EXTERNAL MORPHOLOGY OF THE TERMITE, *ODONTOTERMES OBESUS* (RAMBUR) (ISOPTERA : TERMITIDAE). PART 1. SOLDIER

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(With 2 Tables and 5 Text-figures)

CONTENTS

I—INTRODUCTION

The detailed morphology of none of the Indian species of termites, with the exception of the primitive species, *Archotermopsis wroughtone* (Imms, 1919), has been worked out. Some work on *Odontotermes redemanni* has been done by Mukerji and co-workers (1940-49), but they studied only a few special organs, such as the exudate organs, the anatomy of the alimentary system, etc. Holmgren (1909) in his systematic works has touched upon briefly on some aspects of the morphology of some oriental termites, but not *Odontotermes obesus* (Rambur). Some work on the ecology of this species has been done presently by Gupta (1953*a*, *b*) and by Roonwal & Gupta (1952).

To fill this gap in our knowledge, the morphology of one of the higher oriental termites, namely, *Odontotermes* (*Odontotermes*) *obesus* (Rambur)

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(Isoptera, family Termitidae) was taken up for study. In Part 1, the morphology of the soldier caste is presented; that of the workers and alates will follow in the subsequent parts.

Acknowledgments.—My sincere thanks are due to Dr. M. L. Roonwal, Chief Research Officer (Forest Entomologist), Forest Research Institute, Dehra Dun, for his care and guidance during the progress of the work. I am also thankful to the Principal, S. K. N. Agricultural Institute, Jobner, for kindly permitting me to carry on this work and to Shri Balwant Singh, Research Assistant (I), Dehra Dun, and my colleague Shri B. K. Kaul for kind suggestions.

II—MATERIAL AND METHODS

The material for study of the soldiers of *Odontotermes obesus* was collected around Dehra Dun (U. P.), *ca.* 2,000 ft. above sea-level, from earthen mounds which this species builds. Specimens were dissected and permanent mounts made on slides.

III—HEAD

(a) *General*

The general colour of the head is shining pale cadmium yellow. The postclypeus is pale yellowish brown and the anteclypeus yellowish white; the labrum is pale brown ochre, darker in the middle than at the borders. The proximal one-third of the mandibles is darker than the labrum; distally it deepens to dark tan and finally becomes shining black at the distal tips. The maxillary palpi are pale clay-yellow, becoming yellowish white at the joints. The antennae are pale clay-yellow basally, gradually changing to pale brown, van Dyke brown and Roman sepia distally; the areas between the joints are paler.

The head (Text-figs. 1*d-f*) is of the prognathous type, *i.e.*, with its long axis horizontal, though slightly inclined ventrally, and with the mouth-parts directed forwards. It is oval, heavily chitinised and sparsely haired, and has its facial area turned upwards. It is bilaterally symmetrical except for the mandibles.

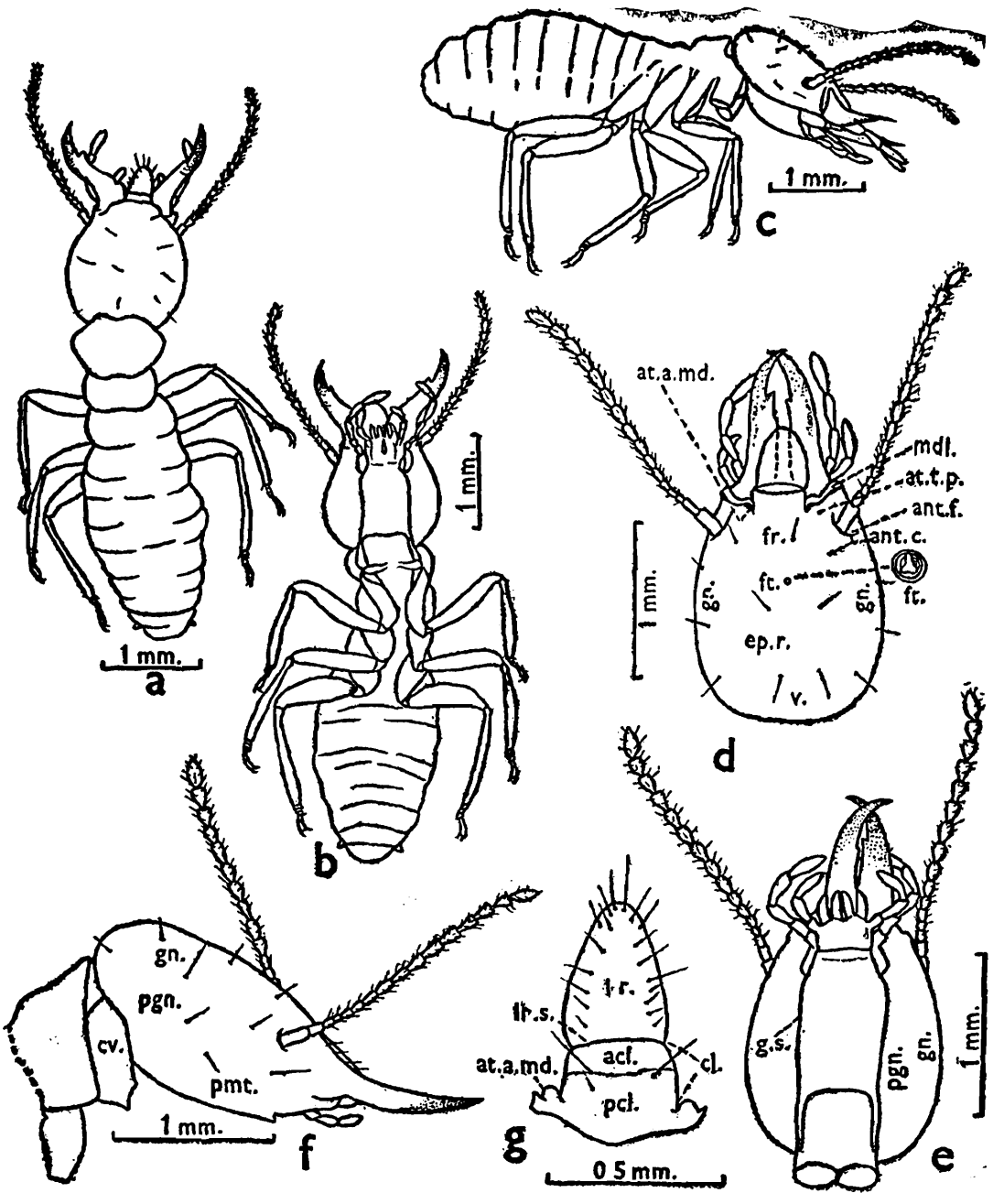
The cranium or the main head-capsule is dorso-ventrally flattened, with its sub-parallel lateral margins rounding into broadly rounded postero-lateral angles. The posterior margin is slightly overlapped by the sellate (saddle-shaped) pronotum. The cranium is supported internally by the tentorium (*vide infra*).

The mouth-parts are of the orthopteroid or mandibulate type and are directed forwards. The labrum overlies the rest of the gnathal appendages which consist of the paired mandibles and maxillae, and an elongate, median labium; the last named, together with the post-genae on either side, form the floor of the cranium. The hypopharynx is located on the prementum; the epipharynx is absent.

