MORPHOLOGY OF THE PRIMITIVE TERMITE, *ANACANTHOTERMES MACROCEPHALUS* (DESNEUX) (ISOPTERA : HODOTERMITIDAE). PART 2. EXTERNAL MORPHOLOGY OF THE ALATE AND WORKER CASTES

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(With 3 Tables and 12 Text-figures)

CONTENTS

I—INTRODUCTION

This is the second paper of the series, the first having dealt with the external morphology of the soldier caste (Gupta, 1962).

Acknowledgements.—I am deeply grateful to Dr. M. L. Roonwal, Director, Zoological Survey of India, Calcutta, for suggesting the problem and for continuous guidance. My thanks are also due to Shri T. C. Mathew, Principal, Dungar College, Bikaner, for his interest and encouragement during the course of this work. I am also grateful to my colleague Dr. S. Venkatachary, for his valuable suggestions in the improvement of the text. I am also thankful to Shri R. K. Goyal who helped me in the preparation of the text-figures. I further wish to put on record my appreciation of the untiring zeal and patience of Shri Chiman Singh of Dungar College, Bikaner, in the collection of the material.

II—MATERIAL AND METHODS

Alates were collected in two lots at the time of swarming from the same locality as for the study of the soldier caste, *i.e.*, the outskirts of Bikaner city in Rajasthan. The swarming took place during a drizzle immediately following the first heavy shower of the rainy season in August 1955 and 1958. The insects were attracted to the strong light of a 'Petromax' lantern between 9-11 p.m. Inspite of my best efforts I failed to collect any alates during the years 1956 and 1957.

Worker forms were also collected from the same locality, while foraging or building the termite-hills.

The material was preserved in rectified spirit. For the study of the sclerites, the body was relaxed either by boiling the insects in a mixture of 30 per cent. alcohol and 5 per cent. glacial acetic acid, or boiling water and 5 per cent. glacial acetic acid, for a period of 20 minutes. For the study of individual parts, the insects were dissected out and the body parts cleared in a 5 per cent. aqueous solution of potassium hydroxide for one to three days. Permanent preparations in canada blasam were made by the usual method. Gage's method (1919), for staining chitin and also alcoholic eosin were used ; both the methods gave good results.

III—EXTERNAL MORPHOLOGY OF THE ALATE CASTE

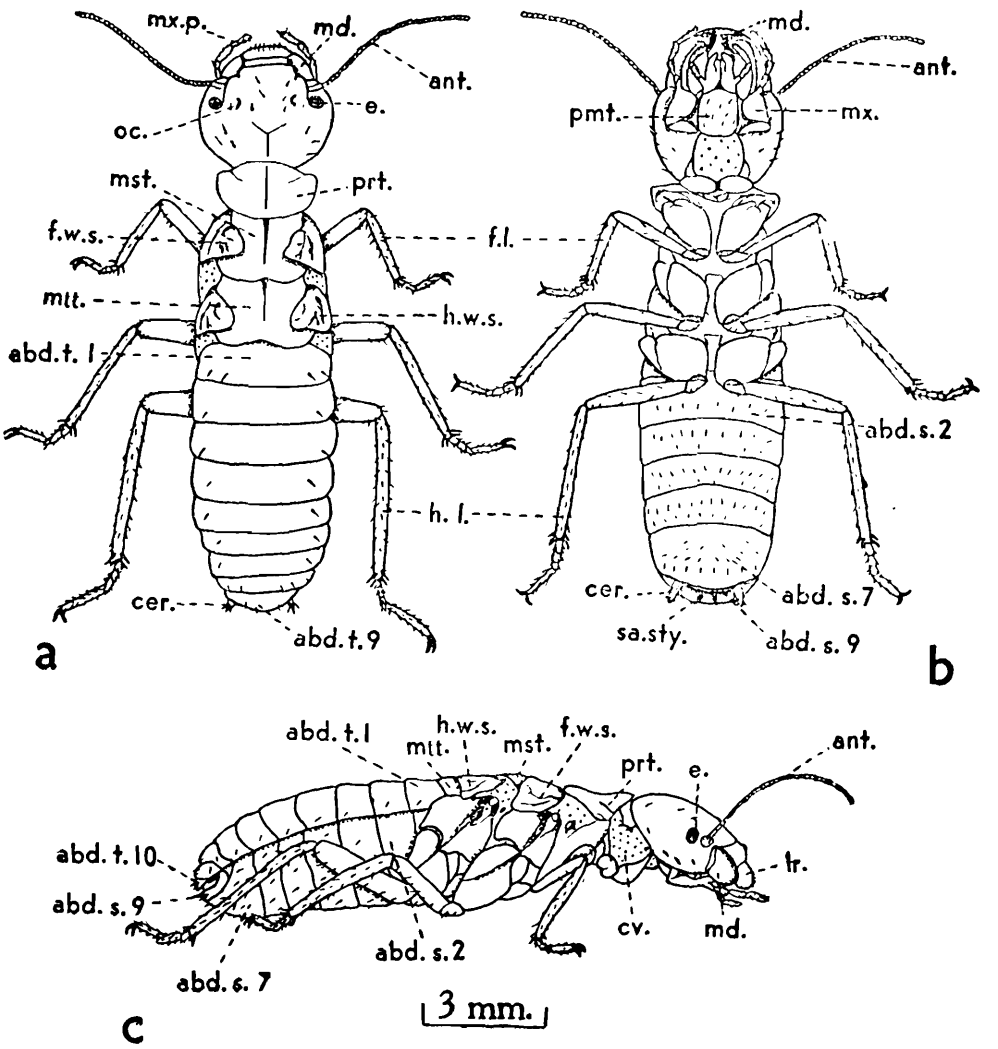
(a) *General*

The following account of the alates applies mainly to the females. The males are similar to the females in most respects, but wherever they differ, the differences are indicated.

Coloration.—The head in alates displays less pigmentation than in the oldier. It is pale brown except in the articular regions for mandibles, maxillae, etc., where it is dark brown. On the underside, the head is pale yellow. The thoracic tergites are strongly chitinised and dark brown, the abdominal tergites, due to differential pigmentation, present a banded appearance, with paler bands alternating with broad, transverse dark-brown band in each tergite. On the ventral side the entire body is yellowish white.

Setae.—The setae on the head are few but prominent. On the dorsal side of the body their number is insignificant except on the anterior margin of the pronotum. On the ventral side, the abdomen has longish setae which are more numerous in the middle of each sternite. The legs have long setae.

Size.—The body without wings measures about 13·8—14·6 mm. from the tip of the labrum (the mandibles lie covered under the labrum to the tip of the abdomen.



TEXT-FIG. 1.—*Anacanthotermes macrocephalus* (Desneux). Alate caste, female.

(*a*). Whole body of dealated adult, in dorsal view. (*b*). Ditto, in ventral view. (*c*). Ditto, in lateral view.

Sexes.—The males can be distinguished by the exposed eighth abdominal sternite, which, in females, lies under the seventh and is partly visible externally as two lateral plates lying apart. In a count of 1,226 individuals the males were found to comprise about 54 per cent. of the population (Table 1).

TABLE 1.—*Ratio of males and females among alates of* Anacanthotermes macrocephalus (*Desneux*) *in two random collections made on outskirts of Bikaner.*

Date of collections	Total number of individuals	Males		Females	
		Number	%	Number	%
20 August, 1956	40	22	55·0	18	45·0
1 August, 1958	1,186	635	53·5	551	46·5
Total and average	1,226	657	54·25	569	45·75

(b) *The head*

(Text-figs. 2 and 3)

The head, which is more or less round, is hypognathous, unlike the prognathous condition in the soldier, and is relatively smaller. It is bilaterally symmetrical, and has the orthopteroid type of mouth-parts. The posterior margin is partly covered by the pronotum as in the soldier caste. The mandibles, unlike those of the soldier, are largely covered by the labrum. As in the soldier, they are asymmetrical in respect of the teeth. In all the 50 insects examined, the left mandible partly crossed over the right one in the resting position.

The head-capsule measures as follows :—

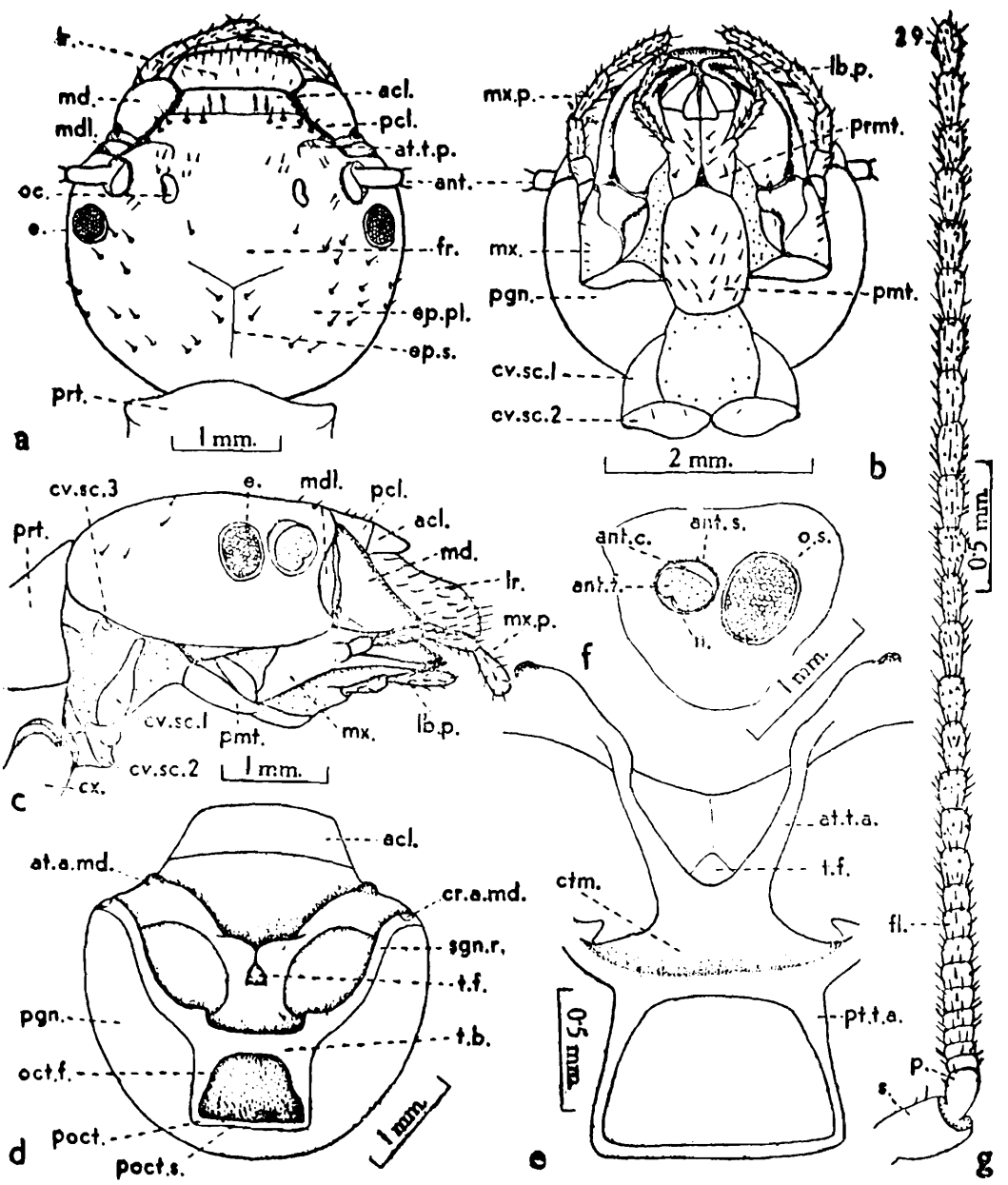
Length from the hind margin to the tip of the labrum .	3·5—3·8mm.
Length from the hind margin to the lateral base of the mandible	2·4—2·6mm.
Maximum height of the head . ..	1·3—1·4mm.
Maximum width of the head .	2·9—3·0mm.

