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**Taxonomy and Biology of a New West African Ant Belonging to the Genus *Amblyopone* (Hymenoptera: Formicidae)**

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**ABSTRACT**

*Amblyopone pluto*, n. sp., has been discovered in unburned savannas of central Ivory Coast. It represents the 3rd *Amblyopone* species to be found in sub-Saharan Africa, although the conspicuous absence of the genus from the central Ethiopian region now appears less an indication of abundance than of collecting procedures. This new, moderately sized species is hypogastic, its cryptobiotic lifeways preventing its discovery until only recently. A taxonomic description of the species is given. This species is narrowly specialized, particularly regarding prey specificity, feeding only on geophilomorph chilopods. The workers forage alone and paralyze the prey with their sting. The prey is then dragged into the nest and is deposited in the vicinity of the brood. The workers penetrate the chilopod integument and feed, but they do not subdivide the prey. Eventually the larvae are carried by the workers to the prey and begin feeding, characteristically thrusting their heads into the soft interior of the chilopod. Several of the behavior patterns of this species, particularly with respect to the level of larval autonomy, reflect a primitive social organization, which supports the placement of the genus *Amblyopone* near the base of the formicid line represented by the Ponerinae, Myrmicinae, and Dorylinae.

The genus *Amblyopone* has up to now been known in Africa from samples of only 5 species: *denticulata* (Roper), *emeryi* Saunders, *mutica* (Santschi), *normandi* (Santschi), and *santschii* (Menozzi). Of these, only *mutica* and *santschii* are sub-Saharan. The distribution of these 5 species is peripheral, being limited to the northern and western fringes of the continent. The absence of the genus from the central Ethiopian region now is being proven more apparent than real. First, excavations by one of us (J.L.) in the inland wet savanna region of the Ivory Coast have revealed a subterranean faunule of *Amblyoponini*, including the genus *Apomyrma* (Brown et al. 1971) and at least 4 species of *Amblyopone* (*A. mutica*, *A. pluto*, n. sp., described hereinafter, and 2 or 3 other species related to *A. normandi* and *A. santschii*). Workers of another undescribed species of the *normandi-santschii* group from the Congo have recently been shown us by A. Francouez. Thus our ideas about the African *Amblyopone* fauna are undergoing radical changes, and doubtless will be further transformed as systematic investigation of soil-inhabiting arthropods is extended in Africa.

One of the most interesting of the soil-inhabiting *Amblyopone* is *A. pluto* and it is the purpose of this paper to describe this new species and to offer a series of preliminary observations on its biology.

**METHODS**

Measurements were made of a series of 15 workers, 5 queens, and 2 ♂♂. Several abbreviations are used in the presentation of these data: TL = total length, HL = head length, HW = head width, CI = cephalic index, AL = alitrunk length, PL = petiolar length, GL = gaster length.

The mouthparts of several specimens were prepared and examined according to the methods outlined by Gotwald (1969). The genital capsule was removed from 1 ♂, and its components were mounted on microscope slides.

The drawings were done with the aid of microprojector and a Wild M-5 dissecting microscope equipped with a drawing tube. All of the drawings were made by the 1st author. The photographs are by the 2nd author.
TAXONOMY OF THE SPECIES

Amblyopone pluto, n. sp.

Worker, Composite Description.—TL 5.66–6.38 mm, HL 1.08–1.17 mm, HW 0.94–1.08 mm, CI 87–96, AL 1.53–1.75 mm, PL 0.67–0.85 mm, GL 2.11–2.43 mm, scape length 0.67–0.72 mm, length of petiolar node 0.67–0.81 mm, width of node 0.81–0.90 mm, hind femur length 0.76–0.85 mm.

Habitus as shown in Fig. 2. Head and alitrunk black to dark reddish-orange (fully pigmented?); genae, Clypeus, and frontal carinae of head, and ventrolateral margins of alitrunk often lighter, approaching a yellowish-orange; gaster dark brown to reddish-orange; petiole (abdominal segment II) sometimes black dorsally; legs rufous to yellow; antennae dark rufous to yellowish-red and always lighter in color than head.

Head as shown in Fig. 4. Genal angle rounded, not prolonged into a genal tooth; frons and genae coarsely punctate, although frons is less so and glossy; eyes greatly reduced, usually with 10 or fewer facets, greatest diameter less than 0.09 mm. Frontal carinae widely separated, strongly diverging from mid sagittal line curved; carinae not prominent but enlarge to form widely separated, expansive frontal lobes which conceal the antennal sockets in dorsal view. Areas surrounding antennal sockets deeply depressed and sculptured with striae which sweep out from the sockets. Clypeus concave medially, descending sharply from area between frontal lobes and bearing a row of elongate tubercles, usually 9–11, the longest (as long as 0.10 mm) placed medially and those placed laterally decrease in length sequentially; clypeal tubercles appear flattened dorso-ventrally and are rounded or truncated apically. Antennae 12-segmented; scape almost straight in dorsal view (Fig. 18).

