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BIOSYSTEMATICS OF THE *CULICOIDES* OF LAOS (DIPTERA: CERATOPOGONIDAE)[1,2]

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Abstract. Sixty-six species (62 named) of *Culicoides* are recorded herein from Laos. Keys to species are presented for females and the known pupae, and 16 species are described as new: *C. nyungnoi, paksongi, nampui, tonmai, hinnoi, huberti, laoensis, tamada, triallantionis, kinari, kisangkini, nyakini, pikongkoi, spiculae, lansangensis,* and *arenicola.* Important new or little-used diagnostic characters and procedures employed are the cibarial and pharyngeal armature and the use of a dark field condenser for improving contrast in the wing pattern. The pupal exuviae of 17 species are described, 14 for the first time, including those of *C. flavescens, tenuipalpis, kisangkini, oxystoma, shortti, geminus, okinawensis, arenicola, huffi, notatus, similis, arakawae, guttifer, hegneri,* and *kamrupi.* Twenty-five species were reared, 18 for the first time, from 55 breeding sites. These sites represent 11 habitats, including a variety of water margins, rotting plant material, and animal manure. *Culicoides tonmai, innoxius, lansangensis,* and *clavipalpis* were reared from a tree wound. *C. palpifer, innoxius,* and *sumatrae* were reared from plant material, and *C. kisangkini* from elephant dung in a stream. *Culicoides flavescens, tenuipalpis, oxystoma, shortti, geminus, okinawensis, arenicola, huffi, notatus, similis, arakawae, guttifer, hegneri,* and *kamrupi* were reared from terrestrial water margins. Of the variables measured for sites at water margins, the following appear important in delimiting species of *Culicoides*: sunny vs shaded conditions; content of moisture, organic detritus, and sand; and substrate texture.

The biting midges of the nearly cosmopolitan genus *Culicoides* Latreille are a huge assemblage of more than 1000 valid species. The females of most species are adapted for bloodsucking, although only a small percentage attack man or his domesticated animals. Their minute size, 0.5–2.0 mm in length, makes their study difficult and leads to underestimating their importance. The group is still poorly known from the tropics. Only 5 species of *Culicoides*, the first records from Laos, were listed by Wirth (1973). They were *C. boophagus* Macfie, *C. shortti* Smith & Swaminath, *C. elbeli* Wirth & Hubert, *C. huffi* Causey, and *C. similis* Carter, Ingram & Macfie. Of the 117 species

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listed by Wirth (1973) for the whole Oriental Region, the breeding sites were known for fewer than 20 species, and either the larva or pupa described for fewer than 10 species.

The purpose of this study was to conduct a biological survey of the biting midges of Laos, with emphasis on descriptions of their breeding habitats and pupal stages. Wirth & Hubert (1959, 1972, in prep.) have in progress a long-range revision of the Oriental *Culicoides* of Southeast Asia, and this paper is coordinated with theirs. The importance of research on the immature stages and breeding habitats of biting midges should not be underestimated. Such studies must precede (1) other detailed biological studies, (2) development of effective control procedures, and (3) research on disease transmission. Furthermore, knowledge on the taxonomy of the immature stages is of immense value to understanding of the systematics of the adults.

Nothing has been reported on the economic importance of biting midges in Laos, and detailed research on this subject was beyond the scope of this study. However, a few observations made during the fieldwork in Laos are appropriate. In man, the bites of many species are characterized by an intense immediate burning sensation, similar to being struck by a burning ash. Many species burrow into the hair on the scalp to bite and cause considerable annoyance. This latter biting habit makes it difficult to correlate a specimen collected with a bite. Many species of *Culicoides* are attracted to lights in houses and once inside will bite, but none were suspected during this study of being particularly domestic or anthropophilic. Persons working outside, however, are occasionally severely bitten by *Culicoides.* The Lao keep smoky fires burning near working areas outside in the evening and at night to repel the biting flies of several families. They call biting midges *hin noi* (little midges) and *nyung noi* (little mosquitoes). During the day, species of the 2 other mammalophilic genera of biting midges, *Leptoconops* and *Forcipomyia,* are often troublesome.

Culicoides, however, appears to be of much greater veterinary than medical importance in Laos. Cattle were often noted with visible clouds of midges swarming around them at dusk. I swept a few of the swarms with a net and noted the species. The most common species in the swarms were *C. oxystoma* Kieffer, *C. shortti, C. peregrinus* Kieffer, and *C. orientalis* Macfie.

Laos is in the middle of one of the old centers of tropical evolution. The country stretches 1160 km north-to-south and 125–500 km east-to-west, and is bordered by Thailand, Burma, China, Vietnam, and Kampuchea. Its area is approximately 240,000 km^2, and its vertical relief ranges from 100 m to 2817 m. The climate is tropical to subtropical and monsoonal, with great modification by the mountain ranges and high plateaus. The great age, tropical climate, mountainous terrain and central location between the Palearctic Region to the north, the Malayan Subregion to the south, and the Indian Subregion to the west have imparted to Laos a remarkably diverse fauna—a fauna of immense interest in deciphering the history of animal distribution in the Old World. Gressitt (1970) reviewed the biogeography of Laos. Unfortunately, the political strife in the area has accelerated the destruction of this rich fauna and

prevented a more thorough survey of many possible centers of endemism, especially high mountain habitats.

The 66 species of *Culicoides* recorded from Laos in this paper are only a fraction, perhaps less than ⅓, of the number actually occurring in Laos. The 16 species herein described as new are most likely not endemic to Laos but will eventually be found in neighboring countries. It is possible, however, that there are endemic species restricted to islandlike habitats such as mountains, inland salt springs, and caves.

Many of the widespread species may have been spread indirectly through human activities. This is especially true for species closely associated with domestic animals, such as *C. oxystoma, C. imicola* Kieffer, and *C. brevitarsis* Kieffer. From ancient times to the present, cattle drives have occurred between India and Thailand. Species that breed in rotting plant material, such as *C. palpifer* Das Gupta & Ghosh, *C. sumatrae* Macfie, and *C. innoxius* Sen & Das Gupta, are also admirably suited for human-aided dispersal.

The *Culicoides* species of Laos are numbered consecutively and are arranged alphabetically within each subgenus, except for the 2 larger subgenera, *Trithecoides* and *Oecacta,* which are arranged alphabetically within each species group. Species names used in this paper follow those to be used by Wirth & Hubert (in prep.) in their forthcoming revision of Southeast Asian species. Since synonymies will be treated in full in Wirth & Hubert (in prep.), they are not listed herein. Eleven species are not named in this paper but are listed by letter only. Seven of these lettered species will be described by Wirth & Hubert (in prep.). The remaining 4 unnamed species are not described herein because of insufficient material.

MATERIALS AND METHODS

Fieldwork. The fieldwork for this survey was completed between January 1967 and June 1968 while I was stationed in Laos with the International Voluntary Services. Most collecting was done in Sayaboury, Sayaboury Province, and the surrounding area, but significant additional material was also collected in Vientiane and Pakse provinces. Collecting localities are listed in Table 1. Since there are several systems for transliteration of Lao place names into Roman script and geographical names change with time, the coordinates for each site are included. These are taken from Army Map Service maps of several series, scale 1:250,000, and rounded to the nearest minute. In the material examined sections, the localities are cited from north to south and chronologically within each locality. Unless otherwise indicated, all collections were made by me.

Collections. Most emphasis was placed on rearing and obtaining associated pupae and adults. The rearing technique was modified from Wirth (1952). Samples, consisting of 75–125 cc of suspected breeding substrate, were broken up in water in a 300 cc white porcelain dish in the field. Sample size varied with ease of washing and sorting. Samples high in organic detritus were smaller, due to the difficulty of sorting much floating debris. Usually, such samples were equated to a standard sample volume

TABLE 1. Coordinates and elevations for ceratopogonid collecting localities in Laos.

LOCALITY	COORDINATES	ELEVATION (m)
Sayaboury Prov		
Muong Sayaboury	19°16′N, 101°43′E	300–1200
Ban Nala (15 km NE of Sayaboury)	19°21′N, 101°46′E	400
Muong Phieng	19°06′N, 101°32′E	400
Nam Phoui (22 km S of Muong Phieng)	18°55′N, 101°31′E	325
Muong Thadeua	19°26′N, 101°51′E	300
Muong Xieng Hon	19°37′N, 100°49′E	500
Muong Hongsa	19°43′N, 101°21′E	600
Luang Prabang Prov		
Luang Prabang	19°53′N, 102°09′E	300
Xieng Ngeun	19°45′N, 102°10′E	300
Vientiane Prov		
Muong Vientiane	17°58′N, 102°38′E	150
Muong Vang Vieng	18°55′N, 102°27′E	250
Ban Ky Sok (30 km N of Vang Vieng)	19°09′N, 102°21′E	950
Muong Phone Hong	18°30′N, 102°25′E	180
Muong Tourakam	18°26′N, 102°32′E	180
Muong Ban Keun Ban Na Pheng	18°19′N, 102°40′E	180
Sedone Prov		
Pakse	15°07′N, 105°48′E	100
Paksong	15°11′N, 106°14′E	1270
42 km Rte 23 to Paksong	15°11′N, 106°08′E	1150
Ban Lao Ngam	15°10′N, 105°58′E	350

for comparison. Pupae that floated or were seen were removed from the dish individually, using a microspatula mounted at the end of a hypodermic needle and syringe. Each pupa was gently washed off the spatula onto moist cotton in a 2.9 cc shell vial by water spray from the syringe. Usually, each pupa was placed in a separate vial. The vials were stoppered with cotton and later were laid on their sides in shallow trays. After the adult had emerged and hardened, alcohol was added, and the exuviae and adult were preserved together.

Since the substrate was broken up by using fingers, the percentages of vegetation, silt, organic detritus, gravel, sand, and clay could easily be determined and noted. Determinations of pollution and moisture content were more subjective. The level of pollution was estimated from the presence of decomposing organic matter, especially manure, or the presence of a fetid odor, the latter suggesting anaerobic conditions.

Samples of rotting plant material that were suspected of breeding *Culicoides* were

placed in tin cans of various sizes, and the tops of the cans were covered with black cloth. A hole was cut in each can near the top rim and a vial attached with tape to capture the emerging *Culicoides*. Water was added to the cans periodically.

Adults were captured at lights in 2 ways. A small portable fluorescent black light trap, powered by a 6 volt jeep or motorcycle battery, was operated in various habitats and seasons. The bulb and trap assembly were covered with wire mosquito mesh to keep out larger insects. Trapped insects were killed directly in alcohol. "At light" collections were made by directing either a pressure kerosene lamp or jeep headlights onto a bed sheet and aspirating attracted ceratopogonids. The species composition of catches from the 2 kinds of light was significantly different, even when the lights were run concurrently and next to each other, but no attempt has been made to quantify the differences.

Collections were also made by sweeping vegetation along margins of suspected breeding sites and animal pens, and whenever possible by sweeping near cows, horses, and buffaloes. Those midges attracted to or biting me or colleagues were also collected.

Slide preparation. Phenol-balsam was used for making permanent mounts of specimens, using the method of Wirth & Marston (1968). A synthetic mounting medium, Caedax®, was substituted for balsam for slides of some of the light trap collections, but many of these slides became cloudy. One reared adult, together with its associated pupal exuviae, was mounted per slide. Pupal exuviae were cleaned of mud and debris before mounting by brushing with a single camel hair. Exuviae were placed in mounting medium on a slide and the operculum dissected off and moved out of the medium, exterior side up, as far from the exuviae as possible (ca. 6–8 mm). The surface tension of the small amount of mounting medium then held the operculum flat until the coverslip was in place. The ventral portion of the cephalothorax, including the anterodorsal tubercles and developing mouthparts and antennal sheaths, but not the leg sheaths, was dissected off and oriented flat. The remaining part of the exuviae are oriented dorsal side up and stretched to untelescope the abdomen; the coverslip was then added. Dissections were made with sharpened, flattened minuten nadeln probes. The dissected exuviae and 1 wing were flattened under a 12 mm circular coverslip, and the remaining parts of the dissected, associated adult were mounted on the same slide under another 12 mm coverslip in a thicker mount supported by chips of coverslip.

Measurements. Lengths were measured with an ocular micrometer. Angles were measured with a protractor mounted on the ocular tube of the microscope and used in conjunction with the ocular micrometer.

Literature. Only the original description, changes in status, and references to breeding habitat or immature stages are cited for each species, since detailed synonymies will be given in Wirth & Hubert (in prep.).

Depositories. Holotypes and allotypes of the new species described herein are de-

posited in B.P. Bishop Museum, Honolulu (BPBM). Paratypes and voucher specimens of the other included species, if available, are deposited in BPBM, the U.S. National Museum (USNM), and the Thai National Collection (NRCT).

SYSTEMATICS

The arrangement of species is adapted from Wirth & Hubert (in prep.) and is alphabetical within each species group and subgenus. Most species fit within convenient species groups but the state of our knowledge of Oriental *Culicoides* makes any subgeneric classification tenuous. A few subgenera are well defined for Laos species. These are *Trithecoides* Wirth & Hubert, *Avaritia* Fox, and *Pontoculicoides* Remm. The New World *Hoffmania* Fox cannot be separated from *Culicoides* s.s. in the Oriental Region, and *Haemophoructus* Macfie is only weakly separated from *Culicoides* s.s. *Meijerehelea* Wirth & Hubert and *Beltranmyia* Vargas are closely related but both names are retained. *Oecacta* Poey is composed of many distantly related species groups. However, it is premature to attempt to split *Oecacta* into formal subgenera.

Adult

Adult descriptions are based entirely on slide mounted material. Thus, some characters, such as the thoracic color pattern, are obscured. The terminology for the adult midges follows that of Wirth (1952), Arnaud (1956), Wirth & Hubert (1959, in prep.), Khamala & Kettle (1971), and Wirth & Navai (1978).

Measurements and ratios are given either from single specimens or as the mean (minimum value–maximum value, n=number of measurements) and are determined as follows: segment proportions of antenna and palpus are relative segment lengths (1 unit equals approximately 2.35 μm); antennal ratio equals the combined length of the distal 5 flagellomeres divided by the combined length of the basal 8 flagellomeres; palpal ratio is the length of the 3rd segment divided by its maximum width; proboscis/head ratio is obtained by dividing the distance from the tormae to the apex of the epipharynx by the distance from the interocular seta to the tormae; lengths of the wing and costa are measured from the basal arculus to the wing tip and from the basal arculus to the costal apex, respectively; costal ratio equals the length of the costa divided by the wing length; wing width ratio is the maximum width of the wing divided by the wing length; length of the spermatheca is measured from the maximum extent of sclerotization on the entrance to the duct to the apex of the spermatheca; width of the spermatheca is its maximum breadth.

The wing pattern is one of the most useful characters in *Culicoides.* I have found in this study that a dark field greatly increases the contrast of the wing pattern and thus decreases errors in interpreting the boundaries of the pale areas. The wing pattern is described using a dark field condenser, with annotations of the contrast as seen using a conventional bright field condenser.

Unless otherwise stated, the knee color includes both the apex of the femur and the base of the tibia.

The cibarium and pharynx and their ornamentation were first used to separate species of Ceratopogonidae by De Meillon (1937), who described the structures for several species and constructed a key to genera based on pharyngeal characters. The ornamentation is of systematic importance within certain groups of *Culicoides.* These internal head sclerites are believed homologous with those described in Culicidae and Psychodidae, and the terminology used follows that of the excellent review of mosquito taxonomic terms by Knight & Laffoon (1970). However, the spines and other ornamentation in *Culicoides* are quite distinct from those found in culicids.

Pupa (Fig. 1)

The pupal stage, with its wide assortment of sclerotized tubercles, scales, and structures, offers excellent systematic characters. Fortunately, exuviae show all of the characters of the intact pupae. *Culicoides* pupae were first studied in detail by Carter, Ingram & Macfie (1920) for African species and their terminology, with modification, is used in this paper. Further important papers on descriptions of pupae are Kettle & Lawson (1952) on British species, Jones (1961) and Jamnback (1965) on North American species, and Nevill (1969) on African species.

Only slide-mounted exuviae associated with the adult midge were examined. Since most specimens were partially dissected and flattened dorsal side up on the slide, some characters are obscured or distorted. The degree of pigmentation is quite variable within species and should be used with caution. However, the color is relative and therefore useful, since paler individuals usually also have paler infuscated areas.

When available, both sexes were measured. The males are on the average smaller than the females, but the degree of overlap is enough to allow lumping the measurements for both sexes. When the 2 sexes differ markedly, the measurements are given for each sex. Measurements and ratios are presented in the same manner as for the adults, and are determined as follows: total length is measured along the body midline from the anterior margin of the cephalothorax minus the operculum to the tip of the posterolateral processes. Since the abdomen is often telescoped or stretched, only the sclerotized portion of each segment was measured. The maximum length of the respiratory trumpet is given and is divided by its greatest breadth, viewed laterally. Unfortunately, its width is easily distorted by crushing. The operculum width is the distance between the lateral corners; the length is the distance along the midline between the level of the lateral corners and the apex. The angle of divergence of the posterolateral processes is as seen in dorsal view in relatively undistorted mounts. Setae were measured under oil immersion with the setate oriented flat and were measured from the base within the trichogen to the apex. Since many setae are so attenuated that their apices cannot be seen, or are curved, the lengths given should be considered approximate.

The respiratory trumpet is attached dorsally to a distinct pedicel near the anterolateral corner of the cephalothorax. It is an elongate, conspicuous structure of much use systematically. There are 3 or more distal spiracles in a single row along the apical

margin and 0–4 lateral spiracles, usually widely spaced along the dorsal margin. The trumpet is often ornamented with distinct annulations in midportion, or with transverse folds and incomplete annulations, or with wide or narrow triangular scales. In some species there are intergrades between true annulations and folds and between folds and scales.

The operculum corresponds to the frontoclypeus. Since it is bounded by the ecdysial suture laterally and dorsally but remains connected to the cephalothorax ventrally, it springs back to its original position after ecdysis. The operculum is considered here to be oriented basad–distad, corresponding to the ventral and dorsal portions, respectively. The shape of the operculum, especially of the disc distad of the lateral corners, and the type of ornamentation on the disc offer useful group characters. In *Culicoides* there is usually at least a row of minute scales along the lateral margin of the disc. These often also occur on the disc or over all of the operculum. These are sometimes highly modified, for example, hairlike in the subgenus *Avaritia* and acuminate in the *neavei* group. The scales are often reduced to blunt papillae or ( ) (parentheses-shaped) marks. The anteromarginal tubercles (*am*'s) are a single pair of conspicuous tubercles located just basad of the lateral corners. The *am* has 1 apical seta and a basal porelike sensillum. The width of the operculum and size of the *am*'s varies with sex in many species groups.

CEPHALOTHORACIC TUBERCLES

am, anteromarginal. On the operculum q.v.

dm, dorsomedian. Represented by a hairlike seta and located just mesad of the respiratory trumpet pedicel; since it is difficult to see and appears not to vary much between species, it is not described.

ad, anterodorsal. A large tubercle bearing 2 apical or subapical setae and rarely a basal porelike sensillum; located on a separate sclerite just laterad of the operculum disc and anteromesad of the respiratory trumpet.

dl, dorsolateral. A large, rounded tubercle bearing 1 or 2 conspicuous setae and 1 seta hidden in basal cleft; located on the dorsolateral corner just laterad of the respiratory trumpet pedicel.

d, dorsal. Five tubercles grouped just laterad of midline in middle of dorsum, numbered anterior to posterior and laterad; *d 5* represented by a porelike sensillum, others by a seta-bearing tubercle; their arrangement and the size of their setae are important genus- and species-group characters.

vm, ventromedian. One pair near midline on ventral surface just anterior of mouthpart sheaths; each represented by 1 or 2 setae; tubercle inconspicuous or absent.

vl, ventrolateral. A humplike tubercle located on venter just anterolaterad of base of palpal sheath; with 2 setae and sometimes an inconspicuous porelike sensillum present.

ABDOMINAL TUBERCLES

dasm, dorsal anterosubmarginal. Two pairs of setigerous tubercles in transverse row on dorsum anterior of middle of segment; *dasm 1* laterad of *dasm 2.*

lasm, lateral anterosubmarginal. One setigerous tubercle on lateral surface and usually on same level as *dasm*'s.

lpm, lateral posteromarginal. Three tubercles on lateral surface just anterior of posterior margin of segment; in the species studied, *1* and *3* bear a stout spinelike seta, *2* bears a delicate hairlike seta; *1* is ventrad of and *3* is dorsad of *2*.

dpm, dorsal posteromarginal. Five tubercles in transverse row on each side of segment midline dorsally, just anterior of posterior margin of segment; numbered in sequence from lateral margin; *1, 2,* and *5* each bearing a seta, *3* and *4* without setae.

vpm, ventral posteromarginal. Three setigerous tubercles in transverse row on each side of segment midline ventrally at same level as *lpm*'s and *dpm*'s; numbered consecutively from midline.

asm, anterior submarginal. Three inconspicuous sensillae just posterior of anterior margin of segment and laterad of midline, 1 pair on dorsal surface, 2 pairs on ventral surface; in most *Culicoides* each sensillum has a minute peg ca. 5 μm long; it is too difficult to see to use as a character.

The number of abdominal tubercles is reduced on segments 1, 2, and 8 and absent from 9, the caudal segment.

The caudal segment bears large, conspicuous conical posterolateral processes. These curve dorsad in most species but the degree of curvature and other characters are obscured in dorsal mounts. The angle of divergence between them when viewed dorsally appears to be a useful species character. The external genitalia of the adult develop in external lobes on the ventral surface. These are very large in the male and small in the female.

In addition to the tubercles, the integument is often ornamented with patches of minute scales, papillae or ( ) marks. The scales have been variously called *spinules, squamose spines, spines, scales, thorns,* and *spicules* by earlier workers. I prefer the term "scales" with a modifing term to describe their form. Scales are often present on the operculum, respiratory trumpet, dorsum of cephalothorax (often reduced to ( ) marks), in an anterosubmarginal band on abdominal segments 2–9, and on other areas.

Lengths of the setae are given in Table 2, together with a characterization of setal form, i.e., D = delicate or hairlike, S = stout or spinelike, and M = medium or intermediate. The setal forms are not discussed in the descriptions unless they are diagnostic or important. A tubercle is considered produced if it has an apical or lateral projection beyond the tubercle outline or its apical margin is modified.

The key to pupae must be used with caution, since it covers barely ⅓ of the known *Culicoides* fauna of Laos. However, it should be useful, as it probably keys the majority of species that breed in exposed mud along water margins. It was hoped that the key might follow a higher classification scheme and offer further characters towards a more stable subgeneric classification. To a large degree the pupae do fall into the same related groups as the adults, but with the limited number of species studied and the fact that there are more conspicuous species-level characters, some compromises were made to make the key more useable. *C. brevitarsis, C. peregrinus,* and *C. circumscriptus* Kieffer were added to the key from the literature.

KEY TO ADULT *CULICOIDES* SPECIES OF LAOS

1. Wing without distinct pale or dark areas 2
Wing with more or less distinct pale or dark areas 3

2 (1). Two functional spermathecae; eyes hairy ..... 66. **species K**
Three functional spermathecae; eyes bare ..... 65. **kamrupi**

3 (1). Second radial cell at least partially included in poststigmatic pale spot 4
Second radial cell wholly included in a dark spot 53

4 (3). Three functional spermathecae present; 2nd radial cell long and broad; wing usually without distinct subapical pale spot in cell R_5; thorax often bright yellow in large part; 3rd palpal segment usually without a distinct sensory pit or depression ..... (subgenus *Trithecoides*) ... 5
Two functional spermathecae present; 2nd radial cell if very long is usually narrow; cell R_5 often with subapical pale spot; thorax usually brown with paler markings; 3rd palpal segment often with a definite sensory depression 25

5 (4). Mesonotum entirely dark brown, or yellow with at least some brown areas on anterior margin 6
Mesonotum entirely yellow or pale brown, sometimes brownish in front of scutellum 17

6 (5). Mesonotum predominantly dark brown, sometimes with lighter markings ... 7
Mesonotum predominantly yellow or light brown with darker areas on anterior and humeral margins 12

7 (6). Mandible with 6–8 strong teeth, distal ones largest 8
Mandible with 10–13 small subequal triangular teeth 10

8 (7). Spermathecae subequal, pyriform, with slender sclerotized necks; palpal ratio about 4.0; hind tibial comb with 5 spines ..... 6. **tenuipalpis**
Spermathecae unequal, with large unsclerotized entrances to ducts; palpal ratio less than 3.0; comb with 4 spines 9

9 (8). Wing darker, with indistinct narrow pale apex; mesonotum brown .... 7. **macfiei**
Wing tip broadly pale, with extensive pale areas between veins; mesonotum dark brown with small contrasting yellow areas near lateral margin and on disc ..... 8. **nampui, n. sp.**

10 (7). Dark brown of mesonotum and light brown of upper pleuron abruptly meeting in a straight line laterally; ♀ antenna with sensilla coeloconica on flagellomeres 3, 11–15; ♂ parameres slender ..... 13. **elbeli**
Brown markings on mesonotum fading into light brown pleuron laterally, usually with darker brown markings on humeral angles 11

11 (10). Female antenna with sensilla coeloconica on flagellomeres 3, 13–15; ♂ parameres slender ..... 17. **tamada, n. sp.** (part)
Female antenna with sensilla coeloconica on flagellomeres 3, 11–15; ♂ parameres massive, tips recurved ..... 14. **hinnoi, n. sp.** (part)

12 (6). Three subequal, pyriform spermathecae with narrow sclerotized entrances to ducts 13
One large and 2 smaller spermathecae with wide entrances to ducts 15

13 (12). Mandible with 8–9 large recurved teeth; palpal ratio greater than 4; epi- and hypopharynx normal ..... 5. **paksongi, n. sp.**
Mandible with 12–23 teeth; palpal ratio 3 or less; epi- and hypopharynx greatly expanded 14

14 (13). Mandible with 19–23 teeth, apical tooth large and separated from series of small

triangular teeth, 4–5 proximal teeth very short, spinelike, and directed distad; palpal ratio about 3; ♀ tarsal claws simple ..... 3. **paraflavescens**

Mandible with 12–15 large teeth, proximal ones largest; palpus very short, palpal ratio about 2; ♀ tarsal claws bifid ..... 1. **anophelis**

15 (12). Mandible with 7 strong teeth, distal ones largest ..... 11. **species A**

Mandible with 10–13 small subequal triangular teeth 16

16 (15). Female antenna with sensilla coeloconica on flagellomeres 3, 13–15; ♂ parameres slender ..... 17. **tamada, n. sp.** (part)

Female antenna with sensilla coeloconica on flagellomeres 3, 11–15; ♂ parameres massive, tips recurved ..... 14. **hinnoi, n. sp.** (part)

17 (5). Mandible with 21–24 teeth; epi- and hypopharynx greatly expanded in mid-portion; 3 subequal pyriform spermathecae with short, narrow, sclerotized necks ..... 2. **flavescens**

Mandible with 7–16 teeth; epi- and hypopharynx narrow; spermathecae usually not pyriform, usually with large openings to ducts 18

18 (17). Three subequal, pyriform spermathecae with short, narrow, sclerotized necks; 8–9 large triangular teeth, distal ones larger ..... 4. **nyungnoi, n. sp.**

Spermathecae with wide openings to ducts 19

19 (18). Mandible with 7–8 large, curved teeth, distal ones usually largest 20

Mandible with 10–13 small, subequal, triangular teeth 22

20 (19). All knees broadly pale ..... 10. **tonmai, n. sp.**

Hind femur with distinct dark apex 21

21 (20). Apex of epipharynx broad, with 3 distally projecting lobes, median lobe papilla-like; lacinia with 11–13 strong teeth; hind femur with broad, very distinct, subapical pale band ..... 12. **species B**

Apex of epipharynx narrow, only 2 distally projecting lobes; lacinia with 7–11 teeth, proximal ones weak; hind femur dark to tip or with narrow subapical pale band ..... 9. **palpifer**

22 (19). Antenna with sensilla coeloconica on flagellomeres 3, 13–15; halter pale, hind femur dark ..... 19. **species C**

Antenna with sensilla coeloconica on flagellomeres 3, 11–15 23

23 (22). Spermathecae subequal, elongate, usually sausage-shaped; scutellum yellow; wing extensively pale; hind femur with distinct broad subapical pale band ..... 18. **triallantionis, n. sp.**

Spermathecae very unequal, 1 large and 2 subequal small ones; scutellum dark; wing usually darker 24

24 (23). All knees dark; hind femur with distinctly blackened apex and usually with narrow subapical pale band; wing tip broadly pale, indistinct narrow pale streak present in cell M_2 at level of M_{1+2} fork ..... 15. **huberti, n. sp.**

Mid knee broadly pale; hind femur dark to apex; wing tip only narrowly pale; a large diffuse pale spot present in cell M_2 just below M_{1+2} fork ..... 16. **laoensis, n. sp.**

25 (4). Cell R_5 with distal pale spot (or 2nd if 3 are present) usually transverse, sometimes round, but never extending to near apex of cell R_5; pale markings distinct 26

Cell R_5 with distal pale spot broadly meeting apical margin of wing, without pale spot between it and poststigmatic pale spot; or distal pale spots indistinct or absent 41

26 (25). Third palpal segment small, slender, with distinct small circular deep sensory

pit; 2nd radial cell very short, extending ½ or less into poststigmatic pale spot; usually without pale spot in cell M_2 just anterior of mediocubital fork 27

Third palpal segment larger, either without sensory pit or swollen in middle and constricted beyond pit; 2nd radial cell longer, usually extending at least ½ way into poststigmatic pale spot; pale spot usually present just anterior of mediocubital fork 29

27 (26). Three distinct pale spots in cells R_5 and M_1; vein M_1 pale-margined in midportion ..... 39. **hui**

Two distinct pale spots in cells R_5 and M_1 28

28 (27). Wing with proximal part of vein Cu_1 pale-margined on both sides; double pale spot present straddling midportion of vein M_2 ..... 35. **boophagus**

Wing with proximal part of vein Cu_1 dark on both sides; no double pale spot straddling midportion of vein M_2 ..... 41. **jacobsoni**

29 (26). Third palpal segment without a distinct pit, elongate, palpal ratio usually 4.0 or larger, sometimes constricted; wing usually with only 1 long, broad radial cell 30

Third palpal segment with a definite sensory pit or distinct irregular, pitlike depression; palpal ratio usually less than 4.0; 2 radial cells present 36

30 (29). Anal angle with marginal dark streak; hind tibial spur as long as width of tibia ..... 26. **species D**

Base of wing including anal angle all pale; hind tibial spur short 31

31 (30). Hind tibial comb with 4 spines, legs mostly pale; wing without pale spot in cell M_2 just anterior of mediocubital fork ..... 22. **kisangkini, n. sp.** (part)

Hind tibial comb with 5–6 spines, legs dark, with or without pale bands; wing with pale spot in cell M_2 anterior of mediocubital fork fused with pale streak at base of M_2 32

32 (31). Apex of costa mostly pale but extending into dark spot beyond poststigmatic pale spot; only 1 long broad radial cell present; large species, wing longer than 1.4 mm ..... 20. **gemellus**

Costa ends in poststigmatic pale spot or just meets dark spot; 1 or 2 radial cells present; smaller species, wing less than 1.35 mm 33