But for the fact that the facial area is directed forwards, the mouth-parts and other appendages on the head are in the same relative position as in the soldier. As in the soldier, the fontenalle is absent.

The sutures are ill-defined or absent. The Y-shaped *epicranial suture* (*ep. s.*) is faintly visible. The *epicranial plates* (*ep. pl.*) are less extensive than in soldier. As in the soldier, the *clypeo-frontal* or *epistomal suture* is absent, and the *frons* (*fr.*) is thus not separated from the *clypeus* (*cl.*). The epicranial plates pass into the *genae* (*gn.*) and the *postgenae* (*pgn.*). The *occipital suture* is absent. The *gular sutures*, which are present in the soldier caste, are absent here.

The clypeo-frontal area is bounded anteriorly by the usual *clypeo-labral suture* (*lr. s.*). Unlike the soldier, the clypeus is divisible into an anterior membranous *anteclypeus* (*acl.*) and a darker *postclypeus* (*pcl.*) by an *intra-clypeal suture* (*i.cl.s.*) ; the anteclypeus is distinguishable by means of two longitudinal depressions into three regions—one median and two lateral—all of which bulge outwards. Of these, the median bulging is very prominent and accommodates the median elevation of the

labrum (*lr.*). The postclypeus can be said to be divided into right and left parts by a shallow, medio-longitudinal depression, but no distinct *median clypeal suture*, as found in *Odontotermes obesus*(Rambur)(Vishnoi, 1957), is visible. The *postoccipital suture* (*poct.s.*) encloses a *post-occiput arch* (*poct.*) bracing the *occipital foramen* (*oct.f.*) on three sides. The submarginal *subgenal suture* and its corresponding ridge (*sgn.r.*),



TEXT-FIG. 2.—*Anacanthotermes macrocephalus* (Desneux). Alate caste, female. (*a*). Head in dorsal view. (*b*). Head in ventral view. (*c*). Head, along with the cervix , in lateral view. (*d*). Head-capsule (appendages removed), in ventral view. (*e*). Tentorium in dorsal view. (*f*). Part of the cranium, showing left antennal and ocular sclerites. (*g*). Left antenna, showing 29 segments.

starts in front of the *posterior tentorial pit* (*pt.t.p.*), follows the same course as in the soldier and strengthens the ventro-lateral cranial wall for the articulation of the gnathal appendages. The *labium* (*lb.*) is attached directly to the neck membrane between its lateral attachments to the cranial margins just behind the posterior tentorial pits.

The *amennal* (*ant.s.*) and *ocular sutures* (*o.s.*) separate the antennal and ocular sclerites, as in the soldier.

The tentorium (Text-fig. 2 *d*, *e*).—It forms the endoskeleton of the head-capsule. In its essential structure it resembles that of the soldier and the differences are mentioned below :—

(i) The *posterior tentorial pits* (*pt.t.p.*) are not lengthened because of the hypognathous condition of the head. The *posterior tentorial arms* (*pt.t.a.*) are connected medially, forming a narrow transverse bar, the *tentorial bridge* (*t.b.*). Postero-laterally the posterior tentorial arms are produced backwards and become confluent with the postocciput arch to completely enclose the occipital foramen, (*oct.f.*),

(ii) The *corporotentorium* (*ctm.*) is comparatively smaller.

The labrum (Text-fig. 3*a*, *b* ; *lr.*).—The labrum is similar in form to, but slightly differs in structure from, that of the soldier. It measures about 0·98mm. in length and 1·33 mm. in width. In relation to the head-length, the alate labrum is larger than the soldier labrum. Its proximal articular margin shows a median elevation corresponding to the median elevation of the anteclypeus (*vide supra*). It further displays prominent convex curvature antero-posteriorly as well as from side to side, and its distal margin bears a marginal membranous area.

The under surface is lined by cuticle which, unlike the soldier, is not smooth. The labral palate is provided with two types of fine cuticular processes as in the alate forms of *Odontotermes obesus* (Rambur) (Vishnoi, 1956), *viz.*, (i) the small spine-like *aculei* (*lr.ac.*) covering practically the entire area except on the outer side; and (ii) two dentigerous stripes formed by numerous peg-like *denticles* (*lr.dt.*) arranged in antero-posterior rows, one on each side, between the imaginary median axis and the lateral border. The dentigerous stripes are also present in the soldier caste of this species. Imms (1919) did not mention such cuticular processes as the aculei in *Archotermopsis wroughtoni* Desneux though he mentioned " very minute closely set papillae ", probably corresponding to the dentigerous stripes referred to above.

At the basal angles are found, as in the soldier, two medially directed sclerites, the *tormae* (*tm.*) ; the right torma is larger than the left.

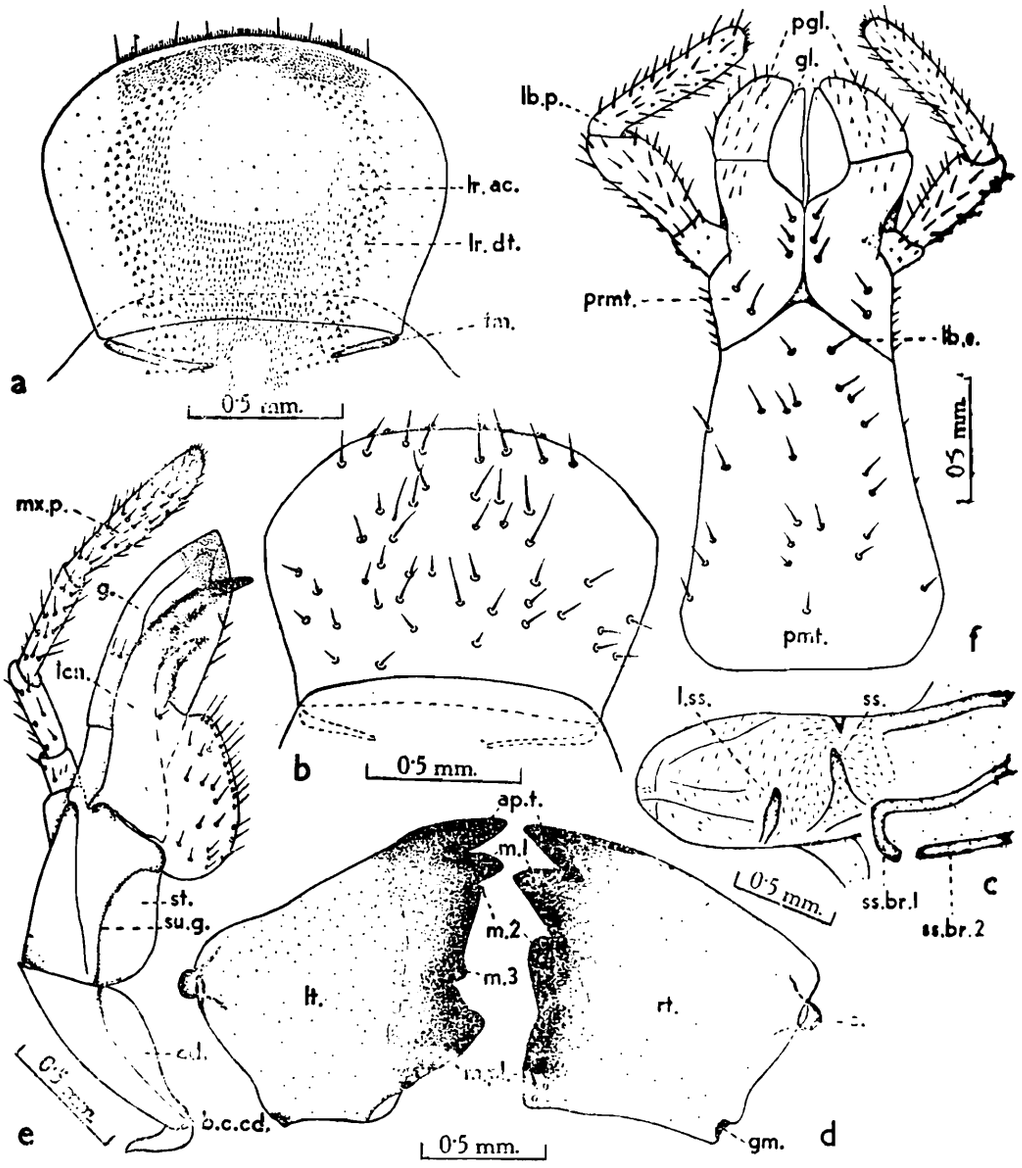
The hypopharynx (Text-fig. 3*c* ; *hyp.*).—The *hypopharynx* is seen in the same relative position and possesses the same structure and form as in the soldier.

The eyes and the head appendages (Text-figs. 2 and 3).—(i) The *compound eyes* (Text-fig. 2*f*; *e.*) : The eyes are larger than in soldiers and consist of a pair of prominent, bulging, dark, pigmented eyes, measuring about 0·53 mm. in the long diameter. They are placed slightly behind the antennal sockets. The facets are roughly hexagonal and number about 142. Each eye is surrounded by an *ocular suture* (*o.s.*) enclosing the *ocular sclerite* ; the internal ridge thus formed surrounds the eye.

In the same position where the ocelli lie in the soldier there are two pale spots (*oc.*), the nature of which requires further study.

(ii) *The antennae* (Text-fig. 2*f*, *g* ; *ant.*).—The antennae, which have 28-29 segments, measure about 4·75 mm. in length. In form, situation, structure, etc., they closely resemble those of the soldier except that the

antennal carinae (*ant.c.*) are less prominent. The number of segments in the two antennae, right and left, show less variation than in the soldier. A count in 50 male and 50 female alates (Tables 2 and 3 showed that 84 per cent. males and 92 per cent. females have an equal number of segments in both the antennae, of which 29-segmented antenna is found in 80 per cent. males and 48 per cent. females ; 16 per cent. males and 8 per cent.



TEXT-FIG. 3.—*Anacanthotermes macrocephalus* (Desneux). Alate caste. female.

(*a*). Labrum, in ventral view. (*b*). Labrum, in dorsal view. (*c*). Hypopharynx, in dorso-lateral view. (*d*). Left and right mandibles. (*e*). Right maxilla, in ventral view. (*f*). Labium, in ventral view.

females carry an unequal number of segments in the two antennae. However, wherever this bilateral asymmetry is found, the difference is of one segment only. In contrast to males, the 28-segmented antennae are more common in females (Table 3). The *scape* (*s.*), the *pedicel* (*p.*) and the first two flageller segments measure in length about 0·23, 0·19, 0·09 and 0·06 mm. respectively.

TABLE 2.—*Variation in the number of antennal segments of the right and left antennae of* 50 *individuals of each sex in alates of* Anacanthotermes macrocephalus (*Desneux*).

Item	Number of segments and frequency					
	Males			Females		
	Frequency	Left	Right	Frequency	Left	Right
(*a*) With one segment more in the left antenna.	5	29	28	1	29	28
	1	28	27	1	28	27
	Total 6 (12%)		—	Total 2 (4%)		—
(*b*) With one segment more in the right antenna.	2	23	29	*Nil*	28	29
	Nil	27	28	2	27	28
	Total 2 (4 %)		—	Total 2 (4 %)		—
(*c*) With equal number of segments in both antennae.	40	29	29	24	29	29
	1	28	28	19	28	28
	1	27	27	3	27	27
	Total 42 (84%)		—	Total 46 (92%)		—

TABLE 3.—*Frequency distribution of the number of antennal segments in* 50 *individuals of each sex in the alates of* Anacanthotermes macrocephalus (*Desneaux*).

