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"ADAPTATIONS" TO SOCIAL LIFE: THE TERMITES (ISOPTERA)

(With Three Plates)

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INTRODUCTION

GREGARIOUS LIFE

Many insects are gregarious feeders, Lepidopterous and sawfly larvae, Hemiptera, and Orthoptera furnishing notable examples. Others live together in large numbers, possibly due only to the fact that the eggs were laid in a mass or close together, as in the case of certain wood-boring beetles; these are mere temporary associations. Again, certain adult insects congregate solely for the purpose of mating; for example, mayflies, mosquitoes, and gadflies. Particularly striking is the habit of the large gadfly (*Tabanus americanus* Forster) as noted by Mosier and Snyder in the lower Florida Everglades where the males congregate in enormous numbers to mate with the females just before dawn. Still other insects have the habit of congregating in large masses for special purposes; for example some Lepidopterous larvae which build webs and live together in them for protection. But in practically all cases, except among the true social insects, the congregating is more or less temporary and is due to hunger, sex or fear, or to combinations of these elemental motivations, although sometimes caused by undue increase in numbers and the necessity for migration. In but few instances can there be traced any modifications which one could say result from such a life.

THE DAWN OF SOCIAL LIFE

In a few exceptional cases, notably among wood-boring insects, there is really a beginning of a true social or colony life and this can be seen in the case of some of the roaches, the wood-boring beetle, *Parandra brunnea* Fab., the pædogenetic beetle *Micromalthus debilis* Lec., and species in the peculiar order Zoraptera, in which there appears to be the foundation of a caste system.

Lameere has noted that it is among wood-boring insects that there is most frequently encountered an association of the two sexes for raising the young.

Roaches of the genus *Dasypoma* of North America live in rotten wood, and males and females are found together with the young. According to A. N. Caudell, of the U. S. National Museum, in the case of roaches in the genera *Salganca* and *Panestehia,* a break often occurs following in general the anal sulcus at the base of the wing, as at the humeral suture of termites, where the wing breaks off after the colonizing flight; in the primitive termites this suture is also often poorly defined. It is also interesting to note that roaches and termites mate in a similar manner. Roaches and termites were probably derived from the same primitive group, the Protoblattoiden of Holmgren, but the termites became more highly specialized. However, the North American roach, *Cryptocercus punctulatus* Scudd., is found wingless as a wood borer in decayed logs; it is in the same family as the genera *Salganea* and *Panestehia.*

Even in the most primitive termite, *Mastotermes darwiniensis* Frogg., the winged form of which is roach-like, social life has "resulted" in a soldier form which is much more specialized than would be expected. The most primitive and largest species of *Kalotermes* (*occidentis* Walker of North America), like all the other lower termites of the family *Kalotermitidae,* has not gone so far in its social adaptation, namely the subdivision of labor and caste formation, that more than one neuter form exists—a soldier in which vestigial wings are always present (pl. 3, fig. 1). Indeed Holmgren established a new genus, *Pterotermes,* for this termite. In many other species of *Kalotermes* and *Kalotermitidae,* vestigial wings occur on soldiers, but only occasionally.

In *Parandra* the eggs are inserted in the solid wood close together and I have observed that adults often mature and mate in wood underground in the bases of telephone poles, etc., without coming above ground and flying about before copulation. The adults are shy and shun the light when found in the open.

Micromalthus debilis Lec. is a remarkable wood-boring insect with a complex life cycle; the first stage larvae are found in wood in a semi-gregarious condition. Pædogenesis undoubtedly enables this insect to continue to live in this semi-social state even in wood below ground independent of the usual flight of winged forms before mating.

Species of *Zorotypus,* in the order Zoraptera of Silvestri are gregarious, and these very active little insects live under conditions very

similar to those in which termites are found, often occurring in the galleries of the slower-moving termites, the young of which they greatly resemble. In addition to this social life, Snyder has noted that species of *Zorotypus* have apterous as well as the winged reproductive forms; the latter individuals lose their wings in a manner similar to the lower termites—the point of breakage being poorly defined—before rearing their young in runways under bark on dead trees, logs, etc., where it is moist. The apterous reproductive forms differ with the species; in one species (*snyderi* Caudell) they are darkly colored, with ocelli; in another (*hubbardi* Caudell) they are colorless and without ocelli, as are the nymphs or young. These apterous adults are present in their colonies in large numbers, as in the case of termites, and undoubtedly polygamy exists, as it does among termites. As in the case of termites, species of *Zorotypus* pass the greater portion of their lives in the dark. Undoubtedly *Zorotypus* is at the dawn of social life.

