13.—*Glyptotermes minutus* Kemner.

Imago and Nymph. From types, Peradeniya, Ceylon. Figs. (a)–(c) Lectomorphotype imago; (d) and (e) nymph.

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

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; *oc.*, ocellus; *pcl.*, postclypeus; *prt.*, pronotum.

not quite reaching the tip of the mandibles; 9–10 segmented. In 9-segmented antenna, segments 2, 3 and 4 subequal, but 4 is thicker. In 10-segmented antenna, segment 3 is smaller than 2 and much smaller and narrower than the very large segment 4.] *Clypeus*: Subtrapezoidal, divided into an ante- and a postclypeus. Ante-clypeus thin, narrow, apilose, strip-like. Postclypeus pilose, of same colour as frons and separated from latter by a thin groove. *Labrum*: Broader than long (Kemner, 1932, p. 150, mentioned this as, much longer than broad); weakly converging in front into a broadly rounded anterior margin; with a few hairs near anterior margin. *Mandibles*: Short and thick; strongly incurved at apex; and with weak basal humps. Left mandible with 3 (2 according to Kemner, 1932) marginal teeth. Right mandible with 2 marginal teeth of equal size. *Postmentum*: Long, club-shaped; maximum width is at anterior one-fourth, whence the sides narrowing posteriorly into a long narrow waist and weakly narrowing in front; near the posterior margin sides again widening out abruptly; anterior margin straight; posterior margin concave and bulged medially.

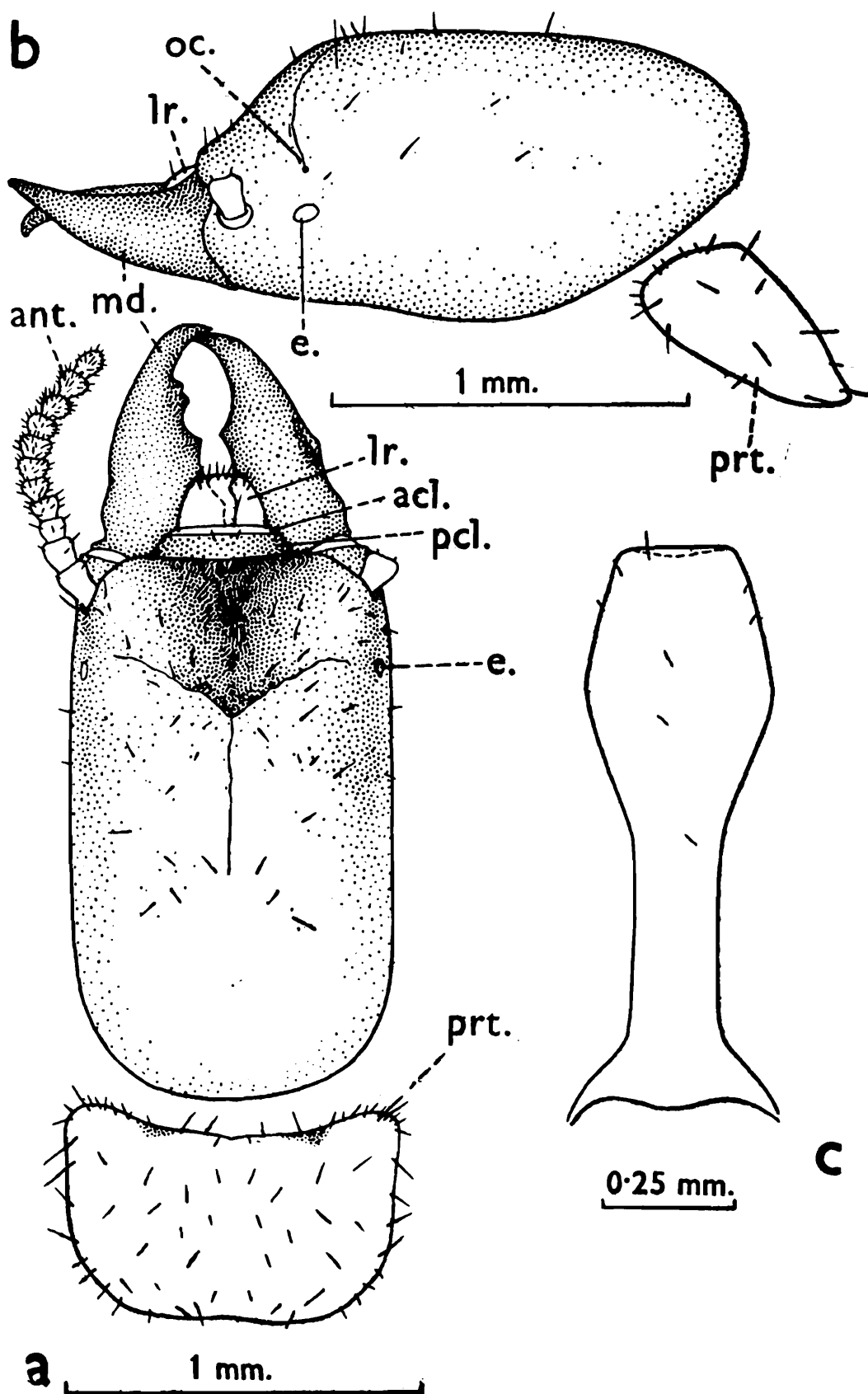
Thorax: Pronotum: Subrectangular; broader than long and slightly broader than head-capsule (Kemner, 1932, p. 150, says: as broad as or a little narrower than head); length 0.60 mm. (0.42–0.44 *vide* Kemner, 1932), width 0.93 mm. (0.70–0.81 *vide* Kemner, 1932); anterior margin broadly concave, with a weak median notch; sides substraight and weakly narrowing behind; posterior margin weakly convex and slightly incurved medially. *Mesonotum* narrower, and *metanotum* as wide as, pronotum; hind margin of both convex and somewhat incurved medially. *Legs*: Only the fore- and the left middle-legs present in the specimen, the others broken; legs short and thick; tibia of existing legs with 3 apical spurs. [According to Kemner (1932), legs short and stout, tibia with three spurs]. Tibial spur formula, thus, 3:3:3. Tarsi 4-jointed.

