

TERMITES FROM THE AMAZON BASIN, BRAZIL, WITH  
NEW RECORDS AND TWO NEW *NASUTITERMES*  
(INSECTA : ISOPTERA)

*By*

M. L. ROONWAL and N. S. RATHORE

*Desert Regional Station*  
*Zoological Survey of India, Paota, Jodhpur*  
(With 6 Text-figures and 5 Tables)

INTRODUCTION

(Text-fig. 1 ; and Table 1)

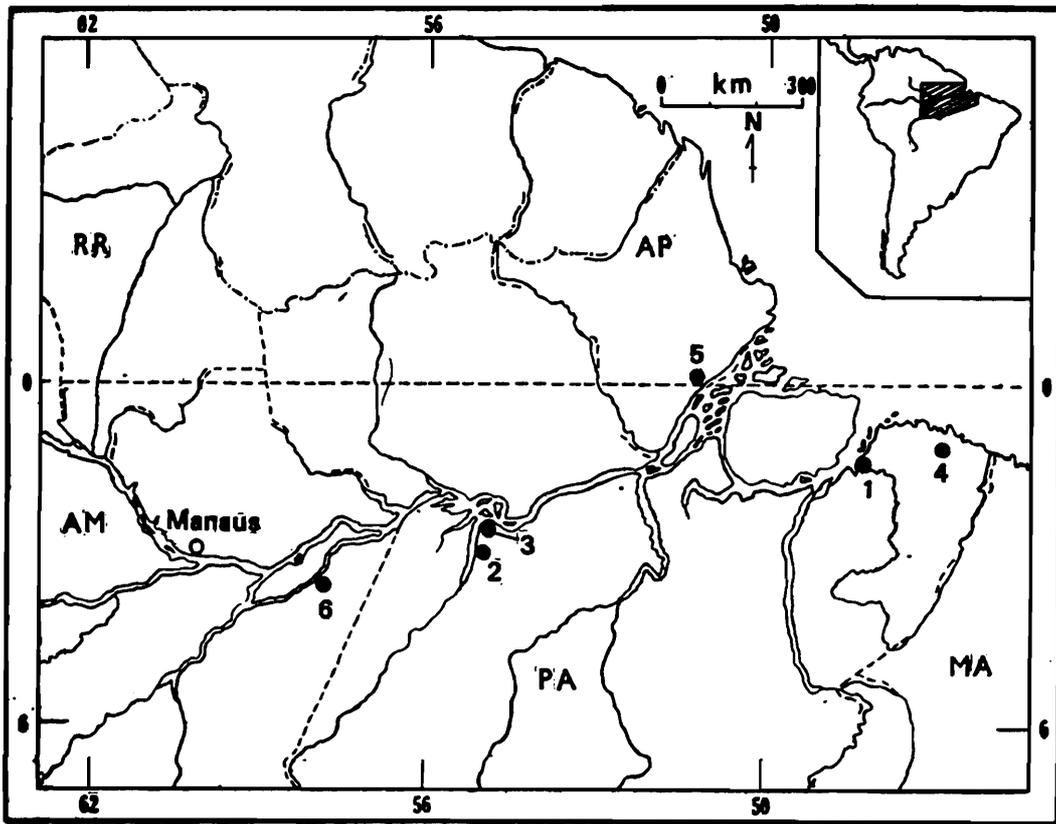
In the year 1957, one of us (M. L. R.), through the good offices of the UNESCO, paid a short visit to the Amazon Basin, Brazil (South America), during which a modest collection of termites (Isoptera) was made. During that same visit were obtained, through the courtesy of a number of Brazilian institutions, especially the Instituto Agronomico do Norte, Belém, some termite collections. The small but interesting collection so assembled from the north-eastern States (Amapá, Amazonas and Pará, *vide* Table 1) is here reported upon. The termite fauna of this vast and rich tract, the Amazon Basin, is very meagrely known, and it is not surprising that the present collection, though modest, has yielded new and valuable information.

The geographical range of a number species is greatly extended by several new locality records, and two new species of the genus *Nasutitermes* (Termitidae : Nasutitermitinae) are described.

The major part of the collection, together with the holotypes of the new species, has been deposited with the Zoological Survey of India, Calcutta ; some of it in Brazil at the Museu de Zoologia da Universidade de São Paulo, São Paulo, and Instituto Agronomico do Norte, Belém ; and at the Forest Research Institute, Dehra Dun.

The taxonomic measurements of termites have been taken in accordance with the limits prescribed in Roonwal (1970).

The Amazon Basin, except near the coast, is a heavily wooded, sparsely inhabited, hot, humid tropical belt with innumerable water-courses, both large and small. The rainfall is heavy, about 140 cm. per annum (Manaus), and is usually received throughout the year but mostly in the southern summer and autumn (January-May). The temperature is high (average over 27°C) the year round. The



Text-fig. 1.—Map of the Amazon Basin, north-eastern Brazil, showing the collecting localities for termites (solid circles). [Inset : South America, showing the approximate area covered by the termite collection. (shaded in diagonal lines)].

1. Belém ; 2. Belterra ; 3. Santarem ; 4. Região Bragantina ; 5. Mazagão ; 6, Maués.

States : AM, Amazonas ; AP, Amapá ; MA, Maranhão ; PA, Pará ; RR, Roraima.

vegetation consists mostly of the equatorial, broad-leaved, evergreen rain-forests, and in places there are plantations of rubber (*Hevea* spp.) and Brazilian nut (*Bertholettia* sp.).

#### Abbreviations used

The following abbreviations have been used :—

Coll.,	Collection ; collected by.	S,	Soldier.
Fd.,	Field.	Sev.,	Several.
Ex.,	From ; out of ; <i>also</i>	W,	Worker.
	Example (s) (exs.).	WM,	Worker Major.
Im,	Imago.	Wm,	Worker minor.
Max.,	Maximum	Z. S. I.,	Zoological Survey of
Ny,	Nymph.		India, Calcutta.

Table 1.—Details of collecting stations for termites in the Amazon Basin, Brazil. (Also see Text-fig. 1.)

Collecting Station	State	Approx. coordinates		Approx. altitude (above M. S. L.)	Remarks
		Latitude	Longitude		
1. Belém	Pará	1°28' S	48°29' W	14 m.	—
2. Belterra	Pará	2°38' S	54°57' W	36 m.	—
3. Santarem (near Airport)	Pará	2°24' S	54°39' W	36 m.	—
4. *Regiao Bragantina (Area between Belém and Braganca)	Pará	1°10' S	46°48' W	—	Approximate
5. Mazagao	Amapá	0°07' N	51°17' W	10 m.	—
6. Maués	Amazonas	3°33' S	57°41' W	18 m.	—

\* This is a general denomination for the region between Braganca (lat. 1°04' S, long. 46°46' W) and Belém, the region being named after a railroad, now discontinued (R. L. Araujo, *in litt.*).

#### ACKNOWLEDGEMENTS

For assistance in various ways we are indebted to the following to whom we would like to express our gratitude :

To the United Nations Educational, Scientific and Cultural Organisation, Paris, for making possible the visit of one of us (M. L. R.) to the Amazon Basin. To Dr. Rubens Lima (Director) and Dr. Elias Sefer (Chief of Entomological Section) at the Instituto Agronomico do Norte, Belém (Brazil), for the donation of a collection of termites (now deposited with the Zoological Survey of India, Calcutta). To Dr. Aristoteles d'Araujo e Silva, Defesa Sanitaria Vegetal, Rio de Janeiro, for assistance in examining collections. To Dr. R. L. Araujo, Museu de Zoologia, Universidade de São Paulo, São Paulo, for valuable taxonomic and other assistance. To Dr. O. B. Chhotani, Zoological Survey of India, Calcutta, for considerable help with measurements and literature. To Mr. S. C. Verma, Jodhpur, for assistance with some measurements. Finally, to the Council of Scientific and Industrial Research, New Delhi, for financial assistance during the later part of this work.

## TAXONOMIC ACCOUNT

The following is a short taxonomic account (together with field notes of one of the authors, M. L. R., given here in the first person), and includes 9 species belonging to 2 families (Rhinotermitidae and Termitidae) and 5 genera. Two species of *Nasutitermes* are new to science, while considerable extension of geographical range, north and north-east has been recorded in others. *Nasutitermes guayanae* Holmgren is recorded for the first time from Brazil.

Early works on South American termites, by naturalists in the 16th to 19th centuries, has been summarised by Hagen (1858a, pp. 269-287), noteworthy among these being the account of H. W. Bates on the termites of Santarem (the area also included in the present collection) in the Amazon Basin (pp. 270-280). Later important works are those of Silvestri (1901, 1903), Holmgren (1906-1912), Strelnikov (1920), John (1920), Snyder (1926, 1933), and Emerson (1938, 1945). Some recent accounts are those of Snyder (1949), Grassé (1949, 1958), Emerson (1952-1955), Araujo (1958a, b, 1970a, b), Roonwal (1962) and Weidner (1970). In spite of these, our knowledge of Brazilian termites is still extremely meagre.

