

ON SOME AUSTRALIAN TERMITES OF THE GENERA
DREPANOTERMES, HAMITERMES AND LEUCOTERMES.

By GERALD F. HILL, F.E.S.

(Plates IX–XII.)

This paper is intended as the first of a series in which it is proposed to record the results of an examination of a large collection of termites from various parts of the Australian continent. The greater part of this collection has been gathered in the northern districts of the Northern Territory, and in North Queensland, but during the past year it has been considerably increased by the addition of numerous small collections received from correspondents in Victoria, Western Australia and South Queensland, and now contains individuals from over 800 colonies. Through the courtesy of the authorities of the South Australian Museum I have been able to examine a number of co-type specimens which have been of the greatest assistance in clearing up many doubtful identifications. In addition to these, I have been able to study many species from localities not represented in my own collection.

For various reasons it has not been found practicable to study the species contained in these collections in systematic order; in many instances imagines, which are sometimes essential to satisfactory determination of species, are wanting; in others, reference to types or authenticated specimens of previously described species is necessary in order to obviate the possibility of creating synonymy. It is proposed, therefore, to deal with the various species more or less at random, leaving the preparation of a more comprehensive work until such time as our knowledge of the Australian termite fauna is much more complete than it is now.

Dr. Eric Mjöberg (1920) has recently added no less than 36 new species to those previously known from Australia and New Zealand, and has otherwise much increased our knowledge of the order. He lists 80 species, exclusive of some which have been too imperfectly described for identification, as comprising the termite fauna of Australia, Tasmania and New Zealand. To this list, however, should be added two old described species, *viz.*, *Calotermes convexus*, Walker, and *C. obscurus*, Walker, the types of which are still in existence, *Leucotermes paradoxus*, Frogg., and eight Northern Territory species described by me in 1915.

Eight new species, one new variety, and one hitherto unknown imago are described in the present paper, leaving at least 20 new species in the writer's collection to be dealt with. In addition to the latter number there are several species which cannot be satisfactorily described until more complete material is available for study.

A critical examination of a large collection of *Hamitermes*, *Drepanotermes*, *Leucotermes*, *Rhinotermes* and *Coptotermes*, has shown conclusively that in many species determinations cannot be made satisfactorily, if at all, from the soldier and worker castes alone. This fact will be made clear in this and subsequent papers.

Although aware of Fuller's recent paper (1920) on the antennae of termites, I have followed recent writers on the Australian species in regarding the number and form of the joints of this organ as possessing considerable taxonomic value. While due allowance must be made for the variations which certainly do exist in the antennae of nest-series, and not infrequently in the antennae of individuals, I see no reason at present for departing from the general practice of referring in some detail to antennal characters in descriptions of new species.

The wing measurements recorded in this paper were taken from the humeral suture to the apex. Head lengths, excepting where otherwise stated, are from the posterior margin of the head to the apex of the mandibles. Measurements are given in millimetres.

The type series, unless the contrary is stated, are in the author's collection.

***Drepanotermes silvestrii*, sp. n.**

Imago.—Head very dark brown, nearly black; postclypeus, thoracic, and abdominal tergites Brussels brown; lower surface chiefly antimony yellow; mid and hind tibiae, pleurae, and lateral blotches on abdominal sternites dark; wings dark brown.

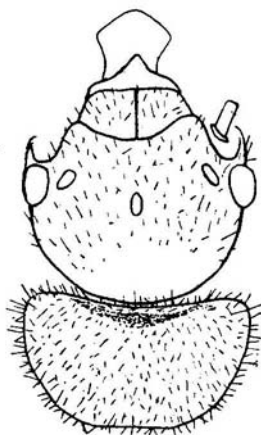


Fig. 1. *Drepanotermes silvestrii*, sp. n., head and prothorax of imago.

Head (fig. 1) rounded behind, flat on the summit, glabrous, moderately setose, Labrum moderately large, swollen on the sides, rounded in front. Anteclypeus, membranous, pointed in front. Postclypeus rather larger than in *D. rubriceps*, Frogg., twice as wide as long. Eyes small, nearly circular (0.329×0.376), slightly projecting. Ocelli large, oval, oblique, well separated from the eyes, anterior margin in line with anterior margin of eyes. A small deep impression on either side between the ocelli and clypeus. Fontanelle large, broadly oval, very distinctly visible, with small indistinct forward extension. Antennae 18-jointed, not variable in size and shape of segments; 1st joint long, stout, cylindrical, more than twice as long as wide; 2nd three-fifths the length and two-thirds the width of 1st; 3rd and 4th very short, shortest of all, narrower than 2nd, coalesced; 5th short but distinctly longer and wider than 3rd and 4th; 6th longer and wider than 5th; 7th, 8th and 9th equal; 10th longer than 9th; 11th to 15th about equal; 16th and 17th a little longer and narrower, 17th narrower than 11th to 16th; 18th as wide as, but longer than 17th, as long as 1st, pointed.



Fig. 2. *Drepanotermes silvestrii*, sp. n., hind tarsus of imago.

Prothorax (fig. 1) nearly flat, slightly sinuate and bent up in front, antero-lateral angles rounded, sides rounded to the rounded posterior margin, moderately setose. Meso- and metathorax uniform brown, wing-stumps similar to those of *D. rubriceps* but smaller. Legs (fig. 2) very long and slender, armature alike in each excepting that the first tibiae bear the usual additional spur; fourth tarsal of each leg very long and slender; femora all about equally stout.

Wings (fig. 3) with the margin ciliate, membrane with very few hairs; dark brown, a little lighter on costal border; subcosta very short, hardly extending beyond suture; costa and radius well separated, the latter very dark, joining the former near the apex, sometimes giving off beyond the middle numerous small veinlets to the costa; median of the fore-wing branching from the radius within the wing-stump, moderately thick at the base, nearer to the cubitus than to the radius, branching very irregularly, sometimes dividing into two before the middle and each branching again into two or three, the main superior branch joining the radius near the distal end of the latter or bending downwards and joining the wing margin at or very near the apex, if the former, a number of small cells are formed beyond the junction; sometimes the branches are all curved downwards and reach the hind margin below the apex. There is always a network of veinlets between the median and radius. The median vein of hind-wing branches from the radius beyond the suture, but otherwise it is like that of the fore-wing; sometimes there is an inferior branch near the base which joins the cubitus about the proximal third of the wing; sometimes this branch joins the second one and forms a large elongate cell, or there may be a succession of cells of varying shape and size. The cubitus of the fore-wing has from 10 to 16 branches, forked or simple, all of which join the hind margin before the distal fourth or fifth of the wing: that of the hind wing has from seven to nine simple or forked branches, the first five to seven of which are much darker than the others.

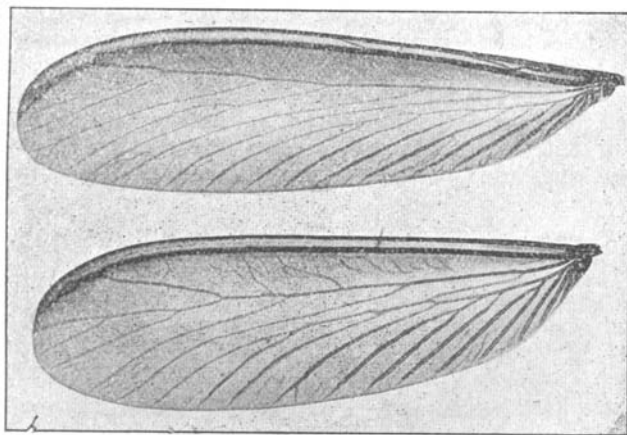


Fig. 3. *Drepanotermes silvestrii*, sp. n., wings of imago.

Abdomen large, distended, with eight distinct broad dark tergites, clothed with short fine hairs, and with apical and lateral margins fringed with longer yellow hairs. Ventral surface of female with six visible yellow-ochre sternites, each with dark lateral blotches, the fifth longer than the preceding ones, but much shorter than the sixth. The male has eight distinct sternites, the fifth and sixth longest, the seventh much shorter and narrower, the eighth shortest and very narrow. Cerci short and stout. Styli absent in both sexes.

Measurements*: Length with wings, 19-20; length without wings, 11; head, with mandibles, 2.16 long; head, at and including eyes, 1.7 wide; antennae, 3; mandibles, right, 0.92-1.03 long, 0.7-0.75 wide; left, 1.03-1.08 long, 0.62-0.65 wide; prothorax, 0.94 long, 1.64-1.78 wide; forewings, 15-16 long, 4 wide; hindwings, 14.5 long, 4.5 wide; tibia (i) 1.42, (ii) 1.55, (iii) 2.11; abdomen, 2.75 wide.

* Given in millimetres.

Queen.—Antennae generally complete, *i.e.*, 18-jointed; wing-stumps often mutilated; two or three legs generally amputated, claws of remaining legs short and blunt, apices of second and third tarsi heavily chitinised. Eight dorsal and six ventral abdominal plates distinct; pleurae and integument cream-coloured. Abdomen 16 long by 6 wide. Other characters as in imago.

King.—Uniformly dark above; abdomen much contracted and plates overlapping; pleurae obscured by dorsal and ventral plates. Other characters as in queen and imago. One specimen examined; apparently very old; associated with two old neoteinic queens.

Neoteinic Queen.—Head and clypeus yellow-ochre, prothorax a little lighter; tergites and sternites amber-yellow, the latter with wearing surfaces dark and heavily chitinised, pleurae and spaces between plates cream-coloured. Head wide; eyes small, hardly projecting, only inner facets pigmented; ocelli as in imago; fontanelle a large oval cavity about as large as and shaped like eye (in nymphs of the first form it is much smaller and proportionately more elongate, as in adult); antennae 17-jointed, apparently never mutilated, third and fourth joints fused, short; prothorax shaped as in imago; wing-buds long, slender, subequal, three-fifths length of the entire sclerite. Abdomen with cuticle horizontally striate.

Measurements: Head, at and including eyes, 1.70 wide; prothorax, 0.94 long, 1.60 wide.

Described from two old individuals found in association with the true king described on a preceding page. Several other similar specimens seen. These forms are derived from nymphs of the second form, *i.e.*, in the stage preceding the acquisition of the long wing-buds characterising nymphs of the first form, *i.e.*, those which are destined to develop into winged imagines. In second form nymphs, and neoteinic queens developed from them, the mesonotum and metanotum, including wing-buds, measure 2.35 in length; in nymphs of the first form, *i.e.*, potential winged imagines and true kings and queens, the length is 4.25. The antenna in each is 17-jointed.

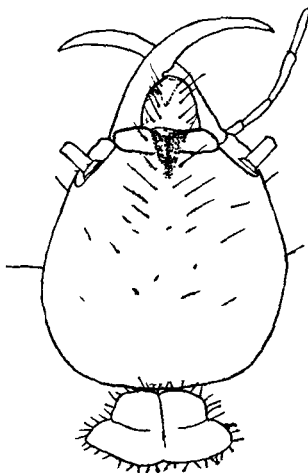


Fig. 4. *Drepanotermes silvestrii*, sp. n.,
head of soldier.

Soldier.—Head orange-rufous to Sandford's brown; mandibles mahogany-red; labrum yellowish, apex hyaline; antennae nearly as dark as head; junction of segments hyaline; pro-, meso- and metathorax russet to argus brown; legs and abdominal tergites light clay-colour.

Head (fig. 4) very large and broad, rounded behind, with a pale median suture from posterior margin forwards, widest behind the middle, sloping in towards the antennae, bearing a few moderately long reddish hairs, variable in size. Mandibles very long, falciform, each with a large angular tooth before the middle (fig. 5). Labrum large, wide at the base, sloping on the sides to the bluntly pointed apex. Clypeus three times as wide as long, divided into two lobes by a deep and wide median cleft, which extends posteriorly into the front of the head. Antennae 17- or 18-jointed, generally segmented as in *D. rubriceps*, Frogg., sometimes third and fourth joints closely fused and together only equal to sixth in length.

Prothorax (fig. 4) much narrower than head, anterior half rounded and bent up in front, slightly emarginate in middle, postero-lateral angles rounded, hind margin rounded and slightly emarginate in middle; the margin clothed with short stout reddish hairs. Mesothorax narrower and shorter than prothorax, hind margin with a few stout reddish hairs. Metathorax as wide as prothorax and clothed like mesothorax. Legs very long and slender, with scattered reddish hairs, fourth tarsal very long. Tibial spurs 3 : 2 : 2, as in other *Drepanotermes* and *Hamitermes*.

Abdomen elongate, narrow, with scattered stout reddish hairs and a few slender golden ones on tergites and sternites. Cerci long and slender. Styli present or absent.

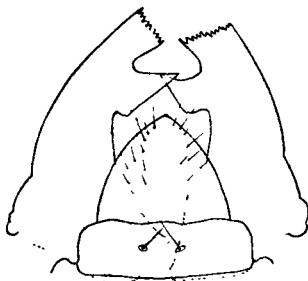


Fig. 5. *Drepanotermes silvestri*, sp. n.,
base of jaws, labrum and clypeus of
soldier.

Measurements: Total length, 6.25-7; head and mandibles, 2.75-3.1 long; thorax and abdomen, 4-4.5 long; mandibles, 1.31-1.64 long; head, 1.6 wide; 1.25-1.35 deep; antennae, 3.29-3.61; prothorax, 0.51-0.56 long, 1.03-1.12 wide; tibia (i) 1.5, (ii) 1.5, (iii) 2.11-2.39; abdomen, 1.5 wide.

Worker.—Colour of head as in soldier, or a little darker, with pale median suture extending forwards from the posterior margin, widening behind the fontanelle and spreading out behind the frons; clypeus clay-colour, labrum yellow-ochre; antennae a little paler; rest of insect clay-colour; prothorax a little darker than tergites and legs. Immature workers and soldiers have body and legs tinged with rose pink.

Head large, rounded on the sides and behind, nearly as wide as long, widest behind the base of the mandibles. Labrum large, convex, swollen on the sides, rounded in front. Anteclypeus membranous, short, pointed. Postclypeus large, convex at base, not quite as long as wide, sides rounded, anterior margin truncate. Antennae very long, 18-jointed, arising within a deep cleft situated well in from sides of head. Fontanelle as in imago.

Prothorax as in soldier, more setose, much narrower than head. Legs long and slender, clothed with scattered reddish hairs. Tibial spurs 3 : 2 : 2.

Abdomen elongate oval, hairs more numerous and more slender than in soldier. Cerci long and slender.

Measurements: Total length, 7-7.5; head, with mandibles, 2.16-2.35 long; thorax and abdomen, 5.5 long; head, 1.93 wide; antennae, 3.61; prothorax, 0.56-0.6 long, 1.22 wide; mandibles, left, 0.97 long, 0.65 wide, right, 0.86 long, 0.77 wide.