SOCIAL LIFE

Certain other insects—the social insects, such as ants, bees, wasps, and termites—live permanently together in more or less fixed communities or colonies. The basic "adaptations" to social life are found in the caste system. Here the specialization follows a more or less closely adhered-to division of labor with forms better and often strikingly fitted for the principal purposes of life as feeding, reproduction, and protection. I shall refer only to termites.

THE TERMITES (ISOPTERA)

Termites live together in well-organized communities or large colonies in wood, in the ground, in mound nests, or in carton tree nests. There are marked differences in their life from that of other social insects. Termites have an incomplete metamorphosis; there is no true pupal state, but resting or quiescent stages occur during molting. There are always present in termite colony life, winged, colonizing, sexual forms (appearing each season at a definite period in well-established colonies), soldiers or workers, or both, of both sexes but sterile (neuters) and at least one pair of parent reproductive individuals (pl. 2, figs. 1 and 2). Again, the termite colony is not a feminist society—there are "equal rights" for the male. Both the male and female parent termites feed and care for the young in incipient colonies; their first progeny are *not* always neuters, however, although this is true in some genera; and most of the primitive

termites (family *Kalotermitidae*) have no worker caste. The male continues to live with and fertilize the female, and both have a post-adult growth—remarkable in the case of the queens of the more specialized family *Termitidae*. Both of these reproductive forms are long lived.

In case of the absence of parent reproductive forms of the winged caste, brachypterous (pl. 2, figs. 3 and 4) or apterous (pl. 2, figs. 6-8[1]) reproductive forms of both sexes are present; these forms are distinct castes. There are no fertile workers or soldiers among termites. Among the higher termites the neuters are polymorphic; there may be from one to three different types of soldiers and one to two types of workers of the same species.

The castes of termites, however, vary with the family and genus as does the progeny of a single pair of termites. The character of the progeny and the definite ratio between the castes also vary with the genus and the age of the colony. Hence, a genetic formula for termites would vary with the genus and age of the colony; the first brood of the incipient colony in some genera consists entirely of neuters. It would take years of study and experimentation to work out such a formula.

In no case at the present day do termites exist which do *not* produce as their progeny other castes in addition to the winged, sexual forms which must have been their presocial ancestral condition, *i. e.*, a single male and female sexually associated.

All the castes of termites are determined in the germ plasm of the species and are due to its inherent properties. As Thompson states, they are "segregants, in the sense of the offspring of *Oenothera lamarkiana,* arising generation after generation by the splitting and recombination of the genes of a heterozygous parent form." Hence the varied modifications among termites really are *not* due to "*adaptations*" to environment but let us rather say that favorable modifications have *persisted.*

The social life among termites must have begun some time before the Tertiary period, since wingless, sterile castes have been found in gum copal of the late Tertiary period, *i. e.*, polymorphism existed during the late Tertiary period; winged termites occur in the shales of the Tertiary period.

[1] This illustration of a remarkable apterous form from Java may be compared with the nymph of the first form of the same species (pl. 2, figs. 9 and 10) and with the normal apterous form of *Reticulitermes flavipes* Kol. illustrated in Bull. 108, U. S. Nat. Mus., figure 63, p. 108 and plate 30, figure 2.

Adaptations to social life among the termites can be seen most clearly by their responses to the three primal urges—hunger, sex, and fear. Unlike man, with a double nervous system, insects have no inhibitions.

HUNGER

Lameere has attempted to prove that the neuters of the social insects are of trophogenic origin, *i. e.,* the germinative plasma is labile and is influenced by nourishment. His data on termites are, however, drawn from erroneous sources; the neuters of termites are of blastogenic origin, *i. e.,* there is a distinctive germinative plasma. Although differentiated, nevertheless no caste of any termite is *externally* clearly differentiated at the time of hatching from the egg.