Number of antennal segments	Males				Females			
	Right		Left		Right		Left	
	Frequency	Approx. %	Frequency	Approx. %	Frequency	Approx. %	Frequency	Approx. %
29	42	84%	45	90%	24	48%	25	50%
28	6	12%	4	8%	22	44%	20	40%
27	2	4%	1	2%	4	8%	5	10%

(iii) *The mandibles* (Text-fig. 3*d*; *md.*).—The mandibles are meant for crushing and chewing, and are consequently modified and different from those of the soldiers. Each mandible is trapezoid in form and, as in the soldier, articulates with the cranium by a mid-dorsal *ginglymus* (*gm.*) and a ventro-lateral *condyle* (*c.*); it is worked in the transverse plane by the two apodemes—a smaller outer *abductor* and a larger inner *adductor*. The abductor is attached in a concavity situated just above the condyle, while the adductor is inserted into the large sinus immedia-

tely behind the *molar plate* (*m.pl.*). The distal part of the mandible is practically hidden from view, being covered by the labrum. The two mandibles, unlike the soldier, are subequal in length, though at base the right is slightly broader than the left. However, as in the soldier, the left mandible crosses over the right while in repose (*vide* above).

The two mandibles are asymmetrical in respect of the number of teeth. The right one possesses two *marginals* (*ml.* and 2) behind the *apical tooth* (*ap.t.*) and in front of the *molar plate* (*m.pl.*). The left mandible has three marginal teeth, of which only the first one is well marked and lies behind the apical tooth ; the second marginal is small ; the margin of the *incisor lobe* (*i.pl.*) following it is concave and forms a tooth-like projection, the third marginal (*m.*3), in front of the molar plate. The molar plate of the left mandible is wedge-shaped and, when seen from above, a blunt marginal tooth projects from the under surface. However, according to Ahmad (1950) it should not be mistaken for a marginal tooth.

(iv) *The first maxilla* (Text-fig. 3 *e*; *mx.*).—The maxillae are similar to those found in the soldier. The segments of the *maxillary palp* (*mx. p.*), beginning from the proximal segment, measure about 0·17, 0·21, 0.46, 0·54 and 0·71 mm. in length, respectively.

(v) *The labium* (Text-fig. 3*f*; *lb*).—It consists of the usual two segments, the *prementum* (*prmt.*) and the *postmentum* (*pmt.*), and resembles the labium of the soldier in its structure, position , and relation with the hypopharynx and with the neck membrane. The prementum is attached to the postmentum along the $\wedge$-shaped *labial suture* (*lb.s.*). The *ligula* is medially cleft anteriorly ; further, it has a strong longitudinal depression running up to the apex of the labial suture. In length the segments of the labial palp measure 0·19, 0·57 and 0 73mm., respectively. The postmentum, however, differs from that in the soldier in : (i) being less sclerotised ; (ii) not having the rounded basal angles produced in posteriorly directed arms ; (iii) the absence of the distal membranous part ; and (iv) the absence of the *gular sutures*, since the lateral margins are not connected with the cranial wall. Somewhat near the middle, the postmentum is transversely arched.

(c) *The neck*

(Text-figs. 2*c* & 4*a*)

The *cervix* (*cv.*) or neck with its lateral, ventral and dorsal sclerite, (*cv. sc.* 1, 2, 3) closely resemble those of the soldier and do not need a detailed description.

(d) *The thorax*

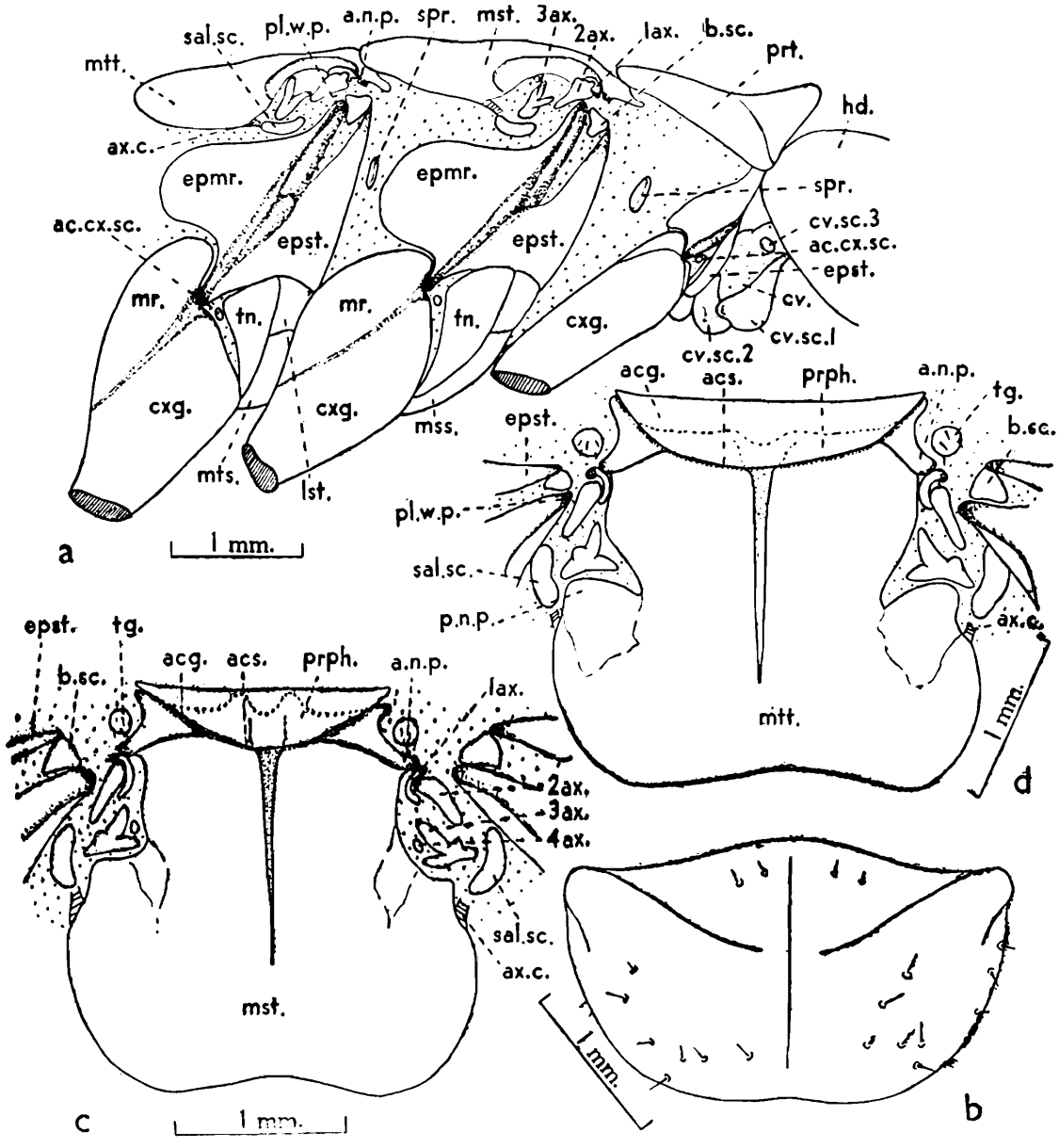
(Text-figs. 4 & 5*a*)

The thorax measures about 4·4 mm. in length and constitutes nearly one-third of the entire length of the insect. It consists of the usual three segments, the pro-, meso- and metathorax, of which the last two, which bear the wings, form the *pterothorax.*

The prothorax.—It is different from the pterothoracic segments both in form and structure. The *pronotum* (*prt.*) is the smallest of the three nota and measures about 1·5 mm. in length and 2·3mm. in breadth. It is saddle-shaped, with prominent, drawn out, antero-lateral spouts

and infolded margins as in the soldier ; only its anterior margin is weakly notched. The *sagittal suture* and *ridge* are distinct and the transverse apodemal inflexion is quite prominent. The anterior infolded margin forms a plate-like structure which becomes confluent with the neck membrane. The *pronotum* bears numerous small hairs.

The sternal sclerites (Text-fig. 5*a*) of the prothorax closely resemble those of the soldier, and the median carinate plate consists of the two fused *prosclerites* (*pro.sc.*) lying between the *episterna* (*epst.*) of the two



TEXT-FIG. 4.—*Anacanthotermes macrocephalus* (Desneux). Alate caste, female. (*a*). Cervix and thorax (wings removed), in lateral view. (*b*). Pronotum, in dorsal view. (*c*). Mesonotum with articular sclerites of the wing in dorsal view. (*d*). Metanotum with articular sclerites of the wing, in dorsal view.

sides. A very weakly pigmented oval plate, the prosternum (prs.), lies between the two coxae of the forelegs and further behind lies a medially placed, dark, pigmented, subcircular plate, the *first spinasternum* (*sp. s.* 1) (the intersternellum of Fuller, 1924), carrying internally a forwadly directed, rod-like structure. The pleuron of the prothorax is similar to that of the soldier caste and does not need a detailed description.

The pterothorax.—The pterothorax is composed of two segments—an anterior mesothorax and a posterior metathorax.

(i) *The tergites.*—The *meso-* (*mst.*) and *metanota* (*mtt.*) are subequal and similar. The *mesonotum* is a slightly arched plate divided in two regions—an anterior, narrow, waist-like *scutum* (*sct.*) and a posterior, slightly skirt-like *scutellum* (*scl.*). The scutum, as in the soldier, is traversed by a transverse submarginal *antecostal suture* (*acs.*) separating off a narrow band, the *acrotergite* (*acg.*) ; the corresponding internal ridge is directed downwards and forwards and displays a wing-shaped *prephragma* (*prph.*) with a pair of thin plate-like medio-lateral, triangular, *apodemal lobes* separated by a median notch, and a pair of lateral extensions (" yokes " of Fuller, 1924). There is no transverse suture to separate the *prescutum.*

The *scutellum* is not separated from the scutum by a transverse suture (the scuto-scutellar or Y-shaped suture of other wing-bearing insects nor is there any reversed notal suture. The scutellum, however, is elevated in the middle and depressed on either side to accommodate the wings when folded.

The sagittal suture is not seen externally. However, the ridge is very well developed and appears as a dark stripe through the notum. It is rather broadly joined in front to the *antecostal ridge* and posteriorly it gradually tapers to an end in the scutellar region. It does not reach the hinder border of the notum, nor does it subdivide into a short prong, as described by Fuller (1924) in *Hodotermes* spp. and other winged termites. This suture may not resemble the Y-shaped scuto-scutellar ridge regarded by Snodgrass (1935) as a fundamental ridge of the tergum in the winged insects, but Fuller (1924) believed that it is difficult to regard it as anything else. According to him it probably represents the two diverging ridges seen on the Blattid endonotum fused into one. However, since this ridge is more or less confined to the scutum, it should be regarded as the median ridge only.

The alar margin of the alinotum.—The lateral margins of the pterothoracic tergites, unlike the soldier, are specially modified in respect of the articular and flexor mechanisms of the wings.

The scutum presents antero-laterally a slightly backwardly directed stumpy process, the *anterior notal wing process* (*a.n.p.*) supporting the neck of the *first axillary sclerite* (1 *ax.*) of the wing base (*vide infra*). Immediately behind this the edges of the scutum become broadly emarginated and slightly incurved, giving the scutum a waist-like appearance. Further behind, the margin fans out to form the less chitinised *posterior notal wing process* (*p.n.p.*) which supports the third *axillary* (3 *ax.*).

