THE PHLEBOTOMINAE OF THE ETHIOPIAN REGION.[1]

By R. KIRK, O.B.E., M.D., and D. J. LEWIS, M.A., F.R.E.S.

(The Stack Medical Research Laboratories, Khartoum, Anglo-Egyptian Sudan.)

Manuscript received 16th March, 1951.

(Read 15th August, 1951)

With 74 Text-figures.

I have gathered a posy of other men's flowers and nothing but the thread that binds them is mine own.—MICHEL DE MONTAIGNE.

CONTENTS.

[1] The cost of publishing this paper was met by grants from the Government Grant in Aid of Scientific Publications (administered by the Royal Society), the Colonial Development and Welfare Fund, and the Sudan Government.

CONTENTS (*contd.*) PAGE

INTRODUCTION.

DIFFICULTY in the identification of *Phlebotomus* arises from the small size of the insects, and from the fact that in most cases specific characters are found only in the internal structures so that each specimen has to be cleared, dissected under the binocular, and then examined under low and high powers of the microscope before it can be identified. In our experience the greatest difficulty of all arises from the scattered nature of the literature, which is, nevertheless, copious. Sinton (1932, 1933) published illustrated keys for the identification of males and females which form a useful starting-point as regards the Indian species. In our studies of the sandflies of the Sudan, extending now over twelve years, we were at first much impeded by the fact that no similar guide was available for the Ethiopian species. We found that the only way to avoid confusion was to copy from the various journals descriptions and figures of each species, and to bind these abstracts together in a single file. By so doing we were able to collect in convenient form an up-to-date account of all the species which had been found in the Sudan and adjacent countries. From this

it was possible to construct keys and diagnostic tables which proved of great assistance in the identification of specimens.

We have from time to time published some of those keys and diagnostic tables for the Ethiopian species, including additions and revisions which have been made necessary by increases in knowledge in recent years. The suggestion that these papers should be collected, and expanded into a comprehensive, up-to-date monograph on the Ethiopian species of *Phlebotomus* was made first of all by Dr. P. C. C. Garnham, of the London School of Hygiene and Tropical Medicine. Other authorities with whom we discussed Dr. Garnham's suggestion considered that such a work might be very useful at the present time, as there is evidence of increasing interest in this important genus of biting insects, especially in Africa.

The present work is the outcome of Dr. Garnham's suggestion, and is presented in the hope that other workers in Africa may find it at least a useful guide to the copious and scattered literature on the subject. No one could be more conscious than the authors of the defects and deficiencies of this work, which deals with matters of classification and synonymy on which opinion is divided at present. Some of the most difficult points have, in fact, been laid before the International Commission on Zoological Nomenclature for their final ruling, which may ultimately prove to be different from that anticipated in this work.

It is a very great pleasure to acknowledge the kind assistance of others who have helped us in this work. First of all to the late Emeritus Professor R. Newstead, who even in his retirement spared no pains to ensure that we were provided with reprints and information on the earliest work on *Phlebotomus*. Thanks are also due to Dr. L. Parrot, of the Institut Pasteur d'Algérie, who has examined many of our specimens and generously given us the benefit of his advice and experience on many points during the course of this work; to Professor P. A. Buxton for his interest and encouragement and for access to collections in the London School of Hygiene and Tropical Medicine; to the Keeper of Entomology for access to collections in the British Museum (Natural History), and to Mr. P. Freeman and Mr. H. Oldroyd for their advice and assistance; to Professor R. M. Gordon and Dr. D. S. Bertram for access to collections in the Liverpool School of Tropical Medicine; to Dr. B. De Meillon for information on South African species; and to Mr. H. D. Fowler for chromatographic analyses of diverticulum contents of *P. papatasi*.

We also acknowledge our indebtedness to the following journals for permission to reproduce figures of *Phlebotomus* as indicated in the descriptions of the figures: *Annales de Parasitologie, Humaine et Comparée; Annals of Tropical Medicine and Parasitology; Archives de l'Institut Pasteur d'Algérie; Bulletin of Entomological Research; Indian Journal of Medical Research; Journal of the Entomological Society of Southern Africa; and the Proceedings of the Royal Entomological Society of London.*

I. Life History, Bionomics, Distribution, Importance and Control.

Life History.

Egg. The egg of *Phlebotomus* is an elongate torpedo-shaped body about 0·4 mm. in length with rounded ends. It is pale in colour when first laid, but soon becomes dark brown or black. The surface shows a peculiar sculpturing

due to the impressions of the cells of the egg follicle, and the pattern varies in different species. The female lays 20–40 eggs in a batch, depositing them on the sides of holes and cracks in the ground and similar places where the required darkness, humidity and shelter exist. The incubation period is approximately a week.

Larva. There are four larval stages. The first larva hatches from the egg by breaking through the shell with the aid of the egg breaker, a specialized chitinous structure on the front of the head. Hatching is completed in a few minutes, and the long caudal bristles, which are at first folded back, then straighten out. The larva has a well-developed head with characteristic bristles and mandibulate mouthparts, but eyes are lacking. The antennae are small and rudimentary. The epicranial suture is well developed, with the small, dark, pointed egg breaker between its two anterior limbs. The three thoracic segments are distinct. There are ten abdominal segments, the first seven of which are readily recognizable by the ventral pseudopod on each. On the dorso-lateral margin of the eighth segment there is a small spiracle, situated on a chitinous tubercle (*metapneustic* larva). The ninth segment bears on a chitinous plate a pair of characteristic, long, caudal bristles which are held erect as the larva crawls about. There are two unequal bristles at the sides of the tenth segment, and the eleventh segment is represented by a pair of membranous pads between which the anal opening lies. The body segments bear characteristic bristles with globular swellings at their apices. The structure and arrangement of these bristles differ in different species.

When the first larva moults it loses its egg breaker, and this structure, being no longer required, does not appear in the second and succeeding stages. In these stages an additional pair of metathoracic spiracles are developed (*amphipneustic* larva) and a second pair of caudal bristles.

The larva of *Phlebotomus* crawls about slowly like a small caterpillar, shams death if disturbed, and is extremely difficult to detect in nature, its colour harmonizing with its surroundings. The larvae feed on organic matter, such as dead leaves, excreta, dead bodies of insects, vegetable debris, etc. Parrot (1932) has shown that they can be reared on dead leaves alone without any animal matter, and this is probably their principal food in nature (Wanson, 1942). In some species the larva can withstand a certain amount of desiccation and freezing, but as they usually live some distance below the surface of the soil they are largely protected from such adverse climatic conditions as heat and desiccation in the Sudan or intense cold in Northern China. The period of diapause by which some species hibernate, and others possibly aestivate, occurs in the fourth larval stage.

Pupa. When fully grown the fourth larva stops feeding and, selecting a suitable spot, becomes motionless with its head and most of the body raised in a very characteristic erect attitude. At this stage the larva may have an opaque swollen appearance due to the formation of the pupa inside the larval skin. The pupa by its movements splits the skin along the dorsal surface of the thorax and then worms its way out through the rent, the head of the larval skin passing along its ventral surface. The pupa of *Phlebotomus* has a very characteristic appearance, as the last larval skin is always attached to the end of it and the four caudal bristles, even if broken off short, can always be made out at the end of the larval skin. There is no other nematocerous larva which

has similar bristles. The developing imago can usually be made out through the thin skin of the pupa (*pupa obtecta*), and when seen from the front has been described as resembling the head of a ram in miniature, the antennae of the developing fly representing the horns of the ram. The imago emerges through its pupal case by a straight cut in the dorsal surface (*orthorrhapha*). The dorsal surface of the thorax protrudes through the rent, which then allows the rest of the thorax and the head to emerge ; lastly the legs and wings are drawn out. Emergence is completed within a few minutes, and then rotation of the terminalia through 180 degrees occurs. The pupal skin left behind is clearly recognizable as that of *Phlebotomus*.

Time occupied by the different stages. The time occupied by the complete cycle varies with temperature and season. At Matadi in the Belgian Congo Wanson (1942) found that it varied between 51 and 56 days in *P. schwetzi*, *P. africanus* and *P. squamipleuris*. In North Africa Parrot (1932) observed periods about three times this duration in the case of *P. papatasi*. These periods do not include any period of diapause. In places where there is a well-marked sandfly season the life cycle may be greatly lengthened by a period of diapause in those broods which hatch out at the end of one season and reach maturity at the beginning of the next one. Some observations on the duration of the different stages in the life cycle are given below.

The period of incubation of the egg is about a week at 28° C. Patton gives up to 12 days in North China.

The duration of the larval stage varies with temperature and season, but is between 35 and 40 days at 28° C., excluding diapause.

The duration of life of the adult varies considerably. Unfed females and males die about the fourth day after emergence, the females having laid no eggs. In captivity females often die during or immediately after egg-laying, but in nature many survive and may live up to 40 days or longer, laying eggs several times provided blood meals are obtained at suitable intervals. A single blood meal suffices for the maturation of ova provided it is large enough and the external temperature sufficiently high. Copulation may occur either before or after the female gorges on a blood meal. Once gorged the female does not fly more than a few feet from the place where she has fed, but seeks the nearest place of refuge which offers suitable conditions of darkness, still air and humidity. Digestion of the blood meal is completed in about 72 hours at 28° C. and the eggs are laid 30–36 hours later.

Breeding places. Sandflies breed in such places as dark and damp cellars, out-houses, caves, dug-outs, piles of rubble, stones, bricks and tiles, crevices in damp stone walls, drains and the banks of streams, cracks and fissures in the soil and animal burrows. In arid semi-desert conditions it has been shown that soil cracks and animal burrows may provide suitable microclimatic conditions of temperature and humidity for sandfly breeding throughout the year. Moist organic matter is essential as well as shelter and darkness, but too much moisture drowns the larvae, and it may be accepted that material from a possible breeding place is too damp if it adheres to the fingers and does not just fall off when rubbed gently between them. Larvae have been found at varying depths in the soil, e.g., by King (1914) in the Sudan and Hindle (Patton and Hindle, 1928) in China. In order to detect them large quantities of soil may have to be examined. This can be done by washing it through sieves of

decreasing size down to 40 strands to the linear inch, and finally through muslin, after which the larvae can be floated off in a concentrated solution of salt in water, or by various modifications of this technique which have been suggested.

In the arid Northern Sudan animal burrows and soil fissures are believed to be the main breeding places of sandflies, cracks in the walls of houses and other situations above ground being probably too dry for larvae except during a short period of the year. The soil fissures are often automatically filled or covered by irrigation, seasonal rains, or the trampling of people or animals. In the Sudan it has often been noticed that houses on the periphery of a town near the untrodden cotton soil are more infested by *P. papatasi* than those in its centre. This has been observed also in more equable climates, where it is attributed to the greater abundance of vegetation suitable for the nutrition of larvae at the periphery of towns.

Bionomics of Adult.

The adult *Phlebotomus* is a very characteristic insect when seen alive—a small hairy midge with large eyes, long legs and hairy pointed wings held at an angle of 45 degrees. In the male the terminalia are generally conspicuous at the end of the abdomen. The colour varies from light yellow to dark grey, but neither colour nor size can be used to differentiate species. The male and unfed female can readily pass through the mesh of an ordinary mosquito net.

The optimum physical conditions for sandflies are still air, darkness, a constant temperature of approximately 28° C. and high relative humidity (approximately saturation). They are delicate insects, and many features of their bionomics depend on the fact that they do not readily withstand much variation from those optimum conditions, especially as regards temperature and relative humidity. Unless conditions are optimal the females of some species refuse to feed and die of starvation. Theodor (1936) has shown that at 30° C. and a relative humidity of 40 per cent. the mean length of life of fed female *P. papatasi* was 3·5 days, while the thermal death point in a 1-hour exposure was 41° C. Condensation of water vapour from the atmosphere may also be harmful as they readily become entangled and drowned in the drops of water thus formed.

Seasonal prevalence. In most places where sandflies are prevalent they exhibit a more or less marked seasonal variation in numbers. In some regions there is a well-defined sandfly season, the prevalence of the flies being restricted to a few months of the year. The seasonal variation in numbers is closely correlated with meteorological conditions, and thus varies in different areas according to the climate. The dominating factors are temperature, humidity, rainfall, insolation and wind, especially the first three. In most places sandflies disappear during the heavy rains. This is so in the Sudan (Kirk and Lewis, 1940), Abyssinia (Martin, 1938) and the Belgian Congo (Wanson, 1942), and in these regions the greatest prevalence occurs just before the rains and, later, shortly after them.

Diurnal prevalence. Adler and Theodor (1931) have drawn attention to the diurnal periodicity of certain species in the Mediterranean zone, by which it is possible to predict almost to an hour when members of a particular species will appear inside houses. In the Sudan a similar diurnal periodicity has been

observed in *P. papatasi* and *P. freetownensis* var. *magnus*, and in the Congo Wanson (1942) has noted that *P. africanus* and *P. schwetzi* were prominent in day-time catches, *P. dureni* and *P. squamipleuris* in night-time catches.

Range of flight. Sandflies are absolutely silent in their movements. They have a characteristic way of flying in short hops, and if disturbed they move in this way very rapidly. They may occasionally fly surprisingly long distances for such delicate insects, but the range of flight is normally very limited, probably less than 300 yards. Dodds-Price and Rogers (1914) found that removal of coolie lines to a new site 300 yards away was sufficient to cut short the occurrence of new cases of kala azar. Rarely they may travel further with the assistance of winds and air currents. But winds and air currents have a markedly deterrent effect on sandflies and they do not readily venture out into them. Sandflies do not fly high ; hence although plentiful at ground level they are usually much rarer in the upper stories of houses but not always, and they have been known to enter bedrooms 50 feet above ground level, probably from high breeding—or resting—places.

Resting places. Sandflies are mainly nocturnal and disappear during the day-time when they may be found resting in dark corners, especially where moisture is present, behind clothes, cupboards, pictures, etc., in the interior of rubble and stone walls, in crevices in trees, drains, caves, dug-outs, and the banks of streams, amongst heaps of damp stones, bricks, tiles, clods of earth ; also in animal burrows and in cracks and fissures in the soil. *P. gigas* and *P. mirabilis* occur typically in caves. *P. adleri*, *P. affinis* and *P. christophersi* var. *calcaratus* have been found chiefly on or near rocky areas. *P. squamipleuris*, though ubiquitous, is associated with damp conditions, e.g., the edges of pools and banks of rivers ; it is attracted to artificial light more than other species, and hence often comes into lighted mosquito-proofed verandahs.

Kirk and Lewis (1947) concluded that the survival of sandflies in some arid areas is due in large measure to their exploitation of a vast subterranean environment, consisting of animal burrows and cracks in the soil in which equable conditions of temperature (27° C.) and relative humidity (approximately 100 per cent.) exist in spite of wide fluctuations above ground. From this subterranean environment they emerge in search of food only after darkness, when the temperature falls and the relative humidity in consequence rises, thus providing suitable climatic conditions for them. Many no doubt find nourishment in animal burrows and in the soil fissures which are inhabited by scorpions, lizards, bats, and other insects besides sandflies. The obliteration of the soil fissures annually by the rains is probably an important factor influencing the seasonal prevalence of *Phlebotomus*.

Many authorities differentiate " wild " and " domestic " species of *Phlebotomus*, the latter being those found frequently in human dwellings, while the former are found mainly in outdoor situations and rarely if ever enter houses. Wanson (1942) considers the terms wild and domestic are inappropriate, since the domestic species can usually be found out of doors with little difficulty and their relative abundance in houses is merely the expression of a preferential food tropism which leads them to seek resting places near the host animal of choice (man). In Russia Petrischeva (1932, 1935) noted that when previously unoccupied regions were occupied by man various species of *Phlebotomus* (e.g., *P. minutus*, *P. caucasicus* *P. sergenti*, which had previously been

recorded in these regions from burrows of rodents and land tortoises) acquired domestic habits, finding conditions favourable for development, shelter and food in association with man and domestic animals.

Feeding habits. In spite of the minute size of *Phlebotomus* their bites may cause severe irritation. They are often described as crepuscular in their biting habits, but they are mainly nocturnal, although they will readily bite in the day-time in dark rooms, latrines and similar places. It is possible that, as in the case of mosquitoes, each species has its peak hour of biting during the night, but there is little information on this subject. Human beings are generally bitten on the face, hands, arms, ankles and legs, the parts of the body most exposed when sitting out in the verandahs of tropical houses or sleeping without adequate protection.

Only the females suck blood, but little is known about the biting habits of most species. Parrott (1934) considered that species with a well-developed buccal armature (*Prophlebotomus*) are habitual parasites of cold-blooded animals and rarely if ever bite man or warm-blooded animals, while those with unarmed buccal cavity (*Phlebotomus*) are habitual parasites of man and warm-blooded animals. In general this may be so, but there are some exceptions and many species about which no data are available. Our present information about the biting habits of sandflies in the Ethiopian Region may be summarized as follows.

P. papatasi bites man voraciously indoors and out of doors; it will bite also dogs, monkeys and various rodents. *P. orientalis* bites man very readily. *P. martini* and *P. longipes* are recorded as biting man in Abyssinia by Martin, who records also dogs, rabbits, guinea-pigs, fowls and pigeons for the latter species. *P. clydei* bites man in and out of doors, but is principally an outdoor species; it will bite also monkeys, ground squirrels, hamsters and dogs. *P. squamipleuris* has been observed biting frogs (Lewis and Kirk, 1950), and Wanson (1942) has identified lizard's blood in its gut by precipitin tests. *P. antennatus* var. *signatipennis* and *cinctus* commonly bite gecko lizards and seldom or never bite man. *P. freetownensis* var. *magnus* (= *P. africanus*) bites man rarely: Wanson's precipitin tests showed that it bit man and lizards. Sinton (1932) records *P. bedfordi* var. *congolensis* as biting man in Kenya. It would be interesting if the Kenya observations could be repeated, as the collection of *P. bedfordi* var. *congolensis* received by Sinton and reported as biting appears to have included males. Theodor (1931) and Wanson (1942) record *P. schwetzi* as biting man in the Belgian Congo, and we have received specimens taken on man from Mombasa. This species will also bite monkeys, fowls, rabbits, bats and lizards. Wanson (1942) records *P. mirabilis* and *P. gigas* as feeding on bats, and *P. dureni*, *P. collarti* and *P. wansoni* on lizards.

The host range of many of the species mentioned above is probably wider than is indicated, but only authentic records are given. Little is known about the feeding habits of the other species or of the males of any of the species. Some authorities believe that the males never feed although they are provided with piercing and sucking mouthparts as in the females. It has often been suspected that in the absence of suitable animal hosts sandflies suck the juices of plants. Smith, Halder and Ahmed (1940) found it was possible to maintain them in the laboratory by allowing them to feed on raisins, which they did by piercing the skin with the proboscis and sucking the juices. None of the Ethio-

pian species have been observed to feed on plants in nature, but it has often been suspected that certain Neotropical species do so, and the remarkable proboscis infections with *Bartonella*-like organisms described by Hertig (1938) were considered to have been derived from other sources than blood meals. In some uninhabited, semi-desert areas of the Sudan animal hosts appear scarce, yet sandflies may emerge at night in such large numbers as to suggest that most of them must die without ever having a meal unless they have some alternative food supply. The contents of the oesophageal diverticula of seven female *P. papatasi* caught at Wad Medani were examined by chromatographic analysis by Mr. H. D. Fowler. He found that they all contained glucose and sucrose and one contained fructose showing that they had fed on plant juices.

Distribution.

There are many parts of the Ethiopian Region in which nothing is known of the *Phlebotomus* fauna. Where surveys have been made many of the records must be discarded because the species concerned have been subdivided, and the same thing may happen again in species which show much variation. Furthermore the Ethiopian fauna cannot be adequately compared with those of other zoogeographical regions until these have been comprehensively described. Nevertheless, enough is known of the Ethiopian fauna to warrant certain comments and conclusions.

The known distribution of *Phlebotomus* in the Ethiopian faunal areas was summarized by Lewis and Kirk (1949), since when three new forms have been described and the status of several others altered. The distribution of the species in the Anglo-Egyptian Sudan was mapped by Lewis and Kirk (1951). In the present work distribution lists of each species have been confined to countries owing to the difficulty of verifying many of the individual records. In the following general notes on distribution, numbers are approximate in view of the constant changes in our knowledge of the species.

The zoogeographical areas mentioned are those of Chapin, which are based on the distribution of birds and have been discussed by Edwards (1941) in relation to the distribution of mosquitoes. *P. hirtus* is included as an Ethiopian species because it occurs in the Ahaggar with other Ethiopian species very near the border of the Region.

The known Ethiopian *Phlebotomus* fauna comprises 58 species and 24 varieties, which are about half of the entire Old World fauna. Very few are common to the neighbouring Palaearctic or Oriental Regions. They are *P. papatasi*, *P. alexandri*, *P. clydei*, *P. christophersi*, *P. antennatus* var. *signatipennis*, *P. babu* (Seychelles), *P. freetownensis* var. *eremitis* and *P. squamipleuris*. Apart from the last-named most occur in the north of the Region. Several other forms are closely allied to some of those species, such as *P. roubaudi* and *P. papatasi* var. *bergeroti*.

Faunal areas. Within the Ethiopian Region one can already see the characteristics of the *Phlebotomus* faunas of several of Chapin's Provinces.

In the Guinean Forest Province 15 species and four varieties have been found, six of which, *P. bedfordi* var. *medius*, *P. lumsdeni*, *P. crosarai*, *P. freetownensis*, *P. renauxi* and *P. richardi*, appear to be restricted to the Province. *P. bedfordi* var. *firmatus*, *P. schoutedeni*, *P. simillimus*, *P. freetownensis* var.

niger, *P. ingrami*, *P. collarti*, *P. decipiens* and *P. dureni* form a group which is evidently centred on this Province. Of the remaining five forms three are widely distributed in the Region. No species of *Sintonius* has been found in the Guinean Forest Province.

In the Guinean Savanna Province 22 species and six varieties are known of which seven species have not yet been found in other areas—*P. buxtoni*, *P. gigas*, *P. hunti*, *P. kirki*, *P. mirabilis*, *P. pastorianus* and *P. yvonnae*.

There are no certain records from the Humid Montane Province.

In the Sudanese Province 27 species and 12 varieties are known, including *P. affinis* var. *vorax* which was inadvertently omitted from Lewis and Kirk's list. The total number is half that for the whole Region, this rather arid Province containing many more species than any other. The distribution of *Phlebotomus* in this Province shows marked differences from that of mosquitoes which was discussed by Edwards (1941). The distribution of mosquitoes shows no clear distinction between the Guinean Savanna and Sudanese Provinces, but within the latter indicates a well-marked division between the Sudanese Arid and Sudanese Savanna Districts. In the distribution of *Phlebotomus* there is a marked distinction between the Guinean Savanna and Sudanese Provinces and very little between the Sudanese Arid and Savanna Districts. Unlike the mosquitoes *Phlebotomus* is well represented in the Sudanese Arid, although in both groups of insects there are several exotic forms.

The North East African Province supports 14 species and eight varieties, *P. heischi*, *P. notatus* and *P. wurtzi* being confined to it. *P. subtilis*, closely allied to the Palaearctic *P. tiberiadis*, is very common on the coast and also occurs inland.

In the Eastern and Southern Province 15 species and eight varieties are known of which *P. katangensis*, *P. rossi*, *P. caffraricus*, *P. meilloni*, *P. meilloni* var. *suberectus*, *P. thomsoni*, *P. transvaalensis*, *P. yusafi*, *P. schwetzi* var. *nigricans*, *P. freetownensis* var. *meridionalis* appear to be restricted to this Province.

Discontinuity in distribution is shown by some species. *P. alexandri*, which covers a large area in the Palaearctic Region, has been found only in one Ethiopian locality, 850 miles from the border, despite collecting in much of the intervening area. The Oriental *P. christophersi* occurs in the southern Sudan, separated from the Oriental Region by a tract in which its variety *calcaratus* occurs. Some species are closely allied to others occurring in distant areas, *P. martini* of the Abyssinian Highland District and Sudan being almost identical with *P. katangensis* of the Rhodesian Highland District, and *P. clydei* of the Sudanese Province being closely allied to *P. meilloni* of the Transvaal.

Notes on species and varieties. The species of *Sintonius* occur chiefly in the drier parts of the Region, but other subgenera are more widespread.

The forms of *Phlebotomus* which are known to be widely distributed and abundant over large areas are *P. schwetzi*, *P. squamipleuris*, *P. bedfordi* var. *congolensis*, *P. papatasi*, *P. clydei*, and the various varieties of *P. freetownensis* and *P. antennatus*.

There is a tendency for large dark-coloured species or varieties of *Phlebotomus* to occur in the more humid areas, such as *P. similimus*, *P. freetownensis* var. *niger*, *P. schwetzi* var. *nigricans* and central African *P. bedfordi* var. *congo-*

lensis. Pale *Phlebotomus* in dry country are seen for example in *P. affinis* var. *vorax* from the Nuba Mountains.

The ecological requirements of the Ethiopian species are little known, but the distribution of some of the species gives an indication of them. *P. gigas* has only been found in caves. *P. christophersi* and its variety *calcaratus* have always been found on or near rocky hills, and *P. clydei* flourishes mainly in arid country with numerous fissures caused by dry season cracking of clay. *P. subtilis* is particularly common in coastal localities, and *P. squamipleuris* is often found in damp situations.

Chapin's 17 zoogeographical districts are named and grouped as follows, and the species of *Phlebotomus* known to occur in each district are shown in the accompanying table :

I. West African Subregion.

A. *Guinean Forest Province.*

1. Upper Guinea Forest District. 2. Lower Guinea Forest District.

B. *Guinean Savanna Province.*

3. Upper Guinea Savanna District. 4. Ubangi-Uelle Savanna District. 5. Southern Congo Savanna District. 6. Uganda-Unyoro Savanna District.

II. East and South African Subregion.

C. *Humid Montane Province.*

7. Cameroon Montane District. 8. Eastern Montane District.

D. *Sudanese Province.*

9. Sudanese Arid District. 10. Sudanese Savanna District.

E. *North-East African Province.*

11. Abyssinian Highland District. 12. Somali Arid District.

F. *Eastern and Southern Province.*

13. East African Highland District. 14. Rhodesian Highland District. 15. East African Lowland District. 16. South-East Veldt District. 17. South West Arid District.

Relation to Disease.

Irritation of bites.—The reaction to sandfly bites has been the subject of considerable attention. Newcomers to a sandfly country often develop a skin eruption of urticarial type. Face, arms and legs are covered with intensely irritating papules, some of which develop into blisters filled with clear or sometimes haemorrhagic fluid. They may become septic through scratching so that the original clinical picture is obscured. In Palestine, where the condition is known locally as " harara," Dostrowsky (1925) concluded on the basis of clinical observation that it is " nothing else than the reaction to sandfly bites " in newcomers to the sandfly country. Experimental work shows (Theodor, 1935) that a process of sensitization to the bites takes place in a relatively short time and is followed later by a slow process of desensitization.

	West African Subregion.						East and South African Subregion.										
	Guinea. Forest.		Guinea.		Savanna		Montane.		Sudanese.		North-East African.		Eastern and Southern.				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
P. adleri	.	.	+	+	.	.	.	.	+	+	.	.	.	.	.	.	.
P. affinis	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.
P. a. var. *vorax*	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.
P. alexandri	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
P. antennatus	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P. a. var. *cinctus*	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.
P. a. var. *dubius*	+	.	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.
P. a. var. *occidentalis*	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.
P. a. var. *signatipennis*	+	.	+	+	.	.	.	.	+	+	+	+	.	.	.	.	.
P. aretasi	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P. bedfordi	.	.	+	+	.	.	.	.	+	+	.	+	+	.	.	.	.
P. b. var. *congolensis*	.	.	.	+	+	+	.	.	.	+	+	.	+	+	.	+	.
P. b. var. *firmatus*	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
P. b. var. *medius*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P. babu	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P. buxtoni	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
P. caffraricus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
P. christophersi	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
P. c. var. *calcaratus*	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.
P. clydei	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	.	.
P. collarti	.	+	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.
P. cowlandi	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
P. crosarai	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P. decipiens	.	+	.	+	+	+	.	.	.	+	.	.	.	.	.	.	.
P. dureni	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
P. freetownensis	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
P. f. var. *ater*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
P. f. var. *eremitis*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
P. f. var. *longior*	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
P. f. var. *magnus*	+	+	+	+	+	+	.	.	+	+	.	+	.	.	+	+	.
P. f. var. *meridianus*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
P. f. var. *niger*	+	+	+	+	+	.	.	.	.	+	.	.	.	.	.	.	.
P. f. var. *sudanicus*	.	.	.	+	.	+	.	.	+	+	.	.	.	.	+	.	.
P. gigas	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
P. guiraudi	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
P. heischi	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
P. hirtus	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.

P. horgani
P. hunti
P. ingrami
P. katangensis
P. kirki
P. lesleyae
P. lewisi
P. longipes
P. lumsdeni
P. martini
P. meilloni
P. m. var. suberectus
P. mirabilis
P. notatus
P. orientalis
P. papatasi
P. p. var. bergeroti.
P. pastorianus
P. renauxi
P. richardi
P. rodhaini
P. rossi
P. roubaudi
P. rutledgei
P. schoutedeni
P. s. var. pungens
P. schwetzi
P. s. var. nigricans
P. sergenti
P. s. var. saevus
P. serratus
P. simillimus
P. squamipleuris
P. s. var. dreyfussi
P. s. var. inermis
P. subtilis
P. thomsoni
P. transvaalensis
P. wansoni
P. wurtzi
P. yusufi
P. yvonnae

Theodor concludes that the " harara " of Palestine represents the reaction to sandfly bites at the height of the sensitization process.

Oriental sore. The possibility that leishmaniasis might be transmitted by *Phlebotomus* was first envisaged by the Sergents (1905) and Pressat (1905). In 1911 Wenyon observed leptomonads in wild-caught sandflies in Aleppo, and considered the possibility that these might be developmental forms of *L. tropica.* In 1921 the Sergents, Parrot, Donatien and Bequet produced a typical oriental sore in a man in Algiers by inoculation of crushed sandflies collected in Biskra, a well-known endemic centre of the disease. After much unsuccessful experimental work it was finally shown by Adler and Ber (1941) that *P. papatasi* can transmit oriental sore by the bite from one human being to another.

Kala azar. Following the work of the Sergents and their colleagues in Algiers, Sinton found that the distribution of kala azar in India corresponded roughly with that of *P. argentipes.* As a result of this observation Knowles, Napier and Smith (1925) fed specimens of *P. argentipes* on cases of kala azar, and found that the parasites underwent multiplication and development in this species. During the following twenty years evidence was accumulated to show that the incidence of leishmaniasis in various endemic regions is as intimately associated with the distribution of specific sandflies as is that of malaria with anopheline mosquitoes, but all attempts to transmit kala azar by the bite of the sandfly were unsuccessful. Finally Swaminath, Shortt and Anderson (1942) using the technique of feeding the flies on fruit juices devised by Smith Halder and Ahmed (1940), were able to show that *P. argentipes* can transmit kala azar from one human being to another by the bite.

General remarks on Phlebotomus *and leishmaniasis.* The specific sandfly vector is different in the different endemic areas, but may be recognized by the facts: (1) that its distribution agrees with that of leishmaniasis, (2) that it is comparatively easy to infect with the local leishmania; (3) that the infection in the sandfly extends forwards into the head (pharynx and prepharynx); (4) that the infection does not die out, but persists for the remainder of the life of the sandfly; and (5) the sandfly is sufficiently prevalent to maintain the cycle of infection. On these criteria *P. papatasi* can be regarded as the vector of oriental sore in Palestine, *P. sergenti* in India and Bagdad. Parrot (1943) names *P. roubaudi* as the probable vector of oriental sore in the Niger basin. *P. argentipes* is the vector of kala azar in India, *P. chinensis* in China, *P. perniciosus* in the western Mediterranean, *P. major* in Crete, and *P. orientalis* in the North-Eastern Sudan. In the Old World in general kala azar is transmitted by species of the *major* group, oriental sore by species of the *sergenti* and *papatasi* groups. We have suspected that *P. clydei*, which is outside these groups, may act as a vector in some parts of Africa, but feeding experiments (admittedly on a small scale) have not borne out this supposition. In the New World leishmaniasis is probably transmitted by several species of Neotropical sandflies. Much interesting work still remains to be done in identifying and mapping the distribution of the vectors of leishmaniasis in Africa and in the New World.

In Russia it has been shown that oriental sore is essentially a zoonosis among burrowing rodents transmitted by *Phlebotomus* spp. Man may become infected by breaking accidentally into this sandfly–rodent–sandfly cycle. The infection may be taken by an infected human being into urban areas and

thereafter transmitted from man to man by sandflies without the intervention of rodent reservoirs, as a result of which it alters its character in certain respects and becomes more specifically fixed for human beings. It is possible that other forms of human leishmaniasis will ultimately be shown to have a similar origin from some reservoir host.

Much interest attaches to the innumerable failures to infect man and animals by the bites of infected sandflies until, after the technique of feeding these insects on fruit juices was evolved, it was found that intense infection developed in the flies and transmission by the bite could be effected with comparative ease. At present it is impossible to say whether anything comparable to this takes place in nature ; but it has been suggested that those instances in which the distribution of the vector is known to be wider than that of the infection might be explained by the limitation of the infection to areas in which the flies were able to feed on fruit juices which stimulated the development of the parasite. These suggestions are, however, purely speculative.

Sandfly fever. Doerr, Franz and Taussing (1909) in Herzgovina proved that this disease is transmitted by *P. papatasi*, and other workers have since confirmed this observation. The distribution and seasonal prevalence of *P. papatasi* corresponds almost exactly with that of sandfly fever. The causal agent is a filterable virus, and the blood is infective to sandflies for 24 hours before the onset of symptoms and 24 hours after it. The female *P. papatasi* becomes infective from seven to ten days after feeding on a patient with sandfly fever during the period in which the virus is circulating in the blood. Whittingham and Rook (1923) claim to have shown that the infection is transmitted hereditarily to the progeny of an infected *P. papatasi.*

Other diseases. The diseases known as oroya fever and verruga peruana, which appear to be limited in distribution to certain narrow valleys in the Andes are transmitted by *Phlebotomus* (Hertig, 1938).

In 1948 Smithburn *et al.* produced yellow fever in a rhesus monkey by inoculating an emulsion made from crushed wild-caught *Phlebotomus* spp. in Uganda. The origin of the virus in the *Phlebotomus* is unknown, and it is impossible to say whether this observation indicates merely an accidental infection or the possibility that *Phlebotomus* may play some part in the natural history of yellow fever. The possibility that in addition to sandfly fever other viruses which circulate in the blood may survive and multiply in *Phlebotomus* is an interesting one on which little experimental work has been done.

It has been shown (Yao, Wu and Sun, 1938) that the embryos of *W. bancrofti* will undergo development in *Phlebotomus* spp., but these insects have never been seriously suspected as vectors of filariasis.

Control.

Control of breeding. The range of flight of the sandfly is comparatively small, and the eradication of breeding places within 300 yards of houses, camps, barracks, etc., will do much to reduce the numbers of these insects. It is generally recommended that the following points receive attention :

(1) Removal of all rubbish, especially heaps of rubble and other debris of building operations.

(2) Grouting, facing and pointing the walls of buildings, etc., in which crevices have appeared likely to provide suitable breeding-places for sandflies.
(3) Levelling the ground by rolling, filling up holes and cracks, rendering the surface impermeable with cement, tar, asphalt or similar material.
(4) The elimination of cracks and crevices in the banks of streams, drains, etc., by smoothing off the surface or lining with cement or concrete.

Destruction of adults. As much natural lighting as possible should be provided, and ventilation and air movement should be satisfactory. Spraying with " flit " and similar insecticides is useful as a temporary measure. The use of D.D.T. residual spray in houses is extremely effective and persistent in its action. Special attention should be paid to doors, windows, ventilators and other routes by which the flies can enter from outside. By the use of D.D.T. or gammexane it should be possible to eliminate the sandfly nuisance from houses. Hertig and Fisher (1945) have reported very favourable results on the control of sandflies with D.D.T. in Palestine. Reports from Peru by Hertig and Fairchild (1948) are equally favourable as regards the control of *Phlebotomus* and of the diseases transmitted by these insects. Those authors also point out that as the life-cycle of *Phlebotomus* is long, a sandfly population takes a long time to build itself up again after being greatly reduced by D.D.T. It is likely that the use of D.D.T., gammexane and other modern insecticides will for most purposes largely supersede other methods of *Phlebotomus* control.

Personal protection. Sleeping on roofs or in upper storeys of houses does not always afford immunity from sandfly bites. The use of dimethyl pthalate as a repellent will give protection for several hours. The use of mosquito boots, smearing the exposed parts of the body with dimethyl pthalate in the evenings and sleeping under a sandfly net at night should give almost complete personal protection under any circumstances, e.g., during a temporary visit to a heavily infested place in which no other protective measures are taken.

II. Structure, Synonymy and Classification.

Anatomy.

The diagnostic characters of the subfamily Phlebotominae are given on page 409, and detailed accounts of the anatomy of *Phlebotomus* will be found in the works of Grassi (1807), Newstead (1911), Perfiliew (1928). Separate studies have been published dealing with the structure of certain organs, e.g., pharynx, buccal cavity and spermatheca (Adler and Theodor, 1926), female genitalia (Sinton, 1927), the proboscis (Jobling, 1928), internal genital apparatus of the male (Parrot, 1937), ascoids, or " geniculated spines " (Parrot, 1940), and the ratio AIII/E (Parrot, 1946). Dolmatova (1942) discovered the existence of a peritrophic membrane in *P. papatasi*. The membrane can be seen in Sudan specimens of *P. papatasi*.

It will be unnecessary to give here more than an explanatory description of the characters which are important in the classification and identification of the Ethiopian species. For this purpose only the characters of the adults,

male and female, are important, since systematic work on the immature stages of *Phlebotomus* has been negligible so far. Many of the older works on *Phlebotomus* laid great emphasis on the measurements of various structures and the ratios between these measurements (" phlebotometry "). Much of this work has now been discarded, and only those measurements and ratios which have retained a useful place in systematics are considered here.

The position of hairs or spines on a segment or other structure can be conveniently indicated by the use of decimal numbers, a notation frequently used in this work. In all cases the proximal end of the segment or structure is taken as zero and the distal end as unity. Thus the statement that a segment bears a spine at 0·6 means that the spine arises at a point six-tenths of the length of the segment from its proximal end.

Practically all the examination of *Phlebotomus* is done with the microscope. Some of the characters used in specific determination are not always easy to make out. Hence it is extremely important to obtain good, clear preparations, otherwise details of structure are obscured and identification may be impossible. The methods of preparing and mounting specimens of *Phlebotomus* for examination are given on pages 500–501.

Head.

The antennae consist of 16 segments, usually indicated by roman numerals, I being the most proximal and XVI the most distal. Normally they are hairy, but the hairs are largely removed by the processes of clearing, etc., used in preparing mounted specimens. The first segment (scape) is small, the second (pedicel) is globular and cup-shaped, while segments III–XV are cylindrical, the terminal segment (XVI) having the form of a blunt cone. The measurements of segments III, IV and V and the length of III as compared with the combined lengths of IV and V are important in systematic descriptions in which III is shown as greater (>), less (<) than or equal to (=) IV+V. The ratio of the length of segment III to that of the epipharynx (AIII/E) is also important.

Newstead used the term geniculated spines for the spines borne on the antennal segments III–XV of *Phlebotomus*, and this term is used in most systematic descriptions. Tonnoir (1935) and Theodor (1947) conclude that these structures should be called ascoids, on the grounds that they are comparable with structures of this name found on the antennae of other PSYCHODIDAE and regarded by Feuerborn (1922) as sense organs. In *Phlebotomus* these spines are often difficult to see, and it may require the use of the oil-immersion lens to make out their structure clearly. Their number and disposition on the antennal segments are important ; also the ratio of their length to that of the segment bearing them, segment IV being taken as typical, and whether their tips extend beyond or fall short of the line of articulation with the next segment.

The antennal formula is a convenient method of expressing in abbreviated form the number and disposition of the geniculated spines, or ascoids, on the antennal segments. In this formula the numerator, in arabic numbers, shows the number of the spines (1 or 2) present on each of the segments, and the denominator in roman numbers shows the serial numbers of the corresponding segments. Thus the antennal formula of a species with two ascoids on all the

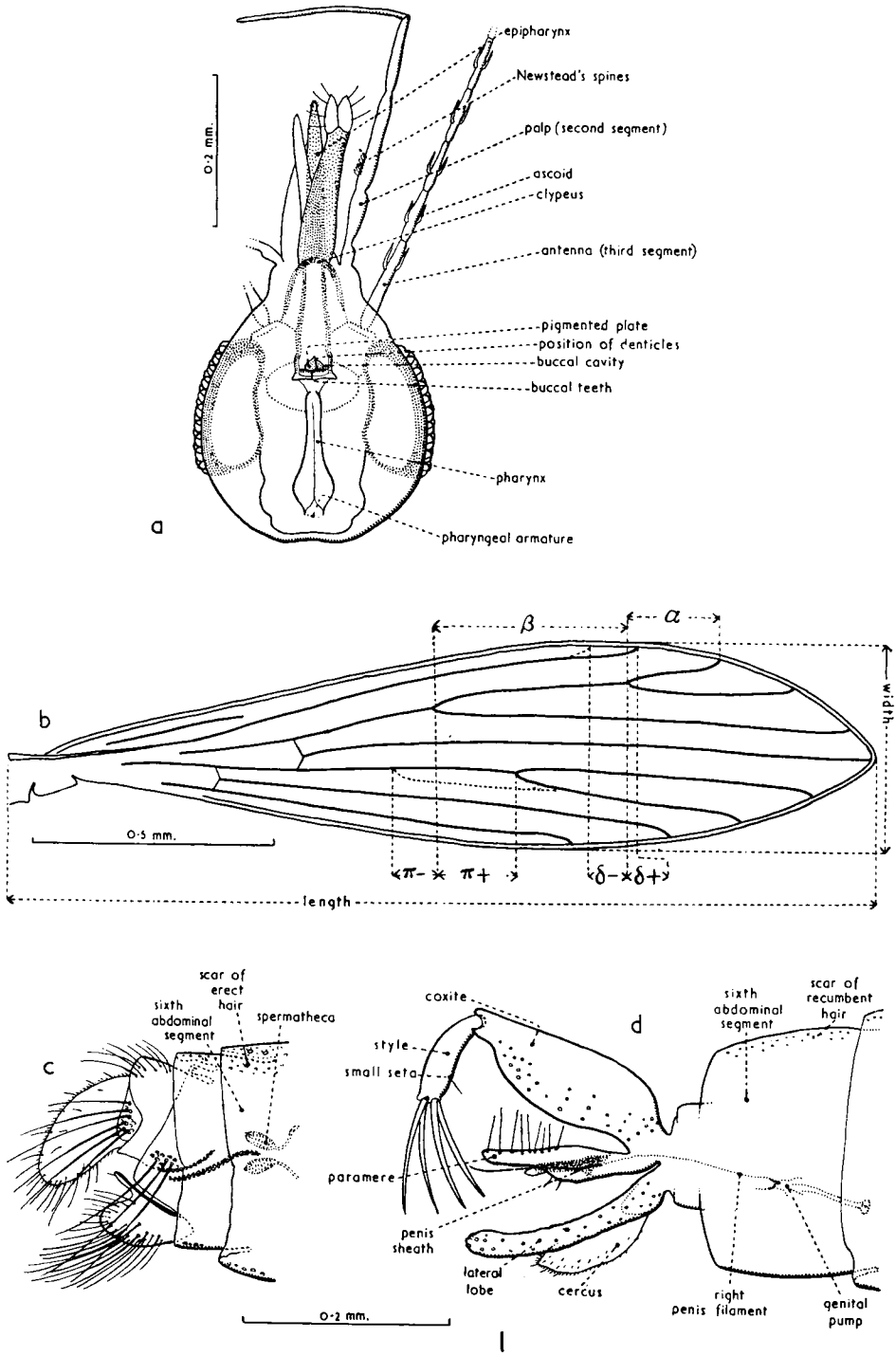


FIG. 1.—Showing the principal structures used in classification: *a*, head (*P. clydei*, ♀); *b*, wing (*P. bedfordi*, ♀); *c*, tip of abdomen of ♀ (*P. clydei*); *d*, terminalia of ♂ (*P. antennatus* var. *signatipennis*).

segments from III to XV inclusive would be 2/III–XV. The formulae of a specimen with two ascoids on segments III, IV, V, VI, VII and one ascoid only on the following segments (VIII–XV) would be 2/III–VII, 1/VIII–XV. The formula of a species which had two ascoids sometimes on III–VII and sometimes on III–VIII and a single spine on VIII–XV or IX–XV would be written 2/III–VII (VIII), 1/VIII (IX)–XV. As a rule the antennal formula shows sexual dimorphism in the subgenera *Sergentomyia* and *Sintonius*, that of the males being 1/III–XV and of the females 2/III–XV. Notable exceptions are *P. squamipleuris* 1/IV–XV in both sexes; *P. mirabilis* ♂ 2/III–VII; and *P. simillimus* ♂, 1/IV, 2/V–XV. In the subgenus *Phlebotomus* there is no sexual dimorphism in the *papatasi* and *sergenti* groups (*Phlebotomus* and *Paraphlebotomus* of Theodor), the formula being 2/III–XV in both sexes. In the *major-chinensis* group (*Larroussius* and *Adlerius* of Theodor) the formula is usually 2/III–XV in the females and 2/III–VII (VIII), 1/VIII (IX)–XV in the males. Some unusual males are *P. rodhaini*, 2/III–XIII, 1/XIV–XV; *P. martini*, 2/III–X, 1/XI–XV; *P. katangensis*, 2/III–IX, 1/X. . .

Palps. The palps are composed of five segments generally designated by arabic numbers, 1 being the most proximal and 5 the most distal. In the palpal formula the numbers of the segments are written in order of increasing length of the segments. Thus a palpal formula of 1,2,4,3,5 indicates that 1 is shorter than 2, which is shorter than 4, which is shorter than 3, which in turn is shorter than 5. It is usual also to give the relative lengths of the palpal segments taking that of segment 1 as unity. For this purpose the figures expressing the relative lengths of the segments are arranged in the true anatomical order of the segments and not according to size. Specimens of *P. rodhaini* from the Sudan had a palpal formula of 1,4,2,3,5, the relative lengths of the segments being 1, 2·4, 3·6, 2·0, 4·6. When two segments are of equal size they are enclosed within brackets in the palpal formula. Thus in Newstead's type specimen of *P. bedfordi* the palpal formula is 1,2,3,(4,5), the relative lengths of the segments being 1, 3·75, 4·75, 6·25, 6·25. The structures known as Newstead's sensory spines occur on the second and third palpal segments in *P. squamipleuris*, but on the third segment only in other species.

The length of the epipharynx measured from the tip of the clypeus is an important measurement, and its relation to that of the third antennal segment; this is expressed by the ratio AIII/E, which may be greater or less than unity and is sometimes useful in differentiating closely similar species. The epipharynx is really a labrum-epipharynx, and is armed at its distal end with a fringe of specialized sensory hairs and spines which probably act as a sieve and prevent large particles from blocking the food channel.

The food channel is formed by the labrum-epipharynx and hypopharynx and is continued backwards into the prepharynx, a relatively long tube consisting of one dorsal and one ventral plate, the former with powerful retractor muscles. The semi-circular flange on its posterior wall which gives origin to the muscles attached to the salivary pump is its posterior limit. At this point it widens to form the mid-pharynx, or buccal cavity of systematic writers. Here also occur the characteristic lateral buccal protuberances in some species. The buccal cavity is a short, wide tube shaped like a truncated cone. About the middle of its widest part there are in some species a pigmented area of chitin on the dorsal wall and a series of teeth on the ventral wall—the so-called

buccal armature. In other species (subgenus *Phlebotomus* s. restr.) these structures are absent or rudimentary. In the species in which they occur the morphology of these structures is of the greatest importance in specific determination—the size and shape of the pigmented area, the number, size, shape and arrangement of the buccal teeth. In addition to the main row of buccal teeth there may be one or more rows of small anterior punctiform teeth, the arrangement of which is characteristic in different species. The use of the oil immersion lens may be necessary to show up clearly the details of the buccal armature.

The buccal cavity is continued posteriorly into the post-pharynx, or pharynx of systematic writers. This structure is composed of three chitinous plates, and is usually narrow anteriorly and wide posteriorly. Important measurements are its length, and the ratio between the widths of its anterior and posterior parts. Its shape is also characteristic in some species (e.g., cordiform, lamp-glass shaped, etc.). In most species the posterior part of the pharynx bears an armature of large or small spines, scales or ridges, and the character of this armature is of great importance in specific determination.

Thorax.

The wing of *Phlebotomus* is densely covered with hairs, but these very readily come off in the processes of clearing and mounting. Fig. 2*a*, *b* shows the wing of *Phlebotomus* with the venation numbered according to the older nomenclature and lettered according to the Revised Comstock Needham nomenclature as interpreted by Tonnoir (1935), who considers that Cu is a convex vein which is very short and that M has four well-developed branches. M_4 was previously interpreted as Cu by most authors. Equivalent terms in the two systems of nomenclature are given below:

Old terminology	*R.C.N. terminology.*
Auxiliary	
Subcosta	Subcosta.
Mediastinal	
First longitudinal vein (R_1)	Radius, which divides into a simple anterior branch, R_1 and a primary branch, the radial sector Rs, which divides into four branches.
Second longitudinal vein (R_{2+3+4})	
Third longitudinal vein (R_5)	
Fourth longitudinal vein (M_{1+2})	Media, with four branches.
Fifth longitudinal vein (M_3)	
Sixth longitudinal vein (M_4)	
	Cubitus.

It will be seen that in *Phlebotomus* the second longitudinal vein (Rs) is forked twice (to give R_2, R_3 and R_4) and the fourth longitudinal vein is forked once (to produce M_1 and M_2), giving the appearance of one long unforked vein, the third or R_5 lying between the two forked veins.

The length and breadth of the wing at its widest part are given in systematic descriptions. Theodor considers wing length is the best measurement to express quantitatively the relative sizes of different specimens. In the deter-

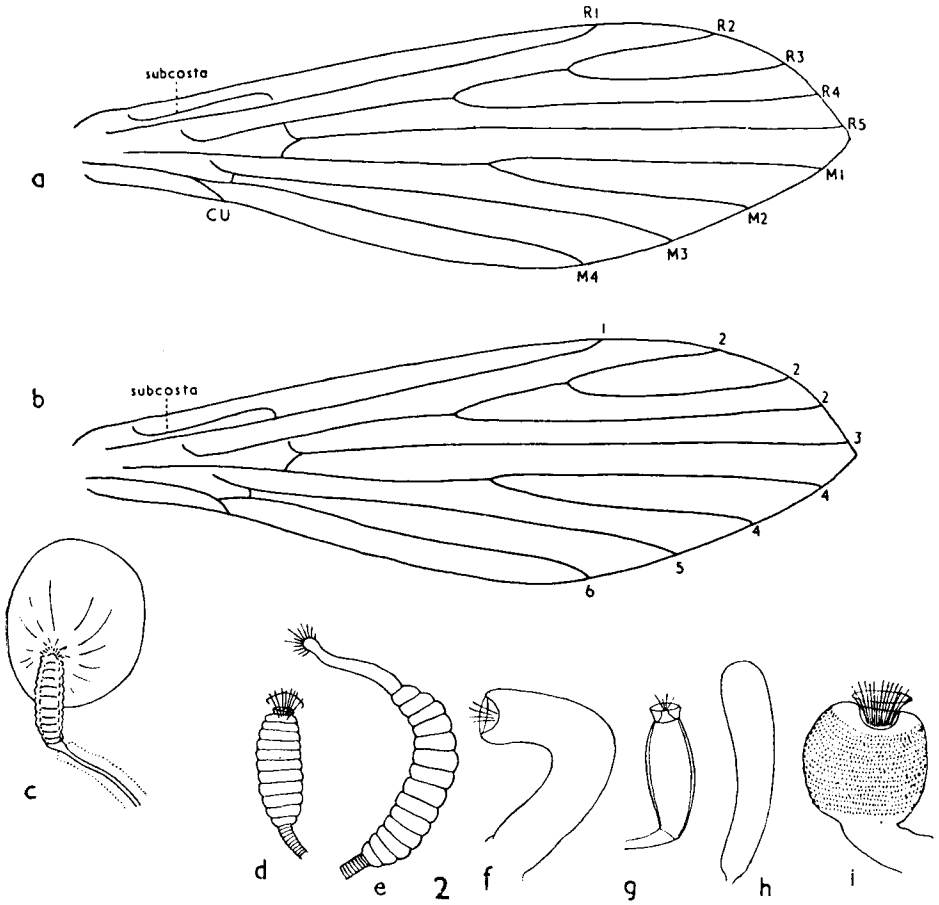


FIG. 2.—*a*, wing of *Phlebotomus* showing venation according to the RCN terminology (abbreviations explained in text); *b*, wing showing old nomenclature; *c*, fresh spermatheca of *P. papatasi* showing the position of the highly chitinized part. Principal types of spermatheca: *d*, segmented (*P. papatasi*); *e*, segmented, with neck (*P. longipes*); *f*, tubular (*P. schwetzi*); *g*, capsular (*P. freetownensis*); *h*, sac-like (*P. lesleyae*); *i*, globular (*P. squamipleuris*). (*c* after Newstead, 1911; *e* after Parrot and Martin, 1939; *f* after Adler, Theodor and Parrot, 1929; *g* after Theodor, 1948; *i* after Parrot, 1930).

mination of species certain measurements of the wing venation are useful. These are:

(1) The ratio of the anterior branch (α) to the stem (β) of the second fork of the second longitudinal vein. This ratio constitutes the alar index (α/β).

(2) The distance (δ) measured along the anterior border, between the extremity of the first longitudinal vein (R_1) and the projection on the anterior border of the second fork of the second vein (R_{2+3}) is prefixed by a + sign if the first vein overlaps the second radial fork as in the illustration (fig. 1 *b*) and by a — sign if it falls short of the second fork.

(3) The relative positions of the fork of the fourth vein and the first fork

of the second vein. The measurement between these two is designated by the symbol π, which is prefixed by a + sign if the first fork of the second vein lies nearer the base of the wing than the fork of the fourth vein, and by a — sign if the latter lies nearer the base of the wing.

The length of the hind leg is often included in systematic descriptions as a more accurate measurement of size than body length. In a few species spines are borne on the femora of the legs, and this is an important character in the species in which it is found, e.g., *P. affinis*, *P. wansoni*, *P. squamipleuris* var. *dreyfussi* and *P. christophersi* var. *calcaratus*. In *P. squamipleuris* the thoracic pleurae bear broad scales like those of mosquitoes, and those are not found in other species in the Old World.

Abdomen.

A very important character in the taxonomy of *Phlebotomus* is the disposition of the hairs on the tergites of abdominal segments II–VI. These hairs may be erect or recumbent, although in all species there are erect hairs of no taxonomic value on the thorax and dorsum of the first abdominal segment. In the processes of clearing and mounting the hairs are usually detached, but Sinton (1932) has pointed out that in mounted specimens, especially if stained, it is comparatively easy to determine the original disposition of the hairs from a study of the scars left on the abdominal tergites. The scars left by erect hairs are much larger and more refractile than those left by recumbent hairs. In species of the subgenus *Phlebotomus* the erect hairs on tergites II–VI are numerous, usually arranged in tufts at the distal ends of the segments. In the subgenus *Sergentomyia* the dorsal abdominal hairs on tergites II–VI are all recumbent (except in some specimens of *P. squamipleuris* which may have scanty erect hairs) and in the subgenus *Sintonius* there are numerous recumbent hairs with scanty erect hairs, the latter often confined to segments II and III, especially in the males.

