# EXTERNAL MORPHOLOGY OF THE TERMITE, *ODONTOTERMES OBESUS* (RAMBUR) (ISOPTERA : TERMITIDAE). PART 2. ALATE AND WORKER

*By*

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(With 1 Table and 12 Text-figures)

CONTENTS



## I—INTRODUCTION

In Part 1 of this series (Kushwaha, 1955, 1960), the external morphology of the soldier caste was described. In the present part, an account of the external morphology of the alates and the worker caste is presented. On the whole, except in body-size, the workers distinctly resemble the alates in the configuration of the head ; and the soldiers rather than the alates in the configuration of the thorax and abdomen. Where the alates and workers do not differ materially from the soldier caste already described, this fact is mentioned and a detailed description avoided.

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## II—Material and Methods

The material for study of the workers and alates was collected from mounds in the areas of New Forest and Jhajra Forest near Dehra Dun (U. P.), *ca.* 2,000 ft. above sea-level. For permanent mounts, specimens were treated with a hot 1 per cent. water solution of KOH for a few minutes, left over-night in the cold solution, and then dissected, suitably washed, stained and mounted in canada balsam.

## III—Morphology of The Alate

### 1. *Head*

(*a*) *General.*—The flexible and translucent cuticle of the head is much more chitinized in alates than in soldiers and workers. The general dorsal colour of the head is dark brown or fuscous approaching black. Anterior to the clypeo-frontal suture (and including the ocelli which are present posterior to it) the colour changes to pale cadmium yellow. The compound eyes and the mandibular teeth are almost black. Ventrally, the head is paler.

The head (Text-fig. 1*d-f*) is more or less rounded and hypognathous. The long axis of the head is inclined almost vertically. The mouth-parts are directed downwards and the facial area forwards. There is bilateral symmetry except for the mandibles which present asymmetry in respect of their teeth. The cranium is antero-posteriorly flattened, when considering the apical direction, with the proximal half hemispherical and gradually narrowed anteriorly. Internally it is supported by an endoskeletal structure, the tentorium (*vide infra*).

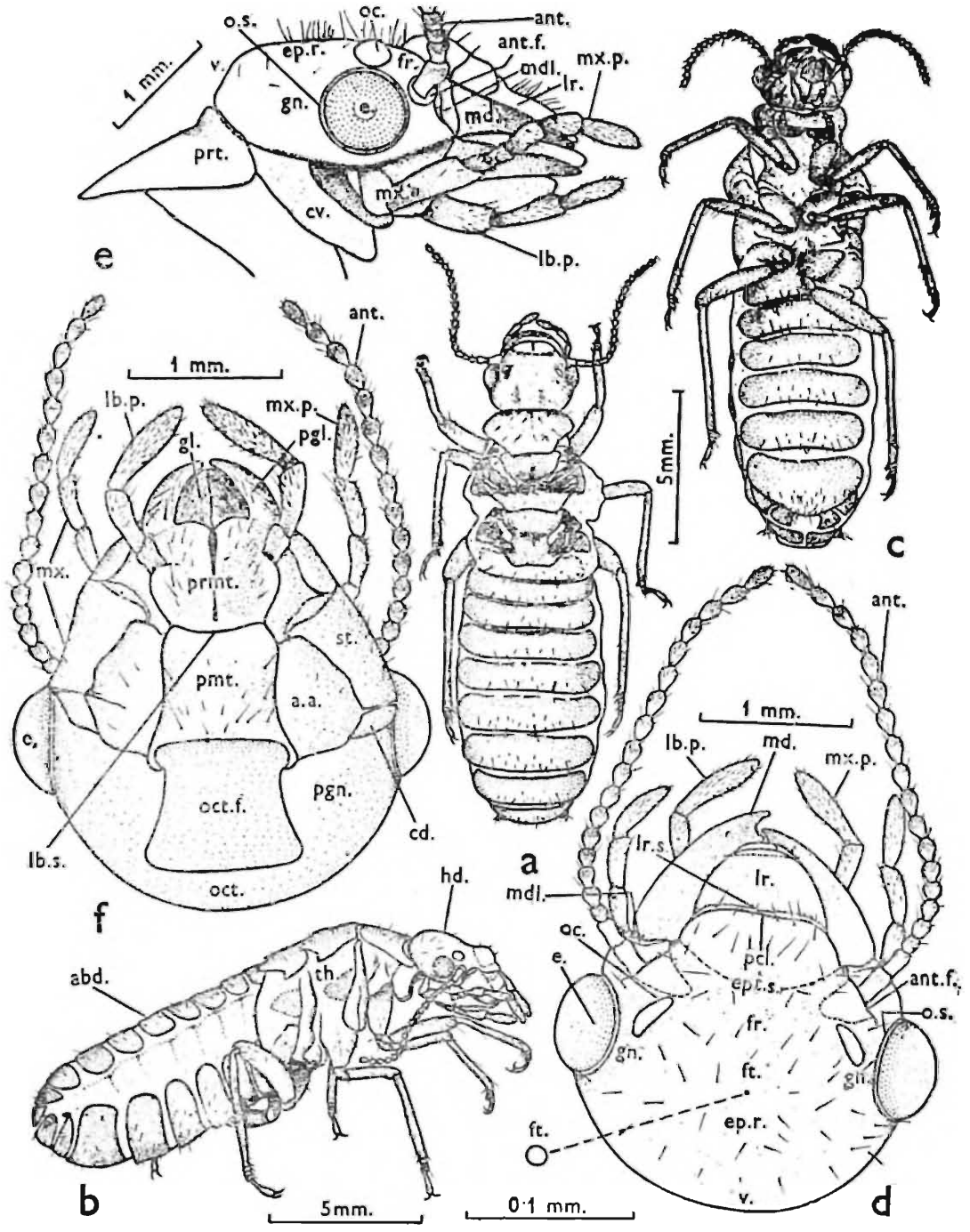
The mouth-parts are of the mandibulate type, directed downwards and are located in their same relative positions as in the soldier. The chief difference from the soldier is that the mandibles and the postmentum are not so much elongated in the alates.

The paired compound eyes (Text-fig. 1*d-f*) and the ocelli (Text-fig. 1*d-f*) are well developed and located laterally and symmetrically on the cranium just above the antennal foveolae. The cornea of the compound eyes is, as usual, divided into numerous hexagonal facets. The two lateral ocelli are reniform and lie inner to the compound eyes. There is no median ocellus. The antennae originate within the antennal foveolae just above the base of the mandibles.

(*b*) *Sutures of the cranium* (Text-figs. 1*d-f* and 3).—The principal sutures of the cranium are: (i) the labral (*lr. s.*); (ii) the *epistomal* or

*clypeo-frontal* (*ept. s.*); and (iii) the *ocular* (*o.s.*) sutures dorsally; and iv) the *postoccipital* (*poct. s.*) and (v) the *labial* (*lb. s.*) sutures ventrally.

The clypeo-frontal or epistomal suture, together with a prominent median longitudinal fold on the clypeus present in the alates, is suppressed in the soldiers. On the other hand, the gular suture,




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

(*a*). Whole body, dorsal view. (*b*). Same, lateral view. (*c*). Same, ventral view. (*d*). Head, dorsal view (Fontanelle, *ft.*, magnified separately). (*e*). Head, lateral view. (*f*). Head, ventral view.

*a.a.*, an articulating area ; *abd.*, abdomen ; *ant.*, antenna ; *ant. f.*, antennal foveola ; *cd.*, cardo ; *cv.*, cervix ; *e.*, eye ; *ep. r.*, epicranial region ; *ept. s.*, epistomal suture ; *fr.* frons ; *ft.*, fontanelle ; *gl.*, glossa ; *gn.*, gena ; *hd.*, head ; *lb. p.*, labial palp ; *lr.*, labrum ; *lr. s.*, labral suture ; *md.*, mandible ; *mdl.*, mandibularia (or trochantin of mandible) ; *mx.*, maxilla ; *mx. p.*, maxillary palp ; *oc.*, ocellus ; *oct.*, occiput ; *oct.f.*, occipital foramen ; *o.s.*, ocular suture ; *pcl.*, postclypeus ; *pgl.*, paraglossa; *pgn.*, postgena ; *pmt*,. postmentum ; *prmt.*, prementum ; *prt.*, pronotum ; *st.*, stipes ; *th.*, thorax ; *v.*, vertex.

characteristic of the heads of some prognathous insects and which is also present in the soldiers here, is suppressed in the alates.

(*c*) *Areas of the cranium* (Text-figs. 1*d-f* and 3).—All the cranial areas discussed in the soldier caste are present in the alates in the same relative positions. The chief differences from that of the soldier are as follows :—

(i) The epicranial region is less extensive than in the soldier. (ii) The frons is separated from the clypeus by the clypeo-frontal or epistomal suture. (iii) The fontanelle is circular and very distinct in the alates, being visible even under a low magnification, and is situated approximately in the middle of an imaginary line joining the upper margins of the two compound eyes. (iv) The postocciput region is more conspicuous here than in the soldier. (v) Unlike as in the soldier, the postmentum is greatly displaced anteriorly and is set apart from the postgenae. There intervenes an area between the cardo and stipes of the maxilla and the postmentum of the labium on either side. This area may be designated as an *articulating area* (*a.a.*) and has been shown as such by Imms (1948) also in the larva of *Embaphion* sp. (Coleoptera : Tenebrionidae).

(*d*) *Tentorium* (Text-figs. 2*a* and 3).—As in the soldier, the tentorium supports the cranium, its inner contents and the *anterior articulation of the mandibles* (Text-fig. 2*b*, *at.a.md.*). The corporotentorium (*ctm.*), however, is here considerably shortened, and forms a narrow, transverse band in conformity with the cranial length.