The posterior border of the dorsum has rounded lateral angles and a broad, deep median notch. The margin is reflected under to form a reduplicated structure or ledge ; the thickened membranous ledge runs forward and outward on each side as the *axillary cord* (*ax. c.*) to the posterior wing articulation where it is applied to the outer edge of the third axillary and then folds sharply over into the edge of the basal membrane of the wing. As in other winged termites, a *postphragma* is not present.

The *metanotum* resembles the mesonotum in all essential respects. However, it differs from the latter in having a narrower acrotergite and a broader portion of the prephragma between the medio-lateral lobe and the lateral extension.

(ii) *The pleuron.*—The pleura of these segments do not differ fundamentally from those of the prothorax, and the differences that are met with are due to a degenerative tendency of the prothoracic pleura on the one hand and, on the other, to the special requirements of the wing-bearing condition in the pterothoracic pleura.

As in the soldier, the mesopleuron is divided by a deep prominent groove, the *pleural suture* (*pl. s.*), running from the base of the wing obliquely backward and downward separating the anterior plate, the *episternum* (*epst.*) from the posterior *epimeron* (*empr.*). Internally, it is produced into a massive apodeme, the *pleural ridge* (*pl. r.*), which is similar in structure to that of the soldier. Proximally, the suture and ridge end in a short, thick fulcral process called the *pleural wing process* (*pl. w. p.*) on which the *second axillary sclerite* (*2 ax.*) of the wing gyrates. Distally, the pleural suture ends in a broad *coxal condyle* (*cx. c.*), and appears to run over on the coxa without interruption.

The episternum (*epst.*) is a triangular sclerite lying in front of the pleural suture. It is bisected dorsally by a membrane-covered slit into an anterior vertical arm with chitinised apical thickening forming a more or less supplementary wing process to which are attached the ligamentous prealar portion of the wing and also the lateral attachment of the *tegula* (*tg.*). Behind the slit and in front of the pleural suture there is a narrow but deep slip of cuticle which slightly widens in the middle. There is no external indication by which the episternum can be divided into a dorsal *anepisternum* from the ventral *katepisternum.*

The epimeron.—The *epimeron* (*epmr.*) is a large, slightly convex plate behind the pleural suture. It is narrow towards the upper end, broad in the middle and again becomes abruptly narrower in the region of the coxal condyle, and is surrounded dorsally, posteriorly and ventrally by membranes.

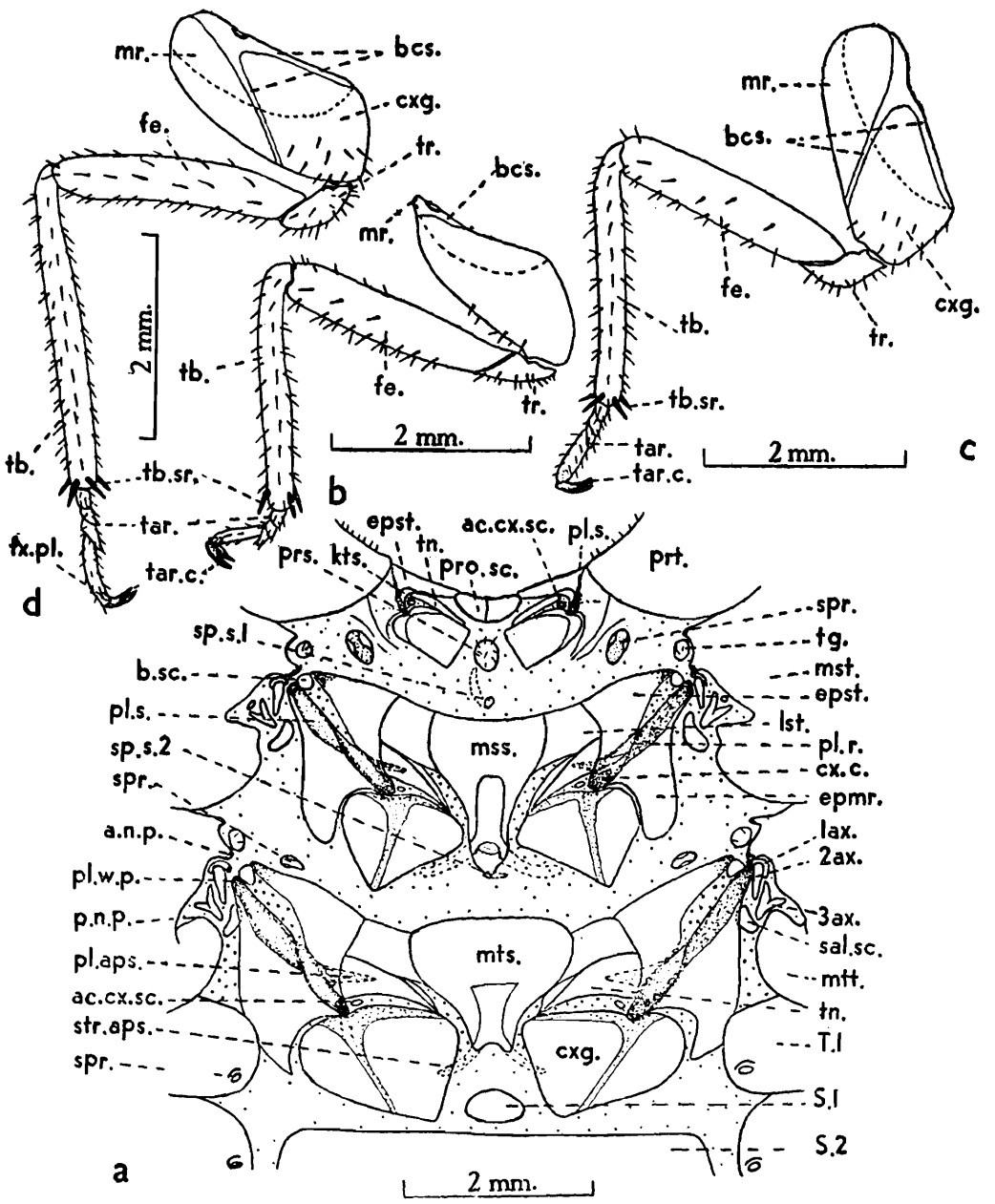
The trochantin.—The *trochantin* (*tn.*) is an elongate, triangular plate placed, as in the soldier, between the *laterosternite* (*lst.*) in front, the *katepisternum* (*kst.*) above, and the coxa behind. It is subequal in the meso- and metathorax but is relatively smaller in the prothorax. In the meso- and metathorax it is further seen to be divided by a ridge (forming an internal apodeme) into an anterior and a posterior triangular region.

The *metapleuron* resembles the mesopleuron in all essential details.

The epipleurites.—A pair of sclerites, called the *epipleurites*, one in front and the other behind the *pleural wing-process* (*pl. w. p.*), lies above the principal pleural sclerites. The anterior episternal epipleurite is called the *basalare* (*b. sc.*), and the posterior or epimeral one the *subalare* (*sal. sc.*) (or the "parapteron" of some authors). The basalare is a single, nodule-like, triangular sclerite which forms a bridge between the chitinous episternal wing-process and the pleural wing-process referred to above. The subalare is a crescent-shaped sclerite lying above the epimeron ; in its concavity the ventral arm of

the third axillary is hinged. Fuller (1924) regarded the chitinous tip of the anepisternum as the first parapteron, and the basalare and the subalare as the second and the third parapterons respectively.

The epipleurities of the metathorax also do not differ from those of the mesothorax. No such structures are present in the soldier.



TEXT-FIG. 5.—*Anacanthotermes macrocephalus* (Desneux). Alate caste, female.

(*a*). Ventral and lateral sclerites of the thorax with the tergites cut medially and spread on either side, in ventral view. (*b*). Right fore-leg, in ventral view. (*c*). Right middle-leg, in ventral view. (*d*). Right hind-leg, in ventral view.

(iii) *The sternal sclerites of the pterothorax.*—The sterna of the meso- and metathorax are subequal and do not differ from each other and from those of the soldier except in induration and pigmentation. The transverse sternal plate (*mss.*) is large and subtriangular, and lies flanked on either side by the subquadrate *laterosternite* (*lst.*) (the epimeral plate of Holmgren, 1909) which, with the episternum, forms the *precoxale*

(*pcx.*), as in the soldier. The backwardly directed slip is better chitinised, slightly flexed transversely and bears the *furca* (*str. aps.*) internally ; it is termed ' furcasternellum ' by Snodgrass (1935). The *second spinasternum* (*sp. s. 2*) is fused with the broad tip of the furcasternellum. The spinasternum of the *metasternum* (*mts.*) is absent as in the soldier, and the furcasternellum ends broadly. The chitinisation of the sternal plates is greater in the alates than in the soldier.

There is no *postcoxale* in any of the three thoracic segments and each of the three tergites, to some extent, overlaps the one which follows it.

There are two pairs of thoracic *spiracles* (*spr.* 1 and 2) situated, as in the soldier, as follows :—A pair each on the pleural membrane between the pro- and meso thorax and between the meso- and metathorax just in front of the episternum.

(e) *The thoracic legs*

(Text-figs.5*b*, *c* and *d*)

There are three pairs of subequal legs, which, in all essential respects, closely resemble those of the soldier. There is no *coxal suture* as reported in the winged forms of *Odontotermes obesus* (Rambur) (Kushwaha, 1960) and other termites (Fuller, 1924), though the coxae of the meso- and metathoracic legs are run obliquely by the *basicostal suture* (*bcs.*), which appears to be a continuation of the plerual suture (*vide supra*), dividing the coxa into an anterior *coxa genuina* (*cx. g.*) and a posterior *meron* (*mr.*). This suture has a prominent apodemal inflexion internally.

The other segments need no description ; the number of *tibial spurs* (*tb. sr.*) is as in the soldier, 3, 4, 4 in the fore- middle- and hind-legs, respectively.

(f) *The wings*

(Text-figs. 4 and 6)

1. *General.*—There are two pairs of subequal, pale-brown membranous wings extending, when folded, far beyond the end of the abdomen. While in repose, the left pair lies over the right. The anterior pair of wings is longer, but less broad than the posterior ones. The forewing with scale measures about 23 mm. long and 5·3 mm. broad, and the hindwing about 22 mm. and 6 mm., respectively. As in other Isoptera, the wings are deciduate and are, after the nuptial flight, shed off along a curved transverse suture near the base of the wing called the *humeral* or *basal suture* (*h.s.*). The proximal part, or the *wing stump*, or *scale* (*w.s.*) (scapular shield of Frogatt) remains permanently attached to the body.

Articulation of wings.—Each wing is attached to the body at its base by a membranous fold running from the *tegula* (*tg.*) in front to the *axillary cord* (*ax. c.*) behind. The wing-base is further strengthened by a group of sclerites called the *pteralia*, which includes the *tegula*,

the anterior *humeral plate*, the three *axillary sclerites* and two *median plates* in addition to the two *epipleurites*, and are described below.

1. *Tegula.*—This is a small lobe or scale-like sclerite lying at the anterior articular region of the wing just proximal to the humeral plate. It is larger in the forewing than in the hindwing, and bears a number of longish setae.

2. *Humeral plate.*—It is a small plate heavily chitinised and articulating with the basal portion of the *costa* (*C.*) (probably the costal sclerite of Comstock, 1918). It supports the ligamentous prealar portion of the wing. In the forewing it is triangular and spur-like ; in the hindwing it is represented by general chitinisation anteriorly to the base of the *subcosta* (*Sc.*).

3. *First axillary* (1 *ax.*).—It is the most anterior lateral wing-sclerite and lies along the margin of the scutum behind the *anterior notal wing-process* (*a.n.p.*), and is shaped like a gun trigger. Its anterior end is rounded and faces outwards, abutting against the anterior notal process of the meso- or metanotum on the one hand, and the base of the wing in the region of the subcosta on the other. In its middle it is strongly concave and receives the tip of the second axillary sclerite, while the tail end is again prominently curved outwards.