In the females the highly chitinized parts of the spermathecae are important characters in the determination of species. In well-cleared specimens these structures can usually be made out inside the abdomen without dissection. The use of the oil-immersion lens is often a great help. The spermathecae vary considerably in structure and may be lightly or heavily chitinized, segmented or smooth, tubular, sac-like or capsular. In segmented or crenulated spermathecae the terminal tuft of hairs may be borne on a long or short " neck." In general the spermathecae are smooth in outline, or show only rudimentary and incomplete segmentation in the subgenus *Prophlebotomus*. They are segmented, or crenulated, in the subgenus *Sintonius*, although in a few species (but no Ethiopian ones so far) the segmentation may be incomplete. They are typically segmented in the subgenus *Phlebotomus*, but a few Ethiopian species of this subgenus have recently been described in which the spermathecae are smooth in outline, e.g., *P. lesleyae*, *P. heischi*. The character of the spermathecal ducts is sometimes important in systematics, whether they are narrow or wide, striated or smooth, and whether they open separately into the vulva or unite to form a common duct.

The chitinized parts of the internal genital apparatus of the male are often very conspicuous though of little systematic value. The pompetta or genital pump is a very efficient pumping apparatus constructed on the same plan as a

hypodermic syringe. The part corresponding to the plunger of the syringe is actuated by a series of small longitudinal muscles which arise from the button-like anterior dilatation and are inserted into the sides of the part corresponding to the barrel of the syringe. The distal opening of the syringe leads into the penis, and divides into two filamentous tubes which may be seen projecting from the distal end of that organ.

Terminalia.

The terminalia of the female are of little value in systematics (Sinton, 1927*d*), except in the case of *P. transvaalensis*, where the long and narrow cerci (fig. 29) and the eighth abdominal sternite bearing a number of stout very long bristles on its posterior border serve to distinguish this species from all other known species in the Ethiopian Region.

The terminalia of the male on the other hand vary considerably, and are of great importance in classification and specific determination. The terminology used by most authors in the description of the male terminalia of *Phlebotomus* is that developed by Newstead. Christophers and Barraud (1926) published a study of the development of the hypopygium of *Phlebotomus* in which the homology of the various parts was clarified. Tonnoir (1935) pointed out that retention of the older terminology is inconsistent with the rules now generally accepted in entomological literature, and that it should be altered to that indicated by the work of Christophers and Barraud, a suggestion endorsed by Theodor (1948). Equivalent terms in the two systems of nomenclature are given below :

Newstead.		*Christophers and Barraud.*
Proximal segment of superior clasper	=	Coxite.
Distal segment of superior clasper	=	Style.
Intermediate appendage	=	Parameres.
Intromittent organ	=	Penis (penis filaments + penis sheath).
Inferior claspers	=	Lateral lobes.
Submedian lamellae	=	Cerci.

Equivalent terms for the female terminalia have been omitted as they are not of systematic importance, but it is proposed in this work to employ throughout the terminology of Christophers and Barraud in descriptions of the male terminalia, which are of the greatest systematic importance. Relative measurements of the coxite, style parameres, penis and lateral lobe of the ninth tergite should be noted. The number, arrangement and shape of the spines or hairs borne on the style are very important. In some species the coxite also bears tufts of hair, either sessile or set on a peduncle, as in *P. sergenti* and its allies. The shape of the penis (sharp, blunt, conical, curved, etc.) may be an extremely useful character in differentiation, as is also that of the parameres (simple, double, or trilobed, and the characters of the various lobes).

Synonymy.

The synonymy of each species is given separately in a later section with the systematic descriptions. The present section deals with points of synonymy

in generic and subgeneric names, and some points in the synonymy of *P. minutus* and *P. africanus* which are important from the point of view of the nomenclature used in this work and which in some cases are not yet definitely settled.

The genus *Phlebotomus* was created by Rondani in 1840, and in 1843 he re-defined it and included in it three species, *P. papatasi* Scopoli, *P. molestus* Costa and *P. minutus* sp. n. Rondani in 1840 used the spelling "*Flebotomus*," in 1843 "*Hebotomus*" and in 1856 "PHLOEBOTOMIDAE." Costa Lima (1932) and Rapp (1942) have argued that the correct spelling of the generic name is that originally used by Rondani—"*Flebotomus*." Article 19 of the Rules of Nomenclature states that "the original orthography of a name is to be preserved unless an error of transcription, a *lapsus calami* or a typographical error is evident." Since the spelling *Phlebotomus* has been generally adopted the consensus of opinion appears to be to regard Rondani's original spelling, "*Flebotomus*," as due to a *lapsus calami* or a typographical error. In any case the name *Phlebotomus papatasi* has been included in a list of *nomina conservanda* as quoted by Handlirsch (1925). The spelling *Phlebotomus* will therefore be employed in this work.

Franca (1919) divided the genus *Phlebotomus* into two subgenera, *Phlebotomus* and *Newsteadia*, on the characters of the male terminalia. Franca and Parrot (1920), finding the name *Newsteadia* was preoccupied, changed the name of this subgenus to *Sergentomyia*, and suggested the creation of a third subgenus, *Neophlebotomus*, with *P. malabaricus* as the type species. No type species was defined for *Sergentomyia*, but in a later paper in the same year Franca (1920) named *P. minutus* Rondani as the type species for *Sergentomyia*. In 1921 Franca and Parrot proposed a more detailed system of classification in which *Sergentomyia*, Franca and Parrot, 1920, is subdivided into *Sergentomyia* (*pro parte*), in which the alar index is greater than unity, and *Prophlebotomus* in which the alar index is equal to or less than unity, and *P. minutus* is included in the new subgenus *Prophlebotomus*. Theodor (1948) points out that this is inadmissible under Article 29 of the Rules of Nomenclature, which states that "if a genus (or subgenus) is divided the type species has to remain with the restricted genus with the same name." He concludes therefore that *Prophlebotomus* has to be considered as a synonym of *Sergentomyia*. *Neophlebotomus* does not appear in the classification of Franca and Parrot (1921) but, as Theodor points out, according to more recent knowledge its type species (*P. malabaricus*) belongs to the same group as *P. minutus* and hence comes into the subgenus *Sergentomyia*, so *Neophlebotomus* also becomes a synonym of *Sergentomyia* and cannot be used again as was done by Dyar (1929), who used the name for certain New World species of *Phlebotomus*. It would appear from Theodor's analysis that the subsequent use of the name *Prophlebotomus* by Parrot (1934*b*) and by the present writers (1946) is inadmissible and that the correct name in this case is *Sergentomyia*. In this work, therefore, the name *Sergentomyia* will be used throughout in place of *Prophlebotomus*.

Difficulties have arisen in connection with the synonymy of *P. minutus* Rondani and *P. africanus* Newstead, which appear in the records as two of the commonest and most widely distributed species of *Phlebotomus* in Africa. It now appears that *P. minutus* is not an Ethiopian species but its synonymy has to be considered in an account of African sandflies.

The species *P. minutus* was created by Rondani in 1843, and later described by Newstead (1911) in an account of the sandflies of the Maltese Islands. In the following year Newstead (1912) separated *P. minutus* var. *africanus* from the typical *P. minutus* Rondani on account of its darker colour and certain differences in external characters. Fourteen years later Adler and Theodor (1926) drew attention to the internal characters (buccal cavity, pharynx and spermatheca) on which the determination of species of *Phlebotomus* is now largely based. In two Palestinian forms which had previously been determined on external characters as *P. minutus* and *P. minutus* var. *africanus*, they found that the differences in external characters were correlated with differences in internal structure and accordingly raised the variety to specific rank as *P. africanus* Newstead. A collection of *Phlebotomus* determined on external characters as *P. minutus* and *P. africanus* was found to contain *P. africanus* and two other species, one similar to the *P. minutus* of Palestine, the other a species which could not be differentiated from *P. minutus* on external characters, but showed very clear differences from *P. minutus* in the buccal cavity and pharynx. It was therefore described as *P. parroti* Adler and Theodor, 1927.

The discovery of the taxonomic importance of the buccal cavity, pharynx and spermatheca stimulated studies in *Phlebotomus*. In the following years many new species were described. *P. minutus* and *P. africanus* were recorded from many localities, and numerous varieties of both species were created, all based on the descriptions of Adler and Theodor. The specimens which Adler and Theodor had described under the names *P. minutus* and *P. africanus* were Palestinian ones, however, and not those for which the names had been originally introduced by Rondani and Newstead.

Sinton (1928*a*) examined one of Newstead's " cotype " (paratype) specimens of *P. minutus* from Malta and found that it agreed with the Palestinian form. Later, however, he states (Sinton, 1933) that " the species now commonly known as *P. minutus* Rondani is that described by Adler and Theodor (1926, 1927) from Palestine. It is doubtful whether this is the same as *P. minutus* Rondani from Italy. The latter may be synonymous with *P. parroti* Adler and Theodor, 1927." Parrot (1942, 1943*a*) found that the only *Prophlebotomus* occurring in Malta and Italy was in fact a variety of *P. parroti* (*P. parroti* var. *italicus* Adler and Theodor, 1931). He therefore concluded that this must be the original *P. minutus* Rondani and re-described it under this name in 1943. With the revelation that *P. minutus* Rondani was different from what it was generally believed to be, the Palestinian form originally described as *P. minutus* by Adler and Theodor was re-named *P. theodori*, and other forms which had previously been regarded as varieties of *P. minutus* were raised to specific rank as the simplest solution of the difficulty thus created.

Many of these forms are very similar to each other, being separated by minor differences only. Re-examination of Newstead's type specimens of *P. antennatus* by Kirk and Lewis (1950) shows that they are all closely allied to this species and might very well be regarded as varieties of it. In this work the Ethiopian forms previously regarded as varieties of *P. minutus*, and some allied species, are treated as varieties of *P. antennatus* Newstead. *P. minutus* Rondani is essentially a Palaearctic species and does not occur in the Ethiopian Region. Previous records of this species are therefore invalid as they refer to some other species, most commonly *P. antennatus* or one of its varieties.

The position is somewhat similar in the case of *P. africanus*, about which there are several discrepancies in the literature referring to the type. Adler, Theodor and Parrot (1929) depict *P. africanus* from the Belgian Congo with no anterior small teeth in the buccal cavity. Theodor (1933) states that the form which occurs in the Sudan and Congo is typical, and depicts the buccal armature of this form as having anterior punctiform teeth. Sinton (1928*a*) examined one of Newstead's paratypes from Southern Nigeria, and concluded it was identical with the Palestinian form described by Adler and Theodor. Newstead's original specimens came, however, from North-Eastern Rhodesia. The numerous varieties of *P. africanus* now recorded from Africa and elsewhere were created without reference to this specimen and on taxonomic characters which were not recognized by Newstead. Re-examination of Newstead's type-specimens by the present writers has shown that they are quite different from the *P. africanus* of Adler and Theodor (1926) and all subsequent authors. Also there are some important discrepancies between Newstead's written description and the labels on the specimens.

The type series, including a specimen clearly labelled "type ♀" in Newstead's writing, is mainly *P. squamipleuris* or a variety of this species, but includes other species. It is difficult to believe that in designating type-specimens of *P. minutus africanus* Newstead could have missed such an unusual species as *P. squamipleuris* Newstead, especially as the two species were described in the same paper. Also to accept this conclusion would require exchanging the names of two common species. To avoid this a petition is being submitted to the International Commission on Zoological Nomenclature asking for the suppression of the name *africanus* for ever. This will enable the name *squamipleuris* to be retained for the species at present known by that name, and a new name has to be found for the species and varieties now known under the name *africanus*. Following orthodox practice we suggest the adoption of the name of the first synonym or subspecies of *africanus*, viz., *P. freetownensis* Sinton, 1930.

P. freetownensis was described by Sinton (1930) from one female specimen collected by Sir Rickard Christophers at Sierra Leone in September, 1926. The specimen was at first thought to be a variety of *P. africanus*, but so many points of difference were found between it and the Palestinian form of *P. africanus* (subsequently known as var. *asiaticus*) that it was given specific rank as *P. freetownensis*. Theodor (1948) later concluded it should be regarded as merely a variety of *P. africanus*. We have been unable to trace the specimen, but Sinton's detailed descriptions and figures define it with precision. It differs in some minor details from the typical African form of *P. africanus* Newstead described by Adler, Theodor and Parrot (1929) from the Belgian Congo. As pointed out by Theodor (1948), the latter appears to be identical with the form described by Sinton (1932) as *P. africanus* var. *magnus*, which now becomes *P. freetownensis* var. *magnus*. The only alteration in nomenclature required as regards the other varieties of *P. africanus* is that they become instead varieties of *P. freetownensis*.

Classification.

The sandflies (Phlebotominae) belong to the Psychodidae, a family of the lower or simple Diptera. Alexander (1929) subdivided the Psychodidae

into four sub-families, PSYCHODINAE, TRICHOMYIINAE, BRUCHOMYIINAE and PHLEBOTOMINAE on the characters of the wing venation, and this classification has been accepted by Tonnoir, Edwards and Theodor. Only the PHLEBOTOMINAE are blood-suckers, by which character and the wing venation they are readily separated from all other PSYCHODIDAE. The characters of the sub-family PHLEBOTOMINAE may be summarized as follows :

Eyes round. Palps with five, antennae with 16 segments. Mouthparts adapted for piercing and blood-sucking. Wings held away from body at an angle of 45 degrees. Rs four-branched, pectinated, R_4 originating in middle of wing, R_5 originating proximal to R_4 from Rs near wing base. Cu very short, A absent. According to the old nomenclature the second longitudinal vein is forked twice and the fourth longitudinal vein forks once, giving the appearance of one long unforked vein, the third, between the two forked veins.

Attempts to classify the species of the PHLEBOTOMINAE have been made from time to time. Most of them follow the same general lines but differ considerably in the details. Most authors classify the PHLEBOTOMINAE in a single genus *Phlebotomus*, but Theodor has proposed a division into four genera, with several subgenera. Since the different classifications suggested often entail differences in nomenclature and no system has yet been universally accepted, the various schemes which have been proposed for the Old World species are summarized and briefly discussed below. According to Theodor (1948) the New World species are not well enough known for a definite classification. Most of the species which have been fully described have a buccal armature which differs from that of the Old World species, but a few of the species have no armature. It is uncertain at present whether the American species without a buccal armature can be put into the same group as the Old World species without a buccal armature or will have to be separated. Theodor puts them provisionally into a separate genus, *Brumptomyia* Franca and Parrot, the American species with a buccal cavity being placed in the genus *Lutzomyia* Franca.

Early Classifications.

Newstead (1911) divided the sandflies of the Maltese Islands into two groups : (i) those in which the hairs on the dorsum of the abdomen are erect, and (ii) those in which these hairs are recumbent. A similar division was used by Sinton (1924) in compiling a diagnostic table of the males of the Indian species.

Franca (1919) made an attempt to classify the species of *Phlebotomus* by dividing them into two subgenera on the characters of the male genitalia. After suggesting various modifications of this system, which are mentioned on page 406, Franca and Parrot (1921) divided the genus into five subgenera, namely, *Phlebotomus*, *Prophlebotomus*, *Brumptomyia*, *Lutzia* (emend *Lutzomyia* Franca, 1924) and *Sergentomyia*. In this classification *Prophlebotomus* was separated from the other subgenera by the alar index being less than unity in *Prophlebotomus*, and greater than or equal to unity in the other subgenera. The remaining subgenera were separated according to differences in the male genitalia. This classification was unsatisfactory in many ways. In a later publication Parrot (1934) points out that the scheme was conceived as a guide to further work and research rather than as a categorical affirmation of definitive characters.

Classification of Sinton.

In 1926 Adler and Theodor showed from an examination of Palestine sandflies that in certain species the posterior portion of the buccal cavity bears a number of teeth and a pigmented area of chitin, which are absent in other species. They showed further, that the morphology of these structures and of the pharynx and spermatheca were of diagnostic value in the determination of species. In 1927 Sinton found that Newstead's division into erect- and recumbent-haired species was correlated with definite morphological characters in the buccal cavity and spermatheca, species of the erect-haired group having no buccal armature and spermathecae with a crenulated or segmented appearance, while in those of the recumbent-haired group the spermatheca has a smooth outline and a buccal armature is present. Sinton (1927*a*) proposed a division of the genus into three main divisions, which were further subdivided, as follows.

A. The Erect-haired Division.

The members of this division have always some erect hairs on the dorsal aspects of segments II to VI of the abdomen. The heavily chitinized parts of the spermathecae of the females of this division are segmented in their entire length. The species in this division may be arranged into two groups :

Group I : The erect abdominal hairs are numerous, usually occurring in tufts at the distal ends of the segments ; dorsal recumbent hairs very scanty or absent on abdominal segments II to VI ; buccal armature and pigmented area absent or rudimentary ; the spermathecal chitinizations and male hypopygium usually having specific characters and the pharyngeal armature showing a useful diagnostic morphology.

Group 2 : Species with scanty erect hairs on the dorsal aspects of abdominal segments II to VI ; such hairs often confined to segments II and III, especially in the males ; dorsal recumbent hairs usually numerous ; buccal armature and pigmented area usually well developed and with specific morphology.

B. The recumbent-haired Division.

In this division the dorsal abdominal hairs on segments II to VI are all recumbent : the body of the spermathecal chitinizations usually with smooth outline, and any traces of segmentation, if present, are confined to the distal end. The buccal armature and pigmented area are usually well developed and have a specific morphology. The division contains two groups :

Group 3 : In these the morphology of the male genitalia closely resembles that of *P. minutus* Rondani.

Group 4 : The morphology of the male genitalia is distinctly different from that of *P. minutus* Rondani.

C. The intermediate Division.

Only one species, *P. squamipleuris*, is contained in this division. This species may show a few erect hairs on the dorsal aspects of some of the abdominal segments from II to VI, but more usually all the hairs are recumbent in this position. The spermathecal chitinizations are not crenulated, but show a series of transverse rows of small spines. This species differs from all others

in that the thoracic pleurae carry tufts of broad scales like those seen in mosquitoes, in the unilateral geniculate spines of the antennae of the female, in the absence of these spines on segment III, and in the presence of Newstead's sensory spines on both the second and third palpal segments.

Later Classifications.

Other workers who have attempted the classification of *Phlebotomus* (Nitzulescu, 1931 ; Theodor, 1931) appear to regard the buccal cavity as of greater value than the disposition of the hairs on the abdominal tergites, and divide the genus into two primary divisions—species which possess a buccal armature and those without a buccal armature. Nitzulescu found that, in spite of its apparent simplicity, Sinton's primary division into erect- and recumbent-haired species was not always easy to determine in practice (but see page 404) and proposed a division of the genus into five subgenera as follows :

A. Possessing a well-marked buccal armature.

1. Spermatheca segmented . . . . . Subgenus *Sintonius*.
2. Spermatheca not segmented . . . . . Subgenus *Brumptius*.

B. Buccal cavity without teeth and pigmented area.

3. Spermatheca segmented, with long neck . . Subgenus *Larroussius*.
4. Spermatheca segmented with short neck . . Subgenus *Phlebotomus*.
5. Spermatheca smooth (" lisse ") . . . . . Subgenus *Adlerius*.

Parrot (1934*b*) takes exception to this classification on the grounds that it places closely related species like *P. major* and *P. chinensis* in different subgenera, whereas such diverse forms as *P. papatasi*, *P. argentipes* and *P. sergenti* are grouped together in one subgenus, and also because the classification depends entirely on the characters of the female and does not take into account the male genitalia, the importance of which was recognized by previous workers. Parrot agrees, however, with the primary division into species which possess a well-developed buccal armature and those which do not, but states his opinion that it is hardly justifiable in the present state of knowledge to undertake any further subdivision of the genus at the present time, at least as far as the Old World species are concerned. He points out that the first group corresponds in large measure with the subgenus *Prophlebotomus* of Franca and Parrot (1921), and divides the genus into two subgenera, which are defined as follows :

Phlebotomus : Bouche inerme ; indice alar superieur ou au moins égal a l'unité ; poils des tergites abdominaux uniformément dressés ; parasites habituels des animaux à sang chaud. Type : *P. papatasi* (Scop., 1896).

Prophlebotomus : Franca et Parrot, 1921 : bouche armée de dents ; indice alar généralement inférieur ou à peine égal a l'unité ; poils des tergites abdominaux uniformément ou presque uniformément couchées ; parasites habituels des animaux à sang froid. Type: *P. minutus* Rondani, 1843.

Sinton (1928*a*) found wing venation a variable character, unsuitable for primary division, as did Magnitsky and Gutzewitsch (1929), while several species of the subgenus *Prophlebotomus* have since been recorded as vicious biters of man (cf. Kirk and Lewis, 1940). The primary division into those forms which have a buccal armature and those which do not is, however, a

convenient one, because it enables any single male or female, the precise determination of which is doubtful, to be assigned to the appropriate group.

It will be seen that the subgenus *Phlebotomus* of Parrot's classification corresponds with Sinton's group I. Groups 2, 3, 4 and the intermediate division of Sinton are all included in the subgenus *Prophlebotomus*. The species in Sinton's group 2 form a fairly homogeneous group, presenting specific features, which, if the morphology of the spermatheca and hairs on the abdominal tergites be taken into consideration, are rather intermediate between *Phlebotomus* and the other members of the subgenus *Prophlebotomus* as defined by Parrot (1934*b*). The females correspond with Nitzulescu's definition of the subgenus *Sintonius*, and there is considerable uniformity among the males of this group, all those which have been described so far having terminalia of the *minutus* type with hooked parameres and pointed penis. Kirk and Lewis (1946) therefore, suggested a modification of Parrot's (1934*b*) classification in which the Ethiopian species were divided into three subgenera, *Phlebotomus* Rondani, 1840, *Prophlebotomus* Franca and Parrot, 1921, and *Sintonius* Nitzulescu 1931. *Sintonius* differs from *Phlebotomus* in having a buccal armature, and from *Prophlebotomus* in having scanty erect hairs on the abdominal tergites and segmented spermathecae and may be considered as intermediate between the other two subgenera. Of the three subgenera suggested by Kirk and Lewis *Sintonius* is the most homogeneous The subgenus *Phlebotomus* includes several forms, such as *P. gigas*, *P. lesleyae* and *P. heischi*, in which the spermathecae are peculiar. In the subgenera *Phlebotomus* and *Prophlebotomus* (= *Sergentomyia*) of Kirk and Lewis there is considerable variety in the structure of the male, and this has been made the basis of further subdivision by Sinton (1927) and Theodor (1948).

Theodor (1948) has proposed a much more elaborate classification of the PHLEBOTOMINAE. He recognizes two genera in the old World, *Phlebotomus* s. restr. and *Sergentomyia*, corresponding with the subgenera *Phlebotomus* and *Prophlebotomus* of Parrot (1934). The genus *Phlebotomus* is divided into nine subgenera—*Phlebotomus* s. restr., *Paraphlebotomus*, *Synphlebotomus*, *Larroussius*, *Adlerius*, *Euphlebotomus*, *Anaphlebotomus*, *Australophlebotomus* and *Spelaeophlebotomus*—on the characters of the pharynx, spermatheca and male terminalia. *Sergentomyia* is divided into three subgenera—*Sergentomyia* s. restr. (sub-divided into a number of groups which are not given special names), *Sintonius* and *Spelaeomyia*. Apart from the creation of two genera and the introduction of many new names of subgenera, the classification of Theodor follows the same general lines as previous attempts.

It is doubtful at present whether Theodor's classification will become generally accepted or not. Parrot (1951) criticizes it severely in a recent paper. Hence in this work we propose to retain meantime the simpler classification of Kirk and Lewis (1946), in which all the PHLEBOTOMINAE are included in one genus, *Phlebotomus*. We classify the Ethiopian species of *Phlebotomus* into three subgenera, *Phlebotomus*, *Sintonius* and *Sergentomyia* (=*Prophlebotomus*), defined as follows:

Phlebotomus s. restr.

Species with numerous erect hairs on the abdominal tergites II to VI, usually occurring in tufts on the distal ends of the segments; buccal armature and pigmented area absent or rudimentary; the heavily chinitized parts of the spermathecae usually segmented in

their entire length; spermathecal chitinizations and male hypopygium usually having specific characters.

Sintonius Nitzulescu, 1931.

Species with scanty erect hairs on the dorsal aspects of abdominal tergites II to VI, such hairs often confined to segments II and III, especially in the males; dorsal recumbent hairs usually numerous; buccal armature and pigmented area usually well developed and showing a specific morphology; spermathecae crenulated; male hypopygium usually of the *minutus* type, with pointed penis sheath and hooked or beaked paramere.

Sergentomyia Franca and Parrot, 1920, (= *Prophlebotomus* Franca and Parrot, 1921; Parrot, 1934; Kirk and Lewis, 1946.)

Species with dorsal hairs on abdominal segments II to VI all recumbent; buccal armature and pigmented area usually well developed and with specific morphology; the body of the spermathecal chitinizations usually with a smooth outline, and any traces of annulation, if present, confined to the distal end.

The easily recognizable characters of the subgenus *Sintonius* as defined above are confined to the females. In species which are known only by the male it may be difficult to differentiate between *Sintonius* and *Sergentomyia*, as terminalia of the *minutus* type occur in both subgenera. We have found, however, that there is one character by which the males of the subgenus can generally be differentiated (with the exception of *P. squamipleuris*, which is abnormal in other characters) from those of the subgenus *Sergentomyia* with terminalia of the *minutus* type. This character is the relatively large sixth abdominal segment, which is often evident on examination with a hand lens. In addition, Sinton (1932) has pointed out that in specimens which have been mounted, especially if stained, it is comparatively easy to determine the original disposition of the hairs on the abdominal tergites from a study of the scars left on the segments by these hairs.

VARIATION.

There are no agreed definitions of the terms "species" and "variety," and the limits of these categories are generally fixed according to the judgment of the taxonomist. Aberrant forms or ecological variants which are entirely phenotypic modifications may be described as new species by the systematist, but in modern systematics there is a tendency for the classical method in which categories are separated from one another by the degree of morphological differentiation to be supplemented by other methods of analysis which elucidate the role played by variation. Owing to lack of detailed information this has rarely been possible in the case of *Phlebotomus*, many species of which are known only from a short museum series, or even a single specimen. Parrot (1936*b*), however, resorted to breeding experiments for the differentiation of *P. perniciosus* and *P. longicuspis*, two closely allied species which were found always in close association with each other in various localities in Algeria.

Although little is known about variation in *Phlebotomus*, two aspects of the subject may be mentioned in connection with systematics.

Abnormalities. Like other animals specimens of *Phlebotomus* sometimes show obvious abnormalities. Variations in the size and shape of the pigmented area are not uncommon. We have encountered occasional specimens of *P. ingrami* and *P. bedfordi* var. *congolensis* in which the pigmented area was

completely absent, although this structure is normally conspicuous in both species. Parrot and Habibi (1947) have reported some striking abnormalities in wild caught specimens of *P. minutus* var. *parroti*. Newstead (1914), Newstead and Sinton (1921) and Parrot (1921) have reported supernumerary spines on the style of various species. It is extremely likely that the specimens described as *P. mascittii* by Grassi (1908) were aberrant forms of *P. larroussei* with a supernumerary spine on the style, so that *P. larroussei* becomes a synonym of *P. mascittii*. Theodor (1948) suggests that *P. hirtus*, a species known by one male only, may be an aberrant form of this nature, on account of the unusually large number of spines on the style.

Geographical races. Compared with many other insects *Phlebotomus* appears to have a marked tendency to the development of local races and varieties (Theodor, 1933), probably owing to its delicacy and limited powers of flight. Sutton (1950) considers that *P. papatasi* from Malta, Algiers, Italy, India and the Sudan can be differentiated from each other by minor characters. Theodor (1947) states that there are at least five different forms of *P. chinensis* from India, Persia, Syria, Cyprus and Roumania which may eventually have to be separated as varieties or species. Lewis and Kirk (1939) have described differences between the African and Indian forms of *P. clydei*. Differences between the African and Indian forms of *P. squamipleuris* have led to the separation of the latter as var. *indicus* (Theodor, 1931). *P. freetownensis* and its numerous varieties which have been collected in large numbers from many localities will probably, on further analysis, provide interesting data on variation in its geographical aspect.

Many of the species and varieties now separated from each other by minor differences only may be shown after further study to be geographical races. Two very closely allied forms, *P. antennatus* var. *cinctus* and *P. antennatus* var. *signatipennis*, are practically mutually exclusive in their distribution in the Sudan, var. *cinctus* being almost restricted to the southern and var. *signatipennis* to the northern half of the country. Kirk and Lewis (1947) noted that sandflies from the arid northern regions of the Sudan tend to be less heavily pigmented than those from the more humid south, and it is possible that the differences between *P. schwetzi* and its variety *nigricans* are due essentially to the expression of this tendency.

Discussing geographical races in *P. major*, Adler (1946) points out that in addition to minute morphological differences there are also some striking differences in bionomics among the Mediterranean races of this species. He suggests that these may, in the case of *P. major*, prove to be important in the epidemiology of visceral leishmaniasis, since in other groups of sandflies it has been found that slight differences in morphology may be accompanied by profound differences in bionomics and capacity to transmit disease.

III. Keys to the Ethiopian Species.

List of the Ethiopian Species of Phlebotomus.

The following list comprises all the species and varieties of *Phlebotomus* at present recognized as occurring in the Ethiopian Region arranged in the order in which they are described in this work.

For convenience of reference we give below a list of synonyms, which also includes the names of species erroneously recorded from the Ethiopian Region.

Key to the Subgenera, Females.

1. Buccal armature and pigmented area absent or very rudimentary *Phlebotomus.*
   Buccal armature well-developed and with distinctive morphology . . 2.
2. Spermatheca crenulated . . . . . *Sintonius.*
   Spermatheca not crenulated . . . . . *Sergentomyia.*

Key to the Subgenera, Males.

1. Buccal armature and pigmented area absent or very rudimentary; abdominal tergites II–VI with numerous erect hairs . . . *Phlebotomus.*
   Buccal armature and pigmented area usually well-developed; abdominal tergites II–VI with scanty or no erect hairs . . . . . 2.
2. Abdominal tergites II–VI with scanty erect hairs . . . . *Sintonius.*
   Abdominal tergites II–VI with numerous recumbent and no erect hairs . . . . . *Sergentomyia.*

Key for the Females of the Subgenus *Phlebotomus*.

1. Females with numerous erect hairs on dorsal aspect of abdominal segments II–VI, usually in tufts at the distal end of the segment. Buccal armature and pigmented area absent or rudimentary . . 2.
2. Spermatheca sac-like, not segmented . . . . . 3.
   Spermatheca segmented in entire length . . . . . 5.
3. Alar index = 5 or 6; a specialized, very large, cave-dwelling species *gigas* (p. 438).
   Alar index = 0·3 . . . . . 4.
4. Ascoids long (0·6 length of segment) . . . . . *heischi* (p. 436).
   Ascoids short (0·2 length of segment) . . . . . *lesleyae* (p. 435).
5. Spermatheca with a long neck; pharyngeal armature consists of rows of very small point-like teeth . . . . . 6.
   Spermatheca not provided with long neck . . . . . 7.
6. Spermatheca with 10–12 segments; the terminal (non-annulated) dilated part of spermathecal duct long (= $\frac{1}{3}$ of total length of duct) *orientalis* (p. 432).
   Spermatheca with 12–14 segments; terminal (non-annulated) dilatation of spermathecal duct short . . . . . *longipes* (p. 434).
7. Pharyngeal armature composed of coarse teeth; spermatheca with only 4–6 segments, without expanded head . . . *sergenti* and var. (p. 428) *alexandri* (p. 427).
   Spermatheca with more than 5 segments; pharyngeal teeth less marked . . . . . 8.

8. Pharyngeal armature composed of fine ridges and small punctiform teeth; spermatheca has 9–10 segments . . . . . *martini* (p. 431).
Pharyngeal armature appearing as a network of fine wavy lines; spermatheca with 8–12 segments, and large expanded head, with no neck . . . . . *papatasi* and var. (p. 421).
roubaudi (p. 424).
duboscqi (p. 427).

Key for the Males of the Subgenus *Phlebotomus*.

1. Males with numerous erect hairs on abdominal tergites II–VI; buccal armature and pigmented area absent or rudimentary; genitalia usually having a specific morphology . . . . . 2.
2. Coxite bearing on its inner aspect a prominent tuft of hairs arising from a peduncle . . . . . 3.
Coxite without such tuft of hairs . . . . . 7.
3. Style bearing 4 spines . . . . . 4.
Style bearing 5 spines . . . . . 5.
4. One of the distal spines on the style apical, the other subapical; peduncle bearing the tuft of hairs on coxite short . . *alexandri* (p. 427).
The two distal spines on style both terminal (except in var. *saevus*, in which the peduncle bearing the tuft of hairs is elongated) *sergenti* and var. (p. 428).
5. Peduncle on coxite bearing long hairs of uniform length and shape *katangensis* (p. 430).
Peduncle bearing hairs of different length and shape . . . . . 6.
6. Peduncle on coxite bearing about 4 very long bristles apically and a large number of shorter hooked bristles ventrally, the latter decreasing in size from near the apex to the base . . . *rossi* (p. 431).
Peduncle bears a tuft of 6 large flat hairs and about 12 shorter slender hairs, with no regular gradation in size . . . . . *martini* (p. 431).
7. Style bearing 4 spines . . . . . 8.
Style bearing 5 spines . . . . . 9.
8. Paramere bilobed, with characteristic morphology . . *rodhaini* (p. 437).
Paramere single, finger-shaped . . . . . *gigas* (p. 438).
9. Style very elongate, having parallel sides, and bearing 5 short spines; lateral lobe bearing 2–6 apical spines; paramere with 3 characteristic lobes . . . . . 10.
Style irregular in shape, bearing 5 long spines . . . . . 11.
10. Lateral lobe with 4–6 very short terminal spines . . *roubaudi* (p. 424).
Lateral lobe with 2 long terminal spines . . . . . *papatasi* (p. 421).
11. Paramere consisting of an upper lobe bearing hairs, a lower lobe composed of a stem bearing a few hairs, and a thin broad smooth plate . . . . . *lesleyae* (p. 435).
Paramere simple . . . . . 12.
12. Paramere with expanded distal end cut away ventrally; single point of penis sheath directed dorsally . . . . . *longipes* (p. 434).
Paramere less expanded and more rounded at distal end; single point of penis sheath directed infero-externally . . . . *orientalis* (p. 432).

Key for the Females of the Subgenus *Sintonius*.

1. Females having both erect and recumbent hairs on dorsal aspects of abdominal segments II–VI, well-developed buccal armature, and crenulated spermathecae, with short neck . . . . . 2.

2. Cerci long and narrow; sternite of 8th abdominal segment with a number of stout, very long bristles arising from its posterior border *transvaalensis* (p. 450).
   These features not present . . . . . 3.
3. Buccal armature with anterior teeth . . . . . 4.
   Buccal armature consisting of a single row of teeth; no anterior punctiform teeth . . . . . 7.
4. Several (three or more) rows of anterior teeth . . . . *adleri* (p. 439).
   One, or at most two, rows of anterior teeth 5
5. Buccal armature consists of large sharply pointed spike-like teeth; one or two rows of anterior punctiform teeth . . . . *clydei* (p. 445).
   Buccal teeth either broad or narrow, straight and parallel, in palisade formation . . . . . 6.
6. Buccal teeth about 18 . . . . . *subtilis* (p. 447).
   Buccal teeth about 40 . . . . . *caffraricus* (p. 442).
7. Pigmented area and buccal armature poorly developed, the latter with 4–6 widely spaced teeth . . . *christophersi* and var. (p. 443).
   Buccal armature and pigmented area well-developed, with more than 10 buccal teeth . . . . . 8.
8. Buccal teeth less than 20 in number, sharply pointed, with points widely spaced . . . . . *meilloni* (p. 446).
   Buccal teeth 40 or more, straight, parallel, arranged in a palisade. . 9.
9. Spermatheca with 8 segments; buccal teeth 40; pharyngeal armature well developed . . . . . *affinis* and var. (p. 440).
   Spermatheca with 10–12 segments; buccal teeth 50–60; pharyngeal armature inconspicuous . . . . . 10.
10. Pigmented area with corrugated lines converging into the narrow anterior part . . . . . *wansoni* (p. 451).
    Pigmented area without such lines . . . . . *thomsoni* (p. 449).

Key for the Males of the Subgenus *Sintonius*.

1. Males having both erect and recumbent hairs on adbominal tergites II–VI; buccal armature well-developed and with specific morphology; genitalia of the *Sergentomyia* type, usually with hooked paramere and pointed intromittent organ . . . . . 2.
2. Palpal formula 1, 2, 4, 3, 5; anterior punctiform teeth present in buccal armature . . . . . 3.
   Palpal formula 1, 2, 3, 4, 5; buccal armature without anterior punctiform teeth (except in *P. wansoni*) . . . . . 6.
3. Only one row of anterior punctiform teeth in buccal cavity . . . . 4.
   Two or three rows of small anterior punctiform teeth . . *adleri* (p. 439).
4. Buccal armature with 10 or more main teeth . . . . . 5.
   Buccal armature with 2–5 main teeth . . . *christophersi* and var. (p. 443).
5. Buccal teeth arranged in groups of 3–6; six anterior denticles in an irregular row . . . . . *clydei* (p. 445).
   Buccal teeth not arranged in groups, anterior denticles in two lateral groups with small ones between. . . . . *subtilis* (p. 447).
6. 10–12 punctiform teeth at the bases of the main teeth; anterior and posterior femora with spines . . . . . *wansoni* (p. 451).
   No anterior teeth in buccal cavity . . . . . 7.
7. Four spines on style terminal . . . . . *affinis* (p. 440).
   Two of the four spines on style markedly subterminal, the other two being terminal . . . . . 8.

8. Buccal armature has about 35 parallel teeth . . . . *thomsoni* (p. 449).
Buccal armature has 10 broad teeth with serrated edges *meilloni* and var. (p. 446).

Key for the Females of the Subgenus *Sergentomyia*.

1. Species with no erect hairs (except in *P. squamipleuris*) on abdominal tergites II–VI. Buccal armature well developed and with specific morphology. Spermathecae not crenulated . . . . . 2.
2. Well-marked notch in posterior border of buccal plate just anterior to buccal teeth . . . . . *babu* (p. 478).
No such notch present . . . . . 3.
3. With spermathecae in the form of capsules or rounded sacs . . . 4.
With simple tubular spermathecae . . . . . 14.
4. Spermathecae having a special shape, sac-like or turnip-shaped . . 5.
Spermathecae elongate, cylindrical or elliptical capsules with smooth outline . . . . . 8.
5. Spermathecae rounded or turnip-shaped; two well-developed lateral protuberances present anteriorly to the buccal armature . . . 6.
Spermathecae in the form of sacs; no lateral protuberances anteriorly to buccal armature . . . . . 7.
6. Spermathecae bearing transverse rows of small spines; antennal formula 1/IV–XV . . . . . *squamipleuris* and var. (p. 488).
Spermathecae smooth without spines; antennal formula 2/III–XV . *lewisi* (p. 493).
7. Spermathecae sac-like, with many fine parallel ridges . . *wurtzi* (p. 491).
Spermatheca a thin-walled sac; buccal cavity with about 5 delicate pointed teeth . . . . . *horgani* (p. 492).
Spermatheca sac-like, constricted in the middle; buccal teeth 12–14 *mirabilis* (p. 497).
8. Spermathecae more or less cylindrical capsules with wide ducts . . 9.
Spermathecae oval or elliptical capsules with narrow ducts . . . 11.
9. Pharynx heavily armed, cordiform and pigmented; antennal formula 1/IV, 2/V–XV . . . . . *simillimus* (p. 469).
Pharynx not cordiform or heavily pigmented . . . . . 10.
10. 10–12 equal and pointed teeth in buccal cavity, with a row of anterior punctiform teeth, each of which is placed at the interval between two teeth, pharynx three times as wide posteriorly as anteriorly *collarti* (p. 485).
12–14 unequal buccal teeth, the median ones much narrower than the lateral ones which are very wide; no anterior teeth; pharynx slender . . . . . *decipiens* (p. 486).
22–24 pointed teeth in buccal cavity . . . . . *kirki* (p. 483).
11. No large teeth in buccal cavity, only punctiform teeth . . *hunti* (p. 494).
Large teeth present in buccal cavity . . . . . 12.
12. Antennal formula 2/III–XV . . . . . 13.
Antennal formula 2/V–XIII, 1/XIV–XV . . . . . *crosarai* (p. 479).
13. 10 pointed buccal teeth . . . . . *yvonnae* (p. 480).
20–65 parallel buccal teeth, arranged in a palisade *freetownensis* and vars. (p. 472).
14. Pharynx cordiform . . . . . *P. antennatus* and vars. (p. 452).
Pharynx not cordiform . . . . . 15.
15. Palpal formula 1, 2, 4, 3, 5 . . . . . *lumsdeni* (p. 496).
Palpal formula 1, 2, 3, 4, 5, ... 16.

16. Buccal armature with only one row of teeth . . . . . 20.
    Buccal armature with more than one row of teeth . . . . . 17.
17. Posterior row of buccal armature with 30–45 teeth . . . . . 18.
    Posterior row of buccal armature with less than 15 teeth . . . . 19.
18. Median buccal teeth straight and narrow and forming a backwardly projecting salient in the middle of the arc . . . *ingrami* (p. 480).
    Median buccal teeth not forming a salient . . . . *serratus* (p. 482).
19. Anterior buccal teeth comprising one row of 7 strong subconical teeth *notatus* (p. 484).
    Anterior buccal teeth comprising two rows of small punctiform teeth having 16 and seven respectively . . . . . *dureni* (p. 487).
20. Buccal teeth 50–60, equal and monomorphic . . . . . 21.
    Buccal teeth less than 40 . . . . . 22.
21. Buccal teeth about 50, very delicate and arranged in an arc deeply concave posteriorly, the outer teeth directed outwardly *ruttledgei* (p. 495).
    Buccal teeth 58–60, small and monomorphic, in palisade formation, straight or only very slightly concave posteriorly . . *renauxi* (p. 452).
22. Pharyngeal armature a series of transverse parallel lines, without true teeth; buccal armature distinctive . . . . . *schwetzi* (p. 470).
    Pharyngeal armature with well-developed teeth . . . . . 23.
23. AIII/E = unity . . . . . *richardi* (p. 463).
    AIII/E < unity . . . . . 24.
24. Ascoid on IV < 0·5 length of segment . . *schoutedeni* and var. (p. 463).
    Ascoid on IV = or > 0·5 length of segment . . . . . 25.
25. Buccal teeth equal and monomorphic . . . . . 26.
    Median buccal teeth smaller than lateral ones . . . . . 27.
26. Buccal teeth 21 . . . . . *pastorianus* (p. 466).
    Buccal teeth about 25 . . . . . *yusafi* (p. 465).
27. Buccal teeth 13–16, markedly unequal . . . . . *buxtoni* (p. 467).
    Buccal teeth 16–40 . . . . . *bedfordi* and vars. (p. 458).

Key for the Males of the Subgenus *Sergentomyia*.

1. Males having teeth in the buccal cavity (except in *P. wurtzi*), and no erect hairs on abdominal tergites II–VI (except sometimes in *P. squamipleuris*) . . . . . 2.
2. Style bearing more or less than 4 spines . . . . . 3.
   Style bearing 4 spines . . . . . 4.
3. Style bearing only 2 spines . . . . . *mirabilis* (p. 497).
   Stype bearing 7 spines . . . . . *hirtus* (p. 496).
4. Buccal teeth vestigial or absent, pharynx unarmed . . . . . 5.
   Well marked buccal armature . . . . . 6.
5. No teeth or pigmented area in buccal cavity . . . . *wurtzi* (p. 491).
   Buccal teeth vestigial; pigmented area pear-shaped, narrow posteriorly . . . . . *horgani* (p. 492).
6. Penis sheath curved, finger-shaped, with blunt end . . . . . 7.
   Penis sheath conical and tapering . . . . . 13.
7. Two of the spines on the style apical, the other two arise at 0·7 *schwetzi* (p. 470).
   All four spines on style terminal or subterminal . . . . . 8.
8. Third palpal segment as long as, or longer than, fourth segment *antennatus* and vars. (p. 452).
   Palpal formula 1, 2, 3, 4, 5 . . . . . 9.

9. Paramere as long, or nearly as long, as lateral lobe . . . *yusafi* (p. 465).
   Paramere shorter than lateral lobe . . . . . 10.
10. 24–40 teeth in buccal cavity . . . . . 11.
    Less than 20 teeth in buccal cavity . . . . . 12.
11. Buccal cavity with 25 teeth, the outer 5 on each side broad and each with several points, the central teeth narrow and pointed *cowlandi* (p. 462).
    Buccal cavity with 25–35 pointed teeth, median teeth only slightly narrower than lateral ones . . . . . *bedfordi* and vars. (p. 458).
12. About 14 teeth in buccal cavity, the lateral ones being larger than median ones and pointing towards the centre; AIII/E< unity *buxtoni* (p. 467).
    16–18 teeth in buccal cavity, the difference between the median and lateral teeth not being marked; AIII/E> unity . *schoutedeni* (p. 463).
13. Penis sheath tapering to a sharp point . *freetownensis* and vars. (p. 472).
    Penis sheath tapering to a blunt point. . . . . 14.
14. Paramere does not terminate in a beak . . . . . 15.
    Paramere with beaked extremity . . . . . 18.
15. Two of the spines on style terminal; the other 2 at 0·5 . . . . 16.
    All 4 spines on style terminal or slightly subterminal . . . . . 17.
16. Buccal teeth about 35, long, straight, narrow and pointed, with 2 irregular rows of anterior punctiform teeth . . . *serratus* (p. 482).
    Buccal teeth about 30, small and rather irregular, and having a notch about the centre . . . . . *ingrami* (p. 480).
    Buccal teeth about 21, very short and pointed, irregularly arranged in 3 groups—one median, of 4 teeth, and two lateral, of 8–9 teeth *kirki* (p. 483).
17. AIII/E > unity; pigmented area absent . . . . *simillimus* (p. 469).
    AIII/E < unity; buccal cavity with marked lateral protuberances anterior to the buccal teeth; no ascoid on AIII; penis with dilated end; wide scales on thoracic pleurae . *squamipleuris* and var. (p. 488).
18. Pigmented area absent . . . . . 19.
    Pigmented area present . . . . . 20.
19. Buccal teeth 8–10; pharynx unarmed . . . . . *dureni* (p. 487).
    Buccal teeth 10–12, with an anterior row of small punctiform teeth; pharynx armed with fine transverse lines . . . . . *collarti* (p. 485).
20. No posterior row of large pointed teeth in buccal armature *hunti* (p. 494).
    Posterior row of buccal teeth either the only row in the buccal cavity or very large and prominent compared with anterior punctiform ones . . . . . 21.
21. Buccal teeth 12–14, markedly unequal, the 4–5 median teeth being pointed and narrower than the lateral ones (as in the female of the same species) . . . . . *decipiens* (p. 486).
    Buccal teeth 18–20, not markedly unequal . . . . . 22.
22. Buccal cavity rather resembling that of *P. antennatus* var. *signatipennis*, with a row of small anterior teeth . . . . *babu* (p. 478).
    No anterior teeth; buccal teeth broad, irregular in contour, and finely crenulated (like the lateral teeth in *P. cowlandi*) . *aretasi* (p. 468).

IV. Descriptions of the Ethiopian Species.

Phlebotomus (*Phlebotomus*) *papatasi* Scopoli.

Bibio papatasi Scopoli, 1786, *Deliciae faunae et flora insubricae* **1** : 55.
Musca papatasii Gmelin, 1788–93, In *Linnaei Systema Naturae*, Edit. 13.

Flebotomus papatasii Rondani, 1840, *Memoria prima per Serv. alla Ditterologia Ital., Parma*, XIII.
Cynipes molesta Costa, 1843, *Ann. Accad. aspir. Nat.* **1** : 4.
Haemasson minutus Loew, 1884, *Stettin. ent. Ztg.* **5** : 115.
Hebotomus papatasi Rondani, 1843, *Ann. Soc. ent. Fr.* (2) **1** : 265.
Phlebotomus papatasi Loew, 1847, *Stettin. ent. Ztg.* **8** : 140.

The early synonymy of this species has given rise to much discussion (for details *see* Sinton, 1928 and Theodor, 1948) which is now principally of historical interest, since the name *Phlebotomus papatasi* has been included in a list of *nomina conservanda* as quoted by Handlirsch (1925) in Schröder's *Handbuch der Entomologie*, **3** : 91. The descriptions below are from Sudan specimens of this insect, 10 males and 10 females.

♀. *Length :* 3–3·1 mm. *Antenna :* formula 2/III–XV, segment III (0·24–0·30 mm.) > IV + V, AIII/E = 0·67–1, ascoids on IV = 0·5 length of segment. *Palp :* formula 1, 4, 2, 3, 5, relative lengths 1, 3·6, 4·4, 3·0, 7. *Epipharynx :* length 0·3–0·4 mm. *Pharynx :*

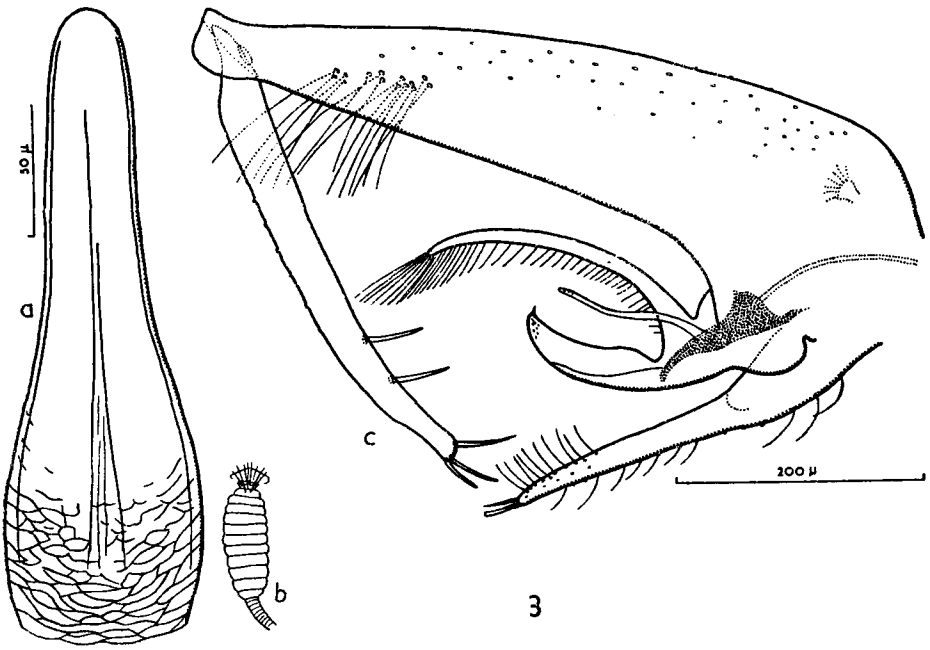


FIG. 3.—*P. papatasi*, ♀ : *a*, pharynx ; *b*, spermatheca. ♂ : *c*, terminalia (*a* after Adler and Theodor, 1926 ; *b*, from Sudan specimen ; *c* after Parrot and Gougis, 1944).

about twice as wide posteriorly as anteriorly, armature a network of fine wavy lines among which can be seen backwardly projecting teeth. *Wing :* length 2·0–2·4 mm., width 0·56–0·63 mm., alar index 1·3–1·8, delta + 0·1 to + 0·15 mm. *Spermatheca :* with about 10 segments, the " head " is large and broad with no distinct neck, segments decrease in size towards the duct which is irregularly annulated and opens separately into the vulva.

♂. *Length :* 2·6 mm. *Antenna :* formula 2/III–XV, segment III (0·27–0·34 mm.) > IV + V, AIII/E = 1–1·25, ascoids on IV = 0·25 length of segment. *Palp :* formula 1, (2, 4), 3, 5, relative lengths 1, 3·6, 5·0, 3·6, 7·2. *Epipharynx :* length 0·23–0·27 mm.

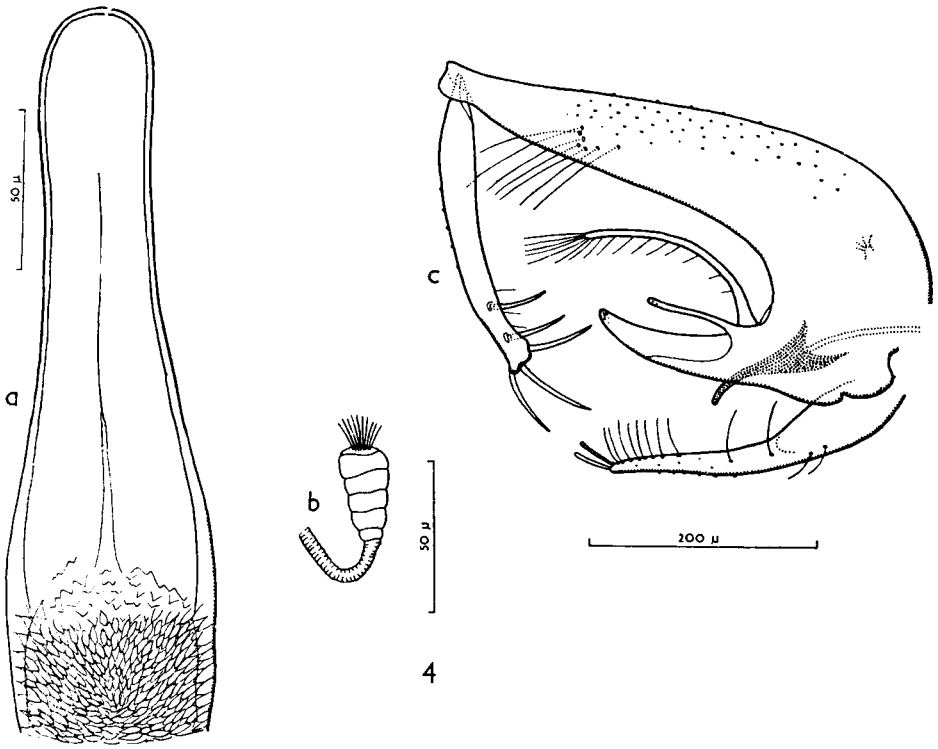
Pharynx : slightly less than twice as wide posteriorly as anteriorly armed with scale-like spines and ridges with punctiform small teeth. *Wing :* length 1·8–2·1 mm., width 0·48–0·53 mm., alar index 1·2–1·4, delta + 0·08 to + 0·09 mm. *Terminalia :* coxite (0·55–0·60 mm.) 1·4 times as long as style (0·37–0·41 mm.), which bears five short spatulate spines, three terminal and two submedian, the distance between the two submedian spines being much less than that between the distal submedian spine and the end of the segment; paramere (0·28–0·37 mm.) three-lobed owing to the presence of two dorsal processes, the sickle-shaped fimbriated process, bearing many hairs, and the straight digitiform process which in *P. papatasi* is much shorter than the fimbriated process ; penis sheath (0·15 mm.) roughly conical with extremity curved downwards ; lateral lobe (0·35–0·4 mm.) with two long terminal bristles.