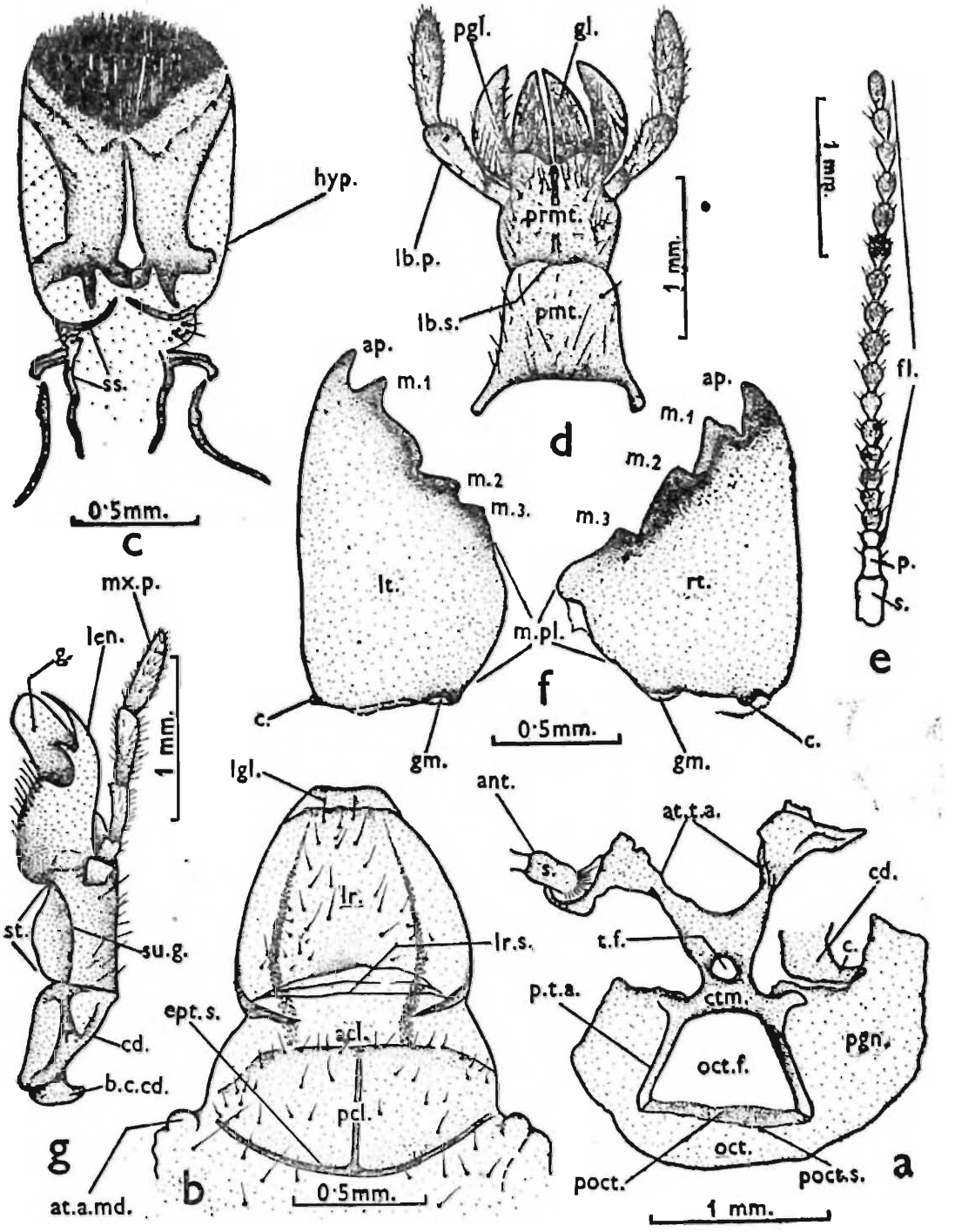
The *anterior tentorial arms* (*at.t.a.*) are as in the soldier, and the *tentorial foramen* (*t.f.*) is of about the same size when the relative size of the tentorium is taken into account.

The *corporotentorium* extends laterally and ends in stumpy processes which become confluent with the postgenae and overlie the postero-lateral angles of the postmentum, near the points where the cardines of the first maxillae articulate. The posterior margin of the corporotentorium is concave and the posterior arms are prolonged posteriorly, bounding the occipital foramen anteriorly and laterally. In the soldier, on the other hand, the posterior arms are fused with the postero-lateral angles of the postmentum at the lateral margins and do not extend much beyond the anterior margin of the occipital foramen.

(*e*) *Head-appendages.*—All the head-appendages found in the soldier also occur in the alates in the same relative position. The shape of the mandibles, labium and antennae, however, differ strikingly from that in the soldiers.

The *labrum* (Text-fig. 2*b*, *lr.*) is a broad, flat lobe gradually narrowing distally to end in a hyaline tip known as *lingula* (*lgl.*). Basally, at the lateral margins on the labral suture (*lr.s.*), lies a narrow subtriangular chitinized sclerite, the torma (indicated in the figure as dark shaded area). There is a membranous fold ventrally, called *palatum* (Cook, 1944), showing numerous microscopic processes densely distributed in a narrow longitudinal area on either side. The setae are arranged in a more or less orderly manner, in rows converging distally.

The *hypopharynx* (Text-fig. 2*c*, *hyp.*) is located in the same relative position as in the soldier, but differs in the fact that the free distal portion is broad and densely fringed with fine hair-like or ciliary structures.

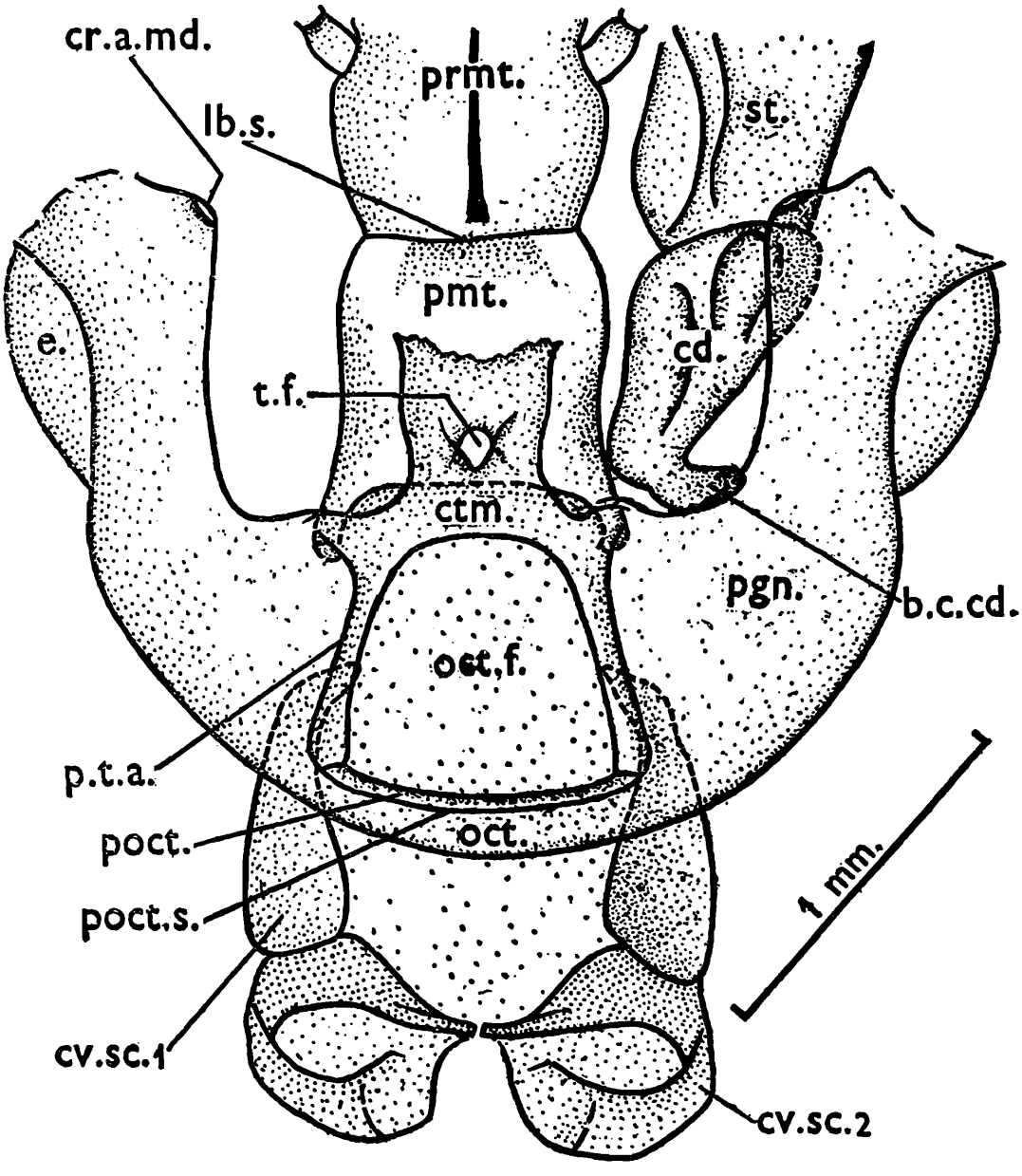



TEXT-FIG. 2.—*Odontotermes obesus* (Rambur), alate caste.

(*a*). Tentorium with ventral wall of cranium (without head-appendages). (*b*). Dorsal view of labrum and clypeus. (*c*). Hypopharynx. (*d*). Labium, ventral view. (*e*). Right antenna. (*f*). Left and right mandibles. (*g*). Maxilla.

*acl.*, anteclypeus ; *ant.*, antenna ; *ap.*, apical tooth of mandible ; *at. a. md.*, anterior articulation of mandible ; *at. t. a.*, anterior tentorial arm ; *b.c.cd.*, basal condyle of cardo ; *c.*, condyle of mandible ; *cd.*, cardo ; *ctm.*, corporotentorium ; *ept.s.*, epistomal suture ; *fl.*, flagellum ; *g.*, galea ; *gl.*, glossa ; *gm.*, ginglymus ; *hyp.*, hypopharynx ; *lb.p.*, labial palp ; *lb.s.*, labial suture ; *lcn.*, lacinia ; *lgl.*, lingula (hyaline tip of labrum) ; *lr.*, labrum ; *lr.s.*, labral suture ; *lt.*, left ; *m.1.*, *m.2.*, *m.3.*, marginal teeth of mandible ; *m.pl.*, mola plate of mandible (or molar lobe, mola, pars molaris) ; *mx. p.*, maxillary palp ; *oct.*, occiput ; *oct.f.*, occipital foramen ; *p.*, pedicel ; *pcl.*, postclypeus ; *pgn.*, postgena ; *pmt.*, post mentum ; *poct.*, postocciput ; *poct.s.*, postoccipital suture ; *prmt.*, prementum ; *rt.*, right ; *s.*, scape ; *st.*, stipes ; *su.g.*, sutural groove of stipes ; *t.f.*, tentorial foramen.

Laterally, it is supported by conspicuous chitinized areas in addition to other rod-like basal *suspensorial sclerites* or apodemes (*ss.*) as in the soldier. The *salivary duct* opens below the hypopharynx.




Text-fig. 3.—*Odontotermes obesus* (Rambur), alate caste.

Ventral wall of cranium, showing points of attachment of the tentorium, labium, maxilla and cervix (complete).

*b.c.cd.*, basal condyle of cardo ; *cd.*, cardo ; *cr.a.md.*, cranial articulation of mandible ; *ctm.*, corporotentorium ; *cv.sc.1*, first cervical sclerite ; *cv.sc.2*, second cervical sclerite ; *e.*, eye ; *lb.s.* , labial suture ; *oct.*, occiput ; *oct.f.*, occipital foramen ; *pgn.*, postgena ; *pmt.*,postmentum ; *poct.*, postocciput ; *poct.s.*, postoccipital suture ; *prmt.*, prementum ; *st.*, stipes ; *t.f.*, tentorial foramen.

