

MORPHOLOGY OF THE PRIMITIVE TERMITE *ANACANTHOTERMES MACROCEPHALUS* (DESNEUX) (ISOPTERA : HODOTERMITIDAE). PART 1. EXTERNAL MORPHOLOGY OF THE SOLDIER CASTE

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(With 3 Tables and 8 Text-figures)

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I—INTRODUCTION

Our knowledge of the morphology of Indian termites is very meagre. Imms (1919) studied in detail the morphology of the primitive termite *Archotermopsis wroughtoni* Desneux (family Hodotermitidae). Bugnion and Popoff (1912), and Mukerji and Raichoudhury (1942, 1944,) have studied particular organs and systems in the various castes of *Odontotermes redemanni* (Wasm.) (their *Termes redemanni* Wasm.). Vishnoi (1956) has described the structure, musculature and feeding mechanism of *Odontotermes obesus* (Rambur), and Kushwaha (1960) has given a detailed account of the external morphology of the same species which is one of the higher evolved and mound-building termites of India.

Anacanthotermes macrocephalus (Desneux), the species I have chosen for study in detail, belongs, like *Archotermopsis wroughtoni* Desneux, to the family Hodotermitidae, but is more highly evolved than the latter in having a worker caste. It inhabits the desert regions of West Pakistan and western India and lives mainly on grass. It has so far been recorded from Karachi and Multan in West Pakistan; and from the Bikaner and Jodhpur Divisions of Rajasthan in India. The present series of papers deal with its morphology.

Acknowledgments.—I am extremely grateful to Dr. M. L. Roonwal, Director, Zoological Survey of India, Calcutta, for guidance. I am also indebted to the Principal, Dungar College, Bikaner, for allowing me the laboratory facilities where the work was mainly done, and to Prof. K. S. Kushwaha for kindly reading through the manuscript and suggesting improvements.

II—MATERIAL AND METHODS

The material was collected from fields and open lands on the outskirts of Bikaner city in Rajasthan. The actual method of catching them is of interest. They were captured either when the insects were foraging in the open or were pulled out of the burrow-holes individually. In the latter case the following procedure was successful : A 'wet', (*i.e.*, active) "mound" or earth-heap, built by the termite was swept aside to expose the ground hole and a grass blade was pushed in through the hole leading to the underground passages. The blade was invariably caught by a soldier, and as soon as this happened it was pulled out to bring the soldier with it.

The material was examined either fresh after killing by dropping the insect in boiling water, or preserved in rectified spirit. Individual structures were dissected out, cleared in 5 per cent KOH for about 24 hours, dehydrated, stained in the usual way with eosin (in 90 per cent alcohol) and mounted in canada balsam on a glass slide.

Three castes are present, *viz.*, the soldiers, workers, and the reproductives (alate males and females). In the present paper the external morphology of the soldier is described.

III—EXTERNAL MORPHOLOGY OF THE SOLDIER

(Text-figs. 1 and 2)

(a) *General*

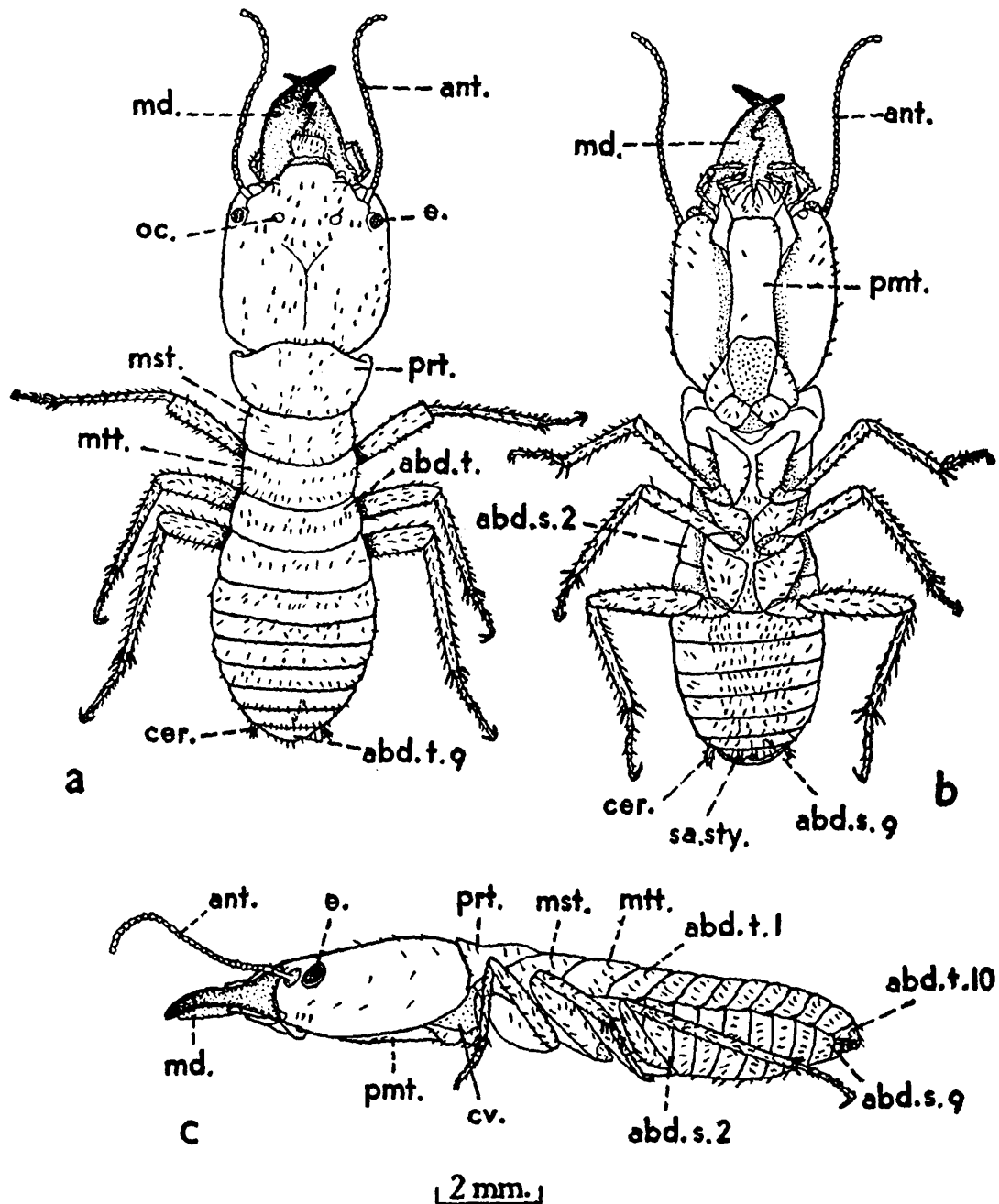
Coloration.—The head is rust brown, paler posteriorly and darker anteriorly in the clypeal region. The anteclypeus is whitish, the labrum, antennae, maxillary palps and prementum of labium pale yellow-brown, and the margins of the mental plate are dark brown. The eyes are black. The mandibles are dark brown at the base and glossy black in the anterior portion.

The prothorax, like the head, is rust brown, gradually becoming paler posteriorly. The abdomen, the cerci and the styli are pale yellow. On account of the presence of fat bodies below the body wall, the abdomen, whose sclerites are translucent, appears dirty white. The leg segments are pale yellow, and the claws dark-brown.

Setae.—The whole body is sparsely beset with irregularly distributed fine bristles or setae. On the head and thorax the setae are longish and more numerous on the dorsal side than on the ventral. On the abdomen the case is the reverse and the bristles are concentrated in the mid-ventral region, the ventro-lateral region having only scattered bristles. The thoracic legs, the cerci and the styli all carry long bristles.

Both the sexes have the styli and the cerci, and it is thus not possible to distinguish the sexes externally in the soldier caste.