Distribution : A.-E. Sudan, Somaliland, French West Africa. Also widely distributed in the Mediterranean area and Western Asia.

Phlebotomus (*Phlebotomus*) *papatasi* var. *bergeroti* Parrot.

P. papatasi var. *bergeroti* Parrot, 1934, *Arch. Inst. Pasteur Algér.* **12** : 383.
P. viduus Parrot, 1936, *ibid.* **14** : 39.
P. papatasi var. *bergeroti* Parrot, 1941, *ibid.* **19** : 437.

Type locality Djanet (Tassili des Ajjers), Central Sahara. The descriptions below are after Parrot (1934, 1940) from 4 males and 19 females. Type specimens in the Institut Pasteur d'Algérie.



4

Fig. 4.—*P. papatasi* var. *bergeroti*, ♀ ; *a*, pharynx ; *b*, spermatheca. ♂ : *c*, terminalia. (*a* and *b* after Parrot, 1936 ; *c* after Parrot, 1944.)

♀. *Length :* 2·4–2·7 mm., hind leg 3·7–3·8 mm. *Antenna :* formula 2/III–XV, segment III (0·22–0·44 mm.) > IV + V, AIII/E = 0·65–0·76, ascoids on IV = 0·75 length of segment. *Palp :* formula 1,4,2,3,5, relative lengths 1, 3, 4, 2·8, 7. *Epipharynx :* length 0·3–0·35 mm. *Pharynx :* twice as wide posteriorly as anteriorly and armed with numerous broad scale-like teeth resembling those in the *sergenti* group, and pointing obliquely towards the mid-line. *Wing :* length 2·18–2·25 mm., width 0·6–0·65 mm., alar index 1·3–1·4, delta + 0·09 to + 0·11 mm. *Spermatheca :* with 5–8 segments, decreasing in size towards the duct, which is irregularly annulated and opens separately into the vulva.

♂. *Length :* 2·4–2·9 mm., hind leg 3·7 mm. *Antenna :* formula 2/III–XV, segment III (0·24–0·28 mm.) > IV + V, AIII/E = 1–1·1, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,2,4,3,5, relative lengths 1, 3·4, 5·2, 3·7, 7·6. *Epipharynx :* length 0·22–0·24 mm. *Pharynx :* as in *P. papatasi*, with the ridges more accentuated. *Wing :* length 1·8–2 mm., width 0·44–0·53 mm., alar index 1·3–1·6, delta + 0·05 to + 0·09 mm. *Terminalia :* coxite (0·37 mm.) 1·4 times as long as style, with a tuft of 6–7 long hairs distally on its internal surface ; style bears five spatulate spines, three terminal and two submedian, the more distal of the latter two arising midway between the apex of the segment and the proximal submedian spine ; paramere three-lobed as in *P. papatasi*, penis sheath conical, lateral lobe with two relatively long spatulate terminal bristles.

The male of var. *bergeroti* differs from the typical *P. papatasi* in the greater length of AIII, the smaller tuft of hairs on the coxite, and the position of the submedian spines on the style. The female is differentiated by the greater length of the ascoids, the more heavily armed pharynx and the spermatheca, with 5–8 segments only.

Distribution : Central Sahara, Abyssinia, A.-E. Sudan.

Phlebotomus (*Phlebotomus*) *roubaudi* Newstead.

P. roubaudi Newstead, 1913, *Bull. Soc. Path. exot.* **6** : 124.
P. duboscqi Franca & Parrot, 1921, *Arch. Inst. Pasteur Afr. N.* **1** : 283.
P. roubaudi Parrot & Gougis, 1944, *Arch. Inst. Pasteur Algér.* **22** : 40.

This species was described by Newstead (1913) from specimens collected in the region from which the type specimens of *P. duboscqi* Neveu-Lemaire were obtained. Although showing specific characters, *P. roubaudi* resembles *P. papatasi* closely, and Newstead pointed out that it might be identical with *P. duboscqi*, the species created but imperfectly described by Neveu-Lemaire in 1906. Detailed descriptions of both sexes of *P. roubaudi* were published in 1944 by Parrot and Gougis who consider that, as the name *P. roubaudi* refers to an adequately described form, it should be regarded as correct until the matter can be settled by re-examination of the type specimens of *P. duboscqi*. The description below is taken from Parrot and Gougis. Type specimen is in the British Museum.

♀. *Length :* 2·25 mm. *Antenna :* formula 2/III–XV, segment III (0·3 mm.) = IV + V, AIII/E = 0·8, ascoids on IV = 0·6 length of segment. *Palp:* formula 1,4,2,3,5, relative lengths 1, 3·1, 3·6, 2·5, —. *Epipharynx :* length 0·37 mm. *Pharynx :* posterior width about twice anterior width, bearing numerous scale-like teeth. *Wing :* length 1·9 mm., width 0·67 mm., alar index 1·35, delta + 0·14 mm. *Spermatheca :* of *papatasi* type, with 8 segments decreasing in size from the terminal one ; ducts narrow, irregularly annulated and opening separately into the vulva.

♂. *Length :* 2·3 mm. *Antenna :* formula 2/III–XV, segment III (0·26 mm.) < IV + V, AIII/E = 1, ascoids on IV = 0·3 length of segment. *Palp :* formula 1,2,4,3,5, relative lengths 1, 2·8, 3·9, 3·2, 7. *Epipharynx :* length 0·25–0·26 mm. *Pharynx :* less than twice as wide posteriorly as anteriorly and armed with numerous scale-like spines, mostly pointed

or appearing as wavy lines with some punctiform denticulations. *Wing:* length 1·83–1·88 mm., width 0·43–0·5 mm., alar index 1·2–1·6, delta + 0·034 to 0·1 mm., pi + 0·05 to + 0·085 mm. *Terminalia:* coxite (0·54–0·63 mm.) about half as long as the abdomen, bearing on the anterior part of its inner surface a small process with short hairs and on its posterior part about 12 long hairs; style (0·42–0·48 mm.) bears five short, strong, spatulate spines, three apical and two internal submedian ones, the most distal of which is equidistant between the apex of the segment and the most proximal spine (compare with *P.*

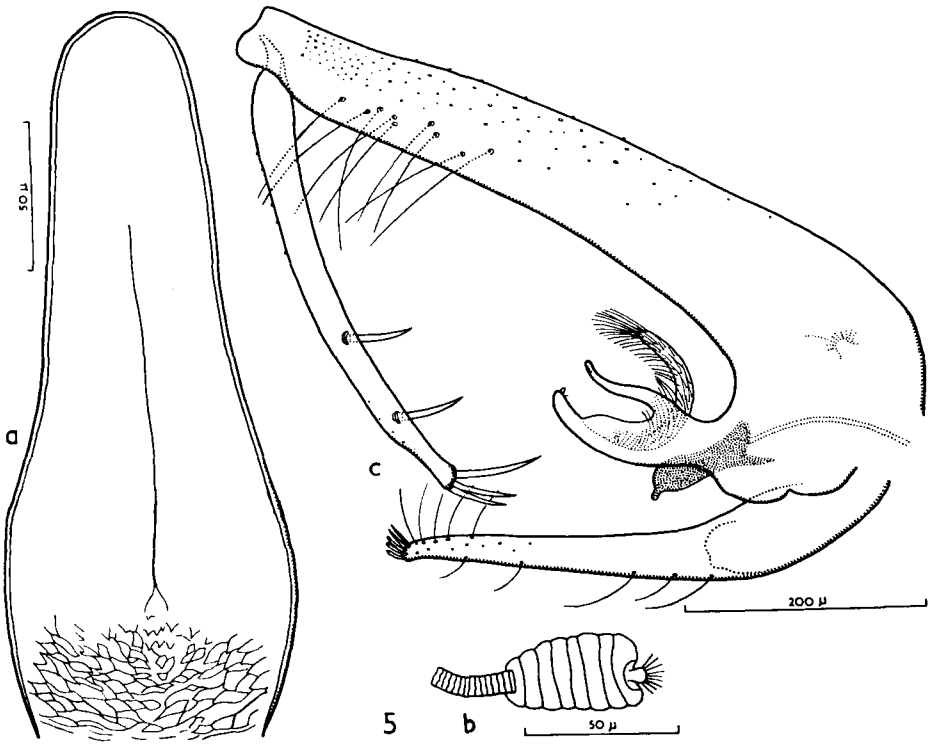


FIG. 5.—*P. roubaudi*, ♀: *a*, pharynx; *b*, spermatheca. ♂: *c*, terminalia. (After Parrot and Gougis, 1944.)

papatasi); paramere (0·27–0·29 mm.) three-lobed, fimbriated process completely covered with hairs and not much longer than digitiform process; penis (0·12 mm.) of irregular shape, lateral lobe (0·38–0·4 mm.) shorter than coxite and armed at its tip with 5 or more short strong spatulate spines.

Distribution: ASHANTI, FRENCH SUDAN, A.-E. SUDAN, NIGERIA, SIERRA LEONE, FRENCH NIGER.

Phlebotomus (*Phlebotomus*) *roubaudi* var. *fourtoni* Floch & Abonnenc.

P. roubaudi var. *fourtoni* Floch & Abonnenc, 1948, *Inst. Pasteur Guyane Territoire de l'Inini, Publ.* **169** (Cayenne).

Type specimens in the Institut Pasteur at Cayenne. The description below is after Floch and Abonnenc, from two males.

♀. Unknown.

♂. *Length :* 3·3 mm. *Antenna :* formula 2/III–XV, segment III (0·296 mm.) < IV + V, AIII/E = 1·1, ascoids on IV = 0·6 length of segment. *Palp :* formula 1,2,4,3,5, relative lengths 1, 4, 5·2, 4·4, 10·2. *Epipharynx :* length 0·25 mm. *Pharynx :* about twice as wide posteriorly as anteriorly, armed with numerous coarse, irregularly arranged teeth. *Wing :* length 1·94 mm., width 0·48 mm., alar index 1·7, delta + 0·09 mm. *Terminalia :* coxite (0·63 mm.) has on its inner surface a small tubercle bearing two long bristles and several short hairs ; style (0·47 mm.) bearing five relatively short spines, three terminal,

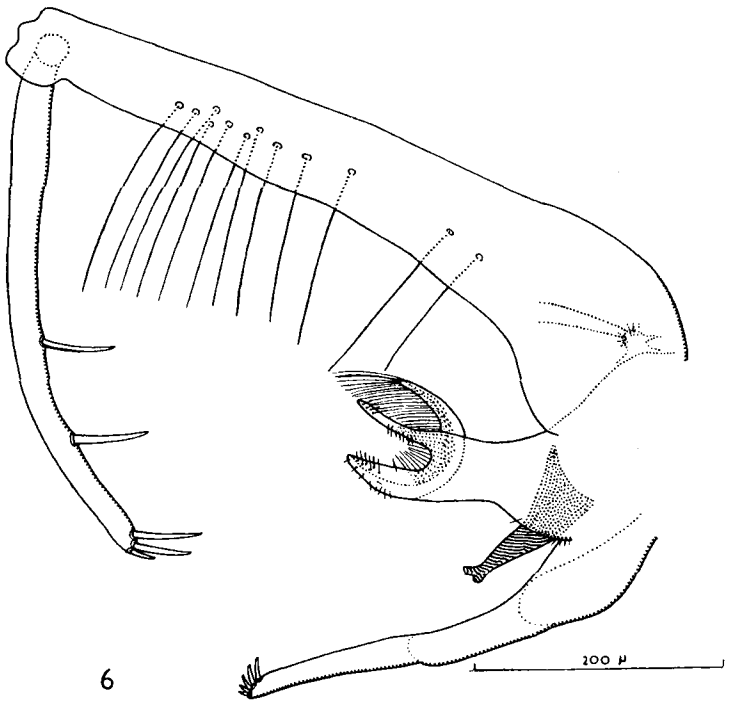


FIG. 6.—*P. roubaudi* var. *fourtoni*, ♂ : terminalia (after Floch and Abonnenc, 1948).

a proximal one arising slightly below the middle of the segment, and the fifth one equidistant between the proximal spine and the terminal ones ; paramere (0·259 mm.) three-lobed as in *P. roubaudi* ; penis sheath (0·11 mm.) with wide base, tapering progressively until just before the dilated extremity, the whole organ having roughly the shape of a boot ; lateral lobe 0·41 mm.

The male of this variety differs from *P. roubaudi* in (1) its greater length, (2) the boot-shaped penis sheath, and (3) the presence of two long bristles and several short hairs on the tubercle of the coxite ; in *P. roubaudi* there are only short hairs.

Distribution : FRENCH SUDAN.

Phlebotomus (*Phelebotomus*) *duboscqi* Neveu-Lemaire.

P. duboscqi Neveu-Lemaire, 1906, *Bull. Soc. zool. Fr.* **31** : 65.
P. duboscqi Picard, 1909, *Bull. Soc. ent. Fr.* **1909** : 164.

Type locality Timbuctoo. This species was created by Neveu-Lemaire in 1906, but the description of it is deficient in essential characters. Picard (1909), who re-examined the type specimen states that he was unable to distinguish any difference between it and *P. papatasi*. The status of the species is uncertain at present and re-examination of the type specimens is required to determine its relation to *P. roubaudi*, *P. papatasi* and *P. papatasi* var. *bergeroti*.

Distribution : FRENCH WEST AFRICA.

Phlebotomus (*Phlebotomus*) *alexandri* Sinton.

P. sergenti var. Newstead, 1920, *Bull. ent. Res.* **11** : 305.
P. sergenti var. *alexandri* Sinton, 1928, *Indian J. med. Res.* **16** : 297.
P. alexandri Parrot, 1936, *Arch. Inst. Pasteur Algér.* **14** : 428.

Type locality Amara, Mesopotamia ; type specimen in the British Museum. The description of the female given below is mainly after Parrot (1936), that of the male from a specimen from the A.-E. Sudan.

♀. *Length :* 2·22 mm., hind leg 2·8–3·1 mm. *Antenna :* formula 2/III–XV, segment III (0·14–0·16 mm.) < IV + V, AIII/E = 0·58–0·62, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,4,2,3,5, relative lengths 1, 2·7, 3·6, 2·2, 4·4. *Epipharynx :* length

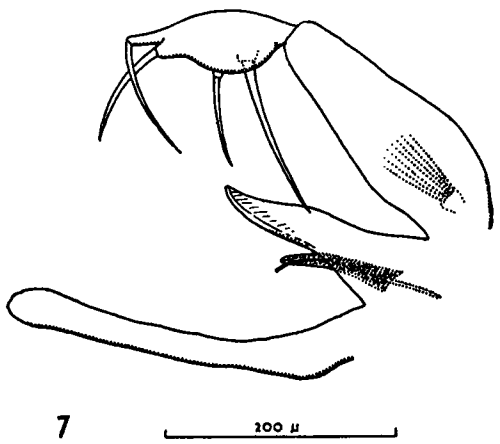


FIG. 7.—*P. alexandri* ♂ : terminalia.

0·22–0·26 mm. *Pharynx :* twice as wide posteriorly as anteriorly, armed with numerous broad pointed leaf-like teeth directed obliquely medially and posteriorly. *Wing :* length 1·85–2 mm., width 0·48–0·51 mm., alar index 1·3–1·5, delta + 0·05 to + 0·07 mm. *Spermatheca :* with 7–8 segments, the terminal one appearing detached from the others ; ducts wide at their origin becoming narrower and opening separately into the vulva.

♂. *Length :* 2·1 mm., hind leg 2·5 mm. *Antenna :* formula 2/III–XV, segment III< or = IV + V, AIII/E = 0·7–1·1, ascoids on IV = 0·4 length of segment. *Palp :* formula 1,2,4,3,5, or 1, (2,4), 3,5. *Pharynx :* less than twice as wide posteriorly as anteriorly and armed with irregular, fine, scale-like ridges. *Wing :* length 2·0 mm., width 0·56 mm., alar index 1·3, delta + 0·08 mm. *Terminalia :* coxite (0·21 mm.) less than twice length

of style and bearing a tuft of straight, rigid, divergent hairs on a short rounded process on its inner surface ; style (0·15 mm.) bears four spines, two submedian, one terminal and one subterminal, the distal, bifurcated spine bearing process of the segment markedly unequal, the terminal branch being about three times the length of the other ; paramere 0·2 mm., penis sheath 0·09 mm., lateral lobe (0·24–0·26 mm.) longer than coxite.

Distribution : A.-E. SUDAN.

Phlebotomus (*Phlebotomus*) *sergenti* Parrot.

P. sergenti Parrot, 1917, *Bull. Soc. Path. exot.* **10** : 564.
P. sergenti Franca, 1918, *ibid.* **11** : 731.
P. sergenti Adler & Theodor, 1929, *Ann. trop. Med. Parasit.* **23** : 271.

Type locality MacMahon (Constantine), Algiers ; type specimen in the Institut Pasteur d'Algérie. The description of the male is after Parrot (1917) and Newstead (1920), that of the female mainly after Franca (1918) and Adler and Theodor (1929).

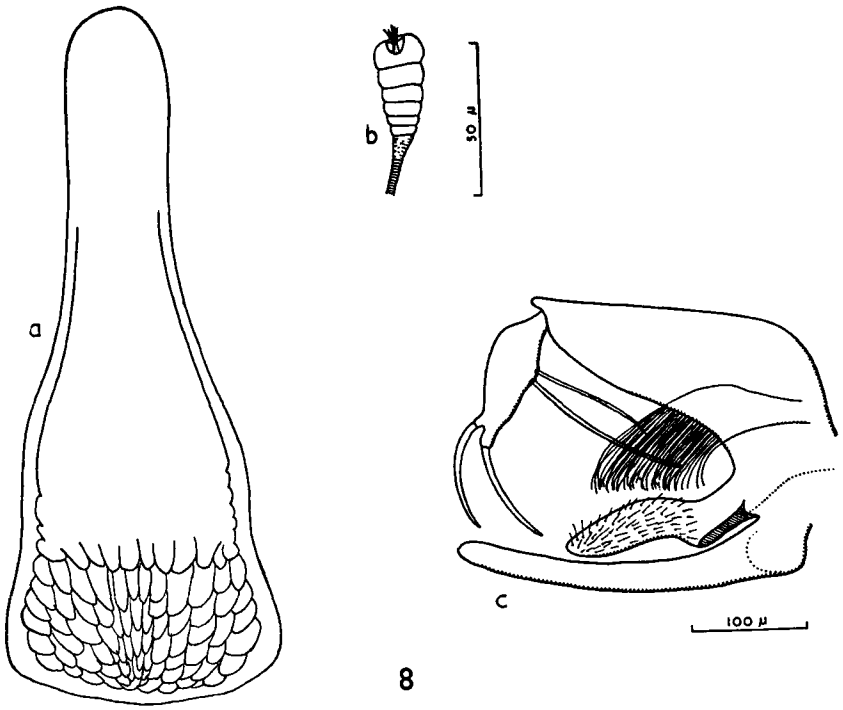


FIG. 8.—*P. sergenti*, ♀ : *a*, pharynx ; *b*, spermatheca. ♂ : *c*, terminalia. (*a* and *b* after Adler & Theodor, 1929 ; *c* after Newstead, 1920.)

♀. *Length :* 1·6–3·0 mm. *Antenna :* formula 2/III–XV, segment III (0·27–0·3 mm.) > IV + V, AIII/E = 0·68–0·88, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,4,2,3,5 (often variable). *Epipharynx :* length 0·32–0·44 mm. *Pharynx :* about 2·5 times as wide posteriorly as anteriorly and armed with very characteristic broad scale-like teeth. *Wing :* length 2·5 mm., width 0·8 mm., alar index 1, delta + 0·08 mm. *Spermatheca :* with 4–6 segments, superior segment longer than others, which diminish in size from above downwards ; the " head " is small and carried on a short neck partly

invaginated into the first segment; ducts enter the vulva separately and widen considerably at their junction with the body of the spermatheca.

♂. *Length:* 2–3·2 mm. *Antenna:* formula 2/III–XV, segment III (0·25 mm.) = IV + V, AIII/E = 1–1·4, ascoids on IV = 0·3 length of segment. *Palp:* formula 1,(4,2), 3,5, relative lengths 1, 4·2, 5, 4·2, 8·5. *Pharynx:* about twice as wide posteriorly as anteriorly, armed with broad leaf-like teeth, but those on the dorsal plate are poorly developed and hence appear separate from those on the lateral plates which appear conspicuous anteriorly. *Wing:* length 1·9 mm., width 0·53 mm., alar index 1·23, delta + 0·07 mm. *Terminalia:* coxite (0·25 mm.) more than twice as long as style (0·11 mm.), which appears almost globular; coxite bears near its base on inner surface a peduncle with rounded extremity, from which arises a tuft of about a dozen hairs; style bears four spines, two terminal on a separate process and two submedian; paramere (0·15 mm.) single, with flat elliptical upper surface; penis sheath (0·06 mm.) short with terminal hook; lateral lobe 0·13 mm.

Distribution: AIR (ASBEN) IN CENTRAL SAHARA, FRENCH WEST AFRICA; also in MEDITERRANEAN AREA and in ASIA.

Phlebotomus (*Phlebotomus*) *sergenti* var. *saevus* Parrot & Martin.

P. sergenti var. *saevus* Parrot & Martin, 1939, *Arch. Inst. Pasteur Algér.* **17**: 484.

Type locality Aouache, Abyssinia; type specimens in the Institut Pasteur d'Algérie. The descriptions below are mainly after Parrot and Martin, from two males and five females.

♀. *Length:* 2·26 mm., hind leg 2·55–3·95 mm. *Antenna:* formula 2/III–XV, segment III (0·22 mm.) > IV + V, AIII/E = 0·7–0·75, ascoids on IV = 0·6 length of segment. *Palp:* formula 1,4,2,3,5, relative lengths 1, 2·8, 4·1, 2·7, 7·1. *Epipharynx:* length 0·28–

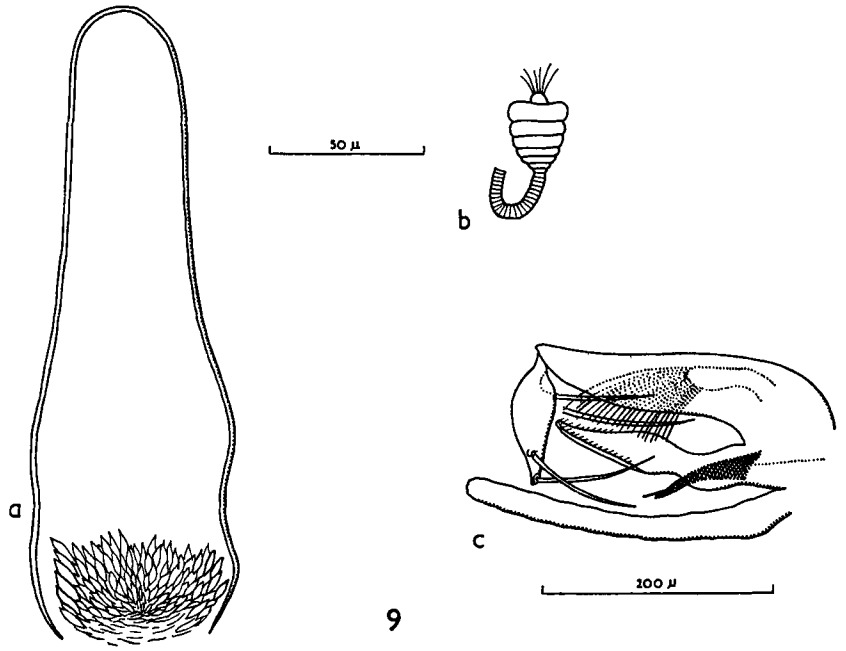


FIG. 9.—*P. sergenti* var. *saevus*, ♀: *a*, pharynx; *b*, spermatheca. ♂: *c*, terminalia. (after Parrot and Martin, 1939.)

0·3 mm. *Pharynx :* less than twice as wide posteriorly as anteriorly, constricted in posterior part which bears numerous broad, scale-like teeth. *Wing :* length 2·1–2·4 mm., width 0·57–0·65 mm., alar index 1·2–1·4, delta + 0·21 to 0·13 mm. *Spermatheca :* with 6 segments, distal one larger than the others ; ducts open separately into the vulva.

♂. *Length :* 2·49 mm., hind leg 4·8 mm. *Antenna :* formula 2/III–XV, segment III (0·32 mm.) = IV + V, AIII/E = 1·06, ascoids on IV = 0·7 length of segment. *Palp :* formula 1,4,2,3,5, relative lengths 1, 3·2, 4, 3·1, 6. *Epipharynx :* length 0·39 mm. *Pharynx* less than twice as wide posteriorly as anteriorly, traversed in its posterior part by iregularly arranged scale-like folds. *Wing :* length 2·49 mm., width 0·65 mm., alar index 1·26, delta + 0·08 mm. *Terminalia :* coxite (0·26 mm.) more than twice length of style (0·12 mm.) and having on its inner surface a tuft of about 25 long curved hairs, arising from an elongated process (0·08 mm. approximately) ; style with four spines as in *P. sergenti*, but one of the two distal spines is terminal and the other subterminal (as in *P. alexandri*).

The male of var. *saevus* differs from *P. sergenti* in (1) the general arrangement of the tuft of hairs on the coxite, (2) the shape of the process bearing these hairs and (3) the arrangement of the terminal spines on the style. The female differs from *P. sergenti* in its greater length and the more numerous but less well-developed teeth in the pharyngeal armature.

Distribution : Abyssinia, A.-E. Sudan.

Phlebotomus (*Phlebotomus*) *katangensis* Bequaert & Walravens.

P. katangensis Bequaert & Walravens, 1930, *Rev. Zool. Bot. afr.* **19** : 35.

Type locality Elizabethville, Katanga, Belgian Congo. The description of the male is after Bequaert and Walravens.

♀. Unknown.

♂. *Length* (thorax to tip of style) : 2·2–2·6 mm. *Antenna :* formula 2/III–IX, I/X..., segment III > IV + V, AIII/E = 0·6. *Palp :* formula 1,2,(3,4),5, relative lengths 1, 2·4,

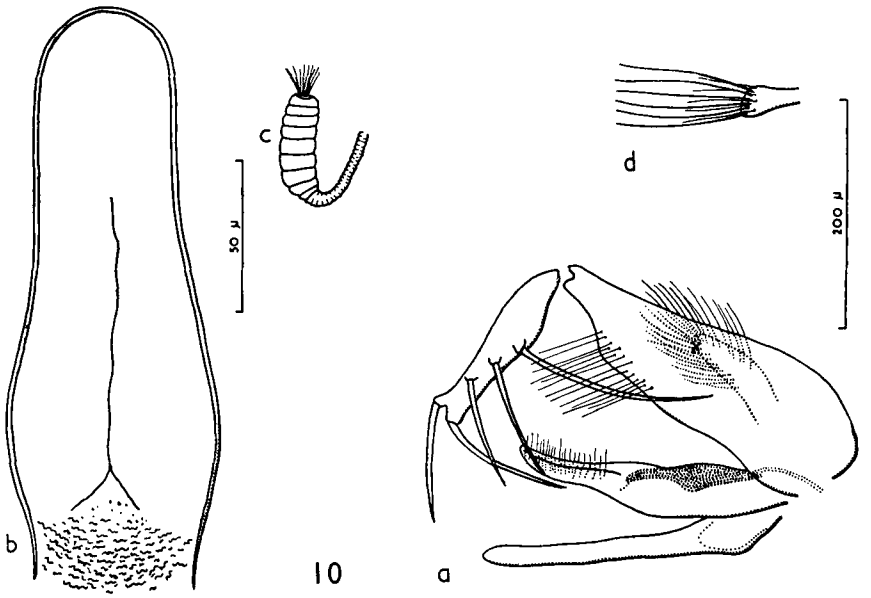


Fig. 10.—*P. katangensis*, ♂ : *a*, terminalia. *P. martini*, ♀ : *b*, pharynx ; *c*, spermatheca. ♂ : *d*, lobe of coxite. (*a* after Bequaert and Walravens, 1930 ; *b–d* after Parrot, 1936.)

2·7, 2·7, 5·7. *Epipharynx:* length 0·21–0·22 mm. *Pharynx:* about 1·5 times as wide posteriorly as anteriorly, armed with irregular transverse ridges bearing small spines. *Wing:* length 1·8–2 mm., width 0·46–0·6 mm., alar index 1·7–2, delta + 0·1 to + 0·18 mm. *Terminalia:* coxite (0·28 mm.) about twice as long as style (0·15 mm.) and having on a process about the middle of its internal surface a tuft of long hairs; style bears five spines two terminal and three lateral, of which two arise on the distal half of the segment and one on its proximal half, this spine being notably longer than the others; paramere (0·2 mm.) blunt; penis sheath (0·1 mm.) slender, curved slightly downwards with blunt points; lateral lobe 0·23 mm.

Distribution: BELGIAN CONGO.

Phlebotomus (*Phlebotomus*) *martini* Parrot.

P. martini Parrot, 1936, *Arch. Inst. Pasteur Algér.* **14**: 30.

Type locality Addis Ababa, Abyssinia; type specimens in the Institut Pasteur d'Algérie. The descriptions given below, after Parrot, from two males and nine females, agree with specimens from the A–E Sudan.

♀. *Length:* 2.2 mm., hind leg 3–3·7 mm. *Antenna:* formula 2/III–XV, segment III (0·18–0·23 mm) > or = IV + V, AIII/E = 0·68–0·93, ascoids on IV = 0·7 length of segment. *Palp:* formula 1,(4,2,),3,5, relative lengths 1, 3·5, 3·9, 3·4, 7·0. *Epipharynx:* length 0·25–0·3 mm. *Pharynx:* about 1·5 times as wide posteriorly as anteriorly, armed with irregular transverse ridges and punctiform teeth. *Wing:* length 1·8–2·4 mm., width 0·53–0·64 mm., alar index 1·2–1·5, delta + 0·09 to + 0·11 mm. *Spermatheca:* with 9–10 segments, no neck but terminating in a tuft of hairs; ducts narrow, irregularly annulated and opening separately into the vulva.

♂. *Length:* 1·8–2 mm., hind leg 2·8–2·9 mm. *Antenna:* formula 2/III–X, I/XI–XIII, segment III (0·18–0·19 mm.) < IV + V, AIII/E = 0·9, ascoids on IV = 0·6 length of segment. *Palp:* formula 1,2,4,3,5, relative lengths 1, 3·1, 4, 3·6, 7·4. *Epipharynx:* length 0·2 mm. *Pharynx:* 1·5 times as wide posteriorly as anteriorly, armed with fine wavy ridges and small punctiform teeth. *Wing:* length 1·6–1·7 mm., width 0·48–0·49 mm., alar index 1·3–1·5, delta + 0·05 to + 0·07 mm. *Terminalia:* coxite (0·27 mm.) more than twice length of style (0·13 mm.) and bearing on its inner surface a process from which arise six long flattened hairs and about 12 small, short, slender ones; style bears five spines, two submedian, one subterminal and two terminal; paramere (0·18 mm.) with blunt extremity; penis sheath 0·07 mm., lateral lobe (0·23 mm.) shorter than coxite.

P. katangensis, *P. martini* and *P. rossi* form a small group (*Synphlebotomus* of Theodor, 1948) distinguished by the prominent tuft of hairs on the coxite and five spines on the style in the male terminalia. The males of *P. katangensis* and *P. martini* are very similar, differing only in the character of the hairs on the process of the coxite. These hairs are described as of uniform size in *P. katangensis*, whereas in *P. martini* there are small as well as large hairs, although the small hairs are very inconspicuous and might easily be overlooked. It is possible that the two species are identical, in which case *P. martini* would become a synonym of *P. katangensis*; but this can only be decided by re-examination of the type specimen of *P. katangensis*.

Distribution: ABYSSINIA, A.-E. SUDAN.

Phlebotomus (*Phlebotomus*) *rossi* De Meillon & Lavoipierre.

P. rossi De Meillon & Lavoipierre, 1944, *J. ent. Soc. S. Afr.* **7**: 44.

Type specimen in the South African Institute for Medical Research, Johannesburg. This species is known from one male only, from Raheen,

Umtali, Southern Rhodesia description of which is given after De Meillon and Lavoipierre.

♀. Unknown.

♂. *Length :* 2·6 mm. *Antenna :* formula 2/III–IX, I/X–XIII, 0/XIV–XV, segment III (0·24 mm.) = IV + V, AIII/E = 1·2, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,2,(3,4),5, relative lengths 1, 3, 4, 4, 9·5. *Epipharynx :* length 0·2 mm. *Pharynx:* 1·5 times as wide posteriorly as anteriorly, armed with irregular ridges and punctiform teeth. *Wing :* length 2·0 mm., width 0·6 mm., alar index 1·4 delta + 0·14 mm. *Terminalia :* coxite (0·3 mm.) about twice as long as style (0·16 mm.) and bearing a process with about four very long bristles apically and a large number of shorter hooked bristles

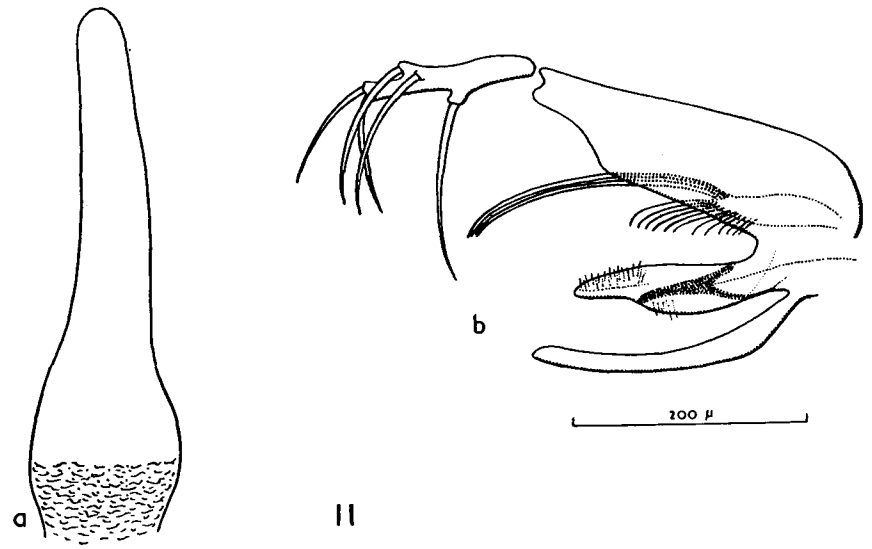


FIG. 11.—*P. rossi*, ♂ : *a*, pharynx ; *b*, terminalia. (After De Meillon and Lavoipierre, 1944.)

ventrally decreasing in size from near the apex to the base ; style bears five long spines, two terminal, two subterminal and one submedian, which is the longest of the five ; paramere (0·18 mm.) evenly rounded distally, penis sheath (0·1 mm.) with rounded distal end ; lateral lobe 0·26 mm.

The male of this species resembles those of *P. katangensis* and *P. martini*, from which it is distinguished by the character of the setae on the coxite.

Distribution : SOUTHERN RHODESIA.

Phlebotomus (*Phlebotomus*) *orientalis* Parrot.

P. langeroni var. *orientalis* Parrot, 1936, *Arch. Inst. Pasteur Algér.* **14** : 30.
P. perniciosus Archibald & Mansour, 1937, *Trans. R. Soc. trop. Med. Hyg.* **30** : 395.
P. perniciosus Sinton, 1937, *ibid.* **30** : 404.
P. perniciosus Kirk, 1939, *ibid.* **32** : 541.
P. langeroni Theodor, 1938, *Bull. ent. Res.* **29** : 165.
P. orientalis Parrot & Clastrier, 1946, *Arch. Inst. Pasteur Algér.* **24** : 60.

P. langeroni was separated as a variety of *P. perniciosus* by Nitzulescu (1930) on the characters of a non-bifid penis sheath and a different antennal

formula and was later raised to specific rank by the same author. In 1936 Parrot described from Abyssinia *P. langeroni* var. *orientalis*, in which the penis is non-bifid but the antennal formula is similar to that of *P. perniciosus*. The specimen reported by Theodor (1938) from the Sudan as *P. langeroni* was probably var. *orientalis*, but as the antennae were missing this could not be decided. In a study of *P. langeroni* and allied forms, Parrot and Clastrier (1946) concluded that *P. langeroni* differed as much from the variety *orientalis* as from two allied species, *P. longipes* and *P. longicuspis*, and accordingly raised the variety to specific rank as *P. orientalis* Parrot, 1936.

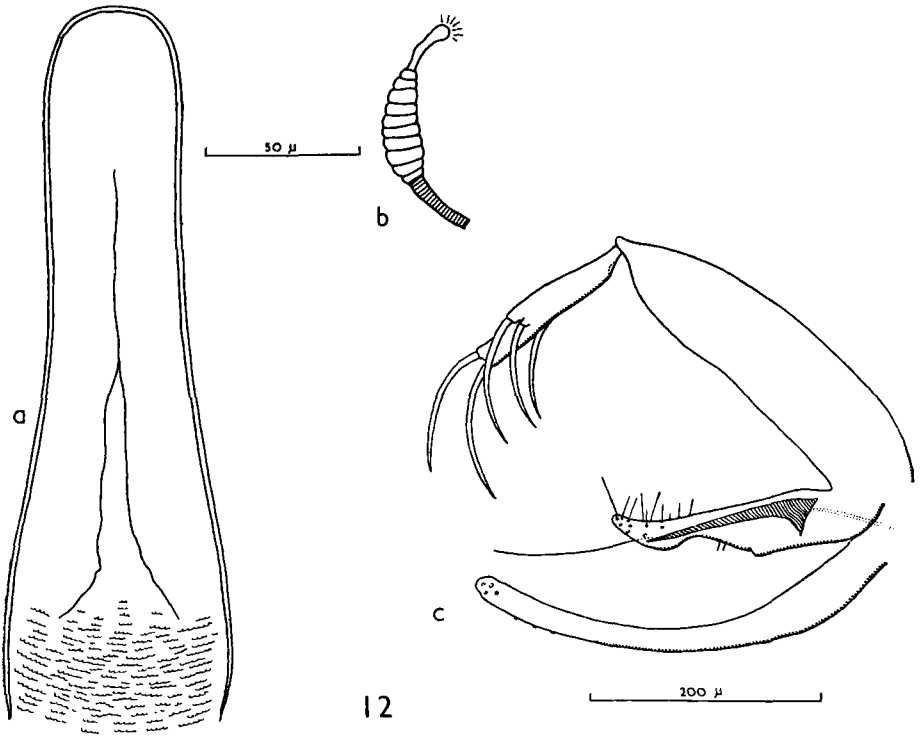


FIG. 12.—*P. orientalis*, ♀ : *a*, pharynx ; *b*, spermatheca. ♂ : *c*, terminalia. (After Parrot, 1936.)

Type locality Dira Dawa, Abyssinia ; type specimens in the Institut Pasteur d'Algérie. The descriptions below are mainly after Parrot's (1936) descriptions of 32 males and 24 females from the type locality which agree with specimens from the A.-E. Sudan.

♀. *Length :* 2·25 mm., hind leg 3·7–4·3 mm. *Antenna :* formula 2/III–XV, segment III (0·25–0·3 mm.) > IV + V, AIII/E = 0·96–1, ascoids on IV = 0·3 length of segment. *Palp :* formula 1,4,2,3,5, relative lengths 1, 3·5, 4·3, 3·3, 8. *Epipharynx :* length 0·26–0·32 mm. *Pharynx :* less than twice as wide posteriorly as anteriorly and armed with transverse rows of fine punctiform teeth. *Wing :* length 1·9–2·5 mm., width 0·6–0·75 mm., alar index 1·6–1·8, delta + 0·11 to + 0·18 mm. *Spermatheca :* with long " neck " and 8–12 segments ; ducts annulated and of uniform diameter for two-thirds of their

length, but smooth and widening progressively in the terminal third, opening separately into the vulva.

♂. *Length:* 2–2·3 mm., hind leg 3·2–3·8 mm. *Antenna:* formula 2/III–VII (VIII), 1/VIII (IX)–XV, segment III (0·25–0·32 mm.) > IV + V, AIII/E = 1·2–1·3, ascoids on IV = 0·2 length of segment. *Palp:* formula 1,4,2,3,5, relative lengths 1, 3·4, 4, 3·3, 8. *Epipharynx:* length 0·2–0·25 mm. *Pharynx:* almost twice as wide posteriorly as anteriorly, armed with fine punctiform teeth. *Wing:* length 1·4–1·6 mm., width 0·46–0·6 mm., alar index 1·5–2·25, delta + 0·07 to + 0·18 mm. *Terminalia:* coxite (0·29–0·35 mm.) approximately twice length of style (0·14–0·17 mm.) which bears five spines, two terminal, one submedian and external, and two internal ones arising nearer to the submedian external spine than to the terminal spines; paramere (0·2–0·23 mm.) slightly upturned at apex; penis sheath (0·14–0·17 mm.) narrow and elongated, ending in a single point, infero-external; lateral lobe (0·3–0·37 mm.) as long as or longer than coxite.

Distribution: ABYSSINIA, A.-E. SUDAN, NORTHERN KENYA.

Phlebotomus (*Phlebotomus*) *longipes* Parrot & Martin.

P. longipes Parrot & Martin, 1939, *Arch. Inst. Pasteur Algér.* **17**: 143.

Type locality Addis Ababa; type specimens in the Institut Pasteur d'Algérie. The descriptions given below are after Parrot and Martin from 896

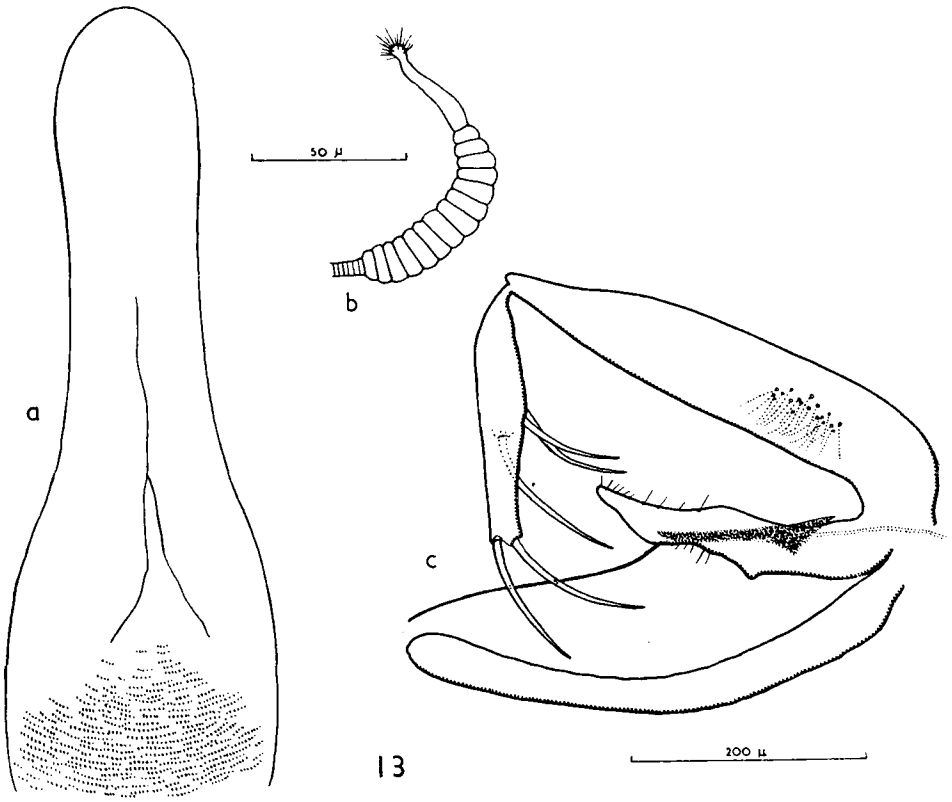


FIG. 13.—*P. longipes*, ♀: *a*, pharynx; *b*, spermatheca. ♂: *c*, terminalia. (After Parrot and Martin, 1939.)

males and 642 females from Abyssinia and agree with specimens from the Sudan.

♀. *Length :* 2·76–3 mm., hind leg 5·32–5·83 mm. *Antenna :* formula 2/III–XV, segment III (0·4–0·44mm.) > IV + V, AIII/E = 1·05, ascoids on IV = 0·4 length of segment. *Palp :* formula 1,(4,2),3,5, relative lengths 1, 3·8, 4·3, 3·6, 9. *Epipharynx :* length 0·35–0·4 mm. *Pharynx :* about twice as wide posteriorly as anteriorly, armed with small punctiform teeth arranged in transverse rows. *Wing :* length 3–3·4 mm., width 0·89–0·99 mm., alar index 1·85–2·64, delta + 0·19 to + 0·34 mm. *Spermatheca :* of *major* type, with 12–14 segments, a relatively long neck, and wide ducts opening separately into the vulva.

♂. *Length :* 2·7–2·8 mm., hind leg 4·8–5·7 mm. *Antenna :* formula 2/III–VII, 1/VIII–XV, segment III (0·45–0·52 mm.) > IV + V, AIII/E = 1·3–1·6, ascoids on IV = 0·3 length of segment. *Palp :* formula 1,(4,2),3,5, relative lengths 1, 3·3, 3·8, 3·1, 8. *Epipharynx :* length 0·3–0·34 mm. *Pharynx :* about twice as wide posteriorly as anteriorly and armed with transverse rows of fine punctiform teeth. *Wing :* length 2·56–3·0 mm., width 0·76–0·85 mm., alar index 2·1–2·7, delta + 0·23 to + 0·28 mm. *Terminalia :* coxite (0·37–0·44 mm.) less than twice length of style (0·21–0·24 mm.) which bears five long spines, two terminal and three submedian, of which two are borne on a process ; paramere (0·23–0·27 mm.) expanded and cut away below at the distal end ; penis sheath (0·14–0·16 mm.) with pointed distal end turned slightly upwards follows inferior border of paramere, but does not reach its distal end ; lateral lobe (0·37–0·45 mm.) approximately as long as coxite.

Distribution : ABYSSINIA, A.-E. SUDAN.

Phlebotomus (*Phlebotomus*) *lesleyae* Lewis & Kirk.

P. lesleyae Lewis & Kirk, 1946, *Proc. R. ent. Soc. Lond.* (B) **15** : 155.

Type Locality Kortala, Nuba Mountains A.–E. Sudan ; type specimens in the British Museum. The description is based on examination of one male and one female.

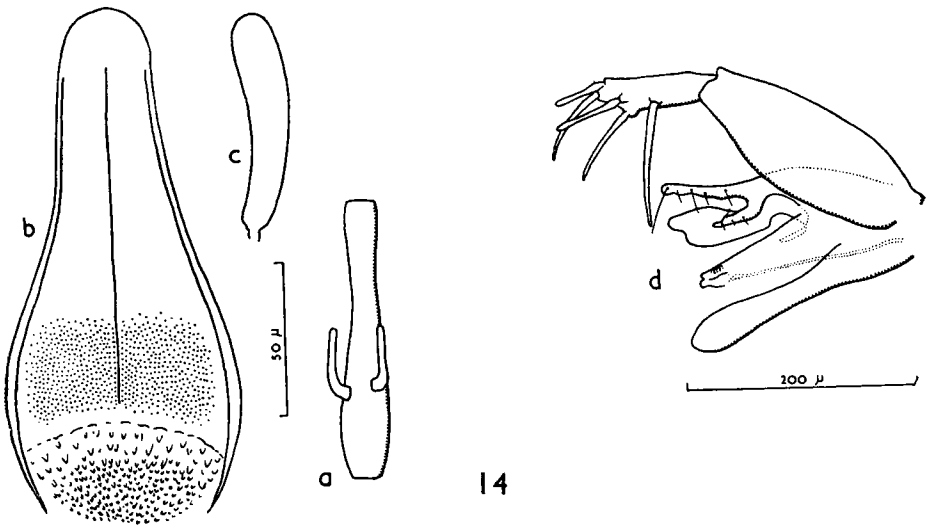


FIG. 14.—*P. lesleyae*, ♀ : *a*, fourth antennal segment ; *b*, pharynx ; *c*, spermatheca. ♂ : *d*, terminalia. (*a*, *b* and *d* after Lewis and Kirk, 1949 ; *c* from Kosti specimen.)

♀. *Length:* 1·9 mm. *Antenna:* formula 2/III–VIII (distal segments missing), segment III (0·15 mm.) < IV + V, AIII/E = 0·8, ascoids on IV = 0·2 length of segment. *Palp:* formula 1,2,3,..(4 and 5 missing), relative lengths 1, 2·7, 3·0..... *Epipharynx:* length 0·20 mm. *Pharynx:* twice as wide posteriorly as anteriorly, pigmented in middle, posterior third armed with strongly developed blunt teeth pointing inwards and backwards. *Wing:* length 1·48 mm., width 0·29 mm., alar index 0·3, delta −0·06 mm. *Spermatheca:* a thin-walled sac, without annulations.

♂. *Length:* 1·7 mm. *Antenna:* formula 2/III–XI (distal segments missing), segment III (0·12 mm.) < IV + V, AIII/E = 1·5, ascoids on IV = 0·2 length of segment. *Palp:* formula 1,2,4,3,5, relative lengths 1, 1·8, 6·0, 4·0, 9·0. *Pharynx:* hardly wider posteriorly than anteriorly, unarmed except for faint ridges. *Wing:* length 1·14 mm., width 0·18 mm., delta −0·11 mm. *Terminalia:* coxite (0·21 mm.) twice as long as style (0·01 mm.), which bears five spines, one terminal, one subterminal, two at 0·7 and one very long spine at 0·3; paramere (0·19 mm.) consisting of an upper lobe bearing hairs and a lower lobe composed of a stem bearing a few hairs and of a thin, broad smooth plate; penis sheath (0·11 mm.) thick and conical with broad distal end, lightly pigmented; lateral lobe 0·2 mm.

With *P. heischi* and *P. gigas* this species presents the unusual feature in the subgenus *Phlebotomus* of having non-crenulated spermathecae. The male terminalia resemble those of certain Oriental species, *P. argentipes*, *P. philippinensis* etc., and on this character *P. lesleyae* has been incorporated with these by Theodor (1948) in the proposed subgenus *Euphlebotomus*.

Distribution: A.-E. Sudan.

Phlebotomus (*Phlebotomus*) *heischi* Kirk & Lewis.

P. heischi Kirk & Lewis, 1950, *Proc. R. ent. Soc. Lond.* (B) **19**: 11.

Type specimen in the British Museum. This species is known from one female specimen only from Wajir, Kenya.

♀ (damaged). *Antenna:* formula 2/III–XV, segment III (0·19 mm.) < IV + V, AIII/E = 0·8, ascoids on IV = 0·6 length of segment. *Palp:* formula 1,4,2,3,5, relative

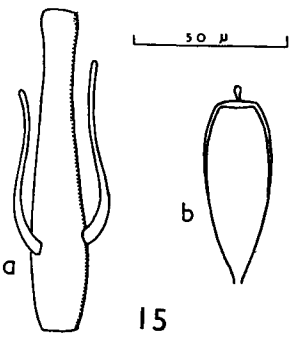


Fig. 15.—*P. heischi*, ♀: *a*, fourth antennal segment; *b*, spermatheca. (After Kirk and Lewis, 1950.)

lengths 1, 2·7, 4·0, 2·5, 6·3. *Epipharynx:* length 0·23 mm. *Pharynx* (lost): unarmed. *Wing:* length 1·5 mm., width 0·45 mm., alar index 0·9, delta + 0·08 mm. *Spermatheca:* a sac without annulations.

♂. Unknown.

P. heischi is a member of the subgenus *Phlebotomus* with the unusual character of a non-segmented spermatheca, like that of *P. lesleyae* from which it differs by having long instead of very short ascoids.

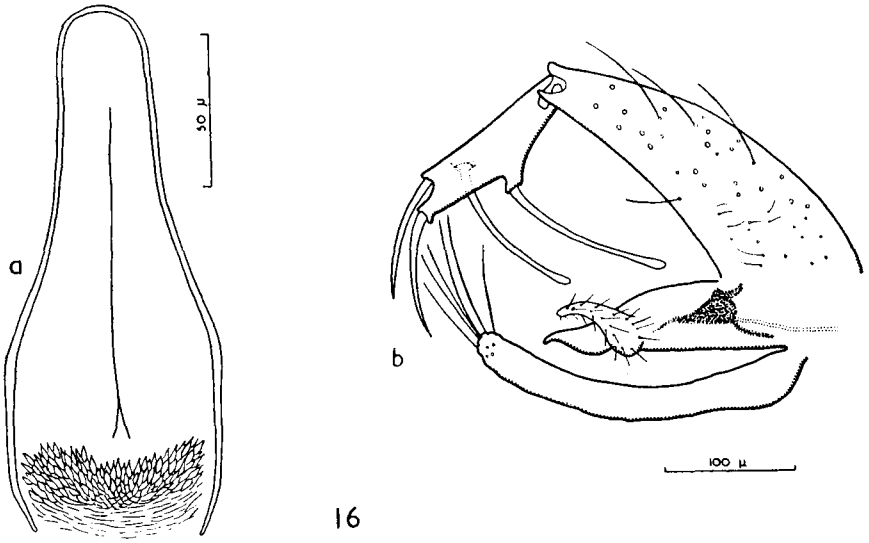
Distribution : KENYA.

Phlebotomus (*Phlebotomus*) *rodhaini* Parrot.

P. rodhaini Parrot, 1930, *Rev. Zool. Bot. afr.* **19** : 181 ; *ibid.* **20** : 103.
P. rodhaini Parrot, 1948, *Arch. Inst. Pasteur Algér.* **26** : 121.

Type locality Mandinba (Lutubu), Belgian Congo ; type specimen in the Museum of the Belgian Congo, Tervueren. The descriptions below are after Parrot, from four males and one female from the Congo and A.-E. Sudan.

♀. *Length :* 2 mm., hind leg 3·1 mm. *Antenna :* formula 2/III–XV, segment III (0·26 mm.) > IV + V, AIII/E = 1·1, ascoids on IV = 0·7 length of segment and project



16

FIG. 16.—*P. rodhaini*, ♀ : *a*, pharynx ; ♂ : *b*, terminalia. (After Parrot, 1948.)

beyond its tip. *Palp :* formula 1,4,2,3,5, relative lengths 1, 2·8, 4·1, 1·8, 5. *Epipharynx :* length 0·3 mm. *Pharynx :* about twice as wide posteriorly as anteriorly, constricted slightly in the middle of its wide part and bearing in its posterior third large scale-like spines which tend to become arranged in transverse lines posteriorly. *Wing :* length 1·78–2 mm., width 0·52–0·6 mm., alar index 1·7–1·8, delta + 0·15 mm. *Spermatheca :* annulated, details not made out (lost).

♂. *Length :* 1·7 mm., hind leg 2·65–2·8 mm. *Antenna :* formula 2/III–XIII, 1/XIV–XV, segment III (0·19–0·24 mm.) > IV + V, AIII/E = 1·4–1·7, ascoids on IV = 0·7 length of segment and project beyond it. *Palp :* formula 1,(4,2),3,5, relative lengths 1, 2·3, 4·3, 2·3, 6. *Epipharynx :* length 0·14–0·16 mm. *Pharynx :* slightly more than twice as wide posteriorly as anteriorly and bearing numerous transverse folds with fine punctiform teeth. *Wing :* length 1·47–1·58 mm., width 0·4–0·46 mm., alar index 1·6–2, delta + 0·034 mm. *Terminalia :* coxite (0·27–0·28 mm.) less than twice as long as style (0·14–0·15 mm.), which bears four spines, one terminal and external, one subterminal and internal, one at 0·75 internally and one at 0·5 externally ; paramere (0·17–0·2 mm.) with two lobes,

an internal one bearing numerous hairs and an external one, chitinized, pigmented, with beak-like point and rounded ventral lobe; penis 0·05 mm., lateral lobe 0·26 mm.