Internal margin of mandible broadly convex (Fig. 8); masticatory margin smoothly continuous with basal margin; internal margin with a conspicuous, elongated apical tooth followed closely by a conical 1st subapical, 2nd subapical often truncated, 3rd subapical followed by as many as 2 or 8 additional teeth which become progressively more rounded and shorter proximal, teeth single ranked. Labrum cleft medially along distal margin (Fig. 7); lateral margin slightly concave along distal two-thirds, deeply notched along proximal third; numerous setae inserted along distal margin and on extensor surface. Maxillary palpus 4-segmented (Fig. 10). Stipes with a conspicuous transverse stigial groove which curves distal, running longitudinally along external face and ending at the level of palpal insertion; lateral shoulder well developed (Fig. 10). Galea with a typically well-developed maxillary comb (Fig. 9); galeal crown with numerous long setae, incising a series of closely arranged setae (usually 7) forming a distinct comb; galeal comb present and composed of 6 or 7 peglike setae. Lacinia triangular with a distinct lacinial comb along ⅔ of free margin (Fig. 9).

Labial palpus 2-segmented (Fig. 11); subglossal brushes well developed; paraglossae absent.

Alitrunk finely punctate, punctures far less numerous per unit of area than on head, surface of integument otherwise smooth and glossy, particularly on dorsum; areas immediately above insertions of 2nd and 3rd coxae and covering hulla of metapleural glands impressed with a series of longitudinal striae. Declivity of propodeum steep and slightly concave. Petiolar node with vertical, flat anterior face, rounding off into the dorsal face at a slightly larger than 90° angle.

Gastral tergites finely punctate, punctures widely scattered; surface of tergum otherwise smooth and glossy except for opaque acrotergites. Stermites of gaster more coarsely punctate, not as smooth or glossy.

Head moderately pubescent, with numerous short, erect and suberect setae, primarily on frons. Alitrunk sparsely pubescent with short setae scattered over dorsal and pleural regions; dorsum with several long, erect setae. Gaster sparsely pubescent except for visible terminal segment, which bears many erect and suberect setae; each segment bears a row of erect setae, in addition to scattered setae, near and parallel to posterior margins of tergites and sternites.

Tarsal claws simple. Tibial spurs 1, 2, 2; meso- and metathoracic tibiae each with a large, broadly pectinate spur and a smaller non-pectinate spur.

Queen, Composite Description.—TL 6.43–6.78 mm, HL 1.12–1.21 mm, HW 1.03–1.12 mm, CI 92, AL 1.89–2.07 mm, PL 0.72–0.81 mm, GL 2.16–2.43 mm, scape length 0.72–0.76 mm, length of petiolar node 0.67–0.81 mm, width of node 0.81–0.94 mm, hind femur length 0.85–0.94 mm, greatest diameter of compound eye 0.18–0.22 mm, forewing length (1 specimen) 3.70 mm.

Habitus as shown in Fig. 1. Generally darker and more homogeneous in color than worker. Gaster lighter than head and alitrunk; legs not yellow as sometimes seen in workers.

Head as shown in Fig. 5. General configuration of head, including absence of genal teeth, similar to worker. Punctuation and structure of frontal carinae as in worker. Head with conspicuous multifaceted compound eyes and with 3 ocelli. Areas surrounding antennal sockets deeply depressed and striated as in worker. Clypeus concave medially and bearing a row of conspicuous tubercles (10 in each specimen examined); clypeal tubercles up to 0.11 mm long; when an even number of tubercles occurs, the middle two are of equal length and one is situated on each side of the mid sagittal line. Antennae 12-segmented; scape almost straight in dorsal view.

Mouthparts almost identical to those of worker. Second subapical tooth of mandible may be con-
Habitus as shown in Fig. 3. Head and thorax black; scape of antennae black to dark brown; funicular light brown; coxae black to dark brown, triangular and proximal end of femur yellowish-brown, remainder of femur dark brown, tibia yellowish-brown, tarsus light yellowish-tan; pediole and gaster black to dark brown with pleural and intersegmental regions yellowish-tan.

Head as shown in Fig. 6. Genae, frons, vertex, and clypeus coarsely reticulate-punctate; fine puncture superimposed over coarse punctures; small area between antennal insertions with fine puncture only. Head glossy. Compound eyes large; 3 prominent ocelli present. Frontal carinae low and inconspicuous, continuous with rims of antennal sockets; carina not forming frontal lobes. Antennae 13-segmented (Fig. 20); funicular segments with 2 type of setae, one type similar to that of queen and worker, the other type, restricted to the male, large and setose.