4. *The second axillary* (2 *ax.*).—It is a stout rod-like sclerite which is obliquely hinged at the anterior rounded end with the concavity of the first axillary. Its other terminal is broadly hinged over the forwardly directed arm of the third axillary, and its ventral surface near the middle fits over the fulcral wing-process of the pleuron (*pl. w. p.*).

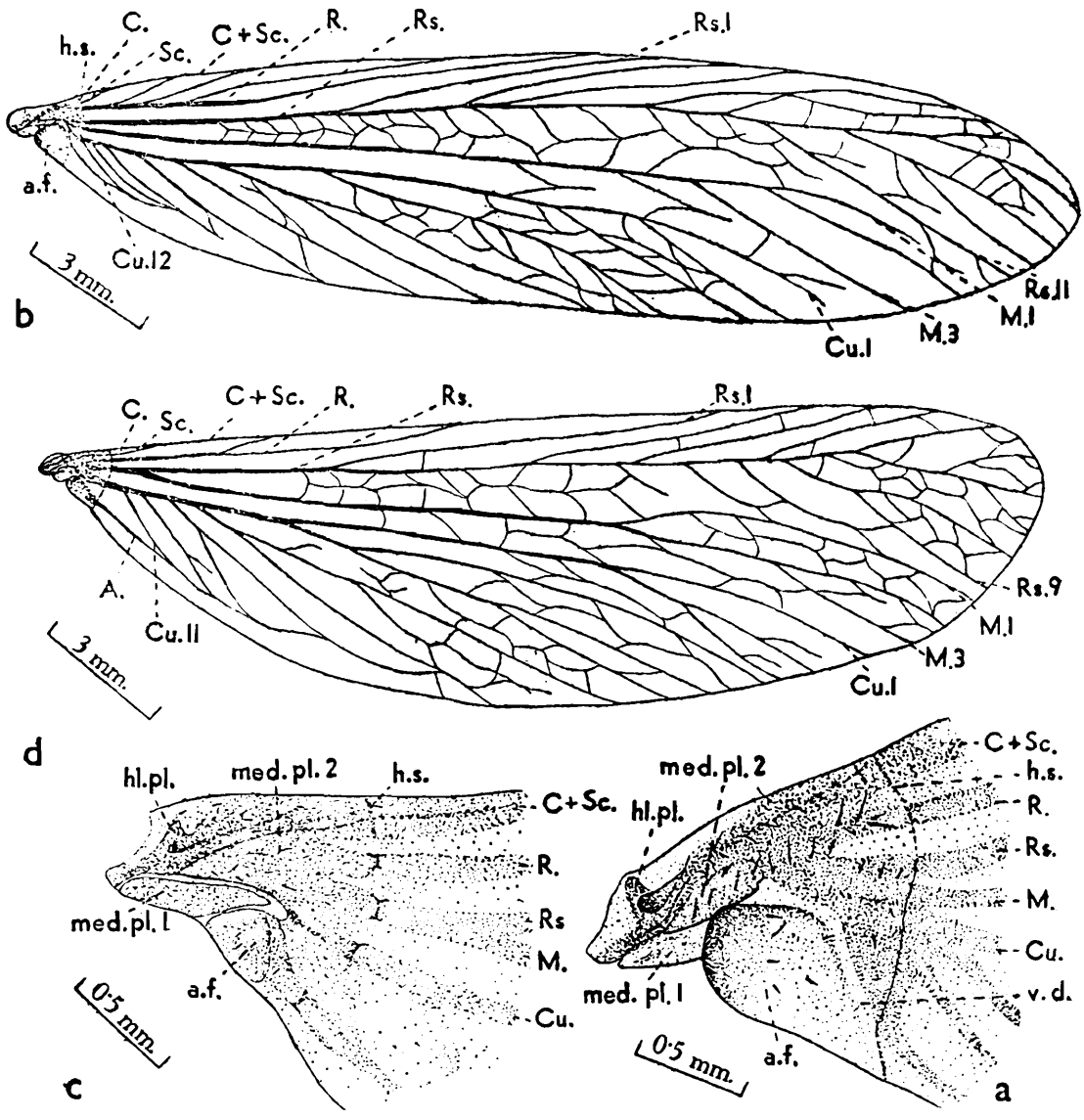
5. *The third axillary* (3 *ax.*).—It is the posteriormost axillary sclerite and lies between the *posterior notal process* (*p.n.p.*) and the second axillary. It is a complex sclerite and slightly differs in the meso- and metathroax. In the metathorax it is triradiate ; the outer ventral ray and the inner posterior ray lie against the postnotal process, with the ventral ray hinging in the concavity of the *subalare* (*sal. sc.*) and the other articulating with the condyle in the anal lobe of the wing. The forwardly directed process hinges with the second axillary and supports the membranous wing-base. The ventral arm is run over by the axillary cord which sharply reflects over to become continuous with the basal membrane of the wing.

6. A small sclerite lies between the apex of the third axillary and the anal lobe of the forewing, as found in other winged termites (Fuller, 1924).

7. *The median plates* (*med. pl.* 1 and 2).—These sclerites are, due to extensive chitinisation of the area, not easily separable. They lie in the median area of the wing-base and are separated by an oblique groove into a proximal plate and a distal plate. The former is more distinct and lies hinged to the third axillary. The distal plate, on account of heavy sclerotisation, cannot be delimited from the base of the veins (mediocubital) of this region. In addition to these sclerites, there are two epipleurites (Text-fig. 4) supporting the membranous base of the wing and have already been described.

2. *The fore-wing* (Text-fig. 6 *a* and *b*).—

The forewing-scale.—The forewing-scale (*f.w.s.*) is subtriangular, larger than the hindwing-scale and measures about 1·25 to 1·5 mm. in length along the median vein, the length being about 1/16th of the entire wing-length. It is delimited from the *lamina* (*la.*) by a *basal or humeral suture*(*h.s.*) (called line of fracture by Fuller, 1919). This suture runs as a definite groove just posterior to the *vena dividens* (*v.d.*) more or less at right angles to the posterior margin of the *anal lobe* (*a.f.*) till it crosses the *cubitus* (*cu.*) ; then it curves outwards to cross over the *median* (*M.*) and *radial sector*



TEXT-FIG. 6.—*Anacanthotermes macrocephalus* (Desneux). Alate caste, female. (*a*). Right forewing-scale, in dorsal view. (*b*). Right forewing, in dorsal view. (*c*). Right hindwing-scale, in dorsal view. (*d*). Right hindwing, in dorsal view.

(*Rs.*). Beyond this it is indistinct and becomes evident only by a constriction in the *radius* (*R.*). Further, it may appear as a faint line in the subcostal and costal regions.

Venation.—(i) *The costa* (*C.*).—Unlike *Mastotermes darwiniensis* Frogatt (Tillyard, 1931) and like *Archotermopsis wroughtoni* Desneux (Imms, 1919), a true *costal vein* emerges behind the humeral plate and runs

along the anterior border of the forewing. On its way to the humeral suture its course is marked by a row of 7-9 setae. It runs very close to the *subcosta* (*Sc.*) within the wing-scale.

(ii) *The subcosta* (*Sc.*).—The subcosta (postcosta of Fuller, 1919) is the second vein and forms the anterior articulation of the wing with the first axillary sclerite. It runs as a strongly chitinised ridge very close to the costa to slightly beyond the humeral suture. Then it separates, to run for a short course to merge again in the costa at about 1/6th of the entire wing-length. It remains unbranched throughout its course.

(iii) *The radius group.*—This vein consists of two stems (in *Archotermopsis wroughtoni* Desneux it has 3 stems, Imms, 1919). Since each of the two stems is multi-branched, it is difficult to name all of them. However, the first stem may be called the *radius* (*R.*) and the second the *radial sector* (*Rs.*). Their course is as follows : (a) *The radius.*—It originates behind the subcosta in the distal median plate and gives off 2-4 anterior branches outside the humeral suture to the costa before it finally merges into the latter at about the middle of anterior border of the wing. (b) *The radial sector.*—It also starts from the distal median plate and runs straight outwards till about 1/3rd of the wing-length before it gives off its first anterior branch to the costa. It gives off a variable number of anterior and posterior branches—3-6 anterior and 3-5 posterior branches. The anterior branches may further subdivide before they merge into the costa. Of the posterior branches, the proximal ones are usually atrophied and may anastomose among themselves or with the media. Three or four of the posterior branches may reach the posterior margin of the wing.

(iv) *The median vein* (*M.*).—The median vein (pseudomedia of Fuller, 1919) arises at the base of the radial sector in the wing-scale and remains closely approximated to the latter upto the humeral suture ; then it separates. The vein is hyaline and slender, as in *Archotermopsis wroughtoni* Desneux (Imms, 1919). It forks about the middle of the wing and each branch may further branch dichotomously before it reaches the posterior border, thus giving off a total of 3-6 branches.

(v) *The cubitus* (*Cu.*).—It starts immediately behind the median vein, but becomes a distinct entity only outside the humeral suture. It is a multi-branched vein, like the radius, and gives off 9-12 posterior branches. Of these, the proximal three may unite at their apices. The other branches may further branch dichotomously.

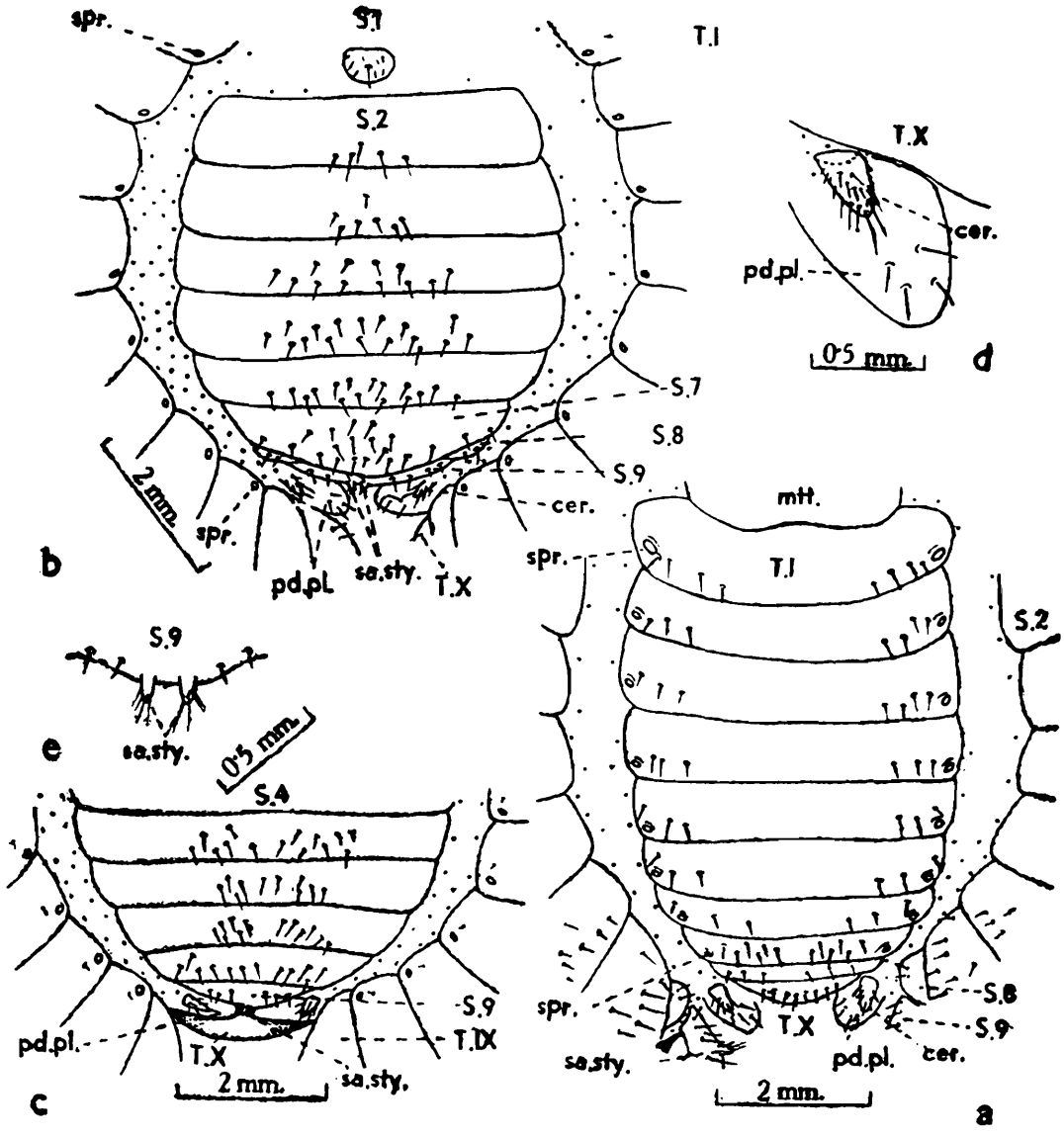
The vena dividens (*v.d.*).—It is in the form of an oblique groove separating the *anal lobe* (*a.f.*) from the costal. It runs from the base of the anal lobe to the posterior border within the wing-scale.