The male and female parent termites share the "royal cell" in incipient colonies and eat wood as food and care for the young until the latter have developed to the point where they can feed themselves. In genera where the first brood consists entirely of neuters, they are of smaller size than those in well-established colonies. In genera where no workers exist (in the family *Kalotermitidae*) the nymphs of the sexual forms perform the duties of the workers. As the colony grows in size the workers or nymphs care for and feed the reproductive forms; the male lives on and repeatedly fertilizes the female. Among the lower termites (*Kalotermitidae*) the queen remains always active (pl. 2, fig. 5) but queens of the higher termites (*Termitidae*) attain a huge size, become inactive and are more dependent, being often imprisoned in the royal cell. They become mere egg-laying machines, and there is a remarkable post-adult growth. The soldier termites have not mandibles adapted for eating wood and have to be fed by the workers or nymphs. The young of termites are also thus fed and cared for in special nurseries. There are two types of special foods—proctodeal (from the anus) and stomodeal (from the mouth).

In addition to these foods, all termites constantly lick exudate or secretions from the bodies of other termites. In their eagerness for exudate, a portion of antenna, leg or wing pad is sometimes bitten off a member of the colony. Termitophiles or guests are present in termite colonies and these serve as other sources of exudate and special food. Termitophiles occur even in colonies of the lower termites, where they are merely tolerated, but in colonies of the higher, more specialized termites, wonderful physogastric termitophiles occur and are eagerly cared for. Mushrooms are cultivated by species

of the *Termes* group in the Tropics, in special beds or gardens (pl. 1, figs. 1-8). Termite diet is further varied by an occasional lapse from the normal pure vegetable food by a meal on a wounded, sickly or dead member of the colony, leading to eugenics, as pointed out by Wheeler. In assisting termites to shed their skins, the insect in the quiescent stage during molting is sometimes eaten by workers instead of merely the shed skin; probably this only occurs in the case of deformed individuals.

The chief diet of termites was always mainly cellulose from presocial to the present times. In all termites except the higher forms, protozoa occur in the guts, and act as enzymes in aiding termites to digest the cellulose when in the form of wood; in mature queens the jaw muscles have degenerated, due to the fact that they are fed on partly digested food, and no longer masticate wood. It is among the higher termites that specialized foods play a more important rôle, and here the special wood-digesting protozoa are absent.

Having progressed thus far, restraining myself from using the much abused term "anthropocentrism," may I be permitted to state that, while termites have brains, and no one can deny but that there is undoubtedly a spirit of the colony or solicitude for the communal welfare, termites cannot be endowed with human reason. Thompson's work on the brains of termites has shown that the young are differentiated at the time of hatching and has proven that worker termites do *not* determine any caste by feeding. Furthermore, many of their instincts of care of the brood, etc., have purely selfish bases. I refer to worker *termites!* What can be said of the workers of the honey bee? Has their social specialization—or possibly domestication—enabled the honey bee (unlike the ants and termites) to make a study of dietetics so intensive as to place the control of the caste of the organisms to come in the hands of the feeding workers? I realize that careful work has been done by competent entomologists throughout the world on the honey bee. Nevertheless may I not make an earnest plea for an open-minded study, combining careful cytological work with experimentation with living colonies, to definitely settle whether or not the difference between the worker and queen of *Apis mellifica* Linn. is blastogenic? Whether an impregnated egg or a three-day-old worker can be developed into a queen by being fed upon the highly nutritious "royal pabulum," or being left in a smaller cell and fed meagerly, develop into a worker—the ultimate fate being subject, as Lull states, to the whim of the workers!