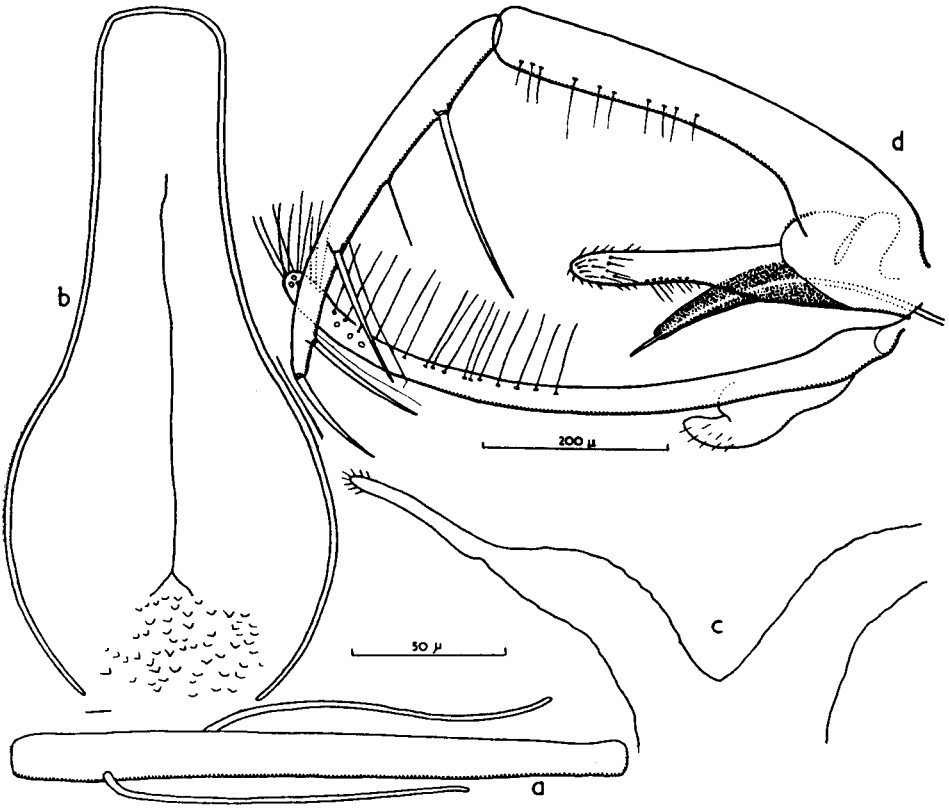
Distribution: Belgian Congo, A.-E. Sudan.

Phlebotomus (*Phlebotomus*) *gigas* Parrot & Schwetz.

P. gigas Parrot & Schwetz, 1937, *Rev. Zool. Bot. afr.* **29**: 224.
P. gigas Parrot & Wanson, 1938, *ibid.* **31**: 153.
P. gigas Parrot & Wanson, 1946, *Arch. Inst. Pasteur Algér.* **24**: 143.

Type locality Thysville, Belgian Congo; type specimens in the Museum of the Belgian Congo, Tervueren. A large, specialized, cave-dwelling form. The descriptions below are after Parrot and Wanson, from 74 males and 88 females.

♀. *Length:* 3·21–3·82 mm., hind leg 8·35–8·69 mm. *Antenna:* formula 2/III–XV, segment III (1–1·18 mm.) > IV + V, AIII/E = 2·3–2·5, ascoids slender and difficult to see, inserted at different levels in each segment, those of segment III being at 0·2 and 0·6, of segment IV at 0·3 and 0·6, the members of each pair being inserted nearer to each other towards the tip of the antenna, till in XIII, XIV and XV they are opposite each other.



17

Fig. 17.—*P. gigas*, ♀: *a*, fourth antennal segment; *b*, pharynx; *c*, spermatheca. ♂: *d*, terminalia. (*a-c* after Parrot, 1948; *d* after Theodor, 1948.)

Palp : formula 1,4,2,5,3, relative lengths 1, 2·7, 4·5, 1·8, 2·8. *Epipharynx :* length 0·42–0·48 mm. *Pharynx :* about three times as wide posteriorly as anteriorly with some scale-like folds in its posterior part. *Wing :* length 3·7–3·75 mm., width 1·14–1·22 mm., alar index 4·7–5·3, delta + 0·75 to + 0·9 mm., pi — 0·24–0·32 mm. *Spermatheca :* non-segmented, opening into vulva by a short, very wide common duct, and having a long neck, bearing hairs and less chitinized than the rest of the organ.

♂. *Length :* 3·31–3·67 mm., hind leg 7·17–7·48 mm. *Antenna :* formula 2/III–IX (X), 1/X (XI)–XV, segment III (1·05–1·12 mm.) very long > IV + V, AIII/E = 4·4–4·9, ascoids long, slender, difficult to see and inserted at different positions in the different segments, those of III at 0·2 and 0·6, of IV at 0·3 and 0·6, while the insertions of those on the following segments become progressively closer to each other and to the base of the segment. *Palp :* formula 1,4,2,5,3, relative lengths 1, 2·6, 5·2, 2·2, 4·2. *Epipharynx :* length 0·21–0·24 mm. *Pharynx :* about 2·5 times as wide posteriorly as anteriorly and bearing some irregular tooth-like ridges. *Wing :* length 2·51–2·75 mm., width 0·8–0·9 mm., alar index 4–5·5, delta + 0·56 to + 0·65 mm., pi — 0·136 to — 0·17 mm. *Terminalia :* coxite (0·51–0·54 mm.) longer than style (0·42–0·49 mm.) which bears four long spines, one at 0·2, the second at 0·6, the third at 0·8 and the fourth terminal; non-deciduous seta inserted between first and second spines; paramere (0·36–0·38 mm.) finger-shaped, penis roughly conical but curved ventrally; lateral lobe (0·65–0·72 mm.) unarmed, longer than coxite.

Distribution : BELGIAN CONGO.

Phlebotomus (*Sintonius*) *adleri* Theodor.

P. adleri Theodor, 1933, *Bull. ent. Res.* **24** : 537.

The description below is after Theodor's original description from six females and 11 males from Accra and Tamale, Gold Coast. Co-type ♂ and ♀ in the British Museum.

♀. *Length :* 1·9–2·45 mm. *Antenna :* segment III < IV + V, AIII/E = 0·65. *Palp :* formula, 1,2,4,3,5, relative lengths, 1, 1·8, 3·4, 2·4, 4·7. *Buccal cavity :* with a straight row of about 20 long pointed teeth; anteriorly 4–5 rows of small punctiform denticles; pigmented area large and roughly heart-shaped with a blunt forward apex. *Pharynx :* lamp-glass shaped, 2·5 times as wide posteriorly as anteriorly, with a few minute teeth.

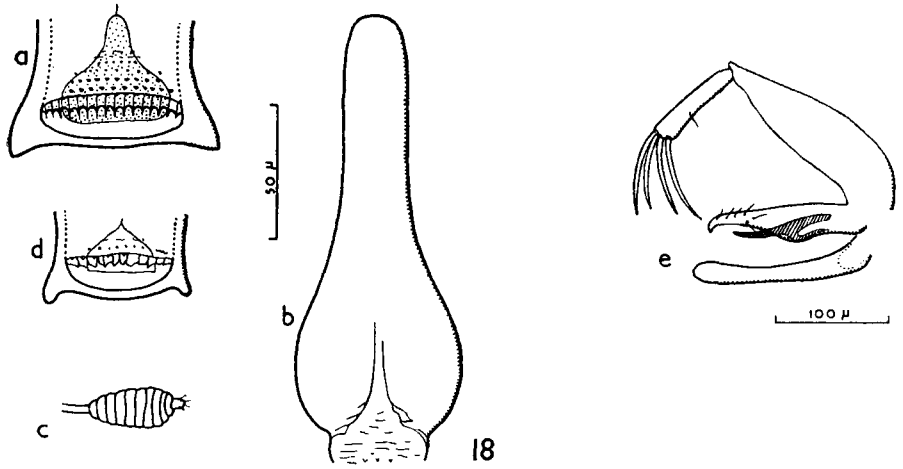


FIG. 18.—*P. adleri*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. ♂ : *d*, buccal cavity ; *e*, terminalia. (After Theodor, 1933.)

Wing : 1·75–1·9 mm. long, 0·36–0·4 mm. wide, alar index 0·45. *Spermatheca :* with 10–12 segments and very long narrow ducts opening separately into the vulva.

♂. *Length :* 2 mm. *Antenna :* segment III < IV + V, AIII/E = 0·75–0·86. *Palp :* as in female. *Buccal cavity :* with 10–12 teeth in a straight line, in some specimens each tooth with 2–3 small secondary apical denticles ; anteriorly 2–3 rows of small punctiform teeth ; pigmented area faint, triangular with its apex forward. *Pharynx :* twice as wide posteriorly as anteriorly, lightly chitinized with some very faint ridges. *Wing :* 1·75 mm. long ; 0·35 mm. broad, index 0·33–0·6. *Terminalia :* coxite twice, or slightly more, as long as style which bears four spines two terminal and two subterminal, and small non-deciduous seta at 0·5 ; paramere moderately beaked ; penis sheath pointed, tapering and bent slightly upwards ; lateral lobe shorter than coxite.

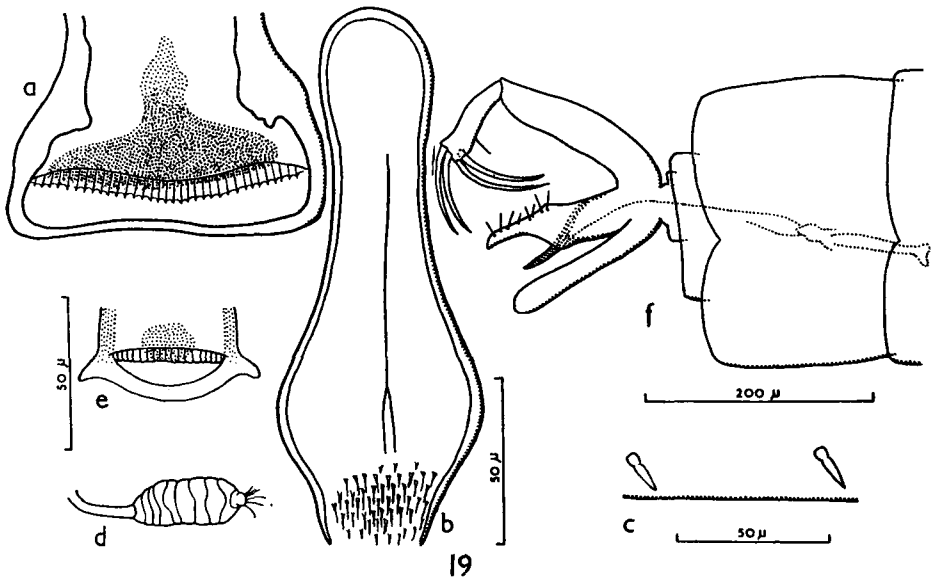
Distribution : Gold Coast, A.-E. Sudan.

Phlebotomus (*Sintonius*) *affinis* Theodor.

P. affinis Theodor, 1933, *Bull. ent. Res.* **24** : 537.
P. affinis Parrot, 1948, *Arch. Inst. Pasteur Algér.* **26** : 122.

The description below is after Theodor and Parrot's descriptions of two females from the type locality (southern A.-E. Sudan, probably near Kapoeta) and Li Rangu, and from the examination of additional females and 2 males from the Sudan.

♀. *Length :* 2·2–2·3 mm. *Antenna :* segment III (0·20 mm.) > IV + V, AIII/E = 1·1–1·15, formula 2/III–XV, ascoids on IV = 0·33 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths, 1, 2·4, 3, 4, 7·5. *Epipharynx :* length 0·18 mm. *Buccal cavity :* with a slightly or strongly retroconvex row of 34–40 monomorphic, narrow, parallel teeth with short points ; pigmented area a narrow elongated ellipse, reaching or nearly reaching the sides of the buccal cavity, with a pale subtriangular forward process ; well marked



19

Fig. 19.—*P. affinis*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spines on hind femur ; *d*, spermatheca. ♂ : *e*, buccal cavity ; *f*, terminalia (*a*, *b* and *d* after Parrot, 1948 ; *c* and *f* from Mvolo specimen).

anterior buccal protuberances with irregular medial margins. *Pharynx:* lamp-glass shaped, 2·5–3 times as wide posteriorly as anteriorly, with relatively few (about 50) strong teeth with long points. *Wing:* 1·94 mm. long, 0·45 mm. broad, alar index 0·9, delta + 0·221 mm. *Legs:* femora (anterior and posterior) armed with up to 10 spines. *Spermatheca:* with 8–9 segments and long narrow ducts.

♂. *Length:* 3·0 mm. *Antenna:* formula 1/III–XV, ascoid on IV = 0·2 length of segment, segment III (0·22 mm.) > IV + V, AIII/E = 1·3. *Palp:* formula 1,2,3,4,5, relative lengths, 1, 2·2, 3·4, 4, 7·5. *Buccal cavity:* with a straight row of about 16 blunt teeth of which the middle ones are parallel to each other and the outer ones incline towards the centre; pigmented area rounded anteriorly except for a small pale forward process. *Pharynx:* lamp-glass shaped, 1·5 times as wide posteriorly as anteriorly, with a few transverse ridges and minute spicules. *Wing:* 1·77 mm. long, 0·42 mm. broad, alar index 0·69 delta + 0·10 mm. *Terminalia:* coxite twice as long as style, which bears four terminal spines and small non-deciduous seta at 0·5; paramere beaked; penis sheath small, slender, and tapering to a sharp point.

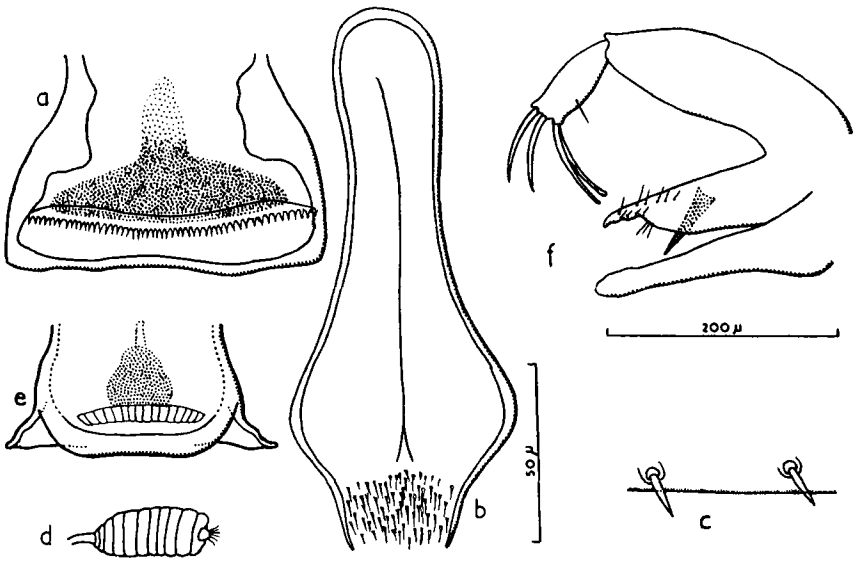
Distribution: A.-E. SUDAN.

Phlebotomus (*Sintonius*) *affinis* var. *vorax* Parrot.

P. affinis Lewis & Kirk, 1940, *Proc. R. ent. Soc. Lond.* (*B*) **9**: 127.
P. affinis var. *vorax* Parrot, 1948, *Arch. Inst. Pasteur Algér.* **26**: 121.

The descriptions below are from the original descriptions, partly after Parrot, of one female and one male from the type locality El Fasher, A.-E. Sudan. Type specimens in the British Museum (Natural History).

♀. *Length:* 2·16 mm. *Antenna:* missing. *Palp:* formula, 1,2,3,4,5, relative lengths, 1, 3·5, 4·5, 5·5, 7·5. *Epipharynx:* length 0·17 mm. *Buccal cavity:* with 56 monomorphic narrow teeth with long points in a palisade slightly convex posteriorly; pigmented area



20

FIG. 20.—*P. affinis* var. *vorax*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spines on hind femur; *d*, spermatheca. ♂: *e*, buccal cavity; *f*, terminalia. (*a–d* and *f* after Parrot, 1948; *e* after Lewis and Kirk, 1940.)

an elongated ellipse with pale triangular forward extension ; anteriorly lateral buccal protuberances are well marked, with irregular inner edges. *Pharynx :* lamp-glass shaped, 2·5 times as wide posteriorly as anteriorly, armed with over 60 spines with long points. *Wing :* missing. *Legs :* the one existing femur bearing 10 short and strong femoral spines. *Spermatheca :* with 10–11 segments and a narrow duct.

♂. *Length :* 3·09 mm. *Antenna :* formula I/III–XV, segment III (0·21 mm.) > IV + V, AIII/E = 1·2 ; ascoid on IV = 0·2 length of segment. *Palp :* formula, 1,2,3,4,5, relative lengths, 1, 3·4, 4·9, 5·5, 9·5. *Epipharynx :* length 0·17 mm. *Buccal cavity :* with 15 broad teeth arranged in a straight line ; pigmented area half moon shaped, with ragged posterior border. *Pharynx :* lamp-glass shaped, less than twice as wide posteriorly as anteriorly, with a few transverse ridges bearing small denticles in its posterior part. *Wing :* 1·78 mm. long, 0·42 mm. broad, alar index 0·68, delta + 0·051 mm. *Terminalia :* coxite (0·21 mm.) more than twice as long as style (0·084 mm.) which bears four terminal spines and small non-deciduous seta at 0·6 ; paramere (0·18 mm.) slightly beaked ; penis sheath (0·066 mm.) elongated, conical, with blunt point ; lateral lobe, 0·20 mm.

Distribution : A.-E. SUDAN.

Phlebotomus (*Sintonius*) *caffraricus* De Meillon & Lavoipierre.

P. caffraricus De Meillon & Lavoipierre, 1944, *J. ent. Soc. S. Afr.* **8** : 38.

Type locality Bizana, Transkei, Cape Province ; type specimen in South African Institute for Medical Research. This species is known from one female only the description of which is after De Meillon and Lavoipierre.

♀. *Length :* 3·56 mm. *Antenna :* formula 2/III–XV, ascoids on IV = 0·5 length of segment, segment III (0·26 mm.) < IV + V, AIII/E = 0·86. *Palp :* formula, 1,2,4,3,5,

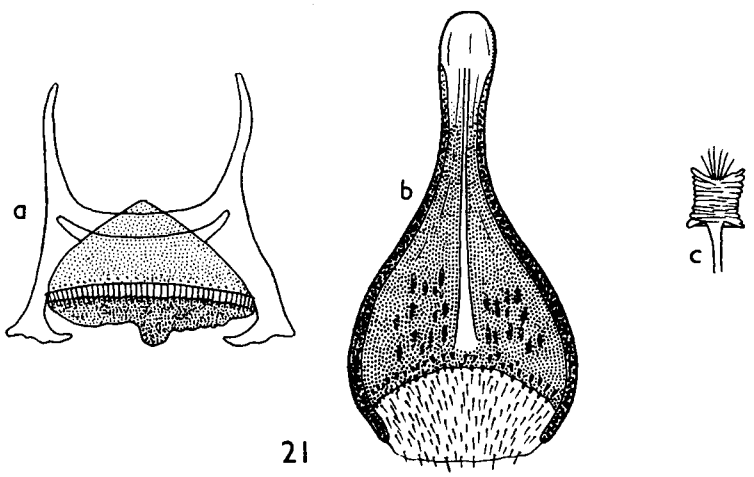


FIG. 21.—*P. caffraricus*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. (After De Meillon and Lavoipierre, 1944.)

relative lengths 1, 1·7, 2·7, 2·3, 4·3. *Epipharynx :* length 0·3 mm. *Buccal cavity :* with about 40 nearly equal, pointed teeth in an even row, anteriorly a row of fine punctiform denticles, pigmented area almost black with ragged posterior edge and prominent posterior median lobe. *Pharynx :* nearly 4·5 times as wide posteriorly as anteriorly, densely pigmented except for posterior part, which bears numerous fine teeth with two irregular rows of strong short spines along the posterior margin of the dorsal plate (other spines, anterior to these,

shown in the figure). *Wing :* length 2·4 mm. breadth 0·7 mm., alar index 1·1, delta : + 0·24 mm. *Spermatheca :* 0·024 mm. long and 0·02 mm. wide, finely striated transversely, but not distinctly segmented (figured from specimen expanded in hot lacto-phenol).

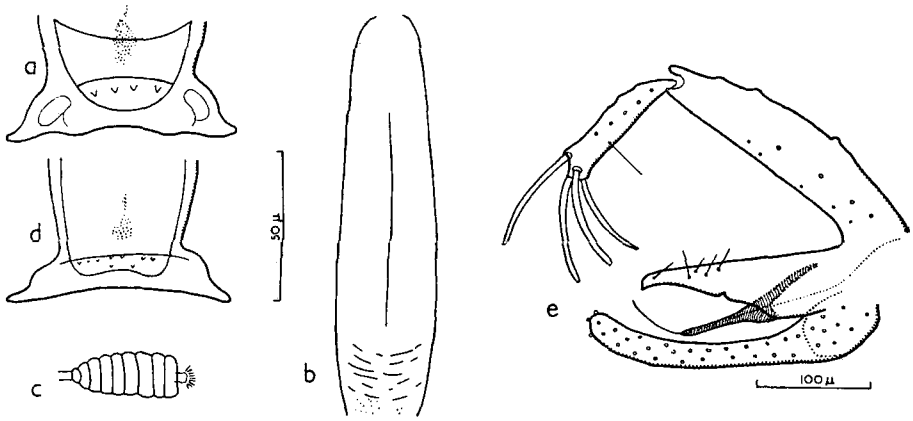
♂. Unknown.

Distribution : CAPE PROVINCE.

Phlebotomus (*Sintonius*) *christophersi* Sinton.

P. christophersi Sinton, 1927, *Indian J. med. Res.* **15** : 33.
P. christophersi Parrot, 1948, *Arch. Inst. Pasteur Algér.* **26** : 121.

Dr. L. Parrot has examined specimens from the A.-E. Sudan and considers that the examination of further, well-preserved, specimens will confirm the existence of the Indian *P. christophersi* in Africa. The above-mentioned specimens, which came from a remote area are provisionally regarded as *P.*



22

FIG. 22.—*P. christophersi*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. ♂ : *d*, buccal cavity ; *e*, terminalia. (*a* and *c–e* after Sinton, 1927 ; *b* from Mvolo specimen.)

christophersi and the description of this species given below has been compiled from Sinton's original description of seven females and five males from the Punjab, and one female (buccal teeth) from the Punjab, examined by Dr. Parrot.

♀. *Length :* 2·5–2·83 mm. *Colour :* the very dark eyes are in contrast to the lighter sides of the thorax. *Antenna :* formula 2/III–XV, ascoids stout and well developed, those on IV = 0·5 length of segment ; segment III (0·114–0·143 mm.) < IV + V. *Palp :* formula 1,2,4,3,5, relative lengths 1, 2·6, 4·9, 3·2, 7·5. *Buccal cavity :* with four or five widely separated and well developed teeth and two groups of lateral denticles in at least *one specimen ; pigmented* area small, carrot-shaped. *Wing :* 1·57–1·73 mm. long, 0·37–0·43 mm. broad, alar index 0·51–0·75, delta + 0·057 to + 0·085 mm. *Spermatheca :* with 8–9 segments.

♂. *Length :* 2·4–2·7 mm. *Antenna :* formula 1/III–XV, ascoids well developed, that on IV = 0·3 length of segment, segment III (0·14–0·157 mm.) < IV + V. *Palp :* formula 1,2,4,3,5, relative lengths 1, 2·8, 5, 3·7, 8·7. *Buccal cavity :* with two or three large teeth and some smaller ones anterior to them ; pigmented area carrot-shaped. *Wing :* 1·50–1·63 mm. long, 0·357–0·370 mm. broad, alar index 0·15–0·64, delta — 0·114 to +

0·028 mm. *Terminalia :* coxite (0·23–0·255 mm.), style (0·11–0·12 mm.) with four terminal spines and small ventral seta at 0·75 ; paramere (0·165–0·218 mm.) hooked and having a very distinct narrow fissure on its concave margin about one-third of its length from the apex ; penis sheath (0·055–0·057 mm.) sharply pointed ; lateral lobe 0·165–0·225 mm.

Variation : Dr. Parrot has pointed out that the males from the Sudan have strongly developed buccal teeth and resemble *P. christophersi* var. *calcaratus*, except in the absence of femoral spines.

Distribution : A.-E. Sudan (Mvolo).

Phlebotomus (*Sintonius*) *christophersi* var. *calcaratus* Parrot.

P. calcaratus Parrot, 1948, *Arch. Inst. Pasteur Algér.* **26** : 121.

This sandfly has been provisionally placed as a variety following a suggestion from Dr. Parrot. Type specimens in the British Museum (Natural History). The descriptions given below are after Parrot's original description of two females and one male from, Agordat, Kassala, and Jebel Moya.

♀. *Length :* 2·18–2·19 mm. *Antenna :* formula 2/III–XV, segment III (0·15 mm.) < IV + V, AIII/E = 0·9, ascoids on IV = 0·35 length of segment. *Palp :* formula

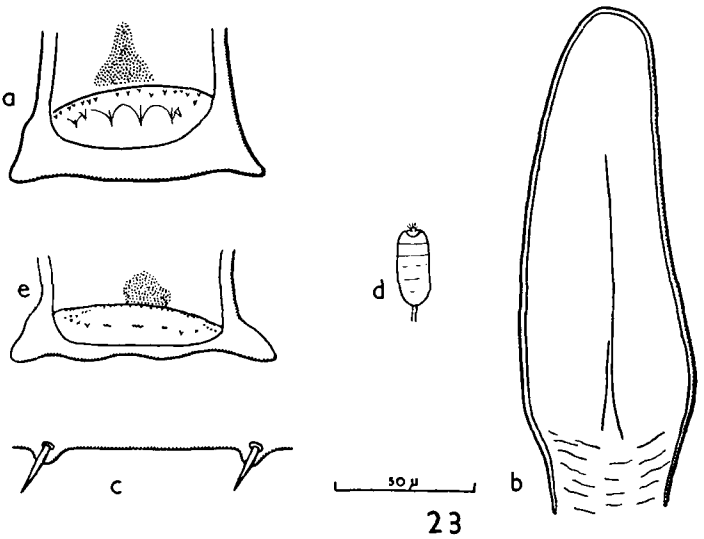


Fig. 23.—*P. christophersi* var. *calcaratus*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spines on femur ; *d*, spermatheca. ♂ : *e*, buccal cavity. (*a–c* and *e* after Parrot, 1948 ; *d* from Rashad specimen.)

1,2,4,3,5, relative lengths 1, 2, 4·9, 4·4, 9·5. *Epipharynx :* length 0·15 mm. *Buccal cavity :* with four widely separated pointed teeth, better developed than in *P. christophersi*, standing on a straight line, the two median ones a little stronger than the laterals (in one specimen two additional smaller teeth present, out of line with the others), anteriorly 12–16 pointed or punctiform denticles (more than in *P. christophersi*), irregularly arranged ; pigmented area an elongated triangle truncated anteriorly. *Pharynx :* less than twice as wide posteriorly as anteriorly, with some sinuous folds. *Wing :* 1·62 mm. long, 0·36 mm. broad, alar index 0·36–0·41, delta — 0·017 mm., pi = 0 to — 0·034 mm.

Legs : four short spines on the anterior and posterior femora. *Spermatheca :* annulated with segments.

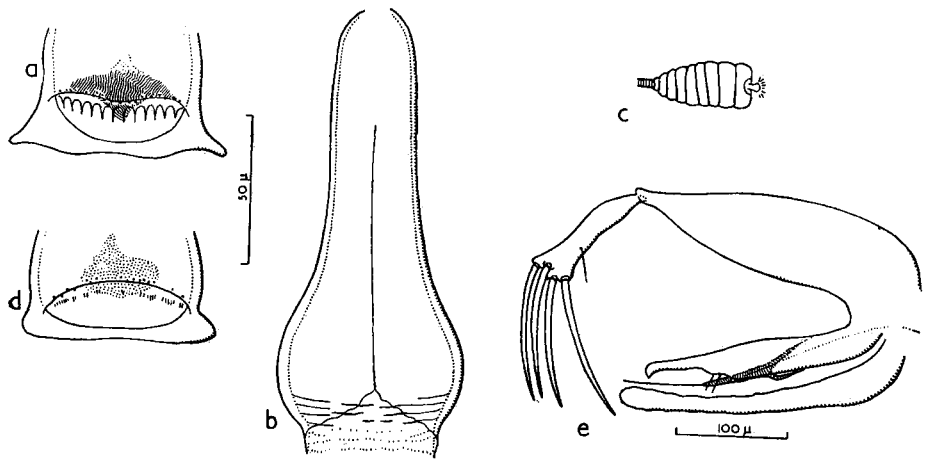
♂. *Length :* 2·16 mm. *Antenna :* formula 1/III–XV, segment III (0·135 mm.) < IV + V, AIII/E = 0·75, ascoid on IV = 0·33 length of segment. *Palp :* formula 1,2,4,3,5, relative lengths 1, 2·3, 4·6, 4·1, 7·7. *Epipharynx :* length 0·18 mm. *Buccal cavity :* with five widely separated teeth nearly in a straight line, the lateral ones short and pointed, the three inner ones wider and each composed of several denticles ; anteriorly many punctiform denticles in groups of 3 or 4 or more, other punctiform or pointed denticles at the sides ; pigmented area subtriangular and equilateral. *Pharynx :* a little less than twice as wide posteriorly as anteriorly, with numerous short, but well-marked spines. *Wing :* 1·5 mm. long, 0·34 mm. broad, alar index 0·56, delta + 0·017 mm. *Legs :* 4–5 short spines on anterior and 10 on posterior femora. *Terminalia :* coxite (0·255 mm.) a little less than twice as long as style (0·138 mm.) which bears two terminal and two subterminal spines and small ventral seta at 0·75 ; paramere (0·164 mm.) shorter than lateral lobe, hooked ; penis sheath (0·114 mm.) an elongated cone slightly turned up towards the point, which is blunt ; lateral lobe (0·225 mm.) unarmed.

Distribution : A.-E. SUDAN.

Phlebotomus (*Sintonius*) *clydei* Sinton.

P. clydei Sinton, 1928, *Indian J. med. Res.* **16** : 179.
P. vagus Parrot & Martin, 1939, *Arch. Inst. Pasteur Algér.* **17** : 143.
P. viator Parrot & Martin, 1939, *ibid.* **17** : 143.
P. clydei Lewis & Kirk, 1939, *Proc. R. ent. Soc. Lond.* (*B*) **8** : 155.
P. clydei Parrot & Martin, 1944, *Arch. Inst. Pasteur Algér.* **22** : 55.
P. clydei Parrot, Mornet & Cadenat, 1945, *ibid.* **23** : 232.

The descriptions given below are from the original descriptions of 11 females and 10 males from Waziristan, India, and from published descriptions of about 63 females and 45 males, certain measurements from smaller numbers. Type specimen is in the British Museum.



24

FIG. 24.—*P. clydei*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. ♂ : *d*, buccal cavity ; *e*, terminalia. (*a* and *b* from Wad Medani specimens ; *c* and *a* after Parrot and Martin, 1939 ; *d* after Parrot and Martin, 1944.)

♀. *Length:* 1·88–2·63 mm. *Antenna:* formula 2/III–XV, segment III (0·138–0·165 mm.) < IV + V, AIII/E = 0·62–0·75, ascoids on IV slightly less then 0·5 length of segment. *Palp:* formula 1,2,4,3,5, relative lengths 1, 2·4, 3·8, 2·9, 6·2. *Epipharynx:* length 0·214–0·228 mm. *Buccal cavity:* with 12–16 strong pointed teeth, the two median ones sometimes smaller than the others; about 18 anterior denticles in one or two rows, the anterior of which contains smaller and fewer denticles, sometimes very few; pigmented area pale brown, shaped like an irregular lozenge with its axis transverse and its lateral and posterior extremities rounded, with a pale forward prolongation. *Pharynx:* a little more than twice as wide posteriorly as anteriorly with a delicate armature, which is often difficult to see, composed of transverse ridges, the posterior of which bear minute spicules. *Wing:* 1·58–1·88 mm. long, 0·45–0·46 mm. broad, alar index 0·61–0·97, delta + 0·035 to + 0·085 mm. *Spermatheca:* with 8–10 segments, narrower towards the duct.

♂. *Length:* 1·9–2·8 mm. *Antenna:* formula 1/III–XV, segment III (0·153–0·185 mm.) < IV + V, AIII/E = 0·83–0·85, ascoid on IV = 0·4 length of segment. *Palp:* formula, 1,2,4,3,5, relative lengths 1, 2·8, 4·7, 3·6, 8·2. *Buccal cavity:* with small pointed teeth, usually in groups of 4–6, on an arc slightly concave posteriorly, anteriorly a row of six or more rather strong rounded denticles; pigmented area a pale brown slightly elongated ellipse. *Pharynx:* about 2·5 times as wide posteriorly as anteriorly, with a faint armature or none. *Wing:* 1·54–1·82 mm. long, 0·36–0·44 mm. broad, alar index 0·55–0·97, delta + 0·028 to + 0·114 mm. *Terminalia:* coxite (0·213–0·271 mm.) more than twice as long as style (0·10–0·12 mm.), which bears two terminal and two subterminal spines and small ventral seta at about 0·7; paramere (0·168–0·225 mm.) hooked, shorter than lateral lobe; penis sheath (0·045–0·072 mm.) a bluntly pointed elongated cone with the tip slightly turned up; lateral lobe 0·270 mm.

Distribution: A.-E. SUDAN, ABYSSINIA, DJIBUTI, SENEGAL, FRENCH NIGER, FRENCH SUDAN, ERITREA; also in MEDITERRANEAN BASIN, INDIA and MIDDLE ASIA.

Phlebotomus (*Sintonius*) *meilloni* Sinton.

P. meilloni Sinton, 1932, *Indian J. med. Res.* **20**: 565.

The description given below is after the original description of 4 females and seven males from the type locality Letsitelle (measurements from 4 females and 4 males). Type specimens are in the British Museum.

♀. *Length:* 2·81–3·1 mm. *Antenna:* formula 2/III–XV, segment III very long (0·29–0·31 mm.) > IV + V, ascoids short, that on IV = 0·25 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·6, 3·7, 4·6, 7·1. *Buccal cavity:* with about 16 large pointed teeth standing almost in a straight line; a well marked mushroom-shaped pigmented area. *Pharynx:* about twice as wide posteriorly as anteriorly, with groups of minute spines along small ridges, the posterior spines longer than the anterior ones. *Wing:* 2·143–2·300 mm. long, 0·643–0·685 mm. broad, alar index 1·66, delta + 0·357 to + 0·385 mm. *Spermatheca:* with eight segments.

♂. *Length:* 2·64–3·4 mm. *Antenna:* formula 1/III–XV, segment III very long (0·36–0·40 mm.) = IV + V. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·8, 3·9, 4·8, 8·5. *Buccal cavity:* about 10 teeth, wider than in the female and often serrated, pigmented area small but distinct, turnip-shaped. *Pharynx:* less dilated posteriorly and more lightly armed than in the female. *Wing:* 2·0–2·4 mm. long, 0·52–0·66 mm. broad, alar index 1·26–1·66, delta + 0·285 to + 0·38 mm. *Terminalia:* coxite (0·27–0·32 mm.) about 2·2 times as long as style, which bears four curved spatulate spines, two terminal and two subterminal and small ventral seta near the subterminal spines; paramere 0·21–0·255 mm.; penis sheath 0·174–0·210 mm., pointed; lateral lobe 0·24–0·28 mm.

Distribution: TRANSVAAL, SOUTH AFRICA (LETSITELLE).

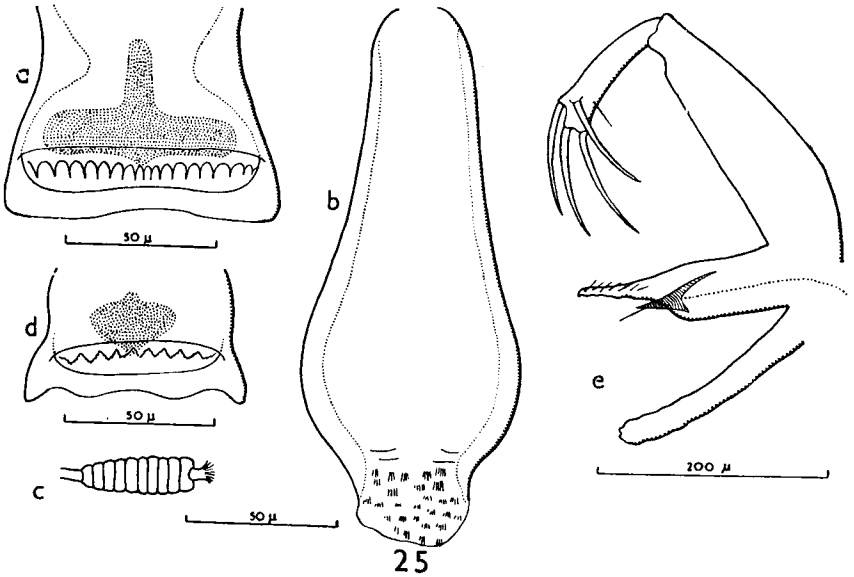


FIG. 25.—*P. meilloni*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca. ♂: *d*, buccal cavity; *e*, terminalia. (After Sinton, 1932.)

Phlebotomus (*Sintonius*) *meilloni* var. *suberectus* Sinton.

P. meilloni var. *suberectus* Sinton, 1932, *Indian J. med. Res.* **20** : 565.

Type locality Mombasa, Kenya, type specimens in the British Museum. This form may prove to be a species when the female is described. The description below is from two males, after Sinton.

♀. Unknown.

♂. *Length:* 3·2 mm. *Antenna:* formula 1/III–XV, segment III (0·34–0·36 mm.) > IV + V, ascoids relatively longer than in *P. meilloni*, that on IV = 0·2 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·3, 3·6, 4·9, 8·8. *Buccal cavity:* with about 22–25 teeth, much smaller than in *P. meilloni*, on an arc concave posteriorly. *Pharynx:* more dilated than in *P. meilloni* posteriorly. *Wing:* 2·26 mm. long and 0·67–0·68 mm. broad, relatively wider than in *P. meilloni*, alar index 1·86–2·1, delta + 0·400 to + 0·443 mm. *Terminalia:* coxite (0·30–0·32 mm.) more than twice as long as style (0·14–0·15 mm.), which bears small ventral seta distinctly proximal to the large spines and the two subterminal of these more proximal than in *P. meilloni*; paramere 0·246 mm., penis sheath 0·185–0·2 mm., lateral lobe 0·29–0·30 mm.

Distribution: KENYA (MOMBASA).

Phlebotomus (*Sintonius*) *subtilis* Parrot and Martin.

P. tiberiadis Parrot, 1936, *Arch. Inst. Pasteur Algér.* **15** : 44.
P. subtilis Parrot & Martin, 1939, *ibid.* **17** : 143.
P. subtilis Parrot & Martin, 1940, *ibid.* **18** : 300.
P. subtilis Parrot, 1948, *ibid.* **26** : 259.

Type locality Awash, Abyssinia; type specimens in the Institut Pasteur d'Algérie. The descriptions given below are after Parrot (1948) from the

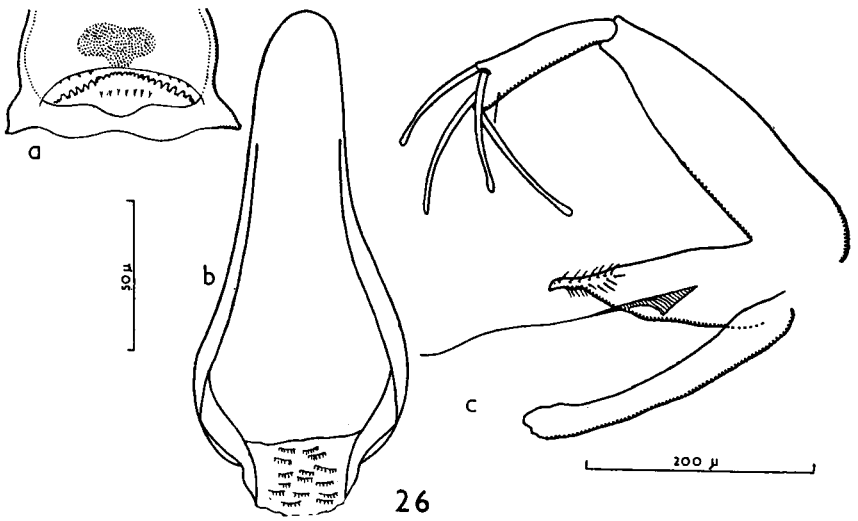


FIG. 26.—*P. meilloni* var. *suberectus*, ♂: *a*, buccal cavity; *b*, pharynx; *c*, terminalia. (After Sinton, 1932.)

published descriptions of 128 females and 463 males from Abyssinia, French Somaliland and the A.-E. Sudan.

♀. *Length:* 1·5–1·9 mm. *Antenna:* formula 2/III–XV, segment III (0·14–0·18 mm) < IV + V, AIII/E = 0·6–0·75, ascoids on IV = 0·4 length of segment. *Palp:* formula 1,2,4,3,5, relative lengths 1, 2·2, 4·5, 3, 7. *Epipharynx:* length 0·21 mm. *Buccal cavity:* with 18 broad pointed teeth arranged almost in a straight line, the lateral teeth being broader than the median ones and pointing obliquely posteriorly and medially; two rows of anterior punctiform teeth, the first of 14–16 being more prominent than the second, which has 10–12 teeth; pigmented area in the form of an ellipse lying transversely with

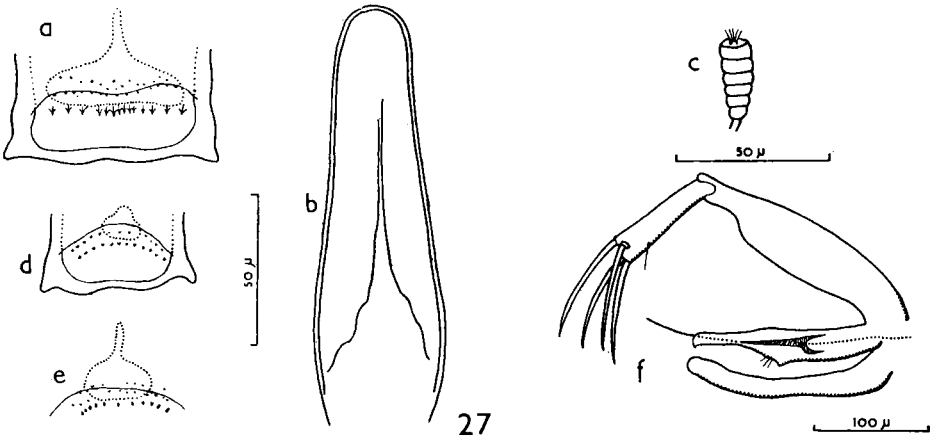


FIG. 27.—*P. subtilis*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca. ♂: *d* and *e*, buccal cavity in Gallabat and Massawa specimens; *f*, terminalia. (*a*, *d* and *e* after Parrot, 1948; *b* and *c* after Parrot, 1936; *f* after Parrot and Martin, 1939.)

an anterior prolongation. *Pharynx:* 1·5 times as wide posteriorly as anteriorly. *Wing:* 1·4–1·7 mm. long, 0·33–0·43 mm. broad, alar index 0·5–0·8, delta 0 to + 0·7 mm. *Spermatheca:* with 6–8 segments, decreasing in width towards the duct, which is narrow and opens separately into the vulva.

♂. *Length:* 1·4–1·8 mm. *Antenna:* formula 1/III–XV, segment III (0·12–0·16 mm.) < IV + V, AIII/E = 0·8–0·9, ascoid on IV = 0·4 length of segment. *Palp:* formula 1,2,4,3,5, relative lengths of segments 1, 2·5, 4·9, 3·7, 7·5. *Epipharynx:* length 0·15–0·19 mm. *Buccal cavity:* with 12–14 pointed teeth, the points directed obliquely towards the centre, and the median teeth smaller than the lateral ones; anteriorly a row of 6 median punctiform denticles with 6–8 larger denticles on each side; pigmented area small, faint, centrally situated. *Pharynx:* less than twice as wide posteriorly as anteriorly, armed with a few fine ridges. *Wing:* 1·2–1·4 mm. long, 0·24–0·30 mm. broad, alar index 0·35–0·57, delta − 0·2 to + 0·3 mm. *Terminalia:* coxite (0·16–0·2 mm.) more than twice as long as style, which bears four terminal spines and small non-deciduous seta at 0·75; paramere (0·136–0·165 mm.) hooked, as long as lateral lobe; penis sheath (0·06 mm.) an elongated and slender cone with blunt tip.

Distribution: ABYSSINIA, ERITREA, A.-E. SUDAN.

Phlebotomus (*Sintonius*) *thomsoni* Theodor.

P. thomsoni Theodor, 1938, *Bull. ent. Res.* **24**: 165.

The descriptions below are after the original descriptions of 3 females and one male from Port Johnson, Nyasaland, the type locality.

♀. *Length:* 2·7 mm. *Antenna:* segment III > IV + V, AIII/E = 1·7. *Palp:* formula 1,2,3,4,5, relative lengths 1, 3·2, 5, 6, 9·5. *Buccal cavity:* with a nearly straight

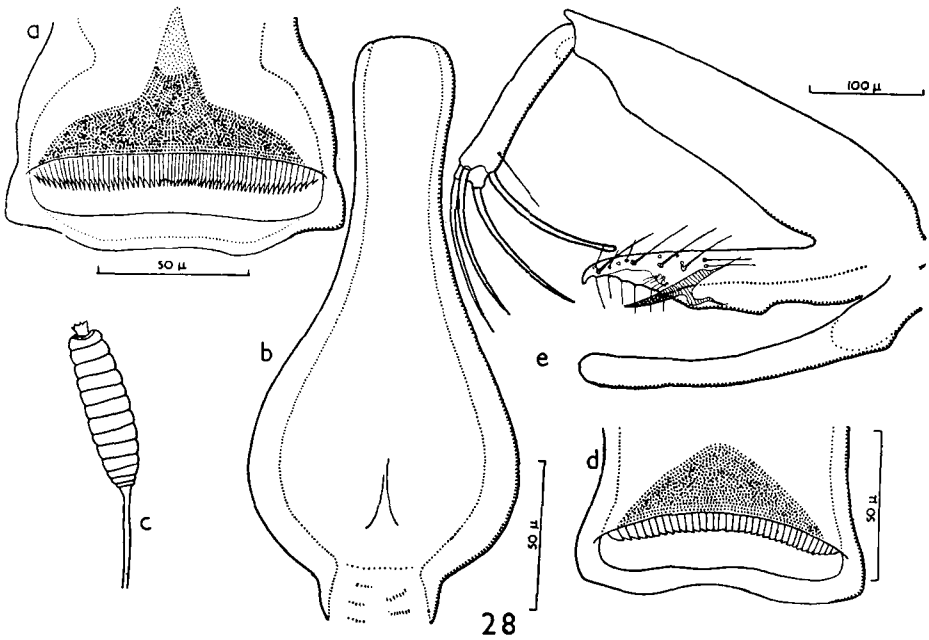


FIG. 28.—*P. thomsoni*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca. ♂: *d*, buccal cavity; *e*, terminalia. (After Theodor, 1938.)

row of 55–60 narrow parallel teeth with long points, the median teeth slightly narrower than the lateral ones, pigmented area rounded anteriorly and straight posteriorly with a long triangular forward process. *Pharynx:* lamp-glass shaped, with very thick walls, three times as wide posteriorly as anteriorly, with some rows of very small teeth. *Wing:* 2·4 mm. long, 0·65 mm. broad, alar index 1·7. *Spermatheca:* with 10–12 segments and a short terminal process.

♂. *Length:* 2·8 mm. *Antenna:* segment III = IV + V, AIII/E = 1·8. *Palp:* formula 1,2,3,4,5, relative lengths 1, 3·6, 5·3, 6·3, 9·5. *Buccal cavity:* with a slightly curved row of 35 short parallel teeth with blunt points; pigmented area broad and triangular. *Terminalia:* coxite more than twice as long as style, two of the four spines markedly subterminal and the small ventral seta arising near the subterminal spines; paramere hooked, with some long hairs; penis sheath straight and tapering to a sharp point.

Distribution: NYASALAND, A.-E. SUDAN.

Phlebotomus (*Sintonius*) *transvaalensis* Sinton.

P. transvaalensis Sinton, 1933, *Indian J. med. Res.* **20**: 879.

Type locality Tzaneen, Transvaal. This species is known by one female only, the description of which given below is after Sinton.

♀. *Length:* 3·75 mm. *Colour:* a very dark insect with dorsal abdominal tufts of erect golden yellow hairs. *Antenna:* formula 2/III–XV, ascoids slender, segment III

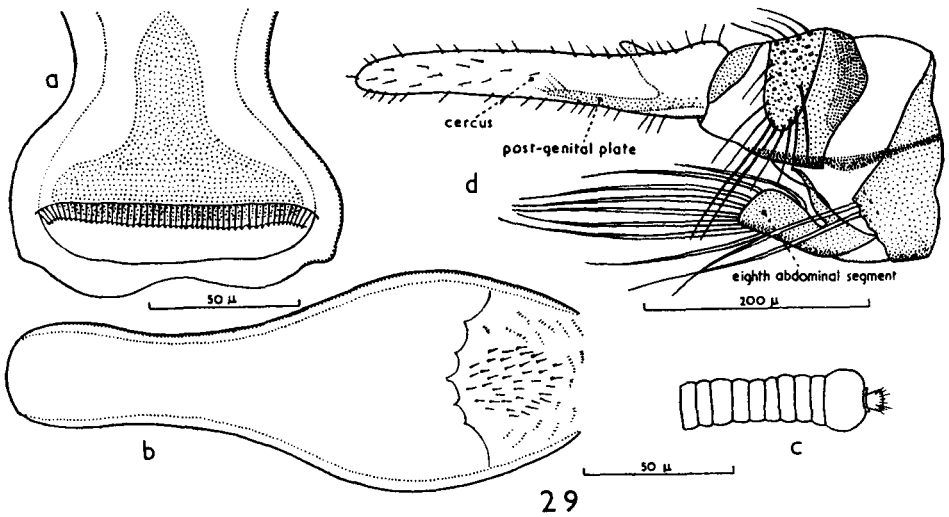


FIG. 29.—*P. transvaalensis*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca; *d*, terminalia. (After Sinton, 1933.)

(0·315 mm.) > IV + V. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·7, 3·1, 3·3, 7·5. *Buccal cavity:* with a nearly straight row of about 50 narrow teeth; pigmented area well developed. *Pharynx:* not very wide posteriorly, with some small median teeth and lateral rows of very minute teeth. *Wing:* 2·57 mm. long, 0·343 mm. broad. *Spermatheca:* with 10 segments. *Terminalia:* cerci very long and narrow; eighth sternite with some very stout long bristles on its posterior border; post genital plate a very elongated triangle, not rectangular as in other species.

This species is readily distinguished from all the other species by the characters of the female terminalia.

♂. Unknown.

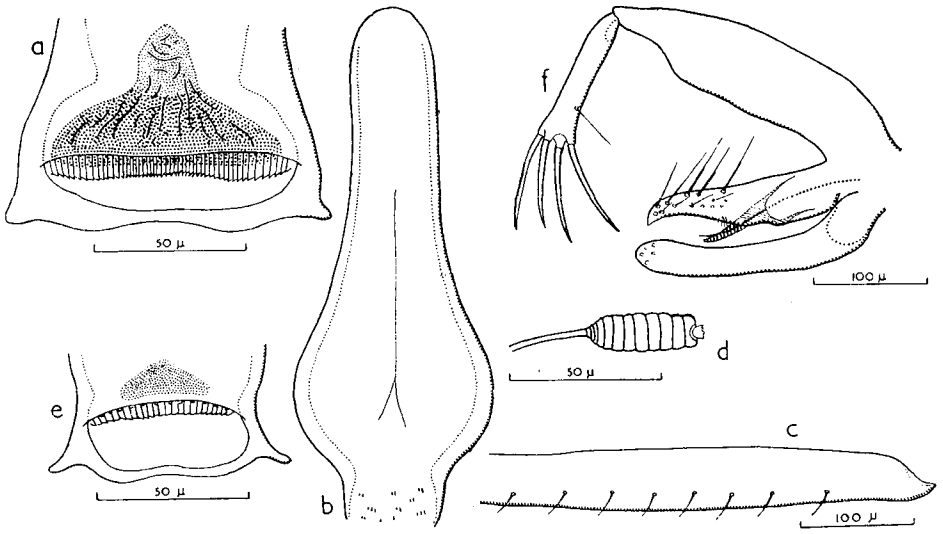
Distribution : TRANSVAAL.

Phlebotomus (*Sintonius*) *wansoni* Parrot.

P. wansoni Parrot, 1938, *Rev. Zool. Bot. afr.* **30** : 361.
P. matadiensis Theodor, 1938, *Bull. ent. Res.* **29** : 165.
P. mansoni Parrot, 1939, *Rev. Zool. Bot. afr.* **32** : 145.

Type specimens in the Museum of the Belgian Congo, Tervueren. The descriptions below are after Parrot's and Theodor's descriptions 4 males and four females, all from Matadi, Belgian Congo.

♀. *Length :* 1·7–2·4 mm. *Antenna :* formula 2/III–XV, segment III (0·21 mm.) >IV + V AIII/E = 1·14–1·17, ascoids on IV = 0·3 length of segment. *Palp :* formula 1,2,3,4,5, *Buccal cavity :* with a row, straight or slightly convex posteriorly, of 50–60



30

FIG. 30.—*P. wansoni*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spines on femur ; *d*, spermatheca. ♂ : *e*, buccal cavity ; *f*, terminalia. (*a*, *b* and *d–f* after Theodor, 1938 ; *c* after Parrot, 1938.)

monomorphic parallel teeth with short points, the median teeth slightly narrower than the lateral ones ; pigmented area dark brown, with corrugated lines converging anteriorly, reaching the sides of the buccal cavity and having a paler truncated forward process. *Pharynx :* lamp-glass shaped, 2·5 times as wide posteriorly as anteriorly, with some very minute teeth or none visible. *Wing :* 1·6–2 mm. long, 0·46–0·6 mm. broad, alar index 1·05–1·47, delta + 0·19 to + 0·21 mm. *Legs :* fore and hind femora with short spines on the posterior surface of the proximal half, five spines on the anterior and seven on the posterior. *Spermatheca :* with 10–12 segments.