Biology.

This is one of the three predominant species of mound-building termites that are found in the Townsville district, N. Queensland. It inhabits the same localities as *H. perplexus*, sp. n., and the termitaria of the two species are often found in close proximity, although those of the latter are rather more common, especially on hill-sides. On the higher and stony localities many large colonies live entirely in underground galleries, the extent and nature of which have not yet been investigated sufficiently to determine whether they are connected with large masses of cells and passages comparable with termitaria. This seems most probable, since it is known that these colonies collect and store considerable quantities of food, and that eggs, young larvae and the reproductive forms are not found in the galleries near the surface, which serve apparently only for the accommodation of workers and soldiers, and a few adolescents of these castes, and for the temporary storage of food material during and just after harvesting operations. As all the normal castes are reared by these colonies, it seems reasonable to assume that each is provided with an underground system suitable for the location of the royal pair and their young and for the storage of food. On the other hand, considerable excavating failed to disclose a regular nest or "nursery" in the closely allied species *D. septentrionalis*, sp. n., in the Northern Territory (Hill, 1915). In the case of *D. septentrionalis*, small foraging parties of soldiers and workers are commonly found in the termitaria of *Coptotermes* and *Eutermes*, but this is not the case with *D. silvestrii*. Access to the surface is gained by means of numerous small oval openings, from 18 in. to 3 ft. apart, and extending over an area of from 6 ft. to 12 ft. in diameter. These openings measure about 3 mm. long by 6 mm., and except when actually in use, *i.e.*, at harvesting or "swarming" periods, are sealed with earthy matter, either level with the surface or just below it, in either case rendering their detection very difficult. Similar surface openings are found in the vicinity of termitaria, when these are constructed; but they appear to be used solely at harvest time—certainly not to provide a means of exit for the winged forms at the time of swarming. The natural dispersal of the imagines has not been observed, and it is not known whether the phenomenon occurs during daylight or at night. A day or two before swarming takes place, slits are cut in the walls of the termitarium, generally in several places near the outer margin and several inches above ground level. These slits are sealed over by a projecting crust of moist earthy matter, as in *H. perplexus*, sp. n., and remain thus until weather conditions are favourable for the flight, after which they are cemented up flush with the general surface of the walls.

One of the most remarkable habits observed in this species, and also in *D. septentrionalis*, is that of gathering food supplies by day as well as by night. Froggatt (1915) observes that travellers in the bush, who have gathered a mass of dried grass upon which to make their temporary bed, have been aroused to find hordes of termites (species not stated) cutting the material into lengths and removing it for food. Such is by no means a rare experience in North Australia, and it occurs during the day as well as at night, *D. septentrionalis* being the species concerned in all cases which have come under my notice. In this district I have frequently seen countless thousands of soldiers and workers of *D. silvestrii* issuing from several holes in the surface and spreading out in irregular columns over an area of several yards, each worker cutting off a length of grass (leaf or stem), a piece of eucalyptus leaf or twig, or seizing a seed or small piece of bark and hurrying back along the column to one of the openings, at each of which there is a good deal of congestion, but no sign of disorder or wasted effort. Throughout these operations the soldiers are much in evidence, regulating the traffic, scouting on the outskirts of the working parties, attacking marauding ants or any other insects or spiders they may encounter, and generally taking a strenuous and important part in the proceedings. Their behaviour is in marked contrast to that of their near allies the *Hamitermes*, and

many other species, in which the soldiers appear to be the embodiment of cowardice and uselessness. On one occasion harvesting operations were observed at night on the roadside in one of the more populous residential areas of the town, the material gathered being almost entirely coarse dry grass, which was cut into pieces about half an inch in length. The nature of the food varies according to the season of the year, the flora in the immediate vicinity and other circumstances. When there is a plentiful supply of dry grass this material appears to be most favoured, but there is nearly always present a quantity of grass and other seeds and a good deal of vegetable debris. In the vicinity of eucalyptus trees they gather pieces of leaf, leaf-stems, twigs and bark. The latter are carried into the termitaria in the rough state and afterwards dressed into pellets of varying size and shape. None of the species of this genus are wood-eaters, nor are they known to attack cultivated cereals.

The termitaria are nearly always low, flat and more or less circular masses composed of intensely hard cement-like material, varying in toughness according to the soil in which they are situated. In size they vary from about 8 in. to 2 ft. in height by 2 ft. 6 in. to 8 or 9 ft. in diameter. In gross appearance they resemble a mass of soft mud which has spread over the surface and hardened by evaporation (Pl. ix, fig. 1). There is no well-defined outer casing or wall (Pl. ix, fig. 2) as in nests of *Coptotermes*, the whole of the superstructure being composed of similar material. The interior is occupied by very large flattened chambers connected with each other by small circular holes large enough to permit of the free passage of soldiers and workers from chamber to chamber. Similar but rather larger chambers extend below ground, under the middle of the superstructure, to a depth roughly corresponding to the height of the latter. These chambers are excavated in the soil, and are much less resistant to digging operations than those above ground. Below them are several passages extending more or less vertically into the soil beneath. The majority of the chambers in the superstructure are occupied by workers, soldiers, and older adolescents, and by masses of grass and other foodstuffs. The latter is generally stored in the rather smaller outer cells, many groups of which are reserved for the reception of the waste matter from the community, *i.e.*, alimentary rejectamenta and the heads of dead soldiers. Evidently much of the waste material is carried in the jaws to these chambers, where it is tightly packed until the space is entirely filled, then the small entrances are cemented up, apparently never to be reopened. Other chambers are reserved for the reception of the faecal matter of certain individuals, probably soldiers and workers, who evacuate directly into them. Such chambers, when in use, are indicated by a deposit of more or less liquid matter just within the small entrance hole, the remainder being empty. As the deposit increases and hardens the entrance becomes blocked and is then cemented up. Analyses of the rejectamenta in these termitaria show that they contain about 32 per cent. of inorganic matter. Additions to these nests are nearly always made by extending the outer walls without increasing the height, and the increase in the diameter of the superstructure is greatly in advance of that of the underground portion. The latter is occupied by the reproductive forms, eggs, larvae and nymphs, and by their attendant soldiers and workers.

All the different castes have been found in the same nest and at the same time, but an ovigerous neoteinic queen has not been found in a nest presided over by a true queen. The soldiers are very numerous, active and pugnacious, and are capable of a most effective fight against marauding ants. When the termitarium is broken into the soldiers rush out in all directions, attacking every animate object they come in contact with—their fellow-soldiers and workers, ants, lizards and one's hands receiving equal attention. Some few devote their energies to rescuing their defenceless larvae, but this function devolves more upon the workers, who are hardly less pugnacious. Normally the colony is presided over by one true queen, who is generally located at, or just below, ground-level in a flattened cell of rather smaller size than the average cell in these nests. In one case only has a true king been found in the

queen cell. The true queen produces an enormous number of eggs, which are carried away by the workers and stored in masses in cells near the walls or near the queen-cell. Egg-laying is not confined to one particular season of the year, but it is not a continuous process, since eggs are often absent in certain thriving colonies while present in great numbers in others close by. Neoteinic queens are substituted for a true queen when a colony is naturally or designedly orphaned. In one colony a true king was found in a large cell with one ovigerous neoteinic queen; in another there were one true king and two of these neoteinics, in a third there were two neoteinics only, and in a fourth one neoteinic king and two neoteinic queens. Neoteinic queens of this species produce neoteinic males and females, as well as soldiers, workers, and nymphs of the first and second form.

The following field notes refer to termitaria of this species which have been kept under observation for some time:—

(1) This colony was orphaned on 22nd August 1919. When examined on 15th June 1920, it contained 20 young neoteinics of both sexes. There were no eggs or very young larvae present, but there were numerous half-grown larvae and second form nymphs. On 26th October 1920, two ovigerous neoteinic queens and four neoteinic males were removed from the nest. Eggs, young larvae and nymphs of the second form were plentiful. Some of the latter and one young neoteinic female were left in the nest, with workers and soldiers. By 15th February 1921, the termitarium was again restored to its original size and presented a very prosperous appearance. Eggs and young larvae were present, but no gravid female could be found. There were no young neoteinics present, but the second form nymphs which were left in the nest on the 26th October had now developed into nymphs of the first form. The parent of the eggs and young larvae found on this date was presumed to be the young neoteinic female left in the nest on 26th October.

(2) This nest was orphaned on 15th June 1920. On 26th October 1920, it contained four ovigerous neoteinics and nine immature neoteinic males and females. There were present also numerous second form nymphs, besides the usual workers and soldiers. The termitarium was now completely destroyed. On 15th February 1921, the nest was found to have been rebuilt to its original size and to contain numerous eggs, young larvae and nymphs of the second form. There were no nymphs of the first form or imagines present and the parent of the eggs and young larvae was not found. The whole termitarium was again destroyed, and on 18th March 1921 a good deal of it was found to have been rebuilt.

Each of several other nests which were orphaned at different periods of the year were found to contain neoteinic queens when examined subsequently. It has not been ascertained if a colony once deprived of its true queen is ever again presided over by another true queen; the contrary appears to be the case. In nests which are presided over by a true queen, or by one or more gravid neoteinics with numerous neoteinics in reserve, nymphs of the second form are found throughout the year, excepting from the middle of December to the end of January. A moult takes place about the former period, and the resulting first form nymphs have been found as late as 13th February, but the majority undergo their final moult and appear as imagines about the beginning of January, and all have moulted before the 8th March. When true queens or mature neoteinic queens are not present, nymphs of the second form may be present throughout the year. First form nymphs have not been found later than 15th February or earlier than 5th November. The actual date of swarming is determined by rainfall. In 1919–1920 first form nymphs were plentiful in the nests on 5th November 1919; the final moult took place between this date and 8th December, when most of the imagines were capable of flight, although some had not yet moulted. On 6th January and 15th January (1920) first form nymphs and imagines were still present in the nests. The former moulted before 30th January, and swarming took place before 10th February. In 1921 the wings of the majority

were fully developed on 15th February, but on 8th March, up to which date only light rain fell, these forms were still present in all the nests examined. On this date the tips of the wings showed marked damage due to prolonged occupancy of the parent nest. Similar conditions prevailed in the nests of *Hamitermes perplexus*, sp. n. Heavy showers fell on the night of the 9th March and throughout the day and night of 10th. Swarming of *H. perplexus* took place during the afternoon and evening of the latter date. The swarming of *D. silvestrii* was not observed, but probably took place about the same time, since none of the nests contained imagines on 14th March.

It is not intended to discuss in detail here the numerous other forms of life which have been found in termitaria, but brief mention may be made of one species which plays an important part in the economy of two species of termites dealt with in this paper. At a very rough estimate it may be said that 80 per cent. of the termitaria of *D. silvestrii* and *H. perplexus* are invaded and permanently occupied by the very common and widely distributed ant, *Iridomyrmex sanguineus*, Forel, which is particularly abundant on the low-lying country in the vicinity of Townsville. The termitaria are entered by means of holes burrowed into the walls (Pl. xii, fig. 2), in and out of which pass endless streams of ants in their journeys from one nest to another. If a termitarium is cut open vertically, it will be found that the ants have greatly enlarged the original galleries so as to form large flattened chambers in tier upon tier, until finally the greater part of the structure is in their undisputed possession. The floor of each cell is thickly covered with the eggs, larvae and pupae of the invaders, and immense numbers of ants throng all parts not actually in possession of the termites. As the ants extend their sphere, the termites are driven back from chamber to chamber and destroyed, until but a few stragglers are left. The complete, or nearly complete, occupation of a termitarium is evidently a matter of time, during which the advance is being constantly delayed by the termites walling up their galleries and passages as they retreat. The remains of the dead termites in the chambers occupied by ants show clearly that the nests are not attacked merely to provide a dry and safe shelter, but that the original occupants are used as food. Immediately the walls are broken with the pick the ants swarm out in countless thousands, destroying and carrying off the dislodged termites, crawling up one's legs and attacking one's hands, head or any skin surface to which they can gain access. Others of their kind gather from all directions to take part in the onslaught, until the nest and the surrounding ground is a seething mass of insect life. Under these conditions a close examination of the nest or its occupants is impossible, and it is only by finding an ant-free nest that one can hope to investigate its interior. Within a few minutes of the nest being broken into all the neighbouring ant-infested termitaria of these two species will be found to contain the bodies of freshly killed termites, while files of ants pass to and fro so long as a termite remains exposed to attack. Plate xii, fig. 1, shows ant tracks made on the surface of the ground approaching a mound of *H. perplexus*. It is a remarkable fact that the mounds of a certain species of *Euterмес*, which are very common amongst those of the *Drepanotermes* and *Hamitermes*, are never molested by *Iridomyrmex*.

The imagines of the beetle, *Cryptodus grossipes*, Fairm., have been found in the cells of *D. silvestrii*, and *Mandalotus germinatus*, Lea, has been taken on two occasions in the nests of *H. perplexus*. Their relationship to their hosts is not known. *Bubaris indemniss*, Pascoe, has been found under the walls of termitaria of several kinds, but they appear not to come directly into contact with the termites.

Ciliates (? *Trichonympha*), which occur in vast numbers in all the workers and soldiers and in many imagines of *Mastotermes darwiniensis*, Frogg., in Townsville, have not been found in *Drepanotermes silvestrii*, or in any other local species of termite.

***Drepanotermes septentrionalis*, sp. n.**

Termes rubriceps, Hill (*nec* Frogg.), Proc. Linn. Soc. N.S.W., xl, pt. 1, 1915.

Imago.—Head bay, clypeus argus brown; labrum, palpi, antennae and legs buckthorn brown, anteclypeus lighter; thorax and abdominal tergites auburn; lower surface of abdomen uniform ochraceous tawny; wings Brussels brown, faintly tinged with yellow behind second vein.

Head wide, rounded behind and on the sides, flat on the summit, moderately hairy. Labrum moderately large, swollen on the sides, rounded in front. Anteclypeus yellow, membranous, slightly pointed in front. Postclypeus convex, twice as wide as long, with median suture very distinct. Eyes small, circular (0.376 diameter), prominent. Ocelli broadly oval, widely separated from eyes. The small deep impression between ocelli and clypeus pale-coloured. Fontanelle broadly oval, about the size and shape of ocelli, with short indistinct forward extension, similar to that of *D. silvestrii*, sp. n., but slightly larger. Antennae 18-jointed; 1st segment moderately long and wide; 2nd half as long as 1st; 3rd, 4th and 5th small and closely fused; 3rd and 4th equal to each other, and a little longer than 5th; 6th longer and wider than 5th.

Thorax similar to that of *D. silvestrii*, but more rounded on the sides, similarly clothed. Legs as in *D. silvestrii*.