SEX

At certain seasons of each year, winged sexual, colonizing forms appear in well-established termite colonies, these forms having color in the body and having eyes. Normally termites shun the light, but these forms are impelled by some irresistible impulse to leave the parent colony and become markedly positively phototropic—a reversal of only temporary nature. As is necessary, the colonizing flight, or "swarming," is often correlated with rainfall, especially in arid regions. The lower termites have a longer, stronger flight and emerge from the parent colony in smaller numbers and at irregular intervals, while the more specialized species are restricted to a few large flights annually. The line of weakness at the base of the wings (where the wing breaks off after the flight) in the lower termites is often poorly defined, but is well defined in the higher termites which sometimes lose the wings in mid air, whereas the lower termites are forced to pry off the wings after alighting. In some genera the sexes are markedly attracted to each other before and after the flight or "swarm." The wings are lost and the males and females now exhibit marked thigmotropism; they burrow under pieces of decayed wood lying on the ground, under the bark on dead trees, logs or stumps, and in arid regions under dry cow chips, stones, etc. Mating does not take place while the insects are in the air and not until they have separated into pairs and together excavated a small "royal cell" and have fed on wood or cellulose in another form. Then the sex organs have matured and are ready to function.

The act of coition is *not* by superimposition; Haviland, not having observed coition, thought that the relatively small male must fertilize the eggs after they had been laid by the huge *Termes* queen; a *Termes* queen with markedly distended abdomen measures 100 mm. in length, 22 mm. in width and 20 mm. in height—the male is 16 mm. in length, 4 mm. in width and 3 mm. in height. However, superimposition in coition is unnecessary, since the sexes mate with the apices of the abdomens opposed. Termites again differ from all the other social insects in the continued cohabitation with and fertilization of the female by the male. Such repeated fertilization is necessary, due to the enormous number of eggs laid in large colonies.

Hence it has been noted that termites in the course of their specialization have lost the strong power of flight, for it is no longer necessary to seek "mates" afar, when they swarm in enormous numbers. The queens lose their power of locomotion after a slow

but remarkable post-adult growth, to accommodate an enormous ovarian development.

It must not be understood that there is only one type of reproductive form—the winged—among termites. Various different types of reproductive forms are first evidenced among insects inclined to be gregarious, as in the aphids.

As one of the "adaptations" of reproduction in termites, due to social life, the use of accessory sexual forms should be noted. Both brachypterous and apterous sexual individuals occur, with a few intermediates. These forms, inasmuch as they appear incapable of producing the winged sexual forms, are extreme social specializations with their reproductive functions more nearly purely colonial (*i. e.*, of the parent colony in contrast to the winged colonizing adults) in purpose. Their inability to produce the winged sexual adult (capable of wider dissemination) shows to excellent advantage their social origin and accessory nature; they are present in numbers and often perform the duties of workers.

Brachypterous reproductive sexual adults or those forms with vestigial wings (wing pads of varying length) have been noted by Snyder in the genus *Reticulitermes* of eastern United States to make a short "pseudo-flight" at the same time that the winged colonizing adults were making their annual flight. It is possible that this appearance in the open with the winged forms is their normal method of emigration to form new colonies, although it may be that their chief method of dispersal is by subterranean galleries. However, they give every evidence of being positively phototropic; they have more or less color in the body and in some of the facets of the compound eye; they also have ocelli and are probably able to perceive light and direction by means of the reduced compound eyes and ocelli but probably not images. Possibly this is the manifestation of an inherited instinct to swarm; running about or short jerky jumps into the air is all that their wingless condition will permit; at this time their sex organs are ready to function.

Polygamy, or perhaps better promiscuity, also exists among the wingless forms as a result of the colonial life of termites (a few males occur among a large number of females), whereas the winged sexual adults are normally monogamous—a less rapid method of increase, especially in young colonies. Exceptions to this occur, as when the deälated sexual male adult, upon the loss of his mate, consorts with a harem of brachypterous females. Neither neoteny nor pædogenesis exists among termites.

FEAR

Ants are terrestrial and dominant creatures; termites, as a rule being blind and soft-bodied, are usually subterranean or secluded in habitat and never dominant. They have been forced to "dig in" to survive and underrun tropical countries. There are a few exceptions, such as in *Hodotermes* of Africa, where the workers are harvesting in habit and come above ground into the sunlight; these so-called "workers" and the soldiers have color in the body and have eyes. Ants being terrestrial and aggressive, use their mandibles, sting, and formic acid spray as weapons of offense as well as for defense. Termites have all their weapons located on the head; mandibles and repugnant frontal gland secretion are used merely for defense. Workers in some genera of termites effectively use their mandibles in the defense of the colony and are more effective than the soldiers.