The compound eyes and ocelli, which are usually well developed in the more primitive termites, are absent here. The antennae take thier origin within the antennal foveolae on the dorsal aspect of the cranium just above the base of the mandibles.

(b) *Sutures of the cranium*

The principal sutures of the cranium are the following :—(i) The labral suture dorsally ; and (ii) the gular, (iii) the postoccipital, and (iv) the labial suture ventrally. They are described below in detail.



TEXT-FIG. 1.—*Odontotermes obesus* (Rambur), soldier caste.

(*a*). Whole body, in dorsal view. (*b*). Whole body, in ventral view. (*c*). Whole body, in lateral view. (*d*). Head of soldier, in dorsal view. (Fontanelle (*ft.*) magnified separately). (*e*). Head of soldier, in ventral view. (*f*). Head of soldier, in lateral view. (*g*). Dorsal view of labrum and clypeus.

acl., anteclypeus ; *ant. c.*, antennal carina ; *ant. f.*, antennal foveola ; *at. a. md.*, anterior articulation of mandible ; *at. t. p.*, anterior tentorial pit ; *cl.*, clypeus ; *cv.*, cervix ; *ep. r.*, epicranial region ; *fr.*, frons ; *ft.*, fontanelle ; *gn.*, gena; *g.s.*, gular suture ; *lr.*, labrum ; *lr. s.*, labral suture ; *mdl.*, mandibularia ; *pcl.*, postclypeus ; *pgn.* postgenae ; *pmt.*, postmentum ; *v.*, vertex.

The *labral suture* (Text-fig. 1*g*, *lr.s.*) is a transverse suture which separates the anteclypeus from the labrum. It provides mobility to the labrum in the vertical plane. There is no distinct clypeal suture but a transverse line divides the clypeus transversely into a distal hyaline

anteclypeus (Text-fig. 1*g*, *acl.*) and a proximal sclerotized postclypeus (*pcl.*).

The epistomal suture (of Snodgrass, 1935) (or clypeo-frontal suture of Fuller, 1915; and Light, 1921), of other termites, which separates the frons from the clypeus is also suppressed here. Similarly, the frontal suture of Snodgrass, 1935 (or transverse suture of Light, 1921), which in other termites forms the arms of the inverted Y-suture separating the epicranium from the frons, is also not present here. In *Archotermopsis* (Imms, 1919) a V-shaped suture separates the epicranial plates from the frons. According to Imms (1948, p. 266) in termites "the median and V-shaped epicranial sutures are frequently evident although extremely variable in their degree of development" The coronal or metopic suture (of Snodgrass, 1935; frontal suture of Light, 1921; the stem of Y-suture of some authors), which divides the epicranium medially and longitudinally into two equal halves, is also suppressed here. Light (1921) has stated that the frontal, transverse and clypeo-frontal sutures are absent or imperfect in most termite soldiers, while the clypeal suture is absent in some forms.

Ventrally, the *gular sutures* (Text-fig. 2, *g.s.*) run longitudinally, separating the lengthened proximal plate of the labium (called post-mentum) from the postgenae. It is formed by the forwardly extended ventral or anterior ends of the postoccipital suture.

The *postoccipital suture* (Text-fig. 2, *poct.s.*) lies ventro-posteriorly on the cranium surrounding the occipital foramen posteriorly and laterally. It runs more or less parallel to the margins of the occipital foramen.

The *labial suture* (Text-fig. 3*c*, *lb.s.*) is a transverse suture separating the prementum from the postmentum.

(c) *Areas of the cranium*

Since the coronal, frontal and epistomal sutures are suppressed the limits of the principal cranial areas have become obscured. For the sake of clarity, the areas are, however, discussed as such and denoted in the figures to mark their positions. The principal areas are the following:—(i) *Dorsal*: the vertex, epicranial region, frons, clypeus, genae, and the trochantin of mandible or mandibularia. (ii) *Ventral*: the occiput, postocciput, postgenae and the postmentum. The post-mentum will be discussed under head-appendages, since it forms a part of the labium; the other cranial areas are described below.

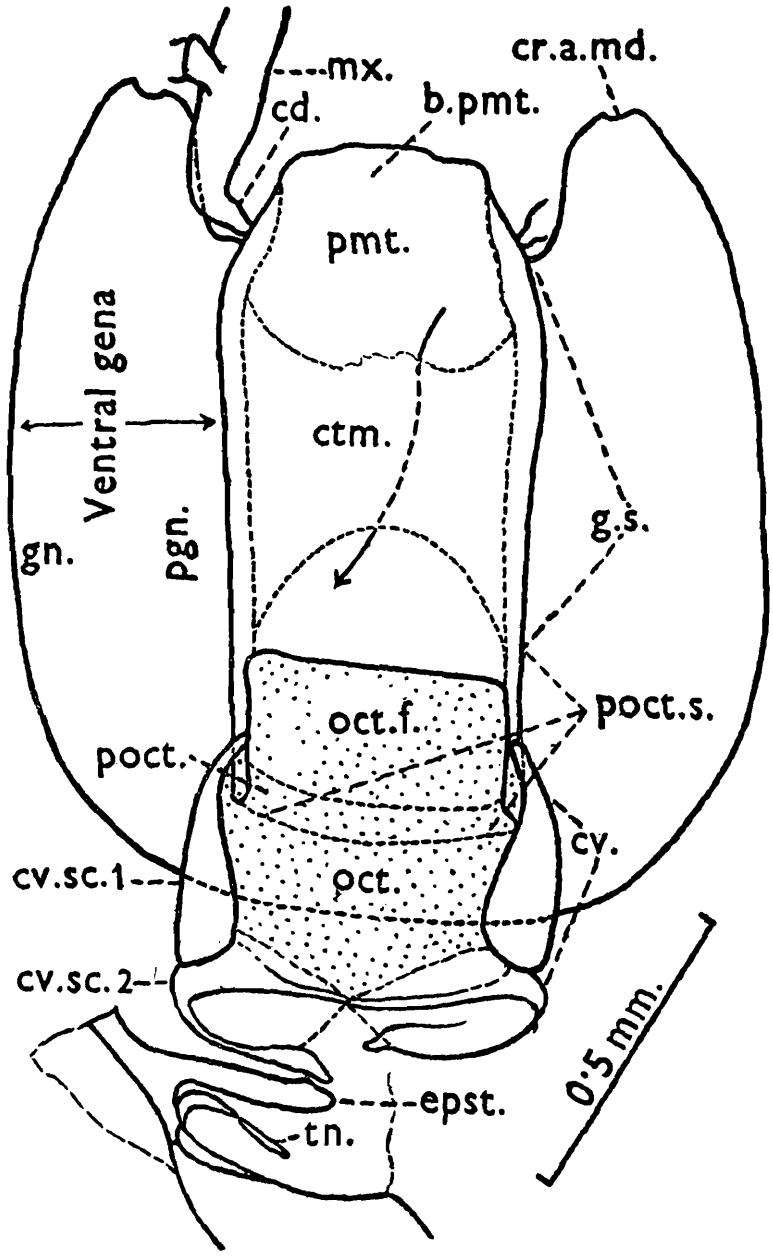
The *vertex* (Text-fig. 1*d*, *v.*) appears as a somewhat flatly arched surface and forms the posteriormost part of the epicranial region.