Abdomen: Oblong, hairy; last tergite more strongly chitinised than the preceding ones. Cerci 2-jointed, 0.09 mm. long. Styli single-jointed, 0.07 mm. long.

3. PSEUDOWORKER (Table 7).—

General: Head pale yellowish brown, somewhat paler anteriorly; antennae, legs and body somewhat paler; mandibles yellowish brown, with dark brown toothed margins. Head and body moderately hairy. Total body-length *c.* 4.0 mm.

Head: Oval, head-capsule subcircular, a little broader than long (length to base of mandibles 0.73, maximum width 0.77 mm.); posterior margin round. *Fontanelle and ocelli*: Absent. *Eyes*: Two hardly discernible, lateral eye-spots present; diameter 0.1 mm. *Antennae*: With 9 segments; segment 1 longest and cylindrical; 2 more than half of 1 and cylindrical; 3 shorter than, or subequal to, 2, and subdivided; 4–8 gradually increasing in length and becoming pyriform; the last ovate, narrower than and subequal to the penultimate one. *Clypeus*: Subtrapezoidal; anterior margin subconvex. Anteclypeus hyaline, apilose. Postclypeus pilose, convex anteriorly. *Labrum*: Subsquamish; sides weakly convex; anterior margin weakly incurved medially. *Mandibles*: Of typically *Glyptotermes*-type; subsquamish. Left mandible



Text-fig. 14.—*Glyptotermes minutus* Kemner.

Soldier. Lectotype, from Peradeniya, Ceylon. (a) Head and pronotum, in dorsal view. (b) Ditto, in side view. (c) Postmentum, in ventral view.

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

with an apical and 2 marginal teeth; apical finger-like and longer than the marginals; 1st marginal triangular, with anterior margin shorter than posterior; 2nd triangular and subequal to 1st, with anterior margin longer than posterior and subequal to posterior margin of 1st. Right mandible also with an apical and 2 marginal teeth; apical finger-like; 1st marginal thick, triangular; 2nd shorter than 1st, with posterior margin only a little longer than molar plate.

Thorax: Pronotum: Subrectangular, flat; with a pair of median, brownish markings a little behind the anterior margin; maximum width 0.67, maximum length 0.43 mm.; anterior margin concave, with a weak median notch; anterior angles projecting in front; sides substraight and weakly narrowing posteriorly; posterior margin convex, with a weak median notch. *Legs:* Short and thick; apical tibial spur formula 3: 3: 3. Tarsi 4-jointed.

Abdomen: Oblong, hairy. Cerci 2-jointed, 0.07 mm. long. Styli absent in the specimen.

(c) *Type-specimens.*—No holotype was selected by Kemner. The lectotype* soldier and a lectomorphototype* imago (dealate) (selected A. E. Emerson, 1957) are present in the Zoologiska Institutet, Lund University, Lund (Sweden) and were examined (*vide* 'Material' above.)

(d) *Type-locality and Distribution.*—No exact locality in Ceylon was mentioned by Kemner, but the label with the type-specimens states 'Peradeniya' [Ceylon, c. 7°16' N., 80°37' E.] which thus becomes the type-locality.

Known only from type-locality.

(e) *Comparison.*—*Glyptotermes minutus* Kemner is close to *G. almorensis* Gardner and *G. coorgensis* Holmg. & Holmg. For differences see under those species, *supra*.

6. *Glyptotermes nigrifrons*† Mathur & Sen-Sarma (Table 6)

(i) *Glyptotermes nigrifrons* M. & S.