The anal lobe or clavus (*a.f.*) is a strongly arched plate as in Blattids. There are no anal veins in the forewing.

3. *The hind-wing* (Text-fig. 6*c* and *d*).—

The hindwing scale (*h.w.s.*).—Like the forewing scale it is also subtriangular but smaller in length, measuring about 1·1-1·2 mm. along the median vein, this being 1/18th to 1/20th of the entire wing-length. The humeral suture is not distinctly seen and can be imagined to run along the constrictions in the major veins such as the *anal* (*A.*), cubitus, radial sector and radius. There is no constriction in the costa and the subcosta.

Venation.—The *costa* and the *subcosta* take their origin in the wing-scale as in the forewing, and remain closely approximated in the wing-scale. Outside the humeral suture the subcosta gets separated for a short distance and remains unbranched. The *radius* (*R.*) gives off 2-3 anterior branches to the costa. The *radial sector* (*Rs.*) gives off 4-6 anterior and 3-5 posterior braches ; some more basal posterior branches atrophy and anastomose among themselves or with the median. Unlike the forewing, the *median* (*M.*) takes its origin from the radial sector outside



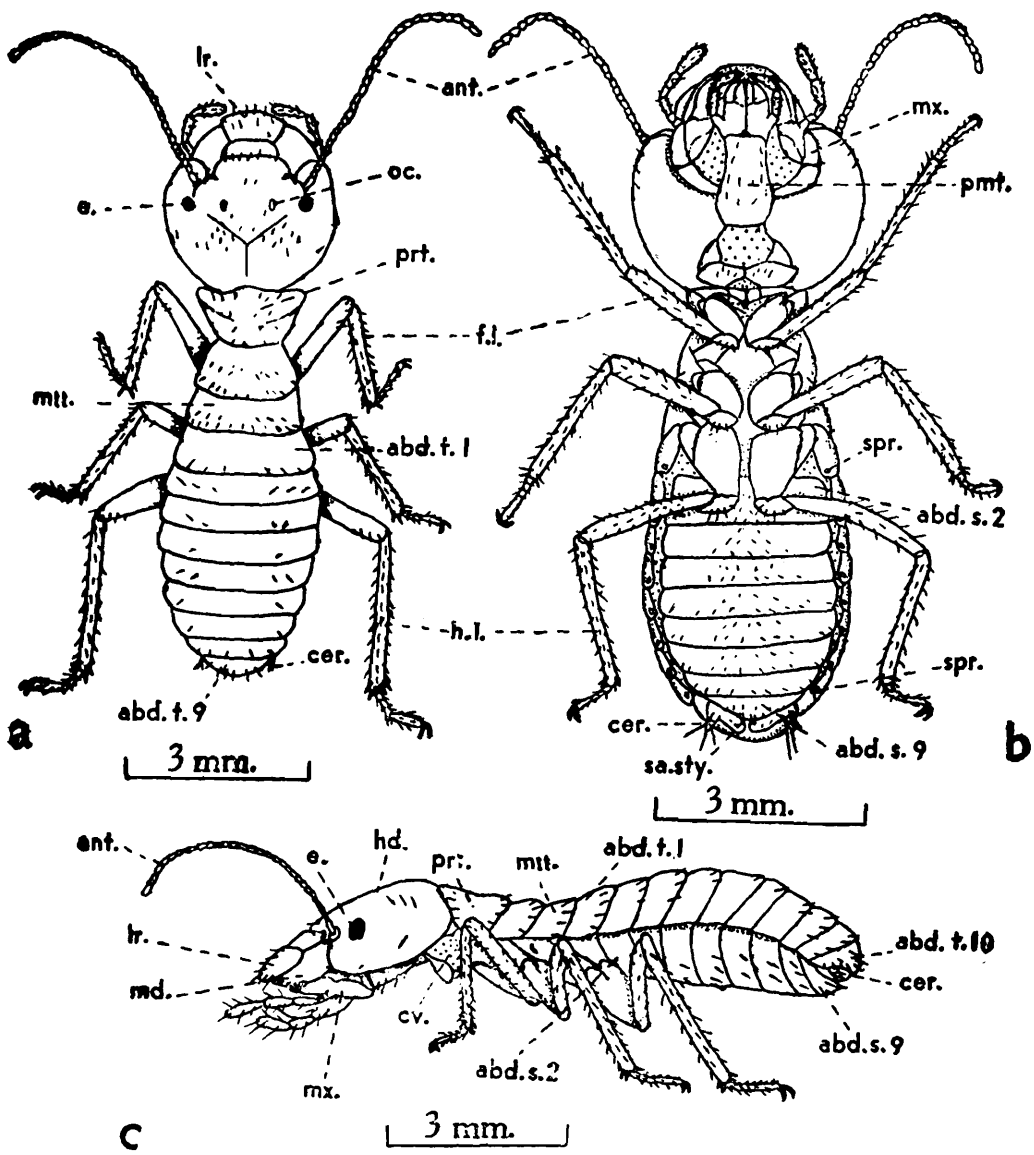
TEXT-FIG. 7.—*Anacanthotermes macrocephalus* (Desneux). Alate caste.
(*a*). Tergites of the abdomen of a female with sternites cut medially and spread on either side, in dorsal view. (*b*). Abdominal sternites of a female with the tergites cut medially and spread on either side, in ventral view. (*c*). Posterior abdominal sternites of a male with tergites cut medially and spread on either side, in ventral view. (*d*). Cercus of a female. (*e*). Subanal styles of a female.

the humeral suture. After running for about 2/3rds in length it gives off 2-3 branches which may again subdivide. Basally along its course it gives off a number of anterior branches which anastomose with the proximal posterior branches of the radial sector. The *cubitus* (*Cu.*) gives off 9-12 branches, all running to the posterior border of the wing ; each of the branches may further subdivide. Of these, the first 3 or 4 atrophy and anastomose amongst themselves.

The *vena dividens* (*v.d.*) is an insignificant anal furrow and does not reach the posterior border of the wing-scale. The length of the area is nearly half of that of the forewing. The *anal vein* (*A.*) comes out of the anal lobe as a prolongation of the latter, enters the lamina and fuses with the posterior basal branches of the cubitus.

(g) *The abdomen*
(Text-fig. 7)

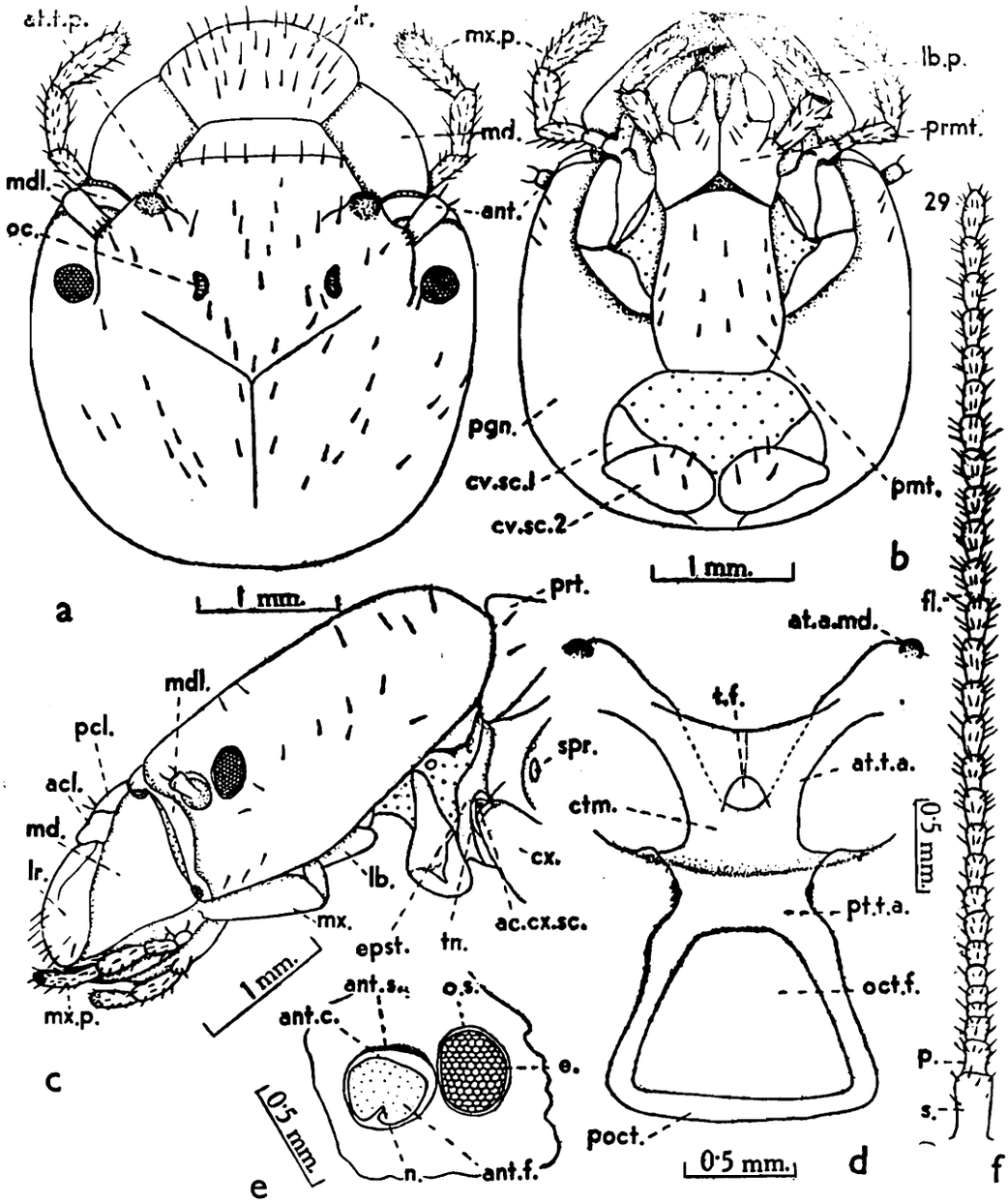
The abdomen has ten segments which have the same arrangement of tergites and sternites as in the soldier. It is broadly united with the thorax



TEXT-FIG. 8.—*Anacanthotermes macrocephalus* (Desneux). Worker caste. (*a*). Whole body in dorsal view. (*b*). Ditto, in ventral view. (*c*). Ditto, in lateral view.

and measures in males 6·0—6·3 mm. in length and 3·3—3·7 mm. in width, and in females 6·0—6·7 mm. and 3·2—3·5 mm., respectively. The tergal plates show comparatively uniform chitinisation. The second sternite has a median longitudinal flexure as in the soldier. In females the arrangement of sternites is different from the males. The VII sternite (the *hypogynium* or the *genital plate*) is greatly enlarged so as to cover the VIII and greater part of the IX sternite. The VIII sternite or the

paragenital plates, partly visible laterally, are divided into two plates lying apart from each other. In males, the VII sternite is not enlarged. The VIII sternite is entire, and, together with the IX sternite, lies exposed. In both the sexes the IX sternite bears a pair of unsegmented. setose and submarginal *subanal styles* (*sa. sty.*) and the X sternite is divided laterally into two lobes, the *paraprocts*. At their basal membrane the latter carry one pair of unsegmented *cerci* which bear longish setae.