The *epicranial region* (Text-fig. 1*d*, *epr.*) forms the dorso-posterior part of the cranium, occupying nearly the entire proximal half of the head above the frons. It corresponds to the "vertex" of Fuller (1915). As already stated, the inverted Y-shaped epicranial suture dividing it into two epicranial plates and separating it from the frons is absent.

The *frons* (Text-fig. 1*d*, *fr.*) (or "Transversalband" of Holmgren, 1909) lies anterior to and adjoining the epicranial region. The frontal sutures bounding it posteriorly and the epistomal suture bounding it

anteriorly in the primitive termites are not found here. According to Light (1921), it is " not at all or imperfectly defined in most soldiers "

A minute, more or less Y-shaped gland-orifice of the cranium, called *fontanelle* (Text-fig. 1*d*, *ft.*), is clearly visible under a high magnification. It is located medially, approximately at the point where the frons and the epicranial region are supposed to meet, and is surrounded by a



TEXT-FIG. 2.—*Odontotermes obesus* (Rambur), soldier caste.

Ventral view of cranium (minus the head-appendages) with the cervix, etc., showing various cranial areas and sutures.

b. pmt., blade of postmentum ; *cd.*, cardo ; *cr. a. md.*, cranial articulation of mandible ; *ctm.*, corporotentorium ; *cv.*, cervix ; *cv. sc. 1*, cervical sclerite 1 ; *cv.sc.2*, cervical sclerite 2 ; *epst.*, episternum ; *gn.*, gena ; *g.s.*, gular suture ; *mx.*, maxilla ; *oct.f.*, occipital foramen ; *oct.*, occiput ; *pgn.*, postgena ; *pmt.*, postmentum ; *poct.*, post-occiput ; *poct.s.*, postoccipital suture ; *tn.*, trochantin of leg.

deeply staining circular band. According to Fuller (1915), it is present in soldiers of certain termites where the Y-suture is obsolete. The fontanelle is present in most of the genera except *Archotermopsis*, *Hodotermes* (*Anacanthotermes*), *Kalotermes*, *Neotermes*, *Glyptotermes* and *Cryptotermes* (*vide* Snyder, 1934).

The *clypeus* (Text-fig. 1*g*, *cl.*) is a transverse sclerite lying anteriorly to the frons. There is no sutural demarcation within it, but a distinct transverse line divides it into a pale, hyaline, membranous *anteclypeus* (*acl.*) and a dark sclerotized *postclypeus* (*pcl.*) which usually bears two prominent bristles, one at each disto-lateral angle. At the outer basal angles of the postclypeus there lies, on either side, a small condyle produced forward; this is the *anterior articulation of mandible* (Text-fig. *1g*, *at.a.md.*). The fusion of the *anterior tentorial arms* (*at.t.a.*) with the cranial wall commences dorsally, close to the point of the anterior articulation of the mandible, and is visible as a dark spot on each side. It is faintly depressed and marks the position of the *anterior tentorial pits* (Text-fig. 1*d*, *at.t.p.*). The anteclypeus sometimes gets partially folded below the postclypeus.

In most termite soldiers where both the frontal and the epistomal sutures are obscured, the region of the frons and the clypeus is together designated as the *frontal area* (Fuller, 1915). According to that author, the term "frons" should be used only in those cases where the Y-suture is demarcated either fully or partially.

The lateral areas of the cranium from the anterior cranial margin or cephalic extremity to and including the vertex are called the *genae* (Text-figs. 1*d-f*, *gn.*), on which are located the *antennal foveolae* together with the prominent *antennal carinae*. Since there is no sutural demarcation, the genae become confluent with the epicranial region on either side. On either side between the basal margin of mandible and the anterior margin of the genae there is a transverse narrow but distinct area dorsally; this is the *mandibularia* (Text-fig. 1*d*, *mdl.*) (or *trochantin of mandible* of Fuller, 1915).

The *occiput* (Text-fig. 2, *oct.*) is an area on the ventral surface (although some authors regard it as situated on the top of the head in other insects). It becomes confluent with the ventral genae (*vide infra*) anteriorly on either sides of the occipital foramen. Fuller (1915) regards it as "forming the convex caudal extremity of the head"

The *postocciput* (Text-fig. 2, *poct.*) is a narrow rim separated from the occiput by the postoccipital suture to which it runs parallel; it is attached to the cervical or neck membrane. The elongated anterior cervical sclerites are articulated on this region postero-laterally.

The ventral regions on either side of the gula or postmentum are called the *ventral genae* (Text-fig. 2) (*vide* Fuller, 1915). They are composed partly of the genae continued from the dorsal side and the whole of the postgenae (Text-fig. 2, *pgn.*) which lie adjacent to the gula and separated from the latter by the gular sutures on both sides. There is on suture separating the genae from the postgenae. In certain species, specially in the genus *Hodotermes*, the postgenae are well demarcated from the genae, but in most other species the suture is either lost or only slightly indicated (Fuller, 1915).

(d) *Tentorium*

The tentorium (Text-fig. 3*i*) is a stout, endoskeletal, chitinous framework giving rigidity to the cranium and strength to the anterior articulations of the mandibles (*at.a.md.*). It also supports the brain and provides attachment for certain cephalic muscles.

The tentorium is composed of a corporotentorium or tentorial body and two pairs of tentorial arms, the anterior and the posterior arms. A pair of dorsal arms (extension of anterior arms) as is found in the cockroach *Periplaneta orientalis* (Orthoptera, Blattidae) and other insects, is absent in *O. obesus*.

The *corporotentorium* (*ctm.*) is a broad median structure. Medially at its anterior border, is present a conspicuous broad *tentorial foramen* (*t.f.*). The anterior margins of the corporotentorium on either side of the foramen are deeply incurved. Posteriorly its margin is considerably incurved, being much pushed in as compared to the posterior margin of the postmentum (Text-fig. 2). The two antero-lateral angles of the corporotentorium are produced forwards and fuse at the points where the cardines of the first maxillae articulate. Similarly, the postero-lateral angles are produced posteriorly, overlying the postero-lateral angles of the postmentum, and become confluent with the post-occipital region at the lateral margins of the occipital foramen.

The *tentorial arms* are the cuticular invaginations of the cranium, uniting internally at the anterior and posterior regions of the tentorial body.

The stout *anterior tentorial arms* (*at.t.a.*) form the most powerful chitinous portions of the tentorium, and are slightly twisted on themselves in order to provide more rigidity. They arise from the faintly demarcated anterior tentorial pits close to the points of the anterior articulation of mandibles. The two arms are inclined at an acute angle with each other and are bound together transversely by means of a *broad strip* (*b.s.*) which forms the anterior border of the tentorial foramen. The arms are further fused with the tentorial body at the lateral margins of the tentorial foramen.

The *posterior tentorial arms* (*p.t.a.*) and the *posterior tentorial pits* (*p.t.p.*) are of considerable interest. We note that the lengthened head is equipped with an endoskeleton rightly suited to provide due rigidity to it. Thus, the posterior tentorial arms are much lengthened. They take their origin from the posterior tentorial pits which are greatly lengthened grooves (gular sutures) extending throughout the lateral margins of the postmentum. Consequently, the edges of the posterior tentorial arms are fused laterally with the margins of the postmentum. They have attained excessive development and, together with the tentorial body, go to compose a slightly arched *tentorial bridge*. The latter forms a roof over the postmentum. The chitinous tunnel is thus formed by the tentorial bridge above and the postmentum below.