The following species are dealt with in the present account :—

Family I. **Rhinotermitidae**

1. *Heterotermes tenuis* (Hagen)
2. *Coptotermes testaceus* (Linnaeus)

Family II. **Termitidae**

3. *Syntermes molestus* (Burmeister)
4. *Cornitermes ovatus* Emerson
5. *Cornitermes silvestrii* Emerson
6. *Nasutitermes araujoi* n. sp.
7. *Nasutitermes bragantinus* n. sp.
8. *Nasutitermes costalis* (Holmgren)
9. *Nasutitermes guayanae* (Holmgren)

Genus (1) **Heterotermes** Froggatt

This genus is almost world-wide in distribution, and a few species also occur in South America.

1. **Heterotermes tenuis** (Hagen 1858)

(Synonyms : *Termes corticola* Bates 1854 ; and *Leucotermes flavipes* subsp. *paraensis* Wasmann 1902).

1858. *Termes tenuis* Hagen, *Linn. Entom.*, Berlin, 12 (2) : 231 (Im), Fig. 35. Type-localities : St. Domingo near Port au Prince, Colombia ; and Brazil.
1925. *Leucotermes tenuis* (Hag.), Emerson, *Zoologica*, New York, 6 (4) : 340-341.
1949. *Heterotermes tenuis* (Hag.), Snyder, *Smiths. misc. Coll.*, Washington, 112 : 70.

*Material* : One tube, as follows :—Tube No. 5 (Fd. Coll. No. R4/2.8.57), sev. S and W, Belterra (Pará), M. L. Roonwal coll., 2 August 1957, ex piece of dry pine plank in a house.

*Measurements (mm.), etc.*

	<i>Soldiers Major</i> (4 exs.)	<i>Soldiers Minor</i> (1 ex.)
1. Head-length to mandible-base	1.80-2.00	1.50
2. Maximum head-width	1.05-1.08	0.90
3. Length of mandibles :		
Right	1.12-1.13	1.05
Left	1.12-1.13	1.05
4. No. of antennal segments	15	15

*Distribution* : The species is widespread in Central and South America, and also occurs in the West Indies.

*Field notes and remarks* : I found several soldiers and workers in a piece of dry pine plank inside a house in a rubber plantation at Belterra. The soldiers are of two types—large (major) and small (minor).

The species is known from imagoes (alates) soldiers and workers. For a summary of its biology, see Araujo (1970a).

## Genus (2) *Coptotermes* Wasmann

### 2. *Coptotermes testaceus* (Linnaeus 1758)

1758. *Hemirobeus testaceus* Linnaeus, *Systema Naturae* (10th Ed.), 1 : 550. Im. Type-locality : America.
1911. *Coptotermes testaceus* (L.), Holmgren, *K. Svenska Vetensk. Akad. Handl.*, Stockholm, 46 (6) : 73.
1949. *Coptotermes testaceus* (L.), Snyder, *Smiths. misc. Coll.*, Washington, 112 : 83. Synonymy.

*Material* : Three tubes, as follows :—(i) Tube No. 10 (Fd. Coll. No. 3), sev. S and W, Mazagao (Amapá), Inacio coll., 6 September

1955. (ii) Tube No. 14 (Fd. Coll. No. 7), 1 S, sev. W. (iii) Tube No. 18 (Fd. Coll. No. 6 or 9), 1 S, sev. W; both Tubes 14 and 18, Regiao Bragantina (Pará), E. Sefer coll., 1956.

*Measurements (mm.), etc.*

	<i>Soldiers</i>	
	Mazagao (Amapá) (2 exs.)	Regiao Bragantina (Pará) (2 exs.)
1. Total length, with mandibles	—	4.31 (1ex.)
2. Head-length to mandible-base	1.35-1.40	1.40-1.45
3. Max. head-width	1.13-1.18	1.15-1.20
4. Min. head-width	0.65-0.68	0.70-0.75
5. Height of head	0.80 (1 ex.)	—
6. Occipito-fontanelle distance	1.33	1.33-1.40
7. Length of mandibles :		
Right	0.95	0.95-0.98
Left	0.95	0.95-0.98
8. No. of antennal segments ..	14 (1 ex.)	15

*Distribution* : This neotropical species is widespread in the West Indies and northern parts of South America, including Brazil.

*Remarks* : The species is known from imagoes (alates), soldiers and workers. It is common in forests and also seriously damages wood-work in houses. For a summary of its biology, see Araujo (1970a).

### Genus (3) *Syntermes* Holmgren

This neotropical genus has been revised by Emerson (1945; and 1952b, p. 488, extension of geographical range of some species).

#### 3. *Syntermes molestus* (Burmeister 1839)

(Synonym : *Syntermes brasiliensis* Holmgren 1911).

1839. *Termes molestus* Burmeister, *Handb. d. Entomologie*, Berlin, 2 : 766 (Im.).
1911. *Syntermes molestus* (Burm.), Holmgren, *Zool. Anz.*, Leipzig, 37 (26) : 547-548. (Im, S).
1911. *Syntermes brasiliensis* Holmgren, *Zool. Anz.*, Leipzig, 37 (26) : 547-548. (Im, S).
1945. *Syntermes molestus* (Burm.), Emerson, *Bull. Amer. Mus. nat. Hist.*, New York, 57 : 467-470. Type-locality designated : Bahia (Brazil).
1949. *Syntermes molestus* (Burm.), Snyder, *Smiths. misc. Coll.*, Washington, 112 : 258.

*Material* : One tube, as follows :—Tube No. 2, Maués (Amazonas), *Flavio* coll., 6 June 1957, sev. S.

*Measurements (mm.), etc.*

	<i>Soldiers</i> (5 exs.)
1. Total length with mandibles	12-13
2. Head-length to mandible-base	3.8-4.2
3. Max. head-width	3.36-3.8
4. Head-width at base of mandibles	2.10-2.18
5. Length of mandibles :	
Right	2.2-2.4
Left	2.2-2.4
6. No. of antennal segments	19

*Distribution* : The species is found in the northern two-thirds of South America, viz., Venezuela, Colombia, Bolivia and almost all over Brazil (Emerson, 1945, 1952*b*, p. 488 ; Snyder, 1949).

*Remarks* : The measurements given above nearly agree with those of Emerson (1945) ; he gives, the number of antennal segments as 19-20. For a summary of its biology, see Araujo (1970*a*).

#### Genus (4) *Cornitermes* Wasmann

This neotropical genus has been revised by Emerson (1952*b*) according to whom it is "essentially a tropical and savanna genus" (p. 507). On the basis of the present account, the known geographical ranges of the two species dealt with below have been considerably extended north and north-east by about 1200-1400 km.

#### 4. *Cornitermes ovatus* Emerson 1952

1952. *Cornitermes ovatus* Emerson, *Bull. Amer. Mus. nat. Hist.*, New York, 99 (8) : 506 (Fig. 16, distribution map) ; 511 (key) ; 534-535, S ; Fig. 31 (S, head and pronotum). Type-locality : Rio Autaz (Amazonas, Brazil).

*Material* : One tube (Tube No. 1) : 15 S, Belém (Pará), Inst. Agron. de Norte, *Cincinato* coll., 1956.

*Measurements (mm.), etc.*

	<i>Soldiers</i> (5 exs.)
1. Total length with mandibles	8.5-8.8
2. Head-length to mandible-base	3.4-3.7
3. Head-length to tip of frontal tube	3.2-3.5

	<i>Soldiers</i> (5 exs.)
4. Length of frontal tube	0.45-0.48
5. Max. head-width	2.8-3.0
6. Length of mandibles :	
Right	1.5-1.6
Left	1.5-1.6
7. No. of antennal segments	15

*Distribution* : NE Brazil (States of Amazonas and Pará) between approximate S. latitudes  $1^{\circ}28'$ — $5^{\circ}00'$ , and W. longitudes  $48^{\circ}29'$ — $62^{\circ}00'$ , as follows :—*Amazonas* : Cururuzinho, Rio Autaz (type-locality) (Emerson, 1952*b*). *Pará* : Belém (*new record*).

*Remarks* : In body-size, the present specimens nearly agree with those of Emerson (1952*b*), except that the frontal tube is longer (0.45—0.48 *vs.* 0.32—0.42 mm.), the head slightly narrower (2.8—3.0 *vs.* 2.98—3.20 mm.) and the mandibles a little shorter (length 1.5—1.6 *vs.* 1.68—1.86 mm.).

This collection considerably extends the known distribution east by about 1200 km., right upto the sea-coast. Only soldiers are hitherto known.