Mandible linear with a straight internal margin not differentiated into basal and masticatory aspects; external margin broadly convex, only apical tooth present (Fig. 13). Labrum broad, deft mediad along the distal margin (Fig. 12); general conformation as in worker but without conspicuous pro-}

spiciously truncated; galeal comb with as many as 9 setae.

Alitrunk finely but more sparsely punctate than in worker; dorsal surface otherwise smooth and glossy. Longitudinal pleural striae present above insertion of meso- and metathoracic coxae. Declivity of propodeum steep and slightly concave as in worker. Petiolar node as in worker.

Sclerites of gaster finely punctate; abdominal segments II through IV more sparsely punctate than remaining segments.

Pubescence as in worker.

Tarsal claws simple. Tidal spurs 1, 2, 2.

Wing venation (Fig. 17) as in A. pallipes (Halde- man).

MALE, COMPOSITE DESCRIPTION.—TL 5.89-6.07

mm, HL 0.90-0.94 mm, HW 0.99-1.03 mm, CI 109-

110, AL 1.84-1.89 mm, PL 0.54 mm, GL 2.02-2.61

mm, scape length 0.13-0.18 mm, length of petiole

node 0.40-0.45 mm, width of node 0.67-0.72 mm,

hindfemur length 0.81-0.85 mm, greatest diameter of

compound eye 0.49-0.54 mm, forewing length 2.96-

3.35 mm.

Fig. 17-20.—A. pluto, wings and antennae. 17. Wings


20. Right antenna of male.

March 1972

GOTWALD and LÉVYX: NEW WEST AFRICAN ANT

387

inserted on the dorsum. Petiolar node and gaster moderately pubescent, with subcercet setae most nu-

merous near the posterior margin of each sternite

tergite; number of setae per gaster sclerite increasing
caudally.

Tarsal claws simple. Tidal spurs 1, 1, 2.

Wing venation (Fig. 19) as in female.

Genitalia as in Fig. 21-26.

The type-nest and 4 additional samples, upon which the descriptions are based, came from the Lampo Field Station of the University of Adjeban in south-central Ivory Coast. Lampo is off the main highway, ca. 50 km south of Tabouli at 61°34’41” W.

The holotype worker, from the type-nest AA 104 collected Aug. 16, 1965, and some paratypes are deposited in the Musée Nationale d’Histoire Naturelle, Paris. Other paratypes are deposited in the Museum of Comparative Zoology at Harvard University and in the British Museum (Natural History).

TAXONOMIC DISCUSSION.—A. pluto represents the 3rd species of Amblyopone to be described from Africa south of the Sahara Desert. The other 2 species are A. santchii, described by Renozzi (1922) from Dukar, Senegal, and A. mutica, described by Santachi (1914) from Badian, Nigeria. Renozzi described the workers in A. santchii as reddish-brown and measuring 4 mm long, or much smaller than A. pluto, and he said that the head of A. santchii was “molto più lungo che largo, subparallelo, appena un poco più allargato antero-posteriormente”.

A. pluto, the head is only slightly longer than wide, and is not at all broadened anteriorly. The mandibles of A. santchii are “strette... leggermente stristato,” while in the new species, the mandibles are shorter and broader in the genus, and their dorsal surfaces are smooth and shiny, with scattered punctures. Evidently also, the mandibular and clypeal dentition of A. santchii are more “as usual for the genus A. mutica (3.5 mm long or smaller),” on the other hand, is easily separated from both A. santchii and A. pluto; its clypeus is devoid of teeth or tubercles, and its petiole is narrowed anteriorly to form a short peduncle. On the basis of these latter characteristics, Santachi erected the subgenus Xyn-

ner (to include mutica), which was subsequently synonymized with Stignatona unknown by Brown (1949).

The worker and queen of A. pluto exhibit most of the distinctive Amblyopone characteristics. The petiole is broadly attached to the petiole (abdominal segment III), the eyes are situated behind the middle of the head, the mandibles bear more than 5 teeth, the frontal carinae form expansive lobes, the antennae are 12-segmented, the promesomeral suture is distinct and complete, the sting is functional and conspicuous, and the clypeus bears a row of tubercles.

A. pluto departs slightly from the Amblyopone pattern in its lack of general teeth and in the shape of the mandibles, which are not as “linear” as in many Amblyopone species.

The clypeal tubercles of A. pluto are particularly
conspicuous and appear to be much longer than those found in many other species. Although their function has not been determined, they may aid in grasping prey or brood. In the case of brood, this idea is an attractive one, because the workers commonly carry their larvae to the freshly captured prey, once the prey has been dragged into the nest. Analogous tubercles or teeth are present in other species of ants and are not restricted to the elypters. They appear, for instance, on the labrum of the amblyoponine, *Aenonympha stygia* Brown, Gotwald, & Lévi. 