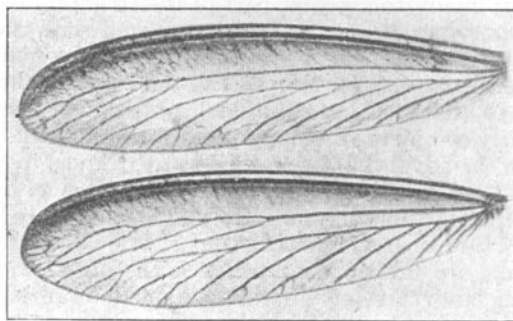


Fig. 6. *Drepanotermes septentrionalis*, sp. n., wings of imago.

Wings (fig. 6) with the margin ciliate; membrane with many hairs, subcosta very short, hardly extending beyond suture, costa and radius well separated, the latter very dark and connected with the former near the apex of the wing by a few indistinct nervures; median of the fore-wing branching from the radius within the wing-stump, that of the hind-wing just beyond suture, nearer to cubitus than to radius; branches of the median and cubitus very irregular and not alike in either fore- or hind-wing.

Abdomen elongate, nearly cylindrical, moderately densely clothed with short reddish hairs; ten dorsal and six ventral plates distinctly visible. Cerci as in *D. silvestrii*.

Measurements: Length with wings, 15; length without wings, 8; head, with mandibles, 2.06 long; head, at and including eyes, 1.78 wide; prothorax, 1.03 long, 1.22 wide; fore-wings, 13 long, 3.25 wide; hind-wings, 12.5 long, 3.5 wide; abdomen, 1.73–1.92 wide.

Soldier.—Very like *D. silvestrii*, sp. n., from which it differs in having the labrum larger and more rounded at the apex, clypeus shorter and less strongly lobed, antennae (fig. 7) of the same number of joints, *i.e.*, 17 or 18, but the size and shape of the basal joints very distinctly different, *viz.*, in *D. septentrionalis* the 1st joint is shorter and wider, the 2nd shorter and narrower, the 3rd and 4th very short, together equal

to the 3rd in *D. silvestrii*, 5th about half the length of corresponding joint in the latter species. The head very slightly redder than in the allied species. In size it is intermediate between individuals of *D. silvestrii* from high stony localities (Castle Hill, Townsville), and those from the low-lying country in the vicinity (Townsville Common).

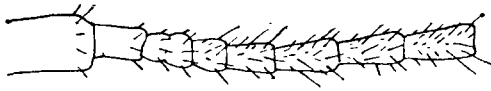


Fig. 7. *Drepanotermes septentrionalis*, sp. n., basal joints of antenna of soldier.

Worker.—Very like that of *D. silvestrii*; head more reddish, median suture very obscure, not widening in front to surround the fontanelle; fontanelle hardly visible; antennae with 18 joints, stouter, but otherwise similar.

This caste, like the soldier, is intermediate in size between *D. silvestrii* from the hill-sides and from the plains, as shown by a series of measurements of antennae, mandibles and tibiae.

Biology.

The imago was originally described under the name of *Termes rubriceps*, Frogg., from a de-alated female taken on 11th January 1914 (Hill, 1915), and is here re-described from a perfect specimen of the same sex taken under similar circumstances and in the same locality on 3rd February 1918.

From a very thorough knowledge of all the country on either side of the Darwin-Katherine Railway within 60 miles of the coast, I am convinced that these termites do not construct termitaria, but live in rambling underground galleries as previously described (Hill, 1915).

***Drepanotermes daliensis*, sp. n.**

Soldier.—Head very dark, nearly black; front of head, clypeus, anterior part of prothorax and mandibles a little lighter, clypeus yellow; antennae, palpi and legs ochraceous tawny.

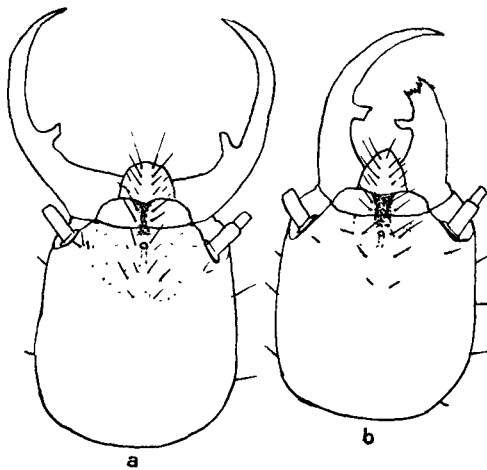


Fig. 8. Head of soldier of (a) *Drepanotermes daliensis*, sp. n.; (b) *D. perniger*, Frogg.

Head (fig. 8, a) very large, widest behind, sloping in slightly to the base of the jaws; frons flattened, a little rugose, median suture indistinct. Mandibles very long and slender, falciform, each with a large angular tooth nearer to the base than to the apex

and generally directed slightly forward. Labrum large, convex, rounded on the sides to the bluntly rounded apex. Clypeus large, slightly convex, emarginate in front, divided medially by a deep depression. Fontanelle very indistinct. Antennae (fig. 9, *b*) very long and slender, 19- or 20-jointed, rarely 18; 1st joint twice as long and about half as wide as 2nd; 2nd nearly cylindrical, one-third longer than 3rd; 3rd narrowest at base, wider than 4th at apex; 4th shortest of all; 5th a little longer and wider than 4th; 6th nearly as long as 2nd; 7th longer and narrower than 6th.

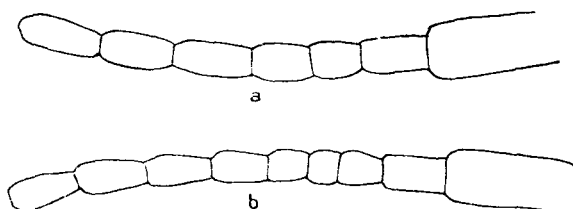


Fig. 9 Proximal segments of antenna of soldier of (a) *Drcpanotermes perniger*, Frogg; (b) *D. daliensis*, sp. n.

Prothorax similar to that of *D. silvestrii*, but anterior half narrower. Legs long and slender, with scattered hairs except on inner side of tibiae, which are fringed with longer and stouter hairs; mid-tibiae with two short stout apical setae on upper side, which are absent in hind tibiae; first three tarsals very short, 4th very long; tibial spurs 3 : 2 : 2.

Abdomen as in *D. silvestrii*, sp. n.

Measurements :—

		<i>D. daliensis</i> , sp. n.	<i>D. perniger</i> , Frogg.
Head and mandibles, long	..	3·290-3·807	.. 3·196
Thorax and abdomen, long	..	3·290	.. 3·290
Mandibles, long	..	1·551	.. 1·598
Head, deep	..	1·175	.. 1·034
„ wide	..	1·645	.. 1·598
Antennae	..	3·666	.. 3·666
Prothorax, long	..	0·658	.. 0·564
„ wide	..	1·128	.. 1·081
Tibia (i)	..	1·410	.. 1·457
„ (ii)	..	1·457	.. 1·363
„ (iii)	..	2·115	.. 2·303
Abdomen	..	1·05	.. —

Worker.—Colour of head as in soldier; clypeus and jaws (excepting teeth) tawny olive; labrum, palpi, antennae, thorax and legs clay-colour.

Head large, rounded behind and on the sides, widest near the middle, a pale coloured and very distinct median suture extending from back of head forwards, spreading out around the fontanelle, which is a sharply defined, small, broadly oval depression; frons sloping slightly to the base of the clypeus, very faintly rugose. Labrum large, very convex, covering apex of jaws, narrower than anteclypeus at base, swelling out sharply in the middle to the rounded apex. Anteclypeus large, middle of anterior margin produced into a point. Postclypeus large, twice as wide as long, convex, truncate in front, strongly arcuate behind, median suture hardly visible, with very few hairs. Antennae 19- or 20-jointed; 3rd, 4th and 5th joints short; 4th shortest.

Prothorax as in soldier, entire surface with stout reddish hairs. Legs long and slender, as in *D. silvestrii*, sp. n.

Abdomen narrow, tapered to the pointed apex, with pale reddish hairs of various lengths. Cerci long and slender.

Measurements :—

	<i>D. daliensis</i> , sp. n.	<i>D. perniger</i> , Frogg.
Total length	6	
Head, long	2·115–2·250	1·927
Thorax and abdomen, long	3·995	3·525
Head, wide	1·739	1·692
Antennae	3·700	3·800
Mandibles :		
left	·987 long by ·658 wide	·890 long by ·640 wide
right	·893 long by ·752 wide	·799 long by ·750 wide
Prothorax, long	0·705	0·611
" wide	1·034	1·128
Tibia (i)	1·316	1·363
" (ii)	1·222	1·316
" (iii)	1·924	2·068

This species is very closely related to *D. perniger*, Frogg. The soldiers are distinguished as follows : In *D. daliensis* the head is very much darker ; the frons is slightly protuberant and rugose, the middle falling gently into the frontal opening. In *D. perniger* (fig. 8, *b*) the frons is only slightly protuberant, but more rugose. The clypeus in *D. daliensis* is less lobed in front and the furrow dividing it medially is narrower and shallower ; the labrum is much shorter and rounder ; the antenna has always one, but generally two or three, additional joints, the fourth and fifth of which are very much shorter than in *D. perniger* (fig. 9, *a*). The worker may be distinguished from that of *D. perniger* by its darker head and 19- or 20-jointed antennae.

Type series in South Australian Museum, co-types in author's collection.

NORTHERN TERRITORY : Upper Daly River (*H. Wesselman*).

Drepanotermes perniger, Frogg.

In his discussion of this species Dr. Mjöberg (1920, p. 69) remarks that the soldiers from different localities show considerable differences in the colour, size and shape of the head, but that he has found no constant characters which justify him in regarding the pale-headed forms from North Queensland and Kimberley as specifically distinct from the typical dark-headed forms. Then follows a description of the imago, but unfortunately no locality is given, nor is it stated if his specimens were associated with pale- or with dark-headed soldiers. On page 57 the same author gives a key for the differentiation of the soldiers of the two hitherto described species of *Drepanotermes*, viz., *D. perniger*, Frogg., and *D. rubriceps*, Frogg., the former being distinguished by the very long jaws and very broad, projecting tooth, and the latter by shorter jaws and triangular tooth. The jaws of *D. perniger* are figured on page 76.

In this paper I have referred to the similarity which exists in the heads of soldiers of certain species the imagines of which show marked specific differences ; for this reason I cannot agree with the suggestion that pale- and dark-headed forms are referable to a single species. If the imagines described by Dr. Mjöberg as *D. perniger* were associated with pale-headed soldiers it is most probable that they are referable to another species. With regard to characters given for the soldiers of *D. perniger* and *D. rubriceps*, it may be said that the shape of the mandibular tooth is variable in specimens from the same colony, and that the form figured by Dr. Mjöberg for *D. perniger* is one commonly found in *D. rubriceps*, *D. silvestrii*, *D. septentrionalis* and occasionally in *D. daliensis*.

Specimens of soldiers and workers in the South Australian Museum from Beverley, W. A., Moorella, C.A., and Leigh Creek, C.A., agree perfectly with co-types of *D. perniger*, Frogg., and are undoubtedly referable to that species. I have not had an opportunity of examining specimens of *Drepanotermes* from Kimberley, nor dark-headed forms of the genus from Queensland.

***Drepanotermes rubriceps*, Frogg.**

Termes rubriceps, Froggatt, Proc. Linn. Soc., N.S.W, xxii, 1897, p. 730.

In an earlier paper (Hill, 1915) I described a de-alated imago under the above name, the determination of the species having been made for me by Mr. Froggatt, from soldiers and workers only. Later, a perfect specimen was secured from the same locality (Darwin, Northern Territory) and under similar conditions. Recently I have had for examination a series of imagines, soldiers and workers from Tennant's Creek and Leigh Creek, Central Australia (South Australian Museum Collection), which, although not compared with the type soldiers and workers, I consider to be *D. rubriceps*, Frogg., the type locality of which is McKinley Ranges, Central Australia. A comparison of the winged forms from Darwin with those from Central Australia shows that they are referable to two quite distinct species. The structural differences between the respective soldiers, however, are hardly appreciable. The heads of the Central Australian specimens are distinctly lighter than those of the Northern species and there are small differences in the structure of the antennae.

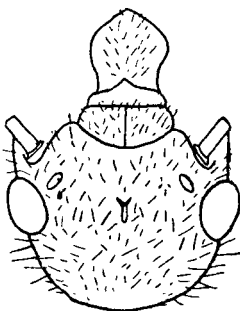


Fig. 10. *Drepanotermes rubriceps*, Frogg., head of imago.

The following is a description of the imago of this species. The Northern species is described in the preceding pages under *D. septentrionalis*.

Imago.—Head very dark brown; clypeus yellow-ochre; antennae darker than clypeus, brownish; trophi and ventral surface antimony yellow; prothorax yellow-ochre, with brown blotches; wing-stumps and abdominal tergites argus brown, the former with dark vein bases; wings brown, radius and branches of the cubitus very dark, costal margin pale.

Head (fig. 10) large, rounded behind, flat on the summit, clothed with numerous short, fine, pale hairs. Labrum narrow at base, swollen on the sides, rounded in front. Anteclypeus membranous, pointed in front. Postclypeus moderately large, twice as wide as long, convex, rounded behind, truncate in front, sloping on the sides. Fontanelle very small, lanceolate, with anterior end bifurcated. Eyes large, projecting moderately, nearly circular (0.610×0.470). Ocelli large, oval, oblique, a little less in length than short diameter (horizontal) of eyes, very close to the eyes, their anterior margin a little posterior to the anterior margin of eyes. Mandibles with dentition as in *D. silvestrii*, sp. n. Antennae very long and slender, 16-jointed;

1st joint more than twice as long as 2nd ; 3rd about as long as 2nd, narrower and more turbinate ; 4th a little shorter than 3rd, wider, oval, always shortest of all, but rarely markedly so ; 5th longer and wider than 4th ; 6th a little shorter and narrower than 5th ; 7th to 9th, inclusive, increasing gradually in length ; 10th to 14th about equal to each other, very little longer than 9th ; 15th and 16th slightly longer than 14th, equal to each other ; joints 5 to 16, inclusive, more or less stalked ; 5 to 15 slightly turbinate ; 7 to 16 distinctly slender ; number and shape of joints apparently very constant.

Prothorax roughly triangular, setose, nearly flat, wider than long, anterior margin slightly arcuate, bent up in the middle, antero-lateral angles rounded, sides nearly straight, sloping sharply to the rounded posterior margin, hairy. Mesothorax with a broad dark stripe down the middle ; wing-stumps large, setose, about two-thirds as long as the mesonotum. Metanotum similar, but wing-stumps small, half as long as the visible portion of the metanotum. Legs as in *D. silvestrii* (fig. 2).