The species is confined to hot tropical rain-forest where the average daily temperature is always above  $20^{\circ}$  C (Emerson, 1952*b*; and Araujo, 1970*a*). Nothing else is known of its biology.

#### 5. *Cornitermes silvestrii* Emerson 1949, 1952

(Synonym : *Cornitermes cumulans* Kollar, 1901, in part.

(Text-fig. 2)

1901. *Cornitermes cumulans* Koll. (in part), Silvestri *Bull. Mus. Zool. Anat. Comp. Torino*, Turin, 16 (389) : 4. Cuyaba (Brazil). Vide Emerson 1949. (in Snyder), 1952*b*.
1903. *Cornitermes cumulans* Koll. (in part), Silvestri, *Redia*, Portici, 1 : 56 (Im, S, W), p. 120 (biology), Figs. 40-41 (nest), Pl. 3, Figs. 96-98 (mI, S). Brazil : Examples from Coxipó and Cuyabá only (*vide* Snyder, 1949 : 263). (Biological observations may apply mainly to *Cornitermes cumulans* Kollar which too occurs here.)
1949. *Cornitermes silvestrii* Emerson (in Snyder), *Smiths. misc. coll.*, Washington, 112 : 263, Brazil : Coxipó and Cuyabá. *Nomen nudum*.
1952. *Cornitermes silvestrii* Emer., Emerson. *Bull. Amer. Mus. nat. Hist.*, New York, 99 (8) : 506 (Fig. 16, distribution map); 511 (key); and 523-524, S and W; Fig. 25 (S, head and pronotum). Type-locality ; Coxipó, Cuiabá (= Cuyabá) (Mato Grosso, Brazil).

*Material* : Two tubes, Santarem (Pará), just outside airport, M. L. Roonwal coll., 2 August 1957, as follows :— (i) Tube No. 6, (Fd. Coll. No. R2/2.8.57), 3 S, sev. W, 1 Ny, *ex* mound of brown earth, c. 60 cm. high. (ii) Tube No. 8 (Fd. Coll. No. R1/2.8.57 (A), 9 S, sev. W, *ex* dome-shaped mound of black earth, c. 30 cm. high. (Mixed with *Nasutitermes costalis*, collected from same mound in field but later on separated into Tube No. 8A/Fd. Coll. No. R1/2.8.57(B), *vide infra*).

*Measurements (mm.), etc.*

	<i>Soldiers</i> (3 exs.)
1. Total length, with mandibles	5.5-6.0
2. Head-length to mandible-base	2.20-2.25
3. Head-length to tip of frontal tube	2.00-2.10
4. Length of frontal tube	0.33-0.38
5. Max. head-width	1.63-1.68
6. Length of mandibles :	
Right	1.00
Left	0.75-1.00
7. No. of antennal segments	15

*Distribution* : Central Brazil, in the States of Mato Grosso and Pará, between S. latitudes 2°55'—15°33' and W. longitudes 54°39'—56°00'.

Hitherto known only from the type-locality, Coxipó (15°30' S. lat., 56°00' W. long., Cuyabá, Mato Grosso). The present records (Santarem, Pará) extend the range north by about 1400 km.

*Field notes and remarks* : Emerson (in Snyder, 1949, p. 263 ; and 1952b, pp. 523-524) has clarified its synonymy and concluded that some examples from Coxipó, determined by Silvestri (1901, 1903) as *Cornitermes cumulans* Kollar, belong here.

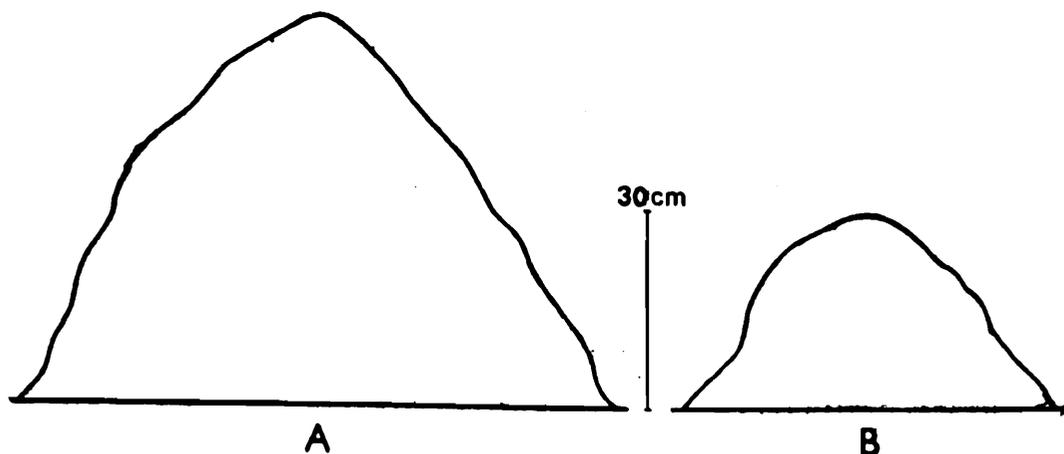
The species is known from imagoes (Silvestri), soldiers and workers. I collected soldiers, workers and a nymph from Santarem. These soldiers are slightly larger than those of Emerson (1952b) from further south, thus : Head-length to mandible-base 2.20-2.25 *vs.* 2.00-2.07 mm., and to tip of frontal tube 2.00-2.10 *vs.* 1.83-1.94 mm.; head-width 1.63-1.68 *vs.* 1.40-1.46 mm.

It is interesting to note that the species *Cornitermes cumulans* Kollar (middle part of South America, e.g., NE. Argentina, Paraguay and S. Brazil) with which *C. silvestrii* was formerly confused, is a

common southern species, and *C. silvestrii* a northern one, with Coxipó (Cuyabá) as the meeting place of the two.

From Coxipó, Silvestri (1903) described the earthen mounds (under *C. cumulans*, *vide* Emerson, 1952*b*, p. 509) as conical and about a metre high and with the same basal diameter; swarming occurs in August or a little later.

In Santarem, I found earthen mounds about 30–60 cm. high, the basal diameter being a little more than double the height. Their shape varied from dome-shaped to subconical and they were made of either brown or blackish earth, with a rugose outer surface (Text-fig. 2). In one case, several soldiers of *Nasutitermes costalis* (Holmgren) (*vide infra*) were also obtained from a mound along with soldiers and workers of *C. silvestrii*.



Text-fig. 2.—*Cornitermes silvestrii* Emerson. Outline of two earthen mounds, A, B. Santarem, Pará, Brazil. (From freehand field drawings by M.L.R.)

*C. silvestrii* is a species of the tropical savanna with many trees and with hot summers (average daily temperatures above 20° C) and mild winters (10°–20° C) (Emerson 1952*b*; Araujo, 1970*a*).

#### Genus (5) *Nasutitermes*\* Banks (*nec* Dudley)

This genus is richly represented in the neotropics by many species.

#### 6. *Nasutitermes araujoi* n. sp.†

(Text-figs. 3–5; and Tables 2 and 3)

*Material*: One tube, as follows :- Tube No. 3 (Fd. Coll. No. R3/2.8.57), sev. S, a few W and Ny, Belterra (Pará), M. L. Roonwal coll., 2 August 1957, *ex* carton nest on rubber tree.