The *labium* shows two regions, *viz.*, a proximal *postmentum* and a distal *prementum* (Text-fig. 2*d.*) The *postmentum* is a more or less trapezoidal sclerite. It is much reduced than in the soldier, the reduction in size being in conformity with the reduction in the length of the cranium. Its postero-lateral angles point backwards and somewhat outwards. The *postmentum* does not lie directly below the corporotentorium due to the forward displacement of the former. The slightly arched, concave posterior transverse margin leans forward in front of the

anterior margin of the tentorial body, but the postero-lateral angles join the postgenae immediately below the stumpy processes of the corporotentorium. The *prementum* is as in the soldier, but the median longitudinal fold dividing the prementum into two halves is more pronounced. In the *ligula*, the glossae and paraglossae are more or less separately marked from the prementum by a transverse suture. The segments of the labial palpi, starting from the proximal one, vary in the following proportions : 5 : 13 : 20. In other respects the alates resemble the soldier.

The *antennae* (Text-fig. 2*e*) are moderately pilose and bristled. The main difference from the soldier caste lies in the number of segments, which is 19 in alates. The basal segment or *scape* (*s.*) is the thickest segment and is subequal to or smaller than segments 2+3. The second segment or *pedicel* (*p.*) is about twice as long as the third segment. The apical segment is oval and is smaller than the scape but subequal to the pedicel.

The *mandibles* (Text-fig. 2*f*) are adapted for crushing the food and are, therefore, very different from that of the soldier where they serve only the defence. The alate mandibles are broad, flat, subtriangular, with nearly straight margins, and the inner margins bear several blunt teeth. The mandibles are hinged by the condyle and the ginglymus. The mandibular length (from the basal condyle to the tip of the apical tooth) varies from 1·21—1·43 mm. In the left mandible (*lt.*) there are two large teeth near the apex, *viz.*, the apical tooth (*ap.*) and the first tooth (*m.1.*), followed by two smaller teeth (*m.2.* and *m.3.*) adjacent to the *molar plate or pars molaris* (*m. pl.*). The right mandible (*rt.*) possesses four large teeth (*ap.*, *m.1.*, *m 2*, and *m.3.*) ; the molar plate (*m.pl.*) is uneven and convex.

The *maxillae* (Text-fig. 2*g*) are as in the soldier but differ in size and in the point of attachment with the cranium. In the soldier they are articulated at the blade of gula in the angle where the postgenae become free from the postmentum, whereas in the alates, the cardines (Text-fig. 3, *cd.*) articulate where the postero-lateral angles of the postmentum join the postgenae. The 5 segments of the *maxillary palpi* are mutually related in length in the following proportion, starting from the proximal segment : 9 : 10 : 22 : 26 : 31.

## 2. *Cervix*

(Text-figs. 3 and 5*a*)

The cervix closely resembles that of the soldier in respect of their sclerites (*cv. sc. 1* and *cv. sc. 2*), their structure and attachment.

## 3. *Thorax*

(Text-figs. 4 ; 5*b*, *c*, and 6*a*, *b*)

(*a*) *The main body of thorax.*—The thorax is divided into two portions, *viz.*, an anterior prothoracic part and a posterior, wing-bearing, meso-metathoracic part termed *pterothorax* by Snodgrass (1935). The two wing-bearing segments of the pterothorax are subequal but differ

from the prothorax structurally in respect of the terga, pleura and sterna. These modifications, as in other Pterygote insects, are adaptations for the movement of the wings.

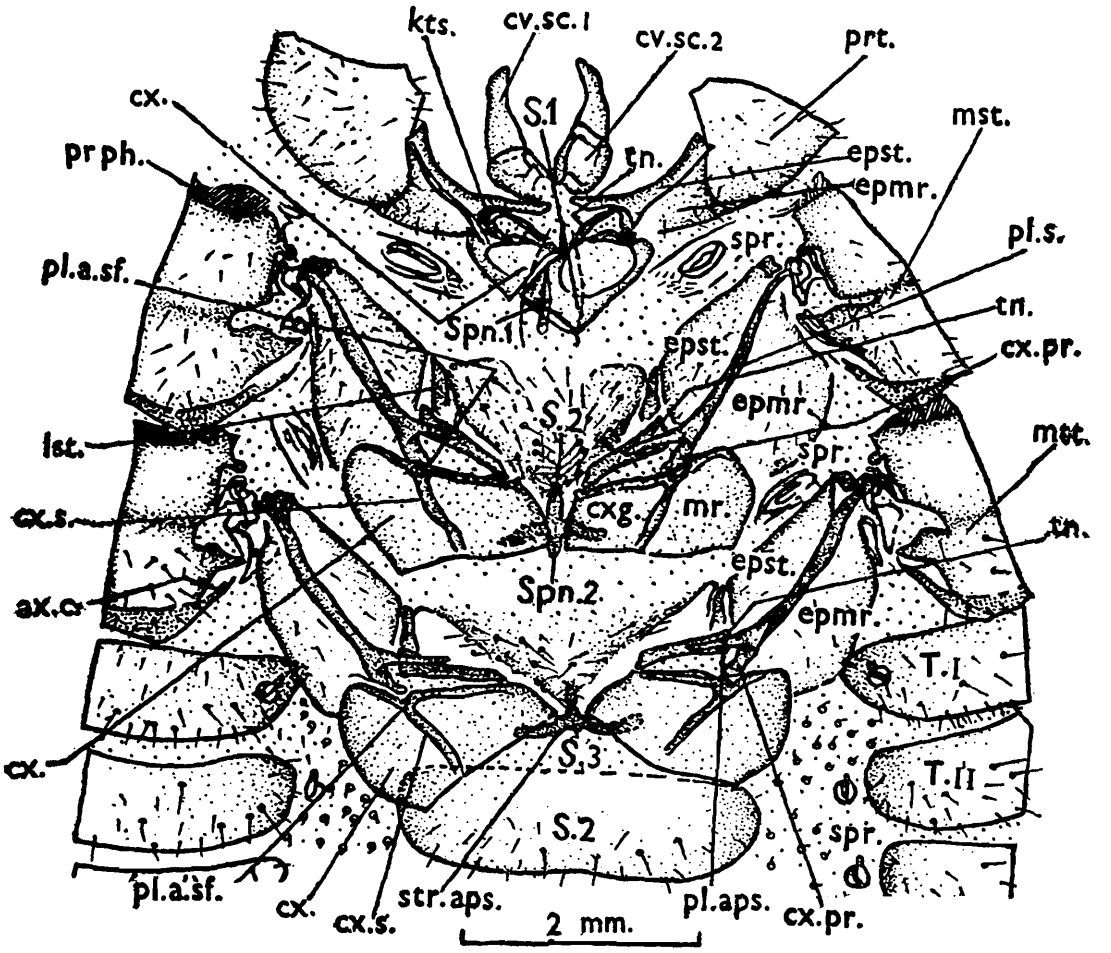
The *pronotum* is the more indurated and pigmented of the three thoracic tergites. It is nonsellate, flat, trapezoid, with the anterior margin wider than the posterior and the antero-lateral corners rounded. It is nearly twice as broad as long and is moderately bristled. It is somewhat notched medially at its anterior margin and mildly incurvated medially at its posterior margin. The dorsal field or profile is straight or slightly arched, but has no anterior hood-like structure or lobe as is present in the soldier. The anterior margin is nearly entire, reduplicated or folded, and is continuous with the neck-membrane and the pleural-membrane. There are no anterior or posterior notal ridges or prephragma.

The *mesonotum* (*mst.*) and *metanotum* (*mtt.*) are nearly alike, and differ greatly from the pronotum. Each of the former is characteristically divisible medially and transversely at its narrowest point into two pigmented regions—an anterior narrower region or *scutum* (*sct.*) and a posterior, wider region or *scutellum* (*scl.*). The scutum is bounded at its anterior margin by the *anterior notal ridge* (*a. n. r.*) which protrudes laterally as a stumpy *anterior notal wing process* (*a.n.p.*). Antero-ventrally the notal ridge is produced into the bilobed *prephragma* (*prph.*). The scutellum stretches antero-laterally into an angular, *posterior notal wing process* (*p.n.p.*) on either side. It slightly tapers caudally, and its hind margin is weakly incurved and folded ventrally so as to form a marginal cord-like rim called the *axillary cord* (*ax. c.*). Thus, the axillary cord arises ventrally from the postero-lateral angles of the pterothoracic notum and continues laterally to the wings to strengthen the inner or anal margin of each wing basally.

There are two pairs of conspicuous thoracic *spiracles* (*spr.*), each pair situated in the pleural region of the meso- and metathoracic segments. Their oblique, slit-like openings are guarded externally by two strongly chitinized, deeply staining lips.

The pleural membrane is uniformly clothed with fine, minute hairs, each of which arises from the centre of a circular, deeply staining area. The pterothoracic pleura differ markedly from that of the prothoracic region in that the pleural sclerotization of the latter lacks the alar elements which are characteristic of the former. In the pterothorax the well developed pleural sclerotization is, as usual, divided by the pleural suture into an *episternum* (*epst.*) and an *epimeron* (*epmr.*). Both the internal *pleural ridge* and the *pleural suture* (*pl. s.*) reinforcing the pleuron above the coxa extend from the *coxal process* (*cx.p.*) upwards into the *pleural wing process* (*w.p.*). The *pleural apophysis* (*pl. aps.*) projects downwards and inwards, as in the soldier. The corresponding *sternal apophysis* (*str. aps.*) associated with it is also very distinct here. The position and the structure of the episternum in all the three thoracic segments is nearly the same as in the soldier, except in size. The prothoracic episternum is a rigid, rod-like collar-band hanging downwards from the pronotum. The episternum in the meso-and metathoracic segments of

the soldier extend ventrally anterior to the coxa forming the precoxal bridge or precoxale, whereas in the alates the precoxal region forms a distinct sclerite separated from and lying in between the episternum, the trochantin and the sternum. This is a small, somewhat triangular sclerite called the *laterosternite* (*lst.*). The prothorax lacks this sclerite. According to Fuller (1924), the laterosternite was described as "presternum" by Snodgrass (1909) and as "epimeral sternite" by Holmgren (1909). Fuller himself (1924) had borrowed the term from Crampton (1914) who had stated that it is present in both the pterothoracic segments of the termites only.




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

Thorax, showing the various ventral and lateral sclerites and the attachment of the coxae, together with the tergites cut medially along the longitudinal axis and spread out flat on either side.

*ax.c.*, axillary cord ; *cv. sc.1*, first cervical sclerite ; *cv.sc.2*, second cervical sclerite ; *cx.*, coxa ; *cx.g.*, coxa genuina ; *cx.pr.*, coxal process ; *cx.s.*, coxal suture ; *epmr.*, epimeron ; *epst.*, episternum ; *lst.*, latero-sternite ; *mr.*, meron ; *mst.*, mesonotum ; *mtt.*, metanotum ; *pl. aps.*, pleural apophysis ; *pl. a. sf.*, pleural articular surface ; *pl.s.*, pleural suture ; *prph.*, prephragma ; *prt.*, pronotum ; $S_1$-$S_3$, sterna 1-3 ; *spr.*, spiracle ; *str. aps.*, sternal apophysis ; *T.I.*, *T.II*, terga first and second ; *tn.*, trochantin of leg.