TEXT-FIG. 9.—*Anacanthotermes macrocephalus* (Desneux). Worker caste. (*a*). Head, in dorsal view. (*b*). Head, in ventral view. (*c*). Head along with cervvix, in lateral view. (*d*). Tentorium, in dorsal view. (*e*). Part of cranium, showing left antennal and ocular sclerites. (*f*). Right antenna, showing 29 segments.

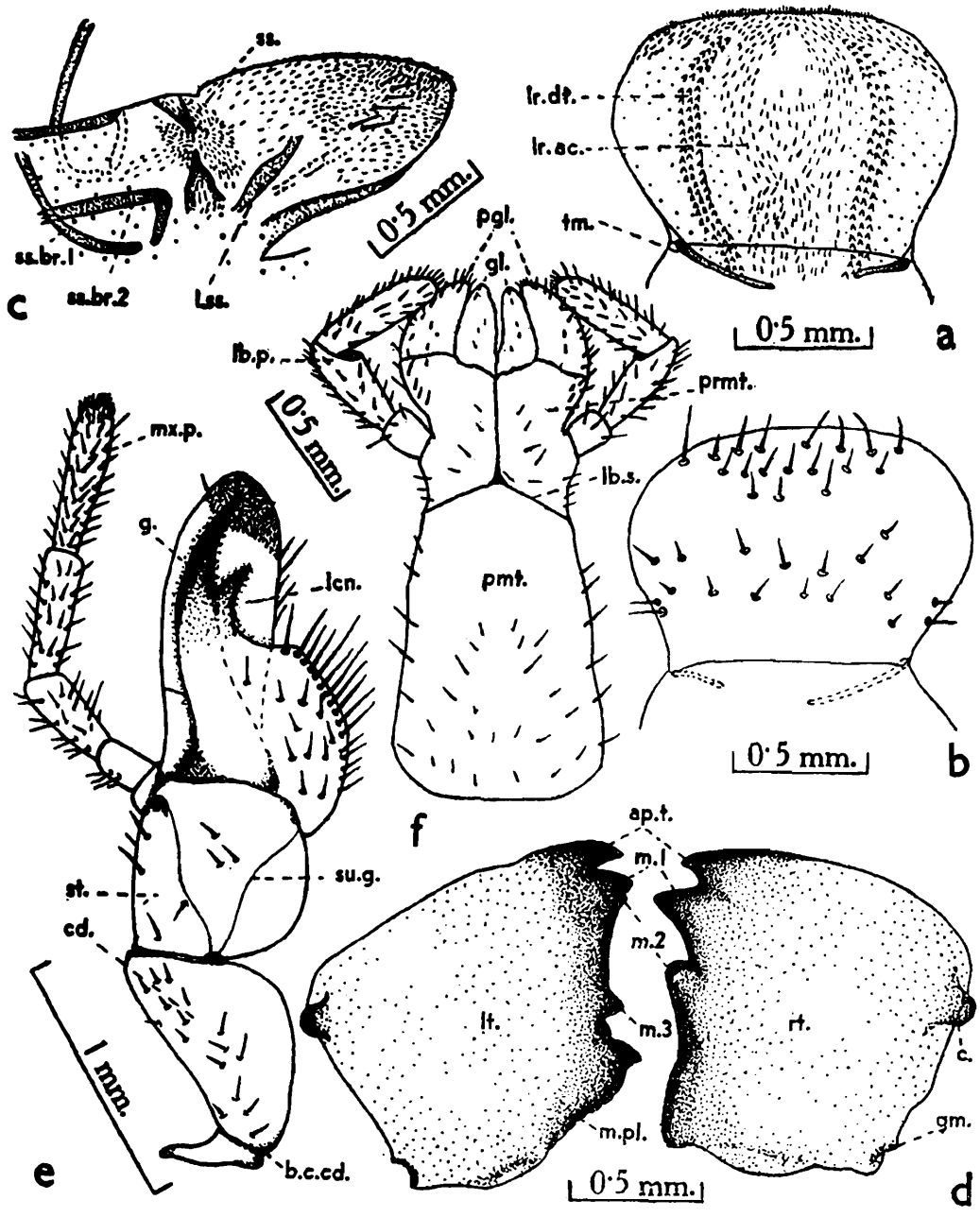
IV—EXTERNAL MORPHOLOGY OF THE WORKER CASTE

(a) *General*

Pigmentation is the poorest in this worker caste. The head is paler than in the alate. The *pronotum* is better chitinised than other thoracic

and abdominal tergites which are dirty white and translucent and appear slaty grey, on account of the contents of the alimentary canal being visible. On the ventral side the same condition occurs.

The setae are more numerous and longer than in the alates. The body length varies from 6·5-10·2 mm., and the sexes, if existent, are indistinguishable externally.



TEXT-FIG. 10.—*Anacanthotermes macrocephalus* (Desneux). Worker caste.

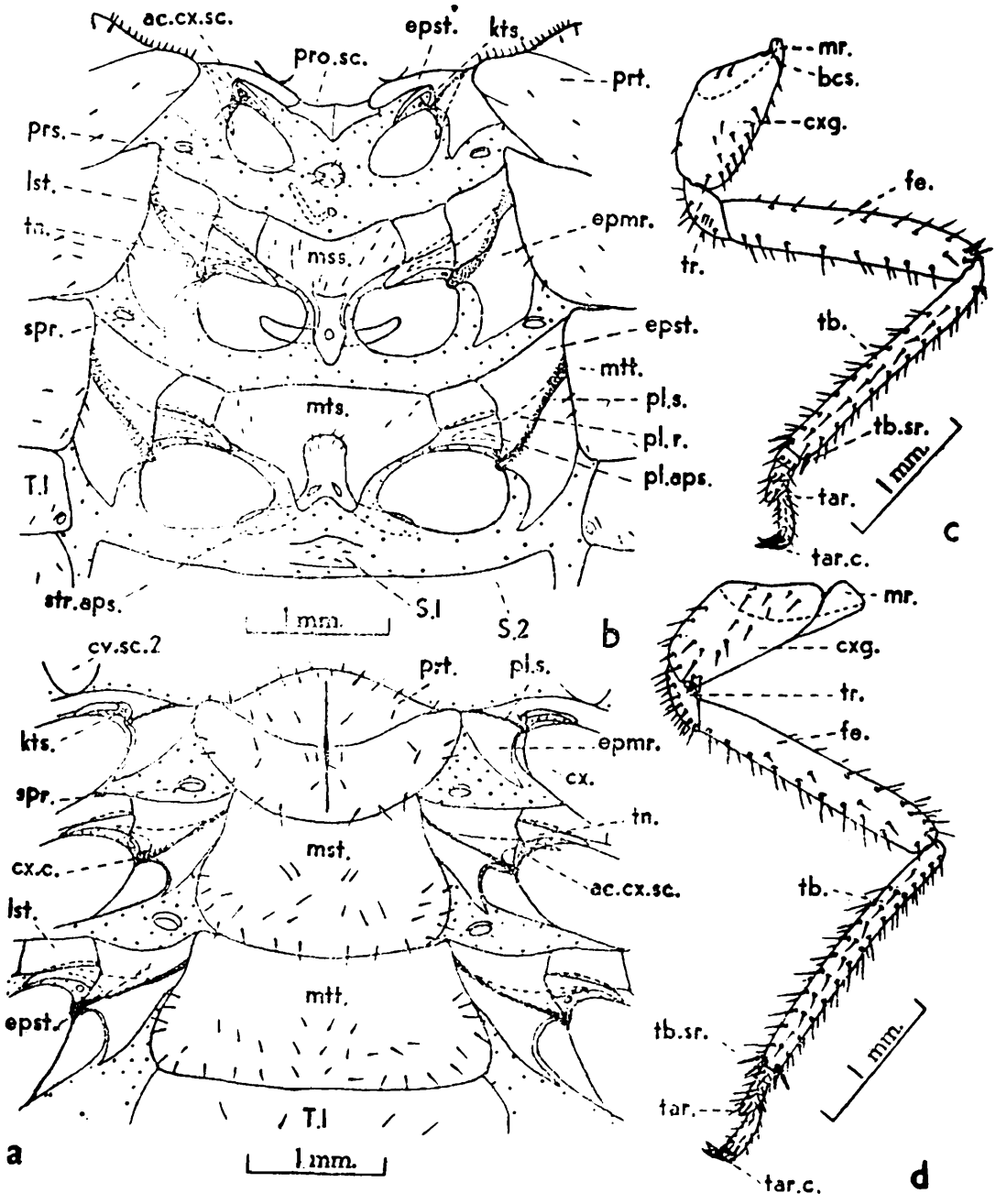
(*a*). Labrum, in ventral view. (*b*). Labrum, in dorsal view. (*c*). hypopharynx, in dorso-lateral view. (*d*). Left and right mandibles. (*e*). Right maxilla, in ventral view. (*f*). Labium, in ventral view.

(b) *The head-capsule and appendages*

(Text-figs. 8, 9 & 10)

In form, size, relation to the long axis of the body, the cranial sutures, the cranial areas, the attachment of various appendages such as the antennae, labrum, mandibles, maxillae, labium, hypopharynx, etc., and

in other structures like the tentorium, eyes, ocelli, etc., the workers, very closely resemble the alates. The mandibles in workers do not cross over each other but lie apposed, the left one being a little dorsal to the right. The antennae have 25-30 segments. Each of the two compound eyes has about 100 facets and the ocelli-like spots are seen in the same position as in the soldier and alate forms.



TEXT-FIG. 11.—*Anacanthotermes macrocephalus* (Desneux). Worker caste.

(*a*). Dorsal and lateral sclerites of the thorax with the sternites cut medially and spread on either side, in dorsal view. (*b*). Ventral and lateral sclerites of the thorax with tergites cut medially and spread on either side, in ventral view. (*c*). Left fore-leg in ventral view. (*d*). Left middle-leg in ventral view.