Among the most remarkable "adaptations" to social life among termites are the variations in development of the mandibles and frontal glands in the soldier caste. Among the lower termites (*Kalotermitidae*), the mandibles of the soldier caste are normally adapted for biting (pl. 3, fig. 1), while the frontal gland is rudimentary. In many of the higher termites (*Termitidae*), the mandibles are absent or vestigial and the frontal gland is highly specialized. Indeed, in the family *Rhinotermitidae,* intermediate between the lower and higher termites, the frontal gland is a specialized organ of defense; in *Coptotermes,* a sticky, white secretion exudes from a short tube opening. In some genera of the *Termitidae* the secretion is exuded from a nasus or beak (*Nasutitermes*), (pl. 3, fig. 2) or from the labrum extended into an elongate slender tube forked at the tip (*Rhinotermes*), (pl. 3, fig. 4). In species of *Armitermes* there are both biting mandibles and a nasus (pl. 3, fig. 3). This pungent secretion is more effective against ants—the worst enemies of termites—than are mandibles; in the specialization of winged termites this gland has passed from a rudimentary, closed (or plate) to an open stage. In other genera (*Capritermes*), (pl. 3, fig. 6), *Mirotermes,* and *Orthognathotermes* (pl. 3, fig. 5)) the mandibles are sometimes markedly asymetrical or at least very elongate and twisted. These mandibles could not possibly be used for biting but they are made use of by bringing together and flipping or snapping particles of earth at the invaders or even flipping away the invaders themselves.

As Wheeler predicted in 1907, "wherever the habits of the soldiers have been carefully studied it has been found that their singular and

apparently hypertrophied structures have a very definite function." Even where it seems most certain that there is a teratological development of the soldier head, it can be proven—even granting such an origin—that they have become exquisitely adapted to particular functions.

In the genus *Anoplotermes* the soldier caste is completely absent but it may be significant that the workers and winged forms often have very elongate mandibles (pl. 3, fig. 7). Species of *Anoplotermes* are often found living closely associated with termites having mandibulate soldiers, or in hard mound nests.

The lower termites (*Kalotermitidae*) and many *Rhinotermitidae* are entirely wood-boring in habit and live a protected life in dead trees, logs, and stumps. They are negatively phototropic to a marked degree, and when boring in logs they always leave a thin layer or shell of wood on the exterior. In one interesting case, *Cryptotermes thompsonae* Snyder of Panama, in making use of the exit holes of a wood-boring beetle, these holes were capped over or closed by the termites using a sticky substance and their pellets of excrement (pl. 3, figs. 10 and 11); this is rather unusual in the case of a Kalotermitid.

In addition to being subterranean in habit, many termites build carton, earth-like shelter tubes (pl. 3, fig. 8) when they desire to come out above ground or into the open. That is, they carry earth, their source of protection and moisture, with them above ground, over stones, up tree trunks, etc. Termites abandon colonies in wood that have been disturbed, emigrating through underground galleries—often to considerable depths; this also occurs to avoid extremes in temperature (and lack of moisture), particularly in arid or cold regions. Some species of termites of subterranean habit have subfossorial legs.

Among the *Termitidae* the nests are often architecturally perfect and nests of the Lower Congo have a regular system of ventilation. The meridional magnetic mounds of the compass termite of Australia and solid earthen mound nests hard enough to support the weight of a wild bull show specialization of a high degree. These towering hillocks—often like negro huts in considerable villages—(pl. 3, fig. 9) afford adequate protection to the immobile queens which are frequently of huge size. These queens are imprisoned in a royal cell, which in some nests is in the central portion near the base. The large carton semi-spherical "niggerhead" tree nests (pl. 3, fig. 12) of *Nasutitermes* are usually of tough texture; queens in these nests are not as large as those of *Termes,* seldom being over

25 mm. in length. Some species of *Anoplotermes* which are of subterranean habit build termitariums of soft earth-like substance (pl. 3, fig. 13); others are of hard texture.

CONCLUSION

It has been seen that the "adaptations" of termites to social life can be most readily traced in their reactions to the fundamental biological phenomena—hunger, sex, and fear. In fact, their colonial life has led or *permitted* individuals to become specialized for these primary purposes.