♂. *Length :* 2–2·15 mm. *Antenna :* formula 1/III–XV, ascoids short, segment III (0·26 mm.) > IV + V, AIII/E = 1·36–1·45. *Palp :* formula 1,2,3,4,5, relative lengths 1, 4, 6, 7, 11. *Epipharynx :* length 0·18–0·19 mm. *Buccal cavity :* with a row, slightly

concave posteriorly, of 18–25 narrow, parallel teeth, the lateral teeth slightly narrower and shorter than the median ones; pigmented area dark brown and subtriangular. *Pharynx:* like that of the female but narrower, a little less than twice as wide posteriorly as anteriorly. *Wing:* length 1·82–1·86 mm., breadth 0·47 –0·51 mm., alar index 1·23 to 1·37, delta + 0·23 mm. *Terminalia:* coxite (0·22–0·23 mm.) about twice as long as style (0·10–0·11 mm.), which bears four terminal spines and small ventral seta at 0·7; paramere 0·18–0·19 mm., long hooked and tapering at the tip; penis sheath tapering to a sharp point and slightly curved upwards; lateral lobe (0·2–0·21 mm.) a little shorter than paramere.

Distribution: BELGIAN CONGO. UGANDA.

Phlebotomus (*Sergentomyia*) *renauxi* Parrot & Schwetz.

P. renauxi Parrot & Schwetz, 1937, *Rev. Zool. Bot. afr.* **29**: 221.

Type locality Malda, Belgian Congo, type specimens in the Museum of the Belgian Congo, Tervueren. The description below is after Parrot & Schwetz.

♀. *Length:* 1·5–1·6 mm., hind leg 1·8–2 mm. *Antenna:* formula 2/III–XV, segment III (0·09–0·10 mm.) < IV + V, AIII/E = 0·62–0·64, ascoids on IV = 0·3 length of segment. *Palp:* formula 1,2,(3,4),5, relative lengths 1, 2·5, 3·5, 3·5, 6·3. *Epipharynx:* length 0·14 mm. *Buccal cavity:* with about 60 small and monomorphic teeth on an arc slightly concave posteriorly; pigmented plate very dark, oval, not reaching the lateral borders of the buccal cavity and with no anterior process. *Pharynx:* about 1·5 times as wide posteriorly as anteriorly and armed in its posterior part, the lateral borders of which are almost parallel, with about 60 short pointed teeth. *Wing:* length 1·3–1·4 mm., width 0·31–0·35 mm., alar index 0·61–0·66, delta + 0·018 to + 0·05 mm. *Spermatheca:* simple, tubular, of *minutus* type.

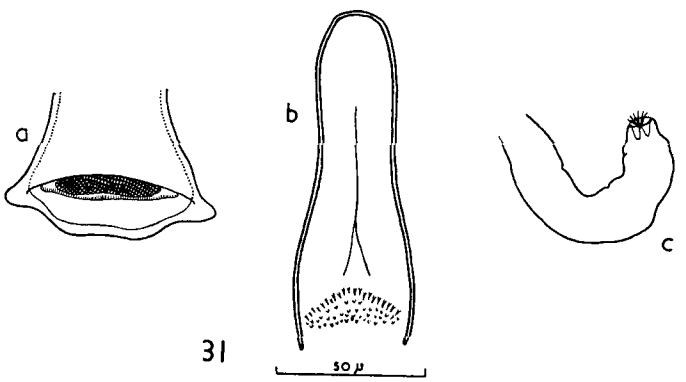


FIG. 31.—*P. renauxi*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca. (After Parrot and Schwetz, 1937.)

♂. Unknown.

Distribution: BELGIAN CONGO.

Phlebotomus (*Sergentomyia*) *antennatus* Newstead.

P. antennatus Newstead, 1912, *Bull. ent. Res.* **3**: 365.
P. antennatus Newstead, 1920, *ibid.* **11**: 305.
P. minutus var. *antennatus* Newstead & Sinton, 1921, *Ann. trop. med. Parasit.* **15**: 103
P. minutus var. *antennatus* Parrot, 1930, *Rev. Zool. Bot. afr.* **19**: 181.

(nec) *P. minutus* var. *antennatus* Theodor, 1933, *Bull. ent. Res.* **24** : 539.
P. antennatus Parrot, 1942, *Arch. Inst. Pasteur Algér.* **20** : 322.
P. antennatus Kirk & Lewis, 1949, *Ann. trop. Med. Parasit.* **43** : 333.

Type specimens, from Salaga, Gold Coast, are in the British Museum.

P. antennatus was originally described by Newstead (1912, 1920) as a distinct species, but later Newstead and Sinton (1921) thought the evidence then available was insufficient to separate it from *P. minutus* and placed it as a variety of that species. Sinton (1933) later found that the differences between both male and female forms of Indian specimens were so great that he considered that *P. antennatus* should again be raised to specific rank, although the identity of the Indian forms with Newstead's African species was uncertain. With Parrot's (1942, 1943) re-description of *P. minutus* Rondani it is evident that the various forms regarded as *P. antennatus* can no longer be considered varieties of *P. minutus* Rondani, and the form described by Parrot (1930)

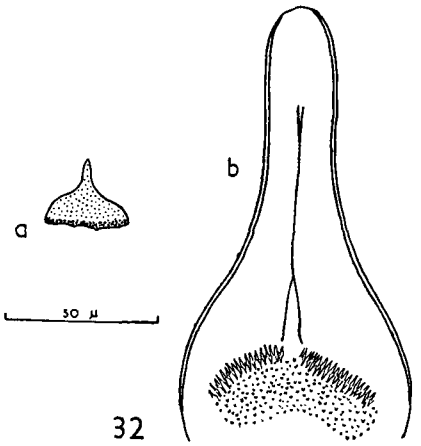


FIG. 32.—*P. antennatus*, ♀: *a*, pigmented area; *b*, pharynx. (After Parrot, 1930.)

from the Congo as *P. minutus* var. *antennatus* was regarded by that worker (1942) as *P. signatipennis*. In 1948 the writers were able to re-examine Newstead's African type specimens of *P. antennatus* and found that this form is closely related to *P. signatipennis*, *P. cinctus* and other forms given specific rank by Parrot (1943) when he found that they could no longer be regarded as varieties of *P. minutus*. In this work these and some allied forms are treated as varieties of *P. antennatus* Newstead. The subject is discussed more fully in the section on synonymy (page 407). The description of the female given below is Newstead's type series (holotype female and seven other female specimens).

♀. *Length:* 1·82 mm. *Antenna:* formula 2/III–XV, segment III (0·08 mm) < IV + V, AIII/E = 0·6, ascoids on IV = 0·5 length of segment. *Palp:* formula 1,2,(3,4),5, relative lengths 1, 3·2, 3·75, 3·75, 8·75. *Epipharynx:* length 0·14 mm. *Buccal cavity:* 26–28 pointed teeth on an arc concave posteriorly, the teeth being equal and monomorphic or a few of the median ones being slightly shorter than the others; pigmented plate helmet-shaped. *Pharynx:* about 2·5 times as broad posteriorly as anteriorly, cordiform,

but not extremely so, and bearing in its posterior part numerous strong spines like those of var. *signatipennis* and var. *cinctus*. *Wing:* length 1·22 mm., width 0·33 mm., alar index 0·43, delta + 0·03 mm. *Spermatheca:* simple, tubular, of *minutus* type.

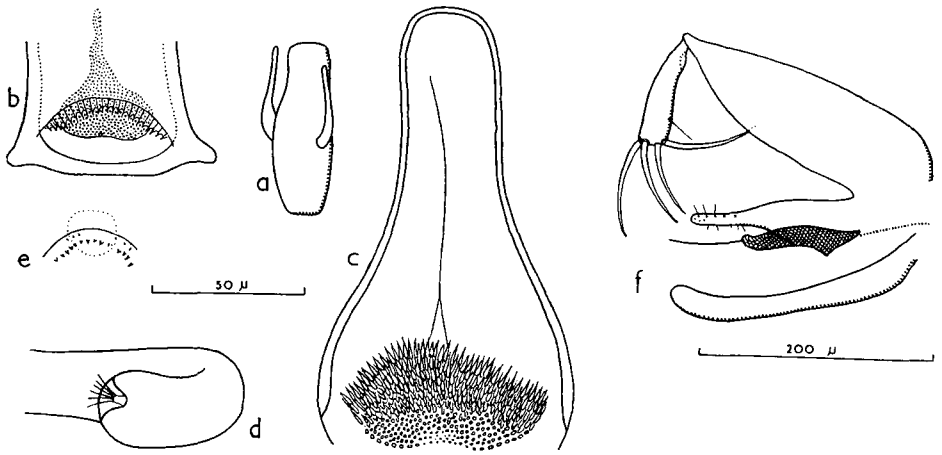
♂. The males of *P. antennatus* and its varieties are extremely difficult to differentiate and usually accurate determination can only be made by referring to the female specimens collected in association with them (Parrot, 1948). A specimen in the British Museum (Natural History) collected in Accra in June, 1919, and labelled by Newstead "*P. antennatus*, type ♂" agrees closely with the published descriptions of the males of var. *cinctus* and var. *signatipennis*, but we consider it unjustified to present a description of the male of *P. antennatus* as it is not known which, if any, of the males corresponds with Newstead's type female.

Distribution: Northern Ashanti, Gold Coast, A.-E. Sudan.

Phlebotomus (*Sergentomyia*) *antennatus* var. *signatipennis* Newstead.

P. signatipennis Newstead, 1920, *Bull. ent. Res.* **11** : 305.
P. minutus var. *signatipennis* Theodor, 1933, *ibid.* **24** : 537.
P. sanneri Gaillard & Nitzulescu, 1931, *Ann. Parasit. hum. comp.* **9** : 233.
P. signatipennis Parrot, 1942, *Arch. Inst. Pasteur Algér.* **20** : 322.
P. antennatus var. *signatipennis* Kirk & Lewis, 1949, *Ann. trop. Med. Parasit.* **43** : 333.

Type specimens from Gambago, Gold Coast, are in the British Museum. The synonyms given above are discussed in the section on synonymy. The



33

Fig. 33.—*P. antennatus* var. *signatipennis*, ♀: *a*, fourth antennal segment; *b*, buccal cavity; *c*, pharynx; *d*, spermatheca. ♂: *e*, buccal cavity; *f*, terminalia. (*a*, *b*, *c* and *e* after Parrot, 1948; *d* and *f* after Parrot, 1942.)

description below is largely after Parrot (1948) from specimens from the A.-E. Sudan (7 females and 33 males).

♀. *Length:* 1·7 mm., hind leg 2·0 mm. *Antenna:* formula 2/III–XV, segment III (0·08–0·1 mm). < IV + V. AIII/E = 0·6–0·75, ascoids on IV = 0·4 length of segment. *Palp:* formula 1,2,(3,4),5, relative lengths 1, 2·3, 3·7, 3·5, 7·3. *Epipharynx:* length 0·14–0·16 mm. *Buccal cavity:* with 22–26 sharp pointed teeth on an arc concave posteriorly; pigmented plate helmet-shaped. *Pharynx:* about 2·5 times as wide posteriorly as an-

teriorly and armed with numerous strong spines giving the appearance of a bilobed or heart-shaped brush. *Wing:* length 1·45–1·63 mm., width 0·31–0·36 mm., alar index 0·52–0·7, delta 0 to + 0·034 mm. *Spermactheca:* simple, tubular, of *minutus* type.

♂. *Length:* 1·6–1·9 mm., hind leg 1·8–2·14 mm. *Antenna:* formula 1/III–XV, segment III (0·09–0·11 mm.) < IV + V, AIII/E = 0·68–0·79, ascoid on IV = 0·4 length of segment. *Palp:* formula 1,2,4,3,5, relative lengths 1, 2·4, 3·7, 3·6, 7. *Epipharynx:* length 0·13–0·14 mm. *Buccal cavity:* with 14–20 short pointed teeth, more or less equal, on an arc concave posteriorly and 6–16 anterior small punctiform denticles; pigmented area irregularly round or oval, sometimes absent. *Pharynx:* about 2·5 times as wide posteriorly as anteriorly, armed with faint oblique transverse ridges bearing fine punctiform spines. *Wing:* Length 1·3–1·5 mm., width 0·22–0·3 mm., alar index 0·33–0·64, delta + 0·017 to − 0·10. *Terminalia:* coxite (0·2–0·24 mm.) about 2·5 times as long as style (0·09–0·1 mm.), which bears four terminal spines and small ventral seta at 0·75; paramere 0·15–0·18 mm., penis sheath 0·08–0·10 mm., lateral lobe 0·17–0·23 mm.

In the female the number of buccal teeth in var. *signatipennis* is similar to that in var. *dubius*, but the two forms are readily separated by the marked inequality of these teeth, the ragged posterior margin of the pigmented plate and the very wide pharynx of var. *dubius*.

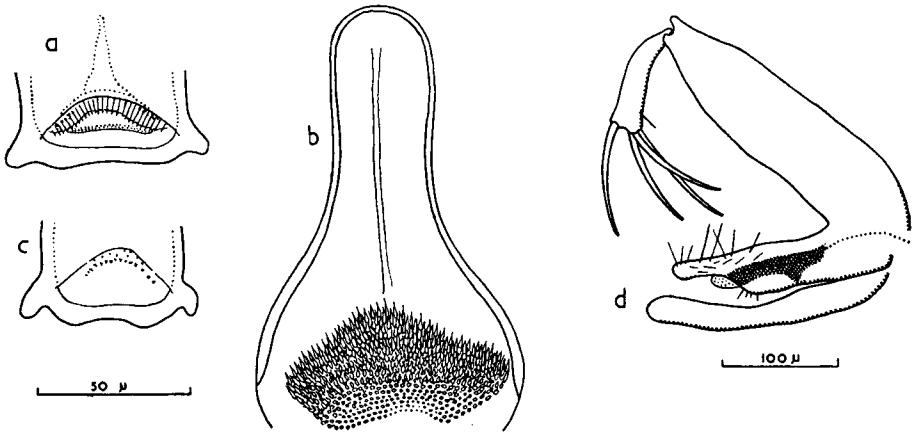
Distribution: Gold Coast, Ivory Coast, Dahomey, French Sudan, Senegal, Gabon, Belgian Congo, A.-E. Sudan, Abyssinia, Eritrea.

Phlebotomus (*Sergentomyia*) *antennatus* var. *occidentalis* Theodor.

P. minutus var. *occidentalis* Theodor, 1933, *Bull. ent. Res.* **24**: 537.
P. occidentalis Parrot, 1942, *Arch. Inst. Pasteur Algér.* **20**: 322.
P. antennatus var. *occidentalis* Kirk & Lewis, 1949, *Ann. trop. Med. Parasit.* **43**: 333.

Co-type specimens (2 ♀) are in the British Museum. The description of the female given below is mainly after Parrot.

♀. *Length:* 1·62–2·1 mm., hind leg 2·1–2·23 mm. *Antenna:* formula 2/III–XV, segment III (0·084–0·1 mm.) < IV + V, AIII/E = 0·58–0·68, ascoids on IV = 0·5 length of segment. *Palp:* formula 1,2,(4,3),5, relative lengths 1, 2·3, 3·5, 3·45, 6. *Epipharynx:* length 0·13–0·14 mm. *Buccal cavity:* with 26–32 narrow, straight pointed teeth on an



34

Fig. 34.—*P. antennatus* var. *occidentalis*, ♀: *a*, buccal cavity; *b*, pharynx. ♂: *c*, buccal cavity; *d*, terminalia. (After Parrot, 1948.)

arc concave posteriorly and sometimes small anterior punctiform denticles at the lateral borders; pigmented plate helmet-shaped. *Pharynx:* cordiform, resembling that of *P. antennatus* var. *signatipennis*. *Wing:* length 1·46–1·6 mm., width 0·31–0·38 mm., alar index 0·4–0·78, delta — 0·034 to + 0·051 mm. *Spermatheca:* tubular, of *minutus* type.

♂. As in *P. antennatus* var. *signatipennis*.

This variety differs from the other varieties of *P. antennatus* in the buccal teeth (24–32) which are very narrow, equal and on an arc less strongly concave than in the others.

Distribution: Gold Coast, Nigeria, A.-E. Sudan.

Phlebotomus (*Sergentomyia*) *antennatus* var. *cinctus* Parrot & Martin.

P. cinctus Parrot & Martin, 1944, *Arch. Inst. Pasteur Algér.* **22** : 55.
P. cinctus Parrot, 1948, *ibid.* **26** : 259.
P. antennatus var. *cinctus* Kirk & Lewis, 1949, *Ann. trop. Med. Parasit.* **43** : 333.

Type locality Djibouti, French Somaliland; type specimens in the Institut Pasteur d'Algérie. The description given below is mainly after Parrot (1948), from 53 males and 25 females.

♀. *Length:* 1·42–1·7 mm., hind leg 1·75–2 mm. *Antenna:* formula 2/III–XV, segment III (0·07–0·93 mm.) < IV + V, AIII/E = 0·47–0·65, ascoids on IV = 0·4 length

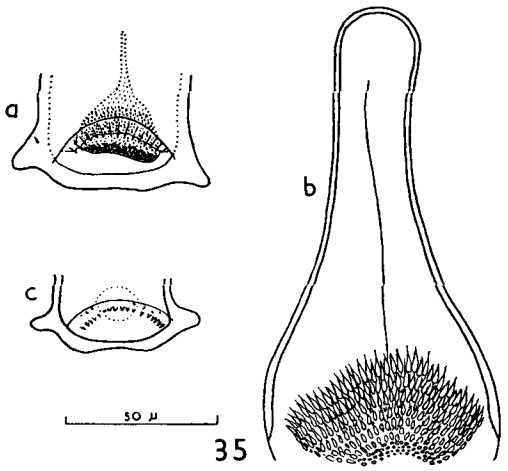


Fig. 35.—*P. antennatus* var. *cinctus*, ♀: *a*, buccal cavity; *b*, pharynx. ♂: *c*, buccal cavity. (After Parrot, 1948.)

of segment. *Palp:* formula 1,2,4,3,5, relative lengths 1, 2·3, 3·7, 3·4, 7·4. *Epipharynx:* length 0·14–0·17 mm. *Buccal cavity:* with 14–20 teeth and on each side a group of 5–8 anterior punctiform denticles; pigmented area helmet-shaped. *Pharynx:* about three times as wide posteriorly as anteriorly, cordiform, and armed with strong spines. *Wing:* length 1·3–1·5 mm., width 0·24–0·34 mm., alar index 0·42–0·83, delta — 0·05 to + 0·034 mm. *Spermatheca:* tubular of *minutus* type.

♂. As in *P. antennatus* var. *signatipennis*.

The female of var. *cinctus* differs from the other varieties of *P. antennatus* in the smaller number of buccal teeth (16–20) and the pharynx, less cordiform in shape, with fewer though stouter spines.

Distribution: French Somaliland, A.-E. Sudan, Uganda.

Phlebotomus (*Sergentomyia*) *antennatus* var. *dubius* Parrot, Mornet & Cadenat.

P. minutus var. *antennatus* Theodor, 1933, *Bull. ent. Res.* **24** : 539.
P. dubius Parrot, Mornet & Cadenat, 1945, *Arch. Inst. Pasteur Algér.* **23** : 232.
P. antennatus var. *dubius* Kirk & Lewis, 1949, *Ann. trop. Med. Parasit.* **43** : 333.

Type locality Senegal. The descriptions given here are after Parrot, Mornet and Cadenat. Type specimens in Institut Pasteur d'Algérie.

♀. *Length :* 1·9–2·12 mm., hind leg 2·1–2·46 mm. *Antenna :* formula 2/III–XV, segment III (0·1–0·11 mm.) < IV + V, AIII/E = 0·6–0·7, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,2,(3,4),5, relative lengths 1, 2·6, 4·2, 4·2, 8·7. *Epipharynx :* length 0·16–0·18 mm. *Buccal cavity :* with 24–28 teeth on an arc concave posteriorly, the six median ones and the 2–3 extreme lateral ones on each side being smaller than the inter-

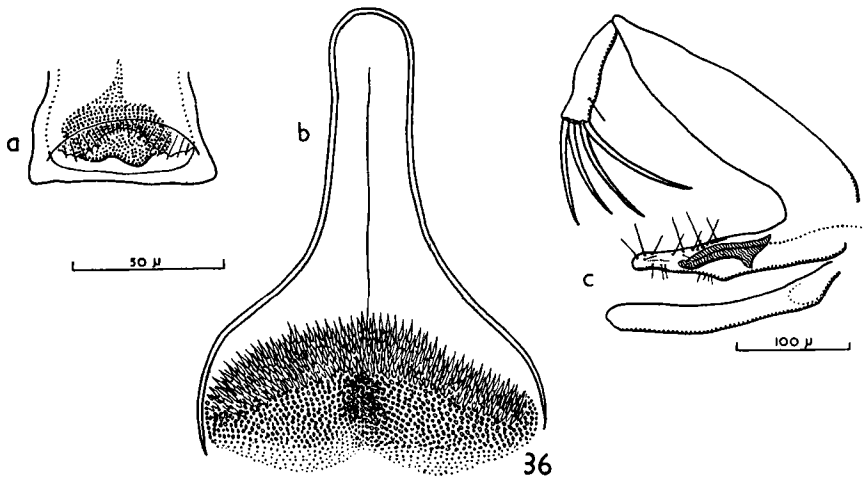


FIG. 36.—*P. antennatus* var. *dubius*, ♀ : *a*, buccal cavity ; *b*, pharynx. ♂ : *c*, terminalia. (After Parrot, Mornet and Cadenat, 1945.)

vening ones, and with a group of 6–8 small anterior punctiform denticles on both sides ; pigmented area helmet-shaped, with irregular posterior margin. *Pharynx :* about four times as wide posteriorly as anteriorly, markedly cordiform, with a prominent armature of many long spines. *Wing :* length 1·5–1·66 mm., width 0·34–0·4 mm., alar index 0·55–0·77, delta + 0·03 to + 0·08 mm. *Spermatheca :* simple, of *minutus* type.

♂. *Length :* 1·8–2·1 mm., hind leg 2–2·15 mm. *Antenna :* formula 1/III–XV, segment III (0·11–0·12 mm.) < IV + V, AIII/E = 0·72–0·82, ascoid on IV = 0·35 length of segment. *Palp :* formula 1,2,(3,4),5, relative lengths 1, 2·6, 4·1, 4·2, 8·6. *Epipharynx :* length 0·14–0·16 mm. *Buccal cavity :* with 14–16 poorly developed irregular teeth on an arc concave posteriorly, the 3–4 median teeth being smaller than the lateral ones, and with a row of 8–10 anterior punctiform denticles ; pigmented area irregular, sometimes absent. *Pharynx :* about twice as wide posteriorly as anteriorly, bearing some transverse ridges with fine short spines. *Terminalia :* coxite (0·24–0·27 mm.) 2·5 times as long as style, which bears four terminal spines and small non-deciduous seta at 0·75 ; paramere (0·17–0·19 mm.) blunt, penis sheath (0·08–0·09 mm.) finger-shaped, lateral lobe (0·19–0·22 mm.) longer than paramere.

The female of var. *dubius* differs from the other varieties of *P. antennatus* in the very wide cordiform pharynx, the morphology of the buccal cavity with

24–28 teeth, the median ones markedly smaller than the others, and the pigmented area with ragged posterior margin.

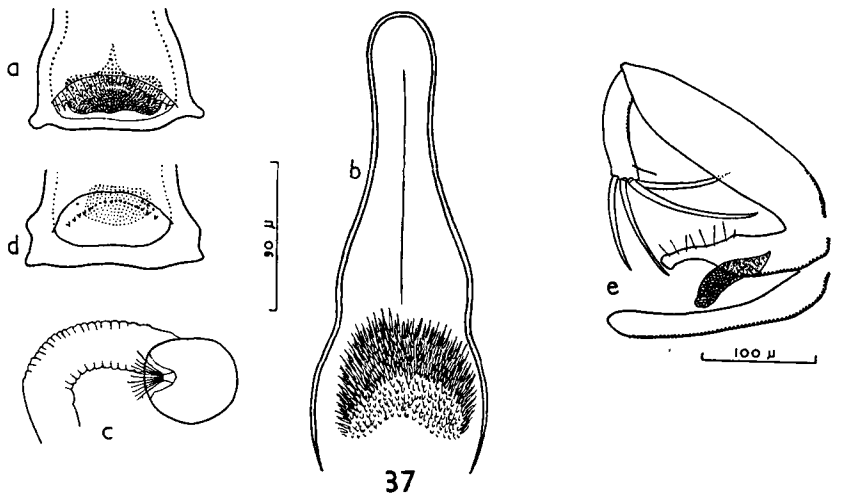
Distribution: Gold Coast, Senegal, French Sudan, French Guinea, Ivory Coast.

Phlebotomus (*Sergentomyia*) *bedfordi* Newstead.

P. bedfordi Newstead, 1914, *Bull. ent. Res.* **5** : 191.
P. bedfordi Parrot, 1921, *Arch. Inst. Pasteur Afr. N.* **1** : 269.
P. congolensis var. *distinctus* Theodor, 1933, *Bull. ent. Res.* **24** : 542.
P. bedfordi Kirk & Lewis, 1949, *Ann. trop. Med. Parasit.* **43** : 333.

Type locality Onderstepoort, Transvaal; type specimen in the British Museum. The description of the female given below is from Newstead's type specimen, that of the male from Sudan specimens determined as *P. congolensis* var. *distinctus*, partly after Parrot (1948).

♀. *Length:* 2·54 mm. *Antenna:* formula 2/III–XV, segment III (0·16 mm.) < IV+V, AIII/E = 0·76, ascoids on IV = 0·5 length of segment. *Palp:* formula 1,2,3,(4,5),



37

Fig. 37.—*P. bedfordi*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca. ♂: *d*, buccal cavity; *e*, terminalia. (*a*, *b*, *c* and *e* from Sudan specimens; *d* after Parrot, 1948.)

relative lengths 1, 3·75, 4·75, 6·25, 6·25. *Buccal cavity:* with about 22 pointed teeth on an arc concave posteriorly, the 7–8 median teeth being smaller than the lateral ones; pigmented area with slightly irregular posterior margin. *Pharynx:* more than twice as wide posteriorly as anteriorly, constricted in its broad posterior portion, which is armed with numerous strong spines, the anterior margin of the armed area being convex anteriorly. *Wing:* length 1·91 mm., width 0·53 mm., alar index 0·8, delta + 0·05 mm. *Spermatheca:* not visible, hence presumably thin-walled and tubular.

♂. *Length:* 1·8–2·5 mm. *Antenna:* formula 1/III–XV, segment III (0·1–0·15 mm.) < IV + V, AIII/E = 0·7–0·94, ascoid on IV = 0·3 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·7, 4·3, 4·8, 9·8. *Epipharynx:* length 0·15–0·17 mm. *Buccal cavity:* with about 20 teeth on an arc concave posteriorly, the median 6–8 being shorter and narrower than the lateral ones, and an irregular and variable row of anterior punctiform denticles; pigmented area irregularly oval with small anterior prolongation.

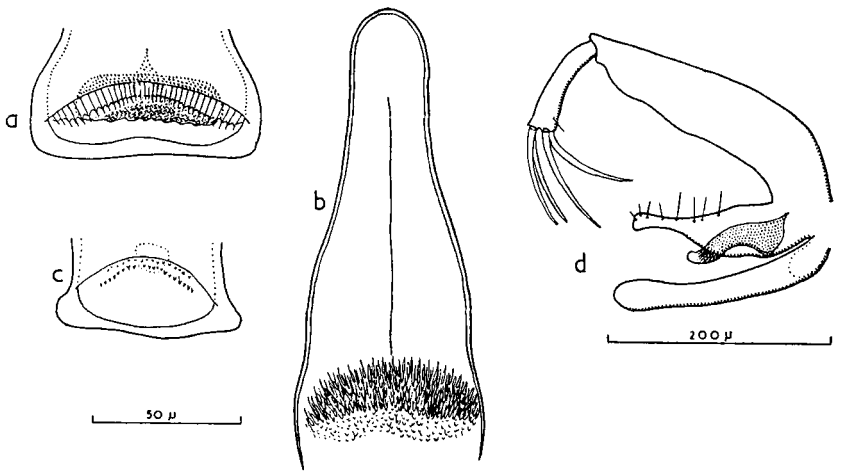
Pharynx : about 1·5 times as wide posteriorly as anteriorly, armed with pointed teeth and, more posteriorly, transverse ridges. *Wing :* length 1·5–1·6 mm., width 0·32–0·4 mm., alar index 0·35–0·7, delta − 0·05 to + 0·07 mm. *Terminalia :* coxite (0·22–0·28 mm.) 2·5 times as long as style (0·1–0·11 mm.) which bears four spines and small non-deciduous seta at 0·8 ; paramere (0·16–0·20 mm.) with blunt tip, penis sheath (0·09 mm.) finger-shaped, strongly curved, with a subapical dorsal indentation, so that the distal extremity appears upturned as a sort of terminal lobe ; lateral lobe 0·19–0·25 mm.

Distribution : TRANSVAAL, A.-E. SUDAN, GOLD COAST, NIGERIA, SENEGAL, FRENCH GUINEA, DAHOMEY, KENYA, UGANDA.

Phlebotomus (*Sergentomyia*) *bedfordi* var. *congolensis* Bequaert & Walravens.

P. africanus var. *congolensis* Bequaert & Walravens, 1930, *Rev. Zool. Bot. afr.* **19** : 38.
P. nairobiensis Theodor, 1931, *Bull. ent. Res.* **22** : 472.
P. congolensis Parrot, 1933, *Rev. Zool. Bot. afr.* **23** : 239.
P. congolensis Theodor, 1933, *Bull. ent. Res.* **24** : 537.

Type locality Katanga, Belgian Congo. The description below is largely after Bequaert and Walravens except as regards the buccal cavity of the female, about which there is some discrepancy between the text and the illustration.



38

FIG. 38.—*P. bedfordi* var. *congolensis*, ♀ : *a*, buccal cavity ; *b*, pharynx. ♂ : *c*, buccal cavity ; *d*, terminalia. (*a* and *b* from Sudan specimens ; *c* after Parrot, 1948 ; *d* after Theodor, 1931.)

♀. *Length :* 2–2·2 mm. *Antenna :* formula 2/III–XV, segment III (0·15 mm.) < IV + V, AIII/E = 0·8–0·9, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·1, 2·7, 3·4, 7·2. *Epipharynx :* length 0·17 mm. *Buccal cavity :* with 34–40 teeth on an arc concave posteriorly, the median 20 teeth being slightly smaller than the lateral ones ; pigmented area roughly oval with ragged posterior margin and small anterior prolongation. *Pharynx :* 3–4 times as wide posteriorly as anteriorly, more heavily armed than in *P. bedfordi*, with less marked constriction in its posterior part. *Wing :* length 1·4–2 mm., width 0·35–0·4 mm., alar index 0·45–0·8, delta + 0·05 to − 0·03 mm. *Spermatheca :* tubular, of *minutus* type.

♂. *Length:* 2·0–2·3 mm. *Antenna:* formula 1/III–XV, segment III (0·15 mm.) < IV + V, AIII/E = I, ascoid on IV = 0·34 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·1, 3·3, 3·9, 7·5. *Epipharynx:* length 0·15 mm. *Buccal cavity:* with 25–30 fine pointed teeth on an arc concave posteriorly, median teeth slightly smaller than lateral ones; pigmented plate small, oval, often absent. *Pharynx:* with some fine point-like teeth and transverse folds. *Terminalia:* coxite (0·5 mm.) more than 2·5 times as long as style (0·17 mm.), which bears four terminal spines and small ventral seta at 0·8; paramere 0·33 mm., penis sheath (0·17 mm.) finger-shaped, curved, with a small up-turned terminal lobe; lateral lobe 0·37 mm.

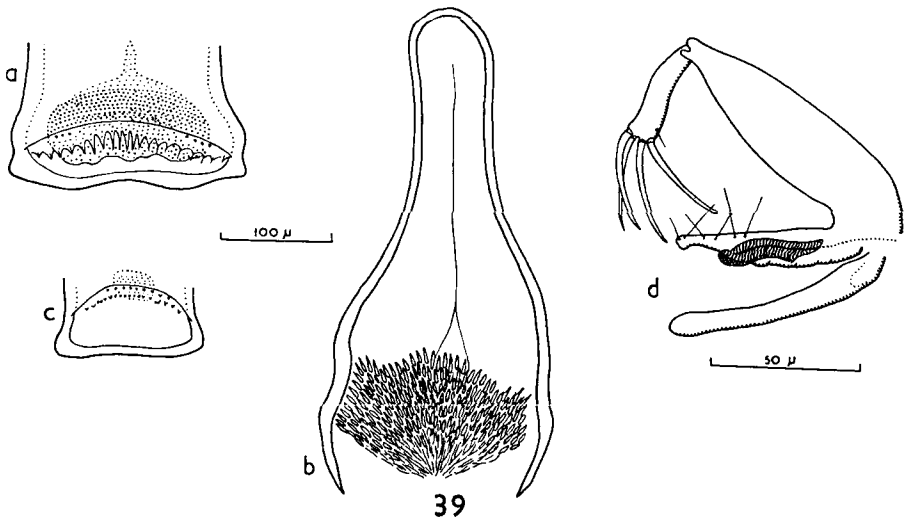
This variety differs from *P. bedfordi* in the greater number and more uniform size of the buccal teeth, wider and more heavily armed pharynx in the female; in the male AIII is as long as or longer than the epipharynx whereas in *P. bedfordi* it is constantly shorter.

Distribution: Abyssinia, A.-E. Sudan, East Africa, Belgian Congo, Southern Rhodesia, Transvaal, Uganda.

Phlebotomus (*Sergentomyia*) *bedfordi* var. *firmatus* Parrot & Malbrant.

P. congolensis var. *firmatus* Parrot & Malbrant, 1945, *Arch. Inst. Pasteur Algér.* **23**: 121.
P. bedfordi var. *firmatus* Kirk & Lewis, 1949, *Ann. trop. Med. Parasit.* **43**: 333.

Type specimens in the Institut Pasteur d'Algérie. The descriptions are after Parrot and Malbrant, from 16 females and 12 males from Brazzaville, Makawa and Ouessa, Middle Congo.



39

Fig. 39.—*P. bedfordi* var. *firmatus*, ♀: *a*, buccal cavity; *b*, pharynx. ♂: *c*, buccal cavity; *d*, terminalia. (After Parrot and Malbrant, 1945.)

♀. *Length:* 1·84–2·15 mm., hind leg 2·3–2·5 mm. *Antenna:* formula 2/III–XV, segment III (0·13–0·14 mm.) < IV + V, AIII/E = 0·8–0·9, ascoids on IV = 0·7 length of segment. *Palp:* formula 1,2,3,4,5. *Epipharynx:* length 0·16–0·17 mm. *Buccal cavity:* with 16–20 pointed teeth, the 4–6 median teeth being straighter and the extreme lateral ones shorter, than the intermediate ones; pigmented plate with irregular posterior margin and faint anterior prolongation. *Pharynx:* about three times as wide posteriorly as anteriorly, with a constriction in its wide posterior part, which bears numerous strong

spines terminating in fine slender prolongations, anterior margin of armed area strongly convex anteriorly. *Wing:* length 1·53–1·63 mm., width 0·37–0·43 mm., alar index 0·65–0·94, delta + 0·1 to + 0·14 mm. *Spermathaca:* tubular, of *minutus* type.

♂. *Length:* 1·9–2·0 mm., hind leg 2·2–2·4 mm. *Antenna:* formula 1/III–XV, segment III (0·14–0·17 mm.) < IV + V, AIII/E = 1–1·2, ascoid on IV = 0·5 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·9, 4·4, 6·1, 9·7. *Epipharynx:* length 0·14–0·16 mm. *Buccal cavity:* 14–18 pointed and irregular teeth on an arc slightly concave posteriorly, the 6–8 median ones slightly smaller than the lateral ones; a variable row of small anterior punctiform denticles; pigmented area irregularly oval, sometimes absent. *Pharynx:* about twice as wide posteriorly as anteriorly, armed with some fine ridges bearing small spines. *Wing:* length 1·5–1·6 mm., width 0·3–0·4 mm., alar index 0·38–0·75, delta – 0·03 to + 0·08 mm. *Terminalia:* coxite (0·2–0·24 mm.) about 2·4 times as long as style, which bears two terminal and two subterminal spines with small ventral seta at 0·9; paramere 0·15–0·17 mm. penis sheath (0·08–0·09 mm.) blunt, finger-shaped and curved, lateral lobe 0·17–0·20 mm.

This variety is distinguished by the relatively long ascoids in both sexes and the smaller number of buccal teeth in the female; in the male the number of buccal teeth is less than in var. *congolensis* whereas AIII is = or > IV + V.

Distribution: FRENCH CONGO.

Phelbotomus (*Sergentomyia*) *bedfordi* var. *medius* Kirk & Lewis.

P. congolensis var. *medius* Kirk & Lewis, 1950, *Proc. R. ent. Soc. Lond.* (*B*) **19** : 11.
P. bedfordi var. *medius* Kirk & Lewis, 1949, *Ann. trop. Med. Parasit.* **43** : 333.

Type specimens in the British Museum. The description below is based on 9 males and 12 females from Bwamba, Uganda, after Kirk and Lewis.

♀. *Length:* 2·0–2·4 mm. *Antenna:* formula 2/III–XV, segment III (0·12–0·14 mm.) < IV + V, AIII/E = 0·73–0·87, ascoids on IV = 0·6 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·3, 3·4, 5, 8·8. *Epipharynx:* length 0·13–0·15 mm. *Buccal cavity:* 30–35 pointed teeth on an arc concave posteriorly, the median teeth being shorter than the lateral ones which incline slightly inwards towards the mid-line; pigmented area helmet-shaped. *Pharynx:* about twice as wide posteriorly as anteriorly with a constriction

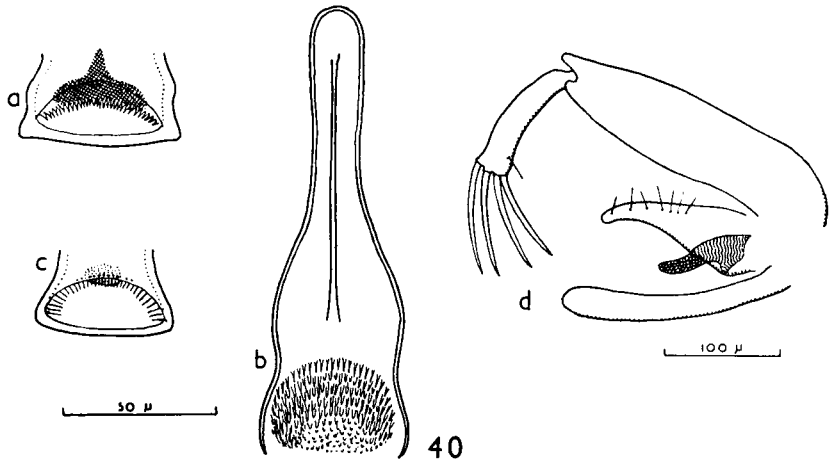


FIG. 40.—*P. bedfordi* var. *medius*, ♀: *a*, buccal cavity; *b*, pharynx. ♂: *c*, buccal cavity: *d*, terminalia. (After Kirk and Lewis, 1950.)

in its expanded part which bears numerous well-developed pointed spines. *Wing:* length 1·45–1·6 mm., width 0·38–0·42 mm., alar index 0·84–1, delta + 0·1 to + 0·12 mm. *Spermatheca:* simple, tubular, of *minutus* type.

♂. *Length:* 2·0–2·35 mm. *Antenna:* formula 1/III–XV, segment III (0·13–0·15 mm.) < IV + V, AIII/E = 0·8–1, ascoid on IV = 0·3 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·7, 3·5, 4·3, 8·6. *Epipharuynx:* length 0·13–0·18 mm. *Buccal cavity:* with about 35 pointed teeth on an arc concave posteriorly, the median teeth shorter and straighter than the lateral ones; anterior to this a row of ill-defined denticles; pigmented area small, irregular, sometimes absent. *Pharynx:* about 1·5 times as wide posteriorly as anteriorly, armed with irregular rows of small punctiform teeth. *Wing:* length 1·35 mm., width 0·3 mm., alar index 0·8, delta + 0·05 mm. *Terminalia:* coxite (0·2–0·27 mm.) more than twice as long as style, which bears four terminal spines and small ventral seta at 0·8; paramere (0·14–0·20 mm.) with blunt tip; penis finger-shaped, strongly curved with blunt extremity; lateral lobe 0·17–0·23 mm.

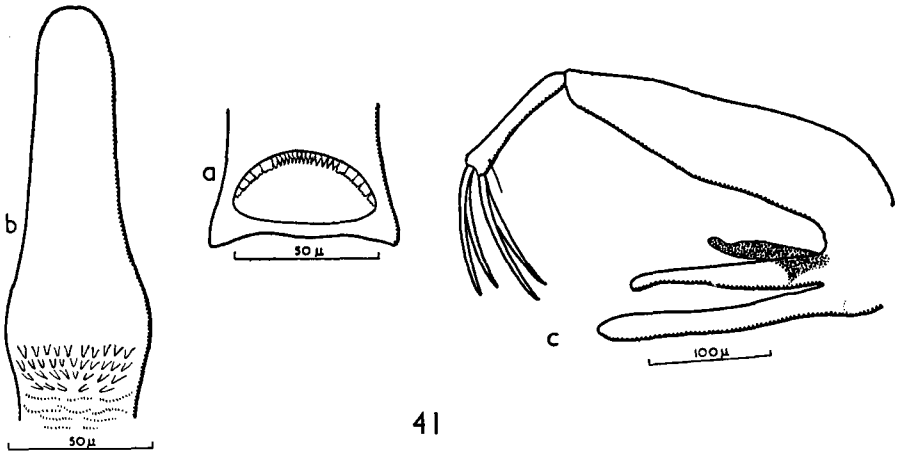
This variety differs from var. *firmatus* in the short ascoids in both sexes. The pharynx in the female is much less heavily armed than in var. *congolensis*, and rather resembles *P. bedfordi*, but the buccal cavity is quite unlike that of *P. bedfordi*.

Distribution: UGANDA.

Phlebotomus (*Sergentomyia*) *cowlandi* Lewis & Kirk.

P. cowlandi Lewis & Kirk, 1946, *Proc. R. ent. Soc. Lond.* (*B*) **15** : 155.

This species is known by a single male specimen from Gallabat, A.-E. Sudan. The type specimen is in the British Museum.



41

FIG. 41.—*P. cowlandi*, ♂: *a*, buccal cavity; *b*, pharynx; *c*, terminalia. (After Lewis and Kirk, 1946.)

♀. Unknown.

♂. *Length:* 2·0 mm. *Antenna:* formula 1/III–XV, segment III (0·13 mm.) < IV + V, AIII/E = 0·9, ascoid on IV = 0·3 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·7, 4, 5·1, 8·3. *Epipharynx:* length 0·17 mm. *Buccal cavity:* with 25 teeth on an arc strongly concave posteriorly, the outer five teeth on either side broad and each with several points, the central teeth narrow and pointed; no pigmented area. *Pharynx:* 1·5 times as wide posteriorly as anteriorly, armed with broad teeth and minute

spicules posteriorly. *Wing :* length 1·4 mm., width 0·35 mm., alar index 0·5, delta + 0·03 mm. *Terminalia :* coxite (0·26 mm.) 2·5 times as long as style (0·1 mm.), which bears four terminal spines and small ventral seta at 0·9 ; paramere (0·19 mm.) blunt ; penis sheath (0·08 mm.) finger-shaped and blunt with notch near the tip ; lateral lobe 0·21 mm.

Theodor (1948) considers this species may be identical with *P. bedfordi* var. *congolensis*.

Distribution : A.-E. SUDAN.

Phlebotomus (*Sergentomyia*) *richardi* Parrot & Wanson.

P. richardi Parrot & Wanson, 1946, *Rev. Zool. Bot. afr.* **39** : 225.

This species is known from one female only, from Duma, Belgian Congo. Type specimen in the Museum of the Belgian Congo, Tervueren. The description below is after Parrot and Wanson.

♀. *Length :* 1·77 mm., hind leg 2·5 mm. *Antenna :* formula 2/III–XV, segment III (0·14 mm.) < IV + V, AIII/E = 1, ascoids on IV = 0·6 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 3, 4·3, 5·9, 7. *Epipharynx :* length 0·14 mm. *Buccal*

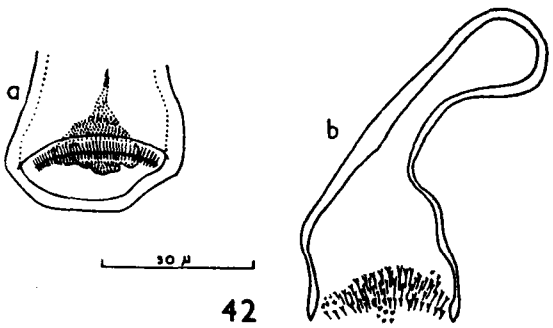


FIG. 42.—*P. richardi*, ♀ : *a*, buccal cavity ; *b*, pharynx. (After Parrot and Wanson, 1946.)

cavity : with 40 pointed monomorphic teeth on an arc concave posteriorly ; pigmented plate roughly helmet-shaped with ragged posterior margin. *Pharynx :* about twice as wide posteriorly as anteriorly, armed with numerous spines with wide bases and fine, backwardly pointing extremities, the anterior margin of the armed area being convex anteriorly. *Wing :* length 1·56 mm., width 0·43 mm., alar index 1·0, delta + 0·032 mm. *Spermatheca :* simple, tubular, of *minutus* type.

♂. Unknown.

This species resembles *P. pastorianus*, but differs in its smaller size, alar index, the greater number of the buccal teeth and the general arrangement of the pharyngeal armature.

Distribution : BELGIAN CONGO, UGANDA.

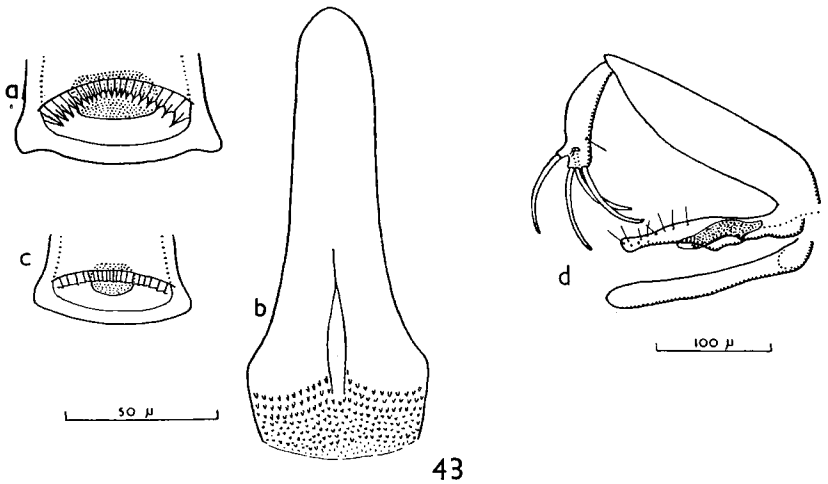
Phlebotomus (*Sergentomyia*) *schoutedeni* Adler, Theodor & Parrot.

P. schoutedeni Adler, Theodor & Parrot, 1929, *Rev. Zool. Bot. afr.* **18** : 72.

Type locality Stanleyville, Belgian Congo, types and co-types in the Hebrew University, Jerusalem and the Institut Pasteur d'Algérie. The description given below is after Adler, Theodor and Parrot, based on 61 females and 97 males.

♀. *Length :* 1·5–1·9 mm., hind leg 2·2–2·4 mm. *Antenna :* formula 2/III–XV, segment III (0·11–0·13 mm.) < IV + V, AIII/E = 0·6–0·7, ascoids on IV = 0·43 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·5, 3·5, 4, 7·1. *Epipharynx :* length 0·19–0·20 mm. *Buccal cavity :* with about 20 pointed teeth on an arc concave posteriorly, the 8 median teeth being smaller and straighter than the lateral ones, pigmented area dark brown, elliptical. *Pharynx :* about twice as wide posteriorly as anteriorly and armed with numerous strong teeth. *Wing :* length 1·4–1·6 mm., width 0·35–0·37 mm., alar index 0·5–0·83, delta + 0·1 to + 0·15 mm. *Spermatheca :* simple, tubular.

♂. *Length :* 1·4–1·8 mm., hind leg 2·1–2·4 mm. *Antenna :* formula 1/III–XV, segment III (0·13–0·17 mm.) < IV + V, AIII/E = 0·88–0·91, ascoid on IV = 0·25 length of



43

FIG. 43.—*P. schoutedeni*, ♀ ; *a*, buccal cavity ; *b*, pharynx. ♂ : *c*, buccal cavity ; *d*, terminalia. (After Adler, Theodor and Parrot, 1929.)

segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·3, 3·4, 4·0, 8·0. *Epipharynx :* length 0·15–0·18 mm. *Buccal cavity :* teeth as in the female but smaller and arranged in a less concave arc ; pigmented plate also smaller and almost circular. *Pharynx :* about twice as wide posteriorly as anteriorly, teeth much less marked than in the female, small and pointed, arranged in rows in the posterior part of the organ. *Wing :* length 1·3–1·6 mm., width 0·27–0·32 mm., alar index 0·56–0·8, delta 0 to + 0·09 mm. *Terminalia :* coxite (0·21–0·24 mm.) slightly more than twice length of style (0·09–0·10 mm.), which bears four spines, two terminal and two sub-terminal, and small ventral seta at 0·7 ; paramere (0·23 mm.) blunt ; penis sheath curved and finger-shaped (0·075 mm.), lateral lobe (0·26 mm.) longer than paramere.

Distribution : BELGIAN CONGO, UGANDA, TRANSVAAL, A.-E. SUDAN, DAHOMEY.

Phlebotomus (*Sergentomyia*) *schoutedeni* var. *pungens* Parrot.

P. schoutedeni var. *pungens* Parrot, 1948, *Arch. Inst. Pasteur Algér.* **26** : 145.

Type specimen in the British Museum. The following description is after Parrot, from seven females from the type locality, Li Rangu, A.-E. Sudan.

♀. *Length :* 1·81–2·13 mm., hind leg 2·45 mm. *Antenna :* formula 2/III–XV, segment III (0·1–0·13 mm.) < IV + V, AIII/E = 0·5–0·6, ascoid on IV = 0·2 length of segment.

Palp : formula 1,2,3,4,5, relative lengths 1, 3·1, 4·2, 4·6, 9·2. *Epipharynx :* length 0·2–0·22 mm. *Buccal cavity :* with 18–20 pointed teeth, the median two or three shorter and straighter than the lateral ones, pigmented area dark, oval, with small anterior prolongation. *Pharynx :* twice as wide posteriorly as anteriorly, armed with numerous strong spines in a transverse band. *Wing :* length 1·46–1·7 mm., width 0·32–0·44 mm., alar index 0·41–0·68, delta + 0·01 to + 0·07 mm.

♂. Unknown.

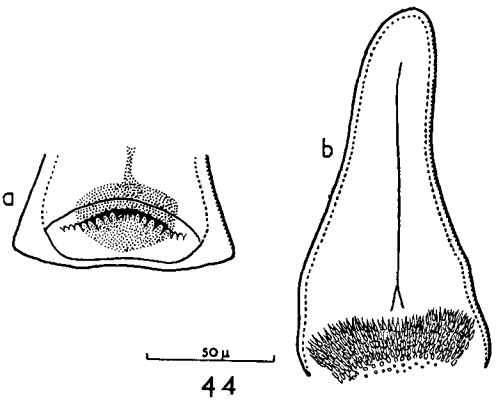


FIG. 44.—*P. schoutedeni* var. *pungens*, ♀ : *a*, buccal cavity ; *b*, pharynx. (After Parrot, 1948.)

This variety is distinguished from the typical *P. schoutedeni* by the greater uniformity of the buccal teeth, the wider and more heavily armed pharynx, and the greater size.

Distribution : A.-E. SUDAN.

Phlebotomus (*Sergentomyia*) *yusafi* Sinton.

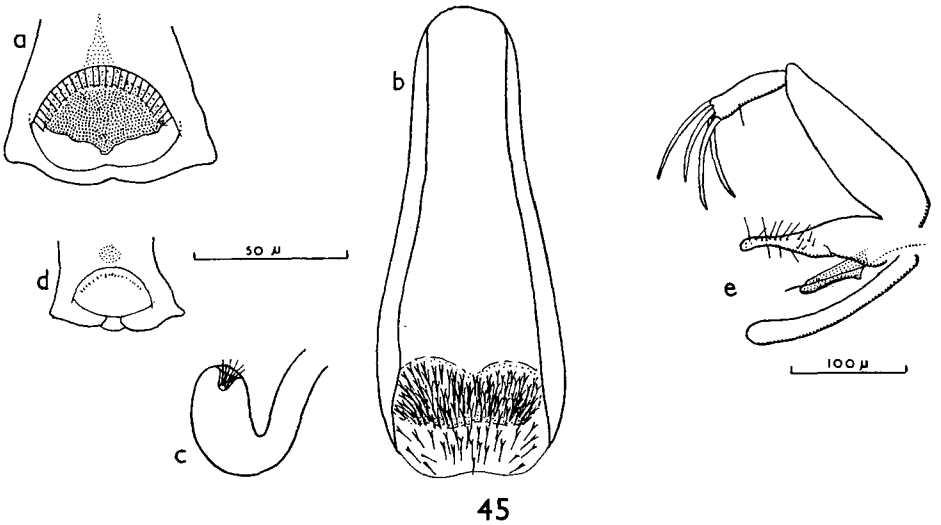
P. yusafi Sinton, 1930, *Indian J. med. Res.* **18** : 181.

Type locality Mombasa ; type specimens in the British Museum. The description below has been abstracted from Sinton's paper, based on two females and one male.

♀. *Length :* 2·2 mm. *Antenna :* formula 2/III–XV, segment III (0·1–0·13 mm.) < IV + V, AIII/E = 0·61–0·81, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·5, 3·6, 4·5, 8·9. *Epipharynx :* length 0·165–0·171 mm. *Buccal cavity :* with about 25 equal pointed teeth on an arc strongly concave posteriorly and a large dark pigmented area with anterior prolongation and ragged posterior margin. *Pharynx :* less than twice as wide posteriorly as anteriorly, pharyngeal armature well-developed and consists of a series of long posteriorly directed spines, those of the posterior part being slender and widely spaced, while the more anterior ones, arising from a dark stained area, are stouter and placed very close together. *Wing :* length 1·48–1·51 mm., width 0·4–0·43 mm., alar index 0·66, delta + 0·064 to + 0·085 mm. *Spermatheca :* simple, tubular, with wide duct.

♂. *Length :* 2·0 mm. *Antenna :* formula 1/III-XV, segment III (0·123 mm.) < IV + V, AIII/E = 0·87, ascoid on IV = 0·3 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·5, 3·5, 4·3, 8·6. *Epipharynx :* length 0·14 mm. *Buccal cavity :* with

about 14 small atrophied teeth and a small, irregular pigmented area. *Pharynx :* about 1·2 times as wide posteriorly as anteriorly, armed with a few toothed ridges and some lines of small teeth posteriorly. *Wing :* length 1·3 mm., width 0·36 mm., alar index 0·55, delta + 0·028 mm. *Terminalia :* coxite (0·2) mm. 2·5 times as long as style (0·081 mm.),



45

FIG. 45.—*P. yusafi*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. ♂ : *d*, buccal cavity ; *e*, terminalia. (After Sinton, 1930.)

which bears four curved spines, all terminal, and small non-deciduous seta at 0·6 ; paramere 0·165 mm. ; penis sheath (0·123 mm.) with broad, bluntly rounded extremity ; lateral lobe 0·17 mm.