33 (32). Cibarium with large mesal patch of spicules; all femora dark, apices narrowly paler; macrotrichia scattered in anterior distal portion of cell R_5 and fewer in longitudinal rows in distal portion of cells M_1 and M_2; antennal sensilla coeloconica present on flagellomeres 3, 11–15, multiple on 14, 15 ..... 25. **spiculae, n. sp.**

Cibarium without spicules; at least apex of hind femur dark or with subapical pale band 34

34 (33). Three transverse dark bands on costal wing margin very narrow, of subequal width; 2 radial cells present; macrotrichia scattered in anterior distal portion of cell R_5 and fewer in longitudinal rows in distal portion of cells M_1 and M_2; antennal sensilla coeloconica weak, present on flagellomeres 3, (11, 12), 13–15, and distal only on segment 14; antennal ratio less than 1.0, costal ratio 0.64 ..... 24. **pikongkoi, n. sp.**

Basal anterior transverse dark band at least 2× as wide as band distad of poststigmatic pale spot; 1 long R cell present; macrotrichia fewer, mostly confined to near wing margin in cells R_5 and M_1; antennal sensilla coeloconica stronger, present on at least flagellomeres 3, 11–15, and multiple on 14, 15; antennal ratio more than 1.0 35

35 (34). Mid knee broadly pale; apical ⅓ of mid femur pale; wing with pale spots large,

confluent; antennal sensilla coeloconica on flagellomeres 3, 11–15 ..... 23. **nyakini, n. sp.**

Mid knee narrowly pale; mid femur ⅕–¼ pale; wing with pale spots smaller, not confluent; antennal sensilla coeloconica on segments 3, (7, 9), 11–15 ..... 21. **kinari, n. sp.**

36 (29). Third palpal segment spindle-shaped with distinct round sensory pit; color of vein R_5 variable 38

Third palpal segment with very irregularly shaped shallow sensory pit, often divided into 2 or more pits; vein R_5 infuscated to point where it bends to meet costa 37

37 (36). Eyes narrowly contiguous; cibarial pump with internal patch of dark spicules; apices of veins M_1, M_2, and M_{3+4} with small pale spots; 2nd radial cell longer ..... 31. **peregrinus**

Eyes separated; cibarial pump without spicules; apices of veins M_2 and M_{3+4} dark; 2nd radial cell short and square-ended, extending only ½ way through poststigmatic pale spot ..... 32. **recurvus**

38 (36). R-m crossvein distinctly infuscated; small proximal pale spot in cell M_4 bordering vein M_{3+4} and separated from mediocubital fork; tips of veins M_1, M_2, and M_{3+4} pale ..... 28. **insignipennis**

R-m crossvein pale, cell M_4 without pale spot so located 39

39 (38). All femora dark to tip; apex of hind tibia darkish; anal angle all dark, pale spot at base of wing very small, not extending distad of level of anal angle except as streak along anal vein; halter very dark ..... 29. **lansangensis, n. sp.**

Fore femur with indistinct subapical pale band; knee very dark; mid femur with pale apical band, knee distinctly pale; hind tibia with yellowish apex; pale spot at wing base larger, extending distad at least as far again as distance from humeral crossvein to level of anal angle 40

40 (39). Pale spot over r-m crossvein small, rounded on distal side, not produced into cell R_5, and at most narrowly crossing vein M; pale spots small, not confluent; usually 5 spines in hind tibial comb; halter usually pale ..... 33. **sumatrae**

R-m pale spot crosses vein M, and with angular distal projection into base of cell R_5; usually 6 spines in hind tibial comb; halter usually dark; wing pale spots often large, sometimes confluent ..... 27. **innoxius**

41 (25). Only 1 very long, broad radial cell present; 3rd palpal segment very long, slender, without trace of pit; large species, wing about 1.38 mm ..... 22. **kisangkini, n. sp.** (part)

Two radial cells present, usually short; 3rd palpal segment with a sensory pit 42

42 (41). Second radial cell very elongate, 2× as long as 1st, and extending about 90% through wide poststigmatic pale spot; wing extensively pale; large species, wing 1.25 mm ..... 30. **liui**

Second radial cell short and extending ½ way or less through poststigmatic pale spot 43

43 (42). Apical pale spot in cell R_5 small and round; wing spots small; eyes separated ..... 52. **species H**

Apical pale spot in cell R_5 large, broadly meeting anterior and distal wing margins; wing pale spots large, or poorly contrasting; eyes contiguous 44

44 (43). Eyes with interfacetal hairs; 2nd radial cell dark, pale only on distal margin along vein R_{4+5}; fore and mid knees pale ..... 34. **actoni** (part)

Eyes bare; 2nd radial cell pale on distal ¼ or more 45

45 (44). Base of anal cell, including anal angle, pale; smaller species, wing usually less than 0.85 mm long 46
Anal angle dark, or at least with dark submarginal streak along anal angle; larger species, wing length usually greater than 0.85 mm 50
46 (45). Legs pale brown, all knees broadly yellowish; thorax yellowish brown; wing with pale spots large, diffuse, and confluent ..... 36. **brevipalpis**
Legs brown with pale bands; at least fore and hind knees very dark; thorax usually dark brown 47
47 (46). Spermathecae very unequal; mid knee distinctly dark; antenna short, flagellomeres 6–9 each about 1.4× as long as wide; 2nd radial cell pale on distal ⅖ or less ..... 37. **brevitarsis**
Spermathecae subequal; mid knee pale or slightly infuscated; antenna longer, flagellomeres 6–9 each about 1.7× as long as wide; 2nd radial cell pale on distal ½ to ¾ 48
48 (47). Antenna with sensilla coeloconica on flagellomeres 3, 12–15; distal dark mark on vein M_2 excised preapically by posterior extension of pale spot in cell M_1; palpal pit apical with irregularly crenulate margin; halter pale ... 40. **imicola**
Antennal sensory pattern 3, 11–15; distal dark mark on vein M_2 narrowed distally, not excised preapically by extension of cell M_1 pale spot; palpal pit preapical with small circular opening; halter pale or infuscated 49
49 (48). Halter infuscated; thorax mostly brown, tan laterally; first costal dark spot darker than posterior dark areas on wing; spermathecae about 1.3× as long as wide ..... 38. **fulvus**
Halter palish; thorax pale brown, yellowish laterally; wing markings paler, 1st dark costal spot not darker than posterior dark areas; spermathecae elongate, about 1.4× as long as wide ..... 46. **species F**
50 (45). Cell M_2 without a pale area just distad of mediocubital fork; distal pale spots on wing poorly defined ..... 45. **species E**
Cell M_2 with a distinct pale spot or streak just distad of mediocubital fork; distal pale spots on wing distinct 51
51 (50). Small isolated quadrate dark spot at apex of vein M_2; cell M_2 with large pale area anterior to and nearly contiguous with mediocubital fork; spermathecae very unequal ..... 44. **wadai**
Without isolated quadrate dark spot at apex of vein M_2; cell M_2 dark adjacent to mediocubital fork, with only pale streak anterior of fork connecting pale spots basad and distad of level of M-Cu fork; spermathecae subequal 52
52 (51). Hind tibia with palish apex; basal 2 dark costal spots subequal in width at wing margin; longitudinal pale streak in anal cell present, sometimes incomplete distally; anal angle pale with submarginal dark streak ..... 43. **orientalis**
Hind tibia with dark apex; basal dark costal spot distinctly wider than stigmatic dark spot at wing margin; longitudinal pale streak in anal cell absent; anal angle mostly dark ..... 42. **maculatus**
53 (3). Wing with only 2 pale spots, 1 on r-m crossvein and 1 at end of costa; 3rd palpal segment greatly enlarged, with a large deep sensory pit opening by a small pore ..... 51. **okinawensis**
Wing with 3 or more spots, sometimes posterior ones very faint 54
54 (53). Cell M_2 with small round distinct pale spot located immediately anterior of mediocubital fork; 2 spermathecae present, pale spots usually distinct 55

Cell M_2 without separate pale spot located immediately anterior of mediocubital fork; 1 or 2 spermathecae, pale spots sometimes indistinct 63

55 (54). Cell R_5 with distal pale spot transverse, hourglass-shaped, and located ½ way between poststigmatic pale spot and apex of cell ..... 48. **oxystoma**

Cell R_5 with distal pale spot small, usually round, located near apex of cell ..... (*similis* group) ... 56

56 (55). Poststigmatic pale spot trilobed, sometimes divided, extending from anterior margin basad then distoposteriorly to or nearly to vein M_1; at least mid knee pale; 3rd palpal segment greatly swollen, with large deep sensory pit opening by a smaller round pore 57

Poststigmatic pale spot transverse or divided into 2 spots, smaller spot directly posterior to spot on anterior wing margin; all knees dark; 3rd palpal segment with large sensory pore with very large opening or segment 3 slender with small deep pit 59

57 (56). Only 1 pale spot in cell M_1, that located near apex of cell ..... 59. **species I**

Cell M_1 with 2 pale spots, 1 in middle and 1 at apex of cell 58

58 (57). Poststigmatic pale spot meeting vein M_1, not divided; antennal sensilla coeloconica present on flagellomeres 3, 8–10 ..... 54. **clavipalpis**

Poststigmatic pale spot not reaching vein M_1, sometimes divided; antennal sensilla coeloconica on flagellomeres 3, (5, 6), 7–10 ..... 57. **parviscriptus**

59 (56). Only 1 pale spot in cell M_1, and that located near apex of cell; poststigmatic pale spot transverse, not divided ..... 53. **arenicola, n. sp.**

Cell M_1 with 2 pale spots, 1 in middle and 1 at apex of cell; poststigmatic pale spot usually divided into 2 spots 60

60 (59). Posterior poststigmatic pale spot located midway between anterior spot and vein M_1, not touching latter, rarely absent; anterior poststigmatic pale spot usually small, round 61

Posterior poststigmatic pale spot located near or touching vein M_1; anterior poststigmatic pale spot transverse, extending posteriorly from anterior wing margin 2× width of 2nd radial cell 62

61 (60). Cell M_2 with 2 distinct round pale spots in distal ½; proximal pale spot in cell M_1 small, not lapping over vein M_2; 3rd palpal segment swollen with large sensory pit opening by a wide irregular pore ..... 56. **notatus**

Cell M_2 with 1 pale spot near apex; proximal pale spot in cell M_1 lapping over vein M_2; sensory pit on palpal segment 3 large with circular opening ..... 58. **similis**

62 (60). Third palpal segment slender with small deep pit; sensilla coeloconica present on antennal flagellomeres 3, 10, 12, 14; proximal pale spot in cell M_1 lapping over vein M_2 ..... 60. **species J**

Third palpal segment swollen distally with broad shallow circular pit; sensilla coeloconica present on antennal flagellomeres 3, 5, 7–10; proximal pale spot in cell M_1 usually not extending into cell M_2 ..... 55. **huffi**

63 (54). With 2 well-developed spermathecae 64

With 1 well-developed spermatheca 67

64 (63). Large indistinct pale spot in apex of cell R_5, broadly meeting anterior and distal wing margin, not touching vein M_1; distal pale spots very indistinct, base of anal cell pale; antennal sensilla coeloconica on flagellomeres 3, 12–15 ..... 34. **actoni** (part)

Apical pale spot in cell R_5 either not meeting distal wing margin or small and round; distal pale spots distinct 65

65 (64). Small circular pale spot present at apex of cell R_5, no pale spot between it and poststigmatic pale spot; poststigmatic pale spot transverse, without basad extension posterior of 2nd radial cell; no spot in this location; sensilla coeloconica tufts on flagellomeres 3, 11–14 ..... 50. **geminus**

Large elongate or irregular pale spot located subapically in cell R_5; poststigmatic pale spot with basal extension posterior of 2nd radial cell or a separate spot in this location 66

66 (65). Wing pale spots contrasting; cell R_5 with large transverse pale spot midway between poststigmatic pale spot and wing apex, usually with additional round pale spot at extreme apex; 2 or 3 pale spots in cell M_1; antennal sensilla coeloconica on flagellomeres 3, 7–10 ..... 49. **shortti**

Wing pale spots poorly contrasting; distal pale spot in cell R_5 longitudinally elongate, not quite attaining apex of cell; sensilla coeloconica on flagellomeres 3, 11, 13, 14 ..... 47. **species G**

67 (63). Cell R_5 with distal pale spot located midway between poststigmatic pale spot and apex; tips of veins M_1 and M_2 pale; 3rd palpal segment swollen, with large deep sensory pit ..... 64. **circumscriptus**

Distal pale spot located at apex of cell R_5; tips of veins M_1 and M_2 dark; palpal sensory pit shallow 68

68 (67). One transverse poststigmatic pale spot; wing spots faint; antennal sensilla coeloconica located on flagellomeres 3, (5, 7, 9), 11–14; mouth unarmed ..... 63. **hegneri**

Two separate poststigmatic pale spots; posterior located proximad of level of anterior; wing spots prominent; entrance to mouth with median sclerite armed with strong triangular spines 69

69 (68). Spermatheca widest near middle with rounded apex; antennal sensilla coeloconica on flagellomeres 3–6, 11–14; median sclerite in mouth with 7–9 large triangular spines; wing with pale spot in cell R_5 posterior to radial cells and touching vein M_1 but not radius ..... 62. **guttifer**

Spermatheca widest near broadly rounded apex; antennal sensilla coeloconica on flagellomeres 3–14; median sclerite in mouth with 11–15 large triangular spines; proximal pale spot in cell R_5 posterior to radial cells present or absent; if present usually closer to radius than M_1 ..... 61. **arakawae**

Key to the known pupae of the *Culicoides* of Laos

1. Operculum with disc beset with numerous long hairlike scales on lateral margin and just distad of *am* tubercles; abdominal segment 4 with only 2 *dpm* tubercles ..... (subgenus *Avaritia*) ... 37. **brevitarsis**

Operculum ornamented with numerous short, triangular scales, none elongate, hairlike; abdominal segment 4 with 5 *dpm* tubercles 2

2 (1). Operculum with prominent subapical median tubercle, usually darker than color of disc; *ad* tubercle with 2 elongate setae, both much longer than tubercle height ..... (subgenera *Haemophoructus* and *Culicoides*) ... 3

Operculum without subapical median tubercle, sometimes a swelling present, clothed with scales of disc; *ad* setae unequal, shorter seta equal to or shorter than tubercle height 5

3 (2). Respiratory trumpet not annulated, without lateral spiracles, somewhat clavate, with numerous scales (Fig. 2c); caudal segment with single fused row of anterosubmarginal scales 4

Respiratory trumpet with scaly annulations in midportion, with 2 lateral spiracles (Fig. 1b); caudal segment with wide anterosubmarginal band of unfused, small, triangular scales ..... 22. **kisangkini, n. sp.**

4 (3). Operculum disc greatly narrowed just distad of lateral corners, wider distad (Fig. 2d); *am* seta long, ½ as long as width across lateral corners ..... 26. **species D**

Operculum disc moderately narrowed just distad of lateral corners, not wider distad; *am* seta shorter, length about ⅓ width across lateral corners ..... 31. **peregrinus**

5 (2). Thoracic tubercles *d* with *1, 2,* and *3* in line; *d 2* posterior of and usually widely separated from *d 1* (Fig. 23d) 6

Tubercles *d 1, 2,* and *3* not in line; *d 2* laterad of *1* and approximad or narrowly separated (Fig. 19a) 15

6 (5). Tubercle *d 2* with long seta of medium thickness; *d 1* with short, stout seta; *lpm 2* usually more strongly bifid than *lpm 1* and *3* .. (subgenus *Trithecoides*) ... 7

Tubercles *d 1* and *2* each with short stout seta of subequal or slightly unequal lengths; *lpm*'s not produced or subequally produced 8

7 (6). *Dpm* tubercles with broadly rounded, somewhat produced, short, shieldlike apex; abdominal segment 8 without dorsomedian patch of scales ..... 2. **flavescens**

Dpm tubercles *1* and *2* strongly bifid; segment 8 with longitudinal dorsomedian patch of scales ..... 6. **tenuipalpis**

8 (6). *Lpm* tubercles strongly produced, apical margin with 2 or more large acute teeth (Fig. 19e) 11

Lpm tubercles with apical margin rounded, without teeth (Fig. 23g) 9

9 (8). *Lpm* tubercles not produced apically beyond base of seta .... 64. **circumscriptus**

Lpm tubercles produced distad of setal base, apex shieldlike 10

10 (9). *D* tubercles widely spaced, *d 2* greater than 1× length of *d 1* seta posteriad of *d 1* (Fig. 23d); caudal segment with posterolateral processes nearly parallel or diverging less than 40° ..... 61. **arakawae**

D tubercles closer, *d 2* usually less than length of *d 1* seta posteriad of *d 1* (Fig. 23e); posterolateral processes diverging about 80° ..... 62. **guttifer**

11 (8). Respiratory trumpet with numerous conspicuous scales, especially in midportion (Fig. 18b) 12

Respiratory trumpet without scales (Fig. 23c) 14

12 (11). Midportion of respiratory trumpet without annulations, usually with few incomplete transverse folds, trumpet infuscated to dark; *lpm*'s with 2–4 apical teeth 13

Midportion of respiratory trumpet pale and constricted by distinct series of ringlike annulations; *lpm* tubercles with apical ridge of 6–9 large triangular teeth ..... 50. **geminus**

13 (12). *Lpm* tubercles strongly bifid; trumpet with fewer than 6 distal spiracles ..... 49. **shortti**

Lpm tubercles with 3–4 large, triangular apical teeth; trumpet with 8–11 distal spiracles ..... 51. **okinawensis**

14 (11). Two *vpm*'s present, not bifid; *dpm*'s rounded, not bifid; *d* tubercles small and widely spaced, *d 1* about 3 × length of its seta from *d 2*; area between *d* tubercles nearly smooth ..... (subgenus *Pontoculicoides*) ... 65. **kamrupi**

Three *vpm*'s present, usually strongly bifid; *dpm 1* and *2* strongly bifid; *d* tubercles larger and closer together, *d 1* about length of its seta from *d 2*; area between *d* tubercles papillate ..... 63. **hegneri**

15 (5). *Lpm* tubercles strongly bifid (Fig. 19g) 17

Lpm tubercles rounded (Fig. 19d) 16

16 (15). Respiratory trumpet with 2–3 lateral spiracles on large, infuscated protuberances, apical portion infuscated, with few acute scales (Fig. 18a); *lpm* tubercles rounded, without shieldlike projection ..... 48. **oxystoma**

Respiratory trumpet with 3 lateral spiracles, only distal one on large unpigmented protuberance, apical portion pale except narrowly at apex, without scales (Fig. 21b); *lpm* tubercles strongly produced apically and laterally to broad shield ..... 53. **arenicola, n. sp.**

17 (15). Respiratory trumpet with small dark triangular scales just distad of annulations in midportion; apical portion infuscated to very dark and usually slightly swollen subapically (Fig. 18e) 18

Respiratory trumpet without scales, apical portion lightly infuscated and usually not swollen subapically (Fig. 18c) 19

18(17). Respiratory trumpet with 2 lateral spiracles, distal one and usually basal one on large infuscated protuberances, apical portion very dark (Fig. 18e); *dasm* and *dpm* tubercles usually rounded ..... 58. **similis**

Respiratory trumpet usually with 3 lateral spiracles on small to medium palish protuberances, apical portion infuscated, darker than basal portion (Fig. 18f); *dasm 1* and *dpm 1* and *2* strongly acutely bifid ..... 55. **huffi**

19 (17). Apices of *d* tubercles *1* and *2* sharply bifid (Fig. 22b); *dasm 1* and *2*, and *dpm 1* and *2* tubercles sharply bifid (Fig. 22a); respiratory trumpet with basal portion ca. ½ length and apical portion ca. ⅓ length of trumpet ..... 56. **notatus**

Apices of *d* tubercles *1* and *2*, *dasm 1* and *2*, and *dpm 1* and *2* produced, rounded, shieldlike; respiratory trumpet with basal portion ca. ⅔ length of trumpet, apical portion very short ..... 60. **species J**

SPECIES DESCRIPTIONS

Subgenus **Trithecoides**

anophelis group

1. **Culicoides (Trithecoides) anophelis** Edwards

Culicoides anophelis Edwards, 1922, Bull. Entomol. Res. **13:** 161 (♀; Malaya, Sumatra, India; ex *Anopheles* mosquitoes; fig. wing, abdomen, parasitized mosquito).

→

FIG. 1. Pupae. **a–c,** *Culicoides kisangkini:* **a,** ♂ pupal exuviae, dorsal view (for tubercle abbreviations see text; RT = respiratory trumpet, O = operculum, P = posterolateral process, G = ♂ genital sheath); **b,** respiratory trumpet; **c,** *lpm* tubercles (m = *lpm 2*). **d,** *Culicoides* sp. D: *lpm* tubercles (m = *lpm 2*).

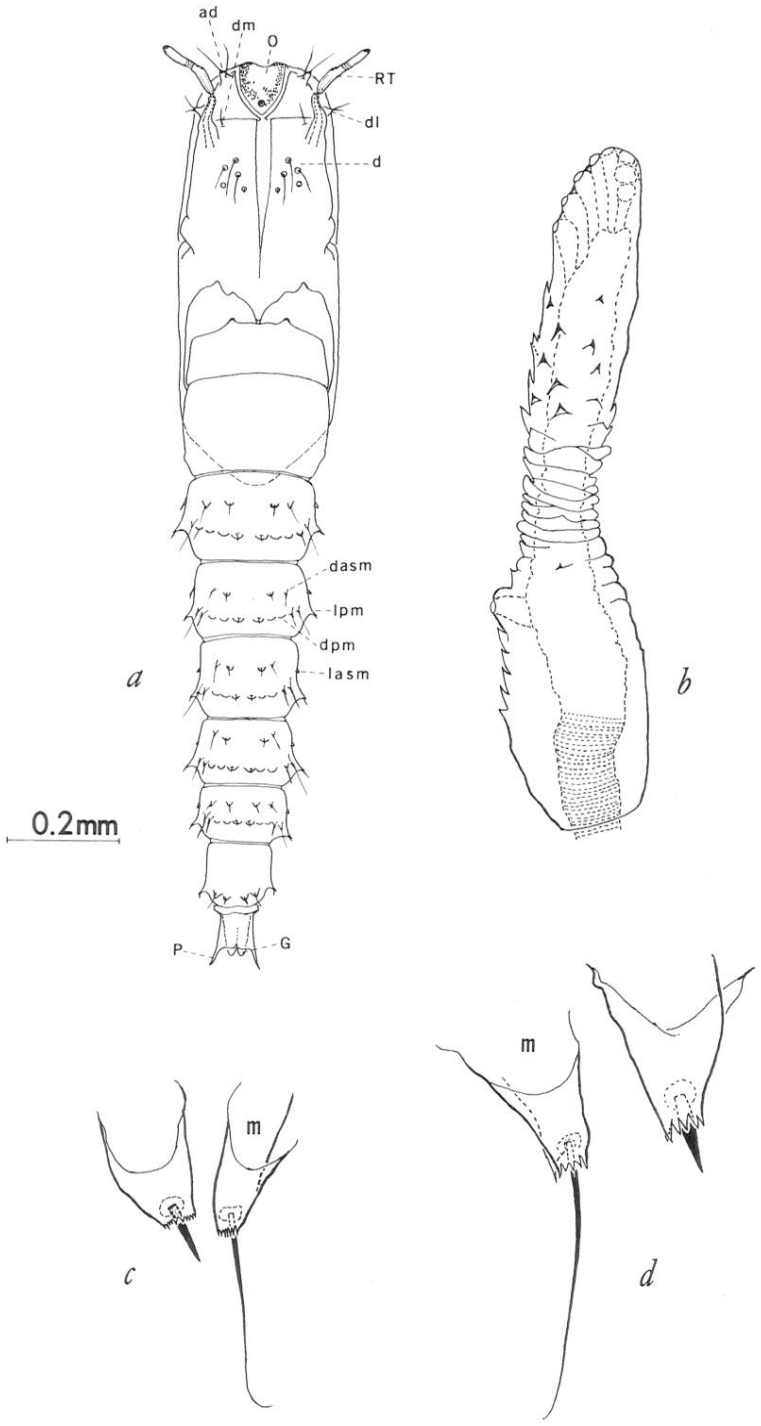
ad
dm
O
RT
dl
d
dasm
lpm
dpm
lasm
a
b
0.2mm
P
G
m
m
c
d

TABLE 2. Measurements of important tubercular setae of *Culicoides* pupae; setal form* given over length (in micrometres).

SPECIES NO. AND NAME		*lpm*		*vpm*			*dpm*			*dasm*	
	lasm	*1, 3*	*2*	*1*	*2*	*3*	*1*	*2*	*5*	*1*	*2*
2. *flavescens*	S	S	D	M	D	M	D	M	S	D	M
	14	19	~33	5	35	16	30	9	3	35	14
6. *tenuipalpis*	S	S	D	S	D	M	D	S	S	D	M
	14	23	60	7	40	16	28	12	4	40	16
22. *kisangkini*	S	S	D	S	D	SM	D	D	S	D	SM
	16	21	~100	10	70	28	65	60	4	70	24
26. sp. D	S	S	D	S	D	MS	D	MS	S	D	SM
	12	17	60	7	35	24	35	12	3	50	20
48. *oxystoma*	S	S	D	S	D	S	D	S	S	D	S
	15	15	40	5	40	14	30	8	2	25	14
49. *shortti*	S	S	D	S	D	S	D	S	S	D	S
	10	13	27	8	22	12	23	10	4	25	10
50. *geminus*	S	S	D	M	D	SM	D	M	S	D	SM
	22	25	50	15	50	18	29	17	4	42	18
	S	S	D	S	D	S	D	S	S	D	S
51. *okinawensis*	22	27	40	15	40	20	24	14	6	30	18
53. *arenicola*	S	S	D	S	D	SM	D	S	S	D	S
	13	17	33	6	33	15	20	10	5	28	13
55. *huffi*	S	S	D	S	D	S	D	S	S	D	MS
	15	16	36	7	35	17	30	13	4	30	12
56. *notatus*	S	S	D	S	D	M	D	SM	S	D	MS
	13	16	40	5	40	15	25	11	4	30	14
58. *similis*	S	S	D	S	D	S	D	S	S	D	S
	13	14	30	7	31	15	25	13	4	28	15
60. sp. J	S	S	D	S	D	S	D	S	S	D	MS
	15	16	35	6	35	16	30	9	4	30	13
61. *arakawae*	S	S	D	S	D	MS	D	MS	M	D	MS
	17	18	40	11	35	17	32	15	5	30	14
62. *guttifer*	S	S	D	M	D	MS	D	MS	M	D	MS
	16	17	40	11	38	16	25	12	5	40	14
63. *hegneri*	S	S	D	M	D	S	D	S	S	D	S
	12	14	24	5	17	12	19	7	2	17	9
65. *kamrupi*	S	S	D	A	D	SM	D	SM	S	D	SM
	13	13	22		18	11	28	9	3	18	9

* S = stout or spinelike, M = medium or intermediate, D = delicate or attenuated, hairlike distally, A = absent.

Biting habits. I collected this species by sweeping a cow and a cow shed at 2100 h near Pakse, Laos; however, *C. anophelis* is not known to take mammalian blood but instead feeds on the hemolymph of mosquitoes (Wirth & Hubert 1959, in prep.).

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 2♀. SEDONE PROV: Muong Pakse, 100 m, 5.IX.1967, sweeping cow and cow shed 2100 h, 6♀.

TABLE 2. Extended.

d				*ad*			*vm*		*vl*		*dl*		
1	*2*	*3*	*4*	*1*	*2*	*am*	*1*	*2*	*1*	*2*	*1*	*2*	*3*
S	DM	S	D	S	S	S	D	D	D	M	D	M	M
19	35	9	40	75	19	70	14	30	28	65	80	18	14
S	DM	S	D	S	S	S	D	DM	D	DM	D	M	M
30	43	9	63	66	21	75	14	40	35	61	85	19	14
DM	DM	S	DM	M	DM	S	D	DM	D	D	D	D	M
100	100	7	90	134	90	120	24	60	56	82	90	60	16
S	DM	S	D	DM	DM	SM	D	A	D	D	D	D	M
19	60	7	70	134	134	100	35		50	70	110	18	12
S	S	S	D	S	S	S	D	D	D	D	D	D	M
27	26	7	40	34	11	37	17	19	25	45	50	25	11
S	S	S	D	S	S	S	MD	M	MD	D	D	MS	M
22	17	9	35	34	15	50	25	38	20	60	60	13	13
S	S	S	D	S	S	S	M	MD	M	MD	D	M	M
30	25	8	60	47	10	61	19	55	25	58	74	21	15
S	S	S	D	S	S	DM	DM	S	D	DM	D	M	M
30	34	7	65	47	22	63	21	50	47	66	55	20	17
S	S	S	D	S	S	S	D	D	D	D	D	M	M
24	20	6	43	39	11	55	15	30	25	60	65	10	14
S	S	S	D	S	S	S	D	D	D	D	D	MS	MS
20	19	6	47	33	11	56	17	30	25	50	50	13	12
S	S	S	D	S	M	S	D	D	D	D	D	M	M
23	17	7	55	34	13	60	13	28	33	65	48	12	15
S	S	S	D	S	S	S	D	D	D	D	D	MS	MS
24	24	8	30	32	12	49	15	30	20	40	40	10	13
S	S	S	D	S	M	S	D	D	D	D	D	MS	MS
20	17	6	45	43	12	61	?	27	15	45	67	10	12
S	S	S	D	S	SM	S	M	MD	MD	MD	D	M	M
21	14	9	30	30	12	54	15	37	22	40	55	13	13
S	S	S	D	S	SM	S	M	M	M	MD	D	M	M
18	14	6	45	26	13	62	13	39	25	60	60	14	14
S	S	S	D	S	S	S	D	D	D	D	D	MS	M
12	14	5	19	19	10	26	12	24	21	35	47	10	9
S	S	S	D	S	S	S	D	D	D	D	D	A	M
16	12	6	32	19	11	21	7	17	15	25	23		10

flavescens group

2. **Culicoides (Trithecoides) flavescens** Macfie Fig. 2a, b

Culicoides anophelis Edwards, var. *flavescens* Macfie, 1937, Proc. R. Entomol. Soc. Lond. B **6:** 114 (♀; Malaya, on cattle).

Culicoides flavescens Macfie, Wirth & Hubert, 1959, Pac. Insects **1:** 13 (status; distributions; fig. wing, palpus, mandible, spermathecae).