(e) *Head-appendages*

The head-appendages consist of the medially placed labrum, hypopharynx and labium, and the paired antennae, mandibles and maxillae.

The *labrum* (Text-fig. 1*g*, *lr.*) is a flat preoral sclerite movably attached to the anteclypeus from which it is separated by the labral or clypeo-labral suture. The latter provides mobility to the labrum in a vertical plane, and the labrum thus functions as one of the gnathal appendages. It overlies the basal portion of the mandibles.

The labral setae show an interesting, more or less bilaterally symmetrical arrangement. This arrangement is sometimes varied due to the absence of the corresponding setae on one side or the other or both. Usually there are 9-12 setae on either side.

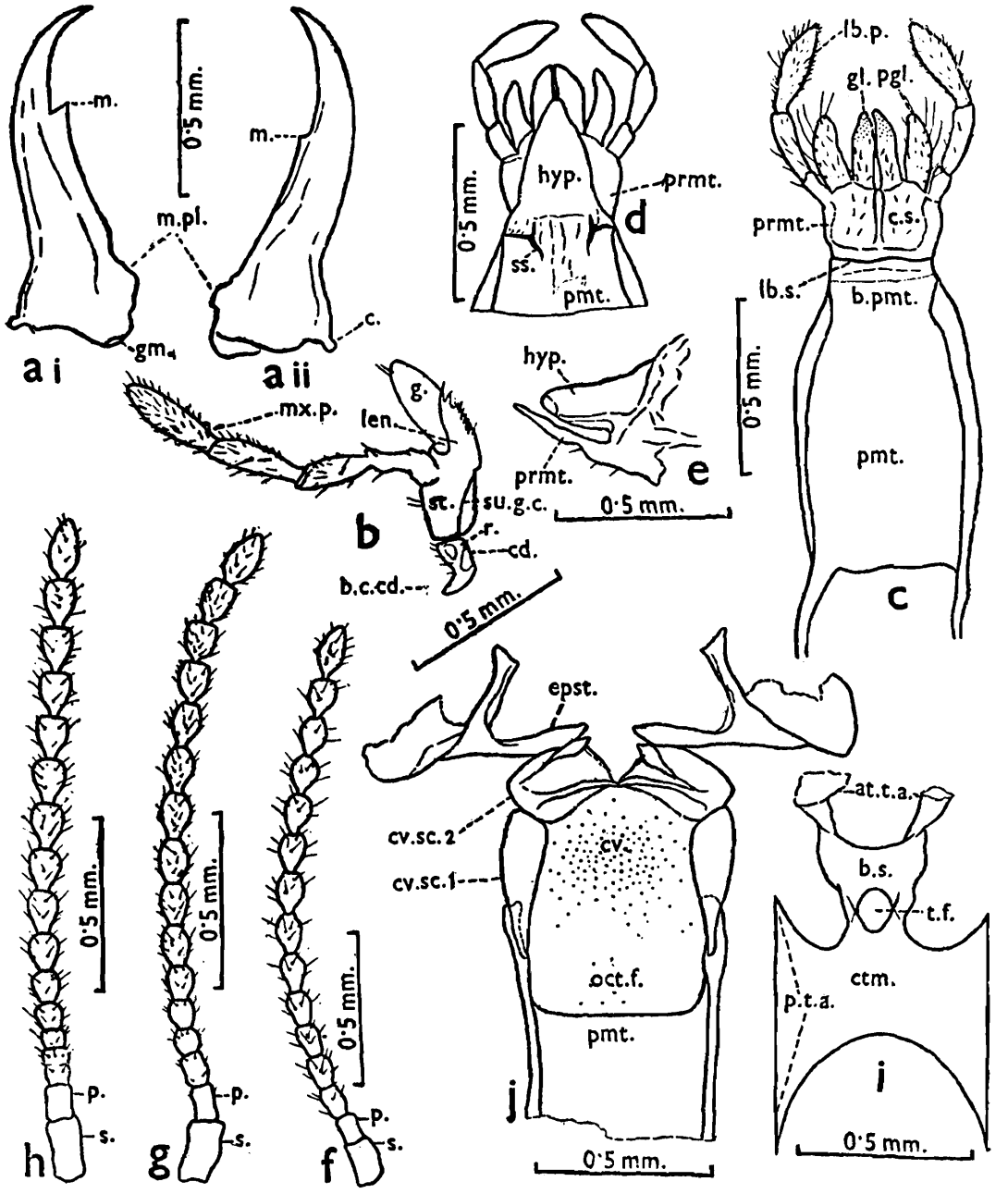
The *hypopharynx* (Text-figs. 3*d*, *e*, *hyp.*) is located in the intergnathal space or preoral cavity, with its aboral wall reflected into the adoral wall of the labium at the base of the prementum. It consists only of the *lingua* which, according to Snodgrass (1935), forms in the more generalised insects the median part of the hypopharynx where superlinguae are present as its lateral lobes. In dorsal view the hypopharynx appears more or less cone-shaped, while in lateral view its dorsal margin is more slanting than the ventral. Medially it appears to be traversed by a fine canal which may be the salivary duct, but this point is not quite clear. The adoral area of the hypopharynx at its base is flanked on each side by a sclerite, constituting the *suspensoria* (*ss.*) of the hypopharynx.

The *labium* (Text-fig. 3*c*, *lb.*) is composed of two primary regions, *viz.*, a proximal rigid postmentum (also called gula, Snodgrass, 1935) and a movable prementum; separating the two is the labial suture. The prementum carries additional movable terminal lobes, namely, the labial palpi laterally and the ligula (consisting of the glossae and the paraglossae) distally.

The *postmentum* (*pmt.*) is a somewhat longitudinally concave, much elongated and subquadrangular sclerite lying between the long postgenal regions of the cranium. It forms the mid-ventral floor of the head with its basal margin deeply invaginated or concave and lying transversely in front of the *occipital foramen* (Text-fig. 2, *oct.f.*). The postero-lateral arms extend much posteriorly along the margin of the occipital foramen, thus circumscribing it antero-laterally. The lateral margins are parallel to each other but converge anteriorly as they separate from the postgenae. The resulting narrow distal region has been called the *blade of postmentum* (*b.pmt.*) by Fuller (1915). *Odontotermes obesus* resembles *Archotermopsis* (Imms, 1919) in having no separate gula as is the case in other insects. The postoccipital suture, as is present in *Termopsis* (Snodgrass, 1935), is very marked in the present species.

The *prementum* (*prmt.*) is a transverse structure divided by a median longitudinal fold into two halves, each having a sub-rectangular *chitinised sclerite* (*cs.*) embedded in its hyaline membrane. Laterally this hyaline membrane is folded dorsally and its margins are chitinized, leaving a

gap in between over which lies the hypopharynx. The palpigers are indistinct. Each lateral half bears distally the inner hyaline *glossae* (*gl.*) bearing microscopic hairs and the outer *paraglossae* (*pgl.*) having, in addition, long hairs. They are similar in size, bluntly pointed and



TEXT-FIG. 3.—*Odontotermes obesus* (Rambur), soldier caste.