Wings (fig. 11) very large and broad ; fore-wing a little longer and a little narrower than hind-wing, margin ciliate. Anterior margin distinctly yellow-ochre. Costa and radius dark at base, becoming yellowish further on, the latter well separated

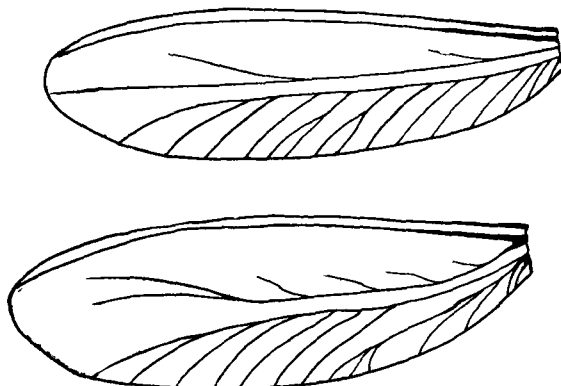


Fig. 11. *Drepanotermes rubriceps*, Frogg., wings of imago.

from the former in the proximal half of the wing, closer but distinctly separated in the apical half to near its junction just before the apex. Median dark at the base only, the rest very indistinct, running much nearer to the cubitus than to the radius. In the fore-wing the median separates from the radius within the wing-stump, runs straight to the apex of the wing, giving off five or six ill-defined superior branches. In the hind-wing the separation from the radius takes place beyond the suture, there are seven or eight very obscure branches, those near the base being short, the others running out to the wing margin, which they join just above or below the apex. The cubitus of the fore-wing joins the hind-margin a little below the apex and gives off from 12 to 15 branches, the first 9 to 12 of which are very distinct and some are forked. In the hind-wing there are generally 12 branches, simple or forked once or twice. Other variations are common.

Abdomen large, showing nine distinct tergites, each clothed with fine, short, pale hairs and a fringe of large golden hairs on posterior margin. Sternites with indistinct brownish patches laterally. Cerci very short and broad.

Measurements: Length with wings, 21-22 ; length without wings, 11 ; head, with mandibles, 2.35 long ; head, at and including eyes, 1.88 wide ; antennae, 3.29-3.75 ; mandibles, right 0.94 long, 0.75 wide ; left, 0.94 long, 0.6 wide ; prothorax, 1 long, 1.78 wide ; fore-wing, 18.3 long, 5 wide ; hind-wing, 17.5 long, 5.25 wide ; tibia (i) 1.36, (ii) 1.5, (iii) 2 ; abdomen, 3.5 wide.

Soldier.—Head (fig. 12) yellow-ochre to ochraceous orange; labrum whitish yellow; clypeus with anterior margin bordered with hyaline membrane; mandibles a little darker than head, darkest at tip; remainder of insect pale yellow.

Antennae very long and slender, 17- or 18-jointed; 1st joint long, rather more than twice as long as 2nd and one-third wider; 3rd as long as 2nd, but narrower; 4th shorter than 3rd but equally wide, more or less fused with it; 5th as long as 3rd, narrow; 5th to 9th increasing successively, all elongate, narrow; 10th to 18th about equal in length, a little shorter than 1st.

Measurements: Head and mandibles (crossed), 2·82 long; head, 1·73 wide; antennae, 3·57; thorax and abdomen, 3·29 long; prothorax, 0·6 long, 1·13 wide; tibia (i) 1·27, (ii) 1·45, (iii) 2·06.

The imago differs from *D. silvestrii* in having a larger body, wings longer and paler, lower surface of abdomen paler, much smaller and differently shaped fontanelle, larger eyes, fewer joints in antennae (16 as against 18 in *D. silvestrii*), segmentation distinctly different, head and prothorax much lighter coloured. The soldier is lighter in colour than that of *D. silvestrii*, and the front of the head a little less rugose; otherwise there is little to distinguish them.

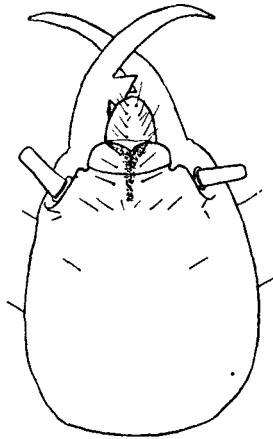


Fig. 12. *Drepanotermes rubriceps*, Frogg., head of soldier.

From *D. septentrionalis*, sp. n., the imago is easily separated by its larger size, longer and darker wings, darker prothorax, and two less joints in the antennae. From *D. perniger*, Frogg., as described by Mjöberg, it differs in being much larger, having much longer wings, and also in the eyes, fontanelle, and antennae.

Type series of imagines in South Australian Museum; co-types in author's collection.

CENTRAL AUSTRALIA: Tennant's Creek (*J. F. Field*); Leigh Creek, Everard Ranges (*S. A. White*). WESTERN AUSTRALIA: Mullewa.

Hamitermes parvus, sp. n.

Imago.—Clypeus, meso- and metathorax, legs, abdominal sternites and tergites mummy-brown; prothorax much darker brown; mouth-parts clay-coloured; tarsi pale stramineous; claws pale ferruginous; wings brown.

Head (fig. 13) clothed with numerous short and moderately long hairs, longer than wide, rounded behind and on the sides to the base of the jaws (widest part), flat on the summit. Fontanelle in the form of two elongate straight clefts in the middle line. Eyes small, hardly projecting beyond sides of head. Ocelli oval and widely separated from the eyes. Antennae 14-jointed, arising from a raised tubercle within a deep and wide fossa in front of the eyes, the tubercle being about equidistant

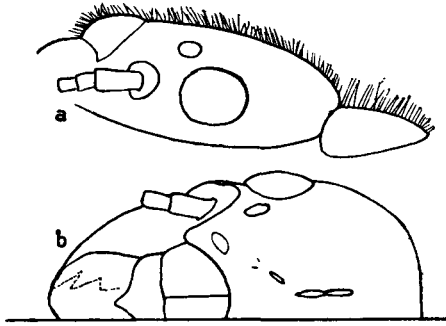


Fig. 13. *Hamitermes parvus*, sp. n., head of imago (a) in profile; (b) from above.

between the anterior margin of the eye and the postero-lateral margin of the clypeus; 1st joint twice as long as 2nd, 3rd shortest, indistinctly separated from the 2nd and 4th. Labrum rather narrow at the base, swollen on the sides, rounded in front. Anteclypeus arcuate anteriorly, slightly convex, half as long as wide, half as wide as postclypeus, divided medially by a suture which extends across the latter. Postclypeus large, convex, anterior margin slightly concave, posterior margin semi-circular, greatest length slightly more than greatest width.

Prothorax nearly twice as wide as long, very slightly convex and bent up along the anterior margin, antero-lateral angles rounded and slightly bent up, sides sloping sharply to the nearly straight posterior margin. Legs with fore tibiae and all femora stout; tibial spurs 3:2:2.

Wings (fig. 14) brown, large veins and first five or six branches of the cubitus well defined; entire margin excepting proximal fifth of hind margin ciliate; veins with a few long hairs along the entire length, venation variable and not always alike in either fore- or hind-wings of the same individual; cross suture straight.

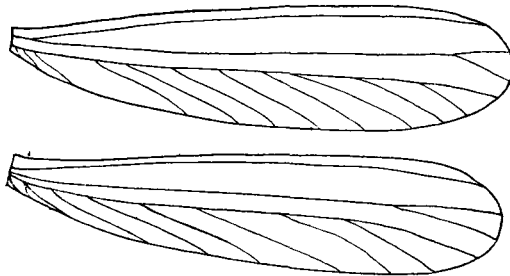


Fig. 14. *Hamitermes parvus*, sp. n., wings of imago.

Abdomen nearly cylindrical; seventh sternite of male much longer and darker than corresponding sternite of female, densely clothed with short fine reddish hairs. Cerci short, conical; basal segment very broad (0.8) and flattened.

Measurements: Length with wings, 6.25-7; length without wings, 3.25-4; head, with mandibles, 0.75-0.84 long; thorax and abdomen, 2.63 long; head, at

and including eyes, 0.65–0.67 wide; antennae, 1.08; mandibles, right, 0.41 long, 0.28 wide, left, 0.4 long, 0.25 wide; prothorax, 0.28 long, 0.51 wide; wings, 5 long, 1.27–1.4 wide; tibia (i) 0.51, (ii) 0.48, (iii) 0.7.

Soldier.—Head buff yellow; antennae, palpi, thorax and legs paler; abdomen grey (due to stomach contents); jaws castaneous, with basal half much paler.

Head (fig. 15) rounded behind and on the sides, compressed dorso-ventrally, clothed with scattered short reddish hairs. Mandibles short and stout, with a blunt angular tooth on each about the middle. Labrum broad at the base, sloping in to the rounded apex. Clypeus broad and rather indistinct. Antennae arising from raised tubercles close to the base of the jaws, 13-jointed; 1st joint nearly twice as long as 2nd; 2nd and 4th equal; 3rd half the length of the 2nd and 4th; 5th and 8th three-fourths the length of the 4th; 9th–11th equal to the 2nd; 12th rather longer; 13th longest, twice as long as 2nd and 4th.

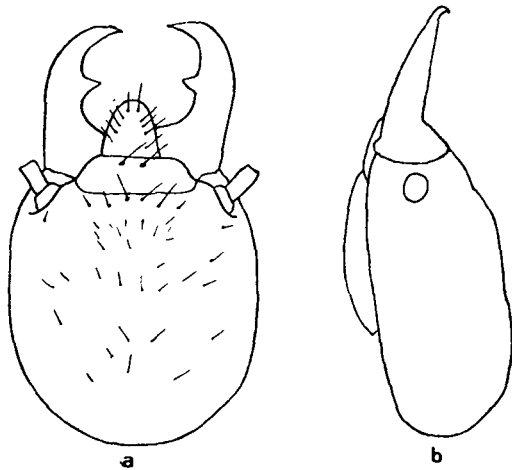


Fig. 15. *Hamitermes parvus*, sp. n., head of soldier
(a) from above; (b) in profile.

Prothorax similar to that of worker. Legs short and moderately stout; tibial spurs 3:2:2.

Abdomen elongate-oval, clothed with numerous moderately long and a few very long reddish hairs.

Measurements: Total length about 3.3; head and mandibles, 1.22 long; thorax and abdomen, 2 long; mandibles, 0.47 long; head, 0.65 wide, 0.47 deep; antennae, 0.86; prothorax, 0.18 long, 0.47 wide; tibia (i) 0.46, (ii) 0.37, (iii) 0.56; abdomen, 0.7 wide.

Worker.—Head creamy; mouth-parts, thorax and legs paler; abdomen nearly hyaline.

Head almost spherical, slightly longer than wide, clothed with scattered red hairs; labrum large convex, rounded in front; clypeus similar in shape to that of winged form, at each end a ferruginous spot (articulation of mandible). Antennae 13-jointed, segmented similarly to that of winged form, arising from a raised tubercle. Dentition as in imago.

Prothorax nearly twice as wide as long, arcuate and bent up in front. Legs stout; tibial spurs 3:2:2.

Abdomen elongate-oval, bluntly rounded at apex, clothed with moderately long and stout hairs, with a few much longer ones scattered over dorsal and ventral surfaces. Cerci large and prominent, base with several very long slender hairs.

Measurements: Total length (about), 3.47; head with jaws, 0.7 long; thorax and abdomen, 2.68 long; head, 0.64 wide, 0.32 deep; antennae, 0.98; mandibles, left, 0.38 long, 0.25 wide, right, 0.36 long, 0.28 wide; prothorax, 0.22 long, 0.4 wide; tibia (i) 0.46, (ii) 0.38, (iii) 0.56.

The small size of the soldier of this species will at once separate it from any other described Australian *Hamitermes*; its nearest ally is *Hamitermes latidens*, Mjög., from which it may be distinguished, *inter alia*, by its smaller size and the form and number of joints in the antennae.

NORTH QUEENSLAND: TOWNSVILLE.

Biology.

Winged adults, soldiers and workers were found in heavily manured garden soil on 10th December and 18th December 1919. About 50 points of rain fell on the night of 17th December, and at 8.30 a.m. on the following morning winged termites were noticed flying up from the very sandy soil. After some searching a small circular opening was found on a bare sandy space from which the winged forms were emerging. One soldier and several workers were congregating about the opening, apparently guarding the entrance to the nest while the winged forms made their exit. Between 8.30 a.m. and 9 a.m. on 16th and 17th November 1920, winged forms were again noticed rising from the grass-covered soil a few yards distant from where the first specimens were taken in the previous year. In most cases they fluttered feebly from a blade of grass or other object, flew a few yards and settled again in the grass, where most of them were caught almost at once by small ants (*Pheidole megacephala*). The first swarm (16th November) was preceded a few hours earlier by a heavy shower of rain and the second swarm, firstly, by a very copious watering of the adjacent soil from the pipe service and, secondly, by a heavy shower of rain about 5 a.m.

Hamitermes perplexus, sp. n.

Imago.—Head and prothorax dark brown (bay); postclypeus lighter than head, anteclypeus whitish with yellow blotches; antennae and tergites of abdomen mummy brown; on the first nine tergites a small clear mark on each side, distinctly comma-shaped on segments 3–6 inclusive; sternites Dresden brown, first four paler than others and only very slightly darker at sides, the rest uniformly dark, plates 1–6, inclusive, with small clear mark at each end, 5–8 uniformly dark; sternum and pleurae not darker than sternites of abdomen; wings brown.

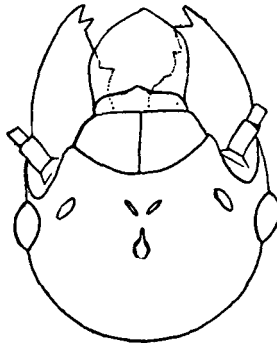


Fig. 16. *Hamitermes perplexus*, sp. n., head of imago.

Head (fig. 16) rounded behind, flat on summit, widest across the eyes, moderately hairy, hairs of variable length. Eyes large, projecting beyond sides of head. Ocelli oblique, oval, widely separated from the eyes. Fontanelle large, oval, with linear

forward prolongation, two oblique impressions in front. Anteclypeus produced in front; postclypeus large, convex, rounded behind, truncate in front, with distinct median suture. Antennae 15-jointed; 1st twice as long as 2nd; 3rd very short, smallest of all; 4th and 5th nearly equal to each other, larger than 3rd; 6th larger than 5th; 7th-12th nearly equal; 13th and 14th very little longer and more cylindrical than 12th; 15th longest, tapered from before the middle to the pointed tip. Very rarely the 5th and 6th joints on one side only are fused.