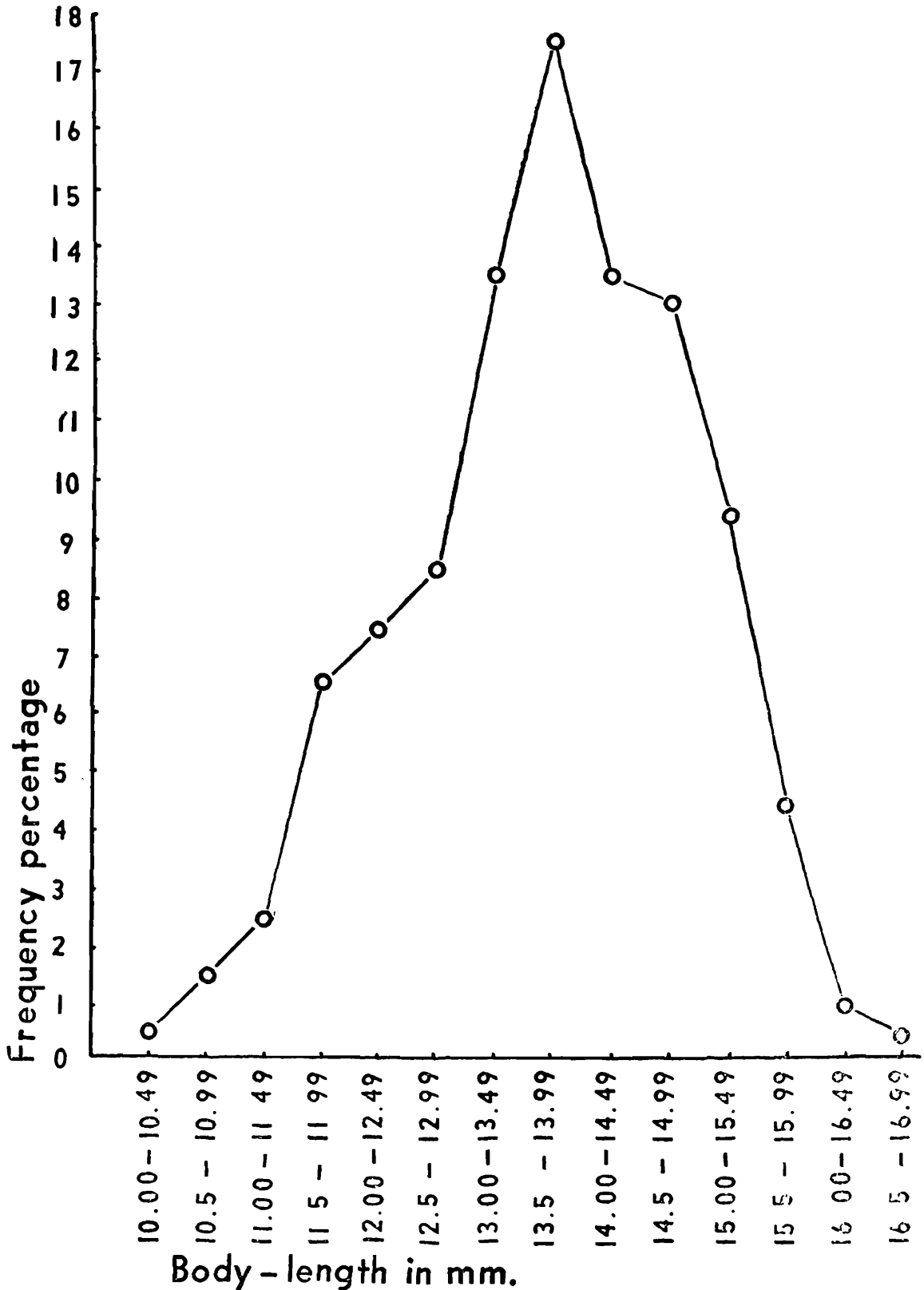
Size.—The soldiers, like those of *Archotermopsis wroughtoni* Desneux (Imms, 1919), show great variation in size. In 200 individuals



TEXT-FIG. 1.—*Anacanthotermes macrocephalus* (Desneux). Soldier caste. (a). Whole body in dorsal view. (b). Ditto, in ventral view. (c). Ditto, in lateral view

preserved in rectified spirit, the body-length (as measured between the foremost tip of the mandible and the last segment of the abdomen) ranged from 10.0 mm. to 16.7 mm. When this length-data was arranged into

0.5 mm. frequency classes, and plotted on a graph (Table 1 and Text-fig. 2) a unimodal curve was obtained which showed that only one type of soldier occurs.



TEXT-FIG. 2.—*Anacanthotermes macrocephalus* (Desneux.) Soldier caste.

Graph, showing the frequency percentage of distribution of body-length (foremost tip of mandibles to tip of abdomen) in 200 individuals preserved in rectified spirit. (Also Vide Table 1).

TABLE 1.—*Frequency distribution (arranged in 0.5 mm. classes) of the body-length (foremost tip of mandibles to the tip of abdomen) in 200 individuals of Anacanthotermes macrocephalus (Desneux), soldier caste. (From specimens preserved in rectified spirit).*

Class	Frequency	Per cent of total
10.00—10.49	1	0.5
10.5 —10.99	3	1.5
11.00—11.49	5	2.5
11.5 —11.99	13	6.5
12.00—12.49	15	7.5
12.5 —12.99	17	8.5
13.00—13.49	27	13.5
13.5 —13.99	35	17.5
14.00—14.49	27	13.5
14.5 —14.99	26	13.0
15.00—15.49	19	9.5
15.5 —15.99	9	4.5
16.00—16.49	2	1.0
16.5 —16.99	1	0.5

(b) *The head*

(Text-fig. 3)

The head is prognathous (*i.e.*, the mouth-parts are directed forwards), sub-squarish, bilaterally symmetrical (except for the mandibles), dorso-ventrally flattened and slightly longer than broad. The postero-lateral angles of the head-capsule are broadly rounded. At its hind margin the head is slightly covered by the pronotum. The head-capsule measures as follows :—

Length, from hind margin to lateral base of mandibles	4.21—4.66 mm
Length, from hind margin to tip of left mandible	6.44— 7.1 mm.
Maximum width of head	.. 3.63— 4.1 mm.
Height of head	.. 2.1—2.63 mm.

The facial area is directed upwards, and the mandibles, maxillae and labium forwards. The labrum overlies the mandibles as a free lobe above the oral cavity. There is a pair of dark coloured compound eyes, one on either side, and situated dorso-laterally immediately behind the antennal sockets. Lying along the imaginary line connecting the two compound eyes there are two small, transparent, subcircular areas which

antennae. The fontanelle is absent. The occipital foramen is situated at the postero-ventral end of the head-capsule.

The mouth-parts are of the "mandibulate type" The mandibles and maxillae take their origin laterally, the labrum projects from the anterior margin of the cranium and the base of the labium lies transversely to the long axis of the head in front of the occipital foramen. Between the labrum above and the labium below lies, inside the oral cavity, the hypopharynx.

(i) *The head-capsule*

(Text-figs. 3 and 4)

The various regions of the head are indistinct, the sutures being ill-defined or absent (Text-fig. 3). Beginning from the posterior end, the vertex of the head is made up of two *epicranial plates* (*ep. pl.*) separated from each other by the stem of a fine Y-shaped *epicranial suture* (*ep. s.*). The two facial arms (transverse sutures of some authors), are directed outwards and forwards and indistinctly separate the epicranial plates from the fronto-clypeal region. In *Archotermopsis wroughtoni* Desneux, this suture is V-shaped, the stem being faintly visible in few soldiers (Imms, 1919), and in most termite soldiers (*vide* Light, 1934), it has been reported as imperfect, suppressed or absent. In each epicranial area there lies anteriorly the antenna and the compound eye of its side.

The fronto-clypeal region has no distinct epistomal suture delimiting the *frons* (*fr.*) from the *clypeus* (*cl.*). This region is bounded anteriorly by the base of the labrum. The clypeus is distinguishable into an anterior membranous *ante-clypeus* (*acl.*), and a posterior well chitinised *post-clypeus* (*pcl.*). There is no intra-clypeal suture. The ante-clypeus lies reflexed under the post-clypeus when labrum is in the retracted condition.

The epicranial plates on either side are continued laterally and ventrally into the *genae* (*gn.*) and the *postgenae* (*pgn.*), there being no sutures separating these sclerites. The postgenae are separated from the *postmentum* (*pmt.*) by the longitudinal *gular* or *postmental sutures* (*g.s.*).

The *subgenal sutures* form a *subgenal ridge* (*sgn. r.*) which runs close to the anterior edge of the cranial wall. The ridge starts from the *posterior tentorial pits* (*pt. t. p.*), that is, in front of the gular sutures, runs forwards and outwards and finally arches upwards to a point just above the *anterior articulation of the mandibles* (*at. a. md.*). It is not continued into an epistomal suture dorsally. According to the terminology of Snodgrass (1935) the ventral portion of the ridge posterior to the mandibles is called hypostomal and the portion lying just lateral or above the mandibles, pleurostomal. It forms a narrow but distinct and highly chitinised rim which thus strengthens the cranial wall for the attachment of the gnathal appendages. The region of the subgenal ridge in which the mandibles articulate has also been termed by some authors as the *mandibularia* (*mdl.*) or the *trochantin of the mandible* (Fuller, 1915).

The occipital suture is absent. The *post-occipital suture* (*poct.s.*) closely surrounds the *occipital foramen* (*oct. f.*) posteriorly and laterally forming a narrow rim constituting the *occipital arch* (*poct.*).

The *ocular (o.s.)* and the *antennal sutures (ant. s.)* demarcate the ocular and antennal sclerites respectively.