The stipples of *A. pluto* have strongly developed transverse stipital grooves. When the mouthparts are withdrawn, the labrum closes, and its distal margin fits snugly into these grooves. Together, then, the labrum and stipital scales secure close the oral cavity and protect the softer mouthpart components. The transverse stipital groove well developed in the *Dorylinae*, Cerapachyinae, and *Pseudomyrmecinae*. However, it is not present in *A. plolipes*, which unlike *A. pluto*, possesses paraglossae. However, in most respects the mouthparts of *A. pluto* and *plolipes* are quite similar.

The workers of 1 colony sample of *A. pluto* (AA104), consisting of 2 workers and 1 queen, are smaller than other species examined. The 2 workers have total lengths of 5.66 and 5.79 mm, while the range for all other workers is 5.98–6.52 mm. The queen of this sample is 6.61 mm long and falls within the range for the other queens (6.43 and 6.78 mm). The lengths of the heads, alitrunk, and petiolaris of these 2 workers represent the lowest measurements in the ranges for the species, while the gaster lengths fall within the species range, although at the lower end. The eyes of these 2 workers are reduced and are represented by only a change in the pigmentation of the integument. They may well consist of a single facet. This reduction in size appears to be allozymic. In all other respects, this colony sample conforms to those characteristics which distinguish this species. Evidence suggests that polymorphism is not well developed within the colonies examined, and this condition is true as well for other species in the genus (Brown 1960). There is little doubt that the colony of smaller individuals is the same species, but we have yet to explain why they are smaller.

Perhaps *A. pluto* is most interesting in its apparent conspicuousness. It is a moderately sized ant and is clearly a new species, but its cryptic behavior has seemingly hindered its discovery. It may be that other "conspicuous" species of *Amblyopone* remain to be discovered in the Ethiopian Region, and that their apparent absence from this Region may be a reflection more of collecting technique than of actual abundance.

**Biology of the Species**

This species was discovered in the humid savannas of central Ivory Coast. Indeed, the distribution of this species is limited, so far as is known, to savannas that have not been burned for several years (Fig. 27). Neither foraging workers nor nests have been observed in those parts of the savanna burned annually.

Unlike other *Amblyopone* found in the same habitat (*A. nubicus*, *A. near normans*, also *Aenonympha stygia*), this species has not been found in the forest. However, like other species of the same genus, it is possible that it extends into the savanna from the neighboring forest, but its density, while more (several nests per hectare), is at least higher in savanna.

The collected nests were situated at a mean depth of 20 cm in black clay soil with a thick cover of litter derived from several years' accumulation of grass. Microclimatic recordings showed that the environmental conditions (light, temperature, relative humidity, etc.) at soil level are like those found in the humus of gallery forests.

Adult males and females as well as sexual brood have been collected from nests during March and April. It is therefore probable that, as with *A. nubica*, the time of mating for the species is correlated with the beginning of the rainy season. No sexual forms of the species were collected at UV light, despite persistent UV collecting within its area of distribution.

It is impossible to determine times of foraging activity or the full extent of the foraging range of *A. pluto* or for the other species of *Amblyopone* observed. The ants belonging to the genus *Amblyopone* never forage, from what we have already observed, on the surface of the ground, even on the humus of areas well covered by vegetation as the unburned savanna. Australian *Amblyopone* sometimes come to the surface of the soil, but do not normally forage there (R. W. Taylor, personal communication; Brown 1960). There are no stings on the savanna that might serve to cover near-surface nests or nest fragments.

Isolated workers are encountered foraging at a depth of 15 cm or more in the ground. The radius of activity from the nest is significant; the workers have been observed foraging up to 6 m in a straight line from the nest. That these workers belonged to the colony under consideration was verified by observing the absence of reciprocal hostility when they were placed in the presence of workers from the nest.

Isolated wingless queens were found moving about in the soil several meters from the colony. It would not be astonishing to find that queens forage in this species, because ponerine foundress queens often do. Haskins and Haskins (1951) observed, in *A. australis* Erichson, that during rearing the queens continue, for a long time after nest foundation, to participate in provisioning the nest concurrently with the workers. Because the observations on *A. pluto* were carried out in March, i.e., during the species' reproductive period, it could be that the females collected were foundress in search of new colonies or practicing progressive provisioning (Wheeler 1914; Haskins and Enzmann 1938; Haskins and Haskins 1950, 1955; Le Masne and Bonnivin 1969).

Prey were gathered in 2 of the 3 nests opened is...
1968; all were geophilomorph chilopods. In the nest already described, 2 chilopods were found in a cavity next to the brood. One was already dead and decayed; the second was still living, although paralyzed. The brood was in a pile beside the chilopod, but no larval fragments could be found. It is interesting to note that in all the nests observed, the presence of visible prey remains belonging to animal groups other than Chilopoda was never noticed.