Distribution : KENYA, A.-E. SUDAN.

Phlebotomus (*Sergentomyia*) *pastorianus* Parrot, Mornet & Cadenat.

P. pastorianus Parrot, Mornet & Cadenat, 1945, *Arch. Inst. Pasteur Algér.* **23** : 281.

This species is at present known from one female only from French Guinea. The description below is after Parrot, Mornet and Cadenat. Type specimen in Institut Pasteur d'Algérie.

♀. *Length :* 2·2 mm. *Antenna :* formula 2/III–XII (distal segments missing), segment III (0·135 mm.) < IV + V, AIII/E = 0·85, ascoids on IV = 0·6 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·5, 3·7, 4·8, 8·6. *Epipharynx :* length 0·162 mm. *Buccal cavity :* with 21 pointed monomorphic teeth on an arc concave posteriorly ; pigmented area helmet-shaped. *Pharynx :* about twice as wide posteriorly as anteriorly, armed with numerous poorly developed spines, ending in long filiform points, the armed area being in the form of a triangle with the base directed anteriorly and widely separated from the sides of the pharynx. *Wing :* length 1·74 mm., width 0·51 mm., alar index 0·64, delta + 0·012 mm. *Spermatheca :* simple, tubular, of *minutus* type.

♂. Unknown.

Distribution : FRENCH GUINEA.

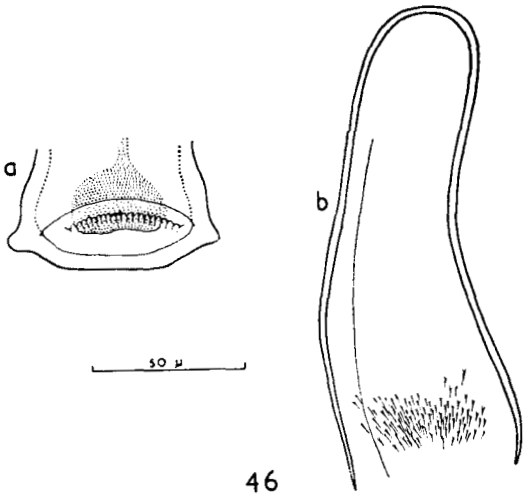


FIG. 46.—*P. pastorianus*, ♀: *a*, buccal cavity; *b*, pharynx. (After Parrot, Mornet and Cadenat, 1945.)

Phlebotomus (*Sergentomyia*) *buxtoni* Theodor.

P. buxtoni Theodor, 1933, *Bull. ent. Res.* **24** : 544.
P. mathisi Parrot, 1935, *Arch. Inst. Pasteur Algér.* **13** : 259.

Type locality Gold Coast (Tamale). The description is mainly after Theodor from one female and two males, supplemented from Parrot's (1935) descriptions of *P. mathisi* and *P. buxtoni* (Parrot, Mornet & Cadenat, 1945) from 42 males and 53 females.

♀. *Length:* 2·45 mm. *Antenna:* formula 2/III–XV, segment III (0·15–0·18 mm.) < IV + V, AIII/E = 0·65–0·8, ascoids on IV = 0·5 length of segment. *Palp:* formula

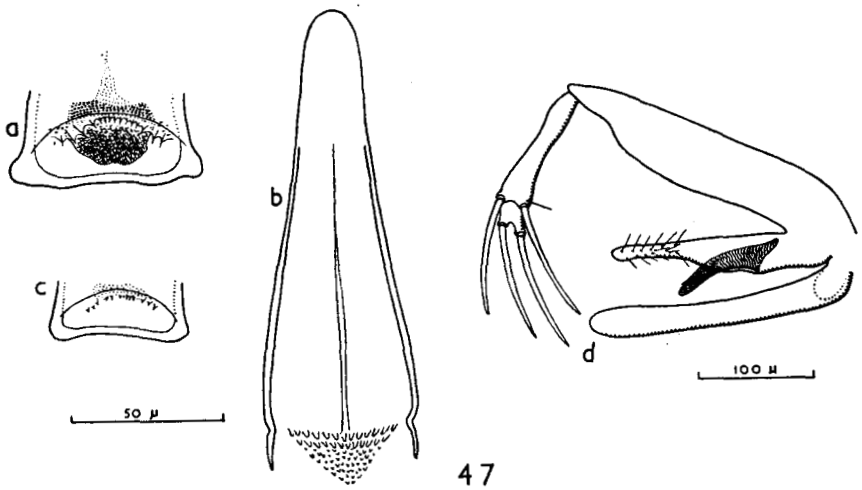


FIG. 47.—*P. buxtoni*, ♀: *a*, buccal cavity; *b*, pharynx. ♂: *c*, buccal cavity; *d*, terminalia. (*a* and *c* after Parrot, Mornet and Cadenat, 1945; *b* and *d* after Theodor, 1933.)

1,2,(3,4),5, relative lengths 1, 2·3, 3·4, 3·5, 4·5. *Epipharynx:* length 0·22–0·24 mm. *Buccal cavity:* with 13–16 teeth on an arc concave posteriorly, the 4–8 median teeth narrow and parallel to axis of body, the 4 lateral teeth on each side large and point inwards as well as backwards; small punctiform denticles may be seen laterally; pigmented area irregular with anterior prolongation and ragged posterior margin. *Pharynx:* twice as wide posteriorly as anteriorly and with an armature of short stumpy teeth. *Wing:* length 1·95 mm., width 0·49 mm., alar index 0·9, delta + 0·09 mm. *Spermatheca:* simple, tubular, of *minutus* type.

♂. *Length:* 2·0–2·3 mm. *Antenna:* formula 1/III–XV, segment III (0·17–0·18 mm.) < IV + V, AIII/E = 0·8–0·9, ascoid on IV = 0·4 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·6, 4, 4·2, 9. *Epipharynx:* length 0·19–0·20 mm. *Buccal cavity:* with 14–17 teeth on an arc slightly concave posteriorly, the lateral teeth larger than the median ones and pointing slightly medially; additional punctiform teeth may be seen laterally; pigmented plate faint or absent. *Pharynx:* slender, with no distinct armature. *Terminalia:* coxite (0·27 mm.) about twice as long as style (0·12 mm.) which bears two long terminal spines and two markedly subterminal ones and small non-deciduous seta at 0·8; paramere (0·19 mm.) with blunt end; penis sheath (0·11 mm.) blunt, finger-shaped, curved downwards; lateral lobe 0·24 mm.

Distribution: Gold Coast, Dakar, A.-E. Sudan.

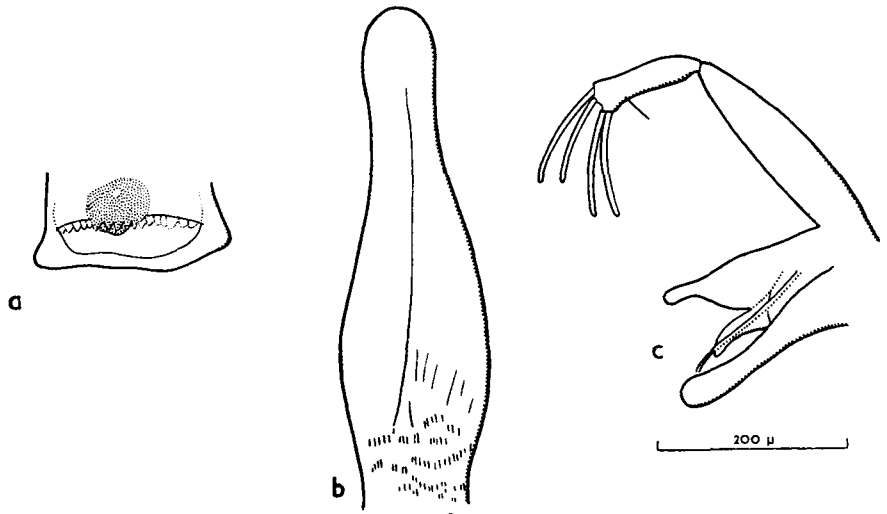
Phlebotomus (*Sergentomyia*) *aretasi* Kervran.

P. aretasi Kervran, 1946, *Ann. Parasit. hum. comp.* **21**: 155.

This species is known by one male only, from Bamako (Point G), French Sudan, and the description below is after Kervran.

♀. Unknown.

♂. *Length:* 2·5 mm. *Antenna:* formula 1/III—XV, segment III (0·28 mm.) > IV + V, AIII/E = 1·6, ascoid on IV = 0·3 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 1·8, 2·6, 3·5, 5·8. *Epipharynx:* length 0·175 mm. *Buccal cavity:* with about 16–18 irregular teeth with milled or serrated edges, pigmented plate dark brown, roughly



48

Fig. 48.—*P. aretasi*, ♂: *a*, buccal cavity; *b*, pharynx; *c*, terminalia. (After Kervran, 1946.)

quadrilateral. *Pharynx:* twice as wide posteriorly as anteriorly and armed with fine longitudinal spines arranged in groups of 4 or 5. *Wing:* length 2·0 mm., width 0·57 mm., alar index 1·1, delta + 0·24 mm., pi = + 0·05 mm. *Terminalia:* coxite (0·23 mm., about 2·5 times length of style (0·095 mm.) which bears four terminal spines and small ventral seta at 0·6; paramere (0·21 mm.) with very wide base and hooked extremity; penis sheath (0·068 mm.) conical lateral lobe (0·23 mm.) same length as coxite.

Distribution: FRENCH SUDAN.

Phlebotomus (*Sergentomyia*) *simillimus* Newstead.

P. simillimus Newstead, 1914, *Bull. ent. Res.* **5** : 180.
P. brodeni Parrot, 1930, *Rev. Zool. Bot. afr.* **19** : 185.
P. simillimus Theodor, 1931, *Bull. ent. Res.* **22** : 475; 1938, *ibid.* **29** : 171.

Type locality Kintampo, Northern Ashanti, type specimens in the British Museum. The descriptions below are partly after Theodor, supplemented from our own material. The antennal formula is different from that given by Newstead (1914) and Parrot (1940). Theodor omits this character.

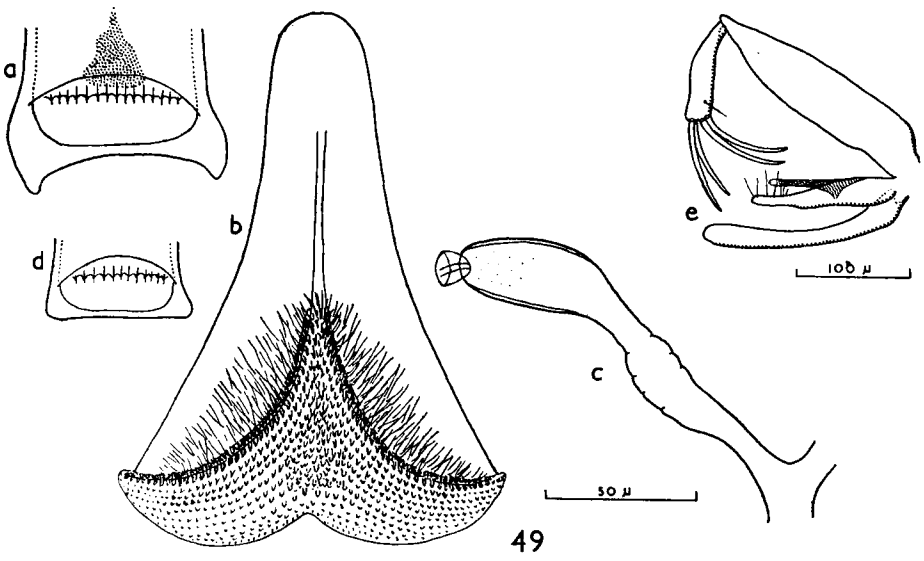


FIG. 49.—*P. simillimus*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca. ♂: *d*, buccal cavity; *e*, terminalia. (*a* and *d* after Parrot, Mornet and Cadenat, 1945; *b* and *e* after Theodor, 1931; *c* after Parrot, 1930.)

♀. *Length:* 1·8–1·9 mm. *Antenna:* formula 2/III–XV, segment III (0·32–0·34 mm.) < IV + V, AIII/E = 1·66, ascoids on IV = 0·4 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·5, 3·8, 4·7, 9·7. *Epipharynx:* length 0·19–0·20 mm. *Buccal cavity:* with 18–20 teeth with short points on an arc concave posteriorly; no pigmented plate. *Pharynx:* heart-shaped, five times as wide posteriorly as anteriorly, bearing a great number of very fine pointed teeth standing on pigmented areas. *Wing:* length 1·76–1·85 mm., width 0·54–0·55 mm., alar index 1·3–1·4, delta + 0·25 to 0·29 mm. *Spermathecae:* elliptical capsules with wide ducts.

♂. *Length:* 1·8–2·3 mm. *Antenna:* formula 1/III–XV, segment III (0·28–0·38 mm.) < IV + V, AIII/E = 1·8–2·2, ascoid on IV = 0·5 length of segment. *Palp:* formula

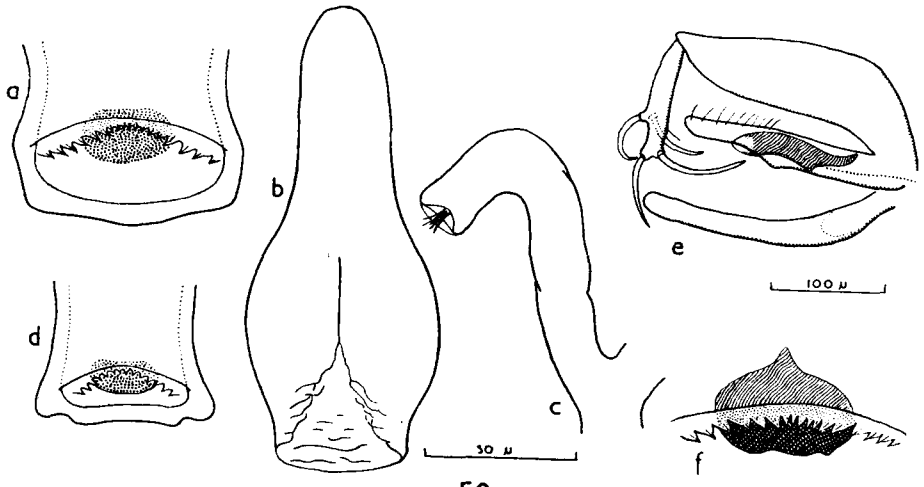
1,2,3,4,5, relative lengths 1, 3·3, 5, 6·2, 9·8. *Buccal cavity :* about 18 teeth with short points ; no pigmented area. *Pharynx :* about twice as wide posteriorly as anteriorly with an armature of well-marked blunt teeth. *Terminalia :* coxite (0·35 mm.) about twice as long as style (0·15 mm.) which bears four terminal spines and small ventral seta at 0.8 ; paramere (0·24 mm.) blunt, penis sheath (0·10–0·11 mm) conical with blunt tip ; lateral lobe (0·27–0·29 mm.) markedly longer than paramere.

Distribution : ASHANTI, GOLD COAST, BELGIAN CONGO, A.-E. SUDAN, DAHOMEY.

Phlebotomus (*Sergentomyia*) *schwetzi* Adler, Theodor & Parrot.

P. schwetzi Adler, Theodor & Parrot, 1929, *Rev. Zool. Bot. afr.* **18** : 72.
P. symesi Sinton, 1930, *Indian J. med. Res.* **18** : 175.
P. schwetzi var. *aethiopicus* Parrot, 1936, *Arch. Inst. Pasteur Algér.* **14** : 30.

The description below has been compiled from published descriptions of 217 females and 80 males from the Belgian Congo, Dire Dawa and Mombasa. Types and co-types are in the Hebrew University, Jerusalem, and the Institut Pasteur d'Algérie.



50

FIG. 50.—*P. schwetzi*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermathecea. ♂ : *d*, buccal cavity ; *e*, terminalia. *P. schwetzi* var. *nigricans*, ♀ : *f*, buccal cavity. (*a–e* after Adler, Theodor and Parrot, 1929 ; *f* after Parrot, 1948.)

♀. *Length :* 1·5–2·54 mm., hind leg 2·6–3·1 mm. *Antenna :* formula 2/III–XV, segment III (0·155–0·189 mm.) > IV + V, AIII/E = 0·77–0·85, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,2,(4,3,),5, relative lengths 1, 2·5, 3·9, 3·7, 7·7. *Epipharynx :* length 0·20–0·23 mm. *Buccal cavity :* with about 16–18 pointed teeth on an arc concave posteriorly, the median teeth being narrower and straighter than the lateral ones ; pigmented plate elliptical. *Pharynx :* more than twice as wide posteriorly as anteriorly, armed with fine transverse wavy ridges without any pointed teeth. *Wing:* length 1·4–1·8 mm., width 0·5–0·55 mm., alar index 0·5–1·2, delta + 0·05 to 0·18. *Spermatheca :* simple, tubular, of *minutus* type.

♂. *Length :* 1·5–2·7 mm., hind leg 2·5–3 mm. *Antenna :* formula 1/III–XV, segment III (0·2 mm.) < or = IV + V, AIII/E = 0·98–1·1, ascoid on IV = 0·3 length of segment.

Palp : formula 1,2,4,3,5, relative lengths 1, 2·3, 3·6, 3·1, 7·4. *Buccal cavity :* with about 16 pointed teeth on an arc concave posteriorly ; pigmented plate elliptical, sometimes absent. *Pharynx :* twice as wide posteriorly as anteriorly, armed as in the female with transverse ridges but no teeth. *Wing :* length 1·4–1·77 mm., width 0·28–0·40 mm., alar index 0·5–0·77, delta + 0·03 to 0·07 mm. *Terminalia :* coxite (0·23–0·32 mm.) nearly 2·5 times as long as style (0·1–0·12 mm.), which bears two terminal spines and two subterminal or submedian ones on a prominent apophysis of variable size ; small ventral seta level with subterminal spines or between the two pairs ; paramere with rounded tip, penis sheath 4–5 times as long as wide, finger-shaped, curved and blunt, with a dorsal notch near the tip ; lateral lobe (0·25 mm.) longer than paramere.

Distribution : A.-E. SUDAN, TRANSVAAL, KENYA, ABYSSINIA, SENEGAL, FRENCH GUINEA, BELGIAN CONGO, widely distributed in EQUATORIAL AFRICA.

Phlebotomus (*Sergentomyia*) *schwetzi* var. *nigricans* Parrot.

P. schwetzi var. *nigricans* Parrot, 1948, *Arch. Inst. Pasteur Algér.* **26** : 269.

Type specimen in the British Museum. The description below is after Parrot, from three females from Katire, A.-E. Sudan.

♀. *Length :* 2·5 mm., hind leg 3·64 mm. *Antenna :* formula 2/III–XV, segment III (0·25–0·28 mm.) > IV + V, AIII/E = 1·1, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 3·9, 5·3, 6·3, 12·5. *Epipharynx :* length 0·23–0·24 mm. *Buccal cavity :* with 17 pointed teeth almost on a straight line, the median ones being straighter than the lateral ones ; pigmented plate very dark, roughly elliptical with a short anterior prolongation, *Pharynx :* as in *P. schwetzi*. *Wing :* length 2·24 mm., width 0·6 mm., alar index 1·1, delta + 0·1 mm. *Spermatheca :* tubular, of *minutus* type

♂. Unknown.

The female of this variety is separated from typical *P. schwetzi* by the heavily pigmented buccal area, the greater length of AIII (AIII/E = 1·1 as compared with 0·7–0·85) and by the palpal formula, segment 4 being longer than segment 3 by about 30 μ.

Distribution : A.-E. SUDAN.

Phlebotomus (*Sergentomyia*) *guiraudi* Kervran.

P. guiraudi Kervran, 1946, *Ann. Parasit. hum. comp.* **21** : 155.

Type locality Bamako (Koulouba), French Sudan. This species is known from one female only and is obviously closely related to *P. schwetzi*. The description below is after Kervran.

♀. *Length :* 1·9 mm. *Antenna :* segment III (0·2 mm.) < IV + V, AIII/E = 0·8, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,2,4,3,5, relative lengths 1, 2·5, 3·8, 3·5, 8·2. *Epipharynx :* length 0·25 mm. *Buccal cavity :* with 16 broad teeth increasing in length from the centre to the periphery ; pigmented plate oval with long axis lying transversely. *Pharynx :* about twice as wide posteriorly as anteriorly, with fine scale-like folds in its posterior part. *Wing :* length 1·75 mm., width 0·45 mm., alar index 1, delta + 0·2 mm. *Spermatheca :* of *minutus* type.

Distribution : FRENCH SUDAN.

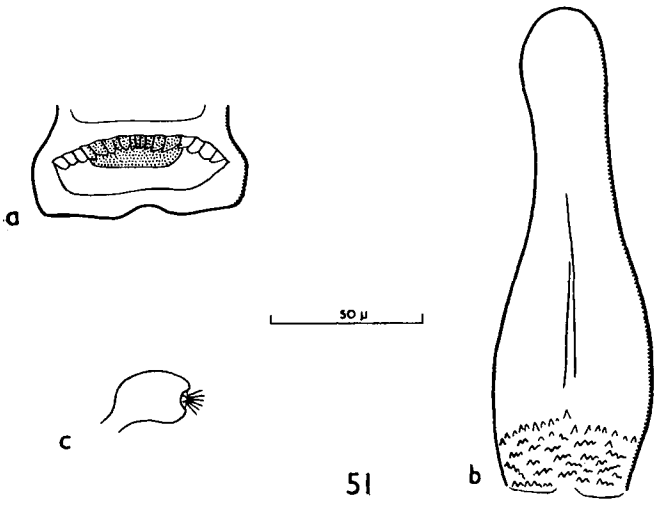


FIG. 51.—*P. guiraudi*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. (After Kervran, 1946)

Phlebotomus (*Sergentomyia*) *freetownensis* Sinton.

P. freetownensis Sinton, 1930, *Indian J. med. Res.* **18** : 171.

This species is known from one female only, from Sierra Leone. In this work the name *africanus* is regarded as a synonym of *P. squamipleuris* (*see* p. 408) and *P. freetownensis* becomes the typical example of the various forms previously known as *P. africanus* and its varieties. The description below is after Sinton.

♀. *Length :* 2·7 mm. *Antenna :* formula 2/III–XV, segment III (0·192 mm.) = IV + V, AIII/E = 1·2, ascoid on IV = 0·25 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·8, 4·4, 4·9, 10. *Epipharynx :* length 0·165 mm. *Buccal cavity :* with about 60 narrow parallel teeth on an arc concave posteriorly ; pigmented plate triradiate with thickened lateral arms, which show rounded ends while the median or anterior one is pointed and the posterior margin is concave posteriorly. *Pharynx :* flask-shaped, about 2·5 times as wide posteriorly as anteriorly, armed with numerous backwardly directed spines, of which there are about 20 in a transverse row at the widest part of the organ. *Wing :* length 1·857 mm., width 0·5 mm., alar index 1·06, delta + 0·193 mm. *Spermatheca :* an elongated oval capsule twice as long as wide, ending in a narrow duct.

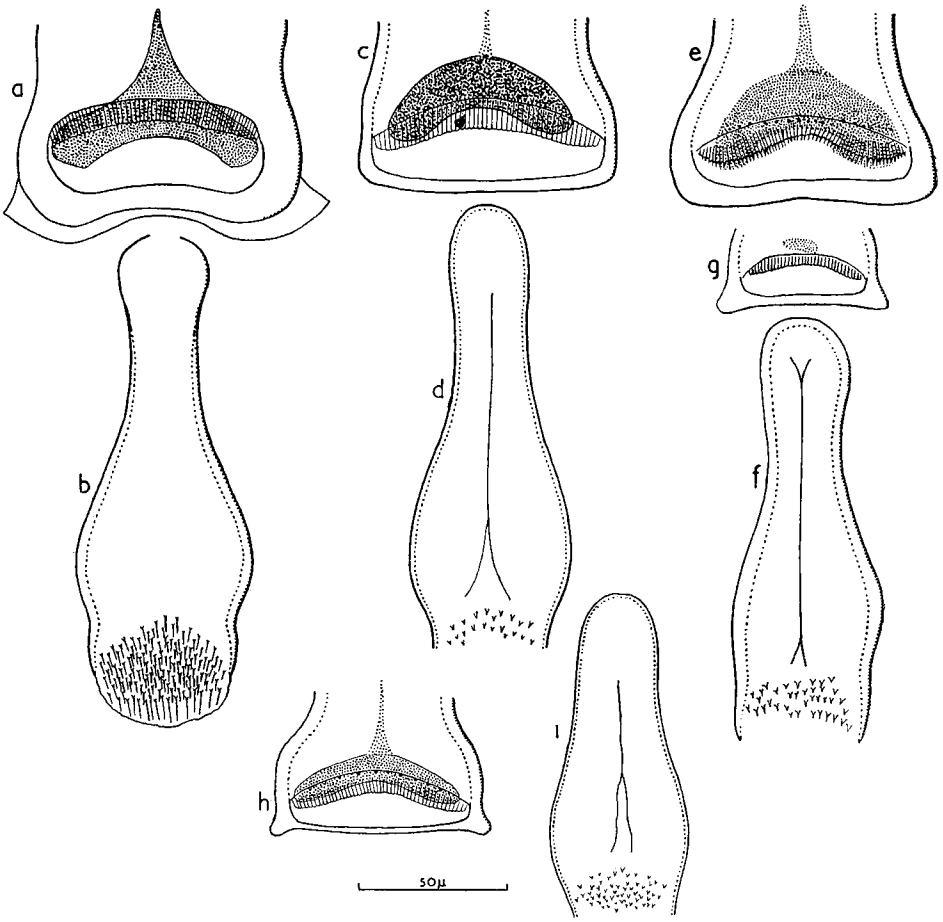
♂. Unknown.

Distribution : SIERRA LEONE.

Phlebotomus (*Sergentomyia*) *freetownensis* var. *magnus* Sinton.

P. africanus Adler, Theodor & Parrot, 1929, *Rev. Zool. Bot. afr.* **18** : 72.
P. africanus var. *magnus* Sinton, 1932, *Indian J. med. Res.* **20** : 565.

P. africanus var. *magnus* was described by Sinton from one female only. Theodor (1948) considered that this was possibly only a large specimen of *P. africanus* and it agrees closely with the form of that species described by Adler Theodor and Parrot from the Belgian Congo. In this work the Ethiopian form previously known as *P. africanus* Newstead is included under the name *P.*



52

FIG. 52.—*P. freetownensis*, ♀: *a*, buccal cavity; *b*, pharynx. *P. f.* var. *ater*, ♀: *c*, buccal cavity; *d*, pharynx. *P. f.* var. *eremitis*, ♀: *e*, buccal cavity; *f*, pharynx. ♂: *g*, buccal cavity. *P. f.* var. *longior*, ♀: *h*, buccal cavity; *i*, pharynx. (*a* and *b* after Sinton, 1930; *c*, *d*, *h* and *i* after Parrot, 1936; *e*, *f* and *g* after Parrot and De Jolinière, 1945.)

freetownensis var. *magnus*. Type locality Letsitelle, Transvaal. The description below is from published descriptions of 152 females and 180 males from the Belgian Congo and Transvaal.

♀. *Length:* 1·45–2·45 mm., hind leg 2·3–2·6 mm. *Antenna:* formula 2/III–XV, segment III (0·135–0·171 mm.) < IV + V, AIII/E = 0·8–1, ascoids on IV = 0·25 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·2, 3·6, 4·2, 8·1. *Epipharynx:* length 0·15–0·17 mm. *Buccal cavity:* with 40–50 straight parallel teeth arranged in a palisade on an arc concave posteriorly; there may be some very small punctiform denticles at the bases of the teeth; pigmented plate sausage-shaped, concave posteriorly and with a paler, triangular, pointed, forward extension. *Pharynx:* about twice as wide posteriorly as anteriorly, armed with short backwardly directed spines in its posterior part. *Wing:*

length 1·4–1·77 mm., width 0·36–0·485 mm., alar index 0·52–0·89, delta + 0·04 to 0·14. *Spermatheca :* an elongated oval capsule, opening into a relatively narrow duct.

♂. *Length :* 1·4–2 mm., hind leg 2·1–2·4 mm. *Antenna :* formula 1/III–XV, segment III (0·15–0·19 mm.) < IV + V, AIII/E = 1·1–1·2, ascoids on IV = 0·22 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·3, 3·9, 4·7, 8·5. *Epipharynx :* length 0·132–0·158 mm. *Buccal cavity :* with about 20–30 straight parallel teeth ; no pigmented area. *Pharynx :* about twice as wide posteriorly as anteriorly, armed with short spines as in the female, but fewer and less well developed. *Wing :* length 1·3–1·56 mm., width 0·28–0·41 mm., alar index 0·36–0·84, delta 0 to + 0·09 mm. *Terminalia :* coxite (0·21–0·25 mm.) about twice length of style (0·09–0·11 mm.) which bears four spines, two terminal and two subterminal, with small ventral seta at 0·5 ; paramere 0·14–0·18 mm., penis sheath (0·09–0·10 mm.) conical ending in a sharp point ; lateral lobe 0·18–0·22 mm., longer than paramere.

Distribution : Widely distributed throughout AFRICA.

Phlebotomus (*Sergentomyia*) *freetownensis* var. *ater* Parrot.

P. africanus var. *ater* Parrot, 1936, *Arch. Inst. Pasteur Algér.* **14** : 43.

Type specimens in Institut Pasteur d'Algérie. The description below is after Parrot, from three females from Dire Dawa, Abyssinia.

♀. *Length :* 1·86–1·89 mm., hind leg 2·1–2·3 mm. *Antenna :* formula 2/III–XV, segment III (0·13–0·14 mm.) < IV + V, AIII/E = 0·82–0·95. *Palp :* formula 1,2,(3,4),5, relative lengths 1, 1·5, 3·3, 3·3, 5·7. *Epipharynx :* length 0·14–0·15 mm. *Buccal cavity :* 46–48 straight long parallel teeth arranged in a palisade on an arc slightly concave posteriorly ; pigmented plate black, not occupying whole width of buccal cavity and with a small triangular anterior prolongation. *Pharynx :* twice as wide posteriorly as anteriorly, constricted posteriorly and armed with a score of moderately long denticles. *Wing :* length 1·86–1·89 mm., width 0·38–0·42 mm., alar index 0·58–0·66, delta + 0·38–0·42 mm. *Spermatheca :* as in *P. freetownensis.*

♂. Unknown.

This form differs from the other varieties of *P. freetownensis* especially in the form and colour of the pigmented plate, the pharyngeal armature and the relative shortness of the fourth palpal segment.

Distribution : ABYSSINIA.

Phlebotomus (*Sergentomyia*) *freetownensis* var. *eremitis* Parrot & de Jolinière.

P. eremitis Parrot & de Jolinière, 1945, *Arch. Inst. Pasteur Algér.* **23** : 56.
P. africanus var. *eremitis* Theodor, 1948, *Bull. ent. Res.* **39** : 85.

The description below is after Parrot and de Jolinière, from 24 males and 10 females from Amgel and Tamanrasset ; type specimens in the Institut Pasteur d'Algérie.

♀. *Length :* 2–2·15 mm., hind leg 2·3–2·6 mm. *Antenna :* formula 2/III–XV, segment III (0·114–0·147 mm.) < IV + V, AIII/E = 0·79–0·96, ascoids on IV = 0·3 length of segment, but the ascoids on each segment especially the terminal ones, are unequal in size. *Palp :* formula 1, 2,(3,4), 5, relative lengths 1, 2·5, 4·2, 4·3, 8·5. *Epipharynx :* length 0·13–0·156 mm. *Buccal cavity :* with 60–65 teeth, parallel, straight and long, the extreme lateral ones slightly bigger than the median ones, arranged in a palisade on an arc slightly concave posteriorly ; at the bases of these teeth is a row of about a dozen punctiform denticles ; pigmented plate dark brown, not occupying whole width of buccal cavity, in the form of a crescent slightly concave posteriorly, with irregular posterior margin and a paler anterior triangular prolongation. *Pharynx :* posterior width slightly less than

twice anterior width armed in posterior part with about 40 well-developed, pointed spines. *Wing :* length 1·65–1·79 mm., width 0·31–0·41 mm., alar index 0·47–0·65, delta − 0·017 to + 0·051 mm. *Spermatheca :* as in *P. freetownensis.*

♂. *Length :* 1·82–2·05 mm., hind leg 1·9–2·4 mm. *Antenna :* formula 1/III–XV, segment III (0·13–0·16 mm.) < IV + V, AIII/E = 0·92–1·06, ascoids on IV = 0·2 length of segment. *Palp :* formula 1, 2,(3,4),5, relative lengths 1, 2·3, 4·1, 4·1, 7·8. *Epipharynx :* length 0·13–0·16 mm. *Buccal cavity :* with 30–35 long parallel monomorphic teeth in a palisade on an arc slightly concave posteriorly ; anteriorly a row of 8–10 punctiform denticles, sometimes not visible ; pigmented area dark brown, small, sometimes absent. *Pharynx :* posterior width about twice anterior width armed with transverse folds bearing a few short spines. *Wing :* length 1·3–1·7 mm., width 0·27–0·36 mm., alar index 0·4–0·58, delta + 0·085 to + 0·017 mm. *Terminalia :* coxite (0·22–0·25 mm.) twice as long as style (0·09–0·11 mm.) which bears two terminal and two subterminal spines and small ventral seta at 0·6 ; paramere (0·16–0·17 mm.) rounded, penis sheath (0·09–0·10 mm.) tapering to a fine point ; lateral lobe 0·195–0·21 mm.

The female is distinguished from other varieties of *P. freetownensis* by the number of the buccal teeth and from var. *niger* by the pigmented plate. For the differentiation of the male see p. 477 (var. *niger*).

Distribution : Al Ahaggar, A.-E. Sudan.

Phlebotomus (*Sergentomyia*) *freetownensis* var. *longior* Parrot.

P. africanus var. *longior* Parrot, 1936, *Arch. Inst. Pasteur Algér.* **14** : 40.

The description below is after Parrot, from two females and three males from Dire Dawa, Abyssinia. Type specimens in the Institut Pasteur d'Algérie.

♀. *Length :* 2·1–2·2 mm., hind leg 2·4–2·8 mm. *Antenna :* formula 2/III–XV, segment III (0·14–0·18 mm.) < IV + V, AIII/E = 0·84–0·87. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·4, 3·7, 4·2, 6·2. *Epipharynx :* length 0·17–0·19 mm. *Buccal cavity :* 48–50 parallel narrow teeth arranged in a palisade on an arc slightly concave posteriorly ; 10–12 anterior slightly pointed denticles ; pigmented area brown, covering the whole width of the buccal cavity and prolonged anteriorly by a clear triangular extension. *Pharynx :* a little less than twice as wide posteriorly as anteriorly, slightly constricted posteriorly and bearing rather numerous short pointed teeth. *Wing :* length 1·6–1·9 mm., width 0·4 mm., alar index 0·6–0·8, delta + 0·05 to + 0·07 mm. *Spermatheca :* as in *P. freetownensis.*

♂. *Length :* 1·9–2·3 mm., hind leg 2·1–2·6 mm. *Antenna :* formula 1/III–XV, segment III (0·14–0·21 mm.) < IV + V, AIII/E = 1·07–1·18. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·3, 3·8, 4, 4·6. *Buccal cavity* and *pharynx :* as in *P. freetownensis* var. *magnus.* *Wing :* length 1·7–1·8 mm., width 0·31 mm., alar index 0·5–0·6, delta + 0·02 to + 0·04 mm. *Terminalia :* in general as in *P. freetownensis* var. *magnus*, but the penis sheath (0·10–0·13 mm.) in the form of an elongated cone with a delicate slightly curved point.

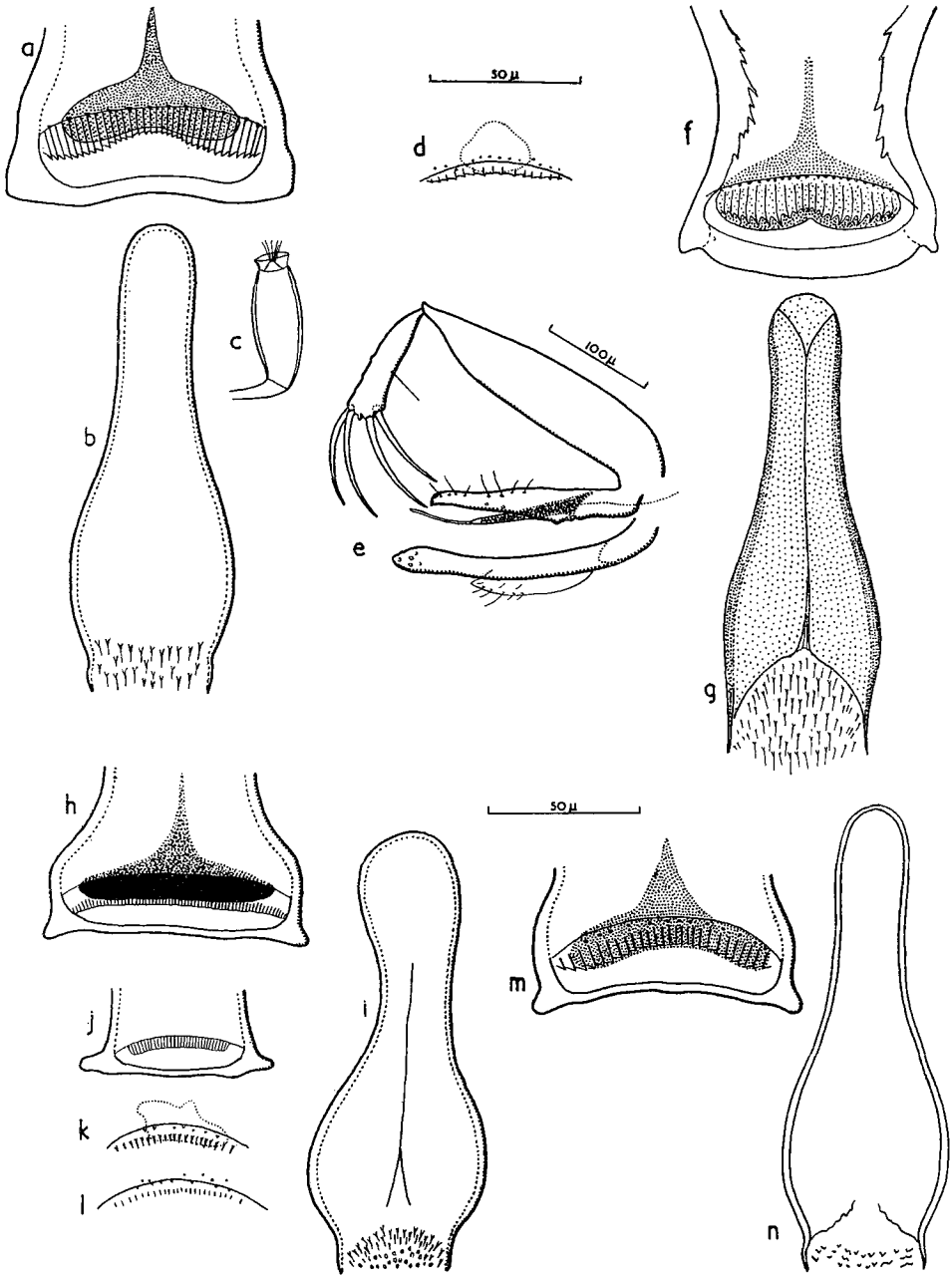
This form is differentiated from other varieties of *P. freetownensis* by the much greater length of the penis in the male and by the number of buccal teeth and the number and length of the pharyngeal teeth.

Distribution : Abyssinia.

Phlebotomus (*Sergentomyia*) *freetownensis* var. *meridianus* De Meillon & Lavoipierre.

P. africanus var. *meridianus* De Meillon & Lavoipierre, 1944, *J. ent. Soc. S. Afr.* **7** : 38.

The description below is after De Meillon and Lavoipierre from two females from Onderstepoort, Transvaal. Type specimen in the South African Institute for Medical Research, Johannesburg.



53

FIG. 53.—*P. freetownensis* var. *magnus*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca ♂: *d*, buccal cavity; *e*, terminalia. *P. f.* var. *meridionalis*, ♀: *f*, buccal cavity; *g*, pharynx, *P. f.* var. *niger* ♀: *h*, buccal cavity; *i*, pharynx. ♂: *j–l*, buccal cavity. *P. f.* var. *sudanicus*. ♀: *m*, buccal cavity; *n*, pharynx. (*a–c* after Theodor, 1948; *d*, *k* and *l* after Parrot, 1948; *e* after Adler, Theodor and Parrot, 1929; *f* and *g* after De Meillon and Lavoipierre, 1944; *h–j* after Parrot and Schwetz, 1937; *m* after Parrot, Mornet and Cadenat, 1945; *n* after Theodor, 1933.)

♀. *Length :* 2·72 mm., hind leg 2·64 mm. *Antenna :* formula 2/111–XV, segment III (0·16 mm.) < IV + V, AIII/E = 0·9, ascoid on IV = 0·25 length of segment. *Palp :* formula 1,2,(3,4),5, relative lengths 1, 1·9, 4·3, 4·3, 8·8. *Buccal cavity :* with about 20 large pointed teeth with their bases nearly in a straight line, about three median and one or two of the extreme lateral teeth shorter than the rest ; immediately anterior to this row of teeth a row of fine punctiform teeth ; pigmented plate large, mushroom-shaped. *Pharynx* posterior width about twice anterior width, armed with numerous sharply pointed teeth posteriorly. *Wing :* length 1·9 mm., width 0·54 mm., alar index 0·74, delta + 0·1 mm. *Spermathecae :* elliptical capsules as in *P. freetownensis.*

♂. Unknown.

This form differs from all other varieties of *P. freetownensis* in the small number of buccal teeth.

Distribution : TRANSVAAL.

Phlebotomus (*Sergentomyia*) *freetownensis* var. *niger* Parrot & Schwetz.

P. africanus var. *niger* Parrot & Schwetz, 1937, *Rev. Zool. Bot. afr.* **29** : 221.
P. africanus var. *niger* Theodor, 1933, *Bull. ent. Res.* **24** : 166.

The description below is from the original description of 17 females and 15 males from several places in the Belgian Congo (types in the Museum of the Belgian Congo, Tervueren) and from Theodor (1933).

♀. *Length :* lengths of body, hind leg, antenna and its parts, palp, wing and spermatheca as in *P. freetownensis* var. *magnus* from the Belgian Congo. *Buccal cavity :* with 60–70 uniform parallel teeth in a palisade on an arc slightly concave posteriorly, and no anterior denticles ; pigmented plate black and sausage-shaped, occupying nearly the whole width of the cavity, with an anterior subtriangular pale prolongation. *Pharynx :* with posterior width twice anterior width, strongly constricted posteriorly, and bearing about 60 fairly long-pointed denticles, smaller, stronger, and more numerous than in *P. freetownensis* var. *magnus.*

♂. *Length :* measurements of body length, hind leg, palp, antenna and wing as in *P. freetownensis* var. *magnus* from the Belgian Congo. *Buccal cavity :* with 28–36 uniform straight parallel teeth, pigmented plate absent. *Pharynx :* as in var. *magnus,* but generally a little wider.

The female of this variety differs from other varieties of *P. freetownensis* by the very dark colour of the buccal pigmented plate (this character makes it easily recognisable) also by the large number of buccal teeth and the character of the pharyngeal armature. The male is distinguished by the greater number of buccal teeth from all other known varieties except var. *eremitis* from which it can be distinguished by the palpal formula and the position of the small ventral seta (at 0·75 in *niger* and 0·6 in *eremitis*).

Distribution : A.-E. SUDAN, BELGIAN CONGO, NIGERIA, FRENCH SUDAN, FRENCH CONGO, FRENCH GUINEA, DAHOMEY, IVORY COAST, UGANDA.

Phlebotomus (*Sergentomyia*) *freetownensis* var. *sudanicus* Theodor.

P. africanus var. *sudanicus* Theodor, 1933, *Bull. ent. Res.* **24** : 541.

The description below is from five males and five females from the Anglo-Egyptian Sudan.

♀. *Length :* 1·4–2·0 mm., hind leg 2·1–2·7 mm. *Antenna :* formula 2/III–XV, segment III (0·11–0·16 mm.) < IV + V, AIII/E = 0·9, ascoids on IV = 0·3 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·2, 3·6, 4·0, 7·2. *Epipharynx :* length 0·11–0·17 mm. *Buccal cavity :* with 30–33 teeth and a small point-like denticle at the base of

every second tooth in the armature. *Pharynx :* as in *P. freetownensis* var. *magnus*, but the teeth are much smaller, sometimes appearing as rows of points. *Wing :* length 1·3–1·9 mm., width 0·3–0·4 mm., alar index 0·5–0·7, delta + 0·03 to + 0·1 mm. *Spermatheca :* as in *P. freetownensis*.

♂. *Length :* 1·8–2·3 mm., hind leg 1·9–3·0 mm. *Antenna :* formula 1/III–XV, segment III (0·16–0·20 mm.) < or = IV + V, AIII/E = 1–1·1, ascoid on IV = 0·2 length of segment. *Palp :* formula 1,2,(3,4),5, relative lengths 1, 2, 4, 5, 6·7. *Epipharynx :* length 0·14–0·15 mm. *Buccal cavity :* with about 16 equal teeth on an arc slightly concave posteriorly, pigmented area absent. *Pharynx :* about twice as wide posteriorly as anteriorly armed with transverse ridges bearing delicate teeth. *Wing :* length 1·1–1·45 mm., width 0·2–0·28 mm., alar index 0·33–0·4, delta + 0·01 to + 0.03 mm. *Terminalia :* coxite (0·21–0·26 mm.) about 2·5 times as long as style, which bears four terminal spines, and small ventral seta at 0·8 ; paramere (0·15–0·20 mm.) shorter than lateral lobe (0·20–0·23 mm.) ; penis sheath (0·05–0·10 mm.) conical, tapering to a sharp point.

Distribution : A.-E. Sudan, French West Africa, Kenya.

Phlebotomus (*Sergentomyia*) *babu* Annandale.

P. babu Annandale, 1910, *Rec. Indian Mus.* **4** : 49.
P. babu Sinton, 1928, *Indian J. med. Res.* **16** : 297 ; 1932, *ibid.* **20** : 55 ; 1933, *ibid.* **21** : 417.

The following description is from the papers of Sinton and the examination of five females and 16 males in the British Museum from India, Ceylon and Mauritius.

♀. *Length :* 1·5–2·1 mm., hind leg 2·4–2·7 mm. *Antenna :* formula 2/III–XV, segment III (0·10–0·14 mm.) = IV + V, AIII/E = 0·9–1·0, ascoids on IV = 0·4 length of segment.

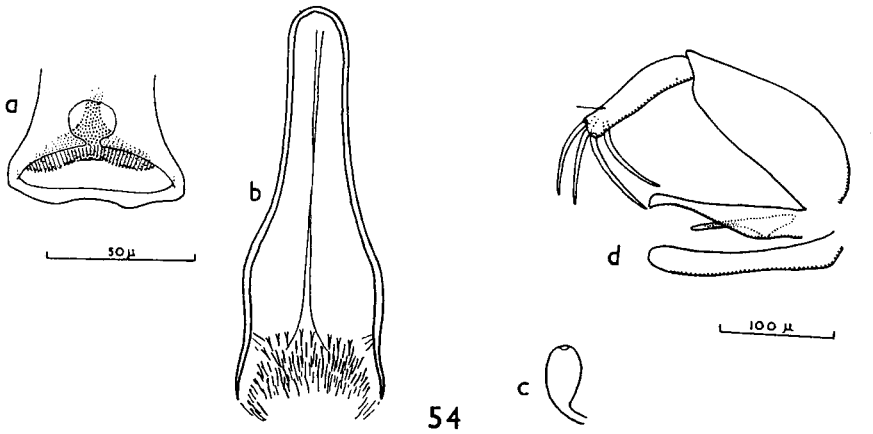


Fig. 54.—*P. babu*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. ♂ : *d*, terminalia. (From specimens from Mauritius.)

Palp : formula 1,2,(3,4),5, relative lengths 1, 2·5, 3·5, 3·5, 7·2. *Epipharynx :* length 0·13–0·15 mm. *Buccal cavity :* with 36–40 equal pointed teeth on a row concave posteriorly and a row of anterior small punctiform denticles anteriorly to which the buccal plate shows a festooned edge with a well-marked median anterior notch ; pigmented area in the shape of a very wide triangle with apex directed anteriorly and base not extending across whole width of buccal cavity. *Pharynx :* slightly more than twice as wide posteriorly as anteriorly, constricted in its wide posterior portion, which is armed with scale-like teeth having

long, backwardly directed points; in the posterior part of the armature only these long filiform points are seen. *Wing:* length 1·4–1·6 mm., width 0·34–0·42 mm., alar index 0·5–0·62, delta + 0·05 to + 0·1 mm. *Spermatheca:* thin-walled elliptical capsules with narrow ducts.

♂. *Length:* 1·6–1·8 mm., hind leg 2·1–2·4 mm. *Antenna:* formula 1/III–XV, segment III (0·12–0·13 mm.) > IV + V, AIII/E = 0·6–1, ascoid on IV = 0·2 length of segment. *Palp:* formula 1,2,(3,4),5, relative lengths 1, 2, 3·6, 3·6, 7·5. *Epipharynx:* length 0·14–0·17 mm. *Buccal cavity:* with two rows of poorly developed denticles, variable and rather difficult to count, approximately 17 in each row; pigmented area very small and centrally situated. *Pharynx:* twice as wide posteriorly as anteriorly, armed with irregular faint wavy transverse rows of delicate pointed teeth. *Wing:* length 1·27–1·53 mm., width 0·34 mm., alar index 0·25–0·6, delta + 0·03 to − 0·08 mm. *Terminalia:* coxite (0·18–0·21 mm.) slightly more than twice as long as style (0·15 mm.), which bears four terminal spines and small ventral seta at 0·7; paramere 0·14 mm., penis sheath (0·06 mm.) narrow, straight, with blunt tip, lateral lobe (0·16 mm.) slightly longer than paramere.

Distribution: MAURITIUS; occurs also in the ORIENTAL REGION.

Phlebotomus (*Sergentomyia*) *crosarai* Parrot and Wanson.

P. crosarai Parrot & Wanson, 1946, *Rev. Zool. Bot. afr.* **39**: 225.

Type specimens in the Museum of the Belgian Congo at Tervueren. The descriptions below are after Parrot and Wanson's original descriptions of 14 females from Bongolokoro and Luna, Belgian Congo.

The female is distinguished from other members of the subgenus by its antennal formula.

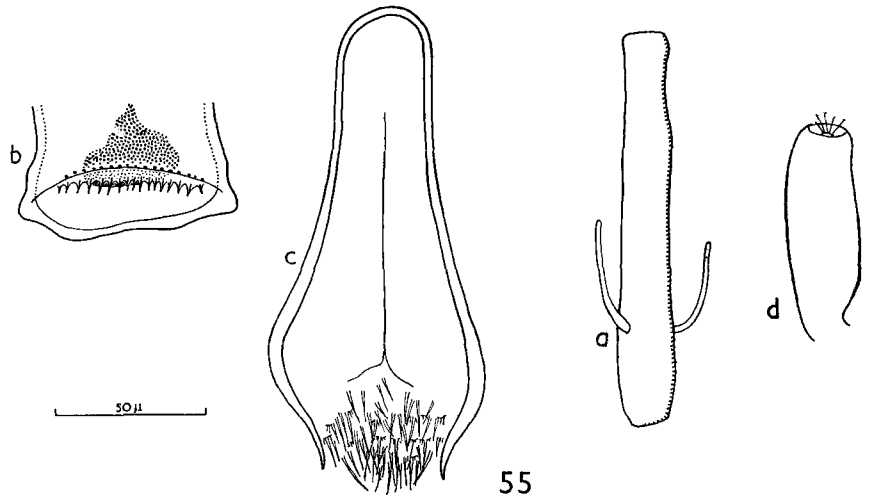


FIG. 55.—*P. crosarai*, ♀: *a*, fourth antennal segment; *b*, buccal cavity; *c*, pharynx; *d*, spermatheca. (After Parrot and Wanson, 1936.)

♂. *Length:* 2·12–2·34 mm. *Antenna:* formula 2/V–XIII, 1/XIV–XV, segment III (0·27–0·28 mm.) > IV + V, AIII/E = 1·4–1·6, ascoids relatively short and fragile, those on V = 0·3 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 3·2, 4·5, 5·5, 8. *Epipharynx:* length 0·17–0·2 mm. *Buccal cavity:* with a row slightly concave posteriorly, of 18–20 equal pointed teeth; anterior to these one or two or sometimes three rows of denticles, the first of 18–20 appearing as large dots, the second of 8–10 delicate denticles and the third

of 1–4 also delicate ; pigmented area brown, irregularly triangular with a more or less marked slightly paler forward process. *Pharynx :* about twice as wide posteriorly as anteriorly, armed with about 50 long strong spines with thread-like tips. *Wing :* 1·87–2·34 mm. long, 0·58–0·84 mm. wide, alar index 1·6–3·5, delta + 0·4 to + 0·5 mm., transverse veins a little nearer the base of the wing than in other species. *Spermatheca :* an elongated capsule.

♂. Unknown.

Distribution : Belgian Congo.

Phlebotomus (*Sergentomyia*) *yvonnae* Parrot and Schwetz.

P. yvonnae Parrot & Schwetz, 1937, *Rev. Zool. Bot. afr.* **29** : 221.

This species is known from one female only, from Siboma, Belgian Congo, and the type specimen is in the Museum of the Belgian Congo at Tervueren. The description below is after Parrot and Schwetz.

♀. *Length :* 1·88 mm. *Antenna :* formula 2/III–XV, segment III (0·18 mm.) < IV + V, AIII/E = 0·94, ascoids short, that on IV = 0·3 length of segment. *Palp :* formula

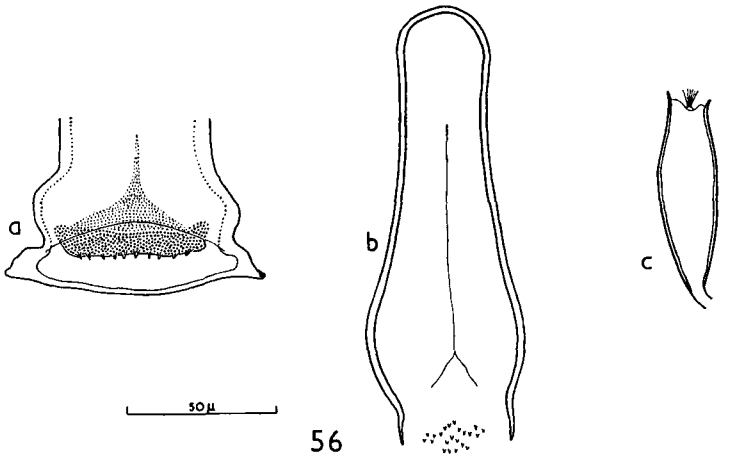


Fig. 56.—*P. yvonnae*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. (After Parrot and Schwetz, 1937.)