The *labrum* (Text-figs. 3 and 4a, *lr.*) is a flat lobe nearly twice as broad as long (about 0.68-0.77 mm. \times 1.02—1.2 mm.). Proximally it is attached with the clypeus along a well defined *clypeo-labral suture (lr. s.)*, and is slightly overlapped by the former. This feature provides for its mobility in the vertical plane. Antero-medially its margin is slightly inflexed. The dorsal surface has numerous longish setae; along the anterior margin are 10-12 setae which appear to be bilaterally arranged. On the otherwise smooth cuticular undersurface, short thick and pointed peg-like denticles are seen to be arranged in two stripes, running from the clypeal plate to the apical border of the labrum midway between the imaginary median axis and the lateral border. These structures have been reported in the winged and worker castes of *Odontotermes obesus* (Rambur) but not in the soldier caste (Vishnoi, 1956). In the postero-lateral angles between the labrum and the clypeus, there lies a pair of oblique, obtuse-angled bar-shaped sclerites, the *tormae (tm.)*, extending into the epipharyngeal surface of the clypeus and directed medially; the right tormae is slightly bigger than the left. In *Archotermopsis wroughtoni* (Imms, 1919) a group of hairs on either side in a similar position are present, and are probably homologous with the structures described here.

The tentorium (Text-fig. 3).—The *tentorium* constitutes the endoskeleton of the head-capsule. It consists of two *anterior arms*, two *posterior arms* and a central plate, the *corporotentorium*. In *Archotermopsis wroughtoni* Desneux (Imms, 1919) and *Odontotermes obesus* (Rambur) (Kushwaha, 1956) also, the structure is similar.

The two *anterior arms (at. t. a.)* originate in the faintly elongated slit-like *anterior tentorial pits (at. t. p.)* immediately above the articulation of the *mandibles*. They are widely expanded anteriorly and are firmly attached to the head-capsule antero-laterally extending in a curvate manner to the rim of the antennal ridge. Each arm is twisted slightly and runs downwards, backwards and forwards to meet its counterpart from the other side and also the corporotentorium. On its way each anterior tentorial arm gives off a broad inwardly directed process which meets its fellow from the other side to form a medianly carinate plate, the *frontal plate* or the *anterior tentorial bridge*. This anterior bridge between itself and the *corporotentorium* encloses a distinct aperture, the *tentorial foramen (t.f.)*. Through this aperture the circumoesophageal connectives of the nerve cord pass towards the brain.

The *posterior tentorial arms (pt. t.a.)* take their origin in the lengthened *postmental sutures (g.s.)* and the *posterior tentorial pits (pt. t. p.)* are also elongated. The arms are plate-like and arched and meet medially forming a *tentorial bridge (t.b.)* lying above the postmentum (*vide infra*); below it pass the salivary ducts and the ventral nerve connectives from the thorax.

The *corporotentorium (ctm.)* in insects is formed by the fusion of the tentorial arms at their inner ends. In termite soldiers, consequential to the prognathous condition of head, it has become a greatly elongated median plate extending between the tentorial foramen and the occipital foramen. Topographically it may be said to embrace two regions—one, obliquely hanging in the cranial cavity behind the tentorial foramen

and demarcated by a flexure from the other, the tentorial bridge, lying above the postmental plate of the labium (*vide supra, t.b.*). Just at their junction the corporotentorium gives off two lateral arms, one on either side, which become continuous with the submarginal subgenal ridge of the cranial wall to further strengthen the articular points of the maxillae. Similarly, the tentorial bridge is continued into a pair of backwardly directed arms which become confluent with the lateral margin of the postoccipital arch.

The hypopharynx (Text-fig. 5a, *hyp.*)—The hypopharynx is a large, conical median lobe situated between the labium and the clypeus separating the dorsal buccal or oral cavity from a small ventral pocket, the *salivarium* (*slv.*) at the base of which the salivary duct opens. In the normal position it lies in close approximation with the ligula of the prementum. Its ventral adoral wall is reflected over the labium at the base of the prementum enclosing a small pocket, the *salivarium* (*slv.*). On the dorsal surface proximally there is a median depression, which, with the opposing epipharyngeal surface of the clypeus, forms a pocket, the *cibarium* (*cb.*).

In the lateral wall of the hypopharynx, there are a pair of *lateral sclerites* (*l.ss.*) the posterior ends of which reach the salivarium. They provide the surface for the attachment of the retractor muscles of the hypopharynx. Proximally the two sides are flanked by a group of sclerites constituting the *suspensoria* of the hypopharynx. Each suspensorium consists of a pair of broad chitinised plates, the *suspensorial sclerites* (*ss.*). The end of the dorsal arm of each suspensorial sclerite lies close to the corresponding end of its fellow from the other side. Posterior to the broad middle portion of these sclerites are two sclerites, a dorsal and a ventral. The dorsal sclerite is L-shaped and is called the *stomodaeal branch* (*ss. br. 1*) ; it leads to the lateral wall of the stomodaeum. The ventral or the *mandibular branch* (*ss. br. 2*) extends laterally to the base of the adductor apodeme of the mandible, and proximally it is loosely attached to the stomodaeal branch. The oral surface of the hypopharynx is beset with numerous small, fine hairs.

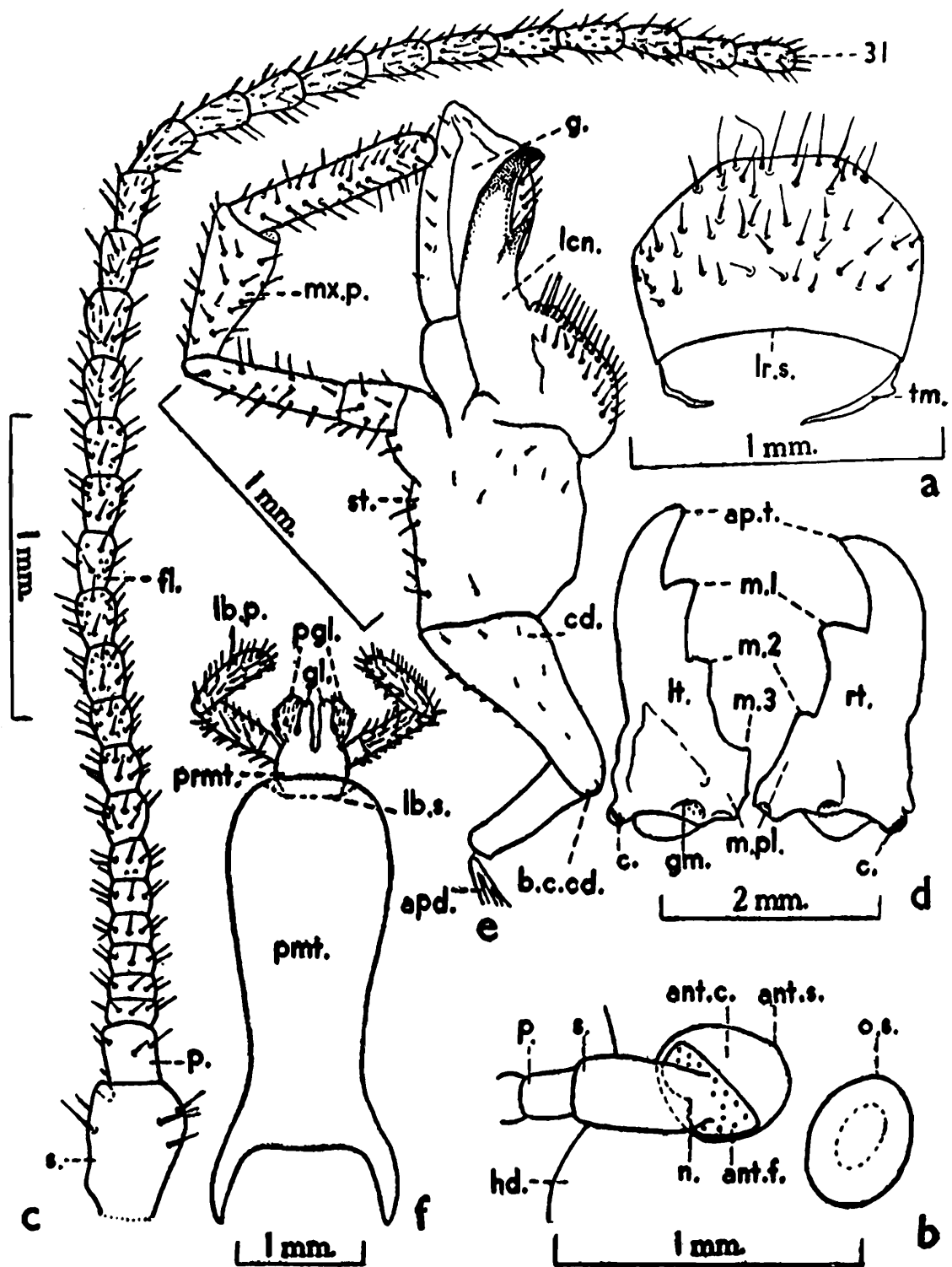
The compound eyes (Text-fig. 4b).—A pair of dark pigmented, oval *compound eyes*, one on either side, is placed laterally behind the antenna. Each eye measures about 0.39×0.31 mm. in diameter and lies obliquely to the long axis of the head. The bulging facets are roughly hexagonal and number about 127. The margin of the eye is surrounded by an apodemal inflexion of the cranial wall forming an *ocular sclerite*. (*o.s.*).