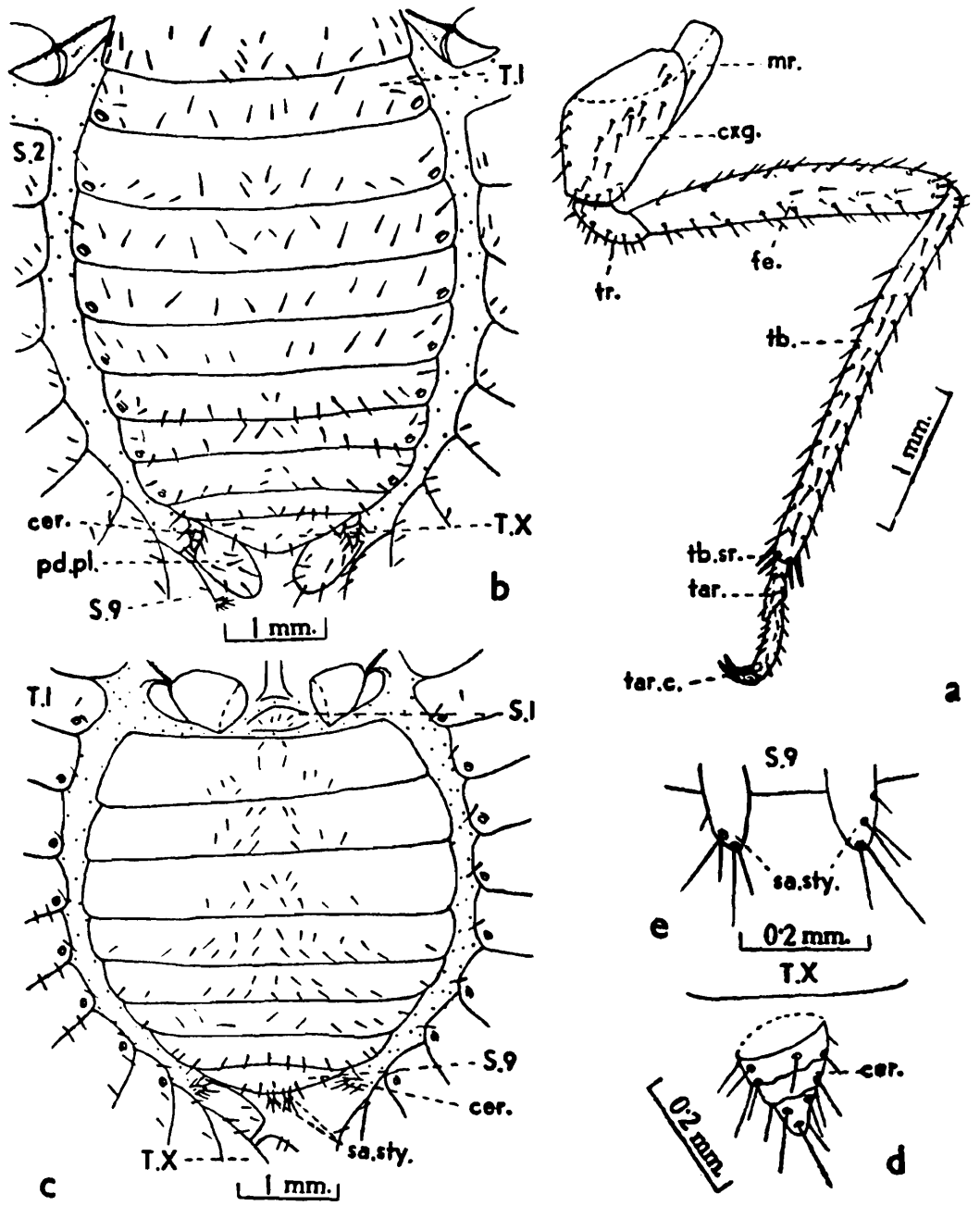
(c) *The neck*

In all essential respects, the neck resembles that of the soldier, and a detailed description is unnecessary.

(d) *The thorax and the abdomen*

(Text-figs. 11 & 12)

The thorax and the abdomen, in respect of tergites, sternites, legs, spiracles, and subanal styles, closely resemble those of the soldier. The *cerci* (Text-fig. 12*d*) here are 3-segmented, unlike those in the alate and soldier castes.



TEXT-FIG. 12.—*Anacanthotermes macrocephalus* (Desneux). Worker caste. (*a*). Left hind-leg, in ventral view. (*b*). Abdominal tergites with ventral sclerites cut medially and spread on either side, in dorsal view. (*c*). Abdominal sternites with dorsal sclerites cut medially and spread on either side, in ventral view. (*d*). Cercus. (*e*). Subanal styles.

V—SUMMARY

1. The external morphology of the alate and the worker castes of *Anacanthotermes macrocephalus* (Desneux) is described.

2. The head in both the castes is hypognathous and the mouth-parts are in the same relative position as in the soldier. The sutures are ill-defined or absent. Unlike the soldier caste, the gular suture is absent and the intraclypeal suture is present.

3. The somewhat asymmetrical mandibles are modified for crushing and chewing. In both castes the labrum is comparatively larger than in soldiers and on the under surface possesses two types of cuticular processes, *viz.*, (i) peg-like denticles arranged in two longitudinal stripes ; and (ii) spine-like aculei. The maxillae and labium differ from those of the soldier in minor details. A pair of compound eyes and a pair of rudimentary ocelli-like spots are present as in the soldier. The fontanelle is absent. The moniliform antennae have 28-29 segments in the alates and 25-30 segments in the worker caste. The tentorial bridge of the tentorium is represented by a narrow transverse bar in both the castes.

4. The neck in both the alates and workers resembles that in the soldiers.

5. The prothoracic sclerites in both the alates and workers very closely resemble those in the soldiers.

6. In the alates the meso- and metathoracic segments constitute the pterothorax. The sclerites in these two segments differ markedly from those in the soldiers and workers in both number and structure ; this is on account of the presence of the two pairs of wings and their articulation with the body. There are two pairs of epipleurites (parapteron of some authors) and three pairs of axillary sclerites. There is a small additional sclerite between the third axillary and the anal lobe of the forewing.

7. The pro-, meso-, and metathoracic sclerites in the worker caste closely resemble those of the soldier.

8. The two pairs of wings are subequal and deciduate. The venation in the fore- and hindwings is slightly variable. In the forewing, the costa is marginal, the subcosta is unbranched and closely approximated to the costa ; the "radial vein" has two stems, the radius and the radial sector, each stem being multibranched ; the median vein, arising from the second stem of the radial inside the humeral suture, has three or more branches ; the cubital vein is multibranched, with 9-12 branches. However, the forewing differs from the hindwing in having (i) a larger wing-scale, (ii) a distinct spur-like humeral plate, (iii) a larger anal lobe, (iv) a very distinct *vena dividens*, and (v) a more clearly demarcated humeral suture. It further differs from the hindwing in the absence of anal vein which in the latter anastomoses with the proximal branches of the cubitus.

9. The three pairs of thoracic legs resemble those of the soldier in both the castes.

10. The abdomen in both the castes has ten segments and a pair of setose unsegmented styles, as in the soldiers. The cerci in workers are 3-segmented, unlike those in the alates and soldiers where they are unsegmented.

11. The sexes are distinguishable externally in alates only. In alates the VII sternite is larger in females and covers the VIII sternite and partly the IX sternite. The VIII sternite is divided into two plates, lying apart. In males the VIII sternite is entire and exposed.

12. In the worker caste the number of tergites and sternites is the same as in the soldier.

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VII—ABBREVIATIONS USED IN THE TEXT-FIGURES

A., anal vein of wing.

abd., abdomen.

abd. s. 1, abd. s. 2, etc., abdominal sternites.

abd. t. 1, abd. t.2 , etc., abdominal tergites.

ac. cx. sc., accessory coxal sclerite.

acg., acrotergite.

acl., anteclypeus.

acs., antecostal suture.

a.f., anal field of wing.

a. n. p., anterior notal process of meso- and metanotum.

ant., antenna.

ant. c., antennal carinae.

ant. f., antennal foveolae.

ant. s., antennal suture.

ap. t., apical tooth of the mandible.

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.

1 ax., 2 ax., 3 ax., 4 ax., first, second third and fourth axillary sclerite of wing joint.

ax. c., axillary cord of meso- and metanotum.

b. c. cd., basal condyle of the cardo.

bcs., basicostal suture of coxa.

b. sc., basalar sclerite of wing joint.

C., costal vein of wing.

c., condyle of mandible.

cd., cardo.

cer., cercus.

cl., clypeus.

cr. a. md., cranial articulation of the mandible.

C+Sc., Costal subcostal vein.

ctm., corporotentorium.

Cu., cubital vein of wing.

Cu. 1, Cu. 2, etc., branches of the cubital vein of wing.

cv., cervix.

cv.sc. 1, first or anterior cervical sclerite.

cv.sc. 2, second or posterior cervical sclerite.

cv.sc. 3, third or dorsal cervical sclerite.

cx., coxa.

cx. c., coxal condyle.

cxg., coxa genuina.

cx. pr., coxal process.

e., eye.

epmr., epimeron.

ep. pl., epicranial plate.

ep. s., epircanial suture.

epst., episternum.

fe., femur

fl., flagellum of antenna.

f. l., foreleg.

fr., frons.

f. w., fore wing.

f. w. s, fore-wing scale.

fx. pl., flexor plate (between claws and distitarsus).

g., galea.

gl., glossa.

gm., ginglymus.

gn., genae.

hd., head.

hd. c., head-capsule.

hl. pl., humeral plate of wing joint.

h. s., humeral suture of wing joint.

h. w., hind wing.

h. w. s., hind-wing scale.

hyp., hypopharynx.

i. cl. s., intra-clypeal suture.

i. pl., incisor lobe of the mandible.

kts., katepisternum.

la., lamina of wing.

lb., labium.

lb. p., labial palp.

lb. s., labial suture.

lcn., lacinia.

lgl., ligula.

lr., labrum.

lr. ac., labral aculei.

lr. dt., labral denticles.

lr. s., labral suture.

lss., lateral sclerite of hypopharynx.

lst., latero-sternite.

lt., left.

M., median vein.

M. 1, M. 2, etc., branches of the median vein of wing.

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.

med. pl. 1, proximal median plate of wing joint.

med. pl. 2, distal median plate of wing joint.

mr., meron.

mss., mesosternum.

mst., mesonotum.

mts., metasternum.

mtt, metanotum.

mx., maxilla.

mx. p., maxillary palp.

oc., ocellus.

oct., occiput.

oct. f., occipital foramen.

o. s., ocular suture.

p., pedicel of antenna.

pcl., postclypeus.

pcx., precoxale.

pd. pl., podical plates.

pgl., paraglossa.

pgn., postgenae.

pl. r., pleural ridge.

pl. s., pleural suture

pl. aps., pleural apophysis.

pl. w. p. pleural wing process.

pmt., postmentum.

p. n. p., posterior notal wing process.

poct., postocciput.

poct. s., postoccipital suture.

prmt., prementum.

pro. sc., prosclerite.

prph., prephragma.

prs., prosternum.

prt., pronotum.

pt., posterior.

pt. t. a., posterior tentorial arm.

pt. t. p., posterior tentorial pit.

R., radius vein of wing.

r., ridge.

Rs., radial sector vein of wing.

Rs. 1, Rs. 2, etc., branches of the radial sector vein of wing.

rt., right.

S. 1, S. 2, S. 3, etc., sterna 1-10.

s., scape.

sal. sc., subalar sclerite.

sa. sty., subanal styles.

Sc., subcostal vein of wing.

scl., scutellum.

sct., scutum.

sgn. r., subgenal ridge.

sp., spine.

sp. s. 1, sp. s. 2, first and second spina-sternum.

spr., spiracle.

ss., suspensoria (sclerites associated at the base of hypopharynx).

st., stipes.

str. aps., sternal apophysis.

su. g., sutural groove of stipes.

T., tergum.

T. I, T II, .T. X, terga first, second, and so on up to tenth.

tar., tarsus.

tar. c., tarsal claw.

tb., tibia.

t. b., tentorial bridge.

tb. sr., tibial spur.

t. f., tentorial foramen.

tg., tegula.

th., thorax.

tm., torma.

tn., trochantin of leg.

tr., trochanter.

v. d., vena dividens.

w. s., wing scale.

MGIPC—M—1 ZSI/60—28-12-62—500.