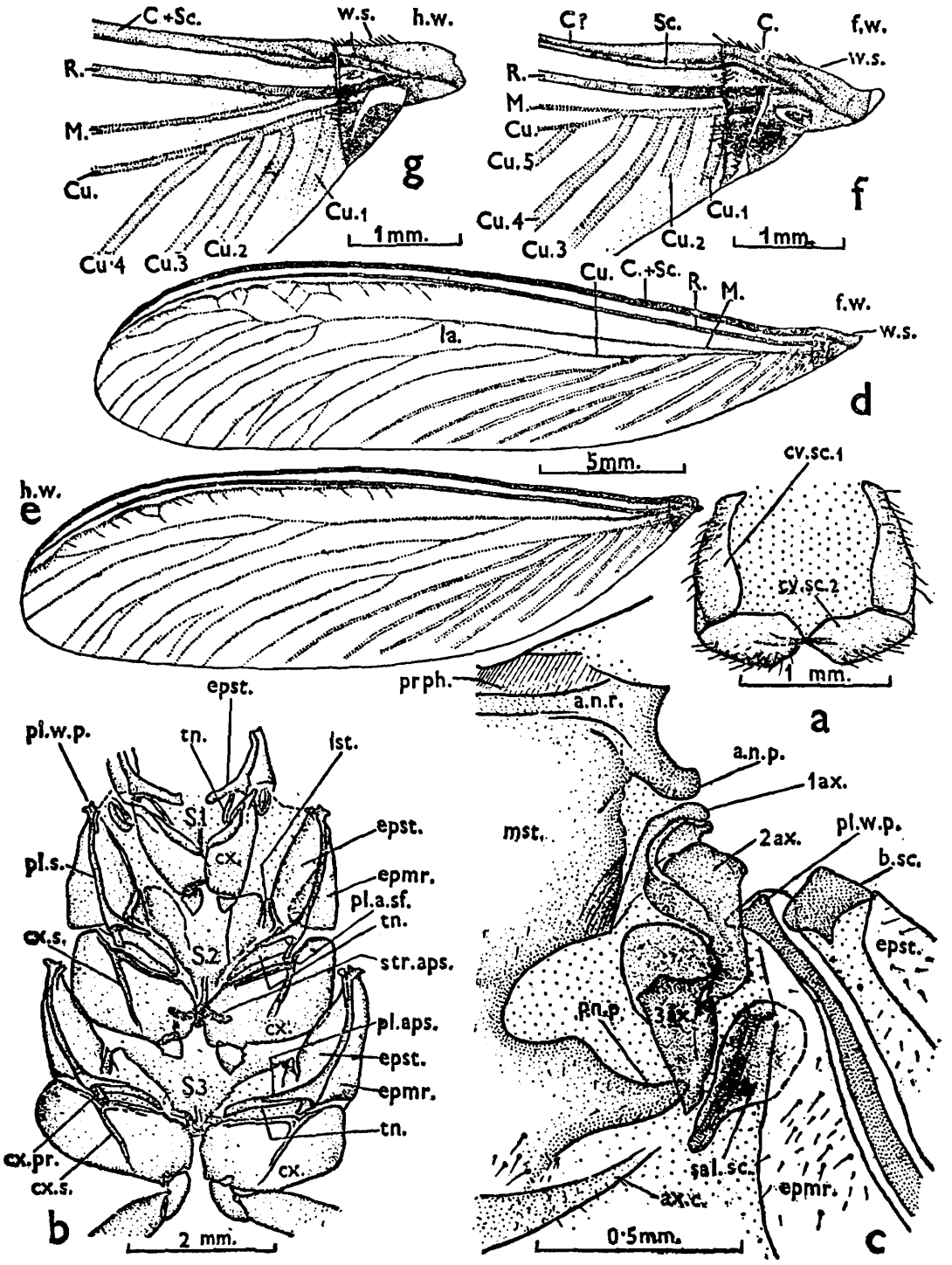
In the pterothorax, the *epimeron* (*epmr.*) occupies the same postsutural position (adjacent to the episternum) as in the soldier, but the prothoracic epimeron in the present caste is a smaller sclerite than those of the pterothorax. In the soldier the prothoracic epimeron was described as a posteriorly directed, narrow sclerite attached at the base of the episternum below the pronotum.

The *trochantin* (*tn.*) of the pterothoracic segments is well developed, broad, elongated and triangular, with its tapering ventral end bluntly rounded to form the *trochantinal articulation of the coxa.* The trochantin of the prothorax, however, is narrower and more slender. Another prothoracic pleural sclerite known as the *katepisternum* (*kts.*) is present as a curved, arm-like process occupying the same position as in the soldier ; it articulates with the trochantin and is associated closely with the proepisternum.

The *thoracic sternum* (*S. 1, S. 2, S. 3*) located in between the coxae is also designated as "eusternum" by Snodgrass (1935). In the alates, the prosternum (*S. 1*) is represented, as in the soldier, by an elongated or more or less oval sclerite. The sternum in both meso-and metathorax, *i.e.*, the pterothoracic sternum, show no sclerotic continuity and get gradually desclerotised anteriorly. It is, therefore, difficult to distinguish their boundaries anteriorly. Each of the pterothoracic sterna bears posteriorly the paired *furcal arms* or *sternal apophysis* (*str. aps.*) arising from a common stalk. The two divergent prongs of this Y-shaped endosternal apodeme or furca are closely associated with the pleural apophysis on either side. The corresponding intersternites known as *spinasterna* (*Spn. 1, Spn. 2*) as described in soldier caste are also present here. The *spinasterna* (*Spn. 1*) between prothorax and mesothorax is similarly represented only by a free spine, and the *spinasterna* (*Spn. 2*) between mesothorax and metathorax being similarly united with the mesothoracic sterna and bearing a comparatively reduced spine pointing backwards.

(*b*) *The legs* (Text-fig. 7, *ai, aii, aiii*).—The three pairs of thoracic legs are subequal and similar in their component parts. They resemble more or less those of the soldier in the general shape of their segments, in the articulating joints and in their attachment with the thorax, but differ in size. All parts of the legs bear fine hairs which are especially dense on the tibiae. The *coxae* (*cx.*) of the pterothoracic legs are very broad. The coxae of all the legs show articular surfaces for the trochantin and for the coxal process of the pleuron. Only the meso-and metathoracic coxae are separately marked into the *meron* (*mr.*) and the *coxa genuina* (*cxg.*) by the deeply inflected *coxal suture* (*cx. s.*), and the two subdivisions occupy the same relative positions as in the soldier. The *trochanter* (*tr.*) is obliquely truncated distally. The *femur* (*fe.*) is short and the *tibia* (*tb.*) long and comparatively slender ; the latter is armed with a pair of robust terminal tibial spurs. Of the 4-jointed tarsi, the most distal one or *distitarsus* is the longest and bears a pair of claws together with a proximal plate which is probably the *flexor plate.*

(*c*) *The wings and their basal sclerites* (Text-figs. 5*c-g* and 6*b, c*).—The two pairs of wings are characterized by their similarity in size, form and venation, and also in the fact that they are shed soon after the nuptial flight. There is a conspicuous *humeral or basal suture* (*h. s.*) along which the wing is shed. The proximal part, which is permanently retained, is termed the *wing-stump* or *scale* (*w. s.*), while the part which is shed is termed the *lamina* (*la.*). Since the scale is more chitinized, the basal arrangement of venation is rather indistinct.

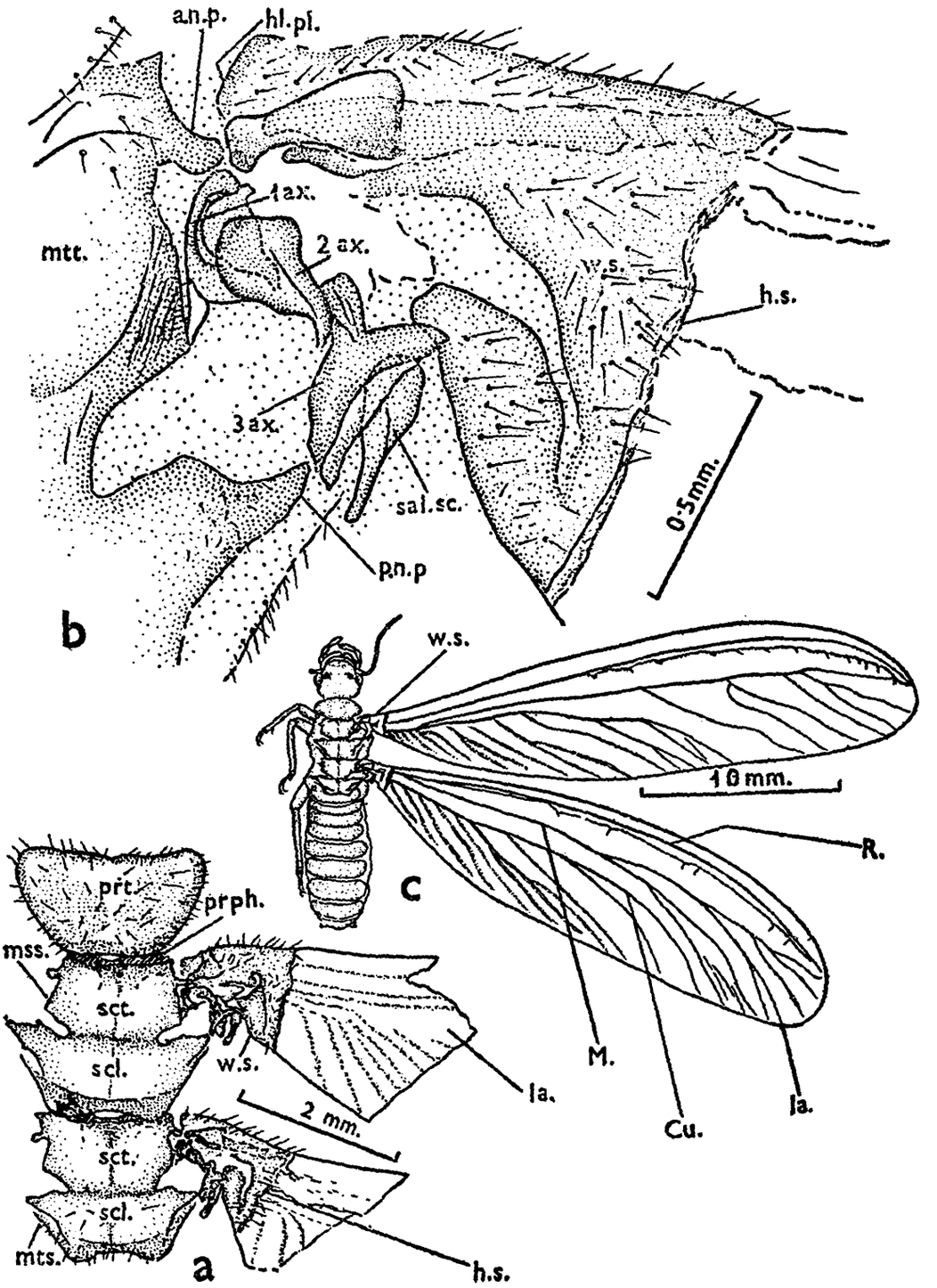



TEXT-FIG. 5.—*Odontotermes obesus* (Rambur), alate caste.