Since then, 7 nests of *A. minax*, the most abundant ambigunid chilopod in this region, have been opened. The only food debris that has been observed inside these nests were the remains of chilopods. Brown (1960) indicated an analogous diet for *A. pollipes* in the United States and *A. hacheri* Wheeler in Australia. On the other hand, the large Australian spe-

The specialized diet of some *Amblypoeone* can be compared with that of other neighboring hymenopteran arachnids. It is interesting to note that numerous families are closely related to the ants (accordin-
g to Brown 1954, Wilson et al. 1967), like *Amblypoeone*, have specialized alimentary needs. Thus Scelidophis, and most Tibellides, attack the larvae of many insect species. Coleoptera, while methochines tibellides live at the expense of cicindelid larvae (Clausen 1940). Although there are many notable exceptions, the higher ants tend to utilize a wider variety of prey.

Because the observations on these arachnid ants are generally considered to be the most conclusive of the various species listed on the Andes, the following observations on *A. plumosum* are offered below. Taking into account the limited spatial distribution of this species in the area studied and the small number of colonies observed, certain observations could not be made in every case. The data are needed for confirmation or revision of some details.

**The Nest of *A. Plumosum*** — Three nests were excavated in March 1968, all at ca. 10 AM. The general plan of the nest was much the same in all cases. The total depth of each nest was 3 to 30 cm, with 2 to 20 cm of one of them was closely observed. This nest, ranging from 10 to 30 cm deep in the soil, showed the following plan. An ellipsoidal passage (5x5 mm) ca. 15 cm long had in some places pockets spaced 5 mm. The walls were usually white in color. This passage could be created by the ants' or other animals the ants could be created by the ants. This could be a burrow elaborated by another soil organism or a part of the site of a missing root. This channel led to a larger cavity about 1.2 cm. high. This chamber contained at the time of observation 6 to 20 cocoon nests. Another opening could be distinguished in the floor which led to a larger cavity, ca. 3 cm high. This chamber contained the greater part of the larva-

The colony contained in this nest at the time of opening consisted of 18 workers, 2 winged females, and 1 male. There is no necessity for a polygeny colony, and such a composition can be in-

The nature of the process by which the excitation in the ants is provoked must be examined. The ants, like all others, are very sensitive to the slightest movement of air, as for instance in moving the body of the chilopod. They are also very sensitive to the slightest disturbance of the soil, and certainly it could involve vibration or deflection linked to a movement of the air generated by the motion of the chilopod. Observation seems to sug-

The observations show that the ants cannot locate their prey at the base of a narrow slit, and the majority of *Amblypoeone* has small, poorly developed eyes. If the prey flees to the other end of the nest, the workers will not follow it. The attack will occur when a foraging worker in the nest passes near the prey. The chilopod immediately becomes much more ac-

tive (rapid movements in all directions, antennal movements). The introduction of the nest of a *Anthelema* can be followed by an emergence of 6-cm *Eurydesmus* in the mandibles. The chilopod flees. There is a very distinct lack of persistence in the attack of the workers. The major attack does not last more than one or twice. At the end of a few minutes, the chilopod escapes, and the ants then begin a new attack. The workers no longer bother it, and return to the brood piled in another corner of the chamber. After a while, a foraging worker seemingly by chance, observes the chilopod in another corner of the nest. In its flight it shows that the attack of the chilopod is more than enough that penetration of the chamber containing the brood, thus causing general excitation. There follows a number of attacks which increase when the chilopod is in the region of the brood. Generally, the attack is con-

In general, several hours pass before a systematic attack on the chilopod begins. But in case an im-

**Feeding Behavior of Adults** — Different types of food were tried, but only chilopods were accepted. Chilopod remains belonging to the same genera as those observed in other attacks were introduced to the laboratory. The internal temperature, measured with a thermocouple, varied with the time of day between 25 and 30°C. Relative humidity, measured with a probe, remained permanently at the saturation point. The observations described below were carried out with 6 colonies collected between February and March.

The feeding behavior of adults varies depending on the type of food provided. Different types of food were tried, but only chilopods were accepted. Chilopod remains belonging to the same genera as those observed in other attacks were introduced to the laboratory. The internal temperature, measured with a thermocouple, varied with the time of day between 25 and 30°C. Relative humidity, measured with a probe, remained permanently at the saturation point. The observations described below were carried out with 6 colonies collected between February and March.

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movements which are not typical of normal walking movements and which are characterized by repeated dorsal arching of the body. One or both portions of the segment behind the point where the ant had been attached...but after a few minutes showed partial recovery. A case was observed in the present study where a chilopod had been able to move again several minutes after death. However, the delay in the recovery was very rapid, it could not be ascertained for sure as to whether there was an effective sting.