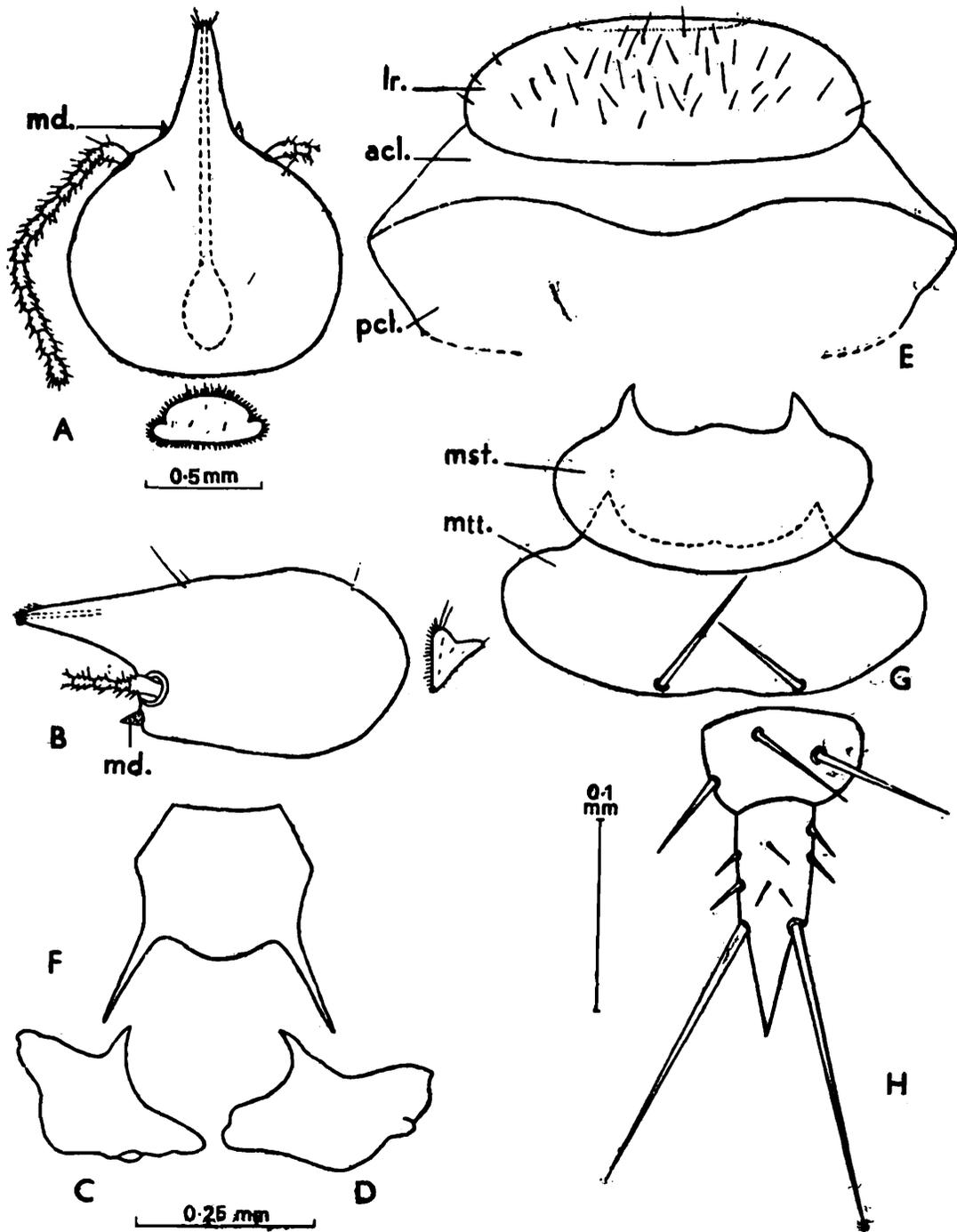
\* For discussion on authorship of genus, *vide* Prasad and Sen-Sarma (1959).

† Named after the well known Brazilian termitologist, Dr. R. L. Araujo, in appreciation of his assistance.

*Description*

1. IMAGO.—Unknown.

2. SOLDIER (Text-fig. 3).—Head dark castaneous brown, rostrum paler ; antennae pale yellowish with brownish edges ; thoracic



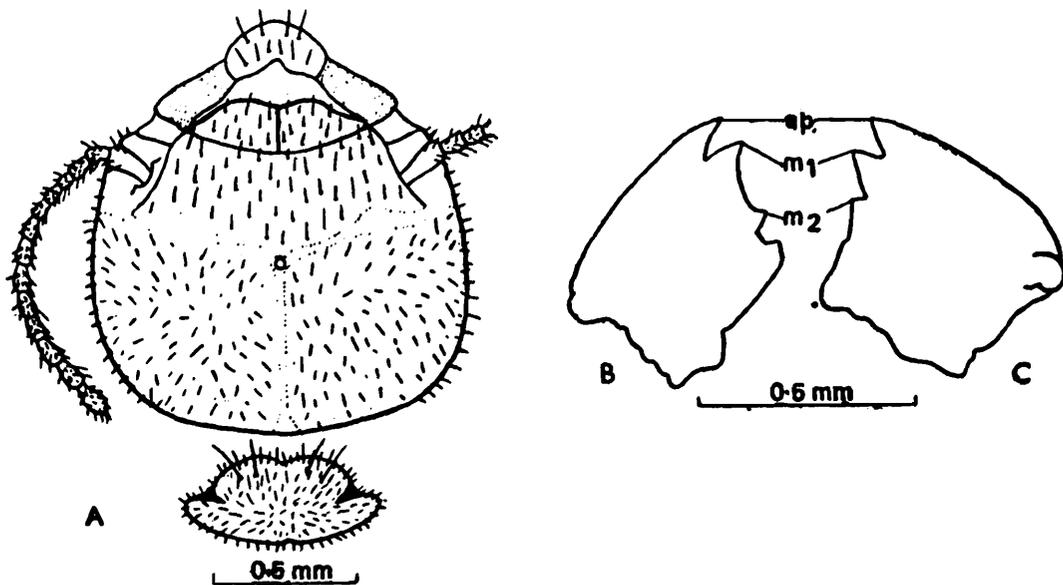
Text-fig. 3.—*Nasutitermes araujoi* n. sp. Brazil (Belterra, Pará). Soldier. (A) Head and pronotum (from holotype), in dorsal view. (B) Ditto, in side view. (C) Left mandible, in dorsal view. (D) Ditto, right mandible. (E) Labrum and clypeus, in dorsal view. (F) Postmentum, in ventral view. (G) Meso- and metanotum, in dorsal view. (H) Right cercus.

*acl.*, anteclypeus ; *lr.*, labrum ; *md.*, mandible ; *mst.*, mesonotum ; *mtt.*, metanotum ; *pcl.*, postclypeus.

terga brownish, legs paler; abdomen pale brownish. Head very sparsely pilose, with 2 or 3 longish hairs; several short hairs present at tip of rostrum; abdomen moderately pilose, with several short and long hairs. Total length to tip of rostrum 3.7-5.1 mm. Head-capsule smooth, rounded, with posterior margin substraight; slightly wider than long. Rostrum short, stout and subconical, *c.* one-third the length of rest of head-capsule. Tips of mandibles visible from above. Fontanelle tube and gland visible. In lateral view, head-capsule with a slight depression in mid-dorsal area followed by a weak hump. Antennae with 13 segments, all fairly pilose; segment 1 longest; 2 slightly longer than 3, the latter smallest; 4 slightly longer than 2; 5 to the last gradually increasing in length. Labrum translucent, colourless, band-like, over twice as wide as long; with several small hairs all over. Anteclypeus band-like, apilose. Postclypeus wider than anteclypeus; with a few hairs. Mandibles reduced, each with a prominent, lateral, non-dentate, spinous process. Postmentum subsquarish, with angulate lateral margins; with two long, lateral processes at posterior end; anterior margin weakly concave, posterior margin prominently convex. Pronotum saddle-shaped, moderately hairy, with rounded anterior lobe; anterior margin convex, posterior substraight, both without median notch. Mesonotum somewhat narrower than pronotum, and with posterior margin without median notch. Metanotum wider than mesonotum; posterior margin weakly concave, and with two long setae. Legs long, slender, moderately hairy. Tibiae long, with numerous spines; apical tibial spur formula 2 : 2 : 2. Tarsi-4 segmented, the last with a pair of terminal claws; arolium absent. Abdomen moderately hairy, with short hairs. Cerci hairy and short (*c.* 0.14 mm. long) but prominent; terminal segment sharply pointed. Styli absent.

*Measurements* : See Table 2.

3. WORKER MAJOR (Text-fig. 4).—Head dark brown, with a narrow pale stripe along arms of Y-suture; thorax and abdomen light brown from above; antennae, legs and sternites pale. Head and body fairly densely hairy. Total length *c.* 5.8-6.1 mm. Head-capsule subsquarish. Fontanelle present at junction of Y-suture as a small rounded spot, *c.* 0.05 mm. in diameter. Eye and ocelli absent. Antennae fairly pilose, with 14 segments; segment 1 longest, stout and cylindrical; 2 almost half of 1; 3 subequal to 2; 4 smallest. 5 to the last gradually increasing in length and becoming pyriform. Anteclypeus hyaline, whitish and apilose; anterior margin projecting in front medially. Postclypeus swollen, pilose, light brown; much broader than long; divided into right and left halves by a median vertical suture. Labrum dome-shaped, with longish hairs; broader than long; anterior tip weakly pointed medially. Mandibles yellowish brown. Left mandible with an apical and 2 marginal teeth;



Text-fig. 4.—*Nasutitermes araujoï* n. sp. Worker Major. (A) Head and pronotum, in dorsal view. (B) Left mandible, in dorsal view. (C) Ditto, right mandible. *ap.*, apical tooth; *m*<sub>1</sub>, *m*<sub>2</sub>, 1st and 2nd marginal teeth.

apical conical; marginal 1 subequal to apical; 2 small, widely separated from 1 by a concave margin. Right mandible similar to left; but marginal 2 closer to 1. Pronotum strongly saddle-shaped; broader than long, fairly pilose; with numerous fine hairs, also with a pair of longish hairs on either side in anterior half; anterior and posterior margins convex; the former with a well-marked, and the latter with a weak, median depression. Legs long and slender, moderately pilose; hind-femur not reaching tip of abdomen; hind-tibiae longer than hind-femora. Tarsi 4-segmented. Apical tibial spur formula 2 : 2 : 2. Abdominal tergites and sternites fairly pilose, with small and long hairs. Cerci short, hairy, 2-segmented. Styli absent.