(*a* i, *a* ii). Left and right mandibles respectively. (*b*). Maxilla. (*c*). Labium, in dorsal view. (*d*). Hypopharynx, in dorsal view, showing its attachment with the labium. (*e*). Hypopharynx, in lateral view, showing its attachment with the prementum. (*f*, *g*, *h*). Right antennae with 15, 16 and 17 segments respectively. (*i*). Tentorium. (*j*). Cervix, showing its attachment with the postmentum and the prothoracic episternum.

at.t.a., anterior tentorial arm; *b.c.cd.*, basal condyle of cardo; *b.s.*, broad strip; c., condyle; *cd.*, cardo; *ctm.*, corporotentorium; *cv.*, cervix; *cv.sc.1*, cervical sclerite 1; *cv. sc.2*, cervical sclerite 2; *epst.*, episternum; *g.*, galea; *gm.*, ginglymus; *hyp.*, hypopharynx; *lcn.* lacinia; *m.*, marginal tooth of mandible; *m.pl.*, molar plate of mandible; *mx. p.*, maxillary palp; *occ. f.*, occipital foramen; *p.*, pedicel; *pmt.*, postmentum; *prmt.*, prementum; *p.t.a.*, posterior tentorial arm; *r.*, ridge; *s.*, scape; *ss.*, suspensorium; *st.*, stipes; *su.g.*, sutural groove; *t.f.*, tentorial foramen.

separated from the prementum by distinct transverse sutures and are collectively called the *ligula*.

The segments of the 3-segmented *labial palpi* (*lb.p.*) vary in length from the basal segment onward in the following proportion: 1 : 2 : 2. The ultimate segment is the thickest and is densely haired and bluntly pointed.

The *antennae* (Text-fig. 3*f-h*, *ant.*) are moniliform and located dorso-laterally on the head at the anterior end of the genae above the trochantin of the mandibles. They are about $1\frac{1}{2}$ times as long as the width of the head, and arise from a shallow trough called the *antennal foveolae* (*ant.f.*) or *antennal fossae*. The rim of each foveola is strengthened by a prominent ridge, the *antennal carina* (*ant.c.*).

Table 1.—*Variation in the number of antennal segments in* Odontotermes obesus (*Rambur*), *soldier caste, collected from different mounds near Dehra Dun, during July 1954.*

Locality and date of collection	Total No.	Number of individuals (Also %)					
		Number of segments in left antenna			Number of segments in right antenna		
		15	16	17	15	16	17
1. Near Chemistry Department, New Forest, Dehra Dun. 18. vii. 1954.	100	0	58	42	0	58	42
2. Compartment 13, near Dy. Ranger's Quarter, New Forest, Dehra Dun. 18. vii. 1954.	100	1	58	41	1	60	39
3. On boundary between Demonstration Area and Power House, New Forest, Dehra Dun. 18. vii. 1954.	100	0	67	33	0	64	36
4. Compartment 17, Demonstration Area, New Forest, Dehra Dun. 18. vii. 54.	100	3	75	22	0	81	19
5. Jhajra Forest, Malhan Range, Kolhuwara, Jhore-ki-ghati. 27. vii. 1954.	100	0	5	95	0	6	94
6. Jhajra Forest, near Dak Bungalow. 27. vii. 1954.	100	0	44	56	0	43	57

The number of antennal segments (Table 1) varies from 15 (rarely) to a maximum of 17, the number frequently varying in the same individual. The extra segment in the 17-segmented individuals arises by a division of the segment III (from the base) into two (when derived from the 16-segmented forms) or by a division of both segments III and IV (when derived from the 15-segmented forms). These segments, when involved in division, attain a length equal to that of the scape. The *scape* (*s.*) is the largest segment, is double the length of the pedicel

TABLE 2.—*Proportions of symmetrical and asymmetrical individuals as regards the number of antennal segments in* Odontotermes obesus (*Rambur*), *soldier caste.*

Locality and date of collection	Total No.	% of individuals showing symmetry.				% of individuals showing asymmetry.				
		15-segmented.	16-segmented.	17-segmented.	Total No.	No. of individuals having more segments in *left* antenna, *i.e.*, 17.	No. of individuals having more segments in *right* antenna, *i.e.*, 17.	No. of individuals having more segments in *right* antenna, *i.e.*, 16.	Total No.	Difference in number of segments in asymmetrical individuals.
1. Near Chemistry Department, New Forest, Dehra Dun. 18. vii. 1954.	100	0	43	27	70	15	15	0	30	1
2. Compartment 13, near Dy. Ranger's Quarter, New Forest, Dehra Dun. 18. vii. 1954.	100	1	49	30	80	11	9	0	20	1
3. On boundary between Demonstration Area and Power House, New Forest, Dehra Dun. 18. vii. 1954.	100	0	56	25	81	8	11	0	19	1
Compartment 17, Demonstration Area, New Forest, Dehra Dun. 13. vii. 1954.	100	0	66	10	76	12	9	3	24	1
5. Jhajra Forest, Malhan Range, Kolhuwara, Jhore-ki-ghati. 27. vii. 1954.	100	0	0	89	89	6	5	0	11	1
6. Jhajra Forest, near Dak Bungalow. 27. vii. 1954.	100	0	34	47	81	9	10	0	19	1

and has no bristles. The *pedicel* (*p.*) has very few bristles present distally. Each segment of the flagellum has a whorl of subequal bristles and is somewhat flask-shaped, except for the apical segment which is globular, bluntly pointed and measures about as long as the scape.

A careful count was made of the number of antennal segments of about 600 individuals collected at New Forest and Jhajra Forest near Dehra Dun (Table 1). Six samples of 100 individuals each were taken, each sample being from a separate mound, *i.e.*, from a separate colony. In four samples of 100 individuals each from the New Forest area, the percentage of 16-segmented individuals varied from 58 to 81 (there being little difference between the right and left antennae); the remainder were mostly 17-segmented (19-42 per cent.) and 15-segmented (1-3 per cent.). In the two samples from the Jhajra Forest, this condition was more or less reversed, in favour of the 17-segmented forms (56-95 per cent.), the remainder being 16-segmented. Bilateral symmetry (Table 2) in the right and left antennae is more frequent (76-89 per cent.) than asymmetry (11-30 per cent.). In the asymmetrical individuals, the difference in the number of segments in the right and left antennae of an individual is always one.

The *mandibles* (Text-fig. 3*ai*, *aii*, *md.*) are partly concealed proximally by the labrum on the dorsal side and the labium on the ventral. Dorsally, their basal margins bound the trochantin of the mandible at its anterior margin on either side. In 50 specimens examined with their mandibles closed, 48 had the left mandible overlying the right; in the remaining 2 the reverse condition occurred.

Each mandible is articulated with the cranium antero-laterally, moving inwards and outwards in a transverse plane, and crossing each other at their distal ends. They have thus the transverse movements of abduction and adduction. Each is hinged by means of a *condyle* (*c.*) and a *ginglymus* (*gm.*). The condyle is a rounded head at the base of the mandible in the ventro-lateral position and fits into a socket called the *cranial articulation of mandible* (Text-fig. 2, *cr.a.md.*) at the distal end of the gena or postgena. The ginglymus, on the other hand, is a cup-shaped cavity at the base of each mandible and articulates with a convex process termed the *anterior articulation of mandible* (Text-fig. 1*d*, *at.a.md.*) located at the posterior outer angles of the postclypeus.