Prothorax slightly bent up in front, antero-lateral margin slightly rounded, sides narrowed to the emarginate posterior border, divided medially by a suture, which is very distinct in the anterior half; two clear impressions on each side behind the anterior margin; the whole surface moderately hairy. A distinct pale mark on each side of the median line of the metanotum.

Wings (fig. 17) with border ciliate excepting on proximal fifth of hind margin; venation very variable, often differing in both fore- and hind-wings of same insect; radius darker than costa, sometimes with short branches near apex of wing. In the fore-wing the median branches from the radius within the wing-stump, in the hind-wing the division is well beyond the suture; the median runs nearer to the cubitus than to the radius and gives off from three to eight branches to the anterior margin,

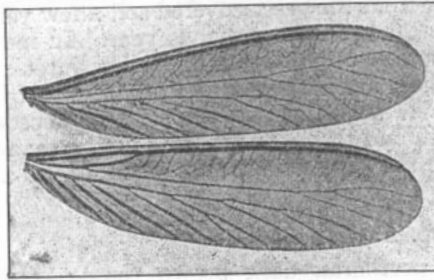


Fig. 17. *Hamitermes perplexus*, sp. n., wings of imago.

apex, or to the hind margin, the first branch generally arising about the distal third or fourth of the wing, but sometimes about the middle of proximal third. In some a short stout vein branches from the median at the proximal fifth and joins the radius about its proximal fourth; cubitus very irregular and seldom alike in the fore- or hind-wings of the same individual. In the fore-wing there are generally from six to eight simple branches, all of which often reach the posterior border before the middle; in the hind-wing there are from seven to eleven branches, some of which are forked. Associated with individuals having a wing venation as described above there are generally many with the venation described by Mjöberg (1920, p. 84) in *H. obtusidens*, Mjöb.

Legs ochraceous tawny, short; tibial spurs, 3 : 2 : 2.

Abdomen with ten distinct dark-coloured tergites; ventral surface much lighter. Styli wanting in both sexes.

Measurements: Length with wings, 12-13; length without wings, 7-8; head, with mandibles, 1.27 long; thorax and abdomen, 6.25 long; head, including eyes, 1.17 wide; mandibles, right, 0.72 long, 0.51 wide, left, 0.73 long, 0.41 wide; antennae, 1.7-1.8; prothorax, 0.61-0.65 long, 1-1.17 wide; tibia (i) 0.85-0.89, (ii) 0.84, (iii) 1.17; abdomen, 1.9 wide.

Neoteinic Queen.—Head and thorax ochraceous tawny to light orange-yellow; tergites of abdomen paler, rest of insect creamy.

Head about as long as wide, widest at the eyes, hairy. Eyes small, not projecting, pigmented in centre. Ocelli roundish, well separated from the eyes. Fontanelle a large globular protuberance. Anteclypeus half as long as postclypeus, nearly truncate in front, sometimes concealed; postclypeus convex, depressed in the middle line, hairy. Labrum swelling out on the sides, bluntly rounded in front, not covering apical teeth. Antennae 15-, rarely 16- or 17-jointed, very variable.

Prothorax as wide as head, shaped as in imago, clothed with red hairs. Wing-pads short, hind pair not reaching beyond middle of first tergite.

Measurements: Total length, 9·5–10; head, with mandibles, 1·32 long, 1·12 wide; abdomen, 2·8–3 wide.

Soldier.—Head ochraceous; mandibles pale ferruginous, a little paler at the base; antennae ochraceous with pale segmentations; clypeus and labrum stramineous with ochraceous blotches, remainder of insect stramineous.

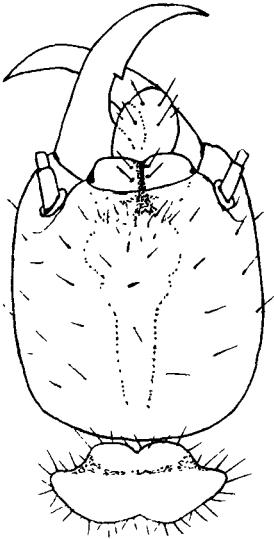


Fig. 18. *Hamitermes perplexus*, sp. n., head and prothorax of soldier.

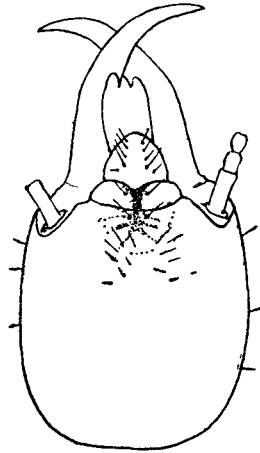


Fig. 19. *Hamitermes germanus*, Hill, head of soldier.

Head (fig. 18) longer than wide, slightly curved on the sides, a bright ferruginous spot on either end of the clypeus. Labrum large, rounded on the sides, rounded in front, not reaching the mandibular teeth. Clypeus wider than long, convex, emarginate in front, divided in the median line by a deep cleft which extends into the head. Mandibles long and moderately slender, falciform, with a sharp backwardly directed tooth about the middle similar to that of *H. germanus*, Hill (fig. 19). Antennae 15-jointed; 1st joint twice as long as 2nd; 3rd half as long as 2nd, smallest; 4th and 5th nearly equal in length; 6th and 7th longer than 5th.

Prothorax (fig. 18) saddle-shaped, rounded and bent up in front, antero-lateral margin rounded, posterior margin rounded, slightly emarginate in the middle. Legs rather short and stout; tibial spurs, 3 : 2 : 2.

Abdomen with scattered, rather short, and a few long yellow hairs. Cerci with base short and moderately broad, apex elongate, sides nearly straight to near the pointed tip.

Measurements: Total length, about 5; head and mandibles, 1.83–1.97 long; thorax and abdomen, 3.1–3.7 long; head, 1.08 wide, 0.84 deep; mandibles, 0.98 long; antennae, 1.69; thorax, 0.36 long, 0.7 wide; tibia (i) 0.84, (ii) 0.75, (iii) 1.08.

Worker.—Head creamy; thorax and legs paler; antennae whitish, tinged with yellow-ochre, distal third darkest; abdomen white (greyish black when alimentary tract contains ingested matter).

Head about as long as wide, clothed with reddish hairs, some moderately long. Labrum large, covering mandibles. Anteclypeus narrow, bluntly pointed in front; postclypeus convex, with reticulate pattern. Mandibles with dentition as in imago. Antennae 15-jointed; 1st joint large, nearly twice as long as and much wider than 2nd; 3rd very small, smallest; 4th and 5th about equal to each other; 6th larger than 5th, but much smaller than 7th and 8th.

Prothorax with anterior portion narrowed and bent up, emarginate in the middle, posterior margin almost semicircular, the whole clothed with reddish hairs of unequal length.

Abdomen elongate-oval, moderately hairy. Cerci small, basal part without hairs, apical part tapered and drawn to a fine point at tip.

Measurements: Total length, about 5.15; head, with jaws, 1.15 long; thorax and abdomen, 4; head, 1.5 wide; mandibles, right, 0.61 long, 0.51 wide, left, 0.66 long, 0.42 wide; antennae, 1.46; prothorax, 0.37 long, 0.8 wide; tibia (i) 0.76–0.78, (ii) 0.67–0.7, (iii) 0.99–1.

NORTH QUEENSLAND: Townsville.

This species appears to be closely related to *H. laurensis*, Mjöberg, from which it differs in the shape of the head and antennae of the soldier and in the antennae of the neoteinic queen. From *H. meridionalis*, Frogg. (fig. 20), it differs in the

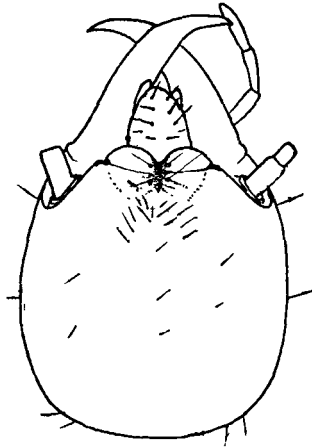


Fig. 20. *Hamitermes meridionalis*, Frogg., head of soldier.

soldiers in the shape of the jaws, colour of the head, form of the antennae, shape of the clypeus and distance of the antennae from the head margin. The winged forms of *H. laurensis* and *H. meridionalis* are not known.

Biology.

This is one of the commonest, if not the commonest, species of termite found in the vicinity of Townsville; how much further it ranges is not known. Like all the species of this genus known to me it is not a wood-eater, but lives on vegetable debris, such as the leaves, stems and seeds of herbaceous plants, the two former being cut into fragments and the latter stored intact in the termitaria. Food is gathered throughout the year, as required, and is stored in the outer galleries. In times of drought or after grass fires there is a noticeable absence of food in these galleries, and at no time is the accumulation of food comparable with that which is found in the nests of the grass-eating species of *Eutermes*. Incipient colonies, and colonies which for some reason or other have no termitaria, do not appear to make any provision for the storage of food in their underground galleries.

In these notes the word termitaria is used to indicate earthy or woody nests constructed by termites upon the surface of the soil, upon stumps, logs, stones, or in the branches of trees; the latter—arboreal nests or termitaria—appear to be constructed only by certain species of *Eutermes*. The species under notice normally constructs earthy nests, but it appears that these are not commenced until the colony has matured a considerable number of individuals of the worker caste in underground galleries. In some cases winged adults also are reared in these galleries. In discussing the habits of *H. eucalypti*, sp. n., reference is made to the construction of tube-like vertical ducts, by means of which the winged adults leave their underground galleries at the time of the annual colonising flight or "swarming." Similar ducts are also, though rarely, constructed by *H. perplexus* for the same purpose, when winged adults are reared in underground galleries. These tower-like ducts are commenced at the end of the dry season after the first showers and before the regular rain sets in; for example, in the summer of 1919 the first heavy shower (0.5) fell on 17th December, and construction commenced on the following day and continued until 22nd December, by which date about 80 ducts were scattered over an area of about 20 ft. square.

It is a common occurrence to find small colonies of soldiers and workers in rambling galleries in the soil, or at the base of abandoned, or partly abandoned, termitaria of *Eutermes* and *Drepanotermes*, and in one instance a de-alated imago of *Eutermes* sp. was found with such a community.

Typical termitaria, however, are very commonly found on hillsides, near the foot of hills (Pl. x, fig. 1), and on the open or scrub-covered plains (Pl. x, fig. 2) to the westward of the town, and occasionally in town gardens and streets. Quite frequently the greater part of the mound rests upon a large rock projecting a few inches to a foot or more above the surface. In such cases, however, one portion of the mound is invariably in direct contact with the soil, and is pierced by the main galleries communicating with the earth below. It may be stated here that such communication is absolutely essential to the existence of all termites, excepting members of the genus *Cryptotermes*, which in many, if not most, cases normally live entirely cut off from access to the soil. By far the greatest number of nests are to be found on the open grazing country and adjacent scrubby areas. In the former localities the nests attain their maximum size and number, and associated with them are almost as many nests of *Eutermes* sp. and *Drepanotermes silvestrii*, sp. n. Near the margin of the lowest lying part of this area the nests of these three species are so numerous as to present a most remarkable feature of the landscape.

In size and shape the nests vary a good deal; those on higher and well drained positions being usually smaller and more pointed than those on the plains (cf. Pl. x, figs. 1 and 2). In the ground-plan, nests on the higher situations are circular or oval, in the latter case the long axis being directed north and south. A nest measuring, say, about 12 by 14 in. at the base would be about 15–18 in. high, with sides sloping

to the pointed apex. On the plains the nests are often very much larger and frequently they have the long axis directed north and south or north-west by south-east, the sides sloping to the bluntly wedge-shaped top, which is rounded off at each end and never surmounted by numerous small points as in *H. meridionalis*, Frogg. (Plate xi). Sometimes the western side is more or less convex and the eastern side vertical or bent over, as in the latter species. The maximum size of such a termitarium is about 6 ft. long by 2 ft. wide at the ground and 4 ft. high. Conical nests are not uncommon.

Only in recently constructed nests, built by large colonies whose former nests have been dismantled, or smaller original nests of strong colonies, are the galleries and passages within the termitarium numerous and extensive. In the great majority of cases the structure is intensely hard and composed almost entirely of earthy particles cemented together. The occupied portions are practically confined to the top and sides, the internal galleries being gradually filled with rejectamenta until they assume the toughness and density of the earthy portions. Additions are made throughout the year, as in *H. meridionalis*, and not only after the rainy season has set in, as stated by Jack (1897). These additions are small and local and usually take the form of thin layers added to the sides (Pl. xii, fig. 2), the insects working from holes cut in the adjacent walls. The almost solid interior is pierced by a few larger passages which pass down into the soil and beneath the walls. Food is stored in the outer galleries and is generally mixed with the bodies of their dead. Near the top of the nest the dead occupy more space than does the vegetable food. They consist chiefly of nymphs of the winged forms in the stage when the wing rudiments first appear; but workers and soldiers are to be found also. In nearly all cases the legs have been amputated. This habit of storing away the dead was first recorded by Mjöberg (1920) in *H. laurensis*, Mjög., *H. meridionalis*, Frogg., and *Eutermes tyriei*, Mjög., in North Queensland, but has long been known to occur in *H. meridionalis* in the Northern Territory, and in an allied species in Central Australia.

Another type of termitarium is that in which there is a more or less solid foundation a foot or more in height, upon which rest several larger or smaller cone-shaped points (Pl. xii, fig. 1). In many instances these nests are obviously constructed on the sites of old nests; in others there is nothing to indicate that such is the case. An examination of the smaller nests, and especially those constructed on land free from rock, shows clearly that the base rests on the natural surface, which is penetrated only by a few passages. Such nests are easily pushed over intact, and if not removed or broken into fragments, form the base of new termitaria, which the insects soon construct in the characteristic cone-like form. Sometimes several of these cones are built up vertically upon the upper surface of the now recumbent old structure.