Immature stages. *Pupa.* Total length 1.94 mm (1.78–2.06, *n*=10). Color light brown, cephalothorax slightly darker than abdomen. *Respiratory trumpet* (Fig. 2a). Length 220 μm (200–230, *n*=10), 6.2× (5.7–7.2, *n*=10) longer than wide, basal portion widest, concolorous with cephalothorax; midportion pale, narrowed, with 6–10 conspicuous annulations in midportion, a few foldlike, incomplete annulations basad of distolateral spiracle; distal ⅓ infuscated, slightly expanded subapically, apex blackened, scales entirely absent; with 3 (2–4, *n*=10) lateral spiracles on infuscated protuberances; tracheoles variable, usually widened distally; 6–7 (6–9, *n*=10) distal spiracles; pedicel ca. ⅕ length of trumpet. *Operculum* (Fig. 2b). About as wide as long, width : length 161 μm (150–170, *n*=5) : 158 μm (150–165, *n*=5) in ♂, and 176 μm (172–179, *n*=5) : 169 μm (160–176, *n*=5) in ♀; subquadrate basad of lateral corners, moderately narrowed just distad of lateral corners; pale brown, without subapical tubercle, sometimes indistinct, unpigmented subapical swelling present; lateral margin of disc with row of small, acute scales, longest 7 μm long, smaller distally; disc with wide basal band of acute scales, smaller mesally, not extending basad of lateral corners; midportion of disc acuductate and with ( ) markings, ( ) marks extending basad of *am* tubercle; *am* tubercle large, dark, well developed, slightly produced to short blunt apical tooth; *am* seta stout, 73 μm (66–82, *n*=10) long, 2.3× (2.1–2.6, *n*=5) in ♂ and 1.4× (1.2–1.8, *n*=5) in ♀ as long as distance between *am*'s. *Cephalothorax.* Setal measurements, Table 2; *dl* tubercle with 1 subapical elongate seta and 2 short setae, 1 in basal cleft; *ad* tubercle large, apically produced to blunt tooth, with 2 very unequal apical setae, without basal sensillum; *vm* with 2 unequal setae; *vl* tubercle large, 2 unequal setae and sensillum present; *d 1* tubercle slightly produced, rounded, ridgelike or bifid; *d 2, 3,* and *4* subequal in size, broadly rounded; *d 1, 2,* and *3* and *1, 4,* and *5* in 2 straight lines as a V, widely separated, *d 2* equidistant from *d 1, d 3,* and *d 4*; *d 3* 3× length of *d 1* seta from *d 1*; *d 5* 3.5× length of *d 1* seta from *d 1*; *d 1* with stout seta, *d 2* with elongate medium seta less than 2× length of *d 1* seta; dorsum near *d* tubercles with numerous ( ) markings; a dorsal sensillum located posterolaterad of *d 5. Abdomen.* Well-developed *lpm* tubercles, produced laterally and apically, lateral margin shieldlike, apex bifid, with 2 large irregular triangular teeth, rarely with acute shieldlike apex and rarely with 3–5 small apical teeth; apicolateral teeth on *lpm 2* ca. ½ length of seta on *lpm 1,* apicolateral teeth on *lpm 1* and *3* ca. ⅕ length of *lpm 1* seta; *lasm, dasm 1,* and usually *dpm 1* somewhat produced, with 2 broadly rounded apical lobes; *dasm 2, dpm 2, 3, 4,* and *5* and *vpm*'s produced, broadly rounded, apical shield wider than long; *dpm 2, 3, 4,* and *5* smaller than *vpm* tubercles. Abdominal segments 2–8 with weakly pigmented transverse dorsomedian spot on anterior margin; segments 2–8 with wide anterosubmarginal band of small acute scales, more numerous mesally on dorsum and venter, absent laterally on segments 2–7, scales becoming less numerous on posterior segments; anterior margin of intersegmental membranes papillate and with ( ) marks. *Caudal segment.* With narrow anterosubmarginal band of strong acute scales encircling segment; a small V-shaped patch of scales on dorsum in midportion. Posterolateral processes large, stout, tapered to acute apices, scales on dorsal, mesal, and ventral surfaces; diverging 58° (50–70°, *n*=5); darkened on distal ½.

Breeding habitats. *Culicoides flavescens* was reared from pupae collected from 2 sites during this study, one a shaded stream margin in a bamboo thicket and one a shaded, stagnant backwater margin. Both sites were heavily shaded, exposed muddy areas near water margins, had moderate amounts of silt, organic detritus and sand, and were moderately to heavily polluted. The stream margin also contained a small amount of gravel and a moderate amount of clay. *Culicoides flavescens* was associated with *C. huffi* and *C. arenicola* at both sites, with *C. guttifer* and *C.* sp. D at the stream margin, and with *C. similis* and *C.* sp. J at the backwater margin.

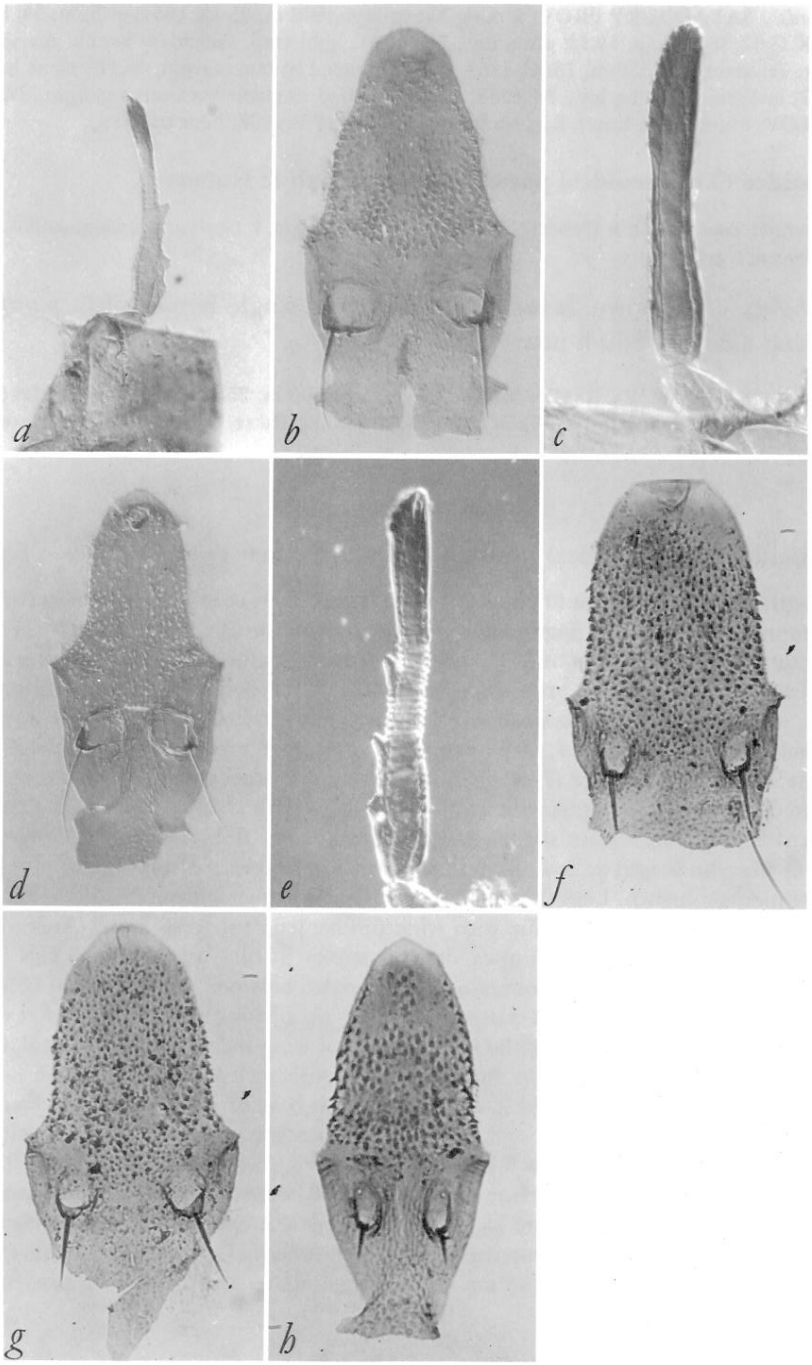

FIG. 2. Pupae. **a–b,** *Culicoides flavescens:* **a,** respiratory trumpet; **b,** ♀ operculum. **c–d,** *Culicoides* sp. D: **c,** respiratory trumpet; **d,** ♂ operculum. **e,** *C. tenuipalpis,* respiratory trumpet. **f,** *C. arakawae:* ♀ operculum. **g,** *C. guttifer:* ♀ operculum. **h,** *C. hegneri:* ♂ operculum.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 5♀; Sayaboury, 300 m, 6.X.1967, light trap, 1♀,1♂; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 1♀; same loc., 330 m, 18.XI.1967, reared, shaded stream margin, 4♀,11♂; same loc., 300 m, 27.XI.1967, at light, 2♀; same loc., 7.I.1968, reared, shaded stagnant backwater margin, 2♀,3♂. VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 9♀.

3. **Culicoides (Trithecoides) paraflavescens** Wirth & Hubert

Culicoides paraflavescens Wirth & Hubert, 1959, Pac. Insects **1:** 15 (♂, ♀; Ceylon; fig. wing, palpus, mandible, spermathecae, ♂ genitalia).

Biting habits. Unknown; however, I collected a single female of *C. paraflavescens* by sweeping a cow at 800 h near Pakse, Laos.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 1♀; Sayaboury, 300 m, 31.X–2.XI.1967, at light, 1♀. SEDONE PROV: Muong Pakse, 100 m, 6.IX.1967, sweeping cow 0800 h, 1♀.

tenuipalpis group

4. **Culicoides (Trithecoides) nyungnoi** Howarth, **new species** Fig. 3, 24a

♀. Length of wing 0.98 mm (0.95–1.03, n=6). *Head.* Eyes contiguous diameter of 4 facets, bare. Antenna (Fig. 3a) with flagellomeres in proportion of 20:17:16:16:17:16:17:17:25:24: 31:33:50, antennal ratio 1.12 (1.06–1.20, n=6); sensilla coeloconica on flagellomeres 3, 11–15. Palpal segments (Fig. 3b) in proportion of 8:23:21:11:12; 3rd palpal segment short, swollen in middle, with scattered sensilla on distal ½, sometimes sensilla grouped in shallow irregular clusters; palpal ratio 2.2 (2.1–2.4, n=6). Proboscis very short, proboscis/head 0.54 (0.52–0.57, n=6). Mandible (Fig. 3c) with 8 (7–9, n=6) large triangular teeth, distal ones larger and more widely spaced; epi- and hypopharynx narrow, hypopharynx bladelike, without teeth; lacinia with 10 small teeth, distal ones slightly larger; tormae very thin. *Thorax.* Scutum, scutellum, upper ½ of pleuron bright yellow, sometimes dark just anterior of scutellum; postscutellum, lower ½ of pleuron brown. Legs (Fig. 3f) predominantly brown with wide pale bands; fore and mid knees broadly pale; hind femur with wide diffuse pale subapical band, knee dark, hind tibia with a wide basal pale band, apex dark; 4 spines in hind tibial comb, 2nd from spur longest. *Wing* (Fig. 3d, 24a). Predominantly dark, paler between veins; 2 small pale spots on anterior wing margin, 1 over r-m crossvein, 1 over tip of long broad 2nd radial cell; other spots located mainly between veins and diffuse; base of wing including part of anal angle pale; indistinct large pale spot apically in anal cell; small indistinct pale spots located in apices of cells M_4 and M_2; large pale spot and streak in cell M_2 at base of mediocubital fork and in M_{1+2} fork; a large spot in middle of M_1 cell which sometimes laps over vein M_2 into cell M_2; apex on wing narrowly pale; costal ratio 0.71 (0.70–0.72, n=6); wing ratio 0.48 (0.47–0.50, n=6); macrotrichia confined to near anterior margin of cell R_5 distad of 2nd radial cell and to a few longitudinal lines in cells R_5, M_1, and M_2. Halters distinctly infuscated to dark. *Abdomen.* Terga light brown; 3 well-developed spermathecae (Fig. 3e), subequal, pyriform, with short, narrow, sclerotized necks, each measuring 33 μm × 26 μm; elongate sclerotized ring present.

♂. Unknown.

Immature stages and breeding habitats. Unknown.

Distribution. Laos.

Holotype ♀, LAOS: SEDONE PROV: Muong Pakse, 100 m, 3.IX.1967, at light in forest (F.G.

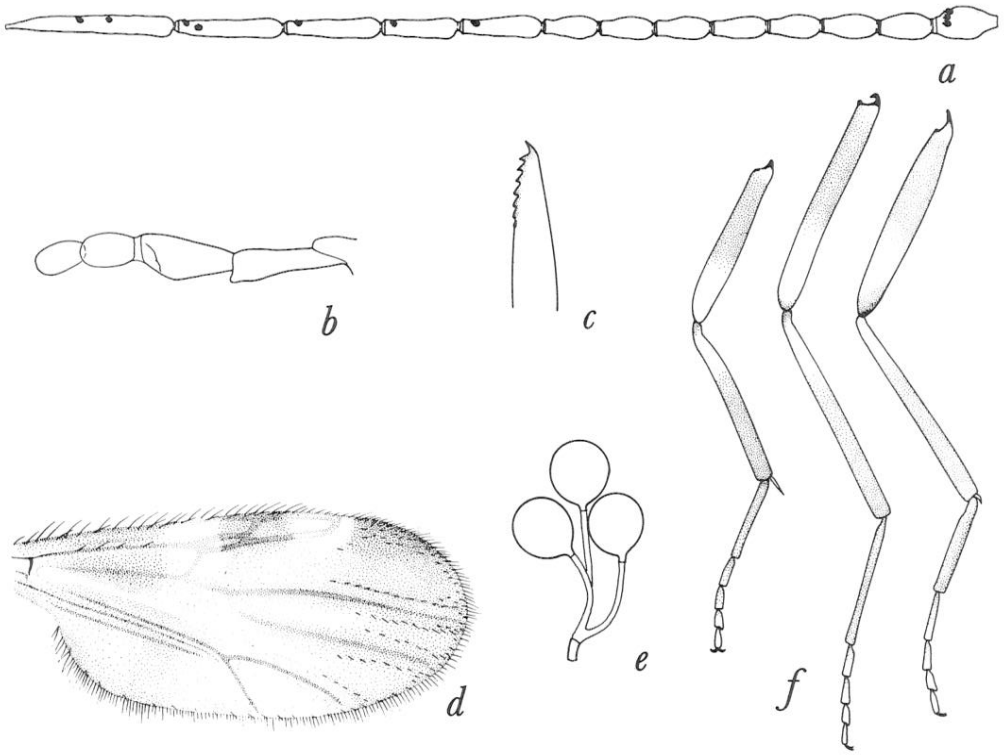

FIG. 3. *Culicoides nyungnoi* ♀: **a,** antenna; **b,** palpus; **c,** mandible; **d,** wing; **e,** spermathecae; **f,** legs.

Howarth) (BPBM 13,012). 5♀ paratypes: same data as holotype, 3♀; VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 2♀ (Howarth).

Remarks. This species occupies an intermediate position between the *tenuipalpis* group and the *macfiei* group. It fits in the *tenuipalpis* group on the basis of the 3 subequal pyriform spermathecae and the 8 mandibular teeth, but is easily separated from the 2 known species in that group by the color pattern of the thorax and wings and the short 3rd palpal segment. The wing and thoracic color pattern and the palpal shape place the species close to *C. palpifer* Das Gupta & Ghosh. However, it is easily separated by the 3 subequal, pyriform spermathecae, the wider subapical pale band on the hind femur, and the dark apex of the hind tibia.

Etymology. The species name is derived from a Lao name for biting midges, *nyung noi,* which literally means "little mosquito."

5. **Culicoides (Trithecoides) paksongi** Howarth, **new species** Fig. 4, 24b

♀. Length of wing 1.38 mm. *Head.* Eyes contiguous for 2½ facets, bare. Antenna (Fig. 4a) with flagellomeres in proportion of 21:24:24:24:27:25:25:26:34:35:41:44:56, antennal ratio 1.07; sensilla coeloconica present on flagellomeres 3, 11–15. Palpal segments (Fig. 4b) in

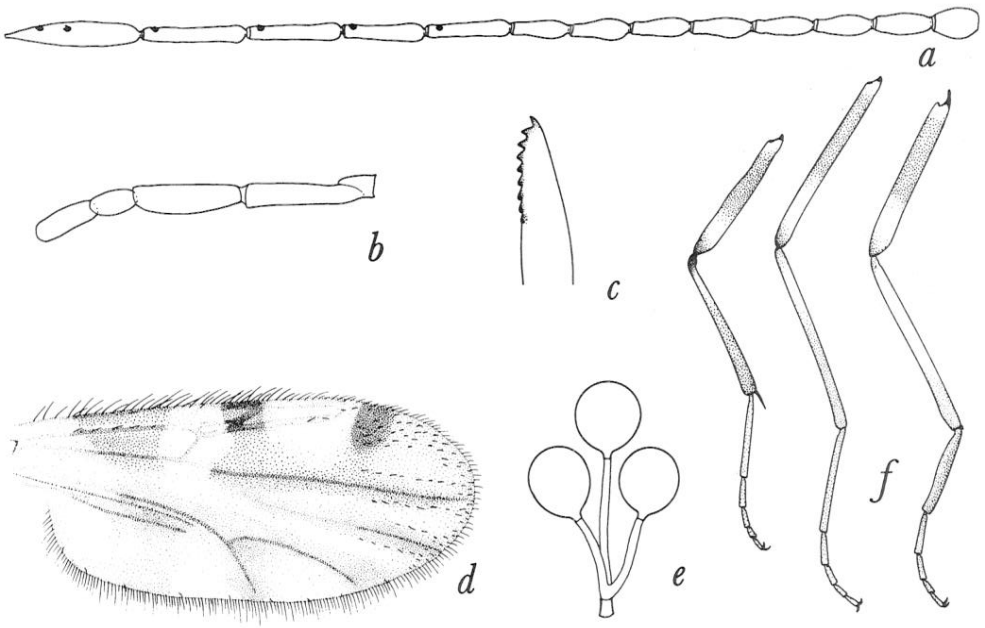

FIG. 4. *Culicoides paksongi* ♀: **a,** antenna; **b,** palpus; **c,** mandible; **d,** wing; **e,** spermathecae; **f,** legs.

proportion of 9:34:31:11:20; segment 3 long and slender, slightly thicker than segments 2 and 4; sensilla scattered over distal ½ of segment; palpal ratio 3.4. Proboscis/head 0.65. Mandible (Fig. 4c) with 9 large teeth, distal ones slightly larger and more widely spaced; lacinia narrow with about 11 small widely spaced teeth; epi- and hypopharynx narrow in midportion; tormae very narrow. *Thorax.* Scutum bright yellow, darker in front of scutellum and very dark on anterior margin; scutellum and upper ½ of pleuron bright yellow; postscutellum and lower ½ of pleuron dark brown. Legs (Fig. 4f) predominantly brown; fore femur with subapical pale band, fore tibia with subbasal pale band, fore knee dark; mid knee lightly infuscated, mid femur with wide subapical pale band, mid tibia with subbasal pale band; hind knee dark, hind femur with distinct subapical pale band, hind tibia pale on basal ½, dark distally; hind tibial comb with 4 spines, 2nd from spur longest. *Wing* (Fig. 4d, 24b). Pattern as figured; dark stigma spot very small on base of 2nd radial cell; dark anterior spot distal of poststigmatic pale spot; 2 large pale spots on anterior wing margin, 1 over r-m crossvein, 1 over 2nd radial cell; 2nd radial cell elongate and broad, almost entirely included within a pale spot; wing dark along veins, paler in cells; large indistinct pale spots located as follows: in apex of cell R_5 broadly meeting anterior and distal wing margin, at base of wing including anal angle, in apex of anal cell and cell M_4; pale streak along basal ½ of vein M_2 including most of cell M_2 and cell M_1; pale streaks in cells M_1 and M_2 connecting basal pale streak with wing margin; macrotrichia scattered in anterior ½ of cell R_5 distad of poststigmatic pale spot and scattered in apices of cells M_1 and M_2; costal ratio 0.73; wing ratio 0.44. Halter very slightly infuscated. *Abdomen.* Terga brown; 3 spermathecae (Fig. 4e), subequal, pyriform, with short sclerotized necks, each measuring 38 μm × 31 μm.

♂. Unknown.

Immature stages and breeding habitats. Unknown.
Distribution. Laos

Holotype ♀, LAOS: SEDONE PROV: Muong Paksong, 1270 m, 6.IX.1967, at light (F.G. Howarth) (BPBM 13,013).

Remarks. *Culicoides paksongi* closely resembles *C. tenuipalpis* Wirth & Hubert. It differs from *C. tenuipalpis* in the color of the thorax and legs (i.e., the bright yellow scutum with dark anterior margin and the distinct subapical pale bands on all the femora) and the presence of only 4 spines in the hind tibial comb. The wing is distinctly paler than in *C. tenuipalpis*, and the double pale spot on midportion of vein M_2 is much enlarged in the new species and extends as a streak along the basal portion of vein M_2.

Etymology. The species is named for the type-locality.

6. **Culicoides (Trithecoides) tenuipalpis** Wirth & Hubert Fig. 2e

Culicoides tenuipalpis Wirth & Hubert, 1959, Pac. Insects **1:** 16 (♀; Taiwan; fig. wing, palpus, spermathecae).

Immature stages. *Pupa.* Total length 2.11 mm (2.01–2.26, *n*=6). Pale brown, cephalothorax slightly darker than abdomen. *Respiratory trumpet* (Fig. 2e). Length 250 μm (236–260, *n*=6), 6.1× (5.7–6.4, *n*=5) longer than wide; basal ⅓ concolorous with cephalothorax, midportion pale, distal ⅓ dark; widest near base, constricted and with wide band of conspicuous annulations in middle ½; apex expanded with spoonlike margin; 3 (3–4, *n*=6) lateral spiracles on large, infuscated protuberances, distal one in convolutions; 8 (7–9, *n*=6) distal spiracles in row along apical margin; pedicel ⅕ length of trumpet. *Operculum.* Slightly longer than wide, 191 μm (181–195, *n*=5):184 μm (177–191, *n*=6) in ♀; light brown with dark acute scales on lateral margin, longest 8 μm long; smaller scales numerous on disc and extending basad to level of *am*'s; ( ) marks numerous basad of *am*'s; apical portion of disc unmarked; *am* tubercle large, weakly produced to short, rounded, shieldlike apex; *am* seta elongate, stout, 75 μm (66–78, *n*=5) long, 2× longer than distance between bases of *am*'s. *Cephalothorax.* Setal measurements, Table 2; *dl* tubercle as in *C. flavescens*; *ad* tubercle large, weakly produced, shieldlike, with acute apex bearing a subapical stout seta 66 μm long and a distinct lateral protuberance bearing a stout seta 21 μm long; setaless pore absent; *d 1* produced with 2 rounded lobes, *d 2* weakly produced; *d 1, 2,* and *3* in nearly straight line, well separated and equidistant; *d 1* with stout seta, *d 2* and *4* each with delicate seta; dorsum near *d*'s with numerous dark strong ( ) marks. *Abdomen.* Tubercles *lpm 1* and *3* weakly to moderately produced, 2 (1–4) short, sharp, triangular apical teeth less than ⅕ length of stout seta on *lpm 1*; *lpm 2* strongly bifid with 2 large, broad, triangular apical teeth more than ½ length of seta on *lpm 1,* sometimes fused into 1 large tooth and rarely 1–2 smaller teeth between larger ones; *lasm* tubercle similar to *lpm 1* but smaller; *dasm 1* and sometimes *2, vpm 2* and *3,* and *dpm 1* and usually *2* produced with 2 broadly rounded apical lobes; *dasm 2, vpm 1,* and *dpm 3, 4, 5* and sometimes *2* with broadly rounded apices not or little produced. Diffuse dark transverse band dorsally on anteromedian margin of segments 2–8; shallow dorsomedian invagination on intersegmental membrane just anterior of abdominal segments 2–9; segments 2–7 with wide anterosubmarginal band of small triangular scales, fewer laterally, and large patch more scattered on dorsum extending nearly to posterior margin; scales larger on posterior segments, segment 8 dorsum nearly all spinulose. *Caudal segment.*

With wide anterior band of strong scales encircling segment, and wide V-shaped patch on dorsum. Posterolateral processes large, spinulose, diverging 40–80° (n=4), darkened on distal ½, weakly concave mesad, tapered to blunt apex.

Breeding habitats. *Culicoides tenuipalpis* was reared 3× from pupae collected from exposed mud at stream and small pool margins. Sites of all 3 collections were partly shaded, very wet, moderately high in organic detritus, and had 50% or more fine silt, a high level of pollution, no vegetation, and no or only a trace of sand. One site also had between a trace and 15% clay, and 1 site contained 5% gravel. Two sites were rocky margins and next to decayed elephant dung. *Culicoides tenuipalpis* was associated with *C. oxystoma*, *C. huffi*, *C.* sp. D, and *C. guttifer*.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 4.III.1967, reared, partly shaded stream margin, 2♀; same loc., 30.V.1967, reared, partly shaded stream margin, 3♀; Muong Phieng, 400 m, 20.VIII.1967, reared, partly shaded rut margin, 1♀,1♂.

macfiei group

7. **Culicoides (Trithecoides) macfiei** Causey

Culicoides macfiei Causey, 1938, Am. J. Hyg. **27:** 411 (♂, ♀; Thailand; fig. wing, spermathecae, ♂ genitalia).

Laos records. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 1♀; same loc., 3.IX.1967, at light in forest, 4♀.

8. **Culicoides (Trithecoides) nampui** Howarth, **new species** Fig. 5, 24c

♀. Length of wing 0.96 mm (0.92–1.02, n=3). *Head.* Eyes contiguous for 3 facetal diameters, bare. Antenna (Fig. 5a) with flagellomeres in proportion of 19:15:17:18:19:19:19:19:26:25:27:27:42, antennal ratio 1.00 (0.96–1.03, n=3); sensilla coeloconica on flagellomeres 3, 11–15. Palpal segments (Fig. 5b) in proportion of 7:21:25:12:12; 3rd palpal segment elongate, very broad in midportion, with sensilla scattered over distal surface, usually clustered in small irregular shallow excavations distally; palpal ratio 2.2 (2.1–2.4, n=3). Proboscis short, proboscis/head 0.58 (0.56–0.59, n=3). Mandible (Fig. 5c) with 7 large triangular teeth, larger distally; lacinia with 9–12 smaller teeth, slightly larger distally; hypopharynx sclerotized, blade-like, narrow in midportion, without teeth. *Thorax.* Scutum dark brown with small bright yellow areas near lateral margin and on disc (as seen in slide mounts); scutellum, postscutellum, lower ½ of pleuron dark brown; upper ½ of pleuron light brown or yellow. Legs (Fig. 5f) dark brown; all knees dark, fore and mid femora each with subapical pale band; tibiae each with subbasal pale band and dark apex; 4 spines in hind tibial comb, 2nd from spur longest. *Wing* (Fig. 5d, 24c). Pale areas extensive; base of wing, including anal angle, broadly pale; pale spot over r-m crossvein broadly meeting anterior wing margin and confluent with spots in cell M_2 and posterior wing margin in anal cell; poststigmatic pale spot covers most of large 2nd radial cell and just meets vein M_1; large double pale spot over midpoint of vein M_2 connected to distal wing margin by streaks in both cells M_1 and M_2; large distal pale spot in cell M_4; very large distal pale spot in cell R_5; wing tip broadly pale; costal ratio 0.67 (0.65–0.68, n=3); wing width ratio 0.49 (n=3). Halter dark. *Abdomen.* Terga dark brown, tergum on 3rd segment 2.4× as wide as long; 3 spermathecae (Fig. 5e), 1 very large and 2 subequal smaller ones with large unsclerotized entrances to ducts; large spermatheca finely rugulose, 38 μm long × 35 μm wide; smaller spermathecae more elongate, each 26 μm × 19 μm; duct from large spermatheca enlarged, saclike, before joining sclerotized ring; ducts from small spermathecae not seen.

♂. Unknown.

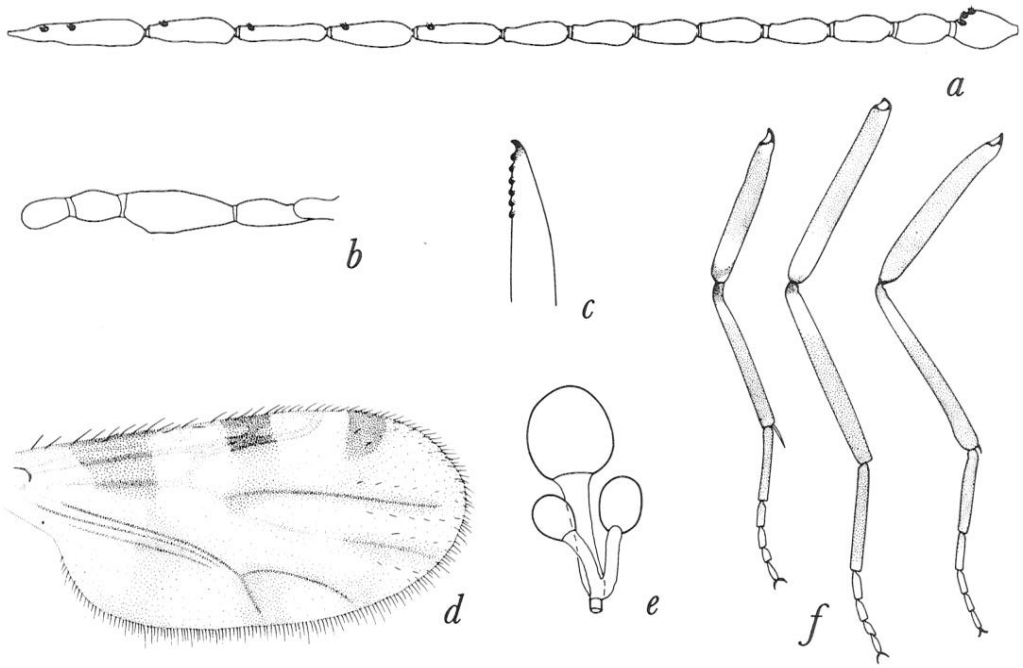

FIG. 5. *Culicoides nampui* ♀: **a,** antenna; **b,** palpus; **c,** mandible; **d,** wing; **e,** spermathecae; **f,** legs.

Immature stages and breeding habitats. Unknown.
Distribution. Laos.

Holotype ♀, LAOS: VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap (F.G. Howarth) (BPBM 13,014). 2♀ paratypes: same data as type, 1♀; SAYABOURY PROV: 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 1♀ (Howarth).

Remarks. This species is closely related to *C. macfiei* but may be easily distinguished by the small bright yellow areas on the scutum, the dark legs, knees, and apices of the hind tibiae, and the extensively pale wing and dark halter. The pale markings on the wing closely resemble those in the *tenuipalpis* group and further confirm the close relationship between the *macfiei* and *tenuipalpis* species groups.

Etymology. The name is derived from the Nam Poui, a river in N Laos.

9. **Culicoides (Trithecoides) palpifer** Das Gupta & Ghosh

Culicoides palpifer Das Gupta & Ghosh, 1956, Bull. Calcutta Sch. Trop. Med. **4:** 122 (♀; Calcutta; reared from rotting banana plants).

Breeding habitats. *Culicoides palpifer* was described from females reared from rotting banana culms near Calcutta, India, and Wirth & Hubert (in prep.) report that C. Manikumar reared it from decaying wild fruits at Kuala Lumpur, Malaysia. I reared a single adult female from a banana culm in advanced state of decay collected in Muong Sayaboury on 31.III.1968. The specimen emerged 14 days later.