(ii) *Head-appendages.*

The antennae (Text-fig. 4c, *ant.*)—Each *antenna* is moniliform, about 5.9 mm. long and has 28-31 segments. It is lodged in a small membranous area, the *antennal socket* or *antennal foveolae* (*ant. f.*), the rim of which is strengthened by an internal submarginal ridge enclosing the *antennal sclerite*. The antennal socket is overhung by a projector called the *antennal carinae* (*ant. c.*). From the rim of the antennal socket arises, in the ventro-lateral side, a small pivot-like process the *antennifer* (*n.*), on which the antenna can move in all directions.

The antenna can be divided into two parts, namely, (i) *the body* consisting of a basal segment or *scape* (*s.*) and a second segment or

pedicel (p.), and (ii) the *flagellum (fl.)* made up of remaining 26-29 segments. The scape is the largest segment, being slightly more than double the pedicel in length. The third and the fourth segments together are nearly equal in length to the second. The flagellar segments increase



TEXT-FIG. 4.—*Anacanthotermes macrocephalus* (Desneux). Soldier caste.

(a). Labrum in dorsal view. (b). A portion of cranium, showing ocular and antennal sclerites in dorsal view. (c). Left antenna, showing 31 segments. (d). Left and right mandibles in dorsal view. (e). Left maxilla. (f). Labium in ventral view.

in length gradually, the first being the smallest and the last nearly thrice its size. The number and distribution of setae on various segments is not uniform, there being 3-5 setae on the scape, 6-8 arranged in a whorl

on the third to seventh or eighth segments. Beyond the eighth segment the number of whorls in each segment gradually increases with a corresponding increase in the number of setae also.

TABLE 2.—*Variations in the number of antennal segments of the right and left antennae of 82 individuals of Anacanthotermes macrocephalus (Desneux), Soldier caste.*

Item	Number of individuals	Number of segments	
		Right	Left
(a) With one segment more in the right antenna.	6	30	29
	12	29	28
	1	28	27
	1	26	25
		<hr/>	
Total		20	
Per cent		24.4	
(b) With one segment more in the left antenna.	3	30	31
	4	29	30
	9	28	29
	4	27	28
	1	26	27
	1	25	26
		<hr/>	
Total		22	
Per cent		26.8	
(c) With equal number of segments in both antennae.	9	31	31
	5	30	30
	17	29	29
	6	28	28
	2	27	27
	1	26	26
		<hr/>	
Total		40	
Per cent		48.8	

TABLE 3.—Frequency distribution of the number of antennal segments in 82 individuals of *Anacanthotermes macrocephalus* (Desneux), Soldier caste.

Number of antennal segments	Right antenna		Left antenna	
	Number of individuals	Approx. per cent.	Number of individuals	Approx. per cent.
31	9	11.0	12	14.6
30	14	17.0	9	11.0
29	33	40.3	32	39.0
28	16	19.5	22	26.8
27	6	7.3	4	4.9
26	3	3.7	2	2.4
25	1	1.2	1	1.2
Total	82	100	82	100

The number of segments in the two *i.e.*, the right and left, antennae of an individual is not always equal. In a random collection of 82 soldiers, it was found (Table 2) that 51.2 per cent individuals have one segment in excess in either of the antenna, whereas 48.8 per cent cases had equal numbers in both. The most frequent number, occurring in about 39 per cent cases (Table 3), is 29.

The mandibles (Text-fig. 4d).—The two mandibles are slightly asymmetrical, the left one being somewhat larger than the right. Both the mandibles are strongly chitinised and incurved structures, with pointed apices and triangular bases. In the normal position of rest, the left mandible, in all cases examined so far, crosses over the right. Each mandible articulates with the cranium at two specialised points, the *ginglymus* (*gm.*) and the *condyle* (*c.*). The ginglymus is dorsally placed concavity receiving a condyle (the anterior articulation of the mandible) from the mandibular segment of the cranium (also called mandibularia). On the ventro-lateral side a condyle fits into a cup-shaped cavity in the cranial wall—this constitutes the *cranial articulation of the mandible* (*cr. a. md.*).

The inner surface of each mandible is differentiated into a distal part, the toothed *incisor lobe* (*i.pl.*), and a proximal part, the *molar plate* (*m.pl.*). The first or the *apical tooth* (*ap. t.*) of the incisor lobe forms the incurved apex of the mandible. The two following teeth are the first and the second *marginal teeth* (*m.1 ; m.2.*). The left mandible is asymmetrical in the possession of an additional well developed tooth (*m.3*) just in front of the molar plate, as in *Archotermopsis wroughtoni* Desneux

(Imms, 1919). The surface of the molar plate of the right mandible is strongly convex and prominently ridged and grooved and that of the left jaw somewhat concave, the two surfaces forming a pestle-and-mortar arrangement. Two apodemes are attached with the base of each mandible, a small one at the outer angle and a large well-developed one at the inner angle.

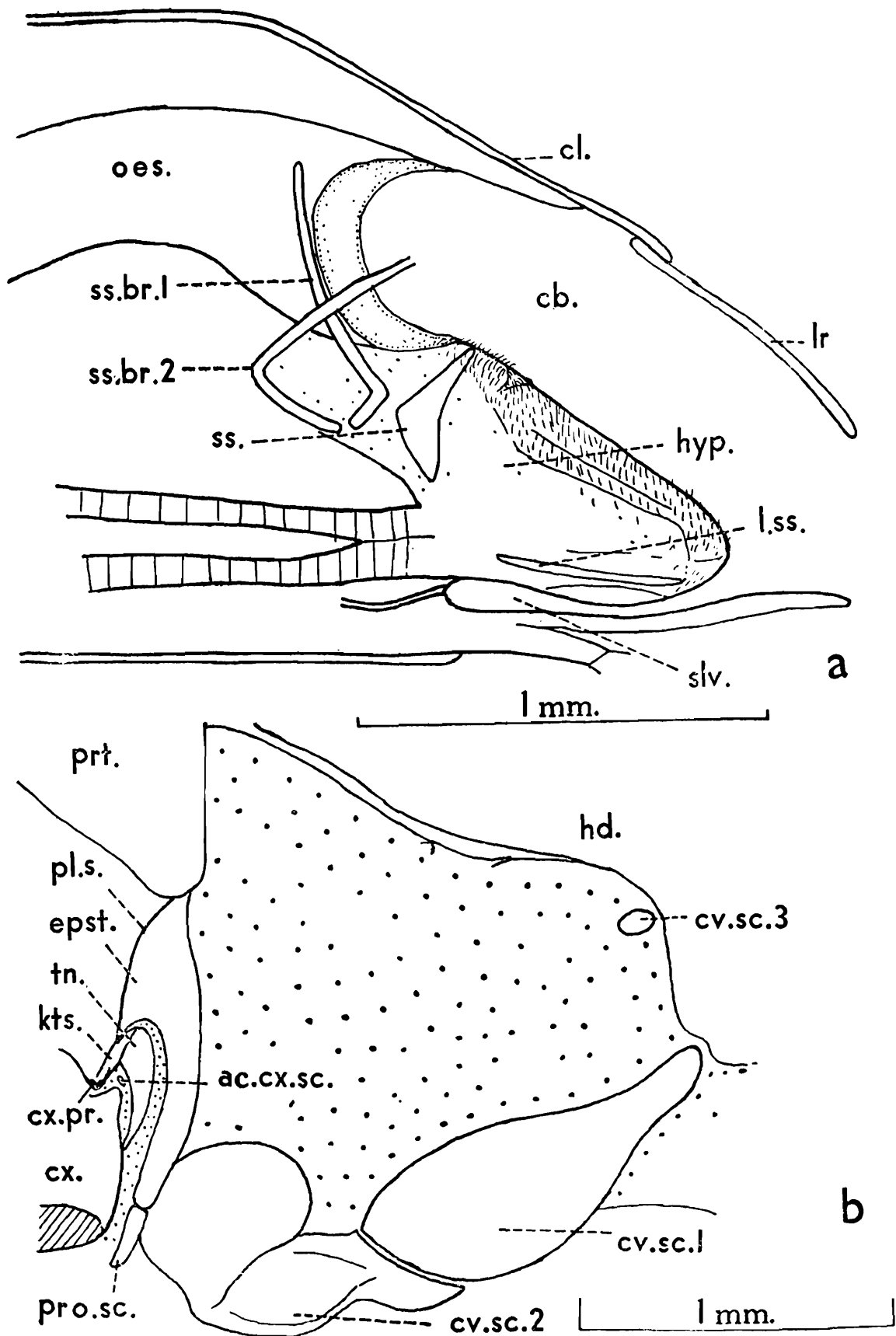
The first maxilla (Text-fig. 4e).—The maxillary base is elongate and two-segmented—the proximal segment is the *cardo* (*cd.*), and the distal the *stipes* (*st.*). The *cardo* is bent outwardly in an obtuse angle. The angle of the bend has a condylar articulation called the *basal condyle of cardo* (*b.c.cd.*), which articulates with the socket in the hypostomal region of the subgenal ridge of the head-capsule. Proximally, the *cardo* is attached to an apodeme, which at its anterior end is broadly attached to the *stipes*. Along the inner margin of *stipes* some muscles are inserted in a groove, the *sutural groove of stipes* (*su.g.*). At its distal end the *stipes* bears two lobes—an outer *galea* (*g.*) and a mesal *lacinia* (*lcn.*). Laterally it bears 5-segmented *maxillary palp* (*mx.p.*).