*Measurements* : See Table 3.

4. WORKER MINOR.—Resembles worker major, except in the following respects :—Smaller (total-length 4.4-5.1 mm.); head-capsule light brown; fontanelle not clear; pronotum weakly saddle-shaped.

Table 2.—*Nasutitermes araujoi* n. sp. and *Nasutitermes braganinus* n. sp. from the Amazon Basin, Brazil.  
Body-measurements (mm.), indices, etc. of soldiers.

Item (1)	<i>Nasutitermes araujoi</i> n. sp. (Tube No. 3)		<i>Nasutitermes braganinus</i> n. sp. (Tube No. 20)	
	Holotype (2)	Range (10 exs.) (3)	Holotype (4)	Range (5 exs.) (5)
1. Total length .. .. .	3.8	3.7 -5.1	3.3	3.2 -3.4
2. Length of head with rostrum . . . . .	1.74	1.63-1.84	1.58	1.53-1.63
3. Length of head without rostrum .. .. .	1.16	1.11-1.21	1.05	1.00-1.11
4. Length of rostrum .. .. .	0.58	0.53-0.63	0.53	0.53-0.58
5. Maximum width of rostrum .. .. .	0.37	0.37-0.47	0.26	0.21-0.26
6. Maximum width of head .. .. .	1.37	1.26-1.37	1.00	0.95-1.00
7. Minimum width of head .. .. .	0.68	0.63-0.74	0.58	0.53-0.58
8. Posterior bulge of head .. .. .	0.37	0.31-0.47	0.37	0.37-0.47
9. Maximum height of head .. .. .	0.89	0.84-1.00	0.63	0.63-0.68
10. Median length of labrum .. .. .	—	0.09 (1 ex.)	—	0.07 (1 ex.)
11. Maximum width of labrum .. .. .	—	0.21 (1 ex.)	—	0.23 (1 ex.)
12. Rostrum-Head Index I (Rostrum-length/Head-length without rostrum) .. .. .	0.50	0.48-0.54	0.50	0.48-0.58

13. Rostrum-Head Index II (Max. rostrum-width /Max. head-width)	0.27	0.27-0.36	0.26	0.21-0.26
14. Head-bulge Index (Posterior head-bulge/Head-length without rostrum)	0.32	0.28-0.41	0.35	0.35-0.47
15. Head Contraction Index (Min. head-width/Max. head-width)	0.50	0.48-0.56	0.55	0.50-0.58
16. Head Index I (Max. width/Length without rostrum)	1.18	1.07-1.19	0.95	0.86-1.00
17. Head Index II (Max. height/Length without rostrum)	0.77	0.76-0.84	0.60	0.60-0.63
18. Head Index III (Max. height/Max. width)	0.65	0.64-0.76	0.63	0.63-0.72
19. Maximum (median) length of postmentum	0.36	0.34-0.38	0.19	0.19-0.20
20. Maximum width of postmentum	0.38	0.36-0.41	0.22	0.22-0.23
21. Length of pronotum	0.18	0.16-0.24	0.16	0.16-0.18
22. Maximum width of pronotum	0.54	0.49-0.59	0.47	0.47-0.49
23. Pronotum Index (Length/Max. width)	0.33	0.33-0.41	0.37	0.33-0.40
24. Length of hind-femur	0.72	0.67-0.90	0.79	0.74-0.79
25. Maximum width of hind-femur	0.18	0.18-0.20	0.14	0.12-0.14
26. Length of hind-tibia	1.16	1.00-1.26	1.11	1.05-1.11
27. No. of antennal segments	13	13	13	13

Table 3.—*Nasutitermes araujoi* n. sp. from the Amazon Basin, Brazil.  
Body-measurements (mm.), etc. of workers (major and minor).  
Tube No. 3, Belterra, Pará.

Item	Workers Major (3 exs.)	Workers Minor (3 exs.)
1. Total length	5.8 -6.1	4.4 -5.1
2. Length of head to lateral base of mandibles	1.16-1.26	0.83-0.86
3. Max. width of head	1.32	1.05-1.11
4. Max. height of head	0.81-0.86	0.68-0.77
5. Length of labrum	0.09-0.10	0.09
6. Max. width of labrum	0.43-0.54	0.36-0.45
7. Length of pronotum	0.32-0.36	0.18-0.20
8. Max. width of pronotum	0.74-0.81	0.56-0.59
9. No. of antennal segments	14	14

*Measurements* : See Table 3.

*Type-specimens* : Deposited as follows:—*Holotype* (a soldier), in a tube (Z. S. I. Reg. No. 14/H11) in the Zoological Survey of India, Calcutta. *Paratypes* (soldiers) and *morphotypes* (workers major and minor ; and nymphs) : (i) 5 S, 2 WM, 2 Wm, 3 Ny, in a tube, in Z. S. I., Calcutta. (ii) 2 S, 1 WM, 1 Ny, in a tube, in Forest Research Institute, Dehra Dun. (iii) 2 S, 2 WM, 1 Ny, in a tube, in the Zoology Museum, São Paulo University, São Paulo, Brazil. The remaining material, in Z. S. I., Calcutta, thus : In a tube, sev. S, a few WM, Wm and Ny. ; also 2 slides of mandibles (1 of S, 1 of WM).

*Type-locality and distribution* : Known only from the type-locality (Belterra, State of Pará, Brazil).

*Comparison* : *Nasutitermes araujoi* n. sp. is close to *N. maximus* (Holmgren) from Peru but differs as follows :—

**SOLDIERS** : Head with rostrum shorter (length with rostrum 1.63-1.84 vs. 1.90-2.05 mm.) but wider (maximum width 1.26-1.37 vs. 1.15-1.30 mm.). Antennae with 13 segments (vs. 14) ; segment 3 smaller than 2 (vs. longer), 5 longer than 4 (vs. smaller).

**WORKERS** : Dimorphic (with major and minor forms (vs. monomorphic). Head narrower (maximum width : major 1.32, minor 1.05-1.11 ; vs. 1.53 mm.). Antennae with 14 segments in both forms (vs. 15).

*Field notes* : In the well-stocked rubber plantation (*Hevea* sp.) where the collection was made, with trees about 5 metres or more high, nests of *Nasutitermes araujoi* n. sp. were very common, almost every twentieth tree having a nest in the forks at the upper end of the bole, usually about 2-3 metres above ground-level, but some were higher.

The nest (Text-fig. 5) is an irregularly roundish mass of black, polyporous wood-carton with a highly rugose surface. An average-sized nest measured about 45 × 60 cm. in diameter. Flat, broad (1-2 cm. wide) wavy strips of runways, composed of black earthy material, extend from the ground at the base of the tree along the surface of the trunk to the nest. Four or five, sometimes more, such runways were found on the trunks of trees which carried a nest, but they were also present on some trees where no nest was visible.

A nest was broken and examined. It was rather fragile and could be broken easily with the hands and a small knife. No termites were seen on the surface, but all over the porous, honey-combed interior, thousands of soldiers, and in the central part of the nest several nymphs, were found. Although the nest was completely broken open, there was no trace of a royal chamber or of the reproductive pair (king and queen). The workers are dimorphic as regards size, there being major (large) and minor (small) forms. They moved about sluggishly when disturbed. The soldiers too, curiously, did not exhibit any extraordinary activity or alertness and were as sluggish as the workers.

The runways on the tree trunks were full of soldiers but no workers were found in them.