Biting habits. I netted 3 females by sweeping cows and a cow shed near Pakse, Laos; however, the biting habits of *C. palpifer* remain unknown.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 5♀; Muong Sayaboury, 300 m, 6.X.1967, light trap, 2♀; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 3♀; same loc., 22–27.I.1968, at light, 1♀; same loc., 31.III–14.IV.1968, reared, old rotting banana stem, 1♀; 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 17♀. VIENTIANE PROV: Muong Van Vieng, 250 m, 16.II.1968, light trap, river margin, 2♀; same loc., 17.III.1968, at light, 1♀; Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 17♀,2♂. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 3♀; same loc., 3.IX.1967, at light in forest, 8♀; same loc., 5.IX.1967, sweeping cow and cow shed, 2♀; same loc., 9.IX.1967, sweeping cow, 1♀; Muong Paksong, 1270 m, 6.IX.1967, at light, 15♀,1♂.

10. **Culicoides (Trithecoides) tonmai** Howarth, **new species** Fig. 6, 24d

♀. Length of wing 1.01 mm (0.93–1.08, *n*=9). *Head.* Eyes contiguous diameter of 3 facets, bare. Antenna (Fig. 6a) with flagellomeres in proportion of 22:20:24:25:26:25:26:24:32:29:34:36:49, antennal ratio 0.96 (0.92–1.05, *n*=8); antennae elongate; flagellomeres 6–9 each 3.2× longer than wide; sensilla coeloconica present on flagellomeres 3, 11–15. Palpal segments (Fig. 6b) in proportion of 9:24:26:11:11; segment 3 elongate, swollen nearly to base, widest in midportion, palpal ratio 2.6 (2.4–2.8, *n*=8); with few sensilla widely scattered over segment. Mandible (Fig. 6d) with 7 (6–8, *n*=8) large triangular teeth, distal ones larger and more widely spaced; lacinia with 11 fine triangular teeth; hypopharynx with smooth, rounded, hyaline bladelike apex; epipharynx with 2 distally projecting pointed lobes; proboscis moderately short, proboscis/head 0.57 (0.55–0.58, *n*=8). *Thorax.* Scutum, scutellum, upper ½ of pleuron pale yellow; postscutellum yellowish brown; lower ½ of pleuron brown. Legs (Fig. 6h) with all femora brown in basal portion and apical 3rd pale yellowish, extreme apex sometimes indistinctly infuscated on fore and hind femora; fore and mid tibiae pale on basal ¼; hind tibia entirely pale; all knees broadly pale; 4 spines in hind tibial comb, 2nd from spur longest; tarsal claws simple. *Wing* (Fig. 6c, 24d). Pale areas very extensive, poorly contrasting on wing posteriorly; stigmal dark spot narrow; anterior pale spots over r-m crossvein and 2nd radial cell large, broadly meeting anterior wing margin and broadly crossing media; base of wing narrowly pale; anal angle with poorly defined dark streak; cells M_1 and M_2 almost entirely pale; wing tip broadly pale; large diffuse pale spot distally in cell M_4 and in anal cell; macrotrichia very few, confined to anterior portion of cell R_5 and at apex of wing in cells R_5 and M_1. Costal ratio 0.71 (0.69–0.72, *n*=8); wing ratio 0.48 (0.47–0.49, *n*=8). Halter slightly infuscated. *Abdomen.* Yellowish brown, terga light brown; 3 functional spermathecae (Fig. 6e) with large, unsclerotized entrances to ducts; spermathecae not rugulose, unequal, 1 large measuring 38 μm long × 38 μm wide, and 2 smaller, subequal, each measuring 27 μm long × 26 μm wide; ducts each with slight bulbous enlargement in midlength, without enlargement at common meeting point just before sclerotized ring.

♂. Smaller than ♀; wing length 0.67 mm. *Genitalia* (Fig. 6g). Sternum 9 with shallow, nearly imperceptible caudomedian excavation; tergum 9 with large, elongate, apicolateral processes, length less than ½ distance between their bases; caudomedian margin with narrow median cleft and short, wide, sublateral lobes. Basistyle with ventral root vestigial, dorsal root well developed, elongate, slender, apex bent; dististyle elongate, strongly curved to blunt point, rugulose in distal portion. Aedeagus with basal arch extending ⅓ total length; basal arms thickened, straight, directed cephalolaterad; basal arch and distal portion of aedeagus weakly sclerotized, broad at base, tapering to short neck, apex expanded, somewhat recurved ventrad.

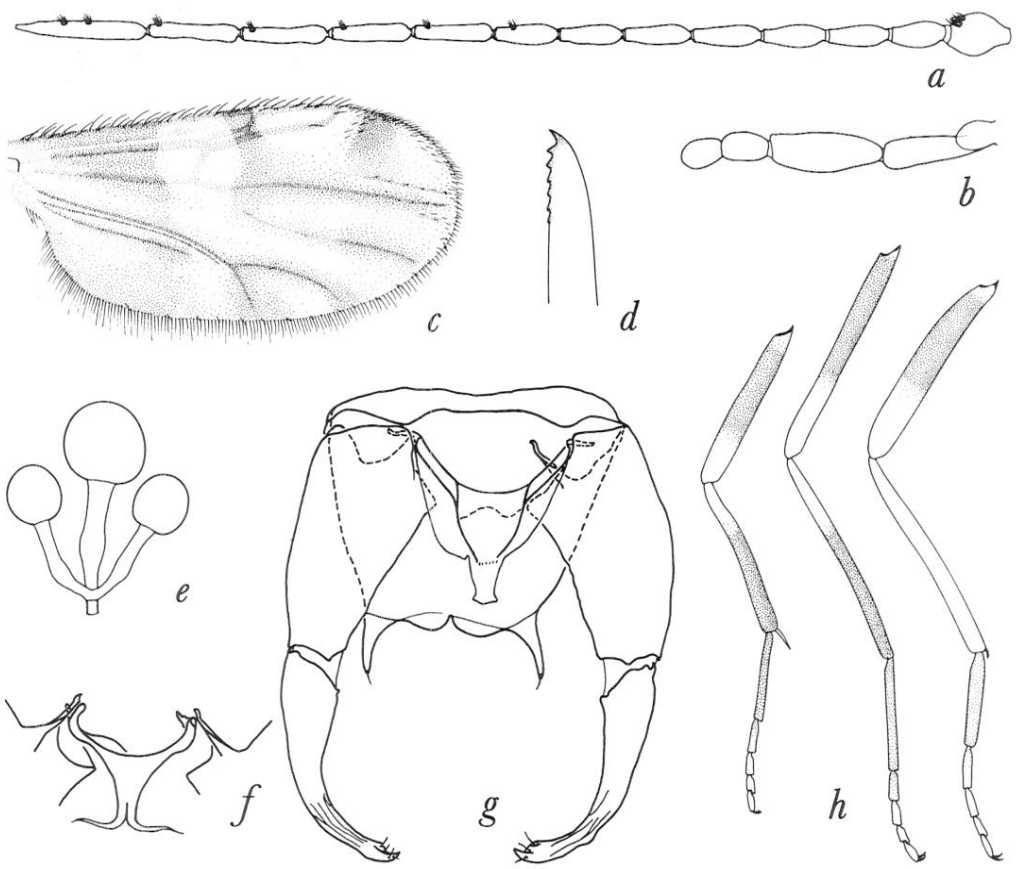

FIG. 6. *Culicoides tonmai:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** ♂ genitalia, parameres removed; **h,** legs.

Parameres (Fig. 6f) with basal bulbs enlarged, apparently fused mesad; basal arms stout basad with basal flange, narrow mesad, subaduncate, curving laterocephalad to cephalad; distal stem bent laterad in midportion, tapering to simple attenuated point directed caudolaterad.

Breeding habitats. *Culicoides tonmai* was reared once from material collected from a slime flux and leaf detritus in a fork of a tree, 1.7 m above the ground near Sayaboury, Laos. The sample was collected and placed in an emergence cage 30.VII.1967. One female emerged between 10.VIII.1967 and 17.VIII.1967, 4 females and 1 male emerged on 18.VIII.1967. *Culicoides innoxius, C. clavipalpis* Mukerji, and *C. lansangensis,* n. sp., were reared from the same sample.

Distribution. Laos.

Holotype ♀, LAOS: SAYABOURY PROV: Sayaboury, 300 m, 30.VII.1967, reared, treewound (F.G. Howarth) BPBM 13,015). Allotype ♂, same data as holotype. 8♀ paratypes: SAYABOURY

PROV: same data as type, 4♀; same data except 4,5.XI.1967, at light, 1♀; 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 1♀; SEDONE PROV: Muong Pakse, 100 m, 3.IX.1967, light trap in forest, 1♀; same, at light in forest, 1♀. (All Howarth.)

Remarks. *Culicoides tonmai* differs from *C. palpifer* and *C.* sp. B by the paler wing, pale knees, and longer 3rd palpal segment. The male of *C. tonmai* differs from *C. palpifer* by the much more slender dorsal root, the more elongate apicolateral processes, the more curved dististyles, the more slender distal portion of the parameres, the fused parameres and the distinct, flangelike tip of the aedeagus of *C. tonmai.*

Etymology. The species epithet comes from the general Lao term for a tree, *ton mai,* and refers to this species' breeding habitat.

11. **Culicoides (Trithecoides) species A**

Biting habits. I netted 1 female by sweeping around myself near Vang Vieng and another female by sweeping cows at Ban Na Pheng; however, the biting habits of this species remain little known.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 1♀; Sayaboury, 300 m, 6.X.1967, light trap, 3♀; same loc., 7.X.1967, secondary woods, light trap, margin of Nam Houng Riv, 3♀; same loc., 22–27.I.1968, at light, 1♀; 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 2♀. VIENTIANE PROV: Muong Vang Vieng, Ban Ky Sok, 30 km N of Vang Vieng, 950 m, 14.III.1968, light trap, 5♀; 15 km N of Vang Vieng, 250 m, 18.III.1968, sweeping man, 1♀; 2 km W of Vang Vieng, 250 m, 11.III.1968, light trap, dry stream in jungle, 1♀; Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 5♀,2♂; same loc., sweeping cows, 1♀. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 1♂; same loc., 3.IX.1967, light trap in forest, 1♀,1♂; same loc., at light in forest, 6♀,2♂; Muong Paksong, 1270 m, 6.IX.1967, at light, 2♀.

Remarks. Wirth & Hubert (in prep.) will name this common species in their forthcoming revision of the *Culicoides* of SE Asia.

12. **Culicoides (Trithecoides) species B**

Laos records. VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 6♀.

Remarks. *Culicoides* sp. B will be described in Wirth & Hubert (in prep.).

raripalpis group

13. **Culicoides (Trithecoides) elbeli** Wirth & Hubert

Culicoides elbeli Wirth & Hubert, 1959, Pac. Insects **1:** 27 [♂ (misidentified), ♀; Malaya, Sabah, Thailand; fig. wing, palpus, mandible, spermathecae, ♂ genitalia].

Biting habits. Wirth & Hubert (1959) record *C. elbeli* biting a human at Segambut, Malaysia. I netted 2 females by sweeping cows near Ban Na Pheng, Laos.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 4♀; Sayaboury, 300 m, 22.VII.1967, sweeping, secondary woods, 1♂. VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 12♀,1♂; same loc., sweeping cows, 2♀. SEDONE PROV: Muong Pakse, 100 m, 3.IX.1967, at light in forest, 31♀,12♂; and light trap in forest, 4♀.

Remarks. Many specimens of both sexes of *C. elbeli,* including the holotype from Malaya, have a conspicuous patch of tiny blunt spines on the cibarial pump. However, the specimens without the cibarial dots appear to be conspecific with *C. elbeli,* even though such intraspecific variation in cibarial ornamentation is unusual in *Culicoides.* The male figured as *C. elbeli* by Wirth & Hubert (1959) represents another species related to *C. gewertzi* Causey.

14. **Culicoides (Trithecoides) hinnoi** Howarth, **new species** Fig. 7, 25a

♀. Length of wing 0.86 mm (0.81–0.93, n=12). *Head.* Eyes contiguous for a distance of 3 facetal diameters, bare. Antenna (Fig. 7a) elongate, flagellomeres in proportion of 17:16:18:19:18:18:18:17:22:22:23:24:36, antennal ratio 0.91 (0.87–0.95, n=10); sensilla coeloconica located on flagellomeres 3, 11–15. Palpal segments (Fig. 7b) in proportion of 7:18:17:9:10; 3rd palpal segment short, swollen in midportion, palpal ratio 2.4 (2.1–2.6, n=12); sensilla clustered along distal ½ of mesal margin and near apex of segment. Proboscis short, proboscis/head 0.56 (0.52–0.61, n=11). Mandible (Fig. 7d) with 11 (10–12, n=10) fine, even, triangular teeth; lacinia with 11 (10–12, n=7) small teeth; epipharynx with 2 distal sharp pointed lobes; hypopharynx bladelike, acutangulate, hyaline distally; cibarium without patch of spicules. *Thorax* (as seen in slide mounts). Scutum variable yellowish to dark brown, dark brown on humeral angles, on anterior margin, and on disc in front of scutellum; scutellum, postscutellum, and lower ½ of pleuron dark brown; upper ½ of pleuron yellowish; boundary between brown of scutum and yellowish of upper pleuron poorly defined, not sharp along lateral suture. Legs (Fig. 7h) predominantly dark brown; fore knee dark, narrow pale band subapically on fore femur and subbasally on fore tibia; mid knee broadly palish, mid femur with broad apical pale band; hind femur dark to tip or with an indistinct narrow subapical pale band, apex of femur darkened, tibia light brown, paler basally and distally; 4 spines in hind tibial comb, 2nd from spur longest; tarsal claws simple. *Wing* (Fig. 7c, 25a). Predominantly dark, darker anteriorly; 3 well-defined, small pale spots, 1 at base of wing not including anal angle, circular one over r-m crossvein attaining costal wing margin, and 1 centered over apex of 2nd radial cell not reaching vein M_1; diffuse, indistinct pale spots located in apex of anal cell and cell M_4; wing tip narrowly pale, paler on disc between veins; costal ratio 0.69 (0.67–0.70, n=10); wing width ratio 0.48 (0.47–0.48, n=10); macrotrichia very scarce, a few near anterior wing margin distad in cell R_5 and in rows parallel to vein M_1 in apex of cells R_5 and M_1. Halter pale. *Abdomen.* Dark brown, terga well sclerotized, tergum on segment 3 about 2× as broad as long; 3 spermathecae (Fig. 7e) with large unsclerotized entrances to ducts, 1 large measuring 33 μm long × 28 μm wide, and 2 smaller subequal subspherical spermathecae measuring 24 μm long × 21 μm wide; ducts from 2 smaller spermathecae join each other in common sac before joining saclike duct from large spermatheca at sclerotized ring.

♂. *Head.* Antennae with sensilla coeloconica on flagellomeres 3, 13–15. *Genitalia* (Fig. 7g). Sternum 9 with broad, shallow caudomedian excavation; tergum 9 with elongate, pencillike apicolateral processes, their length less than ½ distance between their bases; caudomedian margin with deep median cleft and small submedian lobes, variable, sometimes subacute on distomedian margin. Basistyle with ventral root poorly sclerotized, small, triangular, difficult to see; dorsal root well developed, heavily sclerotized, elongate, wide at base tapering to knoblike apex; dististyle somewhat elongate, strongly curved, tapering to subacute incompletely bifid apex, rugulose distally. Aedeagus with basal arch narrow, extending about ½ total length of aedeagus; basal arms thicker mesad, heavily sclerotized, curving cephalad, strongly bent laterad, then dorsocephalad near subacute base; midportion of aedeagus funnel shaped, well sclerotized, tapered to distal stem, lateral margin with weak shoulder, dorsal and ventral

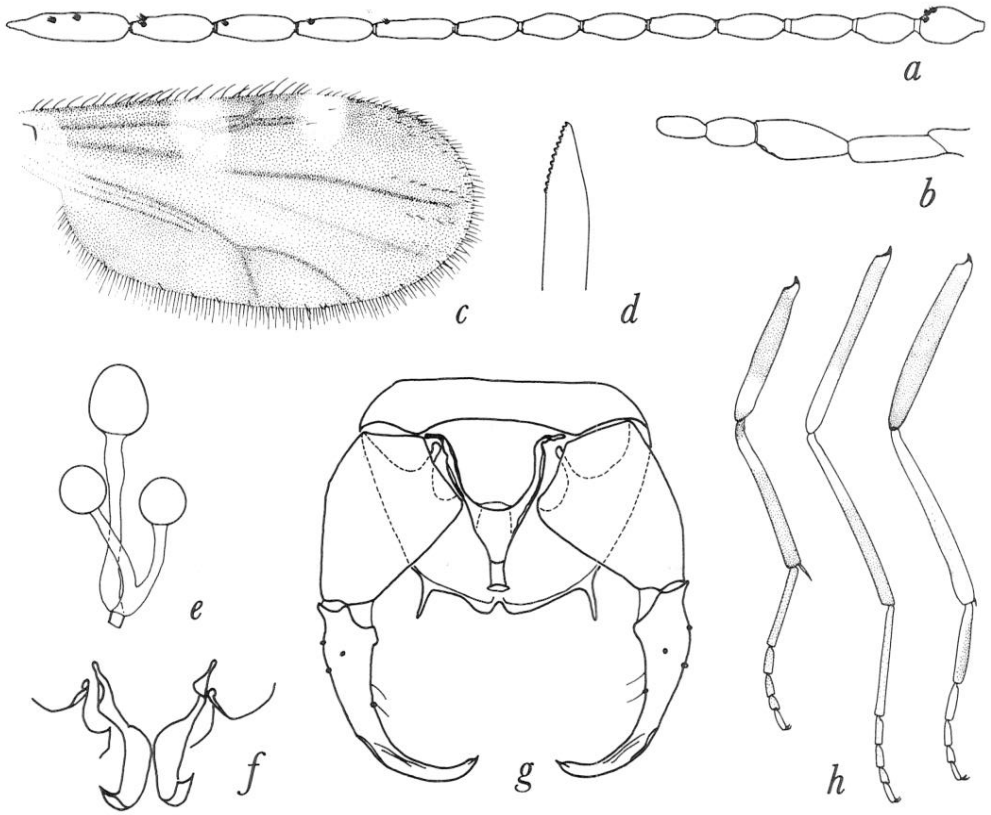

FIG. 7. *Culicoides hinnoi:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** ♂ genitalia, parameres removed; **h,** legs.

membrane of arch well sclerotized, wide internal peg present, directed cephalad; distal stem hyaline, widened, subspatulate, apex strongly bent ventrad. Parameres (Fig. 7f) massive, stout, heavily sclerotized throughout with enlarged basal bulbs; basal arms thicker mesad, directed laterocephalad, expanded, leaflike in midportion; subacute base elongate, directed cephalad; distal stem very wide, sharply bent ventrad; wide, bladelike apex directed lateroventrad.

Immature stages and breeding habitats. Unknown.

Parasites. One mermithid intersex of this species was collected at Pakse 3.IX.1967 at a light trap in forest. The abdomen has a large nematode curled within it, probably Mermithidae. The head has primarily male characters, except the antennae have sensilla coeloconica on flagellomeres 11–15. The antennal plumes and flagellar proportions are male. The wing is predominantly male. However, the tarsal claws are simple as in the female. The abdomen has 1 small spermatheca and nearly normal male basistyles and dististyles. The aedeagus is incomplete and only 1 paramere is complete enough to confirm the species identification. It is certainly sterile.

Distribution. Laos.

Holotype ♂, LAOS: VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap (F.G. Howarth) (BPBM 13,016). Allotype ♀, same data as holotype. 41♀,15♂ paratypes: same data as holotype, 10♀,7♂; SAYABOURY PROV: Sayaboury, 300 m, 6.X.1967, light trap, 1♂; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 5♀; SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 2♀; same loc., 3.IX.1967, at light in forest, 23♀,7♂; same loc., light trap in forest, 1♀, 1 intersex. (All Howarth.)

Remarks. *Culicoides hinnoi* is very closely related to *C. elbeli.* The key differences between the females are the color pattern on the thorax and the shapes of the ducts of the spermathecae. In *C. hinnoi* the dorsum varies from yellow with large dark brown areas in front of the scutellum, on the humeral angle, and on the mesal anterior margin, to a dark brown scutum with lighter areas on the lateral margin which grade imperceptibly into the pale yellow markings of the upper pleuron. *Culicoides elbeli* has a sharp boundary between the dark scutum and pale pleuron. In *C. hinnoi* the ducts from the smaller spermathecae join in a common sac before the junction with the duct from the large spermatheca at the sclerotized ring. In *C. elbeli* the ducts from the small spermathecae come together just before the junction with the duct from the large one, or sometimes the 3 ducts are feebly saclike. Also, the middle spermatheca is not usually as elongate as in *C. elbeli.* Females of *C. hinnoi* differ from *C. gewertzi* by the pale halters, the 10–12 fine mandibular teeth, and the darker scutum. In *C. gewertzi* the halters are dark; there are 15–17 mandibular teeth, and the scutum is pale with dark markings on the anterior margin and humeral angles. The males of *C. hinnoi* differ from other *Trithecoides* by the massive recurved parameres. It further differs from *C. elbeli* and *C. gewertzi* by the elongate, widely spaced, pencillike apicolateral processes on tergum 9.

Etymology. The species epithet comes from the Lao term, *hin noi,* which means "small biting midge."

15. **Culicoides (Trithecoides) huberti** Howarth, **new species** Fig. 8, 25b

♀. Length of wing 0.97 mm (0.86–1.09, n=11). *Head.* Eyes contiguous for distance of 4 facetal diameters, bare. Antennal flagellomeres (Fig. 8a) in proportion of 19:18:19:21:21:20: 19:20:25:24:27:30:41; sensilla coeloconica present on flagellomeres 3, 11–15; antennal ratio 0.93 (0.89–1.01, n=10). Palpal segments (Fig. 8b) in proportion of 7:24:23:9:9; palpal segment 3 slender, slightly swollen on distal ½; sensilla scattered on segment distally, usually grouped in small, shallow, irregular depressions on mesal margin; palpal ratio 2.6 (2.3–2.8, n=11). Proboscis short, proboscis/head 0.60 (0.56–0.63, n=11). Mandible (Fig. 8d) with 11 (10–12, n=11) small triangular teeth, proximal ones slightly larger; lacinia with 12 (10–14, n=10) small triangular teeth. *Thorax.* Scutum, upper ½ of pleuron bright yellow; prescutellar area, scutellum, postscutellum, lower ½ of pleuron dark brown. Legs (Fig. 8h) dark brown, bands prominent; fore knee narrowly black, fore femur with distinct broad subapical pale band, fore tibia with narrow distinct subbasal pale band; mid knee narrowly dark brown, mid femur with subapical or apical pale band, mid tibia with subbasal pale band; hind femur with apex distinctly blackened and with narrow indistinct to distinct subapical pale band, hind tibia with distinct subbasal pale band and indistinct apical pale band; 4 spines in hind tibial comb, 2nd from spur longest; tarsal claws simple. *Wing* (Fig. 8c, 25b). Predominantly dark, darker along anterior

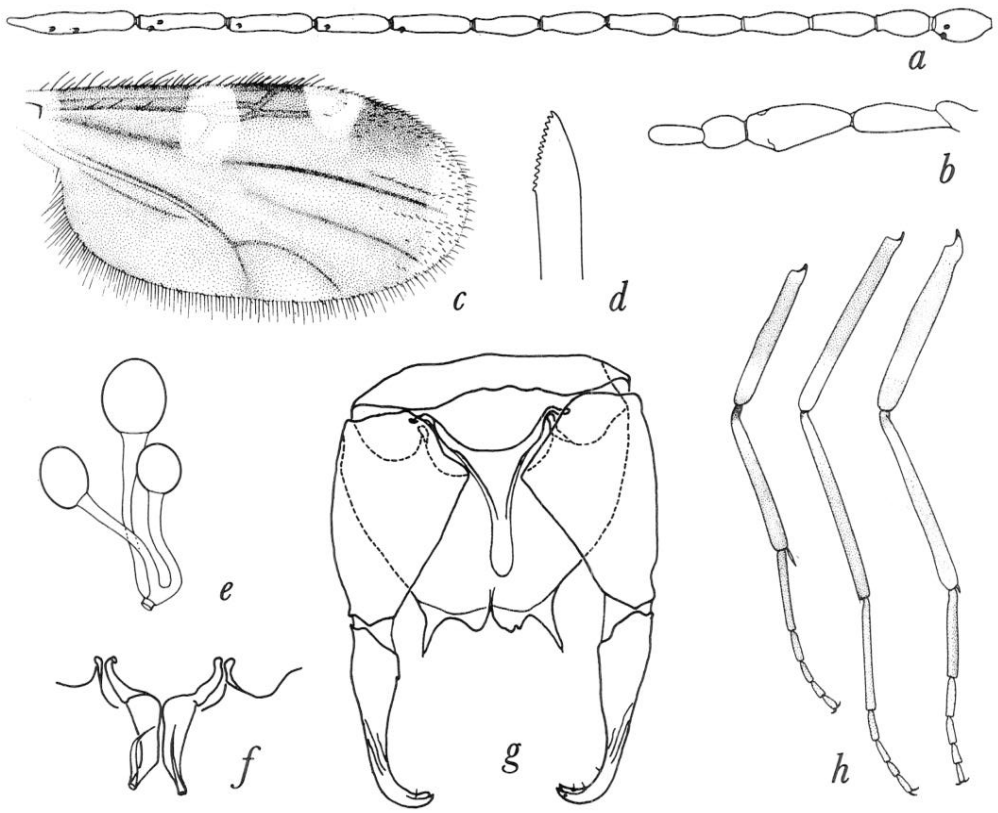

FIG. 8. *Culicoides huberti:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** ♂ genitalia, parameres removed; **h,** legs.

margin; darkish spot over vein R_1 larger than pale spot over r-m crossvein; pale spots very small; 1 at base of wing with short marginal streak into anal angle; 2 anterior pale spots, 1 over r-m crossvein and 1 not quite covering distal ½ of 2nd radial cell; small marginal spots in apex of anal cell and cell M_4; wing tip broadly and distinctly dipped in white, including apices of cells R_5, M_1, and M_2; quite indistinct pale streak in cell M_2 near vein M_{1+2} fork; indistinct pale streak sometimes present in base of cell M_1; macrotrichia few, confined to anterior ½ of cell R_5 distad of poststigmatic pale spot and extreme apices of cells M_1 and M_2 and in longitudinal row parallel to distal portion of veins M_1 and M_2; costal ratio 0.70 (0.68–0.71, n=11); wing width ratio 0.48 (0.47–0.50, n=11). Halter lightly infuscated. *Abdomen.* Pale brown, terga slightly darker, tergum on 3rd segment 2× broader than long; 3 functional spermathecae (Fig. 8e), unequal, with wide unsclerotized entrances to ducts; large one elongate, measuring 35 μm × 28 μm; 2 smaller subequal slightly elongate ones, each measuring 21 μm × 20 μm; ducts from smaller spermathecae join each other at junction with duct from large spermatheca at sclerotized ring; ducts not saclike before junction and each with indistinct hyaline ring near spermatheca.

♂. Antenna with sensilla coeloconica on flagellomeres 3, 13–15. *Genitalia* (Fig. 8g). Sternum 9 with shallow, concave caudomedian margin; tergum 9 with large elongate apicolateral pro-

cesses, wide at base and tapering to acute apices, their length about ½ distance between their bases; caudomedian margin with deep, wide mesal excavation and short, wide submedian lobes. Basistyle with ventral root vestigial; dorsal root well developed, elongate, triangular, with bent apex, lateral margin thickened; dististyle tapering from wide base to narrower curving portion, rugulose distally; basal ¾ straight, distal ¼ strongly curved, subaduncate, apex acute. Aedeagus narrow, subtriangular, basal arch extending less than ¼ total length; basal arms directed laterocephalad with concave mesal margin, thicker mesad, tapering to right angle bend laterad near base, lateral portion thin, relatively long, base acute, directed dorsad; midportion of aedeagus well sclerotized, lateral margin straight or nearly so, tapered to distal stem, internal peg absent, distal stem hyaline, difficult to see; apex expanded, obtuse. Parameres (Fig. 8f) with basal bulbs enlarged, weakly fused basally, inner and lateral margin straight; cephalic margin slightly convex, basal arms thick, well sclerotized, concave mesad, directed laterocephalad, curving cephalad; distal stem elongate, bent laterocaudad at base, curving ventrad to bend cephaloventrad, relatively wide at base, gradually tapered to hyaline, attenuated apex.

Immature stages and breeding habitats. Unknown.
Distribution. Laos.

Holotype ♀, LAOS: SEDONE PROV: Muong Pakse, 100 m, 3.IX.1967, at light in forest (F.G. Howarth) (BPBM 13,017). Allotype ♂, same data as holotype. 10♀,2♂ paratypes: same data as holotype, 6♀,2♂; SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 1♀; Sayaboury, 300 m, 6.X.1967, light trap, 1♀; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 2♀. (All Howarth.)

Remarks. *Culicoides huberti* is closely related to *C. barnetti* Wirth & Hubert, *C. flaviscutatus* Wirth & Hubert, and *C. laoensis*, n. sp. It differs from *C. flaviscutatus* and *C. laoensis*, n. sp., in having the wing tip broadly dipped in white, an indistinct pale streak in cell M_2 without the double pale spot over base of vein M_2, fewer macrotrichia, mid knee dark, hind femur with distinct to indistinct subapical pale band, and other characters listed in the discussion for *C. laoensis*. In the male it differs by the longer parameres and narrower aedeagus. Females differ from *C. barnetti* in having the wing much less pale (i.e., the poststigmatic pale spot covers less than the distal ½ of the 2nd radial cell, and the dark spot over vein R_1 is large, as wide as the r-m pale spot) and in having a less distinct narrow subapical pale band on the hind femur. In *C. barnetti* the poststigmatic pale spot covers nearly all of the 2nd radial cell, the dark spot over vein R_1 is very small, and the subapical pale band on the hind femur is prominent. In males of *C. huberti* the apicolateral processes of tergum 9 are longer, their length nearly equal to ½ the distance between their bases, and the aedeagus is narrower than in *C. barnetti*.

Etymology. I take great pleasure in naming this species for Alexander A. Hubert, in recognition of his contributions to the study of SE Asian biting midges.

16. **Culicoides (Trithecoides) laoensis** Howarth, **new species** Fig. 9, 25c

♀. Length of wing 1.00 mm (0.90–1.10, n=16). *Head.* Eyes contiguous for 3 facetal diameters, bare. Antennal flagellomeres (Fig. 9a) in proportion of 18:17:19:20:20:20:20:21:28:27:32:34:47; sensilla coeloconica on flagellomeres 3, 11–15; antennal ratio 1.03 (0.96–1.08, n=10).