The *galea* is a soft, broad, leaf-like, 2-jointed lobe, which is thickly coated with setae along its inner margin. Dorsally it is excavated to partly receive the *lacinia* when at rest. The *lacinia* is highly sclerotised and has a broad proximal portion which distally tapers to an incurved incisor-like tooth. A similar tooth also arises from the middle of the inner margin. The inner margin of the plate-like main portion is fringed with longish setae together with other smaller and sparsely distributed ones. The *palpus*, which is beset with numerous large and small setae, is 5-jointed, the first segment being the smallest (0.16 mm. long); the following segments are about 0.27, 0.55, 0.7 and 0.8 mm. long. A characteristic elbow flexure exists between the third and the fourth segments. There is no palpifer.

The labium (Text-fig. 4f).—The labium consists of two distinct segments, the distal *prementum* and the more sclerotised plate-like *postmentum* (gula of Snodgrass, 1935), hinged together along the *labial suture* (*lb.s.*). The *prementum* (*prmt.*) is anteriorly cleft in the middle. At its distal end it bears two pairs of terminal lobes, viz., an outer *paraglossa* (*pgl.*) and an inner *glossa* (*gl.*), and a pair of *labial palpi* (*lb.p.*). The *paraglossa* and the *glossa* together constitute the *ligula*. The *labial palpi*, which bear numerous setae, are smaller than those of the *maxilla* and are 3-segmented, the segments from the basal onwards measuring about 0.17, 0.58 and 0.76 mm. in length. The second and third segments of each *palpus* are inwardly elbowed at the joint. There is no palpifer.

The *postmentum* (*pmt.*) is a large, median, rectangular sclerotised plate with waist-like concavities in the middle. It is broadly attached to the ventral wall of the head, and its lateral margin lies parallel to the posterior tentorial arms along postmental sutures (Text-fig. 3, *g.s.*). Posteriorly, the basal angles are drawn into tapering outgrowths which get wedged in between the postgenae and neck membrane and articulate with the tapering anterior end of the *first cervical sclerite* (*cv.sc.1*). Distally, a small part of the *postmentum* is membranous and lies folded over it in such a manner that it is not seen from the ventral side, and the sclerotised part projects forwards to give support to the movable

permentum. The prementum is attached to this membranous portion along a well defined *labial suture (lb.s.)*.



TEXT-FIG. 5.—*Anacanthotermes macrocephalus* (Desneux). Soldier caste.

(a) Sagittal longitudinal section of anterior region of head to show the position of hypopharynx and its attachments (semi-diagrammatic). (b). Lateral view of cervix and a portion of prothorax.

(c) *The neck*

(Text-fig. 5b, cv.)

The *cervix* or neck is a short, narrow, flexible membranous region of the body lying between the head and the thorax. Dorsally it is concealed by the overlapping pronotum. On its ventro-lateral sides are seen two pairs, one on either side, of well developed *cervical sclerites* (cv.sc.1 and 2), hinged on each other. Just behind the head-capsule and dorsal to the anterior cervical sclerite there is, on either side, a small circular chitinised plate—the *dorsal sclerite* (cv. sc. 3). Ordinarily it is concealed from view by the folds of the neck membrane. There are no ventral sclerites. The dorsal sclerite is feebly developed in *Archotermopsis wroughtoni* (Imms, 1919).

The *anterior cervical sclerite* (cv.sc.1) is flask-shaped and its anterior end tapers gradually to form a fulcral knob, which articulates with the tip of the drawn out lateral process of the postmentum as also on the side of the occipital foramen. This arrangement permits the head to move in both the vertical and the horizontal directions. The *posterior cervical sclerite* (cv.sc.2) has a ribbed surface due to the presence of folds. Besides being broadly hinged on the anterior cervical sclerite of its side, it is similarly hinged on the episternum of the prothorax. The two posterior sclerites of each side meet in the mid-ventral line.

(d) *The thorax*

(Text-fig. 6)

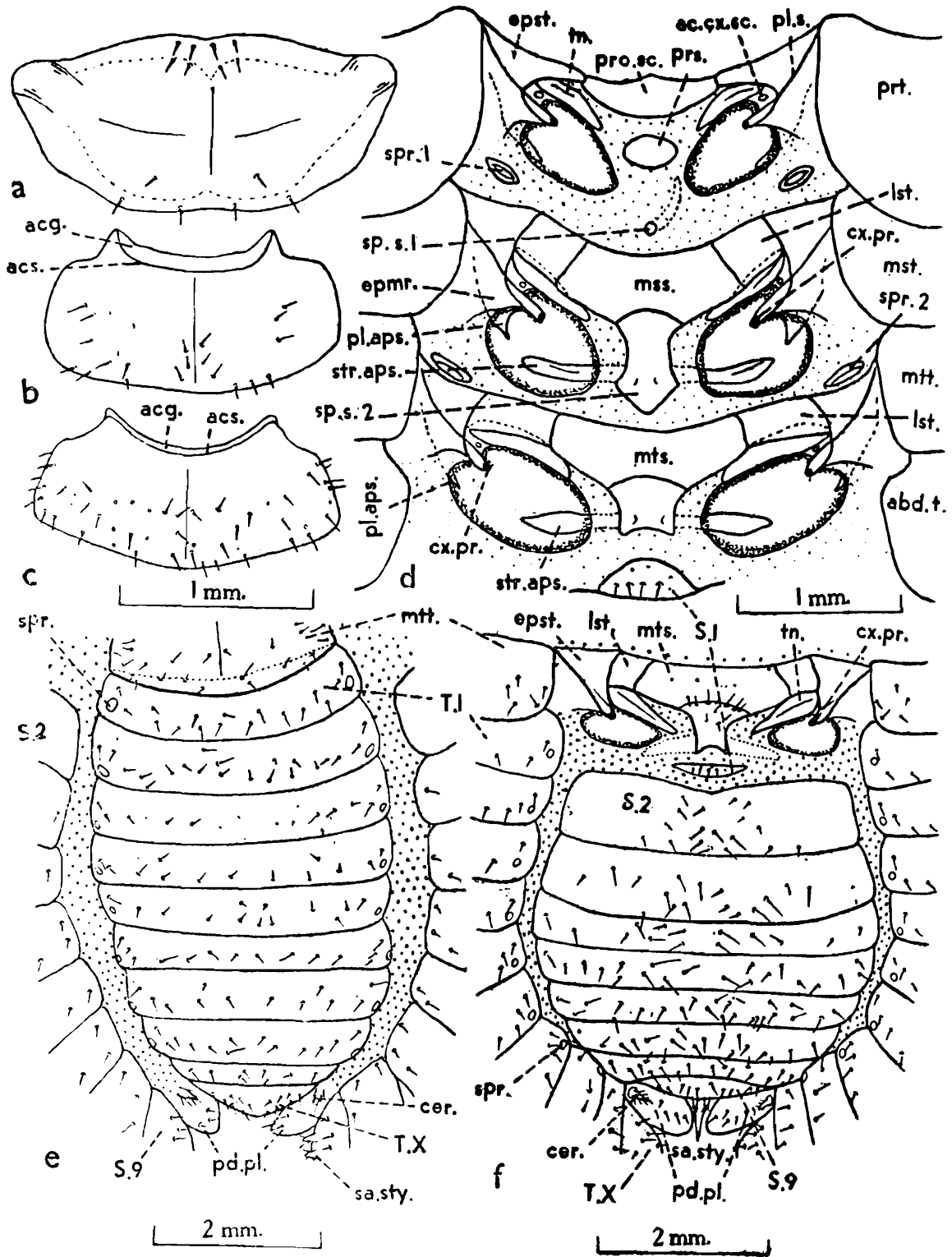
The thorax is made up of three distinct segments, viz., the pro-meso- and metathorax. Each segment consists of three sclerotised plates, viz., a dorsal tergal plate or *notum*, a lateral plate or *pleuron* and a ventral plate or *sternite*.

The tergites.—The prothorax is highly modified and differs markedly from the meso- and the metathorax. The *pronotum* (prt.) is a large saddle-shaped plate which is broader than long and measures about 3.1 mm. at its broadest and 1.6 mm. medially. Its anterior portion is elevated and the antero-lateral ends drawn downwards and outwards, ending in a spout. Thus a transverse groove appears to run from either corner to nearly the middle, dividing the pronotum into an anterior lobe and a posterior lobe. The anterior and posterior margins are faintly notched medially. The whole of the marginal area is infolded downwards to a small extent, thus reduplicating the whole margin. This feature is greatly marked along the anterior margin which becomes continuous with the neck.

The dorsal surface of the pronotum is marked by an incomplete sagittal suture which does not extend from end to end. The transverse groove referred to above shows an apodemal inflexion ventrally. These internal ridges are meant for muscle attachment. On the dorsal surface, there are prominent bristles. Along the infolded anterior margin, the bristles are smaller and more numerous.