Each mandible measures about 0·93-1·02 (mostly *ca.* 0·99) mm. long. The two mandibles are asymmetrical, flattened and upturned apically; they are thickened basally and incurved like the legs of a pair of callipers. The left one (Text-fig. 3*ai*) is armed with a prominent, cone-shaped and bluntly pointed marginal tooth (*m.*) on the edge, at one-third the length of the mandible from apex. The tooth is feebly developed in the right one (Text-fig. 3*aii*). The basal margins are uneven, forming the *molar plate of mandible* or *pars molaris* (*m.pl.*) for mastication.

The *maxillae* (Text-fig. 3*b*, *mx.*) are well developed and composed proximally of a cardo, and distally of a stipes carrying the large inner and outer terminal lobes at its distal end. They lie on the ventral surface of the craninm below the mandibles, and thus partly forming

together with the labium, the floor of the oral cavity. They are articulated laterally at the narrow distal end of the postmentum or blade of gula where the gular sutures end in the angle where the postgenae become free from the postmentum. They are also articulated to the cranium by means of the basal condyle which forms the proximal end of the cardo.

The *cardo* (*cd.*) is broad distally and narrow proximally, and ends in an outwardly projected, nose-like *basal condyle* (*b.c.cd.*) bent at an obtuse angle. A few minute hairs are borne by it laterally. Internally it is supported by a network of prominent *ridges* (*r.*). It is a considerably shorter and narrower sclerite than the stipes and is movably hinged on the latter.

The *stipes* (*st.*) is an elongated sclerite, broad distally with a *sutural groove* (*su.g.*) on the inner margin, which forms internally a submarginal ridge for the attachment of muscles. The sclerite inner to this groove is *parastipes* or *subgalea*. Distally it bears the inner lacinia, the outer galea, and a 5-segmented maxillary palp laterally, below which there is a pair of conspicuous bristles.

The *lacinia* (*lcn.*) is chitinous, apically bi-dentate and partially overlying the galea; its inner margin is fringed with thick bristles. The *galea* (*g.*) is a soft leaf-like, hyaline structure with a pair of conspicuous hairs apically on the outer margin.

The segments of the 5-segmented *maxillary palpi* (*mx.p.*) are mutually related in length in the following proportion, starting from the basal or first segment: 5 : 6 : 13 : 14 : 16. The basal segment is the thickest and without bristles, while the remaining ones possess bristles.

IV—CERVIX

(Text-figs. 1*f*, 2, and 3*j*, *cv.*)

The cervix or neck is a narrow region concealed by the overlapping saddle-shaped pronotum (Text-fig. 1*f*, *cv.*). It consists of a flexible and transparent membrane supported by two pairs (anterior and posterior) of lateral *cervical sclerites* or plates hinged on to each other. The sclerites of the anterior pair (*cv.sc.1*) are elongated and have a forwardly tapering process articulating movably with the postero-lateral arms of the postmentum at the lateral margins of the occipital foramen. They thus form the fulcral points for the movements of the head. The sclerites of the posterior pair (*cv. sc. 2*), on the other hand, are hollowed internally and convex ventrally, and articulate with those of the preceding pair at their anterior border, while their posterior border articulates with the prothoracic episternum of their respective sides. The feebly developed dorsal and ventral cervical sclerites noticed by Imms (1919) in *Archotermopsis wroughtoni* are not found in *Odontotermes obesus*.

V—THORAX

(Text-figs. 4*a*, *c*, and 5*a*)

(a) *The Main Body*

The thorax is composed of three segments, the pro-, meso- and metathorax from before backwards. The dorsal *tergites* are well developed

and strongly chitinised, while the ventral *sternites* are feebly developed. The *pronotum* (*prt.*) or the prothoracic tergum is the most conspicuous and strongly chitinised of the three terga. It is sellate (saddle-shaped), nearly as broad as long, and bears prominent setae at its anterior and posterior margins. Its anterior rim, which is slightly raised, overlaps the cranium a little, while its antero-lateral margins are drawn somewhat downward. The pronotum thus presents a slightly hood-like lobe with the dorsal surface slightly arched.

The *mesonotum* (*mst.*) and *metanotum* (*mtt.*) are subequal and, unlike the pronotum, do not form prominent shields; they are a little wider than long and bear setae on their posterior halves.

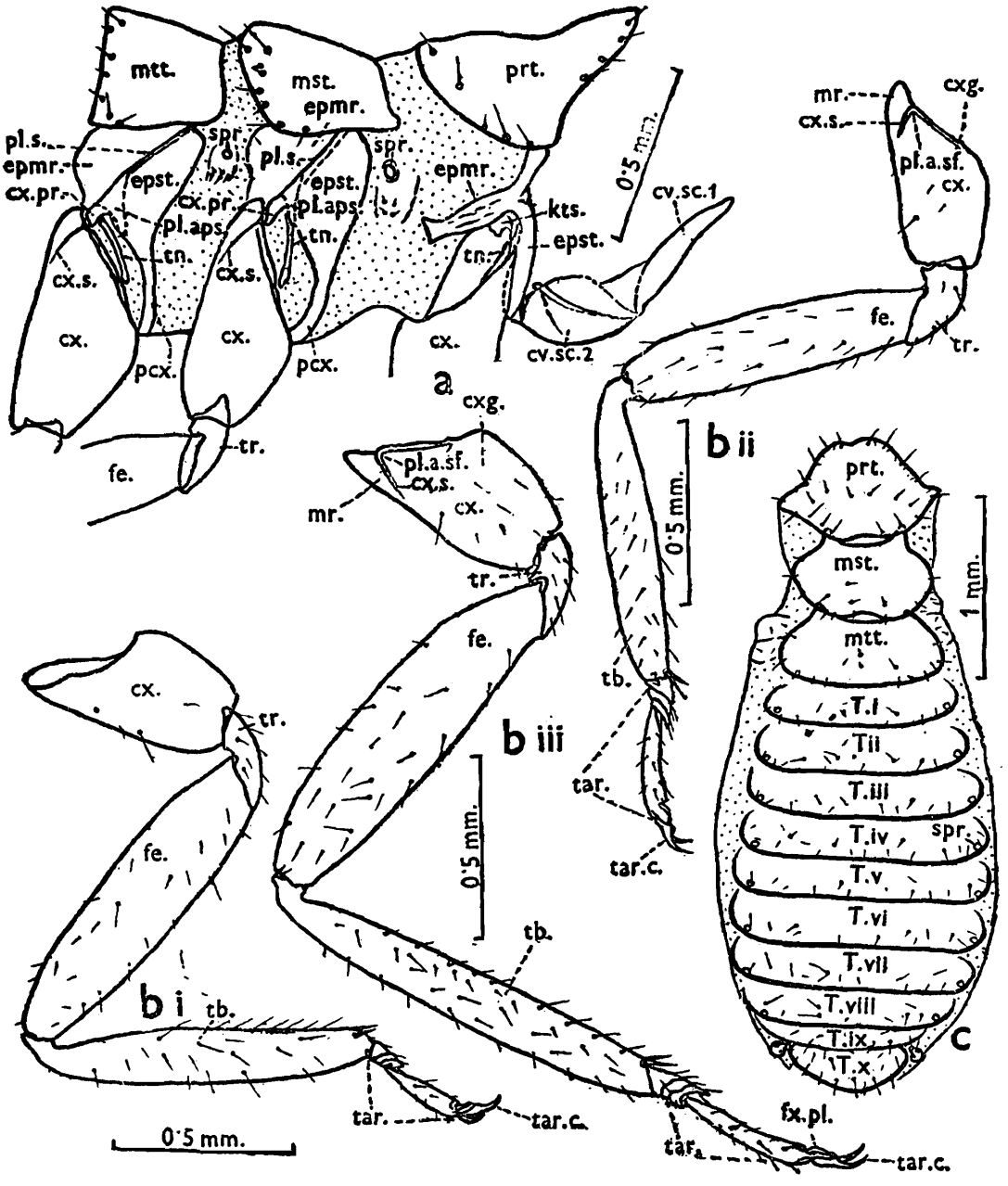
There are two pairs of laterally situated thoracic *spiracles* (*spr.*) in the pleural region, a pair each on the meso- and metathorax. The mesothoracic spiracles are more conspicuous, slightly displaced anteriorly, and lie near the posterior margin of the prothorax. The metathoracic spiracles similarly lie near the posterior margin of the mesothorax.