Once immobilized, the prey is dragged by 1 or more workers into the region where the workers' legs are kept. Still there is no obvious coordination among the various ants doing the work at any given time. However, on the whole, there is a coordination of sorts in that the prey finally arrives at its destination. The chilopod is dragged a point varying in distance (several millimeters to 4 cm) from the brood. This action is the most frequent, but occasionally the chilopod can be found even on the brood, or barred among it (observation, which apparently was exceptional at various times). The prey remains alive, as shown by movement of its body.

These observations confirm and supplement the work of other investigators on other species. The paralyzing process as described by Brown (1960) for A. palipes and by Wilson (in Brown 1960) for Myrmeleotettix castanea (Fr. Smith) of New Guinea. This A. palipes prey paralysis contrasts with other ants, where the prey is killed. Le Masne (1938) observed that there is a lack of the brood and that the prey was dragged to the area containing the brood. This observation agrees with Brown (1960) who wrote of Myrmeleotettix, “the following day, the ants were found to have removed the centipede...to the brood chamber.” Consequences of the brood and the prey were placed on the prey. However, the 2nd movement is less important than the first in terms of the distance covered, Wilson (1958) and Brown (1960), nevertheless the presence of workers of some species of Anamblypode transport their brood to the prey when it is impossible to move the latter from the place where it is killed.

In nature, females can be found 2 or 3 m from the brood. However, the larvae in the laboratory are less active than the workers. She stirs less and spends less time with the brood, but will on occasion glossate the larvae just as the workers do. The queen is likewise involved in mutual lichings with the workers. The queen was never seen to assist in a direct attack on a chilopod, and although such behavior is probable in nature, at least on the part of foundresses, it is clearly much rarer than for workers when the latter are present.

As with the prey, A. palipes, Le Masne, personal communication, and most species of the chilopod is never immediately dismembered by the workers. In fact, the Anamblypode contrasts sharply with other ants that cut up the food received for the larvae.

The A. palipes workers open their prey by biting at the intersegmental membranes. They also cut up the mouthparts. It is relatively difficult to detach a piece of the leg, the cecrum yields more readily. However, workers are most successful at destroying the membrane. Independent of these contacts, several workers push the piece of the leg by their antennae, which are damaged more than the middle of the body. The fact is a direct consequence of the pursuit. They place their mouthparts on the openings thus made, probably attracted to the fluids flowing from the wound. When 1 or more openings are made in the area of the intersegmental membranes, the workers feed on them first. They put their mandibles into the body; sometimes even a part of the head is inserted and thrust into the opening parts of the tergum. When the head of the worker is withdrawn a remnant of food in the form of a long whitish filament can be seen stretching between the labium of the ant and the prey. Though it is indispensable for feeding, the prey may be alive at the beginning, the fact that different cases of castes continue after death, even when the prey does not have to do with a cadaver. It should be noted that the workers can eat or try to feed first, accompanied by wingless females. In this case, the workers can feed on the last meal and without regard for their brood. The winged females are much less active than the workers; they do not show up until the prey is immobilized in the region of the brood where it is placed. The males do not participate in the preliminary phases of discovering and capturing the centipede.

The male's position in the feeding succession follows that of the females in accordance with the length of time they spend feeding. Although they appear to try their mouthparts on the prey cadaver, every attempt to penetrate the integument on their part is fruitless. Thus they are obliged to utilize previously cut openings.

To determine the degree of feeding specificity for A. palipes, a colony was starved 3 days and then presented with members of various arthropod groups (experimentalallophagy). A 1st series of trials showed that A. palipes fed on various types of termites, but none of the workers, nor the brood, were killed. The 1st feeding to the genus Nasutitermes, the second to the genus Bellicositermes. Each introduction unleashed a violent battle in which the termite solid and the chilopod were the combatants. However, the termites were finally killed, and their bodies, treated like other debris, were taken to the nest containing refuse without the ants ever attempting to feed on them.

A 2nd trial, repeated 4 times, with bee's honey deposited on various holders (paper, cardboard, glass, wood) showed that the workers are totally indifferent to honey. After sensing the material with their antennae, they finally turned away, concurring Haskins and Haskins' (1951) conclusion that Anamblypode will not accept honey. We note, however, that the male of A. palipes can eat honey and fruit juice.

A test conducted with the successive introduction of a campeade and a japygide was more interesting. Their size was 5-7 mm. They were immediately attached by the workers, as are all other living arthropods passing close to the brood. The japygide was killed with a single sting; the campeade required three. However, as in the case of the termites, there was no attempt to feed on them. Therefore, at the moment, the workers are not interested in this group of chilopods make up the entire diet of this primitive ant.