The *meso-(mst.)* and *metanota (mtt.)* are subequal and more or less similar plates, which are broader than long. In both cases, the notum is crossed anteriorly by a transverse groove, the *antecostal suture (acs.)* dividing it into a small, flat, anterior *precostal acrotergite (acg.)* and

a large *postcostal* tergite. The outer margins of the postcostal tergites are stretched out considerably on either side immediately behind the acrotergite and run more or less parallel and ultimately turn round so that their hinder margins meet each other. The external intersegmental



TEXT-FIG. 6.—*Anacanthotermes macrocephalus* (Desneux). Soldier caste.

(a). Pronotum in dorsal view. (b). Mesonotum in dorsal view. (c). Metanotum in dorsal view. (d). Ventral and lateral sclerites of thorax with the tergites cut medially and spread on either side. (e). Tergites of the abdomen, with sternites cut medially and spread on either side. (f). Metathoracic and abdominal sternites with the tergites cut medially and spread on either side.

groove, forming the antecostal suture externally, forms internally a submarginal ridge, the *antecosta*.

A faint sagittal suture and corresponding to it an internal ridge, meant for attachment of the muscles, run from the antecostal ridge almost back to the hinder margin, but are not forked as is the case in some winged termites (Fuller, 1924).

The metanotum differs from the mesonotum in having a relatively smaller precostal acrotergite. The hind and lateral margins of both the tergites are infolded or reduplicated.

The distribution of setae on both the meso- and metanota is sparse and is restricted to the posterior region of the tergal plates. The number of setae on the metanotum is larger than on the mesonotum.

The pleurites.—The meso- and metathoracic pleura are similar to each other but differ slightly from that of the prothorax. The pleural plate surrounds the base of *coxa* (*cx.*) anteriorly and dorsally and is divided by a *pleural suture* running from the coxal articulation in the antero-dorsal axis into two subtriangular regions, *viz.*, presutural *episternum* (Text-fig. 6d, *epst.*) and a postsutural *epimeron* (*epmr.*). Internally the pleural suture forms a massive apodemal implex, the *pleural ridge* (entopleurum of Fuller, 1924), which gradually diminishes in size towards the dorsum (tergite) where the pleuron ends in a thickened point which articulates with the side of the tergum of its segment. The pleural ridge is broadest ventrally where it is produced into an *apophysis* (*pl.aps.*) which is connected with the sternal apophysis (*str. aps.*) of its side by means of muscles.

The epimeron is a large, slightly convex subtriangular sclerite. Its posterior border is ill-defined, being weakly chitinised. Ventrally it narrows to a slip lying against the coxal condyle. The *episternum* is a triangular sclerite lying in front of the pleural suture. Towards the dorsum it becomes narrow. Ventrally it articulates with the *laterosternite* and in the region of the coxal condyle with the *trochantin*.

In between the base of the coxa and the episternum lies an elongated somewhat triangular sclerite, the *trochantin* (*tn.*). Its dorsal edge is attached by folds of membrane to the outer margin of the coxal condylar region of the episternum ; its sternal apex articulates with the margin of the coxa. It is also connected with the laterosternite and the sternum by membraneous folds. Along its long axis the trochantin shows an inflexion which divides it into two somewhat triangular portions.

The *accessory coxal sclerite* (Text-fig. 5b, *ac. cx. sc.*) is a small sclerite in the form of a cuticular apodeme lying against the margin of the coxa close to the coxal condyle. Internally, a muscle is attached to it. The *laterosternite* (*lst.*) is a rectangular sclerite lying between the sternum and the episternum with which it fuses to form the precoxal bridge or the precoxale. Its borders are demarcated by submarginal sutures. The laterosternites are present only in the meso- and metathoracic segments and absent in the prothorax.

The *epimeron* does not extend ventrally to form a postcoxale, which is found in certain other insects.

The pleuron of the prothorax (Text-fig. 5b) differs from the pleura of the meso- and metathorax. In addition to the epimeron and the epi-

sternum mentioned above, a *katepisternum* (*kts.*) is present as a continued arm of the coxal condyle (*cf.* Fuller, 1914) articulating with a reduced and slender trochantin. The episternum here is a highly chitinised and rib-like structure. Above, at the point of its fusion with the pronotum, it is flat and faces forwards ; below, it hangs down as a slip and is fused with the *prosclerite* (*vide infra*) to form a complete loop with its counterpart of the opposite side. The epimeron appears to be attached to the base of the episternum below the pronotum, and is directed backwards. In this segment the pleural plates surround the coxa anteriorly, dorsally and to some extent posteriorly to form a massive pillar-like structure.

The sternites.—The sternum in insects is a complex and variable structure. It consists of segmental and intersegmental sclerites either free or fused. However, basically the intersegmental sclerites between the pro- and mesosterna, and meso- and metasterna are either free or, when united, they do so with the preceding segmental sternum. The primary intersegmental sclerite behind the metasternum is generally lost or is united with the abdominal sternum behind. Here the sterna of the three segments are weakly chitinised and differ from each other not only in chitinisation but also in structure and relative size.

(a) *The prosternum* : The segmental sternum (eusternum of Snodgrass, 1935) of the prothorax reported wanting in most termite soldiers, is present here as a small, very faintly chitinised, weakly pigmented, subcircular plate situated between the coxae of the first pair of legs. It bears a number of microscopic setae.

The two episterna, which appear to meet each other (*vide supra*) to form the rigid collar band, show a demarcating line between them and a median keeled sclerite, which appears to have been formed by the union of two sclerites in the median line, called the *prosclerites* (*pro.sc.*). In other termites the episterna of either side closely approximate with each other but do not fuse. In alates of some termites, Fuller (1924) has reported the presence of two sclerites lying behind the episterna and regarded them as the laterosternites of the prothorax. It is likely that in the present species these sclerites have fused with each other and with the episterna on either side to complete the arched loop of the collar band.

The first intersegmental sternite bearing internally a forwardly directed apophysis, called *spinasternum* by Snodgrass (1935), lies freely embedded in the intersegmental membrane in front of the mesosternum.

(b) *The mesosternum* : The mesosternum is a composite sclerite and is the largest of the three thoracic sternum. It is T-shaped, the top part of which is flanked on either side with the *laterosternites* (*lst.*), which, in their turn, meet the episterna of their side to form the precoxale. The stem portion of the plate lies wedged in between the coxae of the second pair of legs. It is strongly chitinised and shows a prominent transverse flexure at its base ; the tip ends in a diamond-shaped plate, bearing internally a Y-shaped *sternal apophysis* (*str. aps.*), called furca, which runs outwards and upwards towards the ends of the pleural apophysis of the pleural ridge. This portion of the sternum is referred to by Snodgrass (1935) as '*furcasternellum*'. The second spinasternum is fused with the '*furcasternellum*' to form the diamond-shaped plate referred to above.

(c) *The metasternum* : Like the mesosternum, the *metasternum* (*mtt.*) is a T-shaped plate but differs in being less chitinised, in showing a stronger flexure at the base of the 'furcasternellum' and in the absence of the third spinasternum. The furcasternellum ends broadly.

There are two pairs of *thoracic spiracles* (*spr.* 1 & 2) lying posterolaterally in the pro- and mesothoracic pleura. In embryonic stages of all insects except Diplura these spiracles are formed in the meso- and metathoracic pleura (Snodgrass, 1935) and thus, here in the adult soldier their position indicates migration anteriorward from the primitive position.

(e) *The legs*

(Text-figs. 7 and 8)

The three pairs of legs, a pair to each of the three thoracic segments, have all the usual components of insect legs, from base onward, *viz.*, a *coxa*, a *trochanter*, a *tibia*, a *tarsus* and a *pretarsus*. Each leg bears prominent setae which are more numerous on the tibia than elsewhere. The first and second pair of legs are subequal ; the third is the largest.

The basal articulation of the legs.—The basal segment or *coxa* (*cx.*) is attached proximally to the body by an articular membrane surrounding it on all sides except where it has an outer articulation with the *coxal process* (Text-fig. 6*d*, *cx.p.*) of the pleuron of its segment ; anteroventrally it further articulates with the *trochantin* (*tn.*). There is no inner sternal articulation.