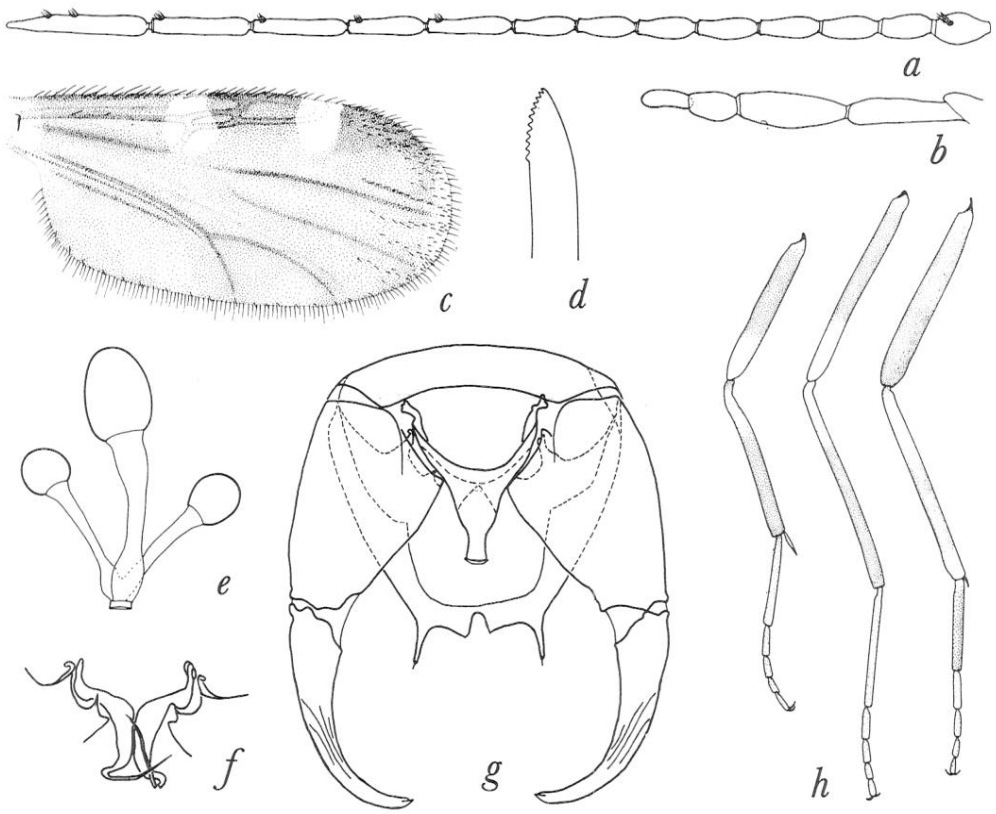

FIG. 9. *Culicoides laoensis:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** genitalia, parameres removed; **h,** legs.

Palpal segments (Fig. 9b) in proportion of 8:27:25:12:12; 3rd segment long, slender, slightly swollen in middle; sensilla scattered on distal ½; palpal ratio 3.0 (2.6–3.3, n=16); 5th segment usually slender, more than 2× longer than broad. Proboscis moderately long, proboscis/head 0.68 (0.63–0.75, n=16). Mandibles (Fig. 9d) with 11 (10–12, n=16) fine small triangular teeth, basal 5 or 6 slightly larger and wider spaced; lacinia with 11–12 very fine teeth, distal ones slightly larger; epipharynx with bifid apex; hypopharynx with acute smooth, bladelike, hyaline apex; tormae moderately thick. *Thorax* (as seen in slide mounts). Scutum pale yellow except dark brown in front of scutellum; scutellum, postscutellum, and lower ½ of pleuron dark brown; upper ½ of pleuron yellow. Legs (Fig. 9h) dark brown, pale bands prominent; fore knee infuscated to dark, fore femur with broad subapical pale band, fore tibia with broad subbasal pale band; mid knee broadly pale, mid femur pale on distal ⅓; hind femur dark to tip, blackened distally, hind tibia with subbasal pale band and palish apex. *Wing* (Fig. 9c, 25c). Predominantly dark; 2 small pale spots on anterior margin, 1 over r-m crossvein and 1 at apex of 2nd radial cell; dark spot over vein R_1 large, much larger than costal pale spots; diffuse pale spots located at base of wing not including anal angle, apex of anal cell, apex of cell M_4, extreme apex of wing including apices of cells R_5 and M_1, and at base of medial fork in cell M_2; no pale spot basally in cell M_1; macrotrichia moderately abundant in anterior portion of cell R_5 distad of poststigmatic spot and in extreme apices of cells M_1 and M_2, and in longitudinal rows along veins M_1 and M_2; costal ratio 0.68 (0.67–0.69, n=10); wing width ratio 0.48 (0.47–0.50, n=10).

Halter pale or slightly infuscated. *Abdomen.* Pale brown, terga darker, tergum on 3rd segment 2× broader than long; 3 unequal spermathecae (Fig. 9e), 1 large measuring 35 μm long × 28 μm wide, and 2 subequal subspherical smaller ones each measuring 19 μm long × 19 μm wide with large unsclerotized entrances to ducts; each duct with hyaline ring near spermatheca and saclike before common junction with other ducts at short sclerotized ring.

♂. Antennal sensilla coeloconica on flagellomeres 3, 13–15. *Genitalia* (Fig. 9g). Sternum 9 with imperceptible shallow caudomedian excavation; tergum 9 with elongate, pencillike apicolateral processes, wide at base, tapered to acute apices, their length about ½ distance between their bases; caudomedian margin with deep wide mesal cleft and short, triangular submedian lobes. Basistyle with ventral root poorly developed, inconspicuous; dorsal root well developed, short, basal portion triangular, distal portion thin with small bent apical knob; dististyle with basal ½ straight, tapered, smaller distad, distal ½ strongly curving mesad, rugulose, tapering to acute apex. Aedeagus well sclerotized; basal arch strongly concave on cephalic margin, extending nearly ½ total length; basal arms rodlike, heavily sclerotized, directed laterocephalad, then bent cephalad a short distance, then bent dorsad a short distance to basal knob directed dorsad; midportion of aedeagus narrow, tapered distally, slight shoulderlike outline on lateral margin; internal peg short, wide, cephalic margin irregular not extending cephalad to margin of basal arch; distal portion of aedeagus widened towards broad blunt apex, bent ventrad. Parameres (Fig. 9f) well sclerotized, basal bulbs large, appressed to each other mesad, lateral and mesal margins straight, cephalic margin slightly convex; basal arms directed laterocephalad with wide caudal flange on shoulder, then bent cephalad to basal knob; basal knob wide dorsoventrally; distal arms wide basally, attenuated, bent lateroventrad at base, then curving ventrad and finally curving mesad to thin simple elongate point.

Immature stages and breeding habitats. Unknown.

Distribution. Laos.

Holotype ♀, LAOS: SEDONE PROV: Muong Paksong, 1270 m, 6.IX.1967, at light (F.G. Howarth) (BPBM 13,018). Allotype ♂, same data as holotype. 15♀ paratypes: same data as holotype, 14♀; SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 1♀ (Howarth).

Remarks. *Culicoides laoensis* is very closely related to *C. flaviscutatus* and *C. huberti.* Males can be distinguished from *C. flaviscutatus* by the longer and more attenuated parameres and the longer apicolateral processes and smaller submedian lobes on tergum 9. Males can be separated from *C. huberti* by the attenuated curving parameres, the wider aedeagus with higher basal arch, and the less curving dististyles. Females differ from *C. flaviscutatus* by possessing a large, diffuse pale spot in cell M_2 posterior of fork M_{1+2}, by lacking a basal pale spot in cell M_1, and by the slightly larger proximal mandibular teeth; and from *C. huberti* by having the narrowly pale wing apex, the pale mid knee and the dark hind femur. The female also differs from both *C. flaviscutatus* and *C. huberti* by longer palpal, antennal, and proboscis/head ratios, and in having all 3 spermathecal ducts more or less saclike at the junction with the sclerotized ring.

Etymology. The species epithet is derived from the country of origin: Laos.

17. **Culicoides (Trithecoides) tamada** Howarth, **new species** Fig. 10, 25d

♀. Length of wing 0.86 mm (0.79–1.00, n=11). *Head.* Eyes contiguous distance of 2 facetal diameters, bare. Antennal flagellomeres (Fig. 10a) in proportion of 19:18:21:23:22:21:21:21:

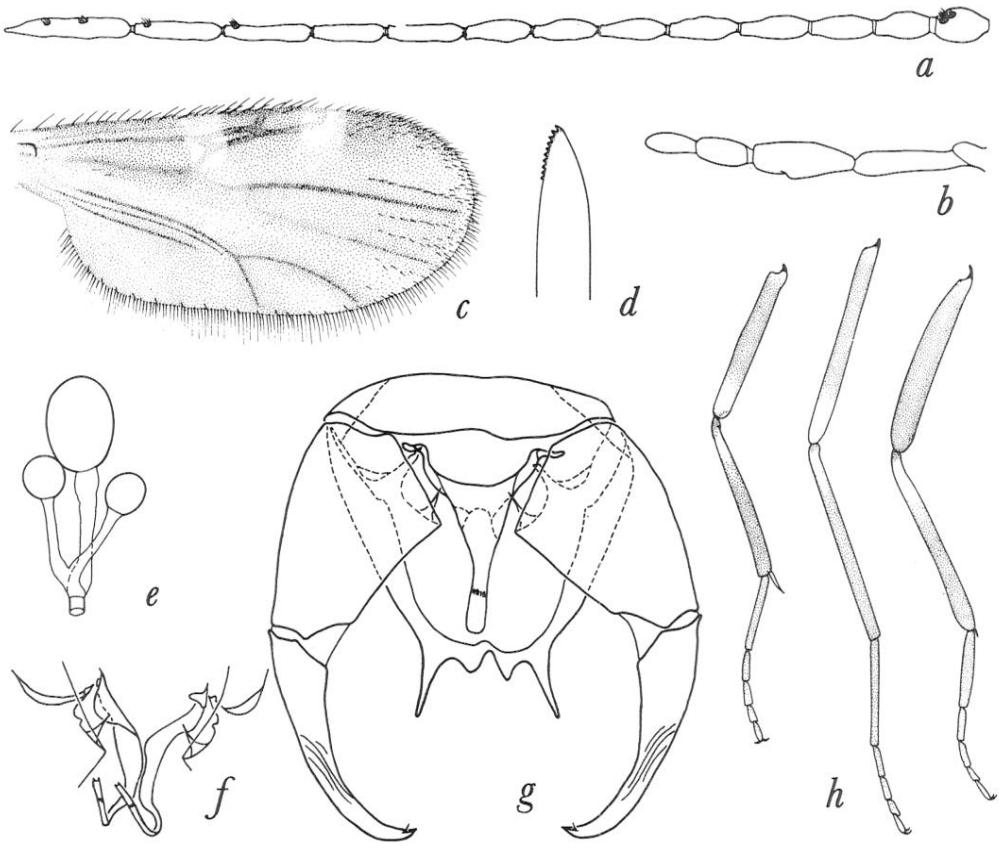

FIG. 10. *Culicoides tamada:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** ♂ genitalia, parameres removed; **h,** legs.

25:22:27:28:41; sensilla coeloconica on flagellomeres 3, 13–15; antennal ratio 0.88 (0.81–0.94, n=10). Palpal segments (Fig. 10b) in proportion of 6:21:21:11:10; 3rd palpal segment moderately elongate, widest in midportion; sensilla scattered on distal ½ of segment, most numerous along distomesal margin, often in small, shallow, pitlike areas; palpal ratio 2.6 (2.3–3.0, n=11). Proboscis moderately elongate, proboscis/head 0.66 (0.60–0.69, n=10). Mandible (Fig. 10d) with 11 (10–12, n=10) fine, triangular teeth, basal ones slightly larger; apex of epipharynx bifid; hypopharynx with acute, bladelike, smooth, hyaline apex; lacinia with 11 (9–12, n=10) fine triangular teeth, distal ones slightly larger. *Thorax* (as seen in slide mounts). Scutum dark brown on anterior margin over humeral angles and on varying amounts of disc; scutellum, postscutellum, and lower ½ of pleuron dark brown; upper ½ of pleuron and varying amounts of lateral margin of scutum light brown; boundary between light color on upper pleuron and dark on scutum undefined, not a straight line. Legs (Fig. 10h) predominantly dark brown; fore knees dark, fore femur with narrow subapical pale band, fore tibia with narrow subbasal pale band; mid knee infuscated, mid femur with apical pale band, mid tibia with basal pale band; hind femur dark to tip, hind tibia with subbasal pale band and indistinct apical pale band; 4 spines in hind tibial comb, 2nd from spur longest; tarsal claws simple. *Wing* (Fig. 10d, 25c).

Predominantly dark, darker on anterior margin, paler between veins on disc; 4 small round pale spots, 1 over r-m crossvein, 1 centered over apex of 2nd radial cell, 1 in base of wing including only part of anal angle, and 1 distally in cell M_4; tip of wing pale only at apices of cell R_5 and cell M_1; macrotrichia, very few, scattered in anterior portion of cell R_5 distad of 2nd radial cell, at apex of wing in cells R_5, M_1 and M_2, and in longitudinal rows distad in cells R_5, M_1 and M_2; costal ratio 0.67 (0.65–0.70, n=11); wing width ratio 0.47 (0.46–0.49, n=11). Halter pale. *Abdomen.* Brown, terga lightly sclerotized, tergum on 3rd segment 2× as broad as long; 3 functional spermathecae (Fig. 10e) with large unsclerotized entrances to ducts; large one elongate, measuring 45 μm long × 28 μm wide, and 2 smaller ones subspherical, each measuring 17 μm long × 17 μm wide; ducts from smaller spermathecae meeting in short common duct before joining saclike duct from large spermatheca at sclerotized ring; common duct from smaller spermathecae enlarged, sometimes saclike.

♂. Antennae with sensilla coeloconica on flagellomeres 3, 14, 15. *Genitalia* (Fig. 10g). Sternum 9 with nearly imperceptible caudomedian excavation; tergum 9 with elongate, pencillike apicolateral processes, their length slightly greater than ½ distance between their bases, base wide, tapered to acute apex; caudal margin with distinct, wide median cleft and short submedian lobes, each usually with subacute apex. Basistyle with ventral root poorly developed, difficult to see; dorsal root well developed, elongate, triangular, wide at base tapering to distal knob; dististyle weakly curved and tapered to distal ⅓, then more steeply curved to acute apex. Aedeagus with basal arch low, extending less than ¼ total length of aedeagus; basal arms narrow, extending laterocephalad, sharply bent cephalad, then bent 90° laterodorsad, base blunt; midportion of aedeagus narrow, well sclerotized, lateral margin straight or slight indication of shoulder, tapered distad to neck; internal mesal peg short and very broad, not extending cephalad to margin of arch; distal portion straight, very hyaline, difficult to see, ⅓ total length of aedeagus. Parameres (Fig. 10f) with basal bulbs enlarged, well sclerotized, lateral margin nearly straight, inner margin strongly convex; basal arms straight, directed laterocephalad to flange at articulation with dorsal root, then bent cephalad to acute base; distal stem thin, bladelike, curving laterocaudad, ventrocaudad, then cephaloventrad; apex hyaline, bladelike.

Immature stages and breeding habitats. Unknown.

Distribution. Laos.

Holotype ♀, LAOS: SEDONE PROV: Muong Pakse, 100 m, 3.IX.1967, at light in forest (F.G. Howarth) (BPBM 13,019). Allotype ♂, same data as holotype. 22♀,4♂ paratypes: same data as holotype, 21♀,2♂; same except light trap in forest, 1♂; SAYABOURY PROV: Sayaboury, 300 m, 30.VII.1967, sweeping, 1♀,1♂ (Howarth).

Remarks. Culicoides tamada resembles *C. hinnoi,* since both share the dark brown scutum with variable amounts of light brown on the disc and lateral margins. It differs from *C. hinnoi* by the location of antennal sensory tufts, the larger, more elongate large spermatheca, the longer proboscis, and the elongate parameres. It differs from *C. raripalpis* Smith, the only other *Trithecoides* species with a dark scutum and sensilla coeloconica absent from antennal flagellomeres 11 or 12, by the pale markings on the scutum, the shorter antennal ratio, the pale halters, the longer aedeagus with the shorter basal arch, and the longer apicolateral processes.

Etymology. The species name is a transliteration of the Lao word *tamada,* meaning "ordinary" or "plain."

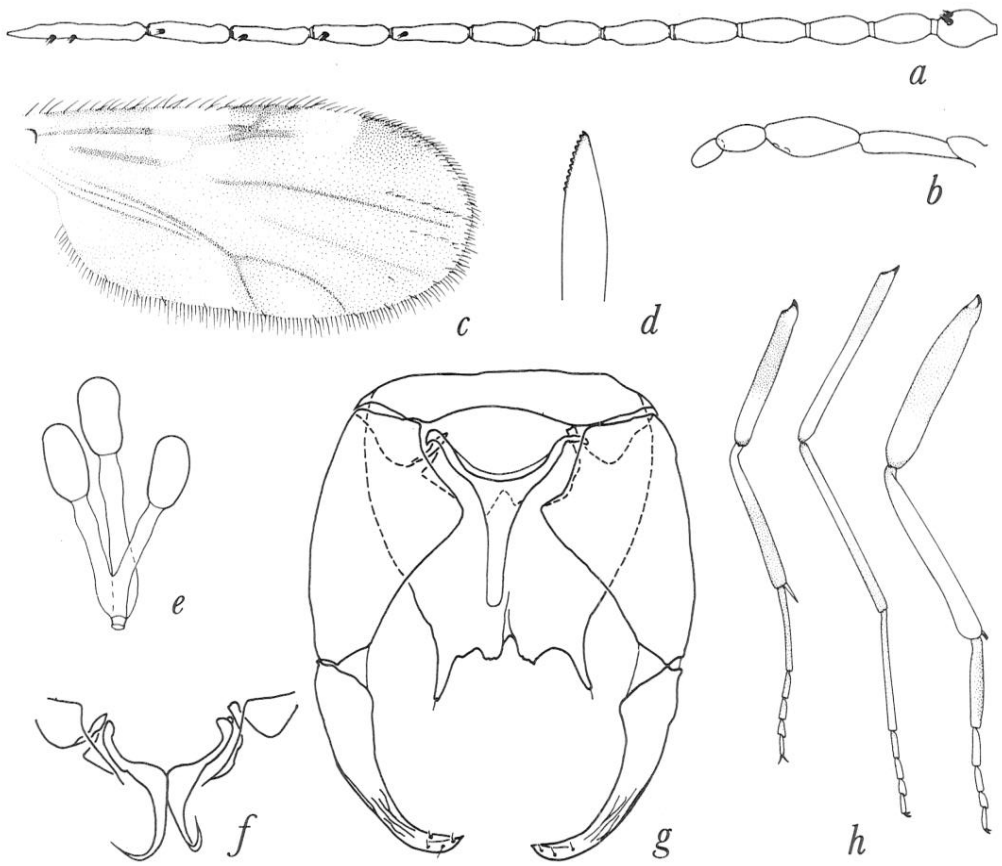

FIG. 11. *Culicoides triallantionis:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** ♂ genitalia, parameres removed; **h,** legs.

18. **Culicoides (Trithecoides) triallantionis** Howarth, **new species** Fig. 11, 25e

♀. Length of wing 0.96 mm (0.92–1.01, *n*=4). *Head.* Eyes contiguous for 4 facetal diameters, bare. Antennae (Fig. 11a) elongate, flagellomeres in proportion of 18:17:17:18:19:19:18:18: 23:22:22:24:40; antennal ratio 0.87 (0.84–0.91, *n*=4); sensilla coeloconica located on flagellomeres 3, 11–15. Palpal segments (Fig. 11b) in proportion of 7:20:18:11:9; 3rd palpal segment small, swollen in midportion, sensilla scattered over distal ½, often grouped in small, shallow, irregular depressions distally; palpal ratio 2.2 (2.1–2.3, *n*=4). Proboscis short, proboscis/head 0.58 (0.55–0.62, *n*=4). Mandible (Fig. 11d) with 11–12 (*n*=4) fine triangular teeth; lacinia with 13 (12–14, *n*=4) fine triangular teeth, distal ones larger; epipharynx apex bifid, outer margin of distal lobes with about 8 fine hyaline triangular teeth; hypopharynx bladelike, smooth, with hyaline acutangulate apex; tormae relatively thick. *Thorax.* Scutum, scutellum, upper ½ of pleuron bright yellow; postscutellum, lower ½ of pleuron dark brown. Legs (Fig. 11h) dark brown, bright yellow bands contrasting; fore knee narrowly dark, fore femur with broad, bright yellow subapical pale band, fore tibia with broad, bright yellow subbasal band; mid knee broadly pale, mid femur ½ pale, apex sometimes lightly infuscated; hind femur with dark apex

and broad, bright yellow subapical band, hind tibia mostly yellow; 4 spines in hind tibial comb, 2nd from spur longest; tarsal claws simple; ventral surface of fore basitarsus with 7–12 thickened hairlike spines in each of 2 rows along basal ¾, similar spines on apical ⅓ of ventral surface of fore tibia. *Wing* (Fig. 11c, 25e). Moderately dark, darker anteriorly, paler between veins; pale spots large, 1 at base of wing including part of anal angle, 1 over r-m crossvein broadly crossing vein M_{1+2}, 1 over apical ½ of 2nd radial cell narrowly meeting vein M_1, 1 each in distal portion of anal cell and cell M_4; wing apex broadly dipped in white, including apices of cells R_5, M_1, and M_2; cell M_1 and distal ¾ of cell M_2 each nearly filled by pale streak; basal portion of vein M_2 pale, macrotrichia few, confined to near anterior wing margin distad of poststigmatic pale spot and to longitudinal rows parallel to vein M_1 in apices of cells R_5 and M_1; costal ratio 0.70 (0.68–0.71, n=4); wing width ratio 0.48 (0.47–0.49, n=4). Halter pale. *Abdomen.* Terga light brown, tergum on segment 3 approximately 2× wider than long, sternum and tergum on segment 8 well sclerotized, dark brown; 3 elongate, subequal, somewhat sausage-shaped spermathecae (Fig. 11e) present, each measuring approximately 38 μm × 19 μm; ducts wide at entrances from spermathecae tapering to common junction point at sclerotized ring.

♂. Antennal sensilla coeloconica on flagellomeres 3, 13–15. *Genitalia* (Fig. 11g). Caudomedian margin on 9th sternum shallowly concave; tergum 9 with long, pencillike apicolateral processes, wider at base, tapering to blunt point, their length equal to ½ distance between their bases; caudomedian margin with relatively deep median cleft and short, wide submedian lobes. Basistyle with ventral root vestigial, dorsal root well developed, heavily sclerotized, short and thick; dististyle tapering from base to distal ⅔, weakly curved at base, more steeply curved distally; apex subacute, distal portion rugulose. Aedeagus with basal arch extending ¼ total length, basal arch and mesal portion of basal arms smoothly deeply concave; basal arms directed laterocephalad, curving cephalad, then bent laterodorsad, then curving laterodorsad; mid-portion of aedeagus well sclerotized, lateral margin straight, tapering distally to narrow distal stem; wide internal peg present, broad, with blunt point not extending cephalad to basal arch; distal stem elongate, spatulate, with obtuse, hyaline apex. Parameres (Fig. 11f) well sclerotized, basal bulbs large, mesal margins straight, appressed to each other; lateral margin straight, cephalic margin shallowly convex; basal arms wide, directed laterocephalad, smoothly curving cephalad, then mesocephalad; distal stem elongate, well sclerotized, curving caudoventrad, then ventrad, finally cephalad, without sharp bend, tapering from narrow base to extremely attenuated simple point.

Immature stages and breeding habitats. Unknown.

Distribution. Laos.

Holotype ♀, LAOS: VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap (F.G. Howarth) (BPBM 13,020). Allotype ♂, same data as holotype. 3♀ paratypes: same data as holotype.

Remarks. *Culicoides triallantionis* is the only known SE Asian species of *Trithecoides* with 3 elongate subequal spermathecae with wide unsclerotized entrances to the ducts. *Culicoides fulvithorax* (Austen) and *C. ochrothorax* Carter from the Ethiopian Region are easily distinguished by the 12 subequal mandibular teeth and the much paler wing in *C. triallantionis.* Besides the uniquely shaped spermathecae, *C. triallantionis* can be distinguished from related SE Asian *Trithecoides* by the association of the thoracic and leg color, the structure of the teeth, and the well-sclerotized abdominal sclerites with the broadly pale wing apex.

Etymology. The modern Greek word *triallantionis,* meaning 3 little sausages, refers to the diagnostic shape of the spermathecae.

19. **Culicoides (Trithecoides) species C**

Breeding habitats. I reared *Culicoides* sp. C 2× from rotting plant material. A single female emerged 24.IV.1968 from a rotting arum axil collected 14.IV.1968 from a shaded damp woodland near Sayaboury, Laos. It was associated with *C. sumatrae.* The 2nd rearing was from humus and loam from the base of a tree buttress collected in the same damp woodland on 14.IV.1968; an adult male emerged 15.IV.1968.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 7♀; Sayaboury, 300 m, 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 1♀; same loc., at light, 1♀; same loc., 14.IV.1968, reared, arum axil from shaded damp woods, 1♀; same loc., reared, humus and loam from base of tree in damp woods, 1♂. VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 2♀. SEDONE PROV: Muong Pakse, 100 m, 3.IX.1967, at light in forest, 9♀,3♂; Muong Paksong, 1270 m, 6.IX.1967, at light, 1♀,1♂.

Remarks. This species will be described in Wirth & Hubert (in prep.).

Subgenus **Haemophoructus**

The subgenus *Haemophoructus* is tentatively retained, even though several new species described herein from Laos are intermediate between *Haemophoructus* and *Culicoides* s.s. *Culicoides spiculae,* n. sp., possesses either 1 or 2 radial cells, sometimes in the same individual, and a somewhat intermediate number of macrotrichia on the wing. On the other hand, *C. kisangkini,* n. sp., does not appear to be closely related to any other *Haemophoructus* or *Culicoides* s.s. species in SE Asia. Any subgeneric classification scheme will remain tenuous until a greater percentage of the species is described and more is known on biologies and morphologies of the immature stages. In this paper, *Haemophoructus* includes a related complex of species which are allied to *Culicoides* s.s. and which lack a sensory pit on the 3rd palpal segment. The 7 species treated below are not subdivided into species groups.

20. **Culicoides (Haemophoructus) gemellus** Macfie

Culicoides gemellus Macfie, 1934, Ann. Trop. Med. Parasitol. **28:** 192 (♀, Sabah; fig. wing).

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 6.X.1967, light trap, 2♀; same loc., 4,5.XI.1967, at light, 1♀.

Remarks. *Culicoides gemellus* is a widespread variable species. The Lao specimens are larger and have a relatively longer 3rd palpal segment than most determined material from elsewhere in SE Asia. Detailed biosystematic studies and more adequate material may show the Lao specimens to be a distinct species.

21. **Culicoides (Haemophoructus) kinari** Howarth, **new species** Fig. 12, 26a

♀. Length of wing 1.18 mm (1.12–1.25, n=10). *Head.* Eyes contiguous a distance of 3 facetal diameters, bare. Antennal flagellomeres (Fig. 12a) in proportion of 21:18:18:19:20:19:20:21:

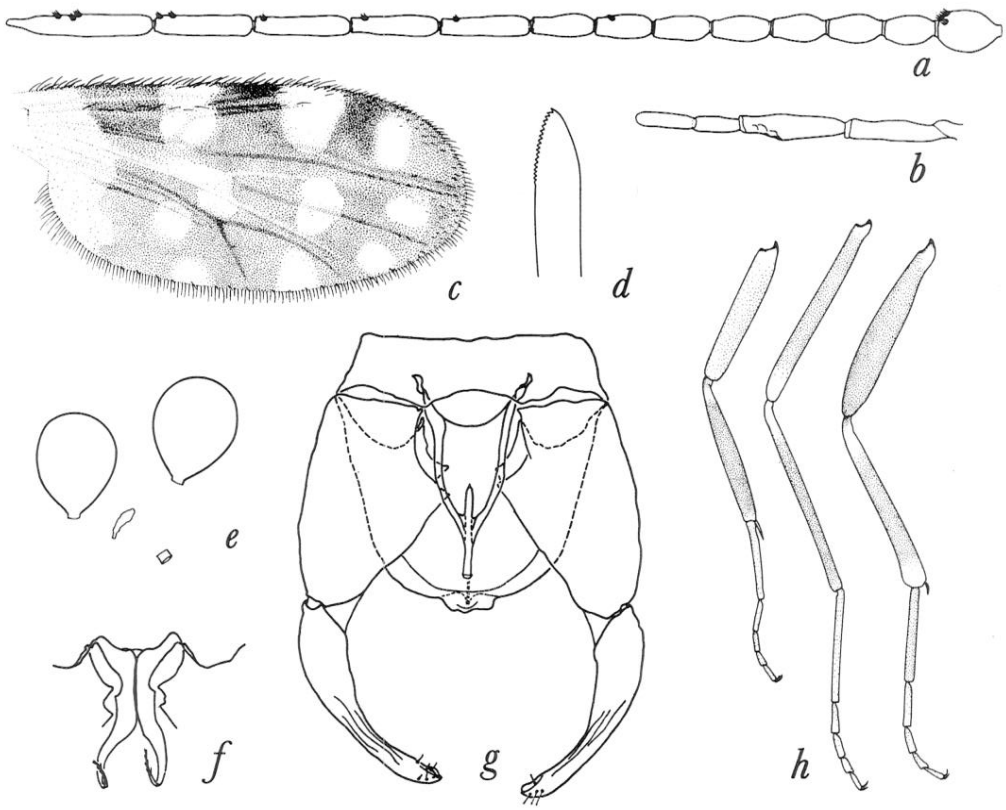

FIG. 12. *Culicoides kinari:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** ♂ genitalia, parameres removed; **h,** legs.

31:31:34:35:52; antennal sensilla coeloconica on flagellomeres 3, (7, 9), 11–15, distal and subdistal on segment 14 and usually present on segments 7 and 9; antennal ratio 1.16 (1.11–1.23, n=10). Palpal segments (Fig. 12b) in proportion of 12:39:39:16:22; segment 3 very long, slender, slightly swollen in midportion, sensilla scattered on distal ½; palpal ratio 4.6 (4.1–5.3, n=10). Proboscis long, proboscis/head 0.86 (0.83–0.89, n=9). Mandible (Fig. 12d) with 16 (15–18, n=10) small, subequal teeth; lacinia with about 24 fine teeth; apex of epipharynx with 5 large, subapical, comblike teeth and 6 apical blunt teeth; hypopharynx with 15 comblike teeth arranged along rounded apex. *Thorax.* Dark brown, without pattern in slide-mounted material. Legs (Fig. 12h) dark brown with contrasting yellow bands; fore knee narrowly pale, fore femur with indistinct narrow apical pale band, fore tibia with narrow basal pale band; mid knee narrowly pale, mid femur pale on distal ¼ or less, mid tibia with narrow basal pale band; hind femur dark to tip, hind tibia with distinct narrow pale basal and apical bands; hind tibial comb with 6 (6–8, n=10) spines, 2nd from spur longest. *Wing* (Fig. 12c, 26a). Pattern of pale and dark spots prominent; base of wing including anal angle pale, pale spot over r-m crossvein broadly meeting wing margin, narrowly crossing media; poststigmatic pale spot not reaching vein M_1, covering apical ⅓ of single long, broad radial cell; distal pale spots in cells R_5 and M_1 not reaching distal wing margin; large double pale spot over midportion of vein M_2; small marginal pale spot each in apices of cells M_2 and M_4; double pale spot in apex of

anal cell; pale spot in cell M_2 just anterior of mediocubital fork present, connected with elongate spot at base of vein M_{1+2} fork; dark band distad of poststigmatic pale spot narrow, less than ½ width of each of 2 basal dark anterior bands; apex of radial cell ends in poststigmatic pale spot; macrotrichia very few, confined to narrow band along anterior margin of cell R_5 distad of poststigmatic pale spot and apices of cells R_5 and M_1; length of costa 68% (65–70, n=10) of wing length; wing width 47% (46–49, n=10) of length of wing. Halter pale. *Abdomen.* Dark brown, terga well sclerotized, tergum on 3rd segment 2× broader than long, faintly rugulose, posterior margin irregular; 2 well-developed oval spermathecae (Fig. 12e) tapering to short, narrow, sclerotized necks; subequal, each measuring 49 μm × 38 μm; rudimentary spermatheca and sclerotized ring present.