(*a*). Cervix in ventral view. (*b*). Thorax, showing the various ventral and latera sclerites and the attachment of the coxae. (*c*). Part of pterothoracic tergite, in dorsal view with alar articular sclerites, epipleural sclerites and parts of epimeron and episternum. (*d*). Left fore-wing. (*e*). Left hind-wing. (*f*). Wing scale and part of lamina of the fore-wing. (*g*). Wing scale and part of lamina of the hind-wing.

*a.n.p.*, anterior notal process ; *a.n.r.*, anterior notal ridge ; *1ax.*, *2ax.*, *3ax.*, first, second and third axillary ; *ax.c.*, axillary cord ; *b.sc.*, basalar sclerite ; *C.*, costal vein ; *C+Sc.*, costal+subcostal vein ; *Cu.*, cubital vein of wing ; *Cu. 1-5*, branches 1-5 of cubital vein ; *cv.sc.1*, first cervical sclerite ; *cv.sc.2*, second cervical sclerite ; *cx.*, coxa ; *cx.pr.*, coxal process ; *cx. s.*, coxal suture ; *epmr.*, epimeron ; *epst.*, episternum ; *f.w.*, fore-wing ; *h.w.*, hind-wing ; *la.*, lamina ; *lst.*, latero-sternite ; *M.*, medial vein of wing ; *pl.aps.*, pleural apophysis ; *pl.a.sf.*, pleural articular surface ; *pl.s.*, pleural suture ; *pl.w.p.*, pleural wing process ; *p.n.p.*, posterior notal wing process ; *R.*, radius vein of wing ; *S.1-3.*, sterna 1-3 ; *sal.sc.*, subalar sclerites ; *Sc.*, subcostal vein ; *str. aps.*, sternal apophysis ; *w.s.*, wing scale.

Each of the fore-and hind-wings is hinged, as usual, to the *anterior notal process* (*a. n. p.*) and the *posterior notal process* (*p.n.p.*) of the respective pterothoracic notum. They also articulate ventrally with the




Text-fig. 6.—*Odontotermes obesus* (Rambur), alate caste.

(*a*). Thoracic tergites with part of the wings attached. (*b*). Part of the pterothoracic tergite in dorsal view with alar articular sclerites and wing-scale. (*c*). Whole body, in dorsal view, with wings of right side stretched out.

*a.n.p.*, anterior notal process ; *1ax.*, *2ax.*, *3ax.*, first, second and third axillary ; *Cu.*, cubital vein of wing ; *hl.pl.*, humeral plate ; *h.s.*, humeral suture ; *la.*, lamina ; *M.*, medial vein of wing ; *mss.*, mesosternum ; *mts.*, metasternum ; *mtt.*, metanotum ; *p.n.p.*, posterior notal wing process ; *prph.*, prephragma ; *prt.*, pronotum ; *sal.sc.*, subalar sclerites ; *scl.*, scutellum ; *sct.*, scutum ; *w.s.*, wing scale.

*pleural wing process* (*pl. w. p.*). As already described, the *axillary cord* supports the posterior margin of each wing at its base.

Situated around the wing-base are the *basal articular sclerites* consisting of three *axillaries* or *pteralia* which participate in the complex joint which articulates the wing with the thorax. The *first axillary* (*1 ax.*) forms the anterior hinge-plate with its anteriorly produced, slender, curved neck and rounded head supported on the anterior notal wing process. Posteriorly it is articulated with the lateral margin of the scutum, and its main body articulates laterally with the second axillary. The *second axillary* (*2 ax.*) is slightly curved and is obliquely hinged to the curved neck of the first axillary to form the pivotal sclerite which rests upon the fulcral wing-process ventrally. The *third axillary* (*3 ax.*) is the posterior hinge-plate and articulates anteriorly with the second axillary and posteriorly with the posterior notal wing-process. It is somewhat Y-shaped, with a bicuspid tip which is pivoted upon the posterior notal process. It provides insertion to the flexor muscle which produces flexion of the wing.

In addition to the above, there is another sclerite associated with the anterior margin of the wing proximally. Most probably it represents the *humeral plate* (*hl. pl.*).

The *epipleural sclerites* are also located below the wing bases. Since they are closely associated with the wings, they are referred to here. Two of them are present, one on each side of the pleural wing process. The *anterior* or *basalar sclerite* (*b. sc.*) is somewhat quadrangular and lies above the episternum, while the *posterior* or *subalar sclerite* (*sal. sc.*) lies slightly behind the pleural wing process above the epimeron.

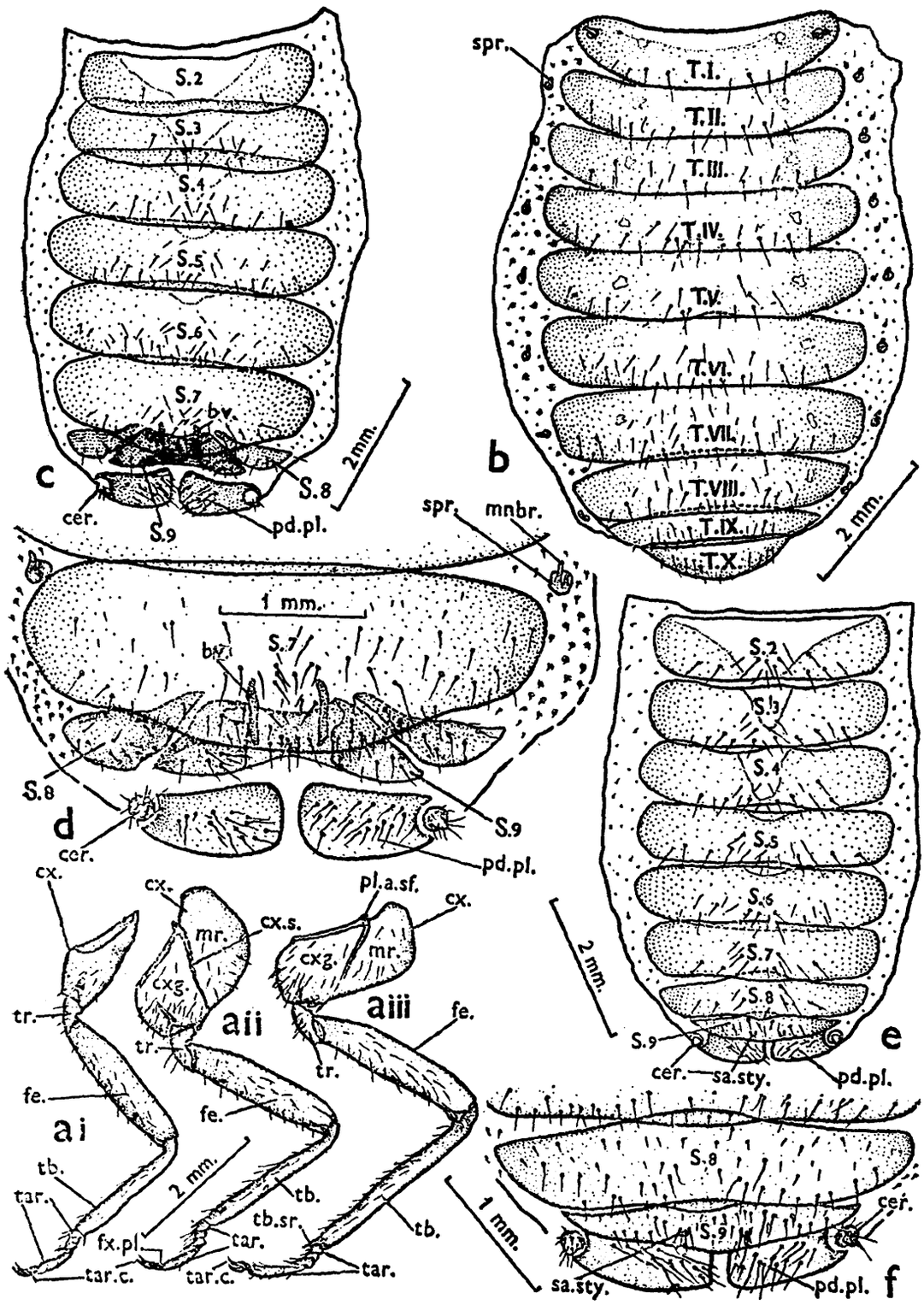
The specialization of the wing venation in *Odontotermes obesus* is evident by a reduction of some of the anterior veins as in *Heterotermes* [*Leucotermes*] and other higher Isoptera (*vide* Imms, 1948). The *costa* and *subcosta* (*C.* + *Sc.*) are probably fused with the costal margin which is greatly thickened. The *radius* (*R*) is represented as a stout and unforked vein which may, according to Imms (1948), be R 4 + 5. Before entering the wing scale of the hind wing the radius is joined by the media whereas in the case of forewing the media runs closer to the cubitus and not joining the radius. The *media* (*M*) branches in the distal half to give several accessory branches which occupy most of that region. The *cubitus* (*Cu*) is another multi-branched vein occupying the remaining proximal region of the wing.

## 4. *Abdomen*

(Text-fig. 7 *b-f*)

The abdomen is broadly attached to the thorax and distinctly segmented into 10 segments, though some of the postgenital segments, particularly in the females, are considerably reduced and modified. As in Isoptera in general, the first abdominal tergum is very closely attached to the metanotum.

Of the eight abdominal pairs of *spiracles* (*spr.*), the first pair is larger and is situated at the lateral edges of the first tergum. The remaining seven pairs are situated on the pleural membrane near the lateral margins




Text-fig. 7.—*Odontotermes obesus* (Rambur), alate caste.

(*ai*, *aii*, *aiii*). Fore-, middle-, and hind-legs respectively, of the right side. (*b*). Dorsal view of the abdominal tergites. (*c*). Ventral view of the abdonimal sternites of female. (*d*). Same, only VII, VIII, IX, and X (podical plates) sternites, magnified. (*e*). Ventral view of the abdominal sternites of male. (*f*). Same, only VIII, IX and (podical plates) sternites, magnified.

*bv.*, basivalvulae ; *cer.*, cercus ; *cx.*, coxa ; *cxg.*, coxa genuina ; *cx.s.*, coxal suture; *fe.*, femur ; *fx.pl.*, flexor plate ; *mnbr.*, manubrium ; *mr.*, meron ; *pd. pl.*, podical plates ; *pl.a.sf.*, pleural articular surface ; *S.2-9.*, sterna 2-9 ; *sa.sty.*, sub-anal styles ; *spr.*, spiracle; T.I., T.II., — T.X., terga first, second, to tenth ; *tar.*, tarsus ; *tar.c.*, tarsal claw ; *tb.*, tibia; *tb.sr.*, tibial spur ; *tr.*, trochanter.

of their corresponding terga, *i.e.*, terga 2-8. In each spiracle the integument seems to get inflected to form a movable and an immovable wall, the former being conspicuously prolonged into a *process* or *manubrium* (*mnbr.*).