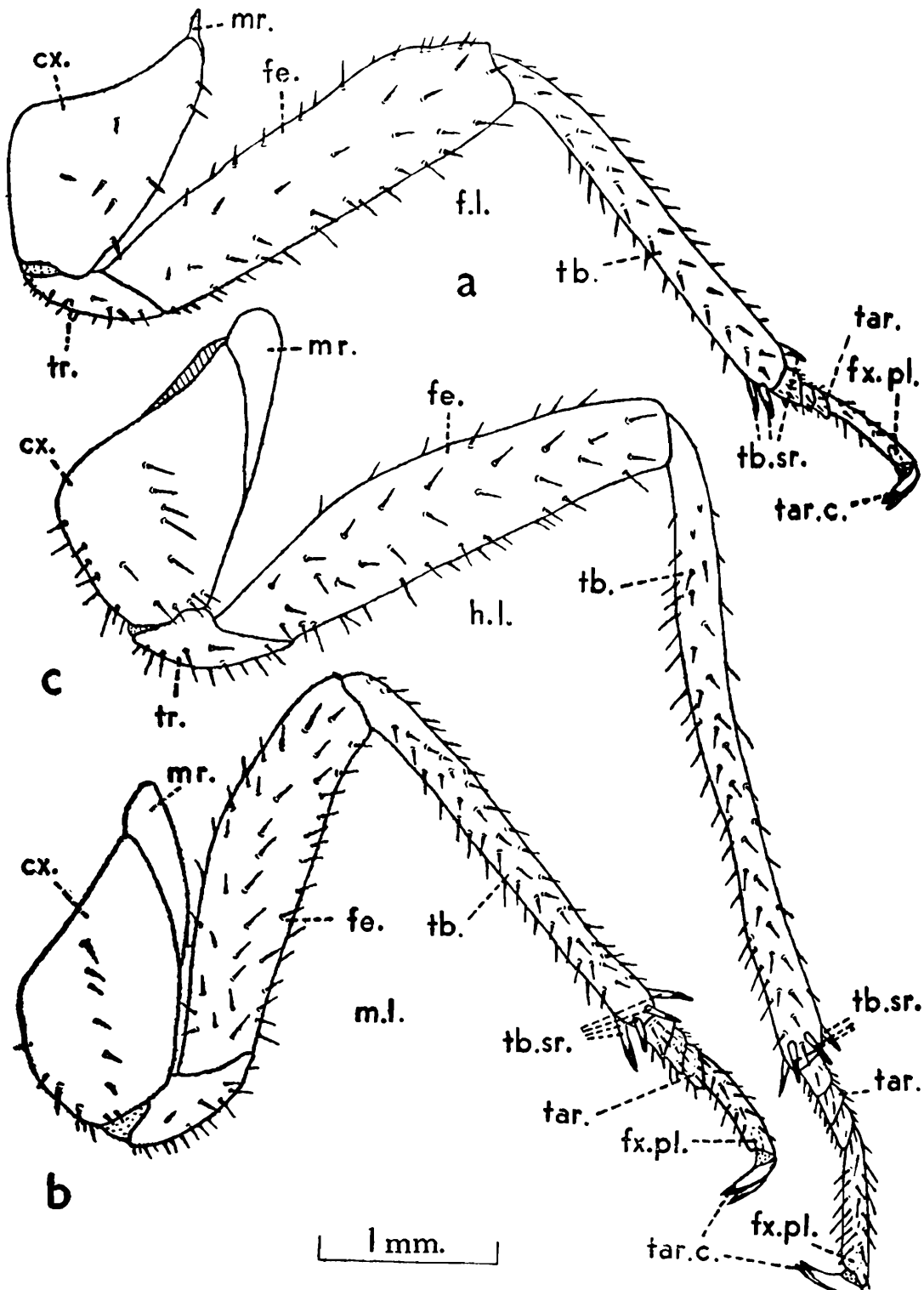
The coxa.—The coxa is the functional base of the leg. The coxae on all the legs are thick, truncated, conical and nearly subequal in length, but coxa of the third leg is the thickest of all (Text-fig. 8). The base of each coxa is girdled by a submarginal *basicostal suture* and the internal ridge so formed is called *basicosta* ; the latter strengthens the base of the coxa and separates a marginal flange, the *basicoxite*. The basicosta is enlarged on the outer wall and mesally becomes weak and confluent with the coxal margin. Opposite to the coxal process of the pleuron, there is a mesal inflexion of the basicosta, bearing a small concavity for the articulation with the former. The coxal inflexion divides the outer basicoxite into a small anterior or prearticular and a large posterior or postarticular part, the *meron* (*mr.*), corresponding to the divisions of the pleuron ; the two parts appear as marginal lobes. The meron of the prothoracic leg is the smallest and that of the metathoracic leg, the largest. On account of the largeness of the meron the coxa appears to be divided into an anterior piece, the '*coxa genuina*' (*cx.g.*), and the posterior, meron. The coxal suture is absent in the three coxae. Distally the coxa articulates with the *trochanter* (*tr.*).

The trochanter.—This is a very small segment lying between the coxa and the femur. Proximally it is movably hinged to the coxa. Distally it is rigidly fixed to the femur.

The femur.—This is the third and the stoutest segment of the leg. It is cylindrical and slightly narrows towards the ends.

The tibia.—This is a slender elongated segment slightly longer than the femur. At the proximal end it articulates with the femur. Distally it bears the *tibial spurs* (*tb. sr.*), 3 being on the first and 4 each on the second and third pair of legs. In *Archotermopsis wroughtoni* Desneux

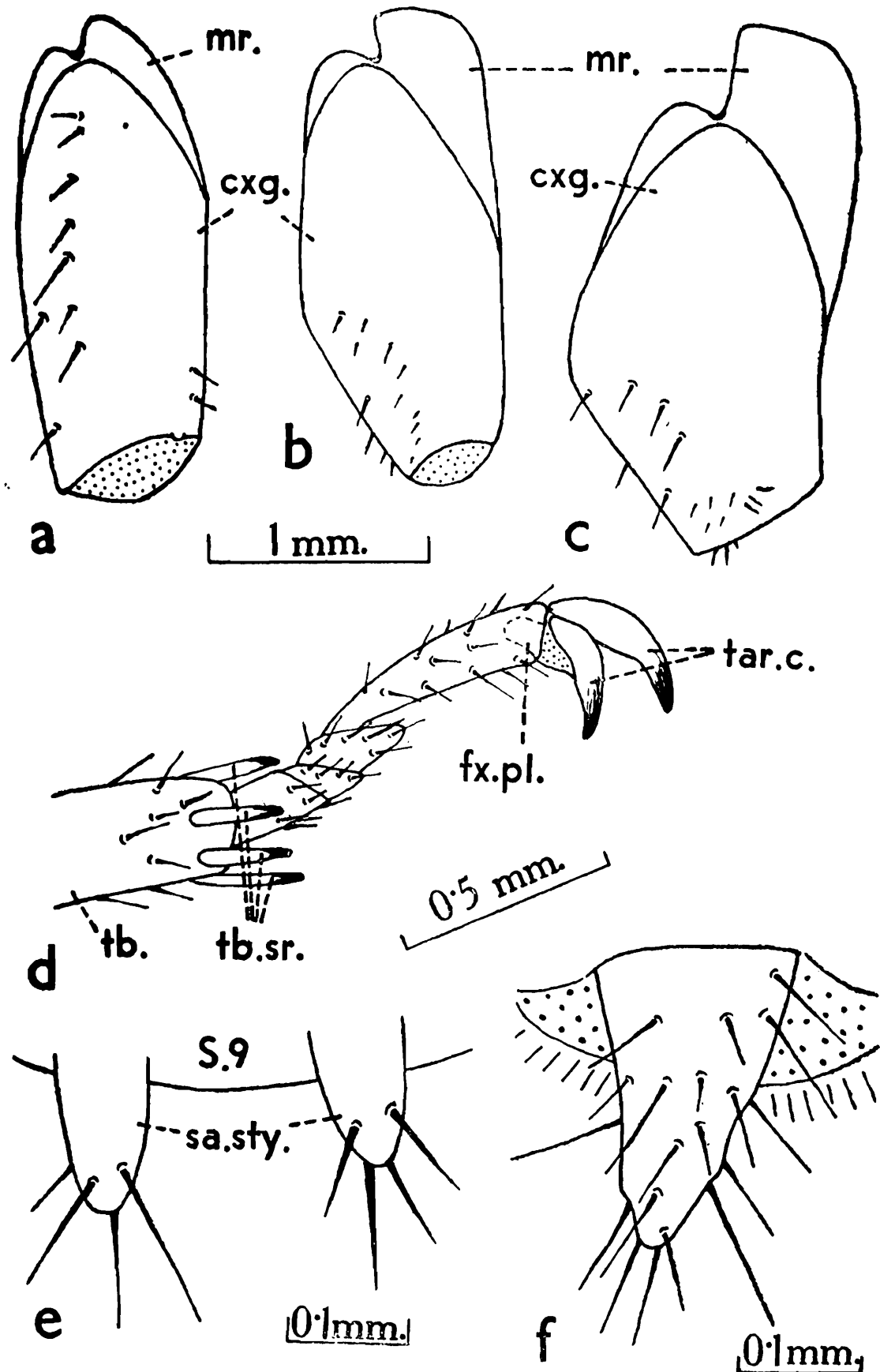
(Imms, 1919) the three tibiae carry a variable number of spines along the external and internal borders ; the number of tibial spurs or apical spines also is variable in the three legs—"Those of the fore-legs are armed with from three to five prominent spines, disposed in a longitudinal



TEXT-FIG. 7.—*Anacanthotermes macrocephalus* (Desneux). Soldier caste.

(a). Fore-leg in ventral view. (b). Left middle-leg in ventral view. (c). Left hind-leg in ventral view.

row along its external border. There are, furthermore, three or four spines situated around the distal extremity of the tibia. In the middle pair of legs the tibiae carry a variable number of 1-4 spines along the external border, and 4-6 spines along the inner border ; there are also



TEXT-FIG. 8.—*Anacanthotermes macrocephalus* (Desneux). Soldier caste.