Social life through hunger impulses has led termites from a pure diet of wood (with protozoa in the guts necessary to the digestive processes) to several specialized foods solicited from each other and even to cultivate mushrooms and exudate-secreting insects; protozoa are then no longer necessary.

Among termites social life has led to unique expressions of sex urge. There is no nuptial flight where one male fertilizes one female at sacrifice of his life in the termites. There is a colonizing flight of an enormous number of males and females (large numbers of both sexes fail to survive) the male lives a long life with the female, and there is repeated fertilization. The progeny is composed of fertile and sterile forms, in definite relative ratios. A remarkable post-adult growth takes place in the queen, and she loses her power of locomotion. Several wingless reproductive forms have developed. Even the winged caste loses its strong power of flight and a suture has developed for the easy shedding of the wings after the flight. Polygamy and promiscuity result from communal life.

Social life has led or forced termites through fear, or desire for protection, to a subterranean existence; strong mound or carton nests have been developed, sometimes in trees, while carton shelter tubes have been utilized to cover forays above ground. As a result the eyes and color have been lost in the neuters and lost or reduced in the wingless reproductive forms; they either have become strongly negatively phototropic or thus merely avoid desiccation.

A wonderfully varied specialization is shown in the development of different types of mandibles and openings for the frontal gland, and a diverse polymorphism has developed among the neuters. Finally the soldier caste is lost in *Anoplotermes*.

EXPLANATION OF PLATES

PLATE 1

HUNGER. TERMES GROUP. JAVA.

FIG. 1. Cross section of a termite comb showing "cauliflowers" on walls, ceiling and floor of passages as bright white granules.
FIG. 2. Small comb of termite.
FIG. 3. Comb of termite nest showing cauliflowers as white granules.
FIG. 4. Comb of termite nest, cauliflowers visible on upper left-hand corner.
FIG. 5. Small comb of termite seen from above.
FIG. 6. Combs of termite with fruiting body of *Agaracineae* growing from it. Excavation on side hill.
FIG. 7. Bit of comb of termite with *Agaracineae* growing from it.
FIG. 8. Comb of termite excavated to show *Agaracineae* growing from it.
Photos. by Dr. David Fairchild, Agricultural Explorer.

Plate 2

SEX

Fig. 1. *Reticulitermes flavipes* Kol. Mature egg-laying female or queen of the first form with abdomen distended as a result of post-adult growth.

Fig. 2. *Reticulitermes flavipes* Kol. Mature male with abdomen only slightly distended as a result of lesser post-adult growth.

Fig. 3. *Reticulitermes tibialis* Banks. Mature egg-laying brachypterous female or queen of the second form with abdomen distended as a result of post-adult growth.

Fig. 4. *Reticulitermes tibialis* Banks. Mature brachypterous male with abdomen only slightly distended as a result of post-adult growth.

Fig. 5. *Termopsis angusticollis* Hagen. Mature female or queen of the first form with but slightly distended abdomen due to post-adult growth. This queen is active.

Fig. 6. *Lacessitermes atrior* Holmgren. Remarkable apterous or ergatoid reproductive form from Java.

Fig. 7. *Lacessitermes atrior* Holmgren. View of head showing mandibles, compound eyes and frontal gland.

Fig. 8. *Lacessitermes atrior* Holmgren. Enlarged view of mandibles.

Fig. 9. *Lacessitermes atrior* Holmgren. Nymph of the first form with wing pads which resembles a Jassid.

Fig. 10. *Lacessitermes atrior* Holmgren. Greatly enlarged view of head of nymph showing mandibles, eyes and frontal gland.

Plate 3

FEAR

Fig. 1. *Kalotermes occidentis* Walker. Soldier showing well-developed mandibles and wing pads.

Fig. 2. *Tenuirostritermes briciae* Snyder. Nasutus with nasus or beak from which a defensive secretion is exuded; the mandibles are vestigial.

Fig. 3. *Armitermes intermedius* Snyder. Soldier with both biting mandibles and nasus.

Fig. 4. *Rhinotermes manni* Snyder. Soldier, small type with labrum extended into an elongate, slender tube "gabelnasutus."

Fig. 5. *Orthognathotermes wheeleri* Snyder. Soldier with mandibles bowed and not adapted for biting.