### 7. *Nasutitermes bragantinus* n. sp.

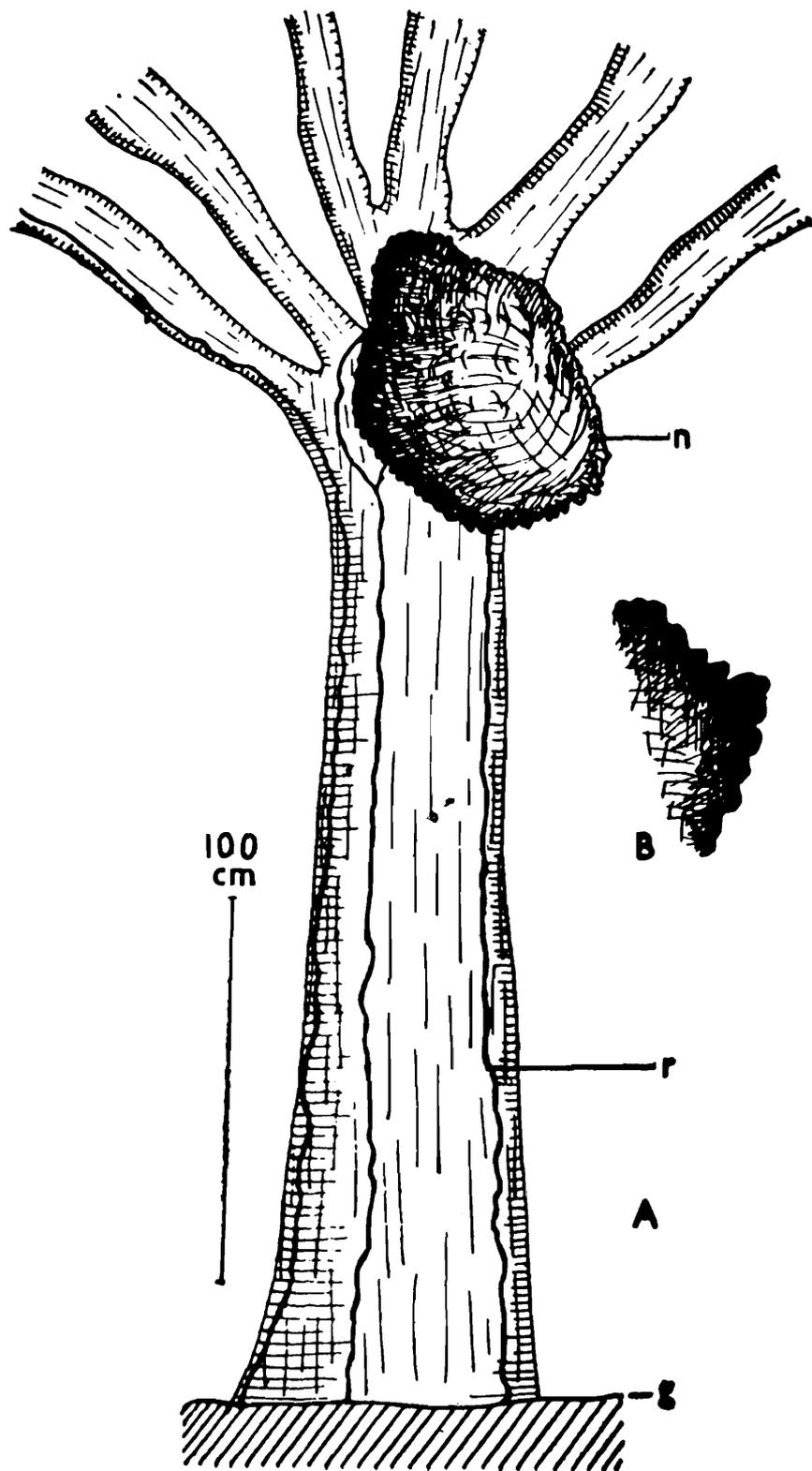
(Text-fig. 6 ; and Table 2)

*Material* : One tube, as follows :—Tube No. 20 (Fd. Coll. No. 8), 9 S, Região Bragantina (Pará), E. Sefer coll., 1956.

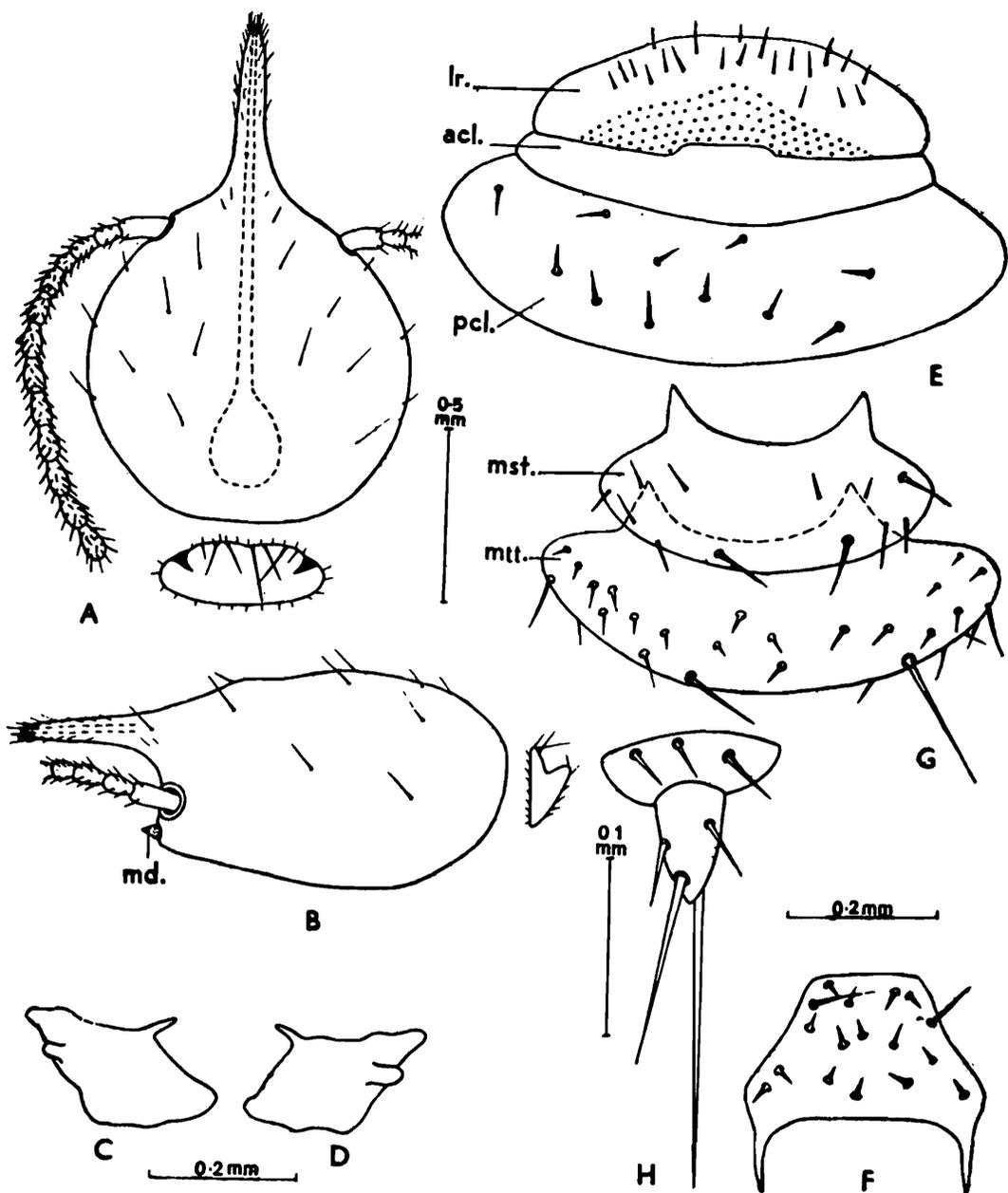
#### *Description*

1. IMAGO.—Unknown.

2. SOLDIER (Text-fig. 6).—Head pale brown ; rostrum darker, but paler at tip ; antennae yellowish brown ; thoracic terga, legs and abdomen brownish. Head with a few longish hairs all over ; tip of rostrum with several small hairs. Abdomen fairly pilose with



**Text-fig. 5.**—*Nasutitermes araujoi* n. sp. Carton nest on rubber tree. Belterra (Pará, Brazil). (From field drawings by M.L.R., 2 August 1957, Fd. Coll. No. R3/2.8.57). (A) Lower part of tree, showing entire nest. (B) Part of nest, enlarged to show surface rugosity. *g.*, ground-level; *n.*, nest; *r.*, runways.



**Text-fig. 6.**—*Nasutitermes bragantinus* n. sp. Brazil (Região Bragantina, Pará). Soldier. (A) Head and pronotum (from holotype), in dorsal view. (B) Ditto, in side view. (C) Left mandible, in dorsal view. (D) Ditto, right mandible. (E) Labrum and clypeus, in dorsal view. (F) Postmentum, in ventral view. (G) Meso- and metanotum, in dorsal view. (H) Left cercus. *acl.*, anteclypeus; *lr.*, labrum; *md.*, mandible; *mst.*, mesonotum; *mtt.*, metanotum; *pcl.*, postclypeus.

several short and longish hairs. Total length with rostrum 3.2-3.4 mm. Head-capsule almost rounded, posterior margin substraight; length (1.53-1.63 mm.) more than maximum width (0.95-1.00 mm.). Rostrum short, rather slender and subcylindrical, about half the length of rest of head-capsule. Tips of mandibles not visible from above. Fontanelle tube and gland visible. In lateral view, head-capsule with a slight hump in foredorsal area, followed

by a shallow depression. Antennae with 13 segments, fairly pilose ; segment 1 long, cylindrical and stout ; 2 about half of one ; 3 slightly longer than 2 ; 4 smallest ; 5 subequal to 3 and much longer than 4 ; 6 to the last gradually increasing in length. Labrum whitish, translucent, band-like, width about twice the length ; anterior margin convex ; anterolateral corners rounded. Anteclypeus hyaline, band-like, much broader than long ; anterior margin slightly protruded in middle. Postclypeus much broader than anteclypeus, with a few stout hairs ; anterior margin concave ; posterior margin rounded, convex. Mandibles small and reduced, each with a non-dental spine-like lateral process. Postmentum subtrapezoidal, slightly broader than long, with anterior end narrower ; fairly pilose ; both anterior and posterior margins substraight. Pronotum strongly saddle-shaped, broader than long ; with a few long and short hairs on both margins ; anterior margin substraight, with a weak median notch ; posterior margin slightly convex, without a median notch. Mesonotum narrower than, and metanotum subequal to, pronotum ; with a few hairs on body ; in both, the posterior margin convex and not medially notched. Legs long and slender ; moderately hairy except for the tarsi which have numerous hairs and stout spines. Apical tibial spur formula 2 : 2 : 2. Tarsi 4-segmented, with a pair of terminal claws ; arolium absent. Abdomen moderately hairy, with short and long hairs. Cerci short (length 0.09 mm.), 2-segmented, hairy. Styli absent.