The termitarium invariably contains two sterile castes, namely, soldiers and workers. In all species of the genus *Hamitermes* (*sensu restricto*) the former caste is represented by very few mature individuals, probably never more than 5 per cent. of the total number of workers, and in this species probably less than $\frac{1}{2}$ per cent. When the nest is broken into there is a general retreat to the remaining galleries, neither caste making any attempt to defend themselves, their fellows, or their home. In all strong colonies there are present also great numbers of young forms in various stages of development. Reproductive forms, or forms which mature into them, are nearly always present. In the earlier stages preceding sexual maturity the latter are creamy white or white, soft-bodied insects, longer and more slender than the workers and possessing short wing-rudiments or wing-buds.* These nymphs are often present in great numbers and appear to be destroyed and stored for food when

* The term "nymph" is used in this paper to denote the young of reproductive forms in which the wing rudiments are evident. The word "larva" is used to denote all apparently undifferentiated young

produced in excess of requirements. The survivors may develop into sexually mature insects of four kinds, namely, neoteinic, or supplementary, kings and queens or true kings and queens. In the former (neoteinics) the wing-buds undergo very little further development, and the eyes and chitinous parts become only partly pigmented. After fertilisation the abdomen of the female becomes greatly enlarged, and she is capable of laying a great number of eggs, which, in this species at any rate, produce individuals of all castes. Those nymphs that are destined to develop into true kings and queens continue to develop the wing-buds until, after a final moult, they emerge as winged imagines, with pigmented eyes and chitinous parts.

In all of the many scores of termitaria examined, the reproductive forms found in each were either neoteinics only, or one true king, and from a few to over 100 neoteinic queens. True queens have not been found, nor have neoteinic kings been observed in any nest in which a true king was present; there are no queen cells or nurseries in these termitaria, the ordinary flattened horizontal cells being utilised as required. The ovigerous neoteinic queens are to be found scattered through all parts of the nest, but generally near the walls. Each queen appears to preside over a restricted area, in which the eggs and young larvae are to be found, the latter in one or more small clusters about the size of a large pea. As the larvae develop they spread out in all directions, mixing with the soldiers and workers. The king is rarely associated with one of these queens; more often he is to be found in one of the larger cells with from 10 to 40 younger queens of various sizes, some only recognisable as such, others apparently as fully developed as the egg-laying individuals. Neoteinic kings, when present, occupy these cells and have not been found in cells occupied by isolated queens. It appears that, as a rule, queens are fertilised and attain nearly their maximum development before they migrate to other parts of the nest to oviposit, and that they are not often re-fertilised from time to time, as is believed to be the case with true queens of other species. The fact that old neoteinic queens, *i.e.*, queens with shrunken abdomens, have not been found in this species and that males are very rarely found with isolated queens, suggests that normally a queen does not mate after she begins egg-laying and that she is destroyed and replaced by a more fecund one as soon as she has passed her prime.

Prior to the final moult, which takes place about November, pigmentation in the nymphs of the first form is confined to the eyes. The wing-buds are short and thick outgrowths from the posterior margin of the meso- and metathorax, measuring about 3 mm. in length. After the moult the wings appear as soft, white, crinkled membranes, which rapidly assume their full length, but remain unpigmented, like the rest of the body, for some days. The duration of the period intervening between the moult and acquisition of the full degree of pigmentation of the chitinous parts and functioning wings is not known, but it appears to be about 10-14 days. Moulting does not take place simultaneously in all the individuals which are destined to take part in the colonising flight, many being still in the final nymphal stage while others are capable of flight. Indeed, some individuals do not develop functioning wings until after the flight. Whether the true king, which is so often found with the neoteinic queens in the termitarium, is developed from one of these, or from one of the earlier matured imagines, or whether he is the original male parent of the colony, is not known. The latter, however, is most improbable, since he rarely, if ever, possesses blunted claws and pigmented apices to the tarsi, which are the indications of age in mature queens. Further, many of the termitaria are evidently very much older than the longest period suggested as the probable life of this caste.

The life of the winged imago within the termitarium is short, and is certainly regulated to a considerable degree by weather conditions, that is, swarming does not occur before the first heavy rain of the season has fallen and the ground is thoroughly moistened.

It has been stated above that true kings, *i.e.*, de-alated, sexually mature imagines, are often found in the nests as consorts of neoteinic queens, but true queens are unknown in this species. The questions that naturally arise are: What becomes of the countless thousands of female imagines (potential queens) which issue yearly from most, but not all, termitaria? Do none of them become the founders of new colonies, as is the case with many species? Is this species perpetuated solely by neoteinic queens and true kings or neoteinic kings? It is beyond doubt that the vast majority of individuals of a colonising flight, *i.e.*, potential true kings and queens, succumb to the attacks of predacious ants, lizards and birds within a few minutes of the commencement of their free life, but it is hardly conceivable that all are irretrievably lost. Observations made during a period of two years, during which many scores of nests have been examined at fairly frequent intervals, convince me that the normal manner of reproduction is by the forms commonly found in the nests, *i.e.*, true and neoteinic kings and neoteinic queens. In seeking an explanation for the apparent non-existence of true queens, one suggests itself as being the most probable, namely, that the life of the winged forms, and probably of the workers and soldiers also, is short, perhaps about two years in the case of the former, that a small proportion escape destruction at the time of the colonising flight, mate and become the parents of the colonies which for some time live in galleries in the soil. Later, these colonies increase to such size that the construction of a termitarium becomes possible, or perhaps necessary; in the meantime, however, the founders have lived their lives and their place in the community has been taken by neoteinics derived from nymphs. This theory does not account for the presence of young true kings in old termitaria, except in the manner suggested in a previous page, nor does it explain why, if male imagines are sometimes retained in the community to be the consorts of neoteinic queens, female imagines also are not retained to obviate the necessity for bringing neoteinic queens into use. Explanations of these and other phenomena in the economy of termites present difficulties which can be overcome only by prolonged and careful field observations.

The invasion of these termitaria by the common ant, *Iridomyrmex sanguineus*, Forel, has been referred to in discussing the biology of *Drepanotermes silvestrii*, sp. n.

Hamitermes perplexus, var. **victoriensis**, nov.

King.—Colour as in *H. perplexus*, sp. n., excepting that the antennae and tergites of the abdomen are lighter (Dresden brown); sternites Dresden brown, the first five distinctly darker at the sides than elsewhere, 6th–8th uniformly dark, no pale marks visible; the first seven tergites only have pale marks at each side, more or less indistinct excepting on 3–6 inclusive; sternum and pleurae argus brown.

Head as in *H. perplexus*, excepting as follows: Ocelli smaller, fontanelle smaller, linear extension rather longer. Thorax as in *H. perplexus*, except that the two smaller lateral impressions on prothorax and the clear marks on metathorax are wanting. Legs as in *H. perplexus*. Abdomen as in *H. perplexus*, excepting as noted above. Measurements as in *H. perplexus*.

Neoteinic Queen.—Head, thorax and wing-stumps light orange-yellow, sternites and tergites of abdomen of the same colour; remainder of abdomen and legs creamy; the whole insect clothed with fine, pale hairs.

(a) Head longer than wide. Eyes small (0.18), pigmented in centre. Ocelli small, situated as in king. Antennae 14-jointed, segmented as in king. Fontanelle not a depression, but a broadly lanceolate scar, with a short straight median line. Thorax as in king, wing-pads of metanotum extending to the middle of the third tergite. Legs with tibial spurs worn down to short, blunt stumps. Apices of the first three tarsals heavily chitinised. Styli absent. (This appears to be a normal queen of the second form.)

Measurements: Total length, 12; head, with mandibles, 1.5 long, 1.22 wide; prothorax, 0.65 long, 1.12 wide; abdomen, 3.25 wide.

(*b*) Gross appearance similar to that of (*a*). Labrum very short, exposing the two apical teeth of both mandibles. Anteclypeus invisible. Eyes and ocelli as in (*a*). Antennae 15-jointed. Fontanelle a large cone-shaped *projection*. Wing-pads of metanotum extending to the base of the second abdominal tergite. Styli absent. (This is evidently an abnormal form.)

Measurements : Total length, 7.25 ; abdomen, 2 wide.

Soldier very similar to *H. perplexus*. Labrum slightly more rounded ; clypeus rather narrower and more deeply emarginate ; antennae inserted nearer the outer margin of head, first two joints not so long and slender ; mandibular teeth rather more hook-like ; gula as seen in dotted line (fig. 21).

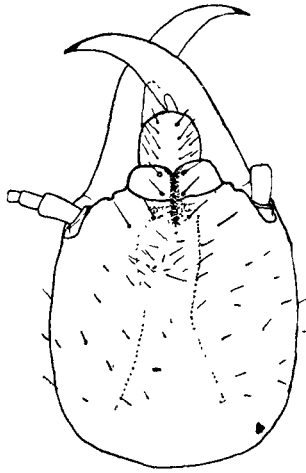


Fig. 21. *Hamitermes perplexus* var. *victoriensis*, nov., head of soldier.

Measurements : as in *H. perplexus*.

Worker.—As in *H. perplexus*.

VICTORIA: Preston (*F. E. Wilson*).

The differences between the Victorian and Townsville specimens are very slight indeed, but appear to me to be sufficient to justify one in separating the former as a variety of the latter.

Biology.

This variety is described from two small colonies found under stones. The first colony was taken on 14th November and comprised a few larvae, soldiers, workers, nymphs of the second form and the neoteinics described above. The eyes of the nymphs are small and very little pigmented, the ocelli are rudimentary, the antennae 15-jointed as in the imago, and styli are present in both sexes. Worker-like individuals of whitish colour and slender form I consider to be immature reproductive forms in the stage prior to the development of the wing rudiments.

The second colony was taken in September and comprised larvae, soldiers, workers, nymphs of the second form and a true king. Neither a true nor a neoteinic queen was found. It appears to be a rare form and the first of the genus to be recorded from Victoria. There are no termitaria of any kind in the district.

Hamitermes neogermanus, sp. n.

Soldier.—Head and base of mandibles orange, mandibles ferruginous at the tip; antennae mars yellow, darker than head; remainder of insect pale stramineous.

Head and mandibles (fig. 22) together twice as long as wide, rounded behind and on the sides. Mandibles very long, falciform, with a sharp hook-like tooth before the middle. Labrum almost as long as wide, rounded in front. Clypeus large, wide, with median shallow depression not reaching the posterior margin. Antennae 15-jointed, long and slender; 1st joint long and narrow, twice as long as 2nd; 2nd cylindrical; 3rd short and narrow, smallest of all; 4th and 5th alike, about twice as long as 3rd; 6th longer, nearly as long as 7th; 7th–12th alike; 13th and 14th a little longer; 15th rather longer than 14th, bluntly pointed.

Prothorax shaped as in *H. perplexus*, sp. n., with scattered long red hairs. Legs moderately slender, similar to those of *H. perplexus*, fore-tibiae with a row of long and stout hairs on the lower side of the apical half.

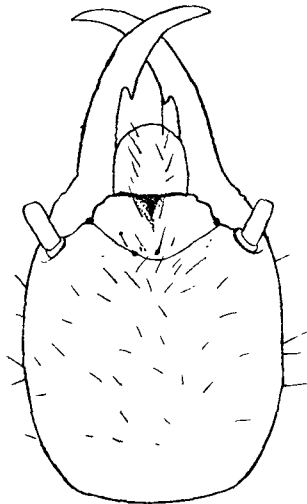


Fig. 22. *Hamitermes neogermanus*, sp. n., head of soldier.

Abdomen wide in the middle, tapered to the pointed apex. Cerci short.

Measurements: Total length, 5.5; head and mandibles, 2.16 long; head, 1.17 wide; mandibles, 1 long; antennae, 2.03; thorax and abdomen, 3.5 long; prothorax, 0.42 long, 0.7 wide; tibia (i) 0.92, (ii) 0.84, (iii) 1.17.

Worker.—Head and thorax pale stramineous; antennae much darker towards the apex; remainder of insect whitish, clothed with red hairs.

Head rounded behind, rather straighter on sides than usual. Labrum large, narrower at the base than across the middle. Anteclypeus large, produced in front. Postclypeus large, convex, truncate in front, rounded behind. Antennae 15-jointed; 1st joint twice as long as 2nd; 3rd very short and narrow, smallest; 4th and 5th about equal to each other; 6th larger; 7th–15th increasing in length gradually.

Prothorax with anterior portion rounded and bent up, antero-lateral angles rounded, posterior margin rounded, with slight emargination, clothed with long and short red hairs. Legs rather short and slender.

Abdomen elongate-oval, clothed with red hairs. Cerci with basal portion short and broad, remaining two-thirds slender.

Measurements: Total length, 5.25; head, with mandibles, 1.5 long; head 1.12 wide; antennae, 1.41; thorax and abdomen, 3.76 long; prothorax, 0.37 long, 0.84 wide; tibia (i) 0.86, (ii) 0.7, (iii) 1; abdomen, 1.8 wide.

This species is most closely related to *H. germanus*, Hill, from the Northern Territory (fig. 19); it differs, however, in its much larger size, larger and more rounded labrum, and larger and differently shaped clypeus. In both species the antennae are similarly segmented and the mandibles are alike except in size. The two species are easily separated.

Described from one soldier, and numerous nymphs and workers in alcohol, and nine soldiers and nine workers on cards.

Type series in South Australian Museum; co-types in author's collection.

SOUTH AUSTRALIA: Mt. Lofty Ranges (*N. B. Tindale*); Gawler (*A. M. Lea*); Angaston (*A. M. Lea*).

***Hamitermes eucalypti*, sp. n.**

Imago.—Palpi and legs buckthorn-brown; head, thorax, wings, abdominal tergites mummy-brown, head darkest, antennae Dresden brown, darker towards the tip.

Head (fig. 23) rounded, slightly longer than wide, widest across the eyes, densely clothed with moderately short hairs. Maxillary palpi with first and second joints very short, together equal to the third; third and fourth equal. Eyes large, rounded, projecting well beyond sides of head. Ocelli large oval, separated from the inner margin of the eyes by a distance equal to their length. Fontanelle large, broadly lanceolate, twice as long as wide.

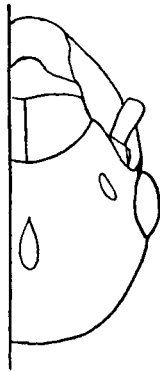


Fig. 23. *Hamitermes eucalypti*, sp. n., head of imago.

Antennae 15- or 16-jointed, dark with clear articulations; 1st joint twice as long as 2nd and much wider; 2nd cylindrical and about as long as 3rd and 4th together; 3rd very short, narrower than 2nd and 4th, indistinctly separated from the latter; 5th and 6th equal in length and shorter than 7th and 8th; 9th to 13th longer than 7th and 8th and nearly equal to each other; 14th slightly longer than 13th; 15th and 16th a little longer than 14th; 15th cylindrical.

Prothorax slightly bent up in front, rounded on the sides to the truncate posterior margin, a clear oblique oval area on each side of the median suture in the anterior third, the whole surface moderately densely clothed with medium-sized hairs. Wing-stumps small, triangular, clothed with numerous short and long hairs, suture straight;

margin of wing (fig. 24), excepting proximal fourth of posterior border, ciliate, with scattered hairs on membrane, especially on apical half and along veins; costa, radius, base of median and first seven or eight branches of cubitus very distinct, branches of cubitus sometimes anastomosing to form cells. Legs with femora moderately stout; tibial spurs, 3:2:2.