1,2,3,4,5, relative lengths 1, 2·4, 3·8, 4·2, 5. *Epipharynx :* length 0·19 mm. *Buccal cavity :* with 10 strong pointed teeth, pigmented area light brown, shaped like an irregular trapezium with its base anteriorly, covering nearly the whole width of the buccal cavity and with a subtriangular paler anterior extension. *Pharynx :* with posterior width a little less than anterior width, sharply constricted towards the posterior end which bears about 30 short pointed denticles. *Wing :* length 1·67 mm., breadth 0·43 mm., alar index 0·77, delta + 0·11 mm. *Spermatheca :* an oblong capsule like that of *P. freetownensis*, but longer.

♂. Unknown.

Distribution : Belgian Congo.

Phlebotomus (*Sergentomyia*) *ingrami* Newstead.

P. ingrami Newstead, 1914, *Bull. ent. Res.* **5** : 179.
P. ingrami Adler, Theodor & Parrot, 1929, *Rev. Zool. Bot. afr.* **18** : 72.
P. ingrami Bequaert & Walravens, 1930, *ibid.* **19** : 34.

P. raptus Parrot, Mornet & Cadenat, 1945, *Arch. Inst. Pasteur Algér.* **23** : 281.
P. ingrami Parrot, 1948, *ibid.* **26** : 121.

Type specimens in the British Museum. The description below is after Parrot (1948), who reviews previous records.

♀. *Length :* 2·23 mm., hind leg 3·2 mm. *Antenna :* formula 2/III–XV, segment III (0·22–0·25 mm.) > IV + V, AIII/E = 1·1–1·4, ascoids on IV = 0·3 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·4, 4·2, 5·2, 9. *Epipharynx :* length 0·16–0·20 mm. *Buccal cavity :* with 24–28 pointed teeth on an arc slightly concave posteriorly, the median teeth being more or less prominent ; one, two or three rows of anterior small denticles, the middle row consisting of 7–10 stout and pigmented denticles ; pigmented plate not extending across whole width of buccal cavity, rounded anteriorly, with a median notch in its posterior border. *Pharynx :* 1·5 times as wide posteriorly as anteriorly, with several rows of fine ridges bearing very small spines. *Wing :* length 2·0–2·17 mm., width

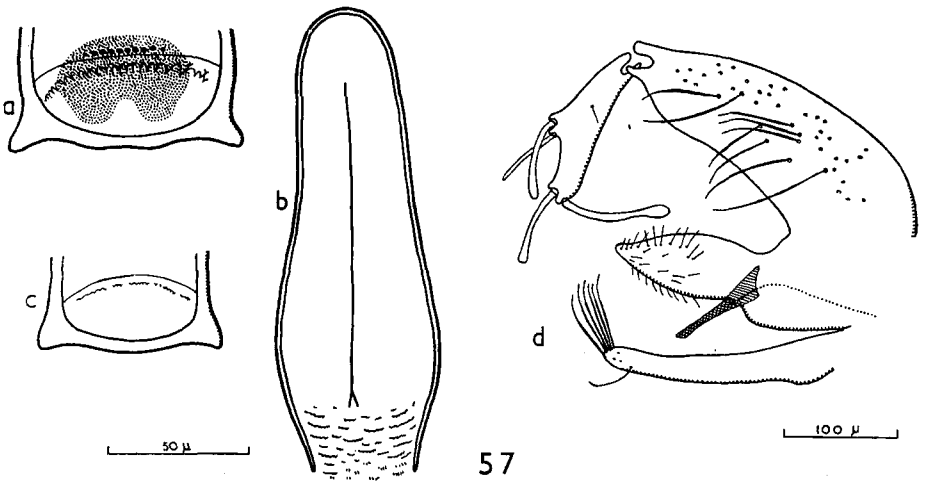


FIG. 57.—*P. ingrami*, ♀ : *a*, buccal cavity ; *b*, pharynx ; ♂ : *c*, buccal cavity ; *d* terminalia. (After Parrot, 1948.)

0·53–0·55 mm., alar index 1–1·3, delta + 0·19 to 0·25 mm. *Spermatheca :* simple, tubular, of *minutus* type.

♂. *Length :* 1·85–2·04 mm., hind leg 3·1 mm. *Antenna :* formula 1/III–XV, segment III (0·20–0·24 mm.) > IV + V, AIII/E = 1·5–1·6, ascoid on IV = 0·25 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·5, 4·3, 5·8, 9·3. *Epipharynx :* length 0·126–0·15 mm. *Buccal cavity :* with 22–30 small short pointed teeth, often not clearly visible, on an arc slightly concave posteriorly ; pigmented plate absent. *Pharynx :* About 1·5 times as wide posteriorly as anteriorly armed with fine folds bearing small spines. *Wing :* length 1·65–1·84 mm., width 0·41–0·46 mm., alar index 0·83–0·90, delta + 0·085 to 0·12 mm. *Terminalia :* coxite (0·25–0·3 mm.) about 2·5 times as long as style (0·09–0·13 mm.), which bears four strong spatulate spines, two of which are terminal and two central or nearly central, with small ventral seta at 0·3 ; paramere lance-shaped (0·17–0·20 mm.), penis sheath (0·09–0·11 mm.) conical with a subapical lateral dilatation ; lateral lobe (0·19–0·21 mm.), bearing at its tip 6–8 long hairs slightly recurved.

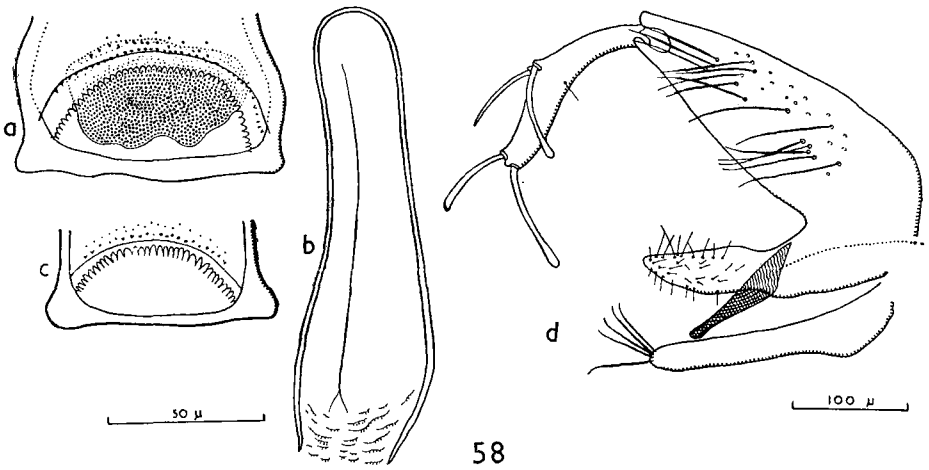
Distribution : ASHANTI, BELGIAN CONGO, IVORY COAST, GOLD COAST, UGANDA, A.-E. SUDAN.

Phlebotomus (*Sergentomyia*) *serratus* Parrot & Malbrant.

P. serratus Parrot & Malbrant, 1945, *Arch. Inst. Pasteur Algér.* **23** : 121.
P. serratus Lewis & Kirk, 1946, *Proc. R. ent. Soc. Lond.* (*B*) **15** : 61.
P. serratus Parrot, 1948, *Arch. Inst. Pasteur Algér.* **26** : 121.

Type specimen from Ouesso, Middle Congo, in the Institut Pasteur d'Algérie. The following description is mainly after Parrot (1948) from the published descriptions of 4 males and two females from the A.-E. Sudan and French Congo.

♀. *Length :* 2·04–2·13 mm., hind leg 2·55–3·0 mm. *Antenna :* formula 2/III–XV, segment III (0·2–0·22 mm) > IV + V, AIII/E = 1·1–1·4, ascoid on IV = 0·3 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·3, 3·8, 5·5, 8·2. *Epipharynx :* length 0·15–0·17 mm. *Buccal cavity :* with 40–52 pointed monomorphic teeth on an arc



58

FIG. 58.—*P. serratus*, ♀ : *a*, buccal cavity ; *b*, pharynx. ♂ : *c*, buccal cavity ; *d*, terminalia. (*a*, *c* and *d* after Parrot, 1948 ; *b* after Parrot and Malbrant, 1945.)

strongly concave posteriorly, the 8–10 median teeth sometimes forming a backwardly projecting salient in the middle of the arc ; three rows of anterior punctiform denticles, the posterior row being most prominent ; pigmented plate not extending across whole width of buccal cavity, rounded anteriorly with a notch in its posterior margin. *Pharynx :* about twice as wide posteriorly as anteriorly, armed with fine ridges bearing small spines. *Wing :* length 1·8–2·13 mm., width 0·44–0·51 mm., alar index 0·85–1·0, delta + 0·15 to 0·19 mm. *Spermatheca :* simple, tubular, of *minutus* type.

♂. *Length :* 2·0–2·4 mm., hind leg 2·8–3·0 mm. *Antenna :* formula 1/III–XV, segment III (0·22–0·27 mm.) > or = IV + V, AIII/E = 1·7–1·8, ascoid on IV = 0·2 length of segment. *Palp :* formula 1, 2,3,4,5, relative lengths 1, 2·7, 4·4, 6, 10. *Epipharynx :* length 0·13–0·16 mm. *Buccal cavity :* with 27–34 straight narrow teeth on an arc strongly concave posteriorly and two irregular rows of anterior punctiform denticles, sometimes occasional members of a third row ; pigmented plate absent. *Pharynx :* about 1·5 times as wide posteriorly as anteriorly with faint wavy transverse ridges and very small spines. *Terminalia :* coxite (0·3–0·32 mm.) 1·5 times as long as style (0·15–0·2 mm.) which bears four strong spatulate spines, two of which are terminal and two central or nearly central, with small ventral seta arising near origin of central spines ; paramere

(0·2 mm.) lance-shaped ; penis sheath (0·10 mm.) conical, with subapical lateral dilatation ; lateral lobe (0·2–0·23 mm.) bearing 6–8 long recurved hairs at its free extremity.

Distribution : FRENCH CONGO, A.-E. SUDAN.

Phlebotomus (*Sergentomyia*) *kirki* Parrot.

P. kirki Parrot, 1948, *Arch. Inst. Pasteur Algér.* **26** : 121.

Type specimens in the British Museum. The description below is after Parrot, from two females and one male from Li Rangu, A.-E. Sudan.

♀. *Length :* 2·56–2·62 mm., hind leg 3·16 mm. *Antenna :* formula 2/III–XV, segment III (0·21–0·23 mm.) > IV + V, AIII/E = 1·2–1·4, ascoids on IV = 0·4 length of segment.

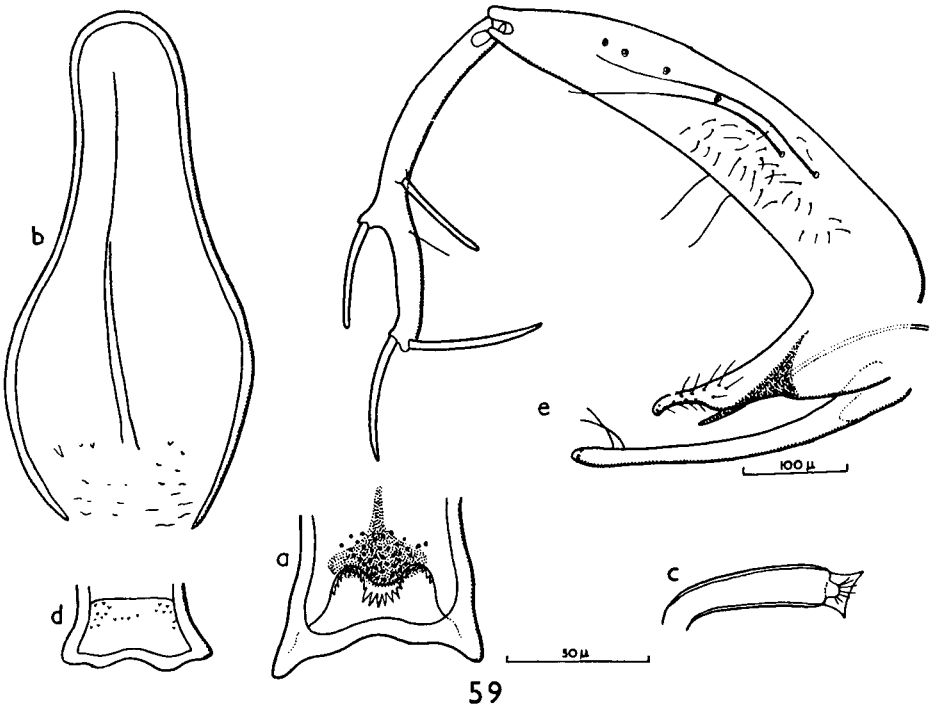


FIG. 59.—*P. kirki*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. ♂ : *d*, buccal cavity ; *e*, terminalia. (After Parrot, 1948.)

Palp : formula 1,2,3,4,5, relative lengths 1, 2·4, 4·3, 4·5, 7. *Epipharynx :* length 0·17 mm. *Buccal cavity :* with 22–24 pointed teeth, the 7–8 median ones larger than the laterals, and projecting strongly backwards, the arrangement of the armature being like a rounded letter M ; an anterior patch of denticles ; pigmented plate brown, lozenge-shaped, with its axis transverse with a slightly paler anterior triangular narrow extension. *Pharynx :* globular with its posterior width a little more than twice its anterior width, armed posteriorly with some scarcely visible short sinuous folds. *Wing :* length 2–2·1 mm., width 0·44–0·46 mm. (five times as long as broad), alar index 0·78–0·9, delta + 0·153 to 0·20 mm. *Spermatheca :* a long sub-cylindrical tube with rigid walls opening into a wide duct of the same diameter.

♂. *Length :* 2·5 mm. *Antenna :* missing. *Palp :* formula 1,2,3,.. (last two segments missing), relative lengths 1, 2·3, 3·7,. . *Epipharynx :* length 0·144 mm. *Buccal cavity :* with 21 very short pointed teeth, irregularly arranged in three groups, a median one of four teeth and two lateral groups of 8–9, the median teeth a little stronger than the lateral ones and projecting posteriorly ; no pigmented plate visible. *Pharynx :* posterior width about twice anterior width, bearing posteriorly some folds bordered with very fine teeth. *Wing :* lanceolate, very long, about six times as long as broad ; length 1·72 mm., width 0·29 mm., alar index 0·47, delta + 0·017. *Terminalia :* coxite (0·45 mm.) 1·5 times length of style, which is 0·31 mm. ; inner surface of coxite with numerous short hairs and six flat long strong silky hairs with well-developed bases ; style long, nearly ten times as long as wide, with four long spatulate spines, an antero-internal one at the middle of the style, a postero-internal one a little below it, and the two others terminal, with small non-deciduous seta arising near the origin of the submedian spine ; paramere (0·22 mm.) turned slightly upward and hooked ; penis sheath (0·114 mm.) an elongated cone with blunt tip, slightly turned up ; lateral lobe 0·30 mm., unarmed, three-quarters length of coxite.

Distribution : A.-E. SUDAN.

Phlebotomus (*Sergentomyia*) *notatus* Parrot.

P. notatus Parrot, 1938, *Arch. Inst. Pasteur Algér.* **16** : 213.

Type locality Dire Dawa, Abyssinia. This species is known from one female only, and Theodor (1948) points out that the position of the species with reference to *P. sylvestris* Sinton must be reconsidered when the male is described. The description of the female given here is after Parrot.

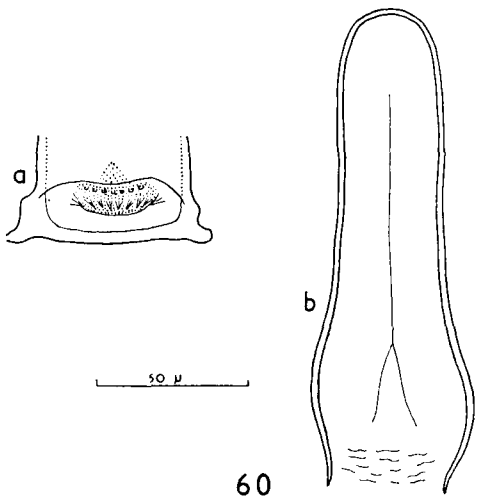


FIG. 60.—*P. notatus*, ♀ : *a*, buccal cavity ; b, pharynx. (After Parrot, 1938.)

♀. *Length :* 2·07 mm., hind leg 2·47 mm. *Antenna :* formula 2/III–XV, segment III (0·15 mm.) < IV + V, ascoids short, those on IV = 0·4 length of segment. AIII/E = 0·84. *Palp :* formula 1,2,(4,3),5, relative lengths 1, 2·2, 4, 3·9, 6·4. *Epipharynx :* length 0·178 mm. *Buccal cavity :* with nine pointed teeth, the three median a little shorter than the lateral ones ; a row of seven anterior subconical strong denticles resembling those of *P. sylvestris* Sinton, but clearly separated from each other and less numerous ; pigmented

plate dark brown and shaped like an irregular crescent, not reaching the sides of the cavity, with a forward prolongation, subtriangular, paler, and rounded at the tip. *Pharynx :* with posterior width 1·5 times anterior width, surrounded posteriorly with fine folds. *Wing :* length 1·61 mm., width 0·32 mm., alar index 0·66, delta + 0·085 mm. *Spermatheca :* simple, tubular.

♂. Unknown.

Distribution : ABYSSINIA.

Phlebotomus (*Sergentomyia*) *collarti* Adler, Theodor & Parrot.

P. collarti Adler, Theodor & Parrot, 1929, *Rev. Zool. Bot. afr.* **18** : 72.

The description below is after the original description of 14 females and 7 males from Stanleyville ; types and co-types are in the Hebrew University, Jerusalem, and the Institut Pasteur d'Algérie.

♀. *Length :* 1·4–1·8 mm. *Antenna :* formula 2/III–XV, segment III (0·15–0·20 mm.) > IV + V, AIII/E = 1·2. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·5, 3·7, 5, 9·4.

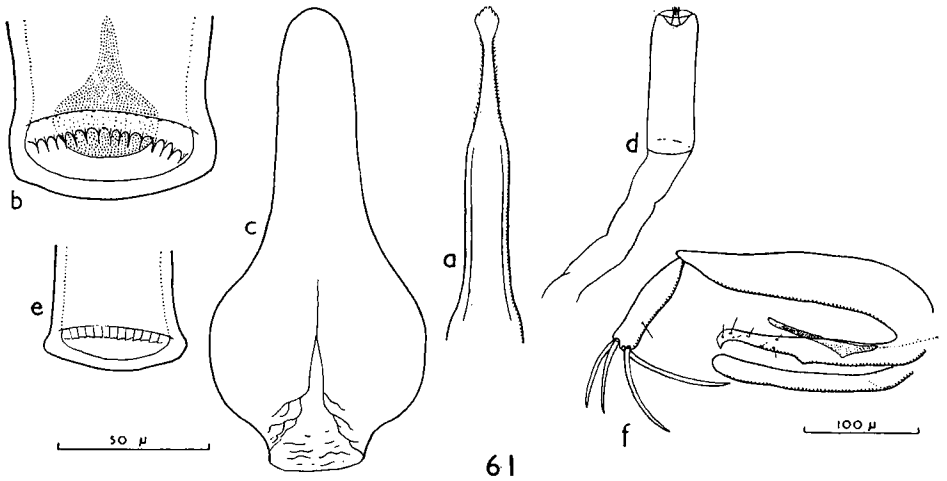


FIG. 61.—*P. collarti*, ♀ : *a*, epipharynx ; *b*, buccal cavity ; *c*, pharynx ; *d*, spermatheca. ♂ : *e*, buccal cavity ; *f*, terminalia. (After Adler, Theodor and Parrot, 1929.)

Epipharynx : 0·12–0·14 mm., tip expanded, not regularly tapering as in other species. *Buccal cavity :* with 10–12 equal rather large pointed teeth on an arc slightly concave posteriorly ; anterior to these a row of small denticles each of which is placed opposite a space between the posterior teeth ; pigmented area pale brown, subtriangular, with an anterior prolongation, sometimes absent. *Pharynx :* with a characteristic shape, three times as wide posteriorly as anteriorly, sharply constricted posteriorly, denticles inconspicuous and in optical section having the appearance of oblique scales and fine parallel folds. *Wing :* length 1·3–1·6 mm., breadth 0·3–0·38 mm., alar index 0·6–1, delta + 0·04 to + 0·12 mm. *Spermatheca :* an elongated cylindrical capsule with a very wide duct.

♂. *Length :* 1·4–1·5 mm., hind leg 2–2·5 mm. *Antenna :* formula 1/III–XV, segment III (0·18–0·2 mm.) > IV + V, AIII/E = 1·5–1·6. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·7, 4, 5·2, 10. *Epipharynx :* length 0·13 mm. *Buccal cavity :* with 10–12 equal teeth on an arc concave posteriorly, smaller and blunter than in the female ; some small short anterior denticles. *Pharynx :* in general shape like that of *P. schwetzi*, denticles less

pointed than in the female. *Wing :* length 1·26 mm., width 0·27 mm., alar index 0·57–0·91, delta 0·04–0·1 mm. *Terminalia :* coxite (0·17–0·2 mm.) 2·5–3 times as long as style (0·75 mm.), which bears four terminal spines and small ventral seta at 0·6 ; paramere hooked, penis sheath cone-shaped with a blunt tip.

Distribution : Belgian Congo, French Congo, A.-E. Sudan.

Phlebotomus (*Sergentomyia*) *decipiens* Theodor.

P. simillimus Adler, Theodor & Parrot, 1929, *Rev. Zool. Bot. afr.* **18** : 72.
P. decipiens Theodor, 1931, *Bull. ent. Res.* **22** : 469.

Adler, Theodor and Parrot described as *P. simillimus* Newstead a species from the Belgian Congo which agreed in its external characters with Newstead's description of that species. Re-examination of Newstead's specimens showed later that the two species were distinct and the one from the Congo was re-

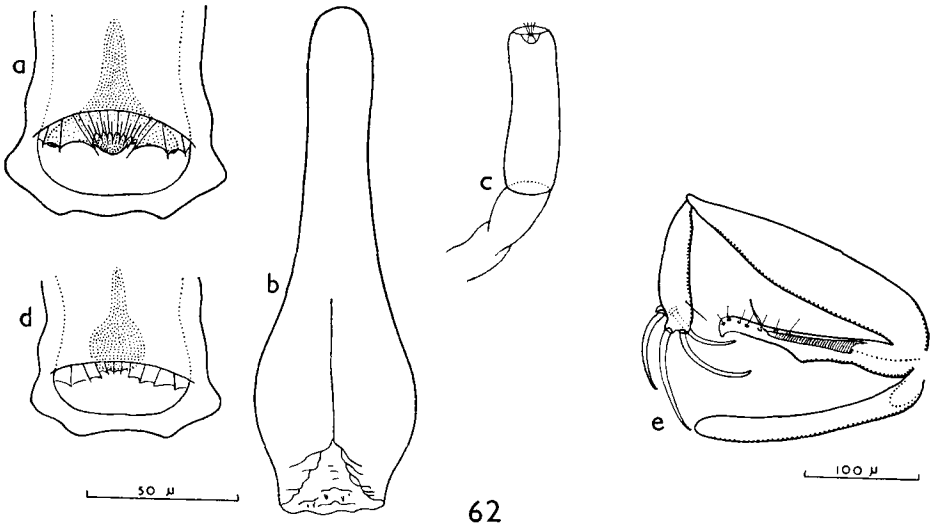


Fig. 62.—*P. decipiens*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. ♂ : *d*, buccal cavity ; *e*, terminalia. (After Adler, Theodor and Parrot, 1929.)

described as *P. decipiens*. The account below is after the original description of 21 females and 28 males from the Congo.

♀. *Length :* 1·0–2·1 mm., hind leg 2·7–3·2 mm. *Antenna :* formula 2/III–XV, segment III > IV + V, AIII/E = 1·4–1·6. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·4, 3·6, 4·9, 8·6. *Epipharynx :* length 0·13–0·15 mm. *Buccal cavity :* with 12–14 pointed dimorphic teeth, the 4–5 median ones pointed and much straighter than the lateral ones, which are very broad and have long points, the appearance of the lateral teeth varying much according to the position in which they are mounted ; pigmented plate dark brown and subtriangular with a median projection on the posterior concave margin. *Pharynx :* like that of *P. schwetzi*, but longer and narrower. *Wing :* length 1·6–1·8 mm., width 0·4–0·5 mm., alar index 1·4–2·0, delta + 0·26 to + 0·32 mm. *Spermatheca :* a cylindrical capsule with a wide duct.

♂. *Length :* 1·7–2·2 mm., hind leg 2·6–3 mm. *Antenna :* formula 1/III–XV, segment III very long > IV + V, AIII/E = 2·1–2·2. *Palp :* formula 1,2,3,4,5, relative lengths

1, 2·2, 3·7, 5, 8·6. *Epipharynx:* length 0·13–0·16 mm. *Buccal cavity:* teeth as in the female but smaller and with shorter points, pigmented plate brown, irregular and less wide at the base than in the female, sometimes absent. *Pharynx:* posterior width nearly three times anterior width and bearing fine folds. *Terminalia:* coxite (0·23–0·28 mm.) more than twice as long as style (0·1–0·13 mm.), which bears two apical and two subapical spines and small ventral seta near subapical spines; paramere hooked, penis sheath conical with blunt point.

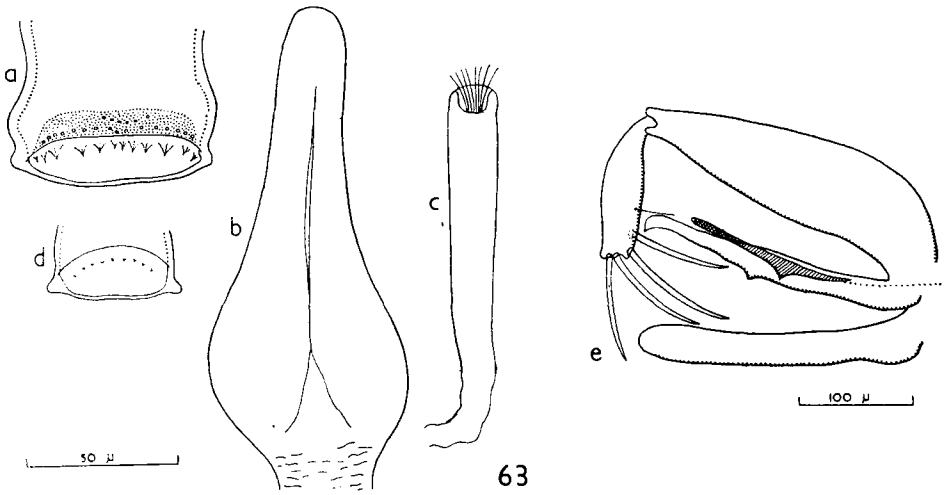
Distribution: BELGIAN CONGO, UGANDA.

Phlebotomus (*Sergentomyia*) *dureni* Parrot.

P. dureni Parrot, 1934, *Rev. Zool. Bot. afr.* **24**: 266.
P. dureni Parrot, 1939, *ibid.* **32**: 145.

The description given below is after Parrot's original description of two females from Opeinge and three females from Matadi, Belgian Congo. Type specimens are in the Museum of the Belgian Congo at Tervueren.

♀. *Length:* 2·18 mm., hind leg 2·5–2·8 mm. *Antenna:* formula 2/III–XV, segment III (0·217–0·23 mm.) > IV + V, AIII/E = 1·36, ascoids short, those on IV = 0·25 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·5, 4·2, 4·8, 10. *Epipharynx:*



63

FIG. 63.—*P. dureni*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca. ♂: *d*, buccal cavity; *e*, terminalia.

length 0·16–0·17 mm. *Buccal cavity:* with 12 pointed teeth on an arc very slightly concave posteriorly, the two median teeth shorter and narrower than the others; two anterior rows of fine denticles, the first with 7 and the second with 16; pigmented plate pale brown, with no anterior prolongation. *Pharynx:* with posterior width about three times anterior width, very constricted posteriorly and with fine ridges as in *P. schwetzi*, but fewer. *Wing:* length 1·6–1·7 mm., width 0·38–0·40 mm., alar index 0·61–0·65, delta + 0·11 to + 0·13 mm. *Spermatheca:* tubular, slightly wider distally than proximally and continuing without clear demarcation into a duct of equal diameter.

♂. *Length:* 1·62–1·69 mm., hind leg 2·35–2·4 mm. *Antenna:* formula 1/III–XV, segment III (0·24–0·25 mm.) < IV + V, AIII/E = 1·66, ascoids very short, as in the female, that on IV = 0·17 length of segment. *Palp:* formula 1,2,3,4,5, relative lengths 1, 3·5,

5·5·, 5·9, 7. *Epipharynx :* length 0·14–0·15 mm. *Buccal cavity :* with 8–10 short pointed monomorphic teeth on an arc concave posteriorly ; no pigmented area. *Pharynx :* posterior width 1·5 times anterior width, without visible folds or denticles. *Wing :* length 1·48–1·63 mm. width 0·28–0·30 mm., alar index 0·58–0·75, delta + 0·04 to + 0·1 mm. *Terminalia :* coxite (0·21–0·22 mm.) slightly more than twice length of style, which bears two terminal and two subterminal spines and anterior small seta at 0·7 ; paramere (0·17 mm.) as long as lateral lobe, hooked ; penis sheath elongated, bluntly pointed, slightly turned up at the tip ; lateral lobe 0·168–0·175 mm., unarmed.

Distribution : Belgian Congo, Ivory Coast, French Congo, A.-E. Sudan.

Phlebotomus (*Sergentomyia*) *squamipleuris* Newstead.

P. squamipleuris Newstead, 1912, *Bull. ent. Res.* **3** : 366.
P. minutus var. *africanus* Newstead, 1912, *ibid.* **3** : 363.
P. squamipleuris Sinton, 1923, *Indian J. med. Res.* **11** : 65 ; 1927, *ibid.* **15** : 24.
P. ghesquieri Parrot, 1929, *Rev. Zool. Bot. afr.* **18** : 90.
P. iraqi Adler & Theodor, 1929, *Ann. trop. Med. Parasit.* **23** : 269.
P. squamipleuris Theodor, 1931, *Bull. ent. Res.* **22** : 470.

Newstead described this species from a single female from Khartoum. In 1923 Sinton recorded this species from India and described both sexes, adding the description of the characteristic buccal armature and spermatheca in 1927. Theodor in 1933 pointed out certain differences between the African and Indian forms of the species and separated the latter from the type as *P. squamipleuris* var. *indicus*. The synonymy of *P. squamipleuris* and *P. africanus* is discussed on p. 408.

The description given here has been compiled from published descriptions of 16 female and 9 male African specimens supplemented by our own material from Khartoum and examination of one of Newstead's specimens, labelled co-type ♀, from Khartoum, which is in the British Museum.

♀. *Length :* 1·4–1·9 mm., hind leg 2·3–2·6 mm. *Antenna :* formula 1/IV–XV, segment III (0·15–0·17 mm.) < IV + V, AIII/E = 1–1·1, ascoid on IV = 0·5 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·5, 3·8, 4·6, 8·4 ; Newstead's spines on segments 2 and 3. *Epipharynx :* length 0·15–0·17. *Buccal cavity :* with 36–40 long teeth, blunt in appearance but shown by dissection to be very pointed, arranged on an arc strongly convex posteriorly ; pigmented plate dark brown, convex posteriorly, resembling in shape a section of an orange with a small narrow pointed paler anterior prolongation ; anteriorly to the pigmented plate a pair of lateral buccal protuberances project inwardly from the wall of the buccal cavity ; in specimens cleared with caustic potash a row of small anterior denticles can sometimes be seen in front of the buccal teeth (*P. iraqi*). *Pharynx :* with posterior width about four times anterior width, sharply constricted posteriorly, pigmented in the centre and bearing numerous strong denticles. *Wing :* length 1·5–1·9 mm., width 0·36–0·45 mm., alar index 1–1·3, delta + 0·12 to + 0·21 mm. Thoracic pleurae in fresh specimens are seen to bear tufts of broad scales like those seen in mosquitoes. *Spermathecae :* non-crenulated, globular, turnip-shaped covered with regular transverse rows of small spiniform projections. *Abdomen :* may show a few erect hairs on the dorsal aspects of segments II–VI, but usually all hairs are recumbent in this position.

♂. *Length :* 1·4–1·7 mm. *Antenna :* formula 1/IV–XV, segment III (0·14–0·16 mm.) < IV + V, AIII/E = 1·1, ascoid on IV = 0·28 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·5, 4·1, 4·7, 7 ; Newstead's spines on segments 2 and 3. *Epipharynx :* length 0·128–0·145 mm. *Buccal cavity :* with about 18 small blunt teeth slightly separated from each other ; pigmented plate brown, irregularly oval, sometimes absent ; lateral buccal protuberances less marked than in the female. *Pharynx :* as in the female, but

non-pigmented and with less well-marked denticles. *Wing:* length 1·5 mm., width 0·32–0·36 mm., alar index 0·93–1·28, delta + 0·10 to + 0·18 mm. Broad scales on thoracic pleurae. *Abdomen:* sixth segment large and slightly tapering. *Terminalia:* coxite (0·18–0·23 mm.) a little more than twice as long as style (0·08–0·10 mm.), which bears four terminal spines and small ventral seta at 0·6; penis sheath pointed, penis filaments bifid with bulbous expanded extremity.

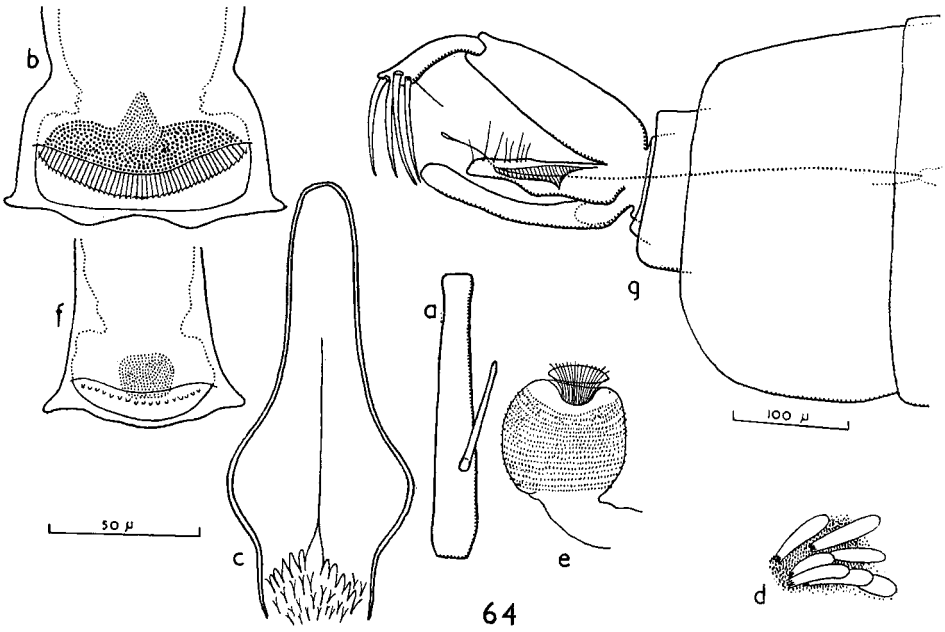


FIG. 64.—*P. squamipleuris*, ♀: *a*, fourth antennal segment; *b*, buccal cavity; *c*, pharynx; *d*, pleural scales; *e*, spermatheca. ♂: *f*, buccal cavity; *g*, terminalia. (*a* and *g* from Sudan specimen; *b* and *c* after Theodor, 1938; *d* after Newstead, 1912; *e* and *f* after Parrot, 1930.)

P. squamipleuris presents a number of highly characteristic features such as the unusual antennal formula (especially in the female) the presence of scanty erect hairs on the abdominal tergites, the broad scales on the thoracic pleurae and the presence of Newstead's spines on the 2nd and 3rd palpal segments.

Distribution: ABYSSINIA, MADAGASCAR, MOZAMBIQUE, NIGERIA, A.-E. SUDAN, SENEGAL, FRENCH SUDAN, IVORY COAST, DAHOMEY, FRENCH CONGO. Also in Palaearctic Region.

Phlebotomus (*Sergentomyia*) *squamipleuris* var. *dreyfussi* Parrot.

P. squamipleuris var. *dreyfussi* Parrot, 1933, *Arch. Inst. Pasteur Algér.* **11**: 603.
P. squamipleuris var. *dreyfussi* Ristorcelli, 1941, *Arch. Inst. Pasteur Maroc.* **2**: 521.
P. squamipleuris var. *dreyfussi* Parrot & Durand-Delacre, 1947, *Arch. Inst. Pasteur Algér.* **25**: 77.

Type locality Laghuat, Algeria; type specimen in the Institut Pasteur d'Algérie. The description below is mainly after Parrot and Durand Delacre, from ten females and one male.

♀. *Length :* 1·8–2·2 mm. *Antenna :* formula 1/IV–XV, segment III (0·17–0·21 mm.) > IV + V, AIII/E = 1·07–1·2. *Palp :* formula 1,2,3,4,5, relative lengths 1, 3·1, 4·2, 5·1, 8·4. *Epipharynx :* length 0·18 mm. *Buccal cavity :* with 42–45 monomorphic teeth on an arc convex posteriorly ; pigmented plate dark brown, shaped like an irregular section of an orange with a pale triangular forward prolongation. *Pharynx :* three times as wide posteriorly as anteriorly, bearing numerous strong spines. *Wing :* length 1·7–2 mm. breadth 0·4–0·53 mm., alar index 0·68–1·1, delta + 0·085 to + 0·17 mm. *Legs :* each trochanter with short spines as described by Newstead and Sinton in *P. squamipleuris ;* proximal half of each femur with short, slightly curved spines on the inner surface, 8–9 on the first femora, 5–4 on the second, and 4–3 on the third. *Spermatheca :* a turnip-shaped capsule slightly elongated with nearly parallel sides, pigmented from its junction with the duct for two-thirds of its length and very finely pubescent, larger than in *P. squamipleuris* (0·040–0·045 mm. long and 0·035–0·038 mm. wide).

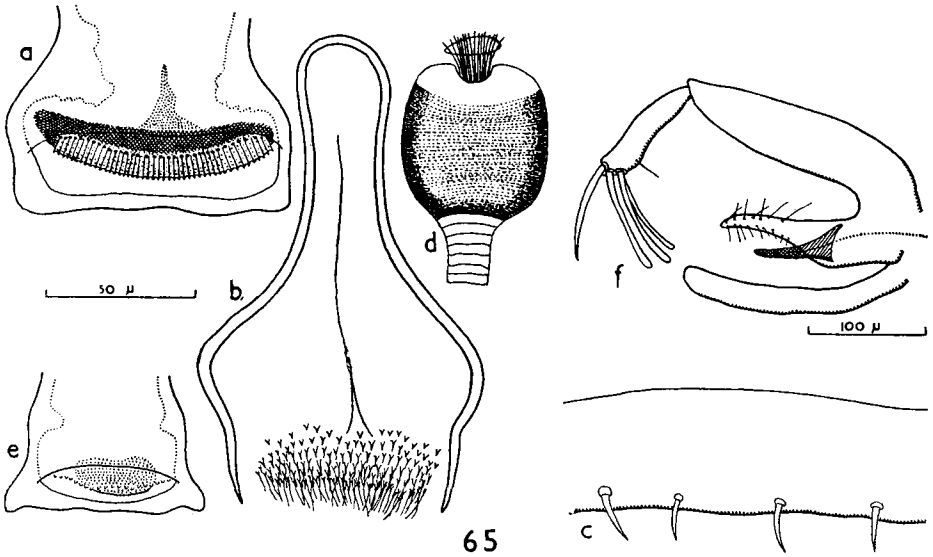


FIG. 65.—*P. squamipleuris* var. *dreyfussi*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spines on first femur ; *d*, spermatheca. ♂ : *e*, buccal cavity ; *f*, terminalia. (After Parrot and Durand-Delacre, 1947.)

♂. *Length :* 1·94 mm. *Antenna :* formula 1/IV–XV, segment III (0·23 mm.) < IV + V, AIII/E = 1·5, ascoid on IV = 0·3 length of segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 2·9, 4·1, 4·5, 8·3. *Epipharynx :* length 0·15 mm. *Buccal cavity :* with 22 teeth, pigmented area and prominent lateral buccal protuberances as in *P. squamipleuris*. *Pharynx :* about twice as wide posteriorly as anteriorly armed with fine, short spines. *Wing :* length 1·84 mm., breadth 0·39 mm., alar index 0·95, delta + 0·15 mm. *Legs :* spines on all femora as in the female. *Terminalia :* coxite (0·21 mm.) more than twice as long as style (0·1 mm.), which bears two terminal and two subterminal spines and small ventral seta at 0·8 ; paramere 0·1 mm., penis sheath (0·08 mm.) elongated, conical with sharp point, lateral lobe 0·20 mm.

This variety differs from typical *P. squamipleuris* and its other varieties by the presence of the femoral spines in both sexes, in the male by the greater body length and greater length of AIII and higher value of AIII/E, and in the

female by the number of buccal teeth, the shape of the pharyngeal armature and the large spermatheca.

Distribution : ABYSSINIA, ERITREA, also in North Africa.

Phlebotomus (*Sergentomyia*) *squamipleuris* var. *inermis* Theodor.

P. squamipleuris var. *inermis* Theodor, 1938, *Bull. ent. Res.* **29** : 165.

The description given below is after the original description from 28 females from Gadau. This variety differs from *P. squamipleuris* chiefly in the armature of the buccal cavity and pharynx.

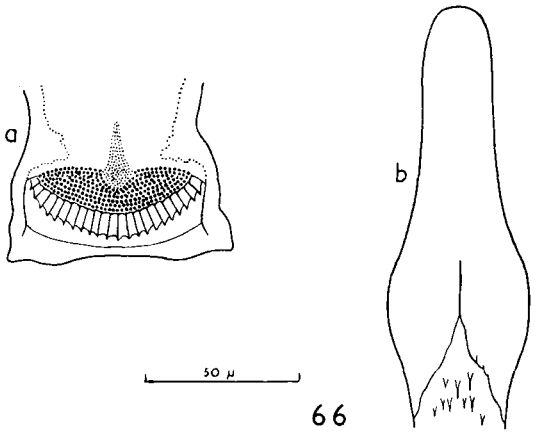


FIG. 66.—*P. squamipleuris* var. *inermis*, ♀ : *a*, buccal cavity ; *b*, pharynx. (After Theodor, 1938.)

♀. All measurements and indices as in *P. squamipleuris*. *Buccal cavity :* with 20–24 teeth, pigmented plate like the segment of a circle with the straight side anteriorly. *Pharynx :* with posterior part less widened than in *P. squamipleuris* and hardly any armature except a few small teeth. *Legs :* no spines on the femora. *Spermatheca :* as in the type form.

♂. Unknown.

Distribution : NIGERIA, ABYSSINIA, A.-E. SUDAN.

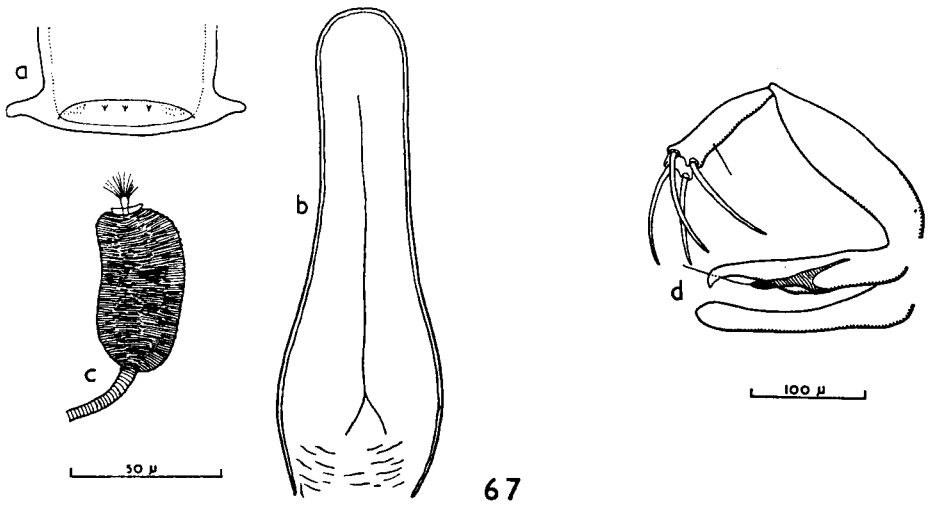
Phlebotomus (*Sergentomyia*) *wurtzi* Parrot.

P. wurtzi Parrot, 1938, *Arch. Inst. Pasteur Algér.* **16** : 213.

The description below is after Parrot, from one female and one male from Dire Dawa, Abyssinia. Type specimens in the Institut Pasteur d'Algérie.

♀. *Length :* 2·25 mm., hind leg 3·1 mm. *Antenna :* formula 2/III–XV, segment III (0·168 mm.) = IV + V, AIII/E = 1·0, ascoids long, but not reaching beyond the tips of their segments, those on IV = 0·6 length of segment. *Palp :* formula 1,2,4,3,5, relative lengths 1, 1·8, 4·6, 3·8, 7. *Epipharynx :* length 0·168 mm. *Buccal cavity :* with three short, pointed, widely separated median teeth and on each side a dozen fine, irregular, scarcely visible denticles ; pigmented plate absent. *Pharynx :* with posterior width a little less than twice anterior width and with several transverse folds. *Wing :* length 1·82 mm., width 0·44 mm., alar index 0·63, delta + 0·066 mm. *Spermatheca :* sac-like with numerous fine parallel transverse folds.

♂. *Length :* 2 mm., hind leg 2·62 mm. *Antenna :* formula 1/III–XV, segment III (0·175 mm.) = IV + V, AIII/E = 1·1, ascoid on IV about a third of its length. *Palp :* formula 1,2,4,3,5, relative lengths 1, 2·2, 4·7, 3·3, 7·3. *Epipharynx :* length 0·157 mm. *Buccal cavity :* without visible teeth and without pigmented plate. *Pharynx :* 1·5 times as wide posteriorly as anteriorly, without denticles or visible folds. *Wing :* length 1·56



67

FIG. 67.—*P. wurtzi*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. ♂ : *d*, terminalia. (After Parrot, 1938.)

mm., width 0·34 mm., alar index 0·7, delta + 0·09 mm. *Terminalia :* coxite (0·20 mm.) about twice length of style (0·098 mm.) which bears four long terminal spines and small ventral seta at about 0·7 ; paramere 0·164 mm., hooked ; penis sheath (0·06 mm.) a little turned up towards its apex with rounded tip ; lateral lobe 0·178 mm., a little shorter than coxite.

Distribution : ABYSSINIA.

Phlebotomus (*Sergentomyia*) *horgani* Lewis and Kirk.

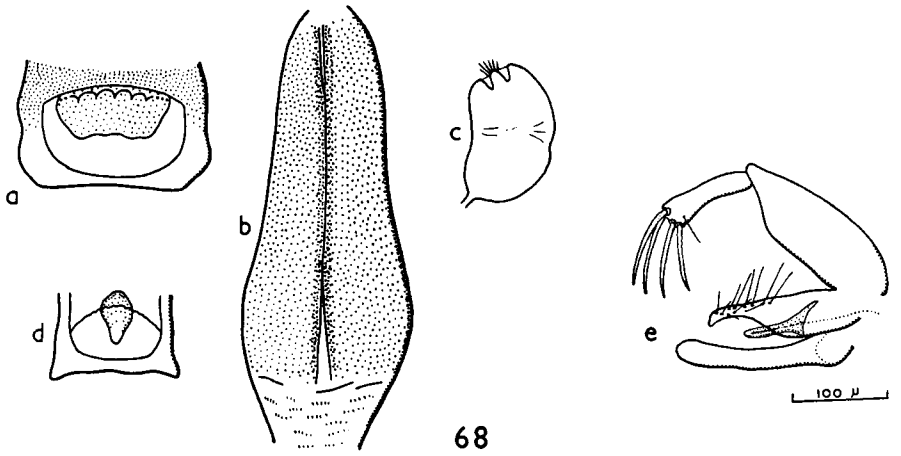
P. horgani Lewis & Kirk, 1946, *Proc. R. ent. Soc. Lond.* (*B*) **15** : 55.

Type specimens in the British Museum. Descriptions are based on one female and 4 males from Lake Jur and R. Zeraf, A.-E. Sudan. Theodor (1948) considered that *P. horgani* might be a synonym of *P. wurtzi*.

♀. *Length :* 2·6 mm., hind leg 3·6 mm. *Antenna :* formula 2/III–XV, segment III (0·20 mm.) = IV + V, AIII/E = 0·8, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,2,(4,3),5, relative lengths 1, 1·6, 2·4, 2·3, 5. *Buccal cavity :* about five delicate pointed teeth (some may be missing), pigmented plate narrow and with irregular hind margin. *Pharynx :* with posterior width 1·5 times anterior width, thin walled and pigmented with a few minute ridges and spicules. *Epipharynx :* length 0·26 mm. *Wing :* length 1·8 mm., width 0·5 mm., alar index 0·8, delta + 0·14 mm. *Spermatheca :* a rather delicate thin-walled sac.

♂. *Length :* 1·8–2·1 mm., hind leg 2·5–2·7 mm. *Antenna :* formula 1/IV–XV, segment III (0·14–0·17 mm.) < IV + V, AIII/E = 0·9. *Palp :* formula 1,2,3,4,5, relative lengths

1, 2·0, 3·4, 4·2, 8·4. *Epipharynx:* length 0·19 mm. *Buccal cavity:* teeth vestigial, pigmented plate small and pear-shaped, pointed posteriorly. *Pharynx:* with posterior width twice anterior width, very lightly pigmented and unarmed. *Wing:* length 1·3–1·6 mm., width 0·28–0·30 mm., alar index 0·7, delta + 0·05 to 0·09 mm. *Terminalia:* coxite



68

FIG. 68.—*P. horgani*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca. ♂: *d*, buccal cavity; *e*, terminalia. (After Lewis and Kirk, 1946.)

(0·18–0·20 mm.) about twice as long as style (0·09–0·10 mm.), which bears four terminal spines and small ventral seta at 0·9; paramere 0·10–0·14 mm., hooked; penis sheath 0·08–0·09 mm., conical and blunt, but appearing dagger-like and pointed unless its position is changed by pressure; lateral lobe 0·17–0·18 mm.

Distribution: A.-E. SUDAN.

Phlebotomus (*Sergentomyia*) *lewisi* Parrot.

P. lewisi Parrot, 1948, *Arch. Inst. Pasteur. Algér.* **26**: 121.

The description given is after Parrot's original description. The species is known from one female only, from Abri, A.-E. Sudan. The type specimen is in the British Museum (Natural History).

♀ (damaged). *Antenna:* formula 2/III–XV, segment III (0·20 mm.) > IV + V, AIII/E = 1·23, ascoids very short and with rounded tips, those on IV = 0·2 length of segment. *Palp:* formula 1,2,(3,4),5, relative lengths 1, 3·3, 4·8, 4·8, 8; modified spines of Newstead only on proximal third of segment 3. *Epipharynx:* length 0·162 mm. *Buccal cavity:* with 21 pointed equal monomorphic teeth in a straight line; anteriorly a row of 21 strong round denticles, each placed about opposite an interdentary space; more anteriorly, and laterally, two groups of 6–7 smaller denticles; pigmented plate dark brown, shaped like an irregular ellipse, elongated transversely and reaching the sides of the buccal cavity, with an anterior, paler, broad, truncated extension; two well-developed pre-buccal lateral processes, pointing inwards and with irregular inner margins. *Pharynx:* posterior width about 2·5 times anterior width, sharply constricted at the posterior end, which bears numerous strong spines with long points. *Wing:* length 1·77 mm., width 0·51 mm., alar index 0·81, delta + 0·136 mm. *Spermatheca* as in *P. squamipleuris*, a poppy-head shaped body, apparently smooth.

♂. Unknown.

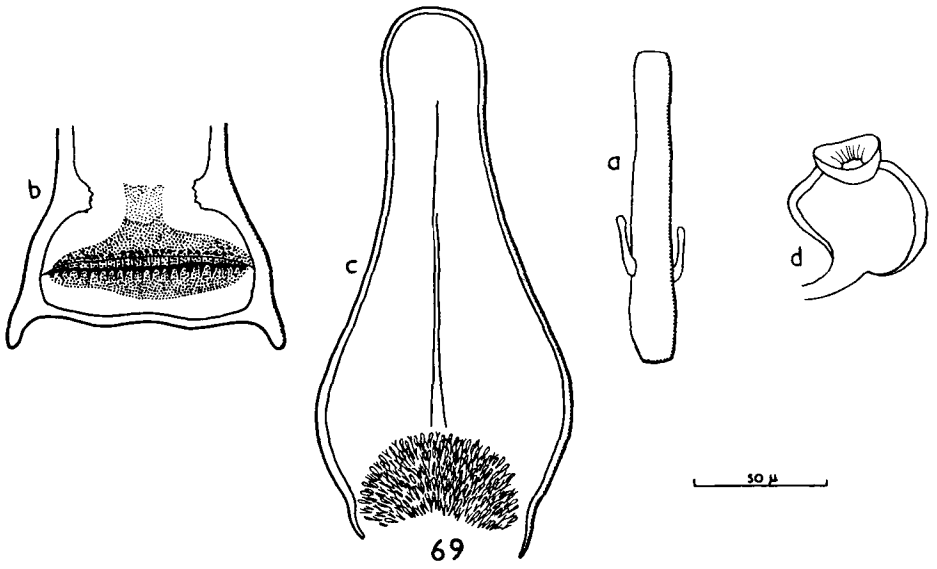


FIG. 69.—*P. lewisi*, ♀: *a*, fourth antennal segment; *b*, buccal cavity; *c*, pharynx; *d*, spermatheca. (After Parrot, 1948.)

Variation. A female from Agordat, in Eritrea, possibly of this species, has been examined by Dr. L. Parrot. He noted that the antennal ascoids were a little less spatuliform and the buccal denticles less conspicuous than in the type.

Distribution: A.-E. SUDAN, ERITREA.

Phlebotomus (*Sergentomyia*) *hunti* Lewis and Kirk.

P. hunti Lewis & Kirk, 1946, *Proc. R. ent. Soc. Lond.* (*B*) **15** : 55.

From the original description of 6 females and 3 males from Li Yubu, A.-E. Sudan. Type specimens in the British Museum.

♀. *Length:* 2·7–3·4 mm., hind leg 4·7–4·9 mm. *Antenna:* formula 2/III–IX (distal segments missing), segment III (0·41–0·42 mm.) > IV + V, AIII/E = 1·6, ascoids on IV = 0·3 length of segment. *Palp:* formula 1,2,3,4, (5 missing), relative lengths 1, 2·5, 3·8, 5·2. *Epipharynx:* length 0·26–0·28 mm. *Buccal cavity:* with no normal teeth but with numerous tooth-like thickenings in the position occupied by the anterior denticles of many species; pigmented plate very wide, extending to the sides of the cavity, with a short forward pale projection, hind margin variable in shape, smooth or irregular. *Pharynx:* with posterior width twice anterior width, slightly constricted, at hind end armed with minute spicules. *Wing:* length 2·21–2·36 mm., width 0·64–0·73 mm., alar index 2·2, delta + 0·44 to + 0·55 mm. *Spermatheca:* thin-walled and sub-cylindrical, broader distally.