The *pleura* of the meso- and metathorax resemble each other but differ markedly from that of the prothorax. Each pleuron of the meso- and metathorax is divided by the *pleural suture* (*pl.s.*) into two oblique, subtriangular sclerites lying above the coxa and forming the presutural *episternum* (*epst.*), and the postsutural *epimeron* (*epmr.*). In addition, there is a slender sclerite, the *trochantin* (*tn.*), pointing ventrally and articulating with its ventral extremity at the anterior margin of the coxa. Anterior to the trochantin the episternum extends ventrally to merge with the sternum and is here known as the *precoxal bridge* or *precoxale* (*pcx.*). A similar extension of the epimeron, forming the *postcoxal bridge* or *postcoxale*, is indistinct in the soldier. The pleural suture arises from the *coxal process* or *coxal articulation* (*cx.p.*) of the pleuron and runs upwards obliquely to form an anterior proclivity. The suture is formed by a shallow invagination of the pleuron and forms internally a ridge, the *internal pleural ridge*, which provides strength to the pleuron. From this ridge arises an apodemal arm, called the *pleural apophysis* (*pl. aps.*), projecting downwards and inwards. The corresponding sternal apophysis, which is usually associated with it in other insects, is not distinctly marked here.

The pleuron of the prothorax has, in addition to the episternum and the epimeron, a reduced and curved arm-like process which articulates with the trochantin and is closely associated with the episternum. It has been called *katepisternum* (*kts.*) by Fuller (1924) in winged termites. The prothoracic episternum differs markedly from that of the succeeding segments in being an elongated, stout, highly chitinised and rod-like structure hanging downwards from the pronotum. It thus forms a sort of rigid collar-band providing attachment to the cervical sclerites ventrally. The epimeron is attached at the base of the episternum below the pronotum and projects more or less posteriorly.

The *sternum* (*S.1, S.2, S.3*) is present in all the three segments *i.e.*, pro-, meso- and metathorax ventrally between the two coxae. The

prothoracic sternum is more or less oval and much less chitinised, whereas the meso- and metathoracic sternum is transverse and narrow sclerite connected with the episternum by the precoxal bridge. Besides, there are intersegmental sclerites or intersternites commonly termed as *spinasterna*. The *spinasterna* (*spn.1*) between the prothorax and



TEXT-FIG. 4.—*Odontotermes obesus* (Rambur), soldier caste.

(*a*). Lateral view of thorax, showing the arrangement of pleural sclerites and articulation of coxae. (*b* i, *b* ii, *b* iii). Fore, middle and hind-legs respectively of the right side. (*c*). Dorsal view of thoracic and abdominal tergites.

cv.sc.1, cervical sclerite 1 ; *cv.sc.2*, cervical sclerite 2 ; *cx.*, coxa ; *cx. pr.*, coxal process ; *cx.s.*, coxal suture ; *epmr.*, epimeron ; *epst.*, episternum ; *fe.*, femur ; *fx. p.*, flexor plate ; *kts.*, katepisternum ; *mr.*, meron ; *mst.*, mesonotum ; *mtt.*, metanotum; *pl. aps.*, pleural apophysis ; *pl.a.sf.*, pleural articular surface ; *pl.s.*, pleural suture; *pcx.*, precoxale ; *prt.*, pronotum ; *spr.*, spiracle ; *Ti.-Tx.*, terga 1 to 10., *tb.*, tibia ; *tn.*, trochantin of leg ; *tar. c.*, tarsal claws ; *tr.*, trochanter.

mesothorax is represented only as a median, elongated, forwardly pointing apodemal process or spine, whereas the *spinasterna* (*spn.2*) between the mesothorax and metathorax is united with mesothoracic sterna with a usual median spine pointing forwards.

(b) *The legs*

(Text-figs. 4*b*i, ii, iii)

The legs bear fine hairs which are especially dense on the tibiae. The pro- and mesothoracic legs are subequal, the metathoracic legs being larger. The most proximal leg segment or *coxa* (*cx.*) is a relatively small, thick segment articulated with the pleuron. The articular joint is surrounded by the episternum and epimeron anteriorly and dorsally. The coxa, which is truncate, cone-shaped, somewhat cylindrical and with outer surface projecting upwards, is separated proximally from the body by a distinct suture. It articulates with the ventral extremity of the trochantin at the anterior margin of the latter. Slightly above this articulation it bears another articular facet, the *pleural articular surface* (*pl.a.sf.*) (Snodgrass, 1935), which articulates with the *coxal process* (*cx.pr.*) of the pleuron. At its distal end the coxa is articulated with the trochanter at two articular points. The coxa of the mid- and hind-legs is divided obliquely into two by an inflexion of its wall called the *coxal suture* (*cx.s.*) which falls in line with the *pleural suture* (*pl. s.*). That portion which is in line with the episternum is most probably the *coxa genuina* (*cx.g.*), and the portion in line with the epimeron is the *meron* (*mr.*).

The *trochanter* (*tr.*) is a small segment of the leg with its distal end obliquely truncated. It is hinged proximally to the coxa, and is rigidly fixed to the femur distally. The *femur* (*fr.*) is the stoutest segment and is slightly narrowed at the ends. The *tibia* (*tb.*) is slender and has its proximal end constricted and slightly bent towards the femur so as to be flexed closely underneath the latter. It provides a condylic hinge to the femur. The tibiae of the fore-and middle-legs are nearly equal in length to the corresponding femora, while that of the hind-leg equals in length the combined femur and trochanter. Each tibia carries a pair of tibial spurs near its distal extremity.