Following Snodgrass (1935), for insects in general, segments VIII and IX of the female and the IX segment of the male may be termed here as the *genital segments ;* those preceding them as the *pregenital* or *visceral segments ;* and those following them as the *postgenital segments.*

Corresponding to the 10 segments, there are 10 tergites (TI-TX), nearly uniform in their structure and arrangement except that the posterior ones are somewhat narrower and smaller in size. The first sternite is absent, as in soldier ; only sterna 2-10 being present—the second sternum is, therefore, the first visible sternum. In the females of alates the genital plate or VII sternite is greatly developed. Both paragenital or VIII sternite and the subgenital or IX sternite, have undergone reduction in size. The VIII sternite is split up into a pair of considerably reduced sclerites with their tapering ends obliquely directed forwards and situated outwards on either side of the IX sternite. The latter occupies the inner position in between the sclerites of the VIII sternite. The paired, narrow and linear sclerites adjacent to the anterior border of the IX sternite are the *basivalvulae* (*bv.*).

In the males there is no marked modification in the VII, VIII and IX sternites, except that the last one is very narrow. A pair of small, unjointed, setose, nipple-shaped and closely set *subanal styles* (*sa. sty.*) are borne on the IX sternite of the males alone.

The X sternite is represented in both the sexes by a pair of broad *podical plates* (*pd. pl.*) which are densely hirsute. Adjacent to their outer lateral margins on either side are situated the *anal cerci* (*cer.*).

The sternites of the alates of termites have been variously named. Fuller (1924) suggested the term *genital plate* for the VII sternite, *paragenital* for the VIII, *subgenital* for the IX, and *subanal plates* for the X sternite. Imms (1948) termed the enlarged VII sternite as the *subgenital plate.*

Roonwal (1956) has recently provided illustrations of the genital segments of the two sexes of *Odontotermes obesus* alates, and a summary of the position as occurring in Isoptera in general. He has also given a critically revised terminology of the external genitalia and associated structures of the Isoptera.

The arrangement of the abdominal segments in the two sexes may be expressed as in Table 1.

Table 1.—*The segmental position of the abdomen of alate in* Odontotermes obesus (*Rambur*).

*Note.*—Roman numerals denote the abdominal segments ; those enclosed in a circle are completely atrophied, while those enclosed within brackets are reduced. The presence of the following body-parts in each segment is indicated by the appropriate abbreviation, thus :—*cer.*, cercus ; *pd. pl.*, podical plate ; *sa. sty.*, subanal styles ; *spr.*, spiracle.

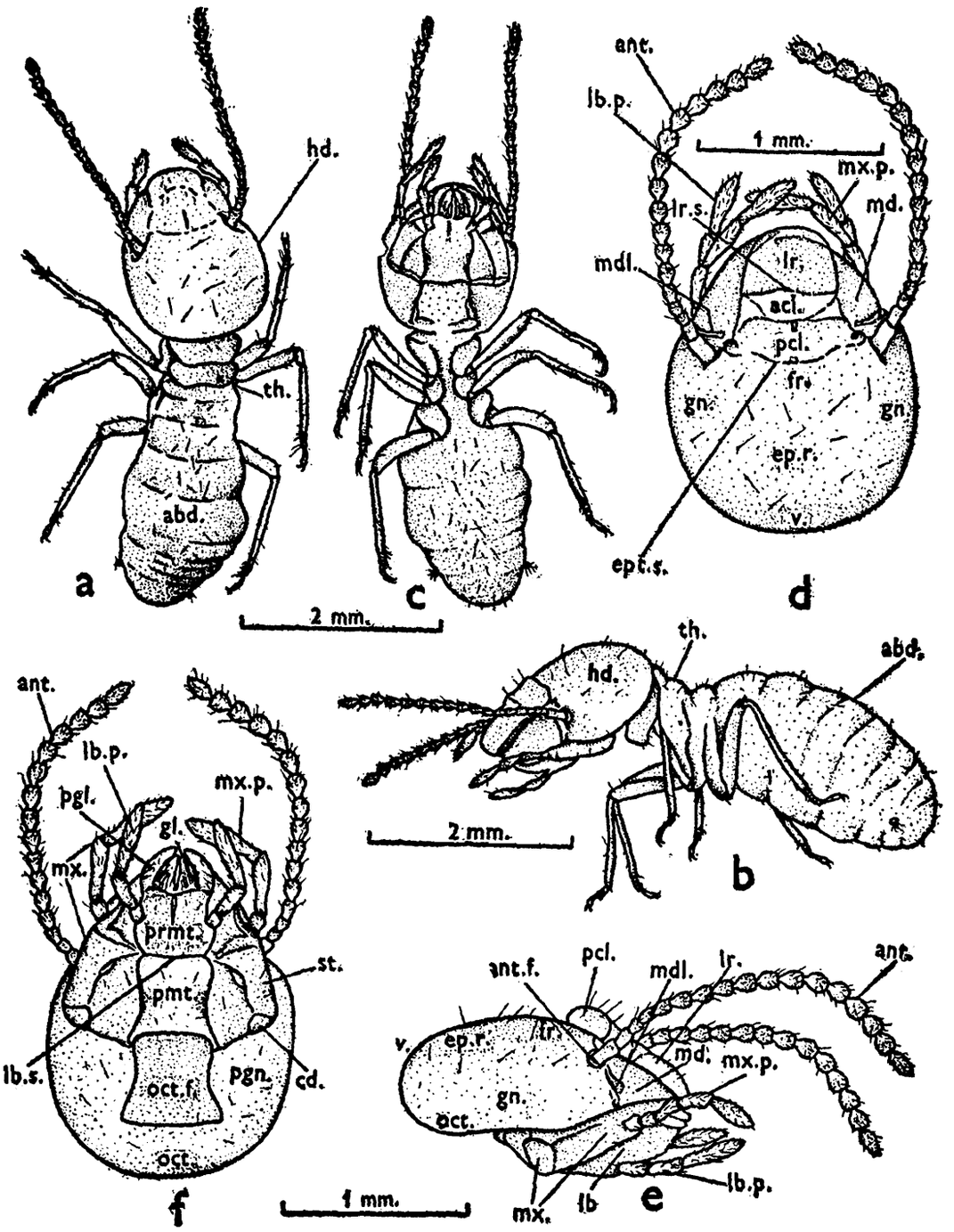
| Sclerites | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | ***Male*** | | | | | |
| Tergites | I spr. | II | III | IV | V | VI | VII | VIII | IX | X |
| Pleura | — | spr. | spr. | spr. | spr. | spr. | spr. | spr. | — | — |
| Sternites | I | II | III | IV | V | VI | VII | VIII | IX sa. sty. | (X=pd. pl) cer. |
| | | | | | ***Female*** | | | | | |
| Tergites | I spr. | II | III | IV | V | VI | VII | VIII | IX | X |
| Pleura | — | spr. | spr. | spr. | spr. | spr. | spr. | spr. | — | — |
| Sternites | I | II | III | IV | V | VI | VII | (VIII) | (IX) | (X= pd. pl) cer. |

## IV—Morphology of the Workers

### 1. *Head*

(*a*) *General.*—The head, its appendages and tentorium, together with the cervix, of the worker bear close similarity to that of the alates except in size, the worker head being generally smaller. It is, therefore, not necessary to give a detailed description, and only the particulars in which the worker head differs from that of the alates will be mentioned here. The cuticle is least chitinized in workers as compared to the

soliders and alates. The general colour of the head is pale yellow, with the thorax and abdomen paler still ; the intersegmental areas appear whitish. There are no compound eyes or ocelli.



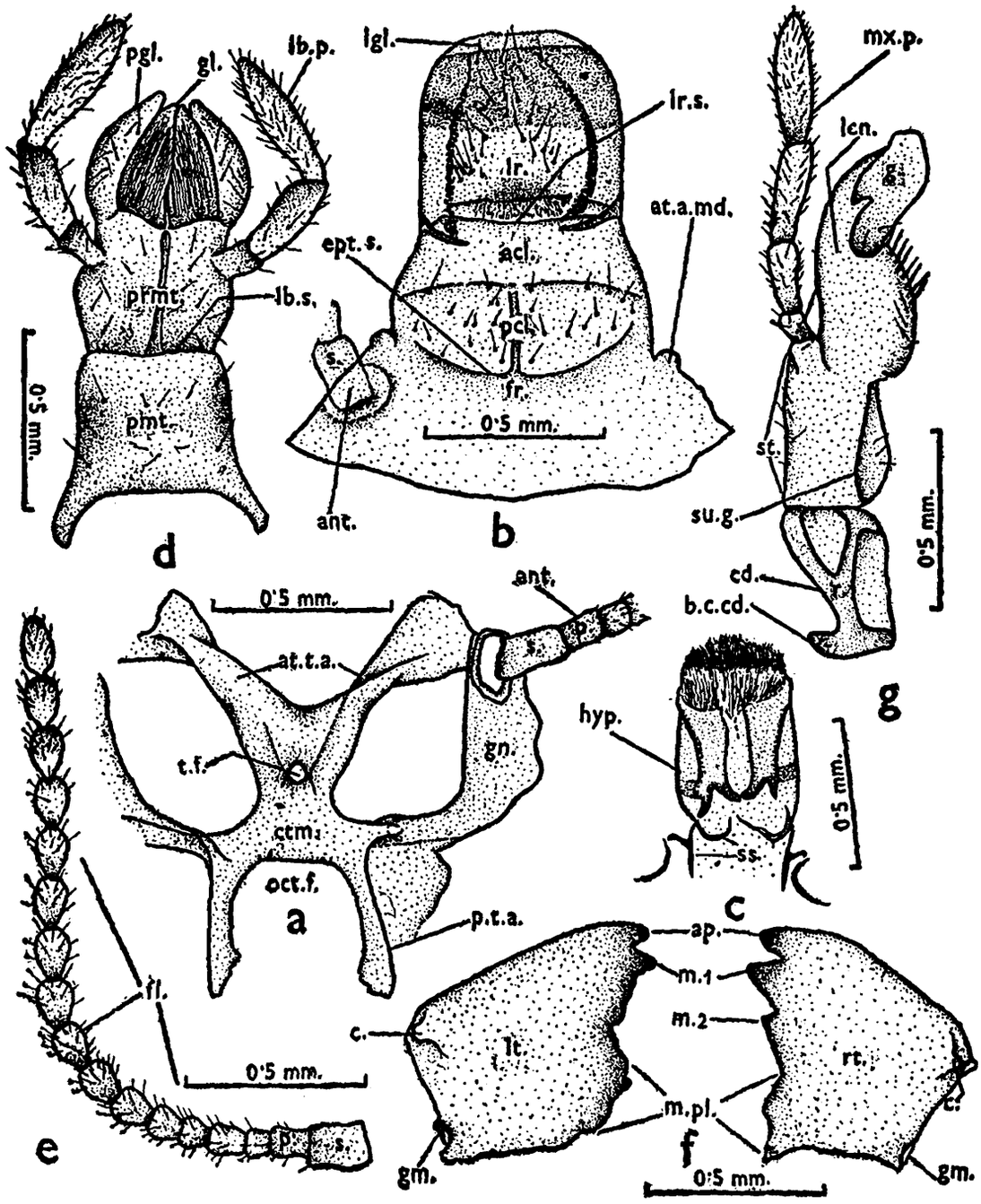

TEXT-FIG. 8.—*Odontotermes obesus* (Rambur), worker caste.