♂. Tarsal claws bifid. Wing with 1 long radial cell as in ♀. *Genitalia* (Fig. 12g). Sternum 9 with distinct narrow caudomedian excavation, membrane without spicules; tergum 9 without apicolateral processes; caudomedian margin with deep median subapical sulcus and short, broad, hyaline apicomedian lobe. Basistyle without median patch of spines; ventral root poorly developed, short, broad, triangular; dorsal root well developed, triangulate, wider at base, tapering to well-sclerotized, subacute apex; ventromesal articulatory condyle thickened, heavily sclerotized, short; dististyle swollen at base, weakly curving to chisellike apex, rugulose distally, narrowest at distal ⅓. Aedeagus narrow, elongate, 2× as long as width across arch; basal arch sclerotized, shallow, extending ¼ total length of aedeagus; basal arms short, heavily sclerotized, twisted, directed ventrocephalad; midportion of aedeagus moderately well sclerotized, lateral margin well sclerotized, distinctly shallowly convex, curving to narrow distal stem; internal peg present, narrow, elongate, with irregular, hyaline apex extending ½ distance to margin of basal arch; distal stem short, ⅕ total length of aedeagus, triangulate at base, tapering to thin neck, tip expanded and slightly recurved ventrad. Parameres (Fig. 12f) contiguous mesad, weakly fused basad; basal arms short, stout, directed laterocephalad a short distance, then bent sharply caudolaterad, abruptly tapered to narrow base articulating with dorsal root; midportion constricted basad, subparallel distad; distal portion ribbonlike, tapered, wide basad, bent caudolaterad, then curving ventrocaudad to sharp bend ventrocephalad; apex directed cephalad, elongate, attenuated to hairy tip.

Immature stages and breeding habitats. Unknown.

Distribution. Laos.

Holotype ♀, LAOS: SAYABOURY PROV: Sayaboury, 300 m, 22.VII.1967, sweeping, secondary woods (F.G. Howarth) (BPBM 13,021). Allotype ♂, same data as holotype. 9♀,1♂ paratypes: same data as holotype, 1♂; VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap 9♀ (Howarth).

Remarks. The combination of the costa ending in the poststigmatic pale spot, the paler legs, sensilla coeloconica on antennal segments 7 and/or 9 in the female, and the fused, hyaline, apicomedian lobe on tergum 9 and the narrow parameres in the male distinguishes *C. kinari* from *C. gemellus.* The narrowly pale fore and mid knees (as described), the smaller pale spots on the wing (for example, the poststigmatic pale spot does not meet vein M_1 and the distal spot in cell M_1 does not meet the wing margin), in the male the differently shaped aedeagus with the shallowly convex lateral margin and the shorter distal stem, and the nonbifid apex of the dististyles separate this species from *C. nyakini,* n. sp.

Etymology. This species is named after the mythical Lao beasts, *Kinari,* which are generally depicted as being ½ woman and ½ bird.

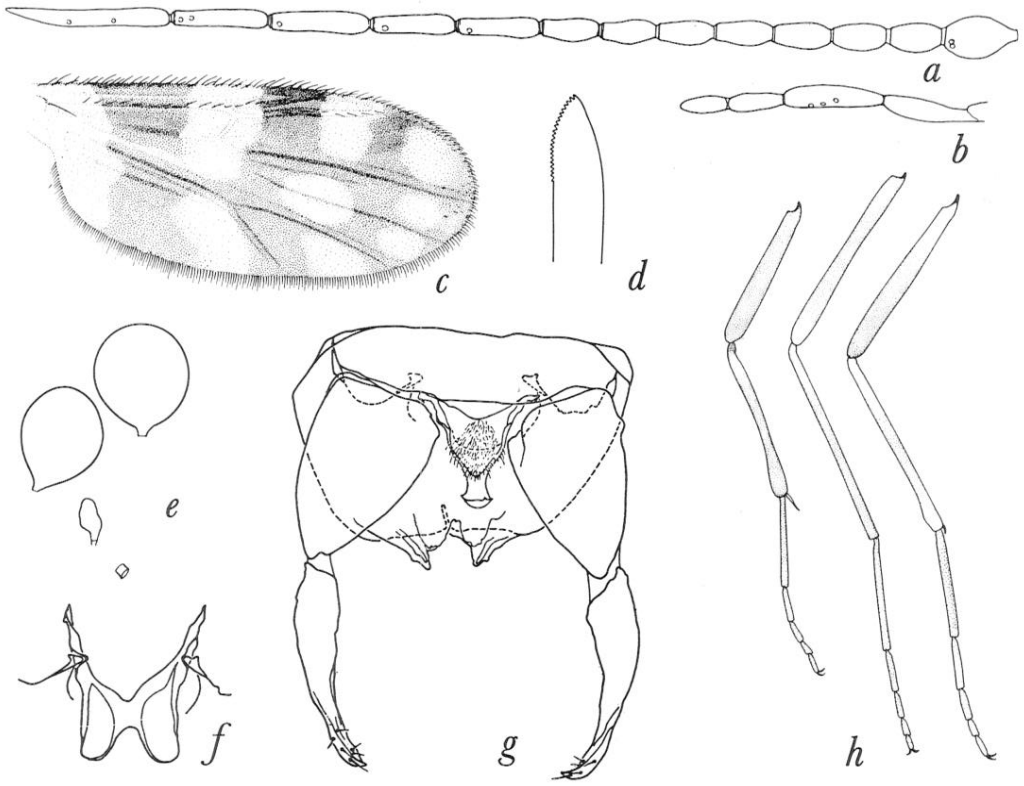

FIG. 13. *Culicoides kisangkini:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** ♂ genitalia, parameres removed; **h,** legs.

22. **Culicoides (Haemophoructus) kisangkini** Howarth, **new species**

Fig. 1a–c, 13, 26b

♀. Length of wing 1.38 mm (1.33–1.43, n=4). *Head.* Eyes contiguous for 3 facetal diameters, bare. Antennal flagellomeres (Fig. 13a) in proportion of 26:20:20:21:21:21:20:21:30:29:39:40:67; antennal ratio 1.17 (1.12–1.21, n=4); sensilla coeloconica present on flagellomeres 3, 11–15. Palpal segments (Fig. 13b) in proportion of 12:40:43:21:20, palpal ratio 4.4 (4.1–4.7, n=4); segment 3 long and slender, slightly thicker in midportion, without trace of pit; sensilla numerous on distomesal margin, few scattered elsewhere on segment. Proboscis long, proboscis/head 0.85 (0.82–0.86, n=4). Mandible (Fig. 13d) with 20 (19–21, n=4) small, subequal, triangular teeth; lacinia with 22 (20–24, n=3) fine teeth; epipharynx with 8 strong distally projecting teeth on distolateral margin and 4 rounded distal deeth. *Thorax.* Scutum, scutellum, postscutellum brown; pleuron lighter brown. Legs (Fig. 13h) pale brown, bands not distinct, fore and hind knees very narrowly darkened; mid knee infuscated; hind tibial comb with 4 spines, 2nd from short spur longest; claws simple, empodium present. *Wing* (Fig. 13c, 26b). One long radial cell present reaching distal dark band; wing darker anteriorly with large pale spots; 3 transverse dark bands on anterior margin, 1 distad of poststigmatic pale spot narrow, ½ width and ⅓ width of mesal and basal bands, respectively; anal angle broadly pale; 8 large pale spots, sometimes fused, 1 over r-m crossvein, 1 over distal portion of radial cell, 1 on distal portion of cell R_5 (sometimes attaining wing apex), 1 subapically in cell M_1, 1 each apically

in cells M_2, M_4 and anal cell, and double pale spot over midportion of vein M_2; no pale spot just anterior of mediocubital fork in cell M_2; costal ratio 0.76 (0.76–0.77, n=4); wing width ratio 0.43 (0.41–0.44, n=4); macrotrichia very sparse in apices of cells R_5 and M_1. Halter lightly infuscated. *Abdomen.* Brown, terga well sclerotized, tergum on segment 3 rectangular, 1.5× wider than long; 2 well-developed, subequal, oval spermathecae (Fig. 13e) with short, narrow, sclerotized necks, each measuring 59 μm × 45 μm; rudimentary spermatheca and sclerotized ring present.

♂. Tarsal claws bifid. Sensilla coeloconica on flagellomeres 3, 13–15. Wing similar to ♀ except 2 radial cells, 1st narrow, 2nd long and broad. *Genitalia* (Fig. 13g). Sternum 9 without caudomedian excavation, membrane without aculeae; tergum 9 with long hairs, apicolateral processes represented only by minute setigerous tubercles; caudomedian margin with narrow median cleft shallow, with large hyaline submedian lobes. Basistyle with long hairs without conspicuous mesal patch of spicules; ventral root vestigial, dorsal root well developed, triangulate, wider at base, elongate, with distal flange; dististyle palish, swollen at base, tapering abruptly to narrow, elongate distal arm, more steeply curved distad to simple point. Aedeagus moderately well sclerotized, relatively wide; basal arch shallow, extending ⅙ total length of aedeagus; basal arms directed cephalolaterad, weakly curving laterad, short, their length equal to ½ distance between their bases; midportion of aedeagus with numerous aculeae on ventral surface; expanded, with distinct, shoulderlike lateral margin tapering to distal stem; internal peg absent; distal stem narrow, hyaline at base, expanding into well-sclerotized, enlarged, bulbous apex, recurved ventrad. Parameres (Fig. 13f) fused mesally, butterfly-shaped; weakly sclerotized, winglike membrane joining apex to base along straight lateral margin; basal arms straight, attenuate, directed cephalad; distal portion of parameres sclerotized on convex mesal margin.

Immature stages. *Larva* unknown. *Pupa* (Fig. 1a). Total length 2.82 mm (2.68–2.92, n=10). Color pale yellowish brown, cephalothorax slightly darker than abdomen. *Respiratory trumpet* (Fig. 1b). Length 256 μm (248–273, n=10), 5.2× (4.8–6.1, n=6) longer than wide; concolorous with cephalothorax, paler in midportion; with 2 (rarely 1 or 3, n=10) lateral spiracles on weak tubercles and 8 (7–13, n=10) distal spiracles along spoonlike apical margin; widest in basal portion, constricted and weakly annulated in middle, apex expanded; large, unpigmented, scales present distad of annulations and on basal portion near lateral spiracular openings; pedicel elongate, ⅓ length of trumpet. *Operculum.* About as wide, 198 μm (188–207, n=10), as long, 196 μm (188–202, n=10); pale with distinct large, brown, rounded subapical median tubercle armed with few triangular scales; lateral margin of operculum with wide patch of small triangular scales, longest 5 μm long, smaller mesally, small patch just distad of *am*; ( ) markings on disc and extending basad of *am*; *am* tubercle large, apex weakly produced to blunt tooth, seta long and stout, length 120 μm (118–127, n=10), 4× longer than distance between bases. *Cephalothorax.* Setal measurements, Table 2; *dl* enlarged rounded tubercle with 2 delicate, elongate, unequal setae and a small basal spine; *ad* a double rounded tubercle with a setaless pore at base, each lobe bearing an elongate seta, setae unequal, 134 μm and 90 μm long; *d* tubercles *1, 2,* and *4* large, apices broadly rounded, weakly produced; *d 1, 2,* and *3* in straight line, well separated and equidistant from each other; *d 1* and *2* subequal, each bearing an elongate subequal seta 100 μm long; dorsum near *d*'s with ( ) markings, some approaching blunt tubercles; *vl* with 2 delicate setae, 82 μm and 56 μm long, and a setaless pore. *Abdomen.* Large, elongate *lpm*'s (Fig. 1c) with produced apical row of 6–10 triangular teeth, ½ length of stout setae on *lpm 1* and *3*; *lasm, vpm 3,* and *dpm 1* with apices produced with comblike row of apical teeth, similar to *lpm*'s; *dasm 1* and *2, vpm 1* and *2,* and *dpm 2, 3, 4,* and *5* with apices produced, broadly rounded, shieldlike. Shallow dorsomedian invagination on each abdominal intersegmental membrane except last; integument with small triangular scales in wide sub-

marginal band on anterior ¼ of segment 4, less numerous laterally, in mesal patch on dorsum, and on anterior ½ of intersegmental membrane; scales more numerous on posterior segments; segment 8 nearly all spinulose. *Caudal segment.* Scales larger, in wide anterior band, in dorsal V-shaped patch on disc, and on posterolateral processes. Posterolateral processes long, slender; diverging 51° (45–55°, n=6); apical ⅓ blackened, tapered to acute apex.

Breeding habitats. *Culicoides kisangkini* is a dung-inhabiting species and is unique in that it breeds in floating elephant feces. *Culicoides kisangkini* pupae were collected in the aerial portion, 0–10 cm above water level, of feces floating in a stream. The larvae are probably predaceous on smaller arthropods and were associated with a *Stilobezzia* sp., horse fly larvae, and muscoid fly pupae. The adult midge must oviposit on relatively fresh stools to assure the development of the larvae and pupae before the floating feces disintegrate in the water, or possibly *C. kisangkini* larvae swim to fresh stools as the older ones disintegrate.

Distribution. Laos.

Holotype ♂, LAOS: SAYABOURY PROV: 20 km NE of Sayaboury, Houey La Stream, 400 m, 26.XI.1967, reared, elephant droppings in stream (F.G. Howarth) (BPBM 13,022). Allotype ♀, same data as holotype. 10♂,3♀ paratypes: same data as holotype, 6♂,1♀; same loc., 25.XI.1967, 4♂,2♀.

Remarks. *Culicoides kisangkini* is placed in the subgenus *Haemophoructus* because of the single long radial cell in the female and the elongate 3rd palpal segment without a sensory pit. However, it does not appear to be closely related to any other species of *Haemophoructus.* The extensively pale wing, especially the large distal pale spot in cell R_5, the absence of a pale spot in cell M_2 just anterior of the mediocubital fork, the presence of only 4 spines in the hind tibial comb, the pale legs, the butterfly-shaped parameres, and the densely hairy aedeagus are unique in *Haemophoructus.*

Etymology. The species epithet is taken from the Lao words *Khi sang kin,* "to eat elephant excrement," and refers to the breeding habitat.

23. **Culicoides (Haemophoructus) nyakini** Howarth, **new species** Fig. 14, 26c

♀. Length of wing 1.27 mm (1.15–1.33, n=6). *Head.* Eyes contiguous for 4 facetal diameters, bare. Antenna (Fig. 14a) with flagellomeres in proportion of 24:21:22:23:23:23:23:25:33:33:37:42:59; sensilla coeloconica located on flagellomeres 3, 11–15, distal and subdistal tufts on segment 14; antennal ratio 1.11 (1.05–1.14, n=6). Palpal segments (Fig. 14b) in proportion of 11:38:46:20:19; segment 3 elongate, slender, widest at distal ⅓, tapering to apex; sensilla scattered over distal ½ of segment, more numerous on inner margin and distally; palpal ratio 4.5 (4.0–5.1, n=6). Proboscis very long, proboscis/head 0.89 (0.84–0.92, n=6). Mandible (Fig. 14d) with 17 (16–19, n=6) small subequal teeth; lacinia with 18–22 (n=4) fine triangular teeth; epipharynx with series of 6 large, comblike, subapical teeth along lateral margin and large retort spine proximad of comb, projecting basad, and with 6 blunt apical teeth; hypopharynx broadly rounded, bladelike, with series of 15 comblike teeth along subapical and apical margin. *Thorax.* Dark brown, often with small, contrasting paler areas on scutum. Legs (Fig. 14h) predominantly dark, pale bands contrasting; fore knee infuscated to dark, fore femur with narrow subapical pale band, fore tibia with subbasal pale band; mid knee broadly pale, mid

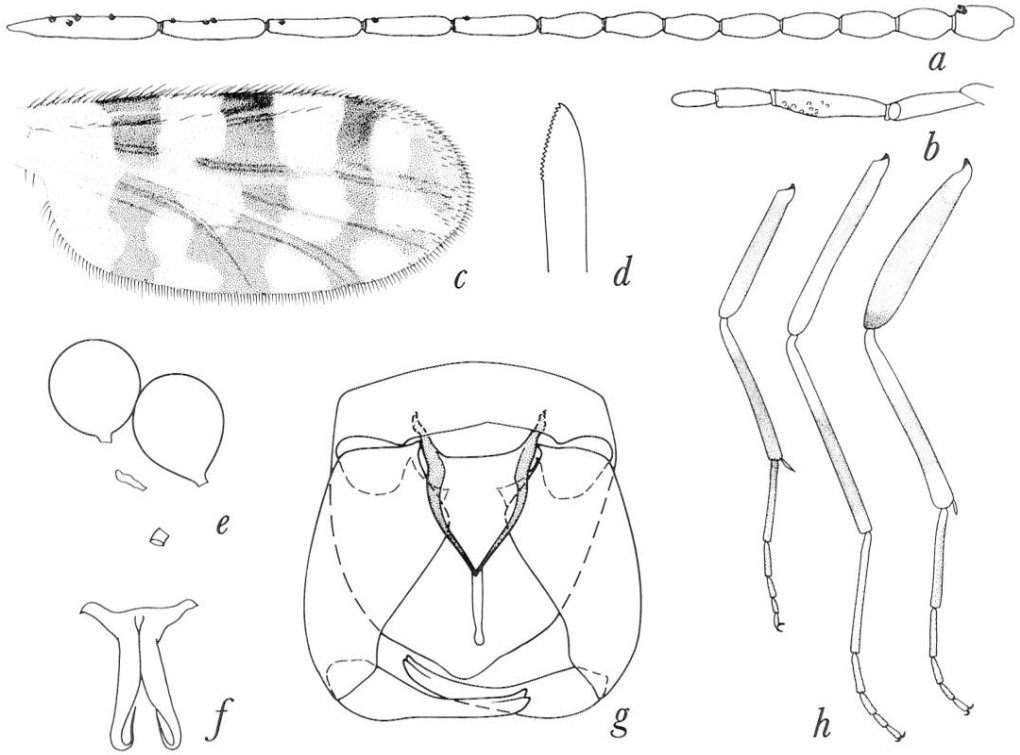

FIG. 14. *Culicoides nyakini:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** ♂ genitalia, parameres removed; **h,** legs.

femur pale on at least distal ⅓; hind femur darkened at apex with indistinct narrow subapical pale band, hind tibia with distinct basal and apical pale bands; 6 spines in hind tibial comb, 2nd from spur longest. *Wing* (Fig. 14c, 26c). One long, broad radial cell, with apex included in poststigmatic pale spot; 3 transverse dark bands on anterior wing margin; distal band narrow, ½ width of basal band and usually ½ width of middle band; pale spots large, often confluent, contrasting; base of wing including anal angle pale; pale spot over r-m crossvein large, crossing vein M_{1+2}, confluent with pale streak in cell M_2; poststigmatic pale spot crosses vein M_1 and joins double pale spot over midportion of vein M_2; distal pale spot in cell M_1 large, confluent with subapical pale spot in cell R_5, meeting distal wing margin in cell M_1; small apical pale spot in cell M_2; large pale spot in apex of cell M_4; double pale spot distally in anal cell; pale spot present just anterior of mediocubital fork fused with large pale spot in cell M_2 at base of medial fork; macrotrichia, very few, confined to narrow marginal band in cell R_5 distad of poststigmatic pale spot and in apex of cell M_1; costal ratio 0.70 (0.69–0.71, n=6); wing width ratio 0.46 (0.41–0.47, n=6). Halter pale. *Abdomen.* Brown, terga well sclerotized, tergum on segment 3 rectangular, rugulose, 2× wider than long; 2 well-developed, subequal, oval spermathecae (Fig. 14e) tapering to moderately long, narrow, annulate necks, each measuring 60 μm × 42 μm; rudimentary spermatheca and sclerotized ring present.

♂. Tarsal claws bifid. Wing with 1 or 2 radial cells. *Genitalia* (Fig. 14g). Sternum 9 with shallow, wide caudomedian excavation, membrane bare; tergum 9 without apicolateral pro-

cesses; caudomedian margin with median subapical sulcus and broadly rounded, hyaline apicomedian lobe. Basistyle without conspicuous mesal patch of spines; ventral root poorly developed, short, triangular; dorsal root well developed, triangular, wider at base, tapered to acute apex; dististyle swollen at base, narrow and rugulose on distal ½, slightly curving to bifid apex. Aedeagus moderately well sclerotized, basal arch wide, shallow, sclerotized, extending less than ⅕ total length of aedeagus; basal arms short, stout, wider caudad, directed laterocephalad, tortilis, tapering to sharp bend cephalad; subacute base directed cephalad; midportion of aedeagus with lateral margin strongly sclerotized, expanded, strongly convex basad, shoulderlike in midportion, distal portion straight, meeting in acute angle at base of distal stem; internal peg present, wide at base, tapering abruptly to elongate, attenuate spine extending more than ½ way to basal arch; distal stem elongate, more than ⅓ total length of aedeagus, narrow, parallel-sided to constriction near apex; apex expanded, knoblike; aedeagus with broad, lateral, inconspicuous, hyaline membrane connecting apex of distal stem to lateral shoulder in midportion. Parameres (Fig. 14f) approximate in midportion, weakly fused basad; basal arms short, stout, tapering slightly, directed laterad to sharp curve caudad, articulating with dorsal root; midportion of parameres constricted basad, expanded, parallel-sided distad of constriction; distal stem bent laterocaudad at base, smoothly curving ventrad and then cephalomesad, apparently without hairs, wide, ribbonlike, tapering to elongate, attenuated simple point.

Immature stages and breeding habitats. Unknown.
Distribution. Laos.

Holotype ♀, LAOS: VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap (F.G. Howarth) (BPBM 13,023). Allotype ♂, same data as holotype. 5♀,5♂ paratypes: same data as holotype, 1♀,3♂; SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 2♀; SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 1♀; same loc., 3.IX.1967, at white light in forest, 1♂; same loc., blacklight trap in forest, 1♀; Muong Paksong, 1270 m, 6.IX.1967, at light, 1♂. (All Howarth.)

Remarks. *Culicoides nyakini* closely resembles *C. gymnopterus* Edwards; however, the male genitalia are quite distinct. In *C. nyakini* tergum 9 has a broad, rounded, hyaline apicomedian lobe without a median cleft or pencillike submedian lobes, the tips of the parameres are bare, and the distal stem of the aedeagus is longer. Females of *C. nyakini* have the hind femoral apex distinctly darkened, usually a darker thorax, and somewhat smaller pale areas on wing, e.g., the apical double pale spot in the anal cell is not confluent with the large pale spot in cell M_2. One male from Ban Na Pheng has the parameres more swollen and the basal arms of the aedeagus more elongate, but it is considered conspecific.

Etymology. This species is named after the mythical female Lao beasts, *Nyak Khini,* that eat human flesh.

24. **Culicoides (Haemophoructus?) pikongkoi** Howarth, **new species**

Fig. 15, 26d

♀. Length of wing 1.21 mm (1.17–1.26, *n*=3). *Head.* Eyes narrowly contiguous for 1.5 facetal diameters, bare; suprainterocular suture present. Antennal flagellomeres (Fig. 15a) in proportion of 19:18:19:20:20:21:20:22:27:26:28:29:41; sensilla coeloconica on flagellomeres 3, (11, 12), 13–15, weakly developed, segment 14 with distal tufts only; antennal ratio 0.95

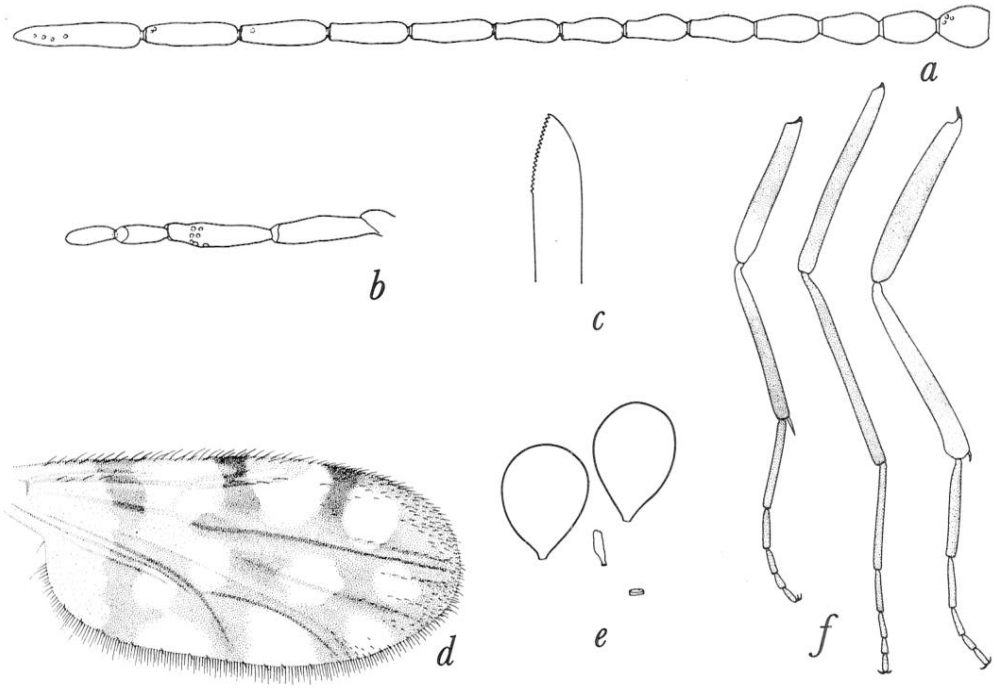

FIG. 15. *Culicoides pikongkoi* ♀: **a,** antenna; **b,** palpus; **c,** mandible; **d,** wing; **e,** spermathecae; **f,** legs.

(0.93–0.96, n=3). Palpal segments (Fig. 15b) in proportion of 14:43:42:21:20; segment 3 elongate, slightly swollen in midportion, with sensilla scattered on distal ½; palpal ratio 4.3 (4.0–4.7, n=3). Proboscis long, proboscis/head 0.89 (0.86–0.92, n=3); 17 (17–18, n=3) small, triangular, subequal teeth on mandible (Fig. 15c); lacinia with about 20 small, subequal teeth; epi- and hypopharynx as described for *C. nyakini. Thorax.* Pale yellowish brown scutum and pleuron with contrasting dark brown markings (in slide mounted specimens); scutellum light brown, postscutellum dark brown. Legs (Fig. 15f) brown with straw-yellow colored bands; fore and mid knee broadly pale, fore and mid femur with broad apical pale band, fore and mid tibia with broad basal pale band; hind femur with darkish apex and subapical narrow pale band, hind tibia with broad basal and narrow apical pale band; 6 (n=3) spines in hind tibial comb, 2nd from spur longest. *Wing* (Fig. 15d, 26d). Pale areas extensive, pattern as figured; 3 transverse dark bands meeting anterior wing margin, narrow, subequal in width; 2 radial cells, 2nd moderately elongate and broad, weakly separated from 1st; base of wing including anal angle broadly pale; pale spot over r-m crossvein large, broadly meeting anterior wing margin and confluent with large pale spot in cell M_2 just anterior of mediocubital fork; post-stigmatic pale spot large, not crossing vein M_1, covering most of 2nd radial cell; costa not reaching distal dark band; distal pale spot in cell R_5 large, round, not crossing vein M_1; apex of wing narrowly pale, large double pale spot over midportion of vein M_2 present; small, round pale spot indistinctly meeting pale wing margin in cell M_1; small, round pale spot in apex of cell M_2 broadly meeting wing margin; large marginal pale spot in cell M_4; large double pale spot distally in anal cell; macrotrichia moderately numerous in anterior ½ of cell R_5 distad of poststigmatic pale spot, in apices of cells M_1 and M_2, and in longitudinal rows parallel to veins

M_1, M_2 and M_{3+4} in apical ⅓ of cells R_5, M_1 and M_2; costal ratio 0.64 (0.64–0.65, n=3); wing width ratio 0.47 (0.47–0.48, n=3). Halter pale. *Abdomen.* Light brown, tergum 3 rugulose, rectangular, 2× wider than long; 2 subequal, oval spermathecae (Fig. 15e) tapering to short, narrow necks, each measuring 75 μm × 55 μm; rudimentary spermatheca and sclerotized ring present.

♂. Unknown.

Immature stages and breeding habitats. Unknown.

Distribution. Laos.

Holotype ♀, LAOS: SEDONE PROV: Muong Paksong, 1270 m, 6.IX.1967, at light (F.G. Howarth) (BPBM 13,024). 2♀ paratypes: same data as holotype.

Remarks. *Culicoides pikongkoi* resembles *C. klossi.* It is, however, easily separated by the all pale anal angle of the wing, the fewer macrotrichia, the hind femur with darkish apex, and the presence of 6 spines in the hind tibial comb.

Etymology. This species is named after the legendary female Lao dwarfs called *Phi-kong-koi,* who live in forests and caves and trap and torment men.