It was impossible to quantify the amount of workers taken in nature. However, a laboratory test can assume 2 chilopods every 1-2 days. It is possible, taking into account the number of prey observed in the opened nests, that this number is superior to that actually ingested in nature. However, the laboratory values are useful, a colony of 20 individuals could consume about 2500 chilopods a year. If one estimates that the density of A. palipes colonies can range from 10 to 20/ha in their preferred biotope and that, at a given time, one can find at least 1 chilopod/m² (value arrived at in one of our colonies) a given number of chilopods. Thus, the number of chilopods in the nest could be considered 2000-5000 chilopods/year. Keeping in mind the chilopod replacement rate and the fact that their real density is probably higher than the estimates indicate, it is possible to judge the amount within its zone of maximal density, an important factor in the limitation of the number of chilopods.

Trophallactic transmissions of food in Anamblypode are very rare; in 1 hr of continuous observation of A. palipes, 1 sure exchange was recorded and 12 probable exchange. The duration of the first was ca. 30 sec. The 2 partners approached each other face to face. After a few contacts with the antennae, the left one pivoted ca. 90° while the other raised its head. The head of the other, thus permitting the mouthparts to come into contact. Liquid could not be seen between the labia.

It is impossible at the moment to conclude whether this abolation of labor (polyethism) exists among the various species of A. palipes. The observation that a worker with a large amount of labor can be seen in other primitive ants like Myrmeicognathus (F.) (Haskins and Haskins 1950, Fordham 1958) or Mesoponera caffra (Fr. Smith) (Dornfels and Poveda 1970), and it is well known for Myrmica (e.g. Camponotus and Myrmeicognathus). It could not be ascertained for A. palipes whether certain workers were more particularly concerned with the brood, while others were involved in foraging.

The following conclusions on A. palipes hunting can be made: based on field and laboratory observations.

a. The workers forage alone in their search for prey.

b. They attack prey that are large and have a greater number of working ants and paralyze it with their sting.

c. The prey is then dragged into the nest to a position near the brood.

d. The workers penetrate the integument of the prey and cut it up, and feed on the soft parts.

e. The chilopods are considered to be of the geophilomorph chilopods.

Note that the range of observed behavior patterns (shy discovery, contact, attack, stinging, transport) occurs in a continuous fashion. There is a more or less gradual transition from each pattern, the longest interruptions taking place at the beginning (discovery and attack phases), at least in the artificial nest.

Still, it is important to examine the manner in which the larvae are fed, an examination of larvae transport is appropriate. This transport occurs in 2 stages. In the 1st stage, the worker moves the larva to be fed to the side of or eventually onto the pit containing the workers. In the 2nd stage, the larva, through independent movements of its thorax, does not attempt to stick its head into the chilopod.

The worker can therefore move a larva and place it beside the chilopod. The larva lies on its side or turns over into the chilopod, which, if the larva shows no sign of pain, may be either behind the head or at the junction of the thorax and abdomen. Seizure occurs in this latter region from 60 to 70% of the time. The worker may also grasp the larva in the abdominal region and, if the larva does not respond, the worker may drag the larva, by the thorax and abdomen. The larva, because it is too soft to be grasped because of larval stages in which the larva are enclosed, as long as the workers. Two cases of larval transport occurred in which the larva involved was left isolated in the middle of the nest without any attempt at transport. Even if the larva is seized, the larva drags its head to the brood area, and as a result of this third phase transport, the larva can sometimes find its own way to the prey. The winged queens behave like the workers and try to place the larva, which is accompanied, on or beside the chilopod. However, they make this attempt less frequently than the workers.

Once beside the chilopod, the hungry larva elongates its thoracic segments, turns its head by protraction of the head and bends it to the side. It may also slightly bend the thorax toward the posterior. Its flexibility is such that this part of the body can assume an S-shape (Fig. 28). If the head moves over to the side, the larva can rock itself from this position. The larva then attempts to hook onto the prey, moving its mouthparts over the surface of the chilopod. If it is situated at the middle of a segment, it is evident unable to pierce the cuticle. If, on the other hand, it is more or less horizontal, the larva searches for a tear in the membrane. If it is near to a place not previously cut by the workers, it will try to pierce the cuticle, but it can do so only where the integument is thinnest. The larval mandibles can be seen through the transparent larval integument.
bitten at and trying to cut the prey cuticle. Once it has reached the cuticle, the larva attaches itself to the prey by means of its mandibles and forces its head into the interior, where it can reach the internal soft parts or fluids (Fig. 29). The attachment serves to anchor the larva in the prey. Once the prey larva is ingested, the larva is able to draw itself to the prey and extend itself within, without moving the prey, by contracting its thoracic segments. While this movement is thus not completely static, the ability of the thorax permits movements not seen in larvac belonging to other genera examined. The larvae of Amblyopone are distinguished, by their mobility and by their relative autonomy, from the more advanced and active foraging ants. It was also noted that the larva, apparently seeking food, may try to attach itself to either other larvae or to the workers.