(*a*). Whole body in dorsal view. (*b*). Same, in lateral view. (*c*). Same, in ventral view. (*d*). Head, in dorsal view. (*e*). Same, in lateral view. (*f*). Same, in ventral view.

*abd.*, abdomen ; *acl.*, anteclypeus ; *ant.*, antenna ; *ant. f.*, antennal foveola ; *cd.*, cardo ; *ep.r.*, epicranial region ; *fr.*, frons ; *gl.*, glossa ; *gn.*, gena ; *hd.*, head ; *lb.*, labium ; *lb.p.*, labial palp ; *lr.*, labrum ; *lr.s.*, labral suture ; *md.*, mandible ; *mdl.*, mandibularia (or trochantin of mandible) ; *mx.*, maxilla ; *mx.p.*, maxillary palp ; *oct.*, occiput ; *oct.f.*, occipital foramen ; *pcl.*, postclypeus ; *pgl.*, paraglossa ; *pgn.*, postgena ; *pmt.*, postmentum ; *prmt.*, prementum ; *th.*, thorax ; *v.*, vertex.

All the sutures described in the case of the alates are distinct here except the ocular suture which is suppressed (Text-figs. 8*d*,*f* and 10).

The workers closely resemble the alates in respect of all the cranial areas (Text-figs. 8 *d-f* and 10), but for the postocciput which is a broader region. The frontal gland is visible but the fontanelle is indistinct The tentorial foramen is somewhat smaller than that of the solider (Text-figs. 9*a* and 10).

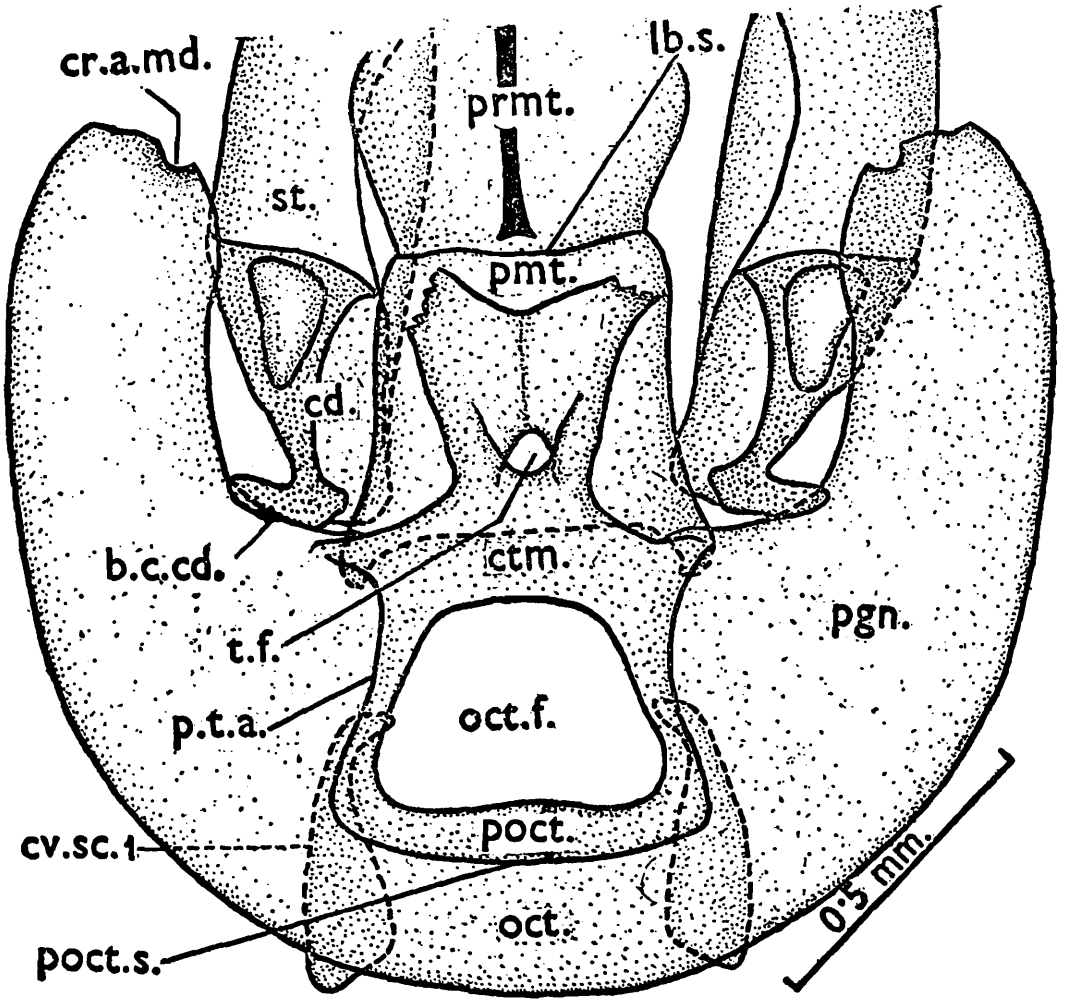



Text-fig. 9.—*Odontotermes obesus* (Rambur), worker caste.

(*a*). Tentorium. (*b*). Dorsal view of labrum and clypeus. (*c*). Hypopharynx. (*d*). Labium in ventral view. (*e*). Left antenna. (*f*). Left and right mandibles. (*g*). Maxilla.

*acl.*, anteclypeus ; *ant.*, antenna ; *ap.*, apical tooth of mandible ; *at.a.md.*, anterior articulation of mandible ; *at.t.a.*, anterior tentorial arm ; *b.c.cd.*, basal condyle of cardo ; *c.*, condyle of mandible ; *cd.*, cardo ; *ctm.*, corporotentorium ; *ept.s.*, epistomal suture ; *fl.*, flagellum ; *fr.*, frons ; *g.*, galea ; *gl.*, glossa ; *gm.*, ginglymus ; *gn.*, gena ; *hyp.*, hypopharynx ; *lb.p.*, labial palp ; *lb.s.*, labial suture ; *lcn.*, lacinia ; *lgl.*, lingula (hyaline tip of labrum) ; *lr.*, labrum ; *lr.s.*, labral suture ; *lt.*, left ; *m1*, *m2*, marginal teeth of mandible ; *m.pl.*, molar plate of mandible (or molar lobe, mola, pars molaris) ; *mx.p.*, maxillary palp ; *oct.f.*, occipital foramen ; *p.*, pedicel ; *pcl.*, postclypeus ; *pgl.*, paraglossa ; *pmt.*, postmentum ; *prmt.*, prementum ; *p.t.a.*, posterior tentorial arm ; *r.*, ridge ; *rt.*, right ; *s.*, scape ; *ss.*, suspensoria ; *st.*, stipes ; *su. g.*, sutural groove of stipes ; *t.f.*, tentorial foramen.

(*b*) *Head-appendages* (Text-fig. 9*b-g*).—The *labrum* (*lr.*) has subparallel lateral margins which get broadly rounded distally to end in a hyaline tip or *lingula* (*lgl.*). The segments of the *labial palpi* (*lb. p.*), starting from the proximal segment, vary, as regards length in the following proportion : 6 : 16 : 24. The *antennae* (*ant.*) have 17 segments. The *mandibles* (*md.*) are subquadrangular with more or less the same arrangement of teeth on the cutting edges as in alates except that the left one has only two prominent teeth (*ap.* and *m.1* ) and the right one only three (*ap.*, *m. 1.*, and *m. 2.*). The mandibles are 0·73—0·82 mm. long from the basal condyle to the tip of the apical tooth. The proportional lengths of the segments of the *maxillary palpi* from the proximal one onward are as 5 : 6 : 12 : 17 : 21.




TEXT-FIG. 10.—*Odontotermes obesus* (Rambur), worker caste.

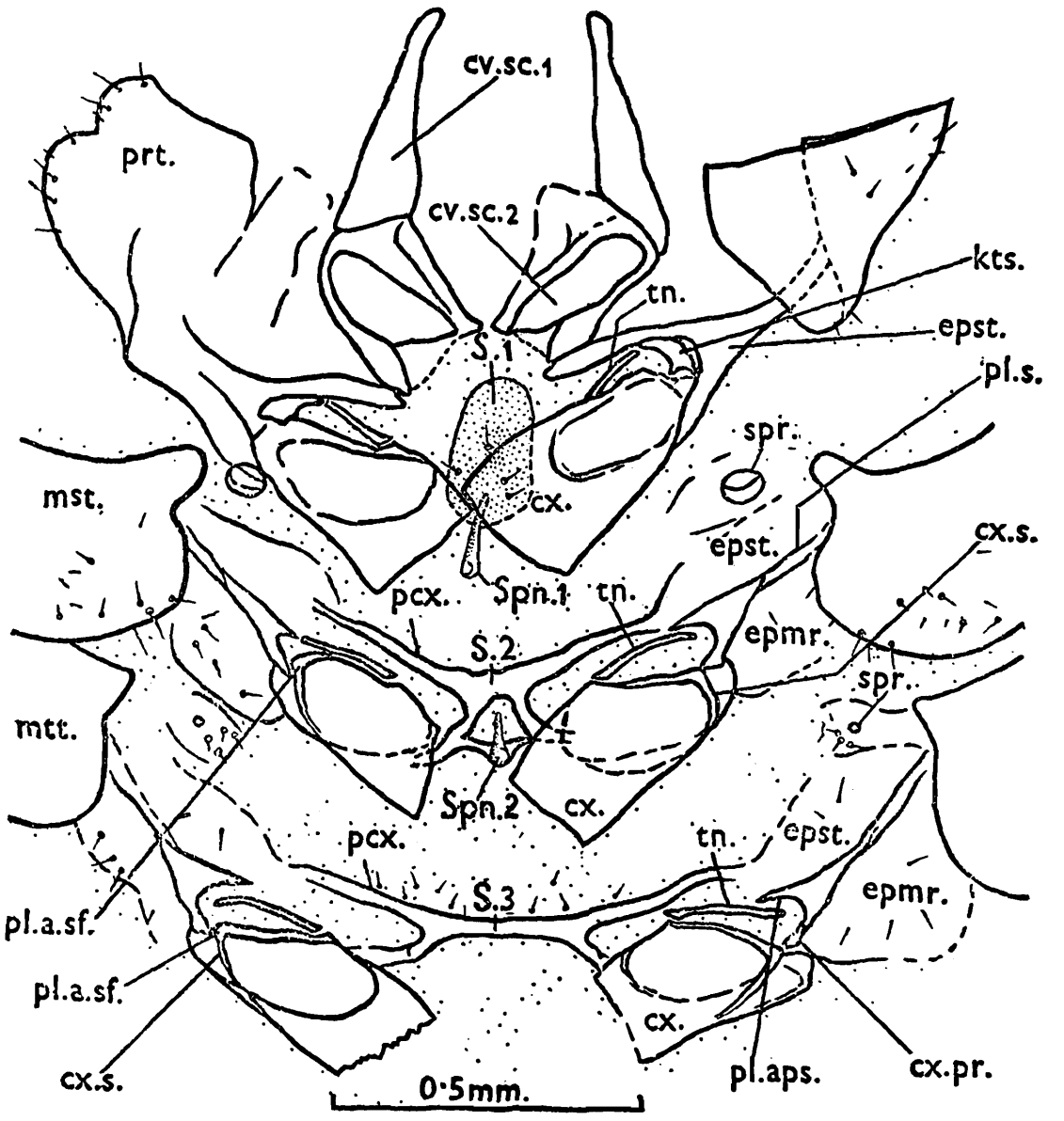
Ventral wall of the cranium, showing points of attachment of the tentorium, labium, maxillae and cervix.