Fig. 6. *Neocapritermes hopkinsi* Snyder. With markedly asymmetrical mandibles.

Fig. 7. *Anoplotermes fumosus* Hagen. Winged adult—head showing well-developed mandibles.

Fig. 8. *Leucotermes tenuis* Hagen. Carton, earth-like shelter tubes, view to show how sometimes these tunnels project into space, forming branching structures. The workers were seen frequently in the openings at the ends of these tunnels, building them up further; taken in the tunnel below the spillway at Mira Flores, 70 feet below the surface; the white part is the concrete ceiling of the tunnel; taken with a flashlight by J. Zetek. Panama.

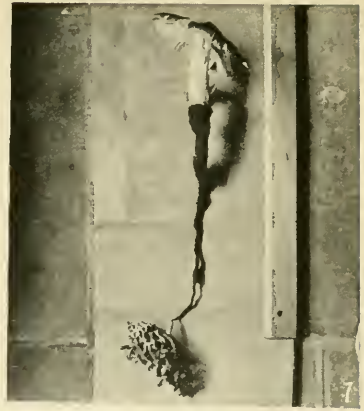
Fig. 9. *Amitermes medius* Banks. Mound termitarium on ground, several feet high. Panama.

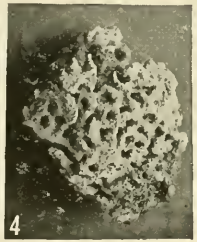
Fig. 10. *Cryptotermes thompsonae* Snyder. Exit holes of a wood boring beetle (*Neoclytus*) in the bark on trunk of an orange tree covered over or capped by this termite by means of its impressed pellets of excrement stuck together. Panama. (View of outer bark.)

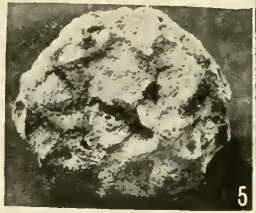
Fig. 11. *Cryptotermes thompsonae* Snyder. (View of inner bark.)

Fig. 12. *Nasutitermes cornigera* Motsch. Carton, semi-spherical tree nest. Panama.

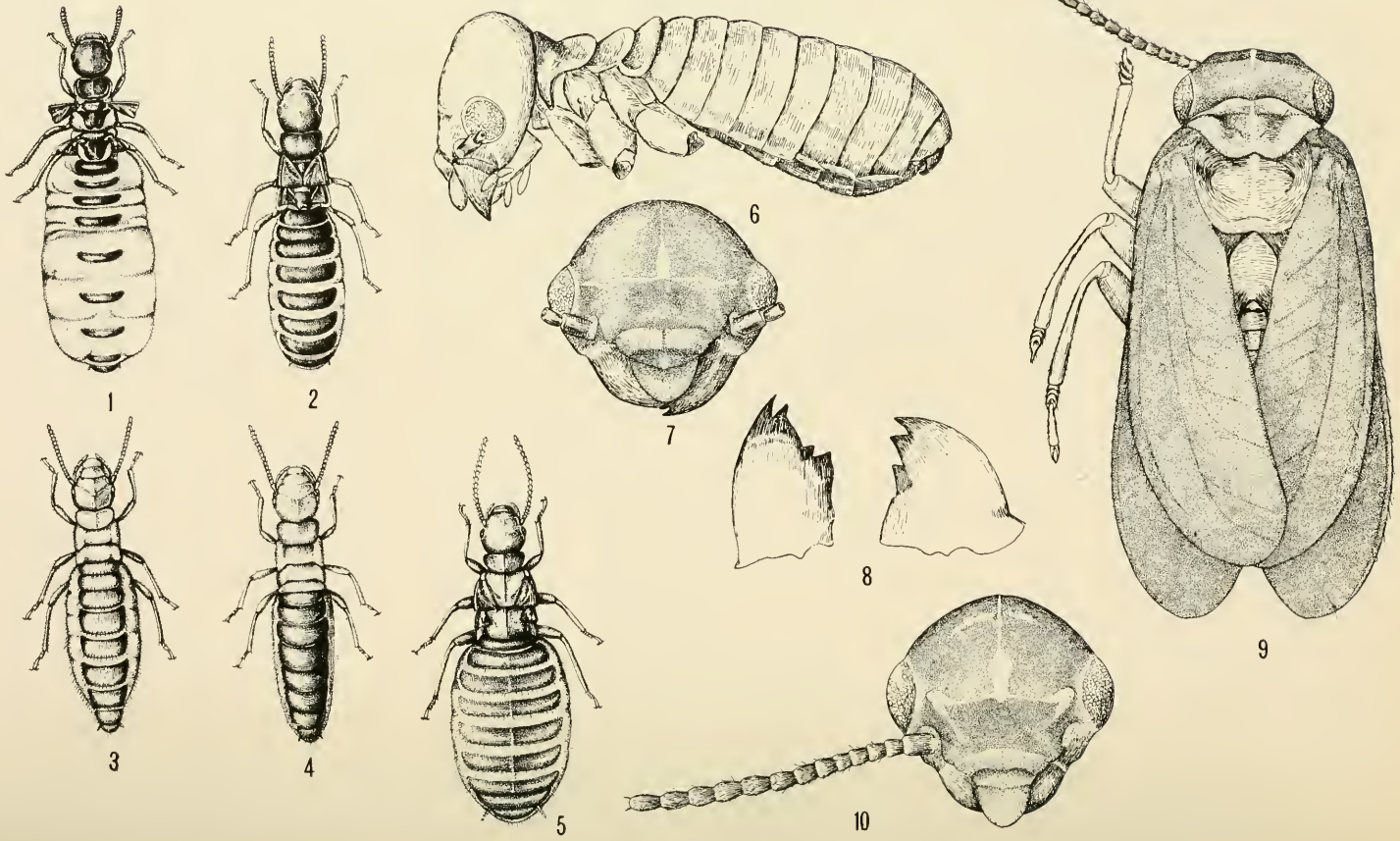
Fig. 13. *Anoplotermes parvus* Snyder. Low, turret-like termitarium of soft, black, earth-like substance built on ground at base of tree. Panama.