25. **Culicoides (Haemophoructus?) spiculae** Howarth, **new species** Fig. 16, 26e

♀. Length of wing 1.13 mm (1.02–1.22, n=20). *Head.* Eyes contiguous for 2 facetal diameters, bare; suprainterocular suture usually present. Antennal flagellomeres (Fig. 16a) in proportion of 21:17:19:19:20:19:20:20:25:28:31:34:48; sensilla coeloconica located on flagellomeres 3, 11–15, well developed, usually apical and subapical on segment 14; antennal ratio 1.08 (1.01–1.14, n=20). Palpal segments (Fig. 16b) in proportion of 10:31:32:12:14; segment 3 elongate, slightly swollen in midportion, sensilla numerous, scattered over distal ½, no trace of sensory pit; palpal ratio 3.9 (3.3–4.7, n=20). Proboscis moderately long, proboscis/head 0.78 (0.72–0.84, n=20). Mandible (Fig. 16d) with 16–21 (n=12) small, subequal, triangular teeth; lacinia with 18–23 (n=4) small, triangular teeth; epi- and hypopharynx similar to *C. nyakini* except proximad subapical spine on epipharynx triangulate; cibarium with conspicuous patch of ca. 50 small, blunt spicules near mouth; lateral pharyngeal membrane at mouth with few blunt, triangular spicules. *Thorax.* Dark brown; scutum dark brown with varying amounts of noncontrasting paler markings (in slide mounts). Legs (Fig. 16h) dark brown; all knees narrowly pale; fore femur with very narrow, indistinct apical pale band, fore tibia with narrow basal pale band; mid and hind femora each with narrow apical yellowish band, mid tibia with narrow basal yellowish band; hind tibia with wide pale basal and narrow apical pale band; hind tibial comb with 5–6 (n=20) spines, 2nd from short spur longest; tarsal claws simple. *Wing* (Fig. 16c, 26e). Pattern as figured; 1 or 2 radial cells, if divided the 2nd broad and 1.5× as long as 1st; 3 dark spots on anterior margin as wide as bordering costal pale spots; base of wing including anal angle broadly pale; pale spot over r-m crossvein broadly meeting wing margin, narrowly crossing vein M_{1+2}, meeting pale streak in cell M_2; poststigmatic pale spot transverse, not meeting vein M_1; distal pale spot in cell R_5 large, usually transverse, narrowly meeting anterior wing margin and rarely crossing vein M_1, often connected to distal wing margin by narrow, indistinct pale streak along anterior wing margin; large double pale spot present over middle of vein M_2; round or elongate pale spot distally in cell M_1, sometimes meeting wing margin; 1 large apical pale spot each in cells M_2 and M_4; double pale spot distally in anal cell; large pale spot in cell M_2 at level of mediocubital fork and base of vein M_2 connected to pale wing base by narrow pale streak in cell M_2; macrotrichia moderately numerous in anterior ½

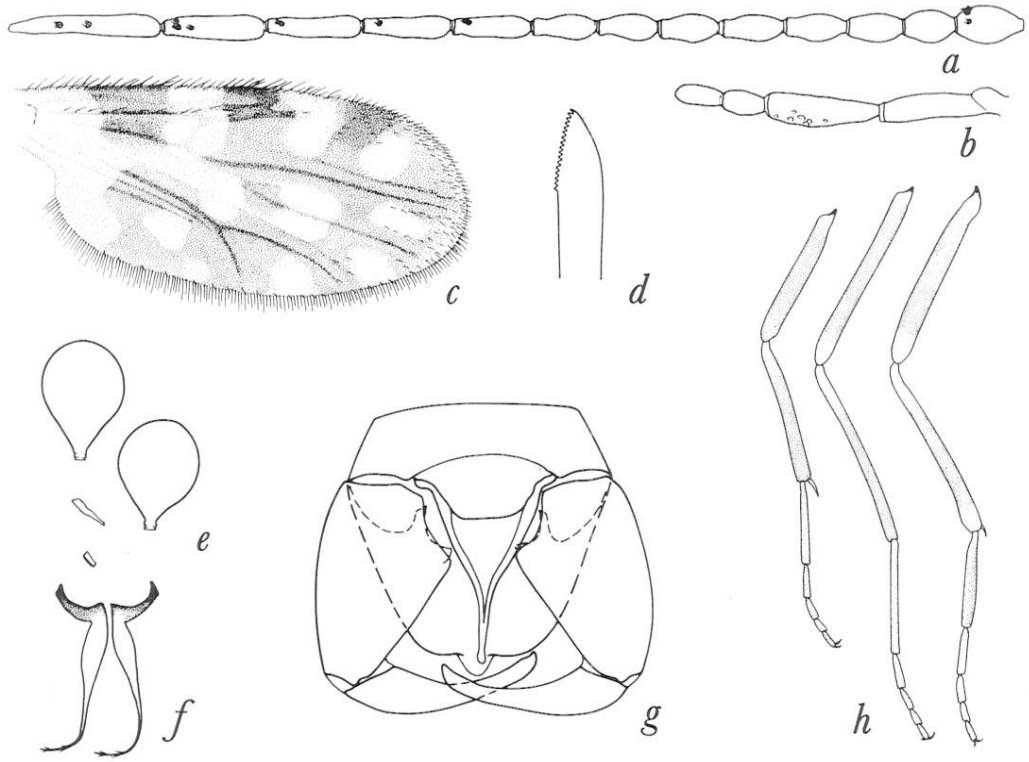

FIG. 16. *Culicoides spiculae:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** ♂ genitalia, parameres removed; **h,** legs.

of cell R distad of poststigmatic pale spot, in apex of cell M_1, and in rows parallel to veins M_1, M_2, and M_{3+4} in cells R_5, M_1 and M_2; costa elongate, costal ratio 0.69 (0.65–0.71, n=20); wing width ratio 0.46 (0.44–0.48, n=20). Halter pale. *Abdomen.* Brown, terga well sclerotized, tergum on 3rd segment 2× wider than long, rectangular, surface rugulose, posterior margin serrate; 2 subequal, well-sclerotized spermathecae (Fig. 16e) present, each measuring 58 μm × 40 μm, tapering conically to narrow entrance to ducts; rudimentary spermatheca and sclerotized ring present.

♂. Sensilla coeloconica located on flagellomeres 3, 13–15. Tarsal claws bifid. Wing with 2 radial cells. *Genitalia* (Fig. 16g). Sternum 9 with broad, moderately deep caudomedian excavation, membrane bare; tergum 9 without apicolateral processes; caudomedian margin with apicomedian sulcus with well-developed, hyaline median lobe. Basistyle with large median patch of spines weakly differentiated from microtrichia on basistyle; ventral root not developed; dorsal root well developed, wider at base, tapering to square apex and sharp point; dististyle swollen at base, slightly curved, narrowest at distal ⅓, rugulose distally, with obtuse apex. Aedeagus moderately well sclerotized, basal arch sclerotized, extending less than ¼ total length of aedeagus; basal arms well sclerotized, directed laterocephalad, tapering to bend laterad, stout base curving dorsad; midportion triangular, moderately well sclerotized, cephalic margin shallowly concave, lateral margin well sclerotized, nearly straight, tapering to narrow distal stem; internal peg present, triangular, wide at base, tapering to rounded apex, extending more

than ½ way to basal arch; distal stem elongate, extending more than ⅓ total length of aedeagus, narrow, with poorly sclerotized, hyaline lateral margin extending ⅔ length; apex with spherical knob. Parameres (Fig. 16f) weakly joined at base; basal arms strongly sclerotized, stout, short, directed laterad, strongly curving cephalad to basal flange articulating with dorsal root, cephalad margin strongly concave, caudal margin strongly convex; basal bulbs weakly sclerotized, slightly swollen, constricted near base; distal stem narrow, elongate, attenuated to hairy tip, hairs inconspicuous.

Immature stages and breeding habitats. Unknown.
Distribution. Laos.

Holotype ♀, LAOS: VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, blacklight trap (F.G. Howarth) (BPBM 13,025). Allotype ♂, same data as holotype. 30♀,5♂ paratypes: same data as holotype, 5♀,2♂; SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at white light, 17♀; Sayaboury, 300 m, 22.VII.1967, sweeping secondary woods, 1♀,1♂; same loc., 30.VII.1967, sweeping, 1♂; same loc., 6.X.1967, blacklight trap, 3♀; SEDONE PROV: Muong Pakse, 100 m, 3.IX.1967, at white light in forest, 4♀,1♂. (All Howarth.)

Remarks. *Culicoides spiculae* is intermediate between the subgenera *Haemophoructus* and *Culicoides* in possessing 1 or 2 radial cells, sometimes in the same individual, and a somewhat intermediate number of macrotrichia on the wing. Placing the *klossi* group in *Haemophoructus* on the common absence of a palpal pit might be a more tenable subgeneric grouping. *Culicoides spiculae* is unique in *Haemophoructus* and the *klossi* group in possessing a conspicuous patch of cibarial dots. These are present in both males and females. It is further separated from *C. klossi* Edwards in lacking the dark spot in the anal angle.

Etymology. The species epithet refers to the minute spines or dots ornamenting the cibarium.

26. **Culicoides (Haemophoructus) species D** Fig. 1d, 2c–d

Immature stages. *Pupa.* Total length 2.54 mm (2.42–2.66, *n*=5). Color yellowish brown, cephalothorax darker than abdomen. *Respiratory trumpet* (Fig. 2c). Length 230 μm (221–238, *n*=5), 6.2× (5.9–6.5, *n*=5) longer than wide; brown, darker than cephalothorax, darker on distal ⅓; widest at base, slightly narrower and without annulations in midportion, distal ⅓ expanded; with dark scales in midportion; no lateral and 11 (10–13, *n*=5) distal spiracles; pedicel ca. ⅓ length of trumpet. *Operculum* (Fig. 2d). Slightly wider than long, 202 μm (190–214, *n*=4):186 μm (184–190, *n*=4), subquadrate basad of lateral corner; disc greatly narrowed just distad of lateral corner; yellowish brown with large, brown, rounded, unarmed subapical tubercle; lateral margin of disc with numerous well-developed scales, longest 9 μm long, becoming weaker mesally and basally and extending between *am*'s; numerous weakly developed scales and ( ) markings basad of *am*'s; *am* tubercle well developed, apex produced, shieldlike, variably bifid, with elongate subapical seta 101 μm (94–106, *n*=4) long, 4–5× longer than distance between their bases. *Cephalothorax.* Setal measurements, Table 2; *dl* tubercle large, rounded, with 3 unequal setae, 1 in basal cleft; *ad* tubercle large, broad, rounded, with 2 very elongate, subequal, moderately stout setae and a basal setaless pore; *d* tubercles *1*, *2*, and *4* large, weakly produced, broadly rounded; *d 1*, *2*, and *3* in nearly straight line, well separated and equidistant, *d 1* with short stout seta, *d 2* seta 3× length of *d 1* seta; dorsum near *d*'s with

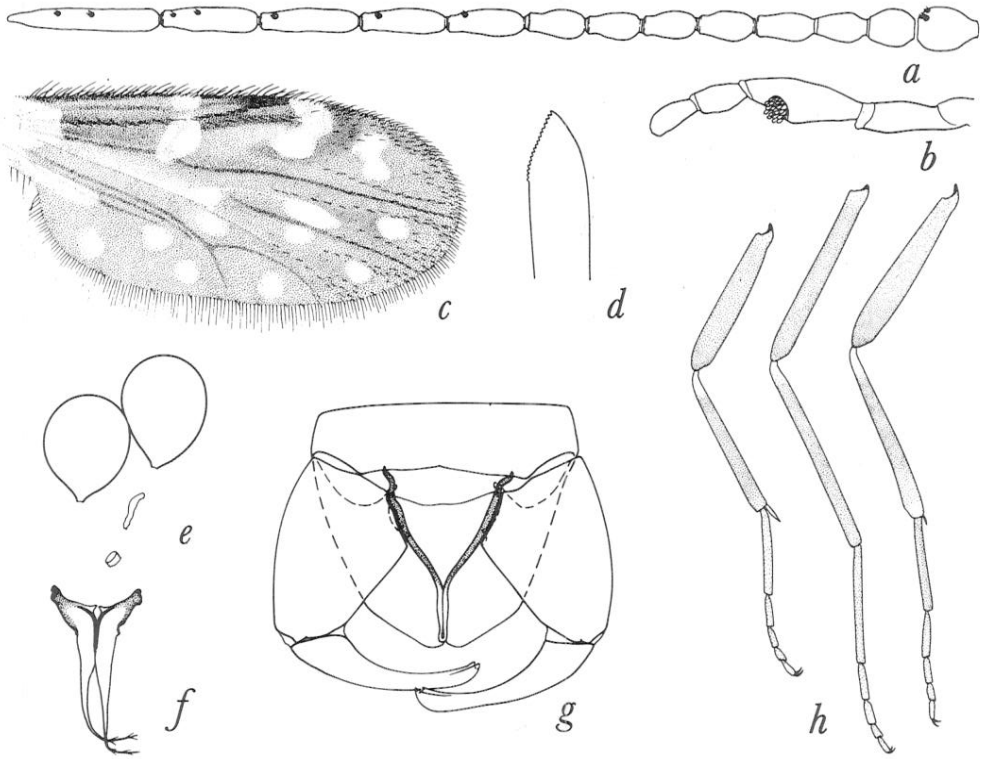

FIG. 17. *Culicoides lansangensis:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** ♂ genitalia, parameres removed; **h,** legs.

a rough reticulated pattern of strong, blunt scales; *vm* with only 1 delicate seta; *vl* on weak tubercle with 2 delicate setae and a setaless pore. *Abdomen.* Well-developed *lpm*'s (Fig. 1d) with produced apical row of 4–8 large, triangular, comblike teeth, sometimes unequal, usually about ½ as long as *lpm 1* seta; *dasm 1* and *2* and *dpm 3, 4,* and *5* weakly produced with broadly rounded apex; *lasm* and *dpm 1* and *2* with greatly produced, rounded, shieldlike apex; *vpm 1, 2,* and *3* variable, usually with produced, shieldlike apex. Moderately deep dorsomedian invagination on each abdominal intersegmental membrane except last; surface of abdomen, including anterior portion of intersegmental membranes, reticulated or rugose, rugosity becoming scalelike towards anterior and distal margins; segments 3–8 with wide anterosubmarginal band of scales fused in short rows of 3–10 triangular scales along reticulated pattern; scales more numerous and interconnected on distal segments. *Caudal segment.* With single anterior row of strong scales fused at bases and encircling segment; dorsal disc with narrow V-shaped patch of scales. Posterolateral processes large, wide, strongly spinulose, diverging 45–50° (n=3); darkened on distal ⅓, and tapered to blunt apex.

Breeding habitats. I reared *Culicoides* sp. D from pupae isolated from 2 collection sites along shaded, highly polluted stream margins. Both sites had no visible vegetation and small to moderate amounts of silt, sand, gravel, organic detritus, and clay. One site was exposed mud on rocky substrate next to a decomposed elephant stool. *Cu-*

licoides tenuipalpis and *C. huffi* were reared from the same samples. The site of the other collection, 0–3 cm above water level at a shaded stream margin in a bamboo thicket, had more sand and clay than the 1st site. There, *Culicoides* sp. D was associated with *C. flavescens, C. guttifer, C. huffi,* and *C. arenicola,* n. sp.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 1♀; 15 km NE of Sayaboury, 330 m, 18.XI.1967, reared, shaded stream margin, 2♀,1♂; Sayaboury, 300 m, 18.II.1967, sweeping shaded stream, dead leaves, 1♀; same loc., 4.III.1967, reared, partly shaded stream margin, 2♂. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 2♀; same loc., 3.IX.1967, at light in forest, 2♀; same loc., light trap in forest, 1♀.

Remarks. *Culicoides* sp. D will be described in Wirth & Hubert (in prep.).

Subgenus **Culicoides**

27. **Culicoides (Culicoides) innoxius** Sen & Das Gupta

Culicoides innoxius Sen & Das Gupta, 1959, Ann. Entomol. Soc. Am. **52:** 626 (♂, ♀; India; fig. scutum, wing, spermathecae, ♂ genitalia).

Breeding habitats. I reared *C. innoxius* 2×. The 1st rearing was from organic material collected from a tree wound in a fork of an unidentified tree, 1.7 m above the ground near Sayaboury, Laos. The material was collected 30.VII.1967, and 2 males emerged between 18.VIII.1967 and 12.IX.1967. *Culicoides lansangensis, C. tonmai,* and *C. clavipalpis* were reared from the same tree wound. The 2nd rearing was from rotting banana stalks, collected 11.V.1968 near Vientiane, Laos, at 150 m elevation; 4 females emerged 18.V.1968.

Biting habits. I collected this species several times by sweeping cows and a cow shed near Muong Pakse, Laos, but no specimens were actually biting when taken.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 30.VII–12.IX.1967, reared, tree wound, 2♂; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 1♀; 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 23♀. VIENTIANE PROV: Muong Vang Vieng, 250 m, 16.II.1968, light trap, river margin, 1♀; Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 3♀; Vientiane, K9, 150 m, 11.V.1968, reared, rotting banana stem, 4♀. SEDONE PROV: Muong Pakse, 100 m, 5.IX.1967, sweeping cow and cow shed, 4♀; same loc., 7.IX.1967, sweeping cow and cow shed, 1♀; same loc., 9.IX.1967, sweeping cow, 2♀.

Remarks. The specimens in the large series from Nam Poui River margin, Sayaboury Province, differ by having the wing pale spots decidedly larger and often confluent, especially the poststigmatic pale spot broadly connecting with the double pale spot over vein M_2, and the proboscis longer, proboscis/head about 0.80. However, the differences do not seem to warrant specific status.

28. **Culicoides (Culicoides) insignipennis** Macfie

Culicoides insignipennis Macfie, 1937, Ann. Trop. Med. Parasitol. **31:** 469 (♀; Malaya; fig. wing).

Biting habits. Wirth & Hubert (in prep.) record this species biting man in Brunei and attracted to carabao in the Philippines. I netted a single female by sweeping around horse stables in Ban Ky Sok, Laos.

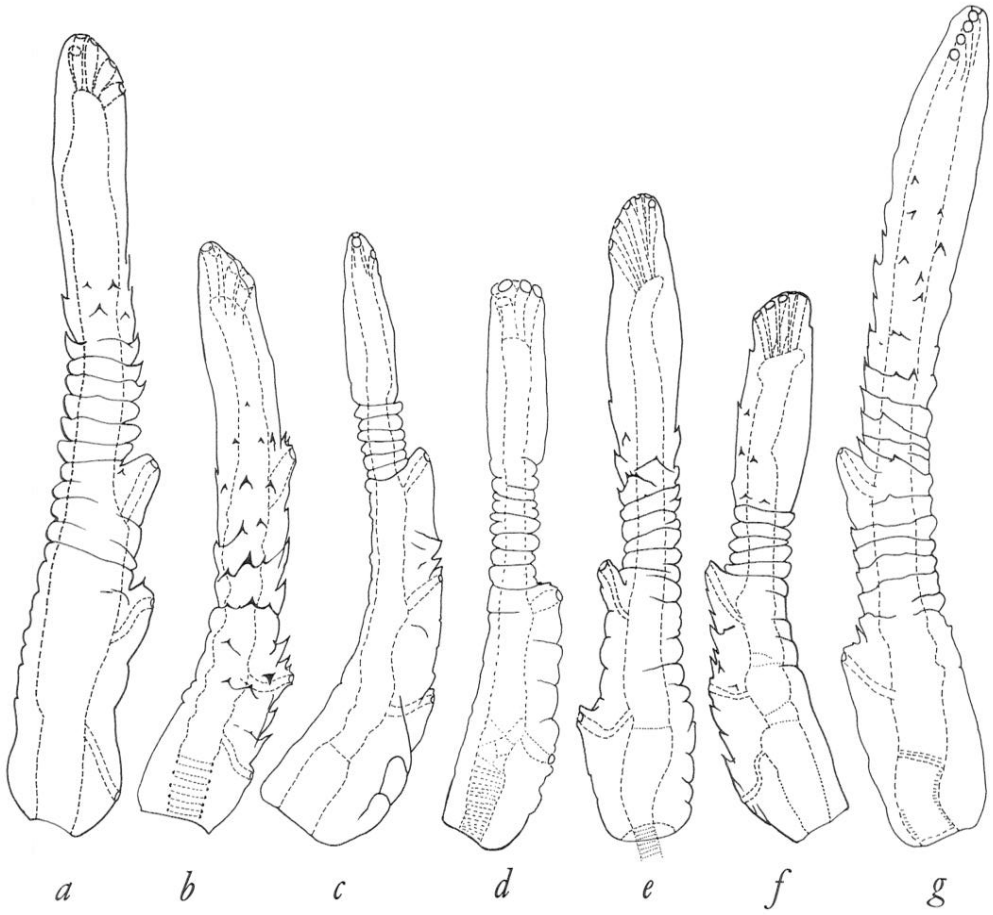

FIG. 18. *Culicoides* spp. pupal respiratory trumpets: **a,** *C. oxystoma*; **b,** *C. shortti*; **c,** *Culicoides* sp. J; **d,** *C. notatus*; **e,** *C. similis*; **f,** *C. huffi*; **g,** *C. geminus.*

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 1♀; Sayaboury, 300 m, 6.X.1967, light trap, 1♀; 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 1♀. VIENTIANE PROV: Ban Ky Sok, 30 km N of Vang Vieng, 950 m, 15.III.1968, sweeping around horse stables, 1♀; Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 6♀,1♂.

29. **Culicoides (Culicoides) lansangensis** Howarth, **new species** Fig. 17, 26f

♀. Length of wing 1.08 mm (1.01–1.15, n=3). *Head.* Eyes contiguous for 3 facetal diameters, bare. Antenna (Fig. 17a) with flagellomeres in proportion of 20:16:17:19:18:17:18:18:25:28: 32:32:50; sensilla coeloconica located on flagellomeres 3, 11–15; antennal ratio 1.13 (1.06–1.17, n=3). Palpal segments (Fig. 17b) in proportion of 8:29:31:14:15; palpal segment 3 moderately elongate, swollen in midportion, with large, round, moderately deep sensory pit at constriction at distal ⅓; palpal ratio 3.0 (2.9–3.0, n=3). Proboscis moderately short, proboscis/head 0.68 (0.65–0.69, n=3). Mandible (Fig. 17d) with 17–19 (n=3) small, triangular teeth; lacinia with 19–21 (n=2) small triangular teeth; epipharynx with bifid apex, each lobe with 3–

4 small, blunt teeth; apicolateral margin with series of 5 large, comblike teeth directed distad and 1 large retort spine proximad of series; hypopharynx broadly rounded, bladelike, with series of 15 comblike teeth along subapical and apical margin. *Thorax.* Thorax and legs (Fig. 17h) dark brown; all femora dark to tip; fore knee dark, fore tibia with narrow, indistinct subbasal pale band; mid tibia with narrow, indistinct pale basal band; hind tibia with distinct, narrow, basal pale band and indistinctly palish apex; hind tibial comb with 6 spines, 2nd from spur longest; claws simple. *Wing* (Fig. 17c, 26f). Pattern as figured; dark fumeus, darker anteriorly, with small contrasting pale spots; r-m pale spot small, divided by dark line along vein R, rounded on distal side, not much produced into base of cell R_5; poststigmatic pale spot small, covering distal ¼ of 2nd radial cell, not crossing vein M_1; distal pale spot in cell R_5 transverse, not crossing media; apex of wing dark; base of wing with small pale spot extending not much distad of level of anal angle; anal vein narrowly pale on basal ½; anal cell and anal angle dark except small round proximal spot in anal angle and 2 small distal spots; double pale spot in cell M_2 just anterior of mediocubital fork and just posterior of medial fork; vein M_2 with double pale spot in midportion; cells M_1 and M_2 each with small, round distal pale spot, not reaching wing margin; cell M_4 with small, round submarginal pale spot; macrotrichia moderately numerous in distal portion of wing confined to anterior ½ of cell R_5 distad of poststigmatic pale spot and distal portions of cells M_1 and M_2 and in longitudinal rows parallel to veins M_1 and M_2 in cells R_5, M_1 and M_2; costa long, extending 0.67 (0.65–0.68, n=3) length of wing; wing 0.46 (0.45–0.47, n=3) as wide as long. Halter very dark. *Abdomen.* Dark brown, tergum 3 rugulose, 2× as wide as long; 2 subequal or slightly unequal, well-sclerotized, oval spermathecae (Fig. 17e) present, measuring 61 μm × 45 μm and 54 μm × 40 μm, tapering to short, narrow sclerotized necks; rudimentary spermatheca and sclerotized ring present.

♂. Hind tibial comb with 5–6 spines; tarsal claws bifid. *Genitalia* (Fig. 17g). Sternum 9 with broad, shallow caudomedian excavation, membrane not spiculate; tergum 9 without apicolateral processes, caudomedian margin with deep, narrow apicomedian sulcus and broad, short, closely appressed, hyaline submedian lobes. Basistyle without median patch of differentiated spicules; ventral root poorly developed, dorsal root well developed, triangulate, sclerotized, apex acute; dististyle slightly curved, swollen at base, distal ½ subparallel, narrow rugulose apex expanded, subacute. Aedeagus with basal arch broad, shallow, extending less than ¼ total length of aedeagus; margin not heavily sclerotized, irregular, slightly concave; basal arms rodlike, heavily sclerotized, extending cephalad short distance, bent laterocephalad and tapered to subacute base; midportion expanded, lateral margin heavily sclerotized, weakly convex basally, weakly acuminate distally, slight shoulderlike margin in middle; internal peg present, variable, triangular, broad at base tapered to acute or broadly rounded, irregular apex; extending ⅓ way to basal arch; distal stem narrow, wider at base, elongate, extending ⅓ total length of aedeagus, with apical spherical knob; membrane laterad of distal stem of aedeagus with numerous conspicuous small spicules. Parameres (Fig. 17f) narrowly fused at base, basal arms thick, heavily sclerotized, narrowest in middle, expanded to wide, leaflike base articulating with dorsal root; basal bulb moderately sclerotized, not or slightly expanded, constricted near base, closely appressed to each other; distal portion thin, narrow, ribbonlike, attenuate to elongate, filiform apex with few fine hairs.

Immature stages. Unknown.

Breeding habitats. I reared this species once from debris collected from a tree wound in a fork of an unidentified tree, 1.7 m off the ground near Sayaboury, Laos. The material was collected 30.VII.1967, and 6 males emerged between 10.VIII and 17.VIII.1967, 3 males and 1 female emerged 18.VIII.1967, and 4 males and 1 female

emerged between 18.VIII.1967 and 12.IX.1967. Two males of *C. innoxius*, 1 male and 5 females of *C. tonmai*, and a male and female of *C. clavipalpis* were reared from the same material.

Distribution. Laos.

Holotype ♂, LAOS: SAYABOURY PROV: Sayaboury, 300 m, 30.VII.1967, reared, tree wound (F.G. Howarth) (BPBM 13,026). Allotype ♀, same data as holotype. 2♀,12♂ paratypes: same data as holotype, 1♀,12♂; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 1♀ (Howarth).

Remarks. *Culicoides lansangensis* is closely related to *C. innoxius* and *C. sumatrae* Macfie. It is easily distinguished from both of these species by the much darker wings, the dark wing tip and darker anal angle, the small pale spot over r-m crossvein, the shorter proboscis, the darker legs with indistinct pale bands, and in the male by the shape of the dorsal root and aedeagus and the presence of a spiculate membrane laterad of the distal stem of the aedeagus.

Etymology. The species name is derived from a former name for Laos, *Lansang*, literally meaning "the land of a million elephants."

30. **Culicoides (Culicoides) liui** Wirth & Hubert

Culicoides liui Wirth & Hubert, 1961, Pac. Insects **3:** 20 (♀; Taiwan; fig. wing, spermatheca, palpus).

Laos records. VIENTIANE PROV: Ban Ky Sok, 30 km N of Vang Vieng, 950 m, 14.III.1968, light trap, 1♀.

Remarks. This specimen differs from paratype material at USNM by having the wing not as pale and the apical pale band on the hind femur not as wide.

31. **Culicoides (Culicoides) peregrinus** Kieffer

Culicoides peregrinus Kieffer, 1910, Mem. Indian Mus. **2:** 191 (♀; India; fig. wing).

Immature stages. The pupa of *C. peregrinus* has been added to the key on the basis of the description by Mayer (1934) from material reared in Sumatra.

Breeding habitats. *Culicoides peregrinus* was not reared during this study. The breeding habitats have been recorded as shaded muddy pool margin in Malaya (W Malaysia) by Edwards (1922), in rice paddy ("Sawahs") in southern Sumatra (Indonesia: Sumatera) by Mayer (1934), from mud at the bottom of a culvert by Wirth & Hubert (in prep.), and at the margins of drains and streams in large numbers by Buckley (1938).

Biting habits. *Culicoides peregrinus* is an avid bloodsucker with a wide host range. Wirth & Hubert (in prep.) give numerous records from man, cattle, pigs, and poultry. I collected 7 specimens by sweeping a cow and a cow shed near Muong Pakse, Laos.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 1♀; Sayaboury, 300 m, 12.VIII.1967, sweeping, 1♂; same loc., 28.IX.1967, at light, 1♀,1♂; same loc., 6.X.1967, light trap, 10♀,1♂; same loc., 31.X–2.XI.1967, at light, 4♀,1♂; same loc., 3.XI.1967, at light, 2♀; same loc., 4–5.XI.1967,

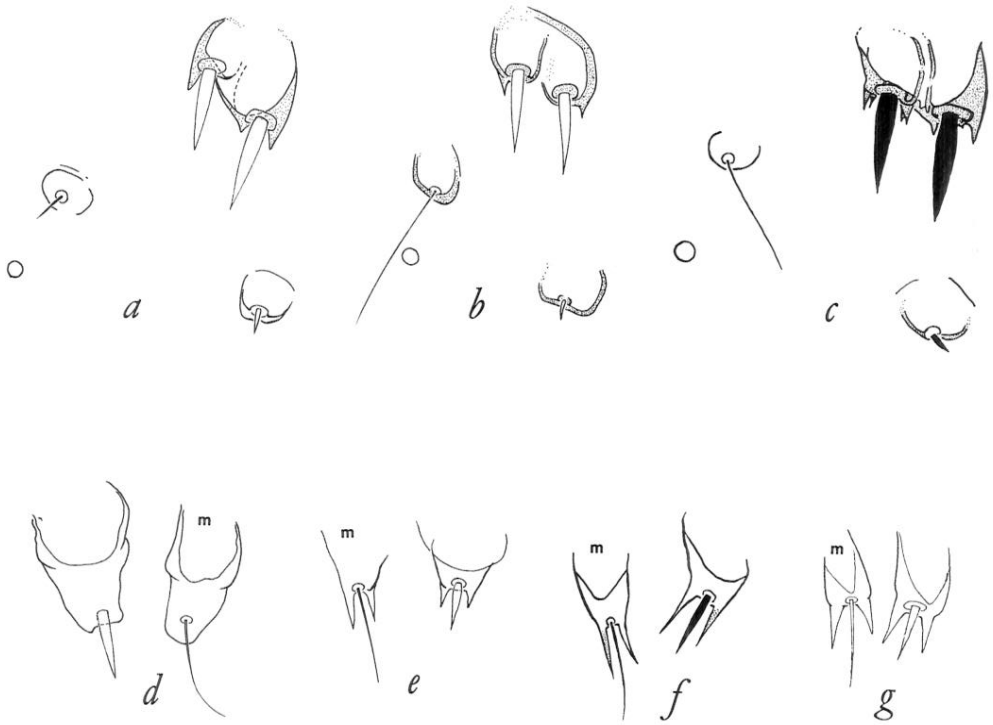

FIG. 19. *Culicoides* spp. pupal tubercles. **a–c,** *d* tubercles: **a,** *C. oxystoma*; **b,** *C. huffi*; **c,** *C. similis*. **d–g,** *lpm* tubercles (m = middle tubercle): **d,** *C. oxystoma*; **e,** *C. shortti*; **f,** *C. huffi*; **g,** *C. similis*.

at light, 2♀,1♂; same loc., 24.XI.1967, at light, 1♀,2♂; same loc., 27.XI.1967, at light, 1♂; same loc., 29.XI.1967, at light, 2♀,1♂; same loc., 30.XI.1967, at light, 1♂; same loc., 22–27.I.1968, at light, 1♀. VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 2♀. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 3♂; same loc., 3.IX.1967, sweeping paddy margin, 1♂; same loc., light trap in forest, 1♂; same loc., 5.IX.1967, sweeping cow and cow shed, 9♀; same loc., 6.IX.1967, sweeping cow, 1♀; same loc., 9.IX.1967, sweeping cow, 1♀,1♂; Muong Paksong, 1270 m, 6.IX.1967, at light, 2♀,3♂.

32. **Culicoides (Culicoides) recurvus** Delfinado

Culicoides recurvus Delfinado, 1961, Fieldiana Zool. **33:** 663 (♀, ♂; Philippines; fig. wing, eyes, palpus, spermathecae, ♂ genitalia).