It should be noted that there is no preparation of the food by the workers. The food is consumed and transported, but even their simple piercing of the integument seems to be needed by the larva. When it has finished eating, the larva withdraws its head from the chilopod body and remains completely immobile. This characteristic of the larva is in contrast to the behavior of the other ants, which leave the body of the chilopod immediately after feeding. This observation agrees with that of Le Masne (1952) on *Hymenoptera eduardi* (Forel) where the larva may be taken away from the larva before it is entirely eaten. It is also observed that the larva is still attached to the prey when it is eating, that a worker, in attempting to take the larva away, does not succeed and moves the chilopod at the same time. Workers were never observed to bring food to a larva that was not consumed, showing that the workers do not store uneaten parts of the prey.

The differences between the smallest and oldest larvae were not detected.

The different castes once fed, the chilopod is abandoned although it is often far from being completely consumed. The contents consumed externally and the parts of the prey not consumed half of the larvae present among the brood. Cauwacism can also occur between small larvae. The contents of certain cocoon are discarded and eaten by the larvae that then feed on the abdomen and the internal thoracic segments of the pupating larva. The mandibles can be observed through the larval integument to shear the tissue contents and to draw the alimentary debris toward the labium. It was not possible to predict whether the other larvae (adult, workers, or perhaps diseased or otherwise unhealthy larvae) were attacked by the larva. In any case, this cannibalism, which takes place on all stages (eggs, larvae, pupae), cannot be confused observationally with such care as is furnished by the larvae to the other larvae. The larvae do not treat themselves as pupating larvae to the workers. They are certainly not aggressive and do not harm the thoracic segments of their sister larvae, although they were seeking to devour them.

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Water and Fat Content of Immature and Adult
Sarcophaga tibialis (Diptera: Sarcophagidae)

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ABSTRACT

The water and fat content of 3rd-stage larvae, pupae, and adult females of Sarcophaga tibialis Macquart were investigated. Adult females were obtained from mixed cages in which both sexes were fed on 10% sugar solution. Water content of larvae and pupae and of adult females was variable. Fat content of pupae exhibited 2 low levels; the first occurred immediately after forma-

tion of the true pupa, 3 days after puparium formation, and the second 12 days after puparium formation. The highest value was observed in 16-day-old pupae. Adult fat content was lowest after oviposition, in 12-day-old flies. The lethal limit of adult female water content was found to be 67.8 ± 1.8% of body weight and the lethal fat content 19.3 ± 4.5% of dry weight.

Changes in lipid content during metamorphosis of insects have been studied by several investigators. Frew (1929) reported that during the later half of the pupal period of the blow fly (species not given) the fat content continuously diminishes. In Phaenicia sericata (Meigen), the 1st loss in fatty acids occurs immediately after pupation (Evans 1932, D’Costa and Birt 1966). The high metabolic rate characteristic of the end of pupal development of Glossina (Bursell 1960) indicates a similar trend in consumption of fats. However, similar loss has not been observed in Musca domestica L. (Pearnoot 1960). In the blow fly Calliphora vicina Robineau-Desvoidy, there is no major change in the lipid phosphorus content during metamorphosis (Levenbook 1953). Gilbert (1967) observed that the prepupa of P. sericata has a higher fat content than the pupa. In Phormia regina Meigen, Haub and Hitchcock (1941) found larvae and adults to have the same percent water content while pupae contained 2-3% less. The fats decrease slowly during the course of metamorphosis; the rate of disappearance being most rapid at the beginning and at the end of metamorphosis (Patton et al. 1941). In general, it is agreed that fat stored during larval development acts as an energy reserve for pupal and adult development (Bursell 1958, D’Costa and Birt 1966).

Sex dimorphism in fat content has been reported in Glossina palpalis (Robineau-Desvoidy) and in Hyalophora cecropia (L.) (Gilbert and Schneiderman 1961, Gilbert 1967). In these species, the female has a higher fat content than the male. This dimorphism is probably a result of the fact that

1 Received for publication Sept. 9, 1970.
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MATERIALS AND METHODS

The flesh flies, S. tibialis, were reared by the method previously described (Abasa 1970). Third-stage larvae, in the wandering phase, were harvested from the sawdust and were kept at room temperature, 21-25°C, in pint mason jars provided with some sawdust. The onset of puparium formation, the pink stage, was noted to within 2 hr. All pupae used in the test were, therefore, of about the same age. Only females of known age were used in investigations requiring adult flies.

Determination of Water Content.—Third-stage larvae and pupae in individually marked test tubes were weighed to obtain live weight. They were transferred to a vacuum oven at 100°C for 24 hr. After that period, they were removed to a desiccator containing anhydrous calcium chloride and reweighed to obtain dry weight. The difference between live weight and dry weight represented the water content. Adult flies were first killed in chloroform or ether vapour before being weighed, dried, and reweighed. All weights were obtained on the Metlar balance.

Determination of Fat Content.—Chloroform was added to each test tube containing a dried specimen. Chloroform-soluble substances were extracted by a modification of the method of Bursell (1959). Each