1960 (Apr.). R. N. Mathur and P. K. Sen Sarma, *Entomologist*, London, 1960: 79-85 figs. 1 and 2 (*s.*), fig. 3. (Ny. mandibles). *S.* and *Ny.* *Type locality:* Top Slip, near Pollachi (Madras State, India).

1962. R. N. Mathur and R. S. Thapa, *Indian For. Leaflet. (Ent.)*, Delhi, No. 167: 11. *India:* Top slip (Madras State),

(a) *Material Examined*

A vial, Z.S.I. Reg. No. 3128/H8, with 2 soldiers (paratypes), Top Slip, near Pollachi, Coimbatore S. Div., (Madras State, India), coll. R. N. Mathur (No. 33), 6.i.1958, ex "rotton wood"

* Professor Emerson selected the lectotype and lectomorphototype 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.

† See "Remarks" on this species below,

(b) Description

As the species has been recently described in detail, I give here only a brief description.

1. IMAGO.—

Unknown.

2. SOLDIER (Table 16).—

General: Head-capsule yellowish brown (dark brown in region of frons), abdomen whitish, 10th tergite strongly chitinised and brown.

Head: Head-capsule subrectangular; antero-lateral corners sharply projected in front; Y-suture present. *Eyes*: Two lateral, oval, unpigmented eyes present. *Ocelli*: Two lateral, dot-like ocelli present; lying at the end of lateral arms of Y-suture. *Antennae*: With 10–12 segments. *Mandibles*: Short, about half of head-length to base of mandibles; left mandible with 3, and the right with 2 marginal teeth.

Thorax: Pronotum: Subrectangular, broader than long; anterior margin concave; posterior margin weakly convex, without median emargination. *Legs*: Short; apical tibial spur formula 3:3:3. *Tarsi* 4-jointed.

Abdomen: Oblong; 10th tergite greatly chitinised and brown. Cerci and styli present.

3. NYMPH.—

Not available to me for study. The tibial spurs of legs *i.e.*, 3:2:2 as given by Mathur and Sen-Sarma (1960) is apparently an error as the tibial spurs in the family Kalotermitidae are always 3:3:3.

(c) Type Specimens.—Holotype and morphotype: A holotype soldier and a morphotype nymph of alate, in Entomological collection at the F.R.I., Dehra Dun.

Paratypes and paramorphotypes: (i) 7 paratype soldiers and 10 paramorphotype nymphs of adults, in F.R.I., Dehra Dun. (ii) Two paratype soldiers, in Z.S.I., Calcutta. (iii) One paratype soldier and 1 paramorphotype nymph in Emerson collections (now in A.M.N.H., New York).

(d) Type-locality and Distribution.—Type-locality: Top Slip, near Pollachi, Coimbatore S. Division, Tamil Nadu, India (10°39' N., 77°03' E.). Known only from the type-locality.

*(e) Remarks.—*Mathur and Sen-Sarma (1960) separated *Glyptotermes nigrifrons* from all the other Indian species of *Glyptotermes* on the basis of the strongly sclerotised 10th abdominal tergite, in the soldier. It may be added, however, that *G. almorensis* Gardner, *G. coorgensis* Holmg. & Holmg. and *G. minutus* Kemner also have a strongly sclerotised 10th tergite.

This species is hardly differentiated from *G. coorgensis* Holmg. & Holmg. and I did not find any character to separate it from the specimens

of *G. coorgensis* which I studied, except that the soldier mandibles have weaker basal humps at outer margins. Krishna (personal communication dated 4th November, 1965, informs that he found this character variable in a collection of *G. coorgensis* with a long series of soldiers from Periyar Lake, Thekaday (S. India). He has also compared the paratype soldier of *nigrifrons* with the cotype soldier of *coorgensis* present in the A.M.N.H., New York and says that these species are not separable. I, in this study, am keeping this species separate as I personally have not examined the cotypes of *coorgensis*.

III—SUMMARY

1. Like the other members of the family Kalotermitidae, the species of the genus *Glyptotermes* are wood termites. Some of the species are serious pests of tea and rubber plantations, thus, they are of considerable economic importance.

2. The present studies deal with the zoogeography and distribution, the phylogenetic position of the genus and the taxonomic revision of the Indian species.

3. In the Indian subregion the genus is confined to India and Ceylon and only six species are known.

4. The generic characters and keys for separation of the six Indian species, based on imago and soldier characters, are given.

5. The following species are redescribed in some detail and illustrated adequately:—*Glyptotermes almorensis* Gardner, *G. ceylonicus* Holmgren, *G. coorgensis* Holmgren and Holmgren, *G. dilatatus* (Bugnion and Popoff), *G. minutus* Kemner and *G. nigrifrons* Mathur and Sen-Sarma. The so far unknown imago caste of *G. coorgensis* Holmgren and Holmgren is described.

6. The types of *Glyptotermes almorensis* Gardner and *G. minutus* Kemner were examined and the lectotypes of *almorensis* Gardner designated.

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