*Measurements* : See Table 2.

### 3. WORKER.—Unknown.

*Type-specimens* : Deposited as follows :—*Holotype* (a soldier) in a tube (Z. S. I. Reg. No. 17/H11) in the Zoological Survey of India, Calcutta. *Paratypes* : (i) 2 S in a tube, in the Zoology Museum, São Paulo University, São Paulo, Brazil. (ii) 2 S (+ 3 broken) in a tube, and 5 slides of various body-parts of S, in Z. S. I., Calcutta.

*Type-locality and distribution* : Known only from the type-locality (Região Bragantina, State of Pará, Brazil).

*Comparison* : The soldiers of *Nasutitermes bragantinus* n. sp. are close to *N. rippertii* (Rambur) [synonyms *N. bahamensis* (Holmgren) and *N. cubanus* (Holmgren)] from the West Indies, but differ as follows :—Total length somewhat smaller (3.2-3.4 vs. 3.5-3.9 mm.) ; head-capsule more rounded (vs. pear-shaped) ; and antennal segment 4 much shorter than 2, and 5 much longer than 4 (vs. 4 subequal to 2, and 5 either subequal to or only slightly longer than 4).

8. *Nasutitermes costalis* (Holmgren 1910)

(Tables 4 and 5)

1910. *Eutermes costalis* Holmgren, *Mitteil. naturhist. Mus. Hamburg*, 27 (Jahrb. Hamburg. wissenschaft. Anstalt, Beih. 2), Hamburg : 293-294 (Im). Fig. 64. Type-locality : Trinidad (West Indies).  
 1949. *Nasutitermes costalis* (Holmg.), Snyder, *Smiths. misc. Coll.*, Washington, 112 : 272-273. (Synonymy).

*Material* : Five tubes as follows :—(i) Tube No. 4 (Fd. Coll. No. R1/3.8.57), sev. S and W, Belém (Pará), *M. L. Roonwal* coll., 3 August 1957, *ex* narrow earthen gallery on trunk of large tree in garden. (ii) Tube No. 7 (Fd. Coll. No. R1/6.8.57), sev. S and W, Belém (Pará), *M. L. Roonwal* coll., 6 August, 1957, *ex* long earthen runways on tree trunk on roadside avenue. (iii) Tube No. 8A (Fd. Coll. No. R1/2.8.57(B), *M. L. Roonwal* coll., 2 August 1957, *ex* mound of *Cornitermes silvestrii*, *vide supra*. (iv) Tube No. 9 (Fd. Coll. No. R 2/3.8.57), sev. S and W, Belém (Pará), *M. L. Roonwal* coll., 3 August 1957, *ex* earthen runways on tree trunk in garden. (v) Tube No. 19 (Fd. Coll. No. 4), sev. S and W (major and minor), Região Bragantina (Pará), *E. Sefer* coll., 1956.

*Measurements* : See Tables 4 (soldiers) and 5 (workers).

Table 4.—*Nasutitermes costalis* and *N. guayanae* from the Amazon Basin, Brazil. Measurement (mm.), etc. of body-parts of *soldiers*.

Item	<i>Nasutitermes costalis</i> (3 exs.). (Belém, Pará) (Tube No. 4)	<i>Nasutitermes guayanae</i> (3 exs.). (Região Bragantina, Pará) (Tube No. 12)
1. Total length to tip of head-rostrum	3.16-4.05	3.26-3.47
2. Head-length with rostrum	1.32-1.58	1.42-1.68
3. Head-length without rostrum	0.95-1.05	0.89-1.05
4. Length of rostrum	0.37-0.53	0.47-0.63
5. Maximum head-width	1.00-1.05	1.00-1.05
6. Minimum head-width	0.53	0.47-0.53
7. Posterior bulge of head	0.26-0.37	0.26-0.32
8. Maximum length of pronotum	0.21-0.26	0.32
9. Maximum width of pronotum	0.47-0.53	0.63
10. Number of antennal segments	13	14

Table 5.—*Nasutitermes costalis* and *N. guayanae* from the Amazon Basin, Brazil. Measurements (mm.) etc. of body-parts of workers.

Item	<i>Nasutitermes costalis</i> (3 exs.). (Belém, Pará) (Tube No. 4)	<i>Nasutitermes guayanae</i> (3 exs.). (Região Bra- gantina (Pará)) (Tube No. 12)
1. Total length	3.32-4.10	2.84-3.16
2. Head-length to lateral base of mandibles	0.68-0.89	0.79-1.05
3. Maximum head-width	1.00-1.16	1.05-1.42
4. Maximum head-height	0.47-0.53	0.68-0.74
5. Length of labrum	0.21	0.21-0.26
6. Maximum width of labrum	0.47	0.63
7. Length of pronotum	0.21-0.26	0.21
8. Maximum width of pronotum	0.47-0.58	0.58-0.63
9. Number of antennal segments	14	15

*Distribution* : Widespread in the neotropics. Hitherto known from the West Indies (Cuba, Haiti, Dominican Republic, Martinique, Grenada and Trinidad) and northern part of South America (Guyana, northern Brazil and Bolivia), *vide* Snyder, 1949, pp. 272-273 ; Araujo, 1970a, p. 562). As a rule not going above about 610 m. altitude. All present collections are from north-eastern Brazil (State of Pará).

*Field notes and remarks* : The species is known from alates, queens, soldiers and workers. I found *N. costalis* very common in Belém (Pará) and obtained it from beneath long, narrow (c. 1 cm. wide) earthen runways made of dark matter and running up the tree trunks in gardens and roadside avenues, sometimes going upto the top of the bole 15 m. or more in height, but no nests were seen on the trees. In some cases soldiers were very common (forming about 95 % of the population in the earthen runways) and in others less so (the workers being more numerous). In one lot (Tube 19) two types of workers, major and minor (large and small respectively), were met with. In Santarem the species was found in a mound of *Syntermes silvestrii* along with examples of the latter species, but the nature of their association is not clear.

For a summary of its biology, see Araujo (1970a).

9. *Nasutitermes guayanae* (Holmgren 1910)(Synonym : *Eutermes* (*E.*) *grandis* Holmgren 1910.)

(Tables 4 and 5)

1910. *Eutermes* (*Eutermes*) *Guayanae* Holmgren, *Mitteil. naturhist. Mus. Hamburg*, 27 (*Jarhrb. Hamburg. wissenschaft. Anstalt.*, Beih, 2), Hamburg : 254-256 (S, W), Fig. 36 (S, head). Type-locality : Upper Surinam (South America).
1910. *Eutermes* (*Eutermes*) *grandis* Holmgren, *Mitteil. naturhist. Mus. Hamburg*, 27 (*Jarhrb. Hamburg wissenschaft. Anstalt.*, Beih. 2), Hamburg : 258-259 (S, W), Fig. 39 (S). Type-locality : Chaquimayo (Peru).
1949. *Nasutitermes guayanae* (Holmg.), Snyder, *Smiths. misc. Coll.*, Washington, 112 : 278-279.

*Material* : Four tubes, all from Região Bragantina (Pará), E. Sefer coll., 1956, as follows :— (i) Tube No. 12 (Fd. Coll. No. 2), sev. S, a few W. (ii) Tube No. 13 (Fd. Coll. No. 5), sev. S, a few W. (iii) Tube No. 15 (Fd. Coll. No. OT), sev. S, 1W. (iv) Tube No. 16 (Fd. Coll. No. 6 or 9), sev. S.

*Measurements, etc.* : See Tables 4 (soldiers) and 5 (workers).