*b.c.cd.*, basal condyle of cardo ; *cd.*, cardo ; *cr.a.md.*, cranial articulation of mandible ; *ctm.*, corporotentorium ; *cv.sc.1*, first cervical sclerite ; *lb.s.*, labial suture ; *oct.*, occiput ; *oct.f.*, occipital foramen ; *pgn.*, postgena ; *pmt.*, postmentum ; *poct.*, postocciput ; *poct. s.*, postoccipital suture ; *prmt.*, prementum ; *p.t.a.*, posterior tentorial arm ; *st.*, stipes ; *t.f.*, tentorial foramen.

## 2. *Thorax and abdomen*

(Text-figs. 11 and 12)

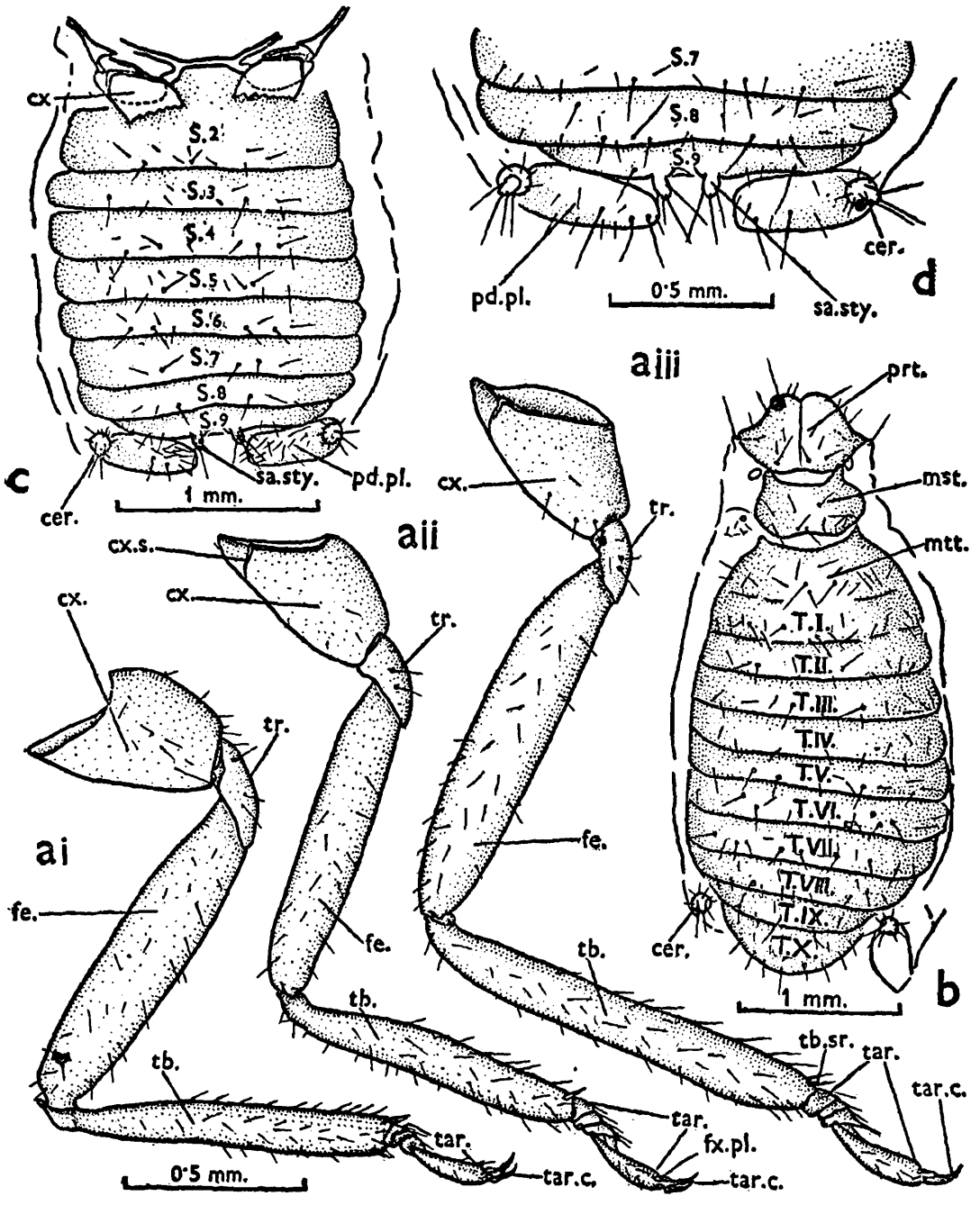
The thorax and abdomen are almost similar to that in soldier as regards the tergites, pleural sclerites, sternites, legs, spiracles and the terminal abdominal appendages in shape and size.




Text-fig. 11.—*Odontotermes obesus* (Rambur), worker caste.

Thorax, showing the various ventral and lateral sclerites and the attachment of the coxae together with the tergites cut and spread out flat on either side.

*cv.sc.1.*, first cervical sclerite ; *cv.sc.2.*, second cervical sclerite ; *cx.*, coxa ; *cx.pr.*, coxal process ; *cx.s.*, coxal suture ; *epmr.*, epimeron ; *epst.*, episternum ; *kts.*, katepisternum ; *mst.*, mesonotum ; *mtt.*, metanotum ; *pcx.*, precoxale ; *pl. aps.*, pleusal apophysis ; *pl. a.sf.*, pleural articular surface ; *pl.s.*, pleural suture ; *prt.*, pronotum ; *S2-3*, sterna 2-3. *spr.*, spiracle ; *tn.*, trochantin of leg.




TEXT-FIG. 12.—*Odontotermes obesus* (Rambur), worker caste.

(*ai*, *aii*, *aiii*). Fore-, middle-, and hind-legs respectively of the left side. (*b*). Dorsal view of the thoracic and abdominal tergites. (*c*). Ventral view of the abdominal sternites. (*d*). Same, only VII, VIII, IX and X (podical plates) sternites, magnified.

*cer.*, cercus ; *cx.*, coxa ; *cx.s.*, coxal suture ; *fe.*, femur ; *fx.pl.*, flexor plate ; *mst.*, mesonotum ; *mtt.*, metanotum ; *pd. pl.*, podical plates ; *prt.*, pronotum ; S.2—9, sterna 2—9 ; *sa.sty.*, sub-anal styles ; T.I., T.II.,.. ..T.X., terga first, second, etc.; *tar.*, tarsus ; *tar.c.*, tarsal claw ; *tb.*, tibia ; *tb.sr.*, tibial spur.

## V—SUMMARY

1. The external morphology of the alate and the worker castes of *Odontotermes obesus* (Rambur) is described. The material was collected from areas around Dehra Dun (U.P.).

2. The workers resemble the alates in the configuration of their head, but they resemble the soldiers in the configuration of their thorax and abdomen.

3. The paired compound eyes and the ocelli are developed only in the alates.

4. The antennae in alates are 19-segmented ; in workers 17-segmented.

5. The more complex pterothoracic segments differ structurally from the simpler prothorax in respect of the terga, the pleura and the sterna.

6. The two pairs of wings are divided by the humeral suture into the permanent wing-stump or scale and the temporary lamina.

7. The three basal articular sclerites (axillaries) participate in complex wing-thorax joint.

8. The costal and subcostal veins of the wings are fused with the costal margin.

9. The abdominal spiracles of the alates show a conspicuous manubrium.

10. The first abdominal sternite is atrophied in both alates and workers. In the female of alates, the VII sternite is hyperdeveloped, while sternites VIII and IX are reduced and each divided into two halves. The paired podical plates represent the X sternite in both alates and workers.

11. In the alates, the subanal styles are borne on the IX sternite of the males alone.

## VI—References

Cook, E. F. 1944. The morphology and musculature of the labrum and clypeus of insects. *Microentomology*, **9**, pt. 1, pp. 1-35.

Crampton, G. C. 1914. Notes on the thoracic sclerites of winged insects.—*Ent. News*, Philadelphia, **25**, pp. 15-25.

Fuller, C. 1924. The thorax and abdomen of winged termites.—*Ent. Mem. S. Afr., Dept. Agri.*, Pretoria, **2**, pp. 49-78, 3 pls.

Holmgren, N. 1909. Termitenstudien. I. Anatomische Untersuchungen.—*K. svenska Vetensk Akad. Handl.*, Uppsala & Stockholm, **44** (3), pp. 1-215, 3 pls.

Imms, A. D. 1948. *A General Text-Book of Entomology, Including the Anatomy, Physiology, Development and Classification of Insects.*—(7th ed.), xii+727 pp.—London (Methuen & Co.).

Kushwaha, K. S. 1955. External morphology of the soldier of *Odontotermes obesus* (Rambur).—*Curr. Sci.*, Bangalore, **24**, pp. 203-204.

Kushwaha, K. S. 1960. External morphology of the termite, *Odontotermes obesus* (Rambur) (Isoptera : Termitidae). Part 1. Soldier.—*Rec. Indian Mus.*, Delhi, **54** [1956], pp. 209-227.

Roonwal, M. L. 1956. External genitalia of termites (Isoptera).—*J. zool. Soc. India*, Calcutta, **7** (2), pp. 107-114.

Snodgrass, R. E. 1909. The thorax of insects and the articulation of the wings.—*Proc. U. S. nat. Mus.*, Washington, **36**, pp. 511-595, 30 pls.

Snodgrass, R. E. 1935. *Principles of Insect Morphology* (1st ed., 5th impression). ix+667 pp.—New York & London (McGraw Hill.).

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