♂. *Length:* 2·7–3·2 mm. *Antenna:* formula 1/III–V (distal segments missing), segment III (0·49 mm.) > IV + V, AIII/E = 2·0, ascoid on IV = 0·2 length of segment *Palp:* formula 1,2,3,4,5, relative lengths 1, 2·8, 4·5, 5·7, —. *Buccal cavity:* with three rows of punctiform denticles about 8, 15 and 18 in number; about six minute pointed teeth; pigmented plate small, oval and ill-defined. *Pharynx:* as in female. *Epipharynx:* length 0·24 mm. *Wing:* length 2·13–2·16 mm., breadth 0·55–0·59 mm., alar index 2·1, delta + 0·41 to 0·43 mm. Genital pump in segment VI. *Terminalia:* coxite (0·34–0·38

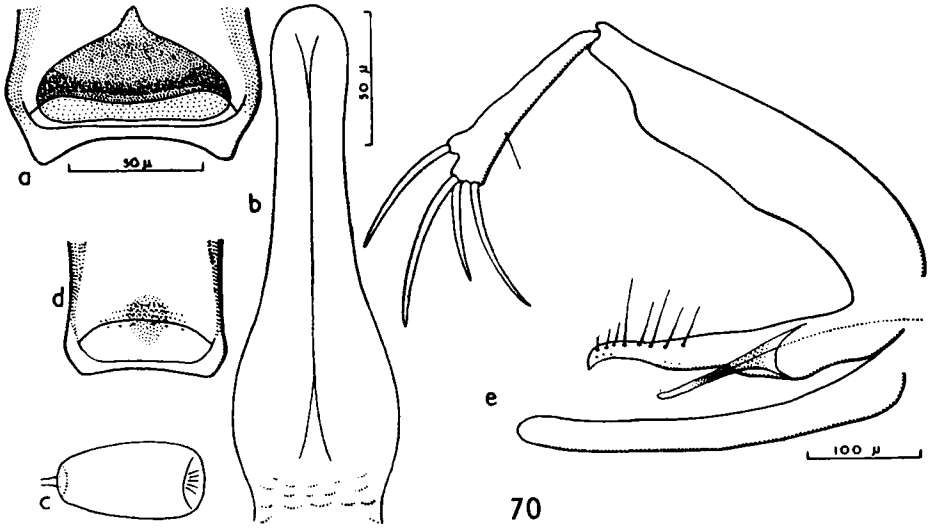


FIG. 70.—*P. hunti*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca. ♂: *d*, buccal cavity; *e*, terminalia. (*a* from Sudan specimen; *b–e* after Lewis and Kirk, 1946.)

mm.) 2·2 times length of style (0·16–0·17 mm.), which bears four terminal spines and small ventral seta 0·7; paramere 0·21–0·24 mm.; penis sheath 0·14–0·15 mm., conical, bluntly pointed and turned up at the tip, with pigmented centre and clear tip; lateral lobe hooked.

Distribution: A.-E. SUDAN.

Phlebotomus (*Sergentomyia*) *ruttledgei* Lewis and Kirk.

P. ruttledgei Lewis & Kirk, 1946, *Proc. R. ent. Soc. Lond.* (*B*) **15** : 55.

This species is known from one female only, from the Zeraf River, A.-E. Sudan. Type specimen is in the British Museum.

♀. *Length:* 1·8 mm., hind leg 2·2 mm. *Antenna:* formula 2/III–XII (other segments missing), segment III (0·08 mm.) < IV + V, AIII/E = 0·5, ascoids on IV more than half

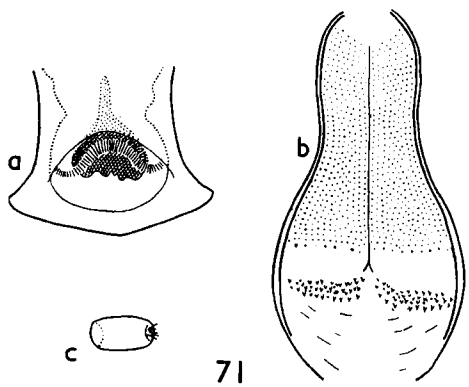


FIG. 71.—*P. ruttledgei*, ♀: *a*, buccal cavity; *b*, pharynx; *c*, spermatheca. (After Lewis and Kirk, 1946.)

length of the short thick segment. *Palp :* formula 1,2,3,4,5, relative lengths 1, 1·9, 3·1, 4·2, 8·8. *Epipharynx :* length 0·17 mm. *Buccal cavity :* with about 50 very fine teeth on an arc deeply concave posteriorly, most of them pointing radially inwards and the outer ones pointing backwards ; some ill-defined denticles at the bases of some of the teeth ; pigmented plate much narrower than buccal cavity, with long narrow forward extension and very uneven posterior margin. *Pharynx :* with posterior width twice anterior width, somewhat constricted before the middle, slightly pigmented in anterior two-thirds ; dorsal plate with faint ridges, ventral plates with a transverse band of delicate but conspicuous pointed teeth. *Wing :* length 1·37 mm., width 0·28 mm., alar index 0·6, delta + 0·03 mm. *Spermatheca :* simple, tubular.

♂. Unknown.

Distribution : A.-E. SUDAN.

Phlebotomus (*Sergentomyia*) *lumsdeni* Kirk & Lewis.

P. lumsdeni Kirk & Lewis, 1950, *Proc. R. ent. Soc. Lond.* (*B*) **19** : 11–13.

♀. *Length :* 1·9 mm. *Antenna :* missing. *Palp :* formula 1,2,4,3,5, relative lengths 1, 2·4, 5, 4, 12·4. *Epipharynx :* length 0·2 mm. *Buccal cavity :* with 15–16 teeth on an arc strongly concave posteriorly ; the median one or two teeth are small, short and straight, differing from the lateral ones which are very large pointed and curved, so that their points are directed medially and posteriorly, those nearest the median teeth being directed more

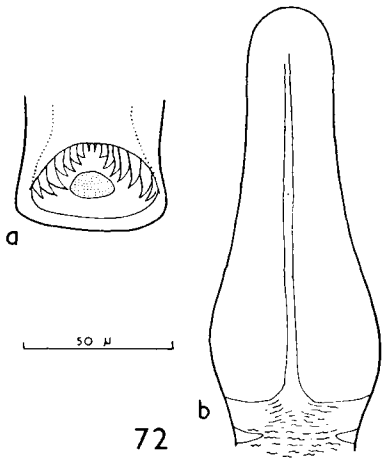


FIG. 72.—*P. lumsdeni*, ♀ : *a*, buccal cavity ; *b*, pharynx. (After Kirk and Lewis, 1950.)

medially than the extreme lateral ones, which are directed more posteriorly ; pigmented area faint and indistinct. *Pharynx :* about twice as wide posteriorly as anteriorly, lamp-glass shaped, with an armature of transverse wavy ridges and, laterally, occasional squamous spines with the points directed medially. *Wing :* length 1·6 mm., width 0·55 mm., alar index 1·8, delta + 0·07 mm. *Spermatheca :* simple, tubular, poorly chitinized, without annulations.

♂. Unknown.

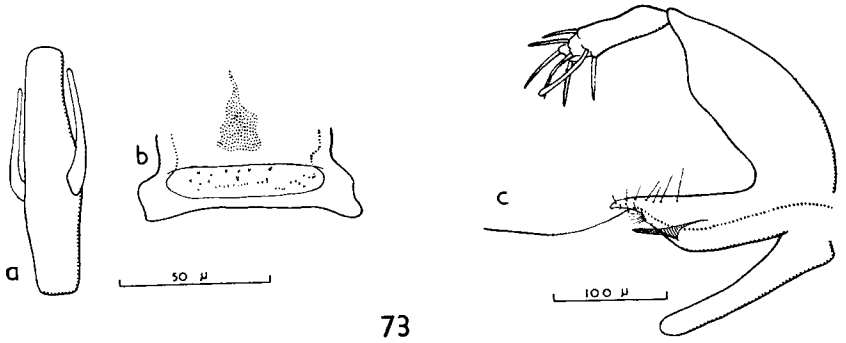
The female of *P. lumsdeni* is distinguished from all the other Ethiopian species by the characteristic morphology of the buccal teeth. Type specimen (one ♀ only) is in the British Museum.

Distribution : UGANDA.

Phlebotomus (*Sergentomyia*) *hirtus* Parrot & de Jolinière.

P. hirtus Parrot & de Jolinière, 1945, *Arch. Inst. Pasteur Algér.* **23** : 56.

Type specimen, from the Ahaggar, in the Institut Pasteur d'Algérie. This species is known from one male only which is readily distinguishable from all the other Ethiopian species by the presence of seven spines on the style. Theodor (1948) considered it might be an abnormality. The description given below is after Parrot and de Jolinière.



73

FIG. 73.—*P. hirtus*, ♂ : *a*, fourth antennal segment ; *b*, buccal cavity ; *c*, terminalia. (After Parrot and De Jolinière, 1945.)

♀. Unknown.

♂. *Length :* 2·62 mm., hind leg 2·8 mm. *Antenna :* formula 2/III–XV, segment III (0·14 mm.) = IV + V, AIII/E = 0·67, ascoids on IV = 0·5 length of segment. *Palp :* formula 1,2,4,3,5, relative lengths 1, 2·5, 4·5, 3·2, 5. *Epipharynx :* length 0·21 mm. *Buccal cavity :* with two median rows and two lateral groups of short, pointed and irregularly arranged teeth ; pigmented plate triangular with base posteriorly. *Pharynx :* posterior width twice anterior width, unarmed. *Wing :* length 1·82 mm., width 0·36 mm., alar index 0·61, delta + 0·017 mm. *Terminalia :* coxite (0·2 mm.) twice as long as style, which bears seven spines, some of which are spatulate ; paramere (0·153 mm.) shaped like the prow of a ship ; penis sheath short (0·08 mm.) ; lateral lobe 0·168 mm.

Distribution : AL AHAGGAR.

Phlebotomus (*Sergentomyia*) *mirabilis* Parrot & Wanson.

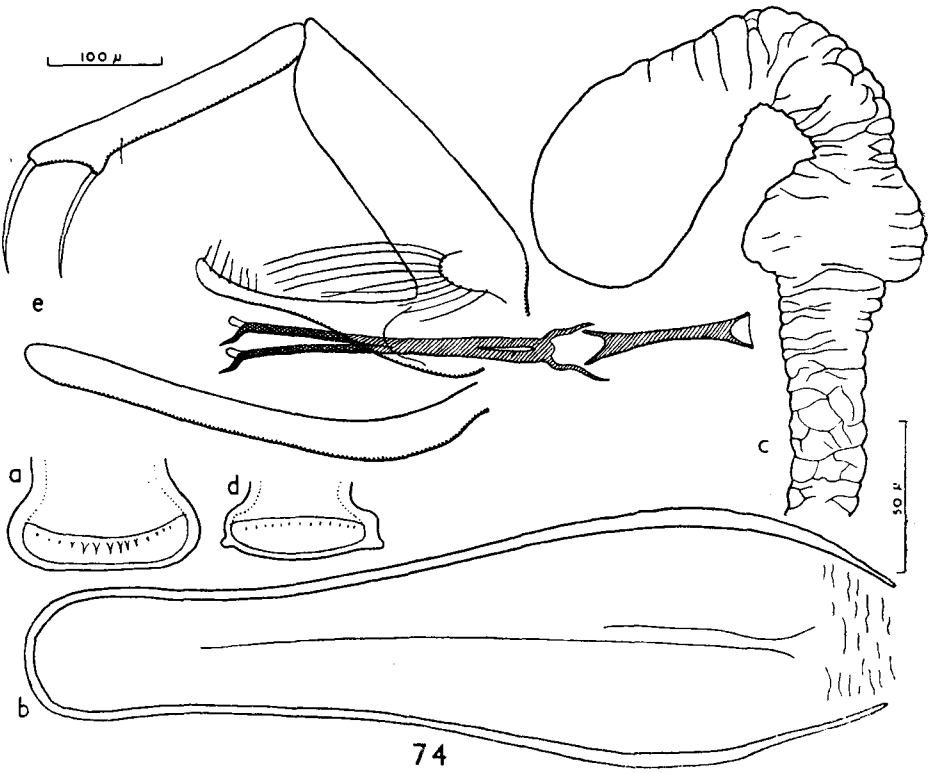
P. mirabilis Parrot & Wanson, 1939, *Rev. Zool. Bot. afr.* **32** : 149.
P. mirabilis Parrot & Wanson, 1946, *Arch. Inst. Pasteur Algér.* **24** : 143.

The type specimens, from Thysville, are in the Museum of the Belgian Congo at Tervueren. The description below is after Parrot and Wanson (1946) from 7 females and 6 males.

♀. *Length :* 2·2–3·2 mm., hind leg 4·4–5·2 mm. *Antenna :* formula 2/III–XV, segment III (0·35–0·38 mm.) < IV + V, AII/E = 1·2–1·3, ascoids long extending beyond the tip of the segments. *Palp :* formula 1,4,2,3,5, relative lengths 1, 3·4, 4·4, 2·7, 7. *Epipharynx :* length 0·27–0·29 mm. *Buccal cavity :* with 10–14 pointed teeth spread out like a fan, the median teeth being bigger than the laterals ; no pigmented plate. *Pharynx :* about twice as wide posteriorly as anteriorly, armed with fine transverse folds. *Wing :* length 2·55–2·67 mm., width 0·76–0·85 mm., alar index 1·1–1·4, delta + 0·17 to 0·20 mm. *Spermatheca :* in the form of a sac bent over like a phrygian cap with thin walls dilated at its

opening into the duct, which is heavily chitinized and pigmented and opens separately into the vulva.

♂. *Length :* 2·23–3 mm., hind leg 4·84–4·92 mm. *Antenna :* formula 2/III–XV, segment III (0·41–0·45 mm.) < IV + V, AIII/E = 1·5–1·8, ascoids long, but do not extend beyond tips of segments. *Palp :* formula 1,4,2,3,5, relative lengths 1, 3·3, 4·4, 3, 7·3. *Epipharynx :* length 0·23–0·24 mm. *Buccal cavity :* with 8–12 strong pointed teeth ; no pigmented area. *Pharynx :* 1·5 times as wide posteriorly as anteriorly and with some transverse ridges in its posterior part. *Terminalia :* coxite (0·3–0·34 mm.) 1·25 times as



74

FIG. 74.—*P. mirabilis*, ♀ : *a*, buccal cavity ; *b*, pharynx ; *c*, spermatheca. ♂ : *d*, buccal cavity ; *e*, terminalia. (*a–d* after Parrot and Wanson, 1946 ; *e* after Theodor, 1948.)

long as style (0·26 mm.) and bearing on its internal surface near the base a tuft of hairs, arising from a short peduncle ; style bears two spines, one terminal the other at about 0·7, with small ventral seta at 0·6 ; paramere (0·25 mm.) hooked, penis sheaths apparently fused together, penile filaments with dilated hyaline tip and subapical process ; lateral lobe (0·39–0·40 mm.) longer than coxite.

Phlebotomus mirabilis, by its numerous unusual features is immediately differentiated from all other species.

Distribution : BELGIAN CONGO, UGANDA.

As pointed out to us by Professor O. Theodor, the Uganda specimens are not identical with the type form and require further study.

Addendum.

Since this paper was submitted for publication a new Ethiopian species, *P. wynnae*, has been described by Watson (1951). It has not been possible to include *P. wynnae* in the diagnostic tables, but a description of the species is given below (*after* Watson, by permission of the *Annals of tropical Medicine and Parasitology*).

Phlebotomus (*Sergentomyia*) *wynnae* Watson.

P. wynnae Watson, 1951, *Ann. trop. Med. Parasit.* **45**: 78.

♀. *Length:* 1·9 mm., hind leg 2·81 mm. *Antenna:* segment III = 0·17 mm., < IV + V, AIII/E = 0·83, formula 2/III–IX . . . (distal segments missing), ascoids long, those on IV = 0·6 length of segment. *Palp:* formula 1,2,4,3,5, relative lengths 1, 3, 5, 4·2, 11·8. *Epipharynx:* length 0·2 mm. *Buccal cavity:* heavily armed with approximately 30 teeth borne on an arc concave posteriorly, in three groups of 10, the median ones being heavier and more widely spaced than the lateral ones; the extreme lateral teeth point slightly towards the mid-line; pigmented area absent. *Pharynx:* lampglass shaped, wide median part 3·3 times as wide as narrow anterior and posterior parts, armed with peculiar ridges restricted entirely to narrow posterior part; pigmented mid-line. *Wing:* length 1·7 mm., width 0·6 mm., alar index 1·1, delta + 0·05 mm. *Spermatheca:* not visible, therefore presumably simple and thin-walled.

♂ Unknown.

P. wynnae is readily distinguished from all other Ethiopian species by the morphology of the buccal cavity and pharynx. The type specimen is in the British Museum.

Distribution: Uganda.

METHODS.

Collecting.

The adult flies can often be obtained with suction catchers or tubes in darkened parts of houses, stables and latrines. They may often be driven from animal burrows by tobacco smoke or a handful of dust. Many can be caught at light, but these are not fully representative of the local fauna.

Very useful traps are simply made with oiled paper. A piece of paper is placed in a cleft stick, smeared with castor oil, and the stick stuck in the ground at dusk, usually near a hole or crack in the soil. In the morning pieces of the paper with sandflies attached are either placed in formalin for storage, or are put in spirit which washes off the flies. When the insects are abundant traps in any situation will catch them.

Species which bite mammals can be caught with oiled paper or taken alive in a sandfly net with a few holes in it placed over a cage containing a monkey or guinea-pig.

Sinton (1932*a*) found that the best method of storage was to keep the insects dry in tubes. Those preserved in 70 per cent. alcohol became brittle and difficult to treat with caustic potash.

Mounting.

For permanent preparations Sinton recommends placing a specimen in a watch glass, wetting it with a single drop of 70 per cent. alcohol, and immediately adding ten per cent. caustic potash which is left overnight or for 12 hours or more. The insect is then washed in three or four changes of water, each lasting 15 to 30 minutes, stained with carbol fuchsin, and finally mounted in Canada balsam.

For rapid examination sandflies may be dissected in Langeron's chlor-lacto-phenol which clears them. Its composition (Sinton, 1933) is:

Chloral hydrate (crystals)	2 parts
Acid, carbolic (crystals)	1 part
Lactic acid, pure	1 ,,

The insect can later be mounted in Puri's medium, the composition of which is given by Hopkins (1936) as follows:

Water	10 c.c.
Gum acacia (picked lumps, not the powdered form)	8 grammes
Chloral hydrate	70 ,,
Glycerine	5 c.c.
Acetic acid (glacial)	3 ,,

The ingredients should be dissolved in the above order, on a water bath at about 80° C. We then filter the fluid through a wad of cotton wool at the bottom of a funnel in a tin kept warm by the heat of the sun or other means. Under Sudan conditions preparations made with this medium seldom require to be ringed with cement if enough Puri's medium is used at the time and after a few days. Canada balsam should never be used for ringing this medium.

De Meillon and Lavoipierre (1944) heated specimens in potash for an hour, left them in it cold overnight, transferred them to chlor-lacto-phenol with a little one per cent. aqueous acid fuchsin, placed them in the same fluid with filter paper to prevent later crystallization of phenol, and dissected and mounted them in de Faure's medium.

When we examine large numbers of flies and keep them for future reference, we place each one straight in a drop of Puri's medium, cut off the head and place it ventral surface upward, and cover the drop with a $\frac{3}{8}$ inch circular cover glass, applying a thick ring of Puri's medium a day or two later. Under Sudan conditions, such preparations, which only take a few seconds to make, appear to be permanent. If further dissection is required, the slide can be wetted and placed overnight in a petri dish containing a little water.

When the structure of a species is such that dissection is necessary to show some feature, we use an ordinary pointed dissecting needle and a flattened one, and a pair of similar but much smaller ones made by sharpening minute entomological pins and mounting them in handles like those of the large needles. It is usually advantageous to allow the fly's hairs to come off and so expose other structures clearly. The fly, usually unstained, is dissected in chlor-lacto-phenol or Puri's medium. To remove the buccal structures and pharynx, the insect is turned on its side, the thorax steadied with one needle and the clypeus transfixed from side to side with the other (Sinton, 1932*a*). By gently drawing on the clypeal needle one can remove the internal structures required.

If the pigmented area is opaque the buccal armature may have to be separated from it. When the shape of the pharynx is important it may be mounted separately beneath a supported cover glass.

The body of a female is usually mounted without further manipulation apart from flattening one or both wings. The spermatheca can usually be seen through the body wall, but must sometimes be dissected out.

The terminalia of males are usually left on the abdomen, but it is often advisable to remove the coxite and style of one side.

Dissection of Sandflies to Search for Parasites.

Sinton (1932*a*) recommends that the fly should be shaken up in a small quantity of saline solution to kill and wet it and remove many of the hairs. The fly is then placed in a drop of normal saline on a slide. The head is carefully separated from the thorax by placing one needle across the base of the head and the other across the front of the thorax and pulling the head forward. The anterior part of the gut is thus drawn out, still attached to the head and the unbroken mid-gut. The abdomen is nicked on either side near the tip, and the hind gut is drawn out and cut through near the anus. The gut is then drawn forward through the thorax by pulling the head forward.

Estimation of Age.

The degree of digestion of the blood and the state of the ovaries provide some information on the minimum age of the female fly. The remains of a peritrophic membrane within the mass of blood in the mid-gut shows that at least one meal has been taken previously. Adler and Theodor (1935) showed that granules appeared in the accessory glands of *P. perniciosus* shortly after feeding. The presence of these granules in a fly shows that it has emerged some time previously.

Breeding Phlebotomus *in Captivity.*

Colonies of *Phlebotomus* have been maintained in laboratories by several workers. Unsworth and Gordon (1946) have reviewed their methods, and described their own work on *P. papatasi*, and the following account is abstracted from their work.

Whittingham and Rook (1922) were the first to establish a colony of *P. papatasi* which they bred for three or more generations in Malta, using a chamber containing earth and stones with moist organic matter for oviposition and larval development. Smith (1925) and later Young *et al.* (1926) and Napier and Smith (1926), confined naturally-fed female flies in glass cylinders and, after two or three days, transferred them to other cylinders standing on a damp plaster of Paris tray containing pebbles and rabbit faeces as food for the larvae. After the eggs had hatched, the cylinders were replaced by an earthenware cover to ensure moisture and darkness for the larvae. Christophers *et al.* (1926), instead of plaster of Paris, used Petri dishes lined with damp filter paper bearing food for the larvae. Shortt *et al.* (1926) substituted

earthenware saucers for Petri dishes and added a little dried blood to the rabbit and goat faeces used for larval food. Ashner (1927) found that this grew moulds, and used one part of garden soil and two parts of rabbit faeces, mixed with water and stirred while drying. The flies of most laboratory colonies have been fed on human blood, but Wanson (1942) used lizards. Smith *et al.* (1940) fed the flies first on human blood and subsequently on raisins. All the work done on breeding *Phlebotomus* emphasizes the importance of maintaining a high humidity without allowing water to condense and entangle the flies.

Unsworth and Gordon (1946) bred *P. papatasi* in England in an incubator at 30° C. using two different methods the second of which was adopted to reduce labour.

In the first method newly emerged males and females were placed in lamp-glasses each containing a white card for flies to rest on. The glasses were closed at the narrow end by cotton wool plugs and at the wide end by organdie with small holes for introducing the flies. The flies were daily given an opportunity of feeding from the human arm, and between meals the wide ends of the glasses were covered with damp lint. Gravid females were transferred to lamp-glasses, of which the narrow ends were placed in small earthenware pots surrounded by damp soil, the space between the glass and the side of the pot being packed with damp cotton wool. The wider ends of the glasses were covered with damp lint. After eggs had been laid the pots were covered with damp lint and left to await hatching. Three or four days after oviposition a little food, consisting of one part of garden soil and two parts of rabbit faeces, was added. A little water was added to the earth in which the pots were embedded so that the larval food remained damp and crumbling, but not too wet. When pupae appeared the pots were uncovered and placed in cages for emergence.

The second method, devised to save time, involved the use of a single piece of apparatus, designed on the principle of a rodent burrow, and on the use of baby rats for feeding the females. A block of porous cement, measuring six inches in each dimension, was fitted with a removable roof which covered an elongated chamber, narrower at one end than the other and open at both ends. Two cylindrical wells, containing water, kept the block and chamber moist. Wooden supports carried two cages which closed the ends of the chamber. The larger cage had a sleeve, and the smaller a small hole for introducing flies. The floor of the chamber was covered with larval food. Every morning a baby rat, less than three weeks old, was placed on a piece of cork on which it was lightly restrained by mosquito netting. The cork was then placed in the chamber, supported on ridges made for the purpose.

Several observations were made on flies while they were bred by the first method. Usually, except on the day after emergence and the two days preceding oviposition, the female either fed in 20 minutes or refused for that day. Most flies took four meals before oviposition, but this number varied from one to five. Eggs were laid from seven to 12 days after emergence, the number of eggs, in 48 flies, varying from three to 66, with an average of 19, the number usually being between 20 and 30. The incubation period was about six days, and most larvae pupated after 25 to 30 days. The average length of the life-cycle from egg to adult was about six weeks, and 28 to 57 per cent. of the eggs eventually produced adults.

Keeping Adults in Captivity.

Where sandflies are abundant it may be unnecessary to breed them, but necessary to keep females alive in captivity for studies on their parasites or their physiology. As in breeding the flies a high humidity without any film of water is important. Waterston (1922), Patton and Hindle (1927), and others achieved these conditions by confining sandflies in damp earthenware pots.

Shortt *et al.* (1926) kept gravid flies alive for four or five days in lamp glasses standing on damp filter paper.

According to Smith *et al.* (1940) *P. argentipes* could be kept alive for a time in a cage with a watch-glass containing a pad of cotton wool soaked in a sterile five per cent. solution of glucose. They found, however, that bacteria soon grew in the glucose and infected the flies, so tried fruit juices and found that raisins were useful. These were washed for half an hour and scalded for a minute, and then supplied to flies kept in lamp glasses. About 50 per cent. of flies, which had taken a first meal on a kala-azar patient and then been fed on raisins, were alive after ten days, but Unsworth and Gordon (1946) achieved comparable results with *P. papatasi* without raisins.

Kirk and Lewis (1949) kept sandflies singly in tubes at a constant temperature and constant high humidity, so that no condensation occurred and the conditions could easily be repeated. Each tube measured 5 by 2·3 cm., was closed with muslin, and contained a piece of filter paper to support the fly and absorb its faeces. The tubes were placed over a solution of caustic potash giving a relative humidity of 90 per cent. in a desiccator which was kept in an incubator at 27°C. *P. orientalis* and *P. clydei* were caught after a blood meal and a considerable proportion kept in this way lived over a week without food.

It was found necessary to take careful precautions against contamination of the tubes by DDT used for mosquito control operations in the neighbourhood.

REFERENCES.

ADLER, S., 1946, The Sandflies of Cyprus (Diptera). *Bull. ent. Res.* **36** : 497–511.

——, and BER, M., 1941, The transmission of *Leishmania tropica* by the bite of *Phlebotomus papatasi*. *Indian J. med. Res.* **29** : 803–9.

——, and THEODOR, O., 1926, On the *minutus* group of the genus *Phlebotomus* in Palestine. *Bull. ent. Res.* **16** : 399–405.

——, ——, 1927, On a collection of *Phlebotomus* sp. of the *minutus* group. *Ann. trop. Med. Parasit.* **21** : 61–8.

——, ——, 1929, The distribution of sandflies and leishmaniasis in Palestine, Syria and Mesopotamia. *Ibid.* **23** : 269–306.

——, ——, 1931, Investigations on Mediterranean kala azar, I–V. *Proc. roy. Soc.* (*B*) **108** : 447–502.

——, ——, 1932, Investigations on Mediterranean kala azar, VI. *Ibid.* (*B*) **110** : 402–12.

——, ——, 1935, Investigations on Mediterranean kala azar, VIII–X. *Ibid.* (*B*) **116** : 499–544.

——, ——, and PARROT, L., 1929, Phlébotomes du Congo Belge. *Rev. Zool. Bot. afr.* **18** : 72–89.

——, ——, and WITENBERG, G., 1938, Investigations on Mediterranean kala azar, XI. *Proc. roy. Soc.* (*B*). **135** : 491–516.

ALEXANDER, C. P., 1929, A revision of the American two-winged flies of the Psychodid subfamily Bruchomyinae. *Proc. U.S. nat. Mus.* **75** (7) : 1–9.

ARCHIBALD, R. G., and MANSOUR, H., 1937, Some observations on the epidemiology of kala azar in the Sudan. *Trans. R. Soc. trop. Med. Hyg.* **50** : 395–406.

ASHNER, M., 1927, Observations on the breeding of *Phlebotomus papatasi* in Palestine. *Ibid.* **20** : 452–4.

BEQUAERT, M., and WALRAVENS, P., 1930, Phlébotomes du Katanga. *Rev. Zool. Bot. afr.* **19** : 34–42.

CHRISTOPHERS, S. R., and BARRAUD, P. J., 1926, The development of the male and female hypopygium of *Phlebotomus*. *Indian J. med. Res.* **13** : 853–70.

——, SHORTT, H. E., and BARRAUD, P. J., 1926, Technique employed in breeding *Phlebotomus argentipes* in Assam. *Indian med. Res. Mem.* **4** : 173–5.

COSTA LIMA, A. DE, 1932, Sobre os phlebotomos americanos. *Mem. Inst. Oswaldo Cruz* **26** : 15–69.

DE MEILLON, B., and LAVOIPIERRE, M., 1944, New records of biting insects from the Ethiopian Region. *J. ent. Soc. S. Afr.* **7** : 38–47.

DOERR, F. K., and TAUSSIG, S., 1909, *Das Pappataci-Fieber, ein endemisches drei-Tage-Fieber in adriatischen Kusten Gebeit Oesterreich-Ungarns*. 166 pp. Leipzig und Wien.

DOLOMATOVA, A. V., 1942, quoted in 1944, *Rev. appl. Ent.* (*B*) **32** : 50.

DOSTROWSKY, H., 1925, Zum Wesen der Harara. *Arch. Schuffs-u. Tropenhyg.* **29** : 443–9.

DYAR, H. G., 1929, The present knowledge of the American species of *Phlebotomus*. *Amer. J. Hyg.* **10** : 112–24.

EDWARDS, F. W., 1941, *Mosquitoes of the Ethiopian Region*. Part III. *Culicine adults and pupae*. London : British Museum (Natural History).

FEUERBORN, H., 1922, Der sexuelle Reizapparat der Psychodiden. *Arch. Naturgesch.* **88** (A) (4) : 1–137 (cited by TONNOIR, 1935).

FRANCA, C., 1919, Observations sur le genre *Phlebotomus*. *Broteria* (*b*) **17** : 102–60.

——, 1920, Observations sur le genre *Phlebotomus*. II. *Bull. Soc. portug. Sci. nat.* **8** : 215–36.

——, and PARROT, L., 1920, Introduction à l'étude systématique des diptères du genre *Phlebotomus*. *Bull. Soc. Path. exot.* **13** : 695–708.

——, ——, 1921, Essai de classification des Phlébotomes. *Arch. Inst. Pasteur Afr. N.* **1** : 279–84.

GAC, P. DE, 1937, Rôle des Pelopées dans la création des gîtes à *Phlebotomus* à l'intérieur des habitations à Madagascar. *Bull. Soc. Path. exot.* **30** : 144–5.

GALLIARD, H., and NITZULESCU, V., 1931, Contribution à l'étude des phlébotomes du Gabon. *Phlebotomus sanneri* n. sp. *Ann. Parasit. hum. comp.* **9** : 233–46.

GRASSI, B., 1907, Ricerche sui flebotomi. *Mem. Soc. ital. Sci. nat.* (3) **14** : 353–94.

HANDLIRSCH, A., 1925, *in* SCHRÖDER (C) *Handbuch der Entomologie* **3** : 91 (cited by THEODOR, 1948).

HERTIG, M., 1942, *Phlebotomus* and Carrion's disease. *Amer. J. trop. Med.* **22** (Suppl.), 47 pp.

——, and FAIRCHILD, G. B., 1948, The control of *Phlebotomus* in Peru with DDT. *Amer. J. trop. Med.* **28** : 207–30.

——, and FISHER, R. A., 1945, Control of sandflies with DDT. *Bull. U.S. Army Med. Dep.* **88** : 97–101.

HINDLE, E., *see* PATTON (W. S.) and HINDLE (E.), 1928.

HOPKINS, G. H. E., 1936, *Mosquitoes of the Ethiopian Region*. Part I. London : British Museum (Natural History).

JOBLING, B., 1928, The structure of the head and mouthparts in *Culicoides pulicaris*. *Bull. ent. Res.* **18** : 211–236.

KERVRAN, P., 1946, Descriptions de quelques espèces de *Phlébotomes* du Soudan français. *Ann. Parasit. hum. comp.* **21** : 155–65.

KING, H. H., 1913, Notes on the bionomics of the sandflies (*Phlebotomus*) of Tokar, Anglo-Egyptian Sudan. *Bull. ent. Res.* **4** : 83–4.

——, 1914, Observations on the breeding places of sandflies (*Phlebotomus* spp.) in the Anglo-Egyptian Sudan. *J. trop. Med. Hyg.* **17** : 2–3.

KIRK, R., 1939, Studies in leishmaniasis in the Anglo-Egyptian Sudan. I. Epidemiology and general considerations. *Trans. R. Soc. trop. Med. Hyg.* **32** : 533–44.

——, and LEWIS, D. J., 1940, Studies in leishmaniasis in the Anglo-Egyptian Sudan, II. The sandflies (*Phlebotomus*) of the Sudan. *Ibid.* **33** : 623–34.

——, ——, 1947, Studies in leishmaniasis in the Anglo-Egyptian Sudan. IX. Further observations on the sandflies (*Phlebotomus*) of the Sudan. *Ibid.* **40** : 869–88.

——, ——, 1946, Taxonomy of the Ethiopian sandflies (*Phlebotomus*). I. Classification and synonymy. *Ann. trop. Med. Parasit.* **40** : 34–51.

——, ——, 1946, Taxonomy of the Ethiopian sandflies (*Phlebotomus*). II. Keys for the identification of the Ethiopian species. *Ibid.* **40** : 117–29.

——, ——, 1948, Taxonomy of the Ethiopian sandflies (*Phlebotomus*). III. New Species and records : alterations and additions to the keys. *Ibid.* **42** : 322–33.

——, ——, 1949, Taxonomy of the Ethiopian sandflies (*Phlebotomus*). IV. *Phlebotomus bedfordi* Newstead and *Phlebotomus antennatus* Newstead. *Ibid.* **43** : 333–6.

——, ——, 1949, Susceptibility of *Phlebotomus* species to DDT. *J. trop. Med. Hyg.* **52** : 223–5.

——, ——, 1950, Three new sandflies (*Phlebotomus*) from East Africa. *Proc. R. ent. Soc. Lond.* (*B*) **19** : 11–13.

KNOWLES, R., NAPIER, L. E., and SMITH, R. A. O., 1925, On a *Herpetomonas* found in the gut of the sandfly *Phlebotomus argentipes* fed on kala azar patients. A preliminary note. *Indian med. Gaz.* **59** : 593–7.

LARROUSSE, F., 1928, Présence de *Phlebotomus ingrami* Newstead à Entebbe (Ouganda). *Ann. Parasit. hum. comp.* **6** : 203–5.

LEGENDRE, J., 1927, Sur l'existence de *Phlebotomus* à Ouagadougou (Haute Volta). *Bull. Soc. Path. exot.* **20** : 342–4.

LEWIS, D. J., and KIRK, R., 1940, The male of *Phlebotomus affinis* Theodor. *Proc. R. ent. Soc. Lond.* (*B*) **9** : 127–8.

——, ——, 1939, The occurrence of *Phlebotomus clydei* in Africa. *Ibid.* **8** : 155–6.

——, ——, 1946, Five new species of *Phlebotomus* (Diptera, Psychodidae) from the Sudan. *Ibid.* **15** : 55–60.

——, ——, 1946, The male of *Phlebotomus serratus* Parrot and Malbrant (Psychodidae, Diptera). *Ibid.* **15** : 61–2.

——, ——, 1949, Zoogeography of the Ethiopian species of *Phlebotomus* Agassiz (Diptera, Psychodidae). *Ibid.* **24** : 51–5.

——, ——, 1951, The sandflies (PHLEBOTOMINAE) of the Sudan. *Bull. ent. Res.* **42** : 563–575.

MAGNITSKY, W. J., and GUTZEWITSCH, A. W., 1929, Zur Frage über die Veränderlichkeit einiger systematischer Merkmale der Arten der Gattung *Phlebotomus*. *Zbl. Bakt.* I. Orig. **110** : 199–208.

MARTIN, R., 1938, Observations sur les Phlébotomes d'Ethiopie. *Arch. Inst. Pasteur Algér.* **16** : 219–225.

——, 1939, Observations sur les Phlébotomes d'Ethiopie (deuxième mémoire). *Ibid.* **17** : 490–501.

NAPIER, L. E., and SMITH, R. A. O., 1926, A study of the bionomics of *Phlebotomus argentipes* with special reference to the conditions in Calcutta. *Indian med. Res. Mem.* **4** : 161–72.

NEVEU-LEMAIRE, M., 1906, Sur un nouveau Nématocère africain appartenant au genre *Phlebotomus*. *Bull. Soc. zool. Fr.* **21** : 64–7.

NEWSTEAD, R., 1911, The papataci flies (*Phlebotomus*) of the Maltese islands. *Bull. ent. Res.* **2** : 47–78.

——, 1912, Notes on *Phlebotomus*, with descriptions of new species. Part I. *Ibid.* **3** : 361–7.

——, 1913, *Phlebotomus* from West Africa. *Bull. Soc. Path. exot.* **6** : 124–6.

——, 1914, Notes on *Phlebotomus*, with descriptions of new species, Part II. *Bull. ent. Res.* **5** : 179–92.

——, 1916, On the genus *Phlebotomus*. Part III. *Ibid.* **7** : 191–2.

——, 1920, On the genus *Phlebotomus*. Part IV. *Ibid.* **11** : 305–11.

——, and SINTON, J. A., 1921, On a collection of pappataci flies (*Phlebotomus*) from India. *Ann. trop. Med. Parasit.* **15** : 103–6.

NITZULESCU, V., 1931, Essai de classification des Phlébotomes. *Ann. Parasit. hum. comp.* **9** : 271–5.

PARROT, L., 1921, Notes sur les Phlébotomes. *Arch. Inst. Pasteur Afr. N.* **1** : 269–78.

——, 1929, Sur un autre Phlébotome nouveau du Congo Belge, *Phlebotomus ghesquieri* n. sp. *Rev. Zool. Bot. afr.* **18** : 90–91.

——, 1930, Sur un collection de Phlébotomes du Congo Belge. *Ibid.* **19** : 181–92.

——, 1930, Sur *Phlebotomus rodhaini*. *Ibid.* **20** : 1.

——, 1932, Nouvelles observations sur la biologie de *Phlebotomus papatasi* (Scop.). *Arch. Inst. Pasteur Algér.* **9** : 407–9.

——, 1933, Phlébotomes du Congo Belge. IV. Sur *Phlebotomus africanus* var. *congolensis* Bequaert and Walravens, 1930. *Rev. Zool. Bot. afr.* **23** : 239–40.

——, 1933, Notes sur les Phlébotomes. VI. Sur une variété Nord Africaine de *Phlebotomus squamipleuris* Newstead. *Arch. Inst. Pasteur Algér.* **11** : 603–5.

——, 1934, Notes sur les Phlébotomes. IX. Une variété nouvelle de *Phlebotomus papatasi* (Scop.) du Sahara central. *Ibid.* **12** : 383–5.

——, 1934, Notes sur les Phlébotomes. XI. Sur les Phlébotomes du groupe *minutus* et sur la classification des Phlébotomes en general. *Ibid.* **12** : 389–92.

——, 1935, Notes sur les Phlébotomes. XVI. Phlébotomes de Senegal. *Ibid.* **13** : 259–62.

——, 1936, Notes sur les Phlébotomes. XXIII. Présence dans l'Aures (Algérie) de *Phlebotomus sergenti* var. *alexandri* Sinton. *Ibid.* **14** : 428–31.

——, 1936, Notes sur les Phlébotomes. XX. Sur *Phlebotomus langeroni* var. *longicuspis* Nitzulescu, 1930. *Ibid.* **14** : 137–43.

——, 1936, Notes sur les Phlébotomes. XVII. Phlébotomes d'Ethiopie. *Ibid.* **14** : 30–47.

——, 1937, Notes sur les Phlébotomes. XXV. Sur l'appareil génital interne des Phlébotomes. *Ibid.* **15** : 108–23.

——, 1938, Notes sur les Phlébotomes. XXVII. Phlébotomes d'Ethiopie (suite). *Ibid.* **16** : 213–18.

——, 1938, Phlébotomes du Congo Belge. VII. *Phlebotomus wansoni* n. sp. *Rev. Zool. Bot. afr.* **30** : 361–3.

——, 1939, Phlébotomes du Congo Belge. X. Description de *Phlebotomus dureni* ♂ et de *Phlebotomus wansoni* ♀. *Ibid.* **32** : 145–9.

——, 1940, Notes sur les Phlébotomes. XXXIV. Les " épines géniculées " des Phlébotomes. *Arch. Inst. Pasteur Algér.* **18** : 307–20.

——, 1941, Notes sur les Phlébotomes. XXXVI. La femelle de *Phlebotomus papatasi* var. *bergeroti* Parr., 1934. *Ibid.* **19** : 437–9.

——, 1942, Notes sur les Phlébotomes. XXXIX. A propos de deux *Prophlebotomus* d'Algérie, *P. minutus* var. *signatipennis* et *P. fallax*. *Ibid.* **20** : 322–35.

PARROT, L., 1943, Notes sur les Phlébotomes. XL. Sur *Phlebotomus* (*Prophlebotomus*) *minutus* Rondani et sa variété *parroti* Adler et Theodor. *Ibid.* **21** : 38–50.

——, 1943, Sur l'agent probable de transmission du bouton d'orient dans la colonie du Niger. *Ibid.* **21** : 268–9.

——, 1946, Notes sur les Phlébotomes. LII. Le rapport AIII/E. *Ibid.* **24** : 66–75.

——, 1948, Notes sur les Phlébotomes. LVIII. Phlébotomes du Soudan Anglo-égyptien. I. *Ibid.* **26** : 121–48.

——, 1948, Notes sur les Phlébotomes. LIX. Phlébotomes du Soudan Anglo-égyptien. 2. *Ibid.* **26** : 259–76.

——, 1951, Notes sur les phlébotomes. LXI. A propos de classification. *Ibid.* **29** : 28–45.

——, and CLASTRIER, J., 1946, Notes sur les Phlébotomes. LI. Sur *Phlebotomus langeroni*. *Ibid.* **24** : 60–5.

——, and DURAND-DELACRE, R., 1948, Notes sur les Phlébotomes. LX. Quelques remarques sur les Phlébotomes des terriers de rongeurs du Sud-Oranais. *Ibid.* **26** : 402–5.

——, and GOUGIS, R., 1944, Notes sur les Phlébotomes. XLI. Sur *Phlebotomus roubaudi* Newstead. *Ibid.* **22** : 40–6.

——, and HABIBI, A., 1946, Notes sur les Phlébotomes. LIV. Formes anormales de *Phlebotomus minutus* var. *parroti* Adler and Theodor. *Ibid.* **24** : 157–9.

——, and DE JOLINIÈRE, P. B., 1945, Notes sur les Phlébotomes. XLVI. Nouveaux phlébotomes du Hoggar. *Ibid.* **23** : 56–63.

——, and MALBRANT, R., 1945, Notes sur les Phlébotomes. XLVII. Phlébotomes du Moyen Congo. *Ibid.* **23** : 121–7.

——, and MARTIN, R., 1939, Notes sur les Phlébotomes. XXVIII. Autres Phlébotomes d'Ethiopie. *Ibid.* **17** : 143–56.

——, ——, 1939, Notes sur les Phlébotomes. XXX. Une variété nouvelle de *Phlebotomus sergenti* d'Ethiopie. *Ibid.* **17** : 484–9.

——, ——, 1940, Notes sur les Phlébotomes. XXXII. Sur *Phlebotomus* (*Prophlebotomus*) *subtilis*. *Ibid.* **18** : 300–4.

——, ——, 1944, Notes sur les Phlébotomes. XLIV. Phlébotomes de Djibouti. *Ibid.* **22** : 55–9.

——, ——, 1945, Notes sur les Phlébotomes. XLIX. Autres phlébotomes du Moyen Congo. *Ibid.* **23** : 279–80.

——, MORNET, P., and CADENAT, J., 1945, Notes sur les Phlébotomes. XLVIII. Phlébotomes de l'Afrique Occidentale Française. I. Sénégal, Soudan, Niger. *Ibid.* **23** : 232–44.

——, ——, ——, 1945, Notes sur les Phlébotomes. L. Phlébotomes de l'Afrique Occidentale Française. 2. Guinée, Côte d'Ivoire, Dahomey. *Ibid.* **23** : 281–9.

——, SCHWETZ, J., 1937, Phlébotomes du Congo Belge. VI. Trois espèces et une variété nouvelles. *Rev. Zool. Bot. afr.* **29** : 221–8.

——, ——, 1938, Phlébotomes du Congo Belge. VIII. Sur le mâle de *Phlebotomus gigas*. *Ibid.* **31** : 153–6.

——, WANSON, M., 1939, Phlébotomes du Congo Belge. IX. *Phlebotomus mirabilis* n. sp. *Ibid.* **32** : 149–53.

——, ——, 1946, Phlébotomes du Congo Belge. XI. *Phlebotomus crossarai* et *Phlebotomus richardi* nov. sp. *Ibid.* **39** : 225–9.

——, ——, 1946, Notes sur les Phlébotomes. LIII. Sur *Phlebotomus gigas* et sur *Phlebotomus mirabilis*. *Arch. Inst. Pasteur Algér.* **24** : 143–52.

PATTON, W. S., and HINDLE, E., 1927, The development of Chinese Leishmania in *Phlebotomus major* var. *chinensis* and *P. sergenti* var. *Proc. roy. Soc.* (*B*) **101** : 369–90.

PATTON, W. S., and HINDLE, E., 1928, The North Chinese species of the genus *Phlebotomus* (Diptera, Psychodidae). *Ibid.* **102** : 533–51.

PERFILIEW, P., 1928, Sur l'anatomie des Phlébotomes. *Bull. Soc. Path. exot.* **21** : 159–71 and 254–7.

PETRISCHEWA, P. A., 1935, cited in *Rev. appl. Ent.* (*B*), **24** : 179.

PICARD, F., 1909, Le rôle pathogène des Phlébotomes (Dipt., Psychodidae) et leur repartition dans l'Afrique Occidentale. *Bull. Soc. ent. Fr.* **1909** : 164–6.

PRESSAT, A., 1905, *La paludisme et les moustiques* (*Prophylaxie*). Paris.

PRICE, J. D., and ROGERS, L., 1914, The uniform success of segregation measures in eradicating kala azar from Assam tea gardens. *Brit. med. J.* **1** : 285–9.

RAPP, W. F., 1944, Catalogue of North American Psychodidae. *J. N.Y. ent. Soc.* **72** : 201–9.

RAYNAL, J., et DE GAC, P., 1937, Phlébotomes dans le nord de Madagascar, *Phlebotomus squamipleuris* Newstead. *Bull. Soc. Path. exot.* **30** : 76–90.

RONDANI, C., 1843, Species italicae generis *Hebotomi* Rndn. ex Insectis Dipteris : fragmentum septimum ad inserviendum dipterologiam italicam. *Ann. Soc. ent. Fr.* (2) **1** : 263–7.

ROUBAUD, E., 1913, Quelques mots sur les Phlébotomes de l'Afrique occidentale française. *Bull. Soc. Path. exot.* **6** : 126–8.

SCHWETZ, J., 1929, Quelques observations sur les Phlébotomes de Stanleyville. *Rev. Zool. Bot. afr.* **18** : 133–46.

——, 1937, Recherches sur les Phlébotomes du Bas Congo et de Kwango, Congo Occidental. *Bull. Inst. R. Colon. Belg.* **8** : 2.

——, 1937, Synopsis des Phlébotomes actuellement connus au Congo Belge. *Rev. Zool. Bot. afr.* **30** : 155–63.

——, 1937, Notes ethologiques sur les phlébotomes du Bas Congo. *C.R. Soc. Biol. Paris*, **124** : 1015–7.

SERGENT, EDM., et SERGENT, ET., 1905, Sur un Culicide nouveau très commun à Biskra (*Grabhamia subtilis*). *Ibid.* **57** : 673.

——, ——, PARROT, L., DONATIEN, A., et BEQUET, M., 1921, Transmission du clou de Biskra par le Phlébotome *Phlebotomus papatasi* (Scop.). *C.R. Acad. Sci. Paris* **173** : 1030–2.

SHORTT, H. E., BARRAUD, P. J., and SWAMINATH, C. S., 1926, Further observations on the breeding of *Phlebotomus argentipes* in Assam. *Indian J. med. Res.* **13** : 943–6.

SINTON, J. A., 1923, Notes on some Indian species of the genus *Phlebotomus*. II. *Phlebotomus squamipleuris* Newstead, 1912. *Ibid.* **11** : 65–78.

——, 1924, Notes on some Indian species of the genus *Phlebotomus*. III. Provisional diagnostic table of the males of the species and varieties recorded from India and Ceylon. *Ibid.* **11** : 807–24.

——, 1927, The identification and classification of the species of the genus *Phlebotomus* with some remarks on their geographical distribution in relation to disease. *Trans. 7th Cong. Far East. Assn. trop. Med.* **3** : 172–80.

——, 1927, Notes on some Indian species of the genus *Phlebotomus*. XX. The morphology of the buccal cavity in some species. *Indian J. med. Res.* **15** : 29–31.

——, 1927, Notes on some Indian species of the genus *Phlebotomus*. XXI. *Phlebotomus christophersi* n. sp. *Ibid.* **15** : 35–40.

——, 1927, Notes on some Indian species of the genus *Phlebotomus*. XIX. The value of the female genitalia in the identification of species. *Ibid.* **15** : 21–7.

——, 1928, The synonymy of the Asiatic species of *Phlebotomus*. *Ibid.* **16** : 297–324.

——, 1928, Notes on some Indian species of the genus *Phlebotomus*. XXIII. *Phlebotomus clydei* n. sp. *Ibid.* **16** : 179–86.

SINTON, J. A., 1930, Some new species and records of *Phlebotomus* from Africa. *Ibid.* **18** : 171–93.

——, 1932, Notes on some Indian species of the genus *Phlebotomus*. XXXVI. Diagnostic table for the females of the species recorded from India. *Ibid.* **20** : 55–74.

——, 1932, Some further records of *Phlebotomus* from Africa. *Ibid.* **20** : 565–76.

——, 1933, A new African sandfly, *Phlebotomus transvaalensis* n. sp. *Ibid.* **20** : 879–81.

——, 1933, Notes on some Indian species of the Genus *Phlebotomus*. Part XXXV. Additions and alterations to the diagnostic table of females. *Ibid.* **21** : 225–8.

——, 1933, Notes on some Indian species of the Genus *Phlebotomus*. Diagnostic table for the males of the species recorded from India. *Ibid.* **21** : 417–28.

——, 1937, [In discussion.] *Trans. R. Soc. trop. Med. Hyg.* **30** : 404.

SMITH, R. O. A., 1925, A simple method of breeding sandflies. *Indian J. med. Res.* **12** : 741–2.

——, HALDER, K. C., and AHMED, I., 1940, Further investigations on the transmission of kala azar : the maintenance of *P. argentipes* on nutriment other than blood. *Ibid.* **28** : 575–9.

SMITHBURN, K. C., HADDOW, A. J., and LUMSDEN, W. H. R., 1949, An outbreak of silvan yellow fever in Uganda with *Aëdes* (*Stegomyia*) *africanus* Theobald as the principal vector and insect host of the virus. *Ann. trop. Med. Parasit.* **43** : 74–80.

SUDLEY, E. W., 1927, *Stegomyia* et *Phlebotomus* à Bamako (Soudan). *Bull. Soc. Path. exot.* **20** : 474–5.

SUTTON, H. J., 1950, Personal communication.

SWAMINATH, C. S., SHORTT, H. E., and ANDERSON, L. A. P., 1942, Transmission of Indian kala azar to man by the bites of *Phlebotomus argentipes* Ann. and Brun. *Indian J. med. Res.* **50** : 473–7.

THEODOR, O., 1931, On African sandflies (Dipt.). *Bull. ent. Res.* **22** : 469–78.

——, 1932, Sobre sistemática de los flebótomos sudamericanos. *Reun. Soc. argent. Path. reg. Norte* (*Tucuman*, 1931), **2** : 764–86.

——, 1932, Ueber eine neue Methode zur Klassifizierung von Phlebotomen und ihre Bedeutung für das Studium der durch Phlebotomen übertragenen Krankheiten. *Arch. zool. Torino* **16** : 1340–9.

——, 1933, Some African sandflies. *Bull. ent. Res.* **24** : 536–47.

——, 1935, A study of the reaction to *Phlebotomus* bites with some remarks on "harara." *Trans. R. Soc. trop. Med. Hyg.* **29** : 273–84.

——, 1936, On the relation of *Phlebotomus papatasi* to the temperature and humidity of the environment. *Bull. ent. Res.* **27** : 653–71.

——, 1938, On African sandflies. III. *Ibid.* **29** : 165–73.

——, 1948, Classification of the Old World species of the subfamily Phlebotominae (Diptera, PSYCHODIDAE). *Ibid.* **39** : 85–115.

TONNOIR, A. L., 1935, The Australian species of the genus *Phlebotomus*. *Ibid.* **26** : 137–47.

UNSWORTH, K., and GORDON, R. M., 1946, The maintenance of a colony of *Phlebotomus papatasi* in Great Britain. *Ann. trop. Med. Parasit.* **40** : 219–27.

WANSON, M., 1942, Sur la biologie des Phlébotomes congolais. *Rec. Trav. Sci. med. Congo Belg.* **1** : 23–43.

WATERSTON, J., 1922, A contribution to the knowledge of the bionomics of sandflies. *Ann. trop. Med. Parasit.* **16** : 69–92.

WATSON, A. G., 1951, A new species of *Phlebotomus* (Diptera, Psychodidae) from Uganda. *Ann. trop. Med. Parasit.* **45** : 78–79.

WENYON, C. M., 1912, Note on the occurrence of *Herpetomonas* in the *Phlebotomus* of Aleppo. *J. Lond. Sch. trop. Med.* **1** : 98–101.

WHITTINGHAM, H. E., and ROOK, A. F., 1922, Demonstration of the life history of *Phlebotomus papatasi* and its maintenance in captivity. *Trans. R. Soc. trop. Med. Hyg.* **16** : 262–6.

——, ——, 1923, The prevention of *Phlebotomus* fever. *Ibid.* **17** : 290–330.

YAO, Y. T., WU, C. C., and SUN, C. J., 1938, The development of *Wuchereria bancrofti* in the sandfly *Phlebotomus sergenti* var. *mongolensis*. A preliminary report. *Chinese med. J.* **1938,** Mar. Suppl. 2 : 401–10.

YOUNG, T. C. M., RICHMOND, A. E., and BRANDISH, G. R., 1926, Sandflies and sandfly fever in the Peshawar district. *Indian J. med. Res.* **13** : 961–1021.