*Distribution* : The species was hitherto known from the north-east (Guyana and Surinam) and the west (Peru) in South America. The present one is the first record from Brazil, and the species may be expected to occur in the intermediate area, *i.e.*, the Amazon Basin lying between north-east Brazil and Peru.

*Remarks* : These examples, especially the workers, are smaller than the type-specimens (Holmgren) from upper Surinam as follows :— *Soldiers* : Total length 3.26-3.47 mm. (*vs.* 3.67); head-length 1.42-1.68 mm. (*vs.* 1.65-1.85). *Workers* ; Total length 2.8-3.16 mm. (*vs.* 5.0).

The species is known from winged forms, soldiers' and workers. Emerson (1938) has described the nest. For a summary of its biology, see Araujo (1970a).

## SUMMARY

1. This paper deals with a collection of termites from the Amazon Basin, made in 1957 by one of the authors (M. L. R.). It includes 9 species belonging to 2 families and 5 genera, the number of species being given within brackets : Fam. Rhinotermitidae : *Heterotermes* (1) and *Coptotermes* (1). Fam. Termitidae : *Syntermes* (1), *Cornitermes* (2) and *Nasutitermes* (4).

2. Two new species are described : *Nasutitermes araujo* n. sp. (type-locality : Belterra, Pará ; soldiers, workers and nymphs) and *N. bragantinus* n. sp. (type-locality : Região Bragantina, Pará ; soldiers only).

3. *Nasutitermes guayanae* is recorded for the first time from Brazil.

4. The distribution range of *Cornitermes ovatus* and *C. silvestrii* in Brazil are considerably extended, by about 1200-1400 km. north and north-east.

## REFERENCES

- ARAUJO, R. L. 1958a. Contribuição à biogeografia dos térmitas de São Paulo, Brasil. Insecta : Isoptera.—*Arq. Inst. biol.* (Dept. Def. sanit. Agric.), São Paulo, 25, pp. 185-217.
- ARAUJO, R. L. 1958b. Contribuição à biogeografia dos termitas de Minas Gerais, Brasil. Insecta : Isoptera.—*Arq. Inst. biol.* (Dept. Def. sanit. Agric.), Sao Paulo, 25, pp. 219-236.
- ARAUJO, R. L. 1970a. Termites of the Neotropical Region, pp. 527-576. In *Biology of Termites* (Ed. by K. Krishna and F. M. Weesner), Vol. 2.—New York & London (Academic Press).
- ARAUJO, R. L. 1970b. Neotropical termite studies (Isoptera).—*Revista brasil. Entom.*, São Paulo, 14 (2), pp. 11-27.
- BATES, H. W. 1858. Beobachtungen über die Termiten von Santarem am Amazonenstrom. (Translated into German by H. A. Hagen, 1858a, *infra*, pp. 270-280).
- EMERSON, A. E. 1925. The termites of Kartabo, Bartica District, British Guiana.—*Zoologica*, New York, 6 (4), pp. 291-459.
- EMERSON, A. E. 1938. Termite nests. A study of the phylogeny of behaviour.—*Ecol. Monographs*, Durham (N. C.), 8 (2), pp. 247-284.
- EMERSON, A. E. 1945. The neotropical genus *Syntermes* (Isoptera : Termitidae).—*Bull. Amer. Mus. nat. Hist.*, New York, 83 (Art. 7), pp. 427-471.
- EMERSON, A. E. 1952a. The biogeography of termites.—*Bull. Amer. Mus. nat. Hist.*, New York, 99 (Art. 3), pp. 217-225.
- EMERSON, A. E. 1952b. The neotropical genera *Procornitermes* and *Cornitermes* (Isoptera : Termitidae).—*Bull. Amer. Mus. nat. Hist.*, New York, 99 (Art. 8), pp. 475-540.
- EMERSON, A. E. 1955. Geographical origins and dispersals of termite genera.—*Fieldiana (Zool.)*, Chicago, 37, pp. 465-522.
- GRASSE', P. P. 1949. Ordre des Isoptères ou termites. (Isoptera Brullé, 1852), pp. 408-544. In : *Traité de Zoologie* (Ed. by P. P. Grassé), Vol. 9, *Insectes*.—Paris (Masson & Co).
- GRASSE', P. P. 1958. Sur le nid et la biologie de *Cornitermes cumulans* (Kollar), termite brésilién.—*Insectes sociaux*, Paris, 5, pp. 189-200.

- HAGEN, H. A. 1855. Monographie der Termiten. Part 1.—*Linnaea Entom.* (Stettin entom. Verein), Berlin 10, pp. 1-144; and 270-325.
- HAGEN, H. A. 1858a. Monographie der Termiten. Part 2.—*Linnaea Entom.* (Stettin entom. Verein), Berlin, 12 (2), pp. 1-342, 3 pls.; and 459 (*errata*).
- HAGEN, H. A. 1858b. Catalogue of the specimens of neuropterous insects in the collection of the British Museum. Termitina.—London (Brit. Mus. Nat. Hist.), London, 34 pp., 1 pl.
- HOLMGREN, N. 1906. Studien über südamerikanische Termiten.—*Zool. Jahrb. (Syst.)*, Jena, 23 (5), pp. 521-676.
- HOLMGREN, N. 1910. Versuch einer Monographie der amerikanischen *Eutermes*-Arten.—*Mitteil. naturhist. Mus. Hamburg*, 27 (*Jahrb. Hamburg. wissenschaft. Anstalt.*, Beih. 2), Hamburg, pp. 171-325.
- HOLMGREN, N. 1911. Termitenstudien. 2. Systematik der Termiten. Die Familien Mastotermitidae, Protermitidae und Mesotermitidae.—*K. Svenska Vetensk. Akad. Handl.*, Uppsala & Stockholm, 46 (6), pp. 1-88, 6 pls.
- HOLMGREN, N. 1912. Termitenstudien. 3. Systematik der Termiten. Die Familie Metatermitidae.—*K. Svenska Vetensk. Akad. Handl.*, Uppsala & Stockholm, 48 (4), pp. 1-166, 4 pls.
- JOHN, O. 1920. Additional note to Mr. I. Strelnikov's article on South American termites.—*Bull. Inst. Sci. St. Petersburg*, St. Petersburg (Inst. Leshaft), 1, pp. 227-234.
- MÜLLER, FRITZ. 1871. Remarks on some white ants.—*Proc. Boston Soc. nat. Hist.*, Boston, 13, pp. 205-206.
- MÜLLER, FRITZ. 1873. Beiträge zur Kenntniss der Termiten. I-II, III.—*Z. Naturw.*, Jena, 7 (3), pp. 333-358, 2 pls.; and 7 (4), pp. 451-463, 1 pl.
- PRASHAD, B. and SEN-SARMA, P. K. 1959. Revision of the termite genus *Nasutitermes* Banks (Isoptera : Termitidae : Nasutitermitinae) from the Indian Region. 6 + 66 pp.—Delhi (Manager of Publ., Govt. of India) [Indian Counc. Agric. Res.].
- ROONWAL, M. L. 1962. Recent developments in termite systematics (1949-60). Pp. 31-50, 1 pl. (Pl. 1). In : *Termites in the Humid Tropics* (*Proc. New Delhi Symp.* 1960).—Paris (UNESCO).
- ROONWAL, M. L. 1970. Measurement of termites for taxonomic purposes.—*J. zool. Soc. India*, Calcutta, 21 (1) [1969], pp. 9-66.
- SILVESTRI, F. 1901. Nota preliminare sui Termitidi sudamericani.—*Bull. Mus. Anat. comp. Torino*, Turin, 16 (389), pp. 1-8.
- SILVESTRI, F. 1903. Contribuzione alla conoscenza dei Termiti e Termitofili dell' America meridionale.—*Redia*, Florence, 1, pp. 1-234.
- SNYDER, T. E. 1926. Termites collected on the Mulford Biological Exploration to the Amazon Basin, 1921-1922.—*Proc. U. S. natnl. Mus.*, Washington, 68 (Art. 14), pp. 1-76, 3 pls.

- SNYDER, T. E. 1933. A new species of Brazilian termite, featuring an intermediate soldier-worker individual.—*Proc. biol. Soc. Wash.*, Washington, 46, pp. 161-165.
- SNYDER, T. E. 1949. Catalog of the termites (Isoptera) of the world.—*Smithson. misc. Coll.*, Washington, 112, pp. 2 + 1-490.
- STRELNIKOV, I. 1920. On the termites of South America. (In Russian).—*Bull. Inst. Sci. St. Petersbourg*, St. Petersbourg, (Inst. Leshaft), 1, pp. 215-226.
- WEIDNER, H. 1970. Isoptera (Termiten).—*Handb. d. Zool*, Vol. 4 (Arthropoda), Sec. 2 (Insecta), Pt. 2 (Special), Lief. 13, No. 14, pp. 1-147.—Berlin (W. de Gruyter & Co.).