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 15.V.1967, at light, 1♂; same loc., 12.VIII.1967, sweeping, 1♀; same loc., 27.VIII.1967, at light, 2♀,1♂; same loc., 28.IX.1967, at light, 1♀; same loc., 6.X.1967, light trap, 3♀; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 1♂; same loc., 31.X–2.XI.1967, at light, 6♀,4♂; same loc., 3.XI.1967, at light, 1♂; same loc., 4–5.XI.1967, at light, 6♀; same loc., 24.XI.1967, at light, 6♀,2♂; same loc., 25.XI.1967, at light, 1♀,1♂; same loc., 27.XI.1967, at light, 1♀; same loc., 29.XI.1967, at light, 2♀; same loc., 30.XI.1967, at light, 2♂.

Remarks. The males from Laos differ from Philippine material by possessing a larger, narrower apicomedian lobe on tergum 9.

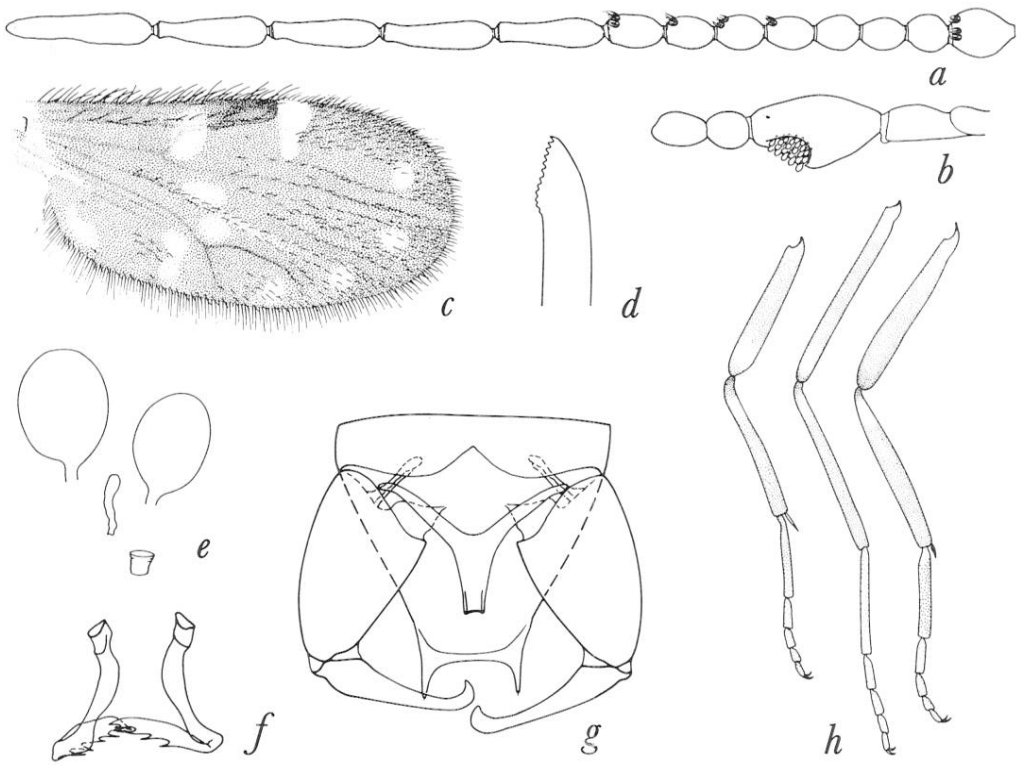

FIG. 20. *Culicoides arenicola:* **a,** antenna; **b,** palpus; **c,** wing; **d,** mandible; **e,** spermathecae; **f,** parameres; **g,** ♂ genitalia, parameres removed; **h,** legs.

33. **Culicoides (Culicoides) sumatrae** Macfie

Culicoides sumatrae Macfie, 1934, Ann. Trop. Med. Parasitol. **28:** 190 (♀; Selangor, Kuala Lumpur, Malaya).

Breeding habitats. Macfie (1934) described the male of *C. sumatrae* from a unique specimen reared from a *Polyporus* fungus at Fort de Kock, Sumatra. Wirth & Hubert (in prep.) record the rearing of this species from a rotting ginger in the jungle near Kuala Lumpur, Malaysia, by C. Munikumar. I reared a single female from a rotting arum axil, *Alocasia* sp., from shaded damp woodland in Moung Sayaboury, Laos, 300 m. The material was collected on 14.IV.1968, and the female emerged on 24.IV.1968. *Culicoides* sp. C was reared from the same sample. The reared specimen differs from more typical *C. sumatrae* in having darker legs and distinctly infuscated halteres.

Biting habits. I collected a single female biting man in Moung Vang Vieng. The bite was intensely painful. I also collected a female by sweeping cows in the evening near Ban Na Pheng.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 3♀; Sayaboury, 300 m, 27.VIII.1967, at light, 2♀; same loc., 14.IV.1968, reared, arum axil from shaded damp woods, 1♀;

22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 1♀. VIENTIANE PROV: Muong Vang Vieng, 250 m, 17.III.1968, biting, 1♀; Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 16♀,1♂; same loc., sweeping cows, 1♀. SEDONE PROV: Muong Pakse, 100 m, 3.IX.1967, at light in forest, 1♀; Muong Paksong, 1270 m, 6.IX.1967, at light, 7♀,3♂.

Subgenus **Avaritia**

34. **Culicoides (Avaritia) actoni** Smith

Culicoides actoni Smith, 1929, Indian J. Med. Res. **17:** 255 (♀; Assam; fig. wing, palpus, spermathecae).

Breeding habitat. Dyce (1982) reported rearing *C. actoni* from rotting fruits in open dry forests in northern Australia. I did not rear this species.

Biting habits. This species is an important veterinary pest in SE Asia and a potential transmitter of disease organisms. I collected it by sweeping bovines and a horse in Laos.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 18.II.1967, swept from zebu bull, 1♀; same loc., 28.IX.1967, at light, 2♀; same loc., 6.X.1967, light trap, 4♀,2♂; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 1♀; same loc., 27.XI.1967, at light, 1♀. VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 2♀. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 12♀,5♂; same loc., 6.IX.1967, sweeping cow, 1♀; Muong Paksong, km 43, Route 23, 1150 m, 6.IX.1967, sweeping horse, 1♀; same loc., Muong Paksong, 1270 m, 6.IX.1967, at light, 1♂.

35. **Culicoides (Avaritia) boophagus** Macfie

Culicoides boophagus Macfie, 1937, Proc. R. Entomol. Soc. Lond. B **6:** 116 (♀; Malaya).

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 22–27.I.1968, at light, 1♀,1♂; same loc., 2.IV.1968, at light, 1♀.

36. **Culicoides (Avaritia) brevipalpis** Delfinado

Culicoides brevipalpis Delfinado, 1961, Fieldiana Zool. **33:** 654 (♀; Philippines; fig. palpus, interocular area, wing, spermathecae).

Breeding habitat. Dyce (1982) reported rearing this species from bovid dung pats in tropical areas in northern Australia. I did not rear this species.

Biting habits. I collected 2 females by sweeping a cow in Pakse.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 2♀; Sayaboury, 300 m, 28.IX.1967, at light, 1♀; same loc., 7.X.1967, at light, secondary woods, margin of Nam Houng Riv, 1♀; same loc., 31.X–2.XI.1967, at light, 1♀; same loc., 24.XI.1967, at light, 1♀. SEDONE PROV: Muong Pakse, 100 m, 9.IX.1967, sweeping cow, 2♀.

37. **Culicoides (Avaritia) brevitarsis** Kieffer

Culicoides brevitarsis Kieffer, 1917, Ann. Hist.-Nat. Mus. Natl. Hung. **15:** 187 (♀; Australia).

Immature stages. The egg stage was described by Campbell & Kettle (1975) and the larval and pupal stages by Kettle & Elson (1976).

Breeding habitats. *Culicoides brevitarsis* apparently breeds only in bovine dung pats

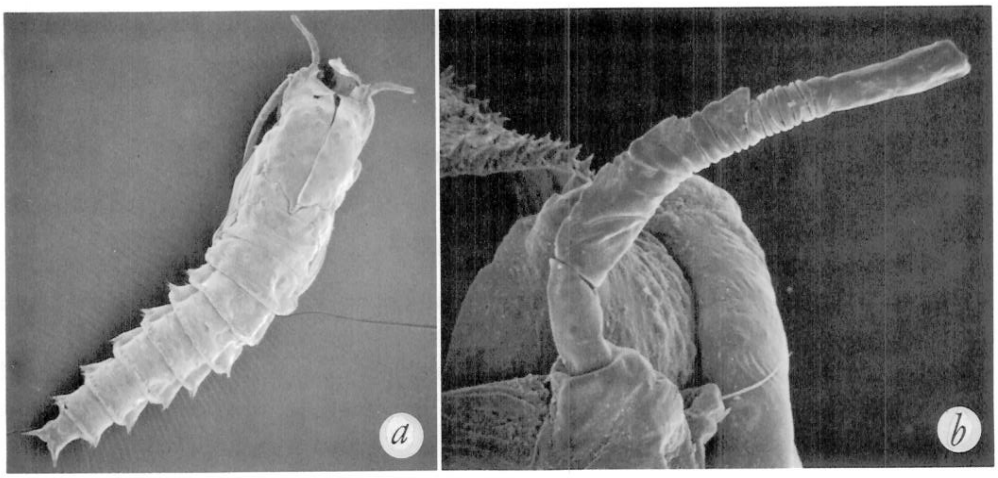

FIG. 21. *Culicoides arenicola* pupa. **a,** pupal exuviae, dorsal view; **b,** respiratory trumpet (*dl* tubercle bottom center).

(Cannon & Reye 1966, Campbell & Kettle 1976, Kettle & Elson 1976, Dyce 1982). Eggs are laid on the surface of cow pats which are less than 7 days old, i.e., before the drying crust becomes too thick. The larvae live within the dung. They move sluggishly and cannot swim if placed in water. Pupation occurs within the pat. Duration of the immature stages from oviposition to adult emergence is 11–24 d (Campbell & Kettle 1976). I did not rear this species.

Biting habits. This species is intimately associated with bovine livestock and is considered an important potential vector of several arboviruses among livestock (Muller et al. 1982). I netted females from cows at Pakse, Laos, both in the morning at 0800 h and in the evening at 1800 h.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 26.V.1967, crepuscular, 1♀; same loc., 30.XI.1967, at light, 1♀; same loc., 2.IV.1968, at light, 5♀. VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 1♀. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 1♂; same loc., 3.IX.1967, at light in forest, 1♀; same loc., 6.IX.1967, sweeping cow, 0800 h, 1♀; same loc., 9.IX.1967, sweeping cow, 1800 h, 4♀.

38. **Culicoides (Avaritia) fulvus** Sen & Das Gupta

Culicoides fulvus Sen & Das Gupta, 1959, Ann. Entomol. Soc. Am. **52:** 628 (♂; India; fig. wing, genitalia).

Biting habits. I collected a female *C. fulvus* by sweeping a cow and cow shed with a net in the evening at Pakse, Laos.

Parasites. A female collected at Pakse, Laos, on 1–2.IX.1967 has 2 large, undetermined nematodes curled within its abdomen. No deformity, common in hosts infected with mermithid parasites, can be seen in the midge.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 5♀; Sayaboury, 300 m, 15.V.1967, at light, 1♀; same loc., 6.X.1967, light trap, 2♀; same loc., 31.X–2.XI.1967, at light,

4♀; same loc., 6.XI.1967, at light, 1♀. SEDONE PROV: Muong Pakse, 100 m, 1–2.IX.1967, light trap, during light rain, 7♀; same loc., 3.IX.1967, at light in forest, 3♀; same loc., 7.IX.1967, sweeping cow and cow shed, 1900 h, 1♀.

Remarks. This species is confusingly similar to *Culicoides* sp. F. Except for the differently shaped spermathecae, *Culicoides* sp. F could be considered to represent pale specimens of *C. fulvus.*

39. **Culicoides (Avaritia) hui** Wirth & Hubert

Culicoides hui Wirth & Hubert, 1961, Pac. Insects **3:** 16 (♀; Taiwan; fig. wing, spermathecae, palpus).

Biting habits. I netted a female by sweeping horse stables in the evening at Ban Ky Sok, Laos.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 22–27.I.1968, at light, 1♀. VIENTIANE PROV: 30 km N of Muong Vang Vieng, Ban Ky Sok, 950 m, 14.III.1968, sweeping horse stables in evening, 1♀; Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 1♂.

40. **Culicoides (Avaritia) imicola** Kieffer

Culicoides imicola Kieffer, 1913, Voyage de Ch. Allauaud et R. Jeanel en afrique orientale 1911–1912. Diptera I, p. 11 (♀; Mombasa, British E Africa).

Breeding habitats. This species has been reported (often as *C. pallidipennis* Carter, Ingram & Macfie) as breeding in cow dung pats and in water saturated soils rich in organic matter, such as swamp mud mixed with organic detritus or dung (Nevill 1968, Braverman et al. 1974, Walker 1977b, Braverman 1978) in Africa and Israel. However, Walker (1977b) and Braverman (1978) found cow dung pats to be relatively unimportant as breeding sites for *C. imicola.* Braverman (1978) reported that the specimens reared by Nevill (1968) from cow dung belonged to an undescribed species closely related to *C. imicola.* Dyce (in litt.) found a highly productive breeding site in Israel and described it as a drainage from a cow shed where water, liberally enriched with cow manure, seeped down an embankment and became mixed with wet, but not submerged, soil.

Biting habits. I netted 2 females by sweeping a cow at 0800 h in Pakse, Laos. *Culicoides imicola* is suspected of being an important vector of bluetongue virus among sheep and cattle and possibly an important vector of ephemeral fever of cattle in Africa (Walker 1977a).

Laos records. SEDONE PROV: Muong Pakse, 100 m, 6.IX.1967, sweeping cow, 0800 h, 2♀.

41. **Culicoides (Avaritia) jacobsoni** Macfie

Culicoides jacobsoni Macfie, 1934, Tijdschr. Entomol. **77:** 215 (♂; Sumatra; fig. genitalia).

Breeding habitats. Wirth & Hubert (in prep.) report the breeding habitats of *C. jacobsoni* near Kuala Lumpur, Malaysia, as decaying jungle fruits, ginger flowers, decaying mushrooms, fungus on a rotting tree, and banana stems. Dyce (1982) reared

this species from similar habitats in tropical areas in Australia. I did not rear the species.

Biting habits. I netted 5 females by sweeping horse stables in Ban Ky Sok and 1 female by sweeping a horse near Muong Paksong.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 1♀; Sayaboury, 300 m, 6.X.1967, light trap, 6♀; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 1♀; 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 35♀. VIENTIANE PROV: Muong Vang Vieng, Ban Ky Sok, 30 km N of Vang Vieng, 950 m, 14,15.III.1968, sweeping horse stables, 5♀; Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 18♀,10♂. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 1♀; Muong Paksong, km 43, Route 23, 1150 m, 6.IX.1967, sweeping horse, 1♀.

42. **Culicoides (Avaritia) maculatus** (Shiraki)

Ceratopogon maculatus Shiraki, 1913, Taiwan Sotokufu Noji Shikenjo Tokubetsu Hokoku **8:** 296 (♂, ♀; Taiwan) (ref. not seen).
Culicoides maculatus: Tokunaga, 1937, Tenthredo **1:** 296 (combination).

Biting habits. I collected 1 female biting man out of doors at night at Paksong and 1 female by sweeping horse stables with a net in the evening at Ban Ky Sok.

Laos records. VIENTIANE PROV: 30 km N of Vang Vieng, Ban Ky Sok, 950 m, 14.III.1968, light trap, 8♀; same loc., sweeping horse stables, evening, 1♀; Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 78♀,29♂. SEDONE PROV: Muong Paksong, 1270 m, 6.IX.1967, at light, 6♀,2♂; same loc., biting man, 1♀.

43. **Culicoides (Avaritia) orientalis** Macfie

Culicoides orientalis Macfie, 1932, Ann. Mag. Nat. Hist. (10) **9:** 490 (♂, ♀; Malaya, India, Java; fig. wing, ♂ genitalia).

Breeding habitats. Buckley (1938) reported rearing *C. orientalis* from 2–3 week old cow manure piles in Malaysia; however, since there was some confusion concerning the identity of *Avaritia* spp. at the time, Dyce (1982) considered the record doubtful.

Biting habits. This species was one of the more common biting midges attacking cows in Laos. I netted a total of 11 females and 1 male by sweeping cows and cow sheds at Ban Na Pheng and Pakse, mostly at night (2100 h). I also collected 1 male apparently biting man at Paksong, Laos. Buckley (1938) considered *C. orientalis* to be potentially an important vector of *Onchocerca gibsoni* (Cleland & Johnson), a filarial parasite of cattle in SE Asia.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 10♀; Sayaboury, 300 m, 27.VIII.1967, at light, 1♀; same loc., 6.X.1967, light trap, 2♀; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 1♂; 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 7♀. VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 27♀; same loc., sweeping cows, 3♀. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 18♀,4♂; same loc., 3.IX.1967, at light in forest, 56♀,2♂; same loc., light trap in forest, 2♀; same loc., 4.IX.1967, sweeping cow, 2100 h, 1♂; same loc., 5.IX.1967, sweeping cow and cow shed, 2100 h, 6♀; same loc., 7.IX.1967, sweeping cow and cow shed, 1900 h, 1♀; same, sweeping cow, 1800 h, 1♀; Muong Paksong, 1270 m, 6.IX.1967, at light, 1♀; same data, "biting man," 1♀.

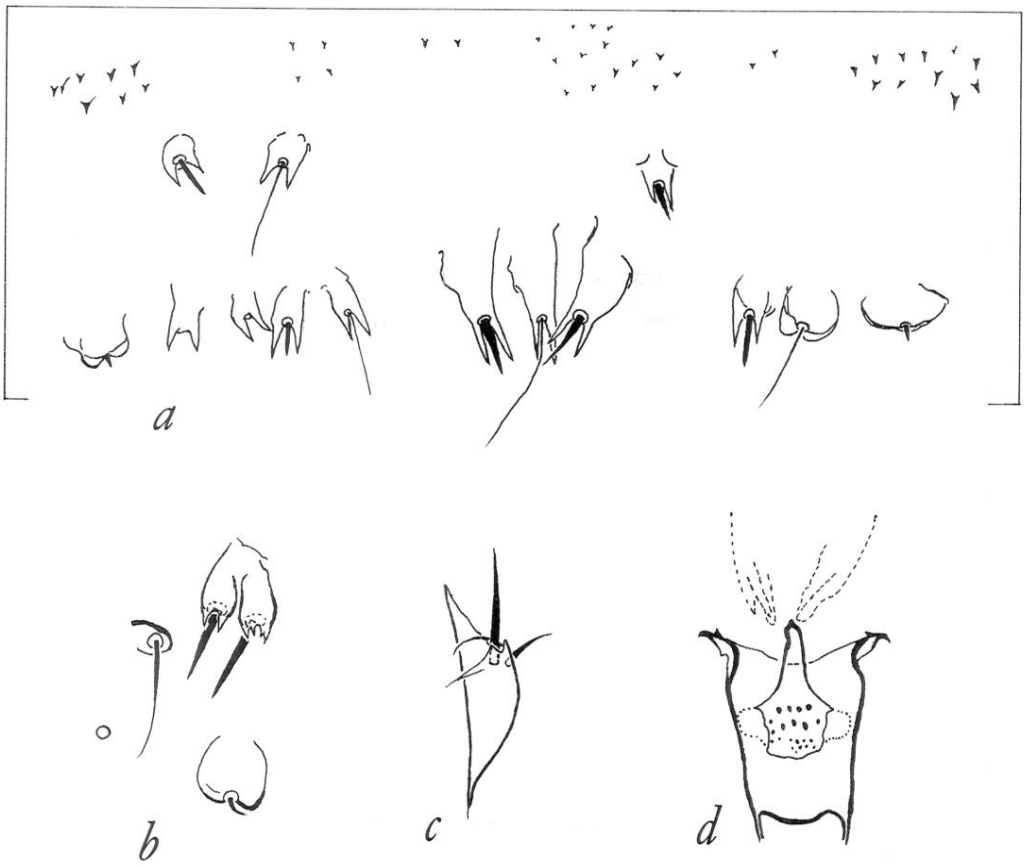

FIG. 22. *Culicoides notatus:* **a,** pupal abdominal tubercles (dorsal side on left); **b,** pupal *d* tubercles; **c,** pupal *ad* tubercles; **d,** adult ♀ cibarium.

44. **Culicoides (Avaritia) wadai** Kitaoka

Culicoides (*Avaritia*) *wadai* Kitaoka, 1980, Natl. Inst. Anim. Health Q. **20:** 14 (♀, ♂; Ryukyu Is; fig. ♀,♂ wings, ♀,♂ palpi, ♀ antenna, spermathecae, ♂ genitalia).

Breeding habitats. Dyce (1982) lists the breeding habitat for *C. wadai* as bovid dung pats in northern Australia.

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 1♀; Muong Sayaboury, 300 m, 25.XI.1967, at light, 1♀; same loc., 22–27.I.1968, at light, 1♀.

45. **Culicoides (Avaritia) species E**

Six females collected in a light trap at Ban Ky Sok, Laos, closely match Palearctic specimens of *C. chiopterus* (Meigen) vide Dyce (in litt.); because males are generally necessary to confirm identifications within the *obsoletus* group, this species remains

undetermined. This is the first record of a member of the *obsoletus* group from SE Asia.

Laos records. VIENTIANE PROV: 30 km N of Muong Vang Vieng, Ban Ky Sok, 950 m, 14.III.1968, light trap, 6♀.

46. **Culicoides (Avaritia) species F**

Breeding habitats. I reared 2 males of this species from old decomposed elephant feces collected from the forest floor in a shaded damp woodland habitat near Sayaboury, Laos. The material was collected 16.IV.1968, and the 2 midges emerged 28.IV.1968.

Parasites. A female collected in Sayaboury in January 1968 has a hypopus of a mite, *Myianoetus* sp. (Acari: Anoetidae) attached to its abdomen. The mite was identified by Mr Alan Dyce, CSIRO, McMaster Laboratory, Glebe, Australia and confirmed by Dr Robert Domrow, Queensland Institute of Medical Research, Brisbane, Australia. According to Alan Dyce (in litt.), the presence of this phoretic mite suggests that this species breeds in dung. It is probably not *M. dycei* Fain & Domrow, the hypopi of which are found on *C. brevitarsis* in northern Australia and Fiji (Fain & Domrow 1980), and New Guinea, Timor, and Java (Dyce, in litt.).

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 6♀; Sayaboury, 300 m, 28.IX.1967, at light, 1♀; same loc., 6.X.1967, light trap, 3♀; same loc., 22–27.I.1968, at light, 1♀; same loc., 16–28.IV.1968, reared from elephant dung, shaded damp woodland, 2♂. SEDONE PROV: Muong Pakse, 100 m, 1–2.IX.1967, light trap during light rain, 1♂; Muong Paksong, 1270 m, 6.IX.1967, at light, 1♂.

Remarks. This species and *C. fulvus* are quite similar (see *C. fulvus*), and they occur together in the same collections from widely scattered localities in Laos. It may be that more material will show the 2 forms to be conspecific, but the current specimens show slight but constant differences, as indicated in the key. It seems premature to describe this species on the basis of the current material.

Subgenus **Oecacta sensu lato**

ornatus group

47. **Culicoides (Oecacta) species G**

Laos records. VIENTIANE PROV: Vientiane, [150 m], 31.V–3.VI.1960, light trap 1♀ (S. & L. Quate).

Remarks. This species is being described by Wirth & Hubert (in prep.).

schultzei group

48. **Culicoides (Oecacta) oxystoma** Kieffer Fig. 18a, 19a, d

Culicoides oxystoma Kieffer, 1910, Rec. Indian Mus. **2:** 193 (♀; Calcutta; fig. proboscis, palpus).

Immature stages. *Pupa.* Total length 1.66 mm (1.49–1.94, n=10). Cephalothorax light brown,

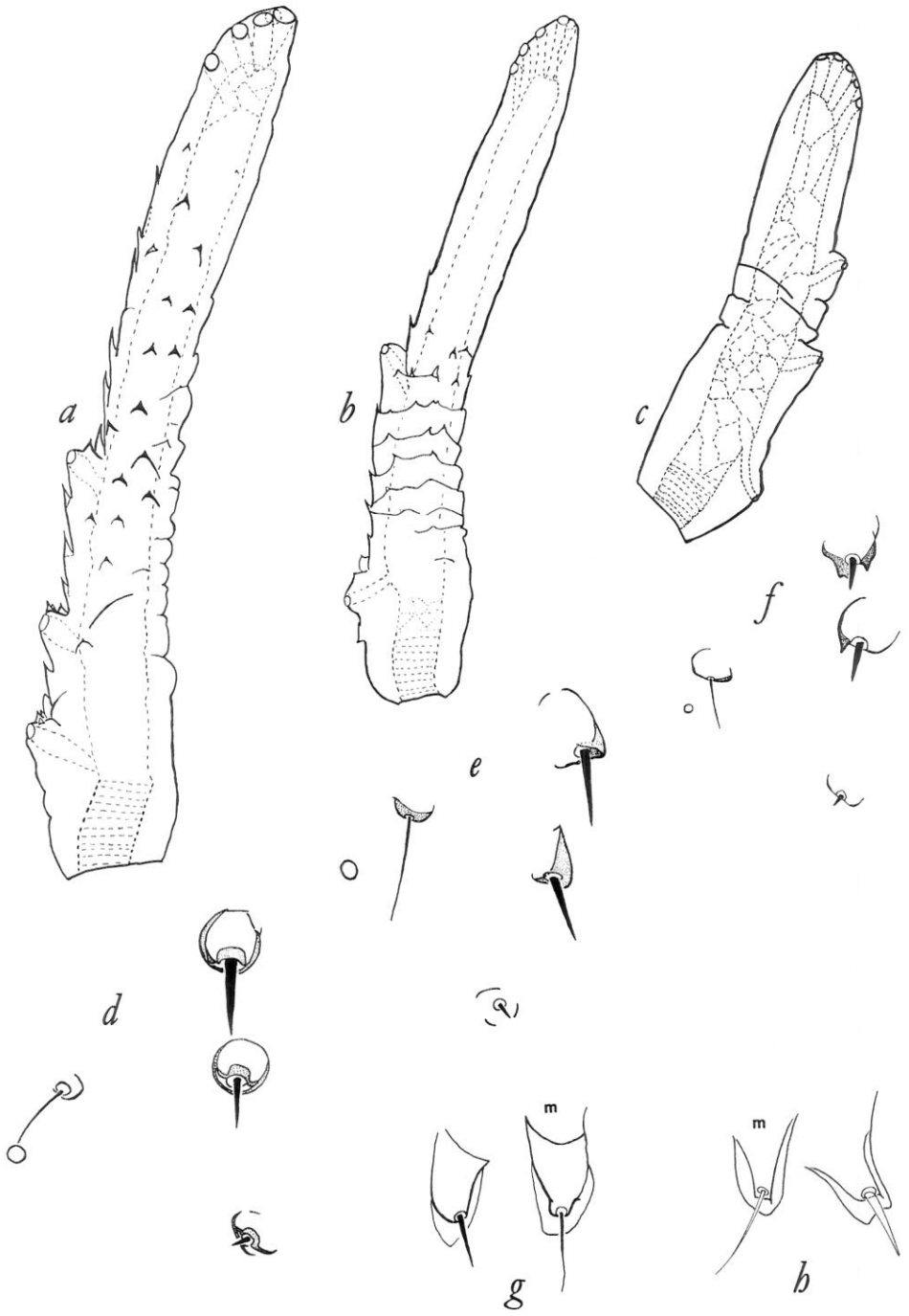

FIG. 23. *Culicoides* spp. **a–c,** pupal respiratory trumpets: **a,** *C. arakawae*; **b,** *C. guttifer*; **c,** *C. hegneri*. **d–f,** pupal *d* tubercles: **d,** *C. arakawae*; **e,** *C. guttifer*; **f,** *C. hegneri*. **g–h,** pupal *lpm* tubercles (m = *lpm 2*): **g,** *C. guttifer*; **h,** *C. arakawae*.

darker anteriorly; abdomen pale. *Respiratory trumpet* (Fig. 18a). Length 205 μm (179–224, *n*=10), 6.6× (5.9–7.3, *n*=10) longer than wide; basal ¼ concolorous with cephalothorax, midportion paler, apical ¼ infuscated to very dark; weakly curving, widest near base, mesal ⅓ conspicuously transversely annulated; similar but incomplete annulations extend basad of distal lateral spiracle; distal portion expanded, a few wide, sharp scales present just distad of annulations, rare elsewhere; 2–3 (*n*=20) lateral spiracles on large infuscated protuberances; tracheoles long and narrow; 4–7 (*n*=10) distal spiracles arranged along curving apical margin; pedicel less than ⅙ length of trumpet. *Operculum.* Longer than wide, length ♂ 160 μm (153–165, *n*=5) and ♀ 165 μm (148–183, *n*=5), width ♂ 122 μm (113–130, *n*=5) and ♀ 139 μm (127–148, *n*=5); lateral margin concave distad of lateral corner, then distinctly convex in midportion; light brown with numerous dark acute scales of 2 sizes, larger series, longest 12 μm long, in row along lateral margin and sparsely on disc, smaller series scattered evenly over disc basad to *am*'s, and on area between and basad of *am*'s; distal margin unmarked; *am* tubercle relatively small, dark, slightly produced to short, blunt apical tooth; *am* seta short, stout, 37 μm (35–40, *n*=10) long, 1.3× (1.1–1.5, *n*=5) in ♂ and 1.0× (0.9–1.1, *n*=5) in ♀ as long as distance between *am*'s. *Cephalothorax.* Setal measurements, Table 2; *dl* with 2 delicate setae, 1 subapical and 1 basal, and medium seta in basal cleft; *vm* with 2 subequal delicate setae; *vl* a low broad tubercle, 2 elongate delicate setae and inconspicuous sensillum present; *ad* with 2 minute apical teeth and 2 unequal apical setae arising close together, basal sensillum absent; *ad* sclerite with large conspicuous patch of small acute scales; *d* tubercles (Fig. 19a) *d 1* approximad and mesad of *d 2*, usually on same swelling; *d 1* and *2* each minutely bifid; *d 3* and *4* subequal, smaller, round apex not produced; *d 1, 3,* and *4* equidistant from each other, distance between ca. 1.5× length of *d 1* seta; *d 5* just posterior of *d 4*; dorsum surrounding *d 1* and *2* with large patch of small, dark, acute scales. *Abdomen.* Tubercles *lpm 1* and *3* (Fig. 19d) and *lasm* not produced, tapered to rounded apical lobe, seta apical; *lpm 2* similar, apex usually somewhat truncate, seta arising from apical pit; *dasm 1* and *2, vpm 1, 2,* and *3,* and *dpm 1, 2, 3, 4,* and *5* broadly rounded, not or little produced to short, broad, apical lobe. Intersegmental membranes with minute papillae laterally; segments 2–8 sometimes with weakly infuscated transverse band on anteromedian margin dorsally; segments 4–7 with anterosubmarginal transverse patch of small acute scales dorsally, more numerous mesally, smaller patch ventrally, no scales laterally; segment 8 with anterosubmarginal band of scales encircling segment, scales fewer laterally. *Caudal segment.* Wide