(a). Coxa of the left fore-leg in outer view. (b). Coxa of the left middle-leg in outer view. (c). Coxa of the left hind-leg in outer view. (d). Tarsus and pretarsus. (e). Subanal styles. (f). Cercus.

two or three spines at their distal extremity. The hind legs, as a rule, bear no spines along the outer border, but there are usually 4-6 present along their inner margin and two apical spines. A feature of these spines is their extreme variability, even the legs of the same pair often differ in respect to the number of spines they carry." Such lateral tibial spines are wanting in *Anacanthotermes macrocephalus*.

The tarsi.—All the three legs have 4-jointed *tarsi* (*tar.*) which are movably hinged upon each other. The first or basal segment, the *basitarsus*, is larger than the second and the third, and is subcylindrical. The fourth segment or *distitarsus* is greatly elongated. At the distal end it is produced medio-dorsally into a very small process, the *unguifer*, which carries apically two claws or *ungues* (*tar. c.*), one on either side.

The pretarsus.—It is the terminal part of the leg, and consists of a membranous base supporting two claws articulating with the unguifer of the distitarsus. There is no arolium or empodium. At the base there is a small sclerite, the *flexor plate* (*fx. pl.*), (the unguitractor of Snodgrass), which lies retracted into the distitarsus.

(f) *The abdomen*

(Text-fig. 6e, f)

The abdomen shows the typical segmentation into ten simple sclerites, each sclerite being composed as usual of a dorsal or tergal and a ventral or sternal plate, the two plates being connected laterally by the membranous pleuron. Posteriorly the margin of each tergum and sternum overlaps the succeeding sclerite with which it is connected by means of an articular membrane. The anterior part of the abdomen comprising the first four segments is broad; behind the fourth sclerite it becomes narrower, ultimately ending in a semicircular terminal sclerite.

The tergites.—The first nine tergites are broad and more or less rectangular plates with infolded lateral margins, while the tenth is subtriangular. The distal tip of the abdomen is slightly curved downwards. The fourth tergite is the largest. The first eight tergites have a pair of spiracles situated on the incurved postero-lateral margins.

The sternites.—There are ten abdominal sternites corresponding to the ten abdominal tergites; the sternum of the first segment is rudimentary and the remaining are well developed. The fourth sternite is the broadest. The sternites of the second and third segments show a strong ventral keel-shaped flexure. The tenth sternite forms a pair of *podical plates* (*pd. pl.*).

A pair of small, setose, unsegmented *subanal styles* (Text-fig. 8, *sa. sty.*) are situated on the ninth sternum slightly in front of its posterior margin—one on either side of mid-ventral line.

The paired *cerci* (Text-fig. 8, *cer.*), one on either side, are short, unsegmented, and setose structures arising laterally from the pleural region of the tenth abdominal segment adjacent to the base of the podical plate. In *Archotermopsis wroughtoni* Desneux the cerci are 5 to 8-jointed (Imms, 1919). Also cf. Roonwal (1956a, b) for the structure of terminal abdominal segments in the Isoptera.

The sexes are indistinguishable externally.

IV—SUMMARY

1. The external morphology of the soldier caste of the primitive termite, *Anacanthotermes macrocephalus* (Desneux) is described.

2. The head is prognathous and has mandibulate mouth-parts. The sutures of the cranium of head-capsule are either ill-defined or absent.

3. The mandibles are somewhat asymmetrical, the left one being slightly larger than the right. The other mouth-parts are of the Orthopteroid type. A pair of compound eyes are present, each compound eye having about 127 facets. A pale spot on each side appears to represent rudimentary ocelli, though this point needs further study. The fontanelle is absent. The antennae are moniliform and with 28-31 segments each. There are no dorsal arms in the tentorium.

4. There are two main pairs of cervical sclerites, the anterior and the posterior. There is no trace of the ventral sclerites. The dorsal sclerites are feebly developed.

5. The pronotum is saddle-shaped and slightly overlaps the head-capsule. The pro-, meso- and metanota have reduplicated margins. The prosclerites fuse with the episternum of the prothorax to form a rigid collarband supporting the neck membrane and the posterior cervical sclerites. The katepisternum, which is a continued arm of the coxal condyle, is present in the prothorax. The sternum of the prothorax, reported as wanting in the soldiers of most other termites, is present here as faintly chitinised and pigmented sclerite. The first spinasterna is found embedded in the membranous region in front of the mesosternum; the second spinasternum is fused with the tip of the "furcasternellum" of the mesosternum; the third spinasternum is wanting.

6. There are three pairs of thoracic legs, each with the usual number of joints. The formula for the apical tibial spines is 3 : 4 : 4. There are two tarsal claws and no arolium or empodium. An unguitactor or flexor plate is present.

7. The abdomen consists of the usual number of 10 segments. The first sternal plate is rudimentary and the remaining nine sterna are well developed. The tenth sternum forms a pair of podical plates. There is a pair each of the subanal styles and cerci both of which are setose and unsegmented.

8. There are ten pairs of spiracles, 2 being thoracic and 8 abdominal.

9. The sexes are indistinguishable externally.

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VI—ABBREVIATIONS USED IN THE TEXT-FIGURES

- abd.*, abdomen.
abd. s., abdominal sternite.
abd. t., abdominal tergite.
ac. cx. sc., accessory coxal sclerite.
acg., acrotergite.
acl., anteclypeus.
acs., antecostal suture.
ant., antenna.
ant. c., antennal carinae.
ant. f., antennal foveolae.
ant. s., antennal suture.
ap. t., apical tooth of the mandible.
apd., apodeme (of any body-part).
aps., apophysis (of any body-part).
at., anterior.
at. a. md., anterior articulation of the mandible.
at. t. a., anterior tentorial arm.
at. t. p., anterior tentorial pit.
b.c. cd., basal condyle of cardo.
bcs., basicostal suture of coxa.
c., condyle of mandible.
cb., cibarium.
cd., cardo.
cer., cercus.
cl., clypeus.
cr.a.md., cranial articulation of the mandible.
ctm., corporotentorium.
cv., cervix.
cv. sc. 1., first or anterior cervical sclerite.
cv. sc. 2., second or posterior cervical sclerite.
cv. sc. 3., dorsal cervical sclerite.
cx., coxa.
cxg., coxa genuina.
cx. pr., coxal process.
e., eye.
epmr., epimeron.
ep. pl., epicranial plate.
ep. s., epicranial suture.
epst., episternum.
fe., femur.
fl., flagellum of antenna.
f.l., fore leg.
fr., frons.
fx. pl., flexor plate (between claws and distitarsus).
g., galea.
gl., glossa.
gm., ginglymus.
gn., genae.
g.s., gular (or postmental) suture.
hd., head.
hd. c., head-capsule.
hyp., hypopharynx.
i.pl., incisor lobe of the mandible.
kts., katepisternum.
l.ss., lateral sclerites of hypopharynx.
lb., labium.
lb.p., labial palp.
lb.s., labial suture.
lcn., lacinia.
lgl., ligula.
lr., labrum.
lr.s., labral suture.
lst., laterosternite.
lt., left.
m.1, m.2, m.3, marginal teeth of the mandible.
md., mandible.
mdl., mandibularia. (or trochantin of mandible).
m.pl., molar plate of mandible.
mr., meron.
mss., mesosternum.
mst., mesonotum.
mts., metasternum.
mtt., metanotum.
mx., maxilla.
mx.p., maxillary palp.
n., antennifer.
oc., ocellus.
oct., occiput.
oct.f., occipital foramen.
oes., oesophagus.
o.s., ocular suture.
p., pedicel of antenna.
pcl., postclypeus.
pd.pl., podical plate.
pgl., paraglossa.
pgn., postgenae.
pl. m., pleural membrane.
pl.s., pleural suture.

pl. aps., pleural apophysis.
pmt., postmentum.
poct., postocciput.
poct.s., postoccipital suture.
prmt., prementum.
pro.sc., prosclerite.
prs., prosternum.
pri., pronotum.
pt., posterior.
pt.t.a., posterior tentorial arms.
pt.t.p., posterior tentorial pit.
r., ridge.
rt., right.
S.1, S.2, S.3, .S.10, sterna 1-10.
s., scape.
sa.sty., subanal style.
scl., scutellum.
sct., scutum.
sgn.r., subgenal ridge.
slv., salivarium.
spr., spiracle.

sp.s.1, sp.s.2, spinasternum first and second.
ss., suspensoria (sclerites associated at the base of hypopharynx).
ss.br.1. stomodaeal branch.
ss.br.2. mandibular branch.
st., stipes.
str. aps., sternal apophysis.
su.g., sutural groove of stipes.
t., tergum.
T. I, T II, T. III, . . . T.X, terga first, second, and so on.
tar., tarsus.
tar. c., tarsal claw.
tb., tibia.
tb., tentorial bridge.
tb. sr., tibial spur.
t.f., tentorial foramen.
th., thorax.
tm., tormae.
tn., trochantin of leg.
tr., trochanter.