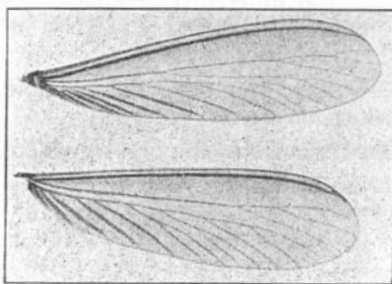


Fig. 24. *Hamitermes eucalypti*, sp. n., wings of imago.

Abdomen long and nearly cylindrical, with 10 dark tergites, each of the first eight very distinct and with a small clear spot towards each lateral margin, moderately hairy; eight distinctly visible sternites, pale except at the lateral margins, where there is on each side a dark spot, sixth longest and darkest. In the male there are seven distinctly visible sternites, with lateral spots on the first three, the remainder nearly uniform in colour; lower surface darker than in female. Cerci short, basal portion as long as apical.

Measurements: Length with wings, 11-12; length without wings, 6.5-8; head, with mandibles, 1.2-1.3 long; head, at and including eyes, 1.1 wide; mandibles, right, 0.6-0.62 long, 0.46 wide, left, 0.65-0.67 long, 0.35-0.37 wide; antennae, 1.65; prothorax, 0.47 long, 0.98 wide; fore- and hind-wings, 9.25 long; fore-wing, 2.58 wide; hind-wing, 2.68 wide; tibia (i) 0.7-0.75, (ii) 0.8, (iii) 1.1-1.13.



Fig. 25. *Hamitermes eucalypti*, sp. n., head of soldier (a) from above; (b) in profile.

Soldier.—Head ochraceous, mandibles ferruginous, labrum whitish; thorax lighter than head; abdomen and legs very light yellow.

Head with mandibles (fig. 25) longer than wide, rounded behind and on the sides, with scattered red hairs. Labrum convex, widest at the base, sloping to the bluntly

pointed apex. Clypeus convex, much wider than long, arcuate in front, divided by a deep median suture which extends into the front of the head, where there is a flask-shaped depression. Mandibles long and moderately slender, falciform, with a sharp hook-like tooth near the middle. Antennae 15-jointed, arising from a prominence within a short and wide fossa behind the base of the mandibles; 1st joint very large, 2nd less than half as long as 1st and much narrower; 3rd very short and narrow; 4th and 5th equal in size, longer and wider than 3rd; 6th much longer and wider than 5th.

Thorax with anterior half bent up, lateral margins angular, posterior margin rounded, clothed with scattered reddish hairs as on head. Legs with femora moderately stout, fore-tibiae stout, mid-tibiae with two short stout setae towards the apex in addition to the two larger apical spurs; tibial spurs, 3:2:2.

Abdomen clothed rather densely with reddish hairs.

Measurements: Total length, about 4; head, including mandibles, 1.78-1.8 long; thorax and abdomen, 2.8 long; head, 1.03-1.12 wide; antennae, 1.41; prothorax, 0.32 long, 0.7 wide; tibia (i) 0.8, (ii) 0.7, (iii) 1; abdomen, 1.17 wide.

Worker.—Head and thorax creamy, rest of insect almost hyaline, the whole surface moderately hairy.

Antennae 15-jointed; 1st joint twice as long as and one-fifth wider than 2nd; 3rd very short and narrow, shorter than broad; 4th and 5th equal in length, longer and wider than 3rd; 6th as long as 2nd; 7th-12th similar to each other, longer than 6th; 13th and 14th equal in length, the latter more cylindrical; 15th as long as 1st, widest at the proximal third, tapered to the pointed apex.

Prothorax with anterior third rounded and bent up, emarginate; lateral margins elongate, bluntly pointed; posterior margin truncate, without emargination; surface clothed with stout reddish hairs. Legs similar in shape and armature to those of soldier, except that the two short setae on the upper surface of the second tibiae of the soldier are replaced by much longer and more slender ones; tibial spurs, 3:2:2.

Measurements: Total length, about 5.2; head, with mandibles, 1.41 long; thorax and abdomen, 3.76 long; head, 1.04 wide; mandibles, right, 0.51 long, 0.42 wide, left, (a) 0.51 long, 0.3 wide, (b) 0.61 long, 0.37 wide; antennae, 1.4-1.7; prothorax, 0.37 long, 0.75 wide; tibia (i) 0.7, (ii) 0.65, (iii) 0.90-0.93.

This species appears to be nearest *H. herbertensis*, Mj b., from which it is easily distinguished by the characters given for the imago and soldier.

N. QUEENSLAND: Magnetic Island, Townsville.

Biology.

This is a common species in the Townsville district and on Magnetic Island, where it is generally found under earthy covered-ways on the trunks of living eucalyptus trees growing on hill-sides and open forest lands. Very rarely these covered-ways are constructed on the trunks of dead trees from which the bark has fallen; but in most cases living trees with friable bark are favoured. At first, tube-like covered-ways are constructed, which extend up the trunk to a height of 6-10 ft., the loose, weathered surface being removed as the tube progresses upwards. Later on these tubes are extended laterally until a considerable surface is encased. On removal of this fragile casing the outer weathered surface of the bark beneath will be found to have been removed—apparently for food. On one occasion a very small and inconspicuous mound of earth, unlike a true termitarium, lay at the base of the tree, and from it the casing extended up the trunk for a distance of 3½ ft., where it had been cut off. The mound was traversed by a few galleries, which contained a few soldiers, workers, and nymphs of the second form (18.viii.1919).

The trunk, which was hollow, was sealed up on top with earth. When a portion of the wood was cut away, the interior was found to be nearly filled with earthy material, pierced by a few galleries, which contained the castes found in the mound. Four months later (15.i.1920) *Coptotermes (?) lacteus*, Frogg., was found in possession of the trunk and had commenced to build a typical termitarium on the site formerly occupied by the small mound referred to above. *H. eucalypti* was found under the casing on the bark and in tunnels in the adjacent soil; in the latter were also three winged adults. It appeared that the invading *Coptotermes* were the survivors from a large termitarium 6 ft. distant, which had been destroyed on 18th August 1919.

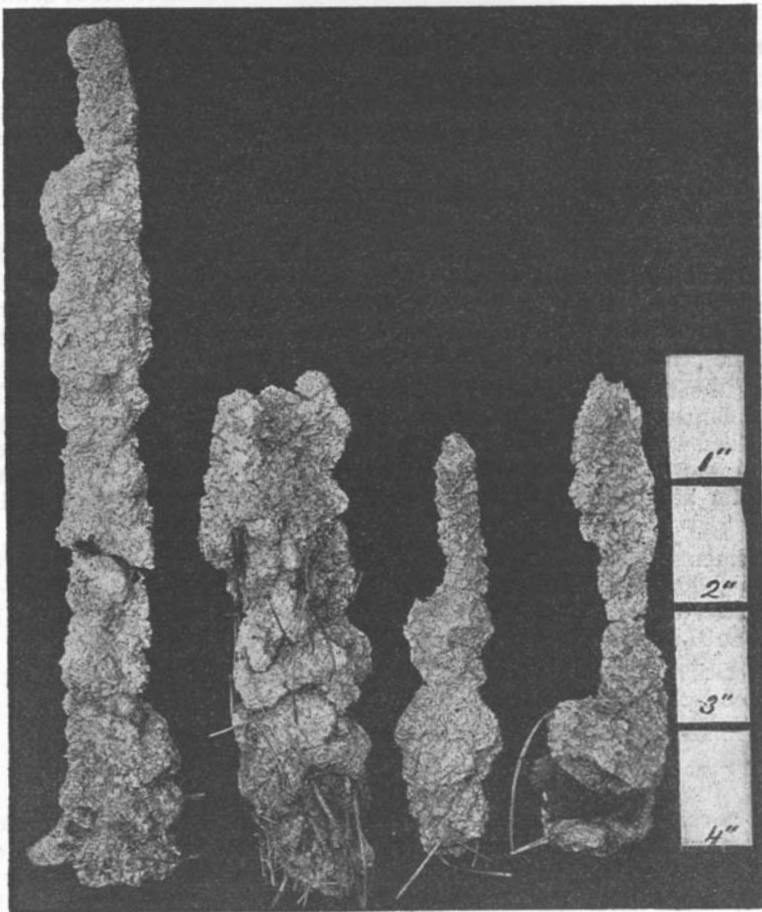


Fig. 26. Vertical tubes constructed by *Hamitermes eucalypti*, sp. n., prior to swarming.

On 25th November 1920, at Magnetic Island, near Townsville, the trunk of a large bloodwood tree (*Eucalyptus*) was found to have its sunny side almost encased in an earthy crust, under which were found many workers and a few soldiers of this species. Nearer the ground a few adult winged forms were found. Arising from the sandy soil near the trunk and within a space of a few feet were about a dozen vertical tubes (fig. 26), ranging from 5-23 cm. in height by about 1-3 cm. in diameter, which communicated each with an irregular chamber about 25 cm. long by 1½ cm. wide,

and these again with a system of small tunnels extending downwards to a depth of about 25 cm. Workers and soldiers only were found in the tubes, but numerous imagines and a few nymphs with short wing-pads were collected in the chambers and galleries. The latter appeared to be nymphs of the second form, *i.e.*, nymphs which would mature into queens and (?) kings of the second form (supplementary royalties). On 4th December a few winged adults were captured at a lamp in this locality.

From my observations I conclude that termites of this species do not construct termitaria, but rear their young and reach maturity in underground galleries. The vertical tubes and adjoining chambers are constructed just before the winged forms reach maturity and for the purpose of enabling these forms to assemble and disperse unmolested by predatory ants and other ground-frequenting enemies. The advantage of these tubes will be apparent to anyone who has witnessed the decimation of the winged forms of certain other species, which make their exit at the time of swarming by an opening made in the surface of the soil. Elsewhere in this paper reference is made to similar tubes constructed by *Hamitermes perplexus*, sp. n., which normally builds termitaria, but which frequently lives in underground galleries, as does *H. eucalypti*.

Leucotermes clarki, sp. n.

Imago.—Upper surface buckthorn-brown, seven hindmost abdominal tergites a little lighter; mouth-parts and lower surface testaceous; abdominal sternites not distinctly darker; wings brown, apical half near costa and radius darkly shaded. The whole insect densely clothed with short reddish hairs.

Head (fig. 27) large, wider than long, widest at eyes. Fontanelle elongate, widest behind, two oblique clear impressions on either side in front midway between anterior end of fontanelle and posterior margin of clypeus; an indistinct suture extending posteriorly from fontanelle. Eyes very large, circular (0.28 dia.), projecting well beyond sides of head. Ocelli large, nearly circular, half as wide as eyes, from

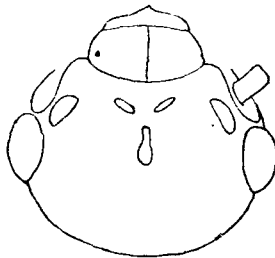


Fig. 27. *Leucotermes clarki*,
sp. n., head of imago.

which they are separated by a rather narrow space. Anteclypeus very small, one-fourth as long as postclypeus, whitish, produced in the middle. Postclypeus large, paler than rest of head, darker than antennae, convex above, slightly curved in front, more so behind, twice as wide as long, divided medially by a narrow dark suture. Antennae 15- or 16-jointed; in 15-jointed antennae, 1st stout, twice as long as and much wider than 2nd, 3rd smallest, 4th and 5th equal, 6th–12th increasing slightly in length, 13th longer, 14th about as long as 13th but more cylindrical, 15th elongate-oval; in 16-jointed antennae the 3rd joint of the other form is divided into two, the first joint is generally more slender; the 3rd joint is very small and fused with the 4th, which is only a little larger.

Thorax moderately flattened above, rounded, slightly bent up and emarginate in front, rounded on the sides, narrowed to the slightly emarginated posterior border, divided medially by a suture, two clear transverse impressions behind the upturned anterior margin. Legs slender; tibial spurs, 3:2:2.

Wing-stumps triangular, suture straight, margin ciliate except at base of posterior border, scattered hairs over entire surface of membrane. In the fore-wing (fig. 28) the median vein branches from the radius within the wing-stump; in the hind-wing the branch is distinctly beyond the cross suture; radius very dark, darker than other veins, shaded above and below beyond the middle; median nearer the cubitus than the radius, dark at the base only, unbranched or with a variable number of indistinct branches near the apex; if branched, the branches joining the wing margin at or above the apex; cubitus with 9-12 branches, the first 4-8 dark and often branched, the remainder lighter, simple or branched once or twice, all reaching the posterior margin.

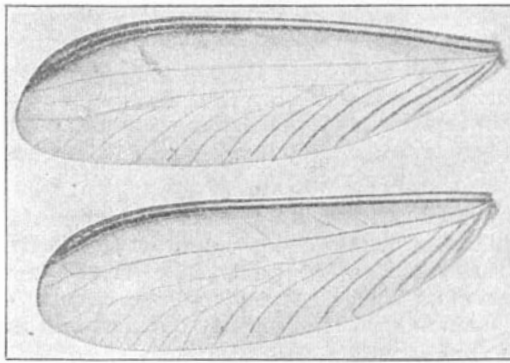


Fig. 28. *Leucotermes clarki*, sp. n., wings of imago.

Abdomen elongate, very little widened in the middle, bluntly rounded at apex; sternites 1-7 with clear spot at each end; cerci short, basal portion as long as apical.

Measurements: Total length, about 7; head, with jaws, 0.99-1.17 long; thorax and abdomen, 5.57 long; head, at and including eyes, 1.2 wide; antennae, 1.7; mandibles, right, 0.61 long, 0.43 wide, left, 0.66 long, 0.37 wide; prothorax, 0.6 long, 0.99 wide; fore-wing, 12.5 long, 3.66 wide; hind-wing, 11.5 long, 3.8 wide; tibia (i) 0.89, (ii) 0.89, (iii) 1.17; abdomen, 1.64 wide.

Soldier.—Head bright yellow, palest behind; mandibles dark ferruginous to bright yellow; labrum and antennae bright yellow; pro-, meso- and metathorax pale yellow, like back of head, remainder of insect whitish. Head, margin of thoracic tergites, and abdomen with scattered, moderately strong, reddish hairs.