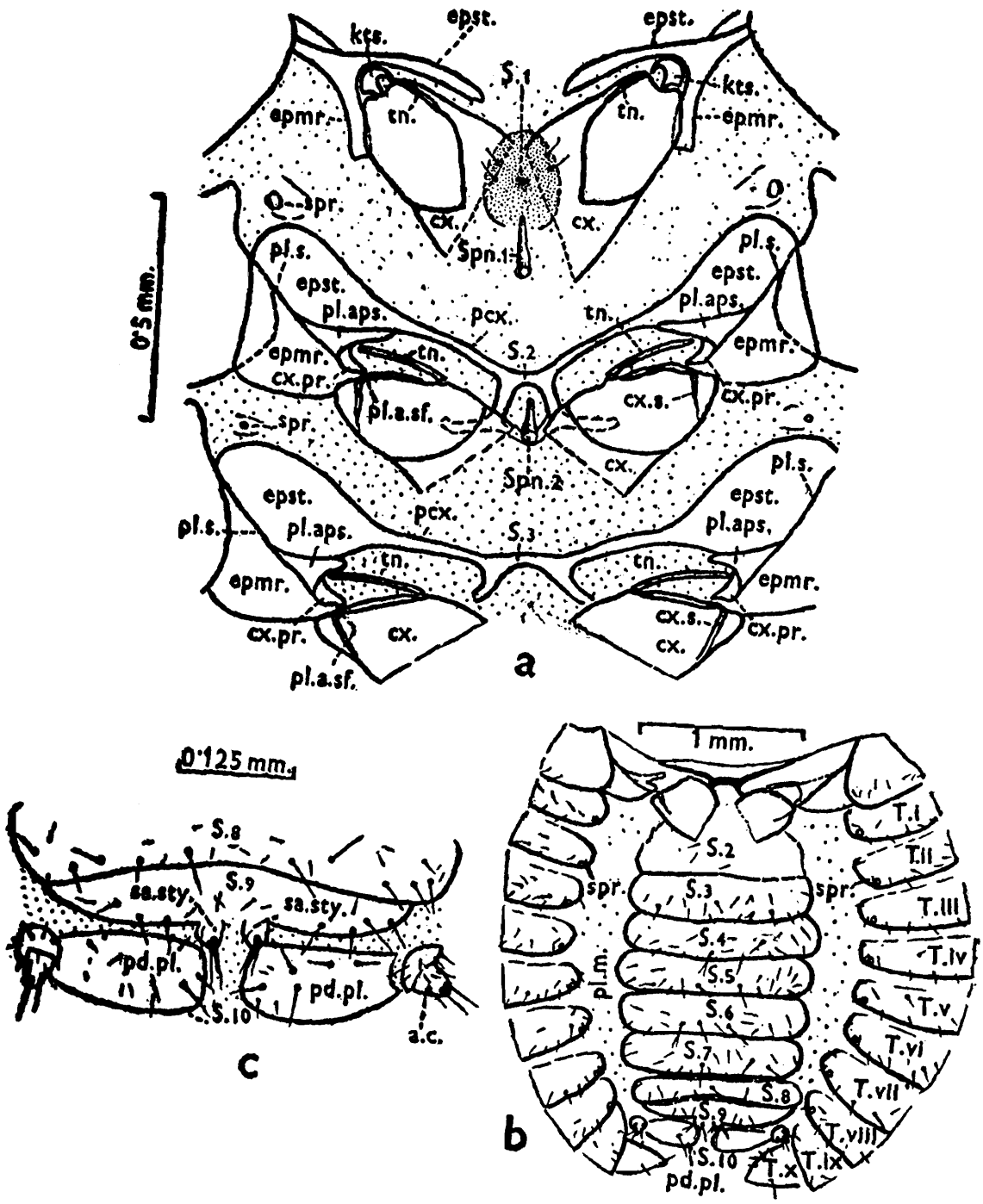
The *tarsi* (*tar.*) in all the 3 legs are 4-jointed. The basal segment or *basitarsus* is subtriangular and is larger than the next two segments The distal segment or *distitarsus* is the longest and has a relatively narrow proximal end; it bears a pair of *claws* (*tar. c.*) which are articulated with the distitarsus by means of a small distal process of the latter. A small sclerite situated ventrally between the claws may possibly represent the *flexor plate* (*fx. pl.*). The terminal region of the leg, including the claws and the flexor plate, may be referred to as the *pretarsus*. The empodium is absent here.

VI—ABDOMEN

(Text-figs. 4*c*. and 5*b*, *c*)

The abdomen is 10-segmented and differs from the head and thorax in the simplicity of its structure. Anteriorly, it broadly adjoins the thorax. There are 10 distinct *tergites* (*Ti* -*Tx*) of which the first eight

bear a pair of *spiracles* (*spr.*) each at their lateral margins. The 5th and 6th tergites are the largest ; the posterior ones undergo a gradual reduction in size. Within each segment the dorsal or *tergal sclerites* and ventral or *sternal sclerites* are separated laterally by the *pleural*



TEXT-FIG. 5.—*Odontotermes obesus* (Rambur), soldier caste.

(*a*). Thorax, showing the different ventral and lateral sclerites and the attachment of the coxae. (*b*). Abdominal sternites, in ventral view, with the tergites cut medially in longitudinal axis and spread on either side. (*c*). The 8th, 9th and 10th (podical plates) abdominal sternites.

a c., anal cercus; *cx.*, coxa; *cx. pr.*, coxal process; *cx. s.*, coxal suture; *epmr.*, epimeron ; *epst.*, episternum ; *kts.*, katepisternum ; *pd. pl.*, podical plate ; *pl. aps.*, pleural apophysis; *pl. a. sf.*, pleural articular surface ; *pl. m.*, pleural membrane ; *pl. s.*, pleural suture; *pcx.*, precoxale ; *s1-s10*, sterna 1-10 ; *sa. sty.* sub-anal style ; *spr.*, spiracle ; *Ti-Tx*, terga 1 to 10 ; *tn.*, trochantin of leg.

membrane (*pl. m.*). The sclerites bear spines of various sizes all over, which are densely distributed at random but the narrow anterior margins are relatively less spinose. Each tergum slightly overlies the one

following it. The apical or tenth tergum is somewhat triangular, is relatively more arched dorsally and has its apex broadly rounded posteriorly.

All the abdominal segments except the first have a corresponding sternite, the first sternum being atrophied. The eighth and ninth sternites are narrower than the rest. The last or tenth sternum is represented by a pair of *podical plates* (*pd. pl.*).

The ninth sternum carries a pair of small, unjointed, setose, somewhat nipple-shaped *sub-anal styles* (*sa. sty.*) at its posterior margin. The two styles lie close to each other on either side of the mid-ventral line. Arising from the pleuro-ventral region, adjacent to the outer lateral margins of the podical plates, there is on either side a setose process called the *anal cercus* (*a. c.*).

It is not possible to distinguish the sexes in the soldier caste.

VII—Summary

1. The external morphology of the soldier caste of *Odontotermes obesus* (Rambur) was studied from material collected around Dehra Dun.

2. The antennal segments vary from 15 (rarely) to 17, the usual number being either 16 or 17 The number may vary in the same individual.

3. The labrum shows a more or less bilaterally symmetrical arrangement of the setae whose number varies from 9-12 on either side.

4. The hypopharynx consists only of the lingua.

5. The meso- and metathoracic segments possess a pair of spiracles each.

6. The pleuron in the meso- and metathoracic segments differs from that of the prothoracic segment in the arrangement of the sclerites.

7 All the abdominal segments except the first have a corresponding sternite. The first sternite is atrophied.

8. A pair of podical plates represent the tenth sternum.

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