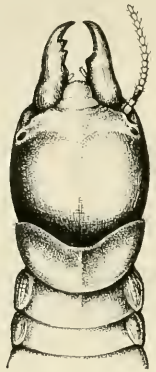




HUNGER. TERMES GROUP. JAVA.



SEX.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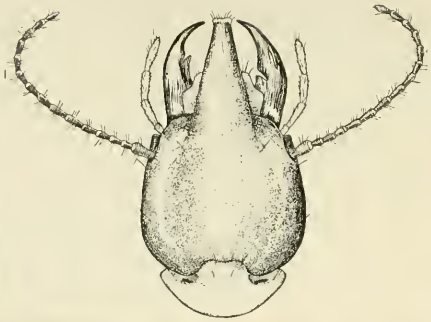
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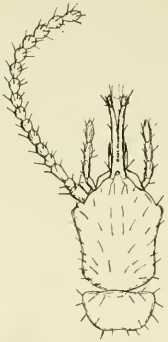
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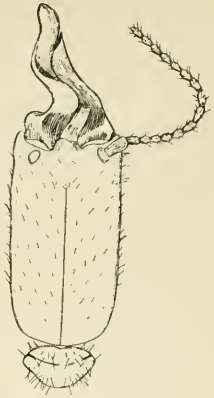
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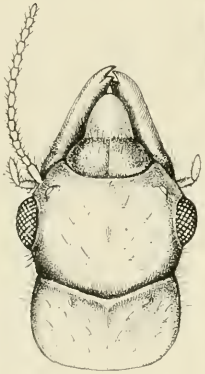
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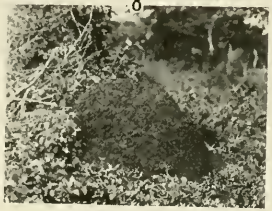
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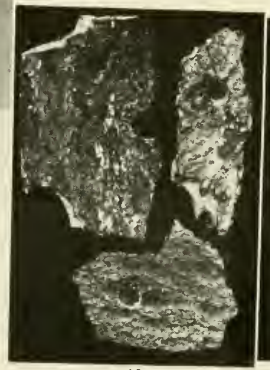
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