Head (fig. 29) long, parallel on the sides, rounded behind. Mandibles long, moderately stout, of typical form. Labrum long and wide (0.47 long, from anterior margin of clypeus, by 0.35 wide across the middle), slightly swollen on the sides, narrowed to the pointed apex. Anteclypeus very short, hardly visible. Post-clypeus nearly twice as wide as long, truncate in front. Fontanelle present. Maxillary palpi with first and second joints half as long as third and fourth; fifth slightly shorter than fourth. Antennae 16- or 17-jointed; in 16-jointed antennae, 1st joint stout, twice as long as 2nd; 3rd shorter and narrower than 4th, shortest; 4th as long as 2nd, swollen; 5th shorter than 4th; 6th as long as 4th; 7th longer:

in 17-jointed antennae the segmentation is as described in the imago. Gula (see dotted line in fig. 29) long and narrow, narrowest in the middle, expanded at the anterior fifth to twice the width at middle, anterior extremity slightly wider than middle.

Prothorax (fig. 29) a little narrower than head, as wide as metathorax, rounded and deeply emarginate in front, rounded antero-laterally, sides narrowed to the rounded and emarginate posterior margin. Meso- and metathorax rounded on the sides and behind, hind margin slightly emarginate. Legs short and stout, hind femora very stout; tibial spurs, 3:2:2.

Abdomen broad, a little wider in the middle than at the base. Styli very long and slender, apparently always present. Cerci long and slender.

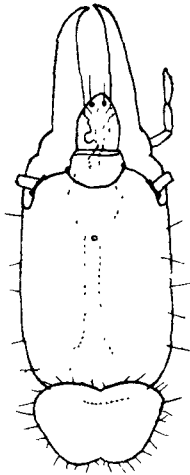


Fig. 29. *Leucotermes clarki*, sp. n., head of soldier.

Measurements: Total length, about 6; head and mandibles, 2.92-3.25; head, without mandibles, 1.65-2.1; mandibles from base, 1.4; head, 1.08-1.22 wide, 1.03 deep; head, base to fontanelle, 1.17; antennae, 1.7; thorax and abdomen, 3-3.25 long; prothorax, 0.6-0.66 long, 0.84-0.98 wide; tibia (i) 0.7-0.8, (ii) 0.61-0.65, (iii) 0.98-1.03; abdomen, 0.94 wide.

Worker.—Head and thorax pale yellow, a large ferruginous spot at either end of postclypeus, rest of insect whitish. Head and body sparsely clothed with reddish hairs.

Head rounded behind, widest across the middle. Anteclypeus small, whitish with a yellow mark on either side, one-third as long as postclypeus, rounded in front. Postclypeus large, convex, a little more than twice as long as wide. Antennae 14- or 15-jointed.

Prothorax rounded, bent up in front and slightly emarginate, sides narrowed to the posterior margin. Legs short and stout, third femora not greatly enlarged; tibial spurs, 3:2:2.

WESTERN AUSTRALIA: Swan River, Dwellingup, Ludlow (*J. Clark*).

Type series in author's collection; co-types in Mr. J. Clark's collection.

This species is most nearly related to *Leucotermes ferox*, Frogg. (fig. 30), a co-type (alate) of which I have examined, but it is easily distinguished by its larger size, darker colour, much darker and larger wings, larger eyes and fontanelle and short broad head. The soldier is larger than that of *L. ferox*. In *L. validus*, Hill, as in *L. paradoxus*, Frogg. (fig. 31), ocelli are wanting in the imago, the fontanelle is minute and set far back on the head, and the wings are much paler.

Silvestri (1909, figs. 127, 130 and 132) refers certain large-sized soldiers from Western Australia to *L. ferox*, Frogg., which I think are most probably referable to *L. clarki*, sp. n. The soldiers of all the species mentioned above are very similar and in most cases I have failed to find any reliable distinguishing characters; for this reason I have withheld descriptions of apparently distinct species from Queensland, Victoria and Western Australia until winged forms are available for study.

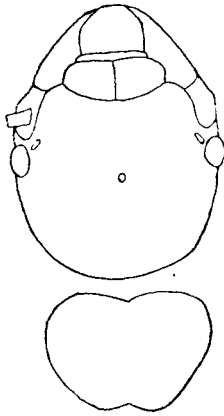


Fig. 30. *Leucotermes ferox*, Frogg, head and prothorax of imago; from a co-type.

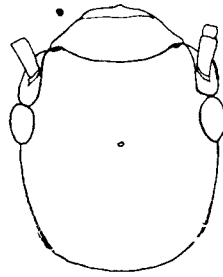


Fig. 31. *Leucotermes paradoxus*, Frogg, head of imago; from a co-type.

Biology.

Described from a few imagines, soldiers and workers taken on 13th May from a small mound about 12 in. high, and from numerous soldiers and workers taken in September of the same year.

REFERENCES.

- BANKS, N. and SNYDER, T. E. (1920). A Revision of the Nearctic Termites.—U.S. National Museum, Bulletin No. 108.
- FROGGATT, W. W. (1896-7). Australian Termitidae, Parts 1, 2, 3.—Proc. Linnean Society of New South Wales.
- FROGGATT, W. W. (1915). White Ants.—Farmers' Bulletin No. 60 (Second edition); Department of Agriculture, New South Wales.
- FULLER, C. (1920). Studies on the Post-embryonic Development of the Antennae of Termites.—Annals of the Natal Museum, iv, part 2.

- HILL, G. F. (1915). Northern Territory Termitidae.—Proc. Linnean Society of New South Wales, xl, part I, no. 157.
- HILL, G. F. (1921). The White Ant Pest in North Australia.—Commonwealth of Australia, Institute of Science and Industry, Bulletin No. 21, Melbourne.
- JACK, R. L. (1897). Notes on the Meridional Ant Hill of the Cape York Peninsula.—Proc. Roy. Soc. Qld., xii.
- MJÖBERG, E. (1920). Results of Dr. E. Mjöberg's Swedish Scientific Expeditions to Australia. Isoptera.—Arkiv. för Zoologi, xii, no. 15.
- RIDGWAY, R. (1912). Colour Standards and Nomenclature. Washington.
- SILVESTRI, F. (1909). Die Fauna Südwest-Australiens, Isoptera, ii, no. 17.
- THOMPSON, C. B. and SNYDER, T. E. (1920). The Wingless Reproductive Type of Termites.—Journal of Morphology, xxxiv, no. 3.
-



Fig. 1. Termitarium of *Drepanotermes silvestrii*, sp. n.

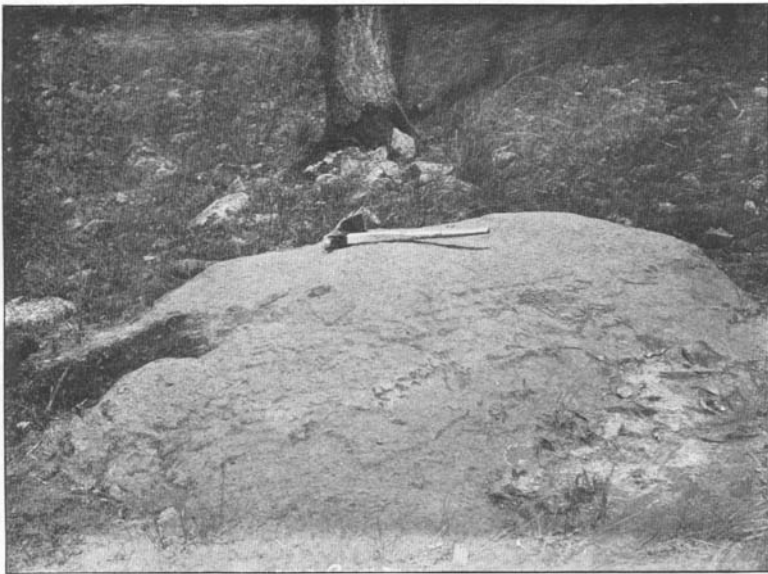


Fig. 2. Termitarium of *Drepanotermes silvestrii*, sp. n.,
showing internal structure.



Fig. 1. Termitarium of *Hamitermes perplexus*, sp. n., built on rocks.

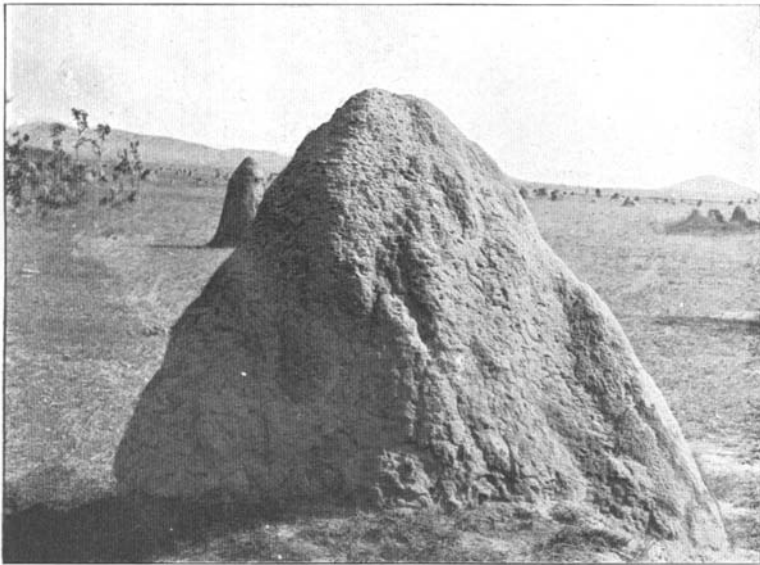
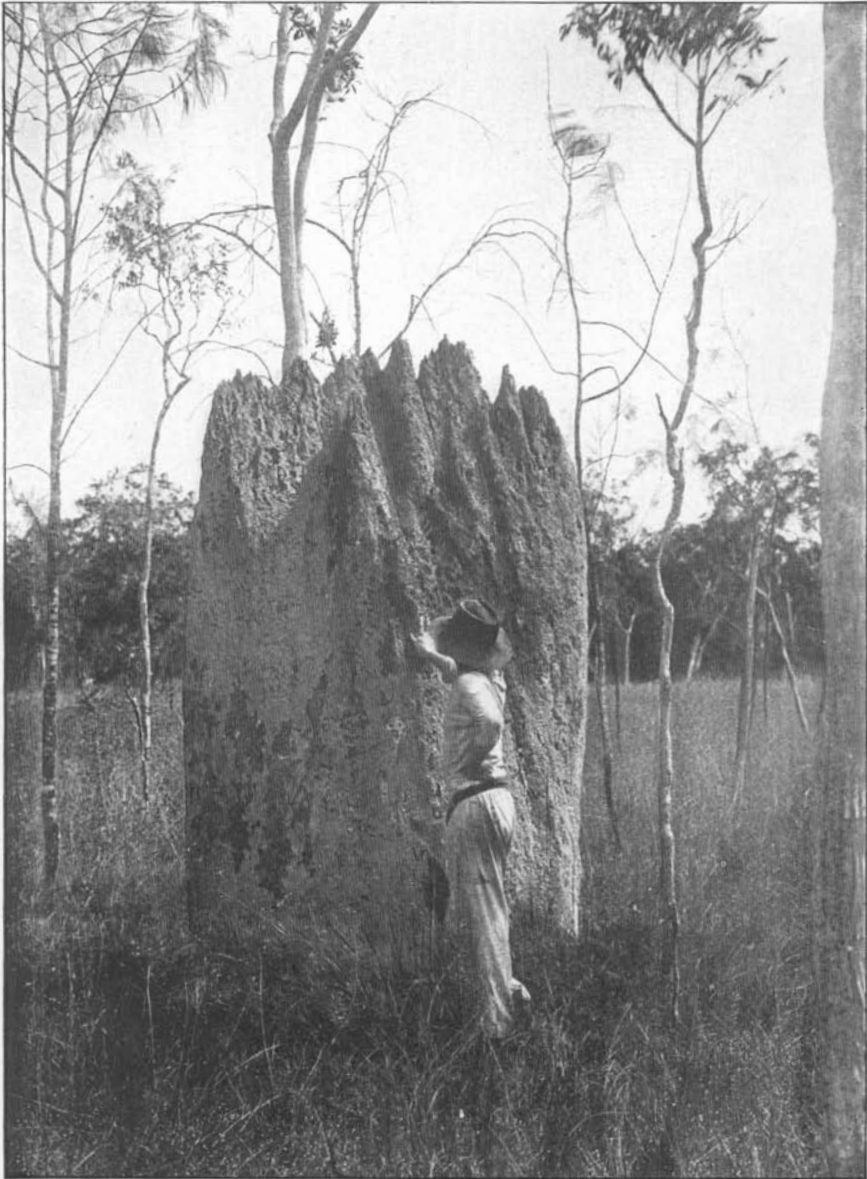


Fig. 2. Form of termitarium of *Hamitermes perplexus*, sp. n., built on open plains.



Termitarium of *Hamitermes meridionalis*, Frogg., near Darwin. Northern Territory, Australia.



Fig. 1. An unusual type of termitarium of *Hamitermes perplexus*, sp. n. The track in the foreground has been made by an invading army of ants (*Iridomyrmex*).

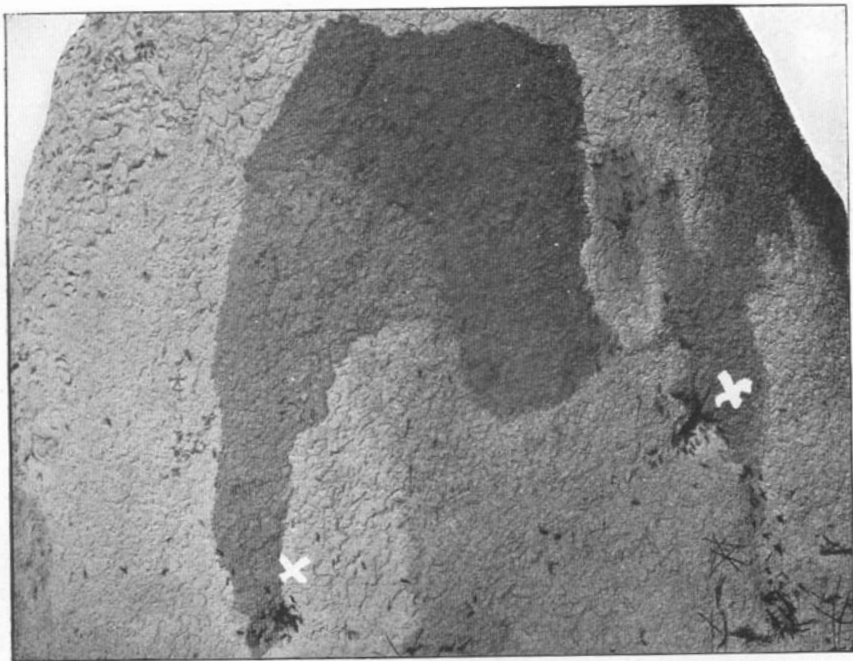


Fig. 2. Termitarium of *H. perplexus* invaded by *Iridomyrmex*, which have entered at holes marked **X**. The dark portions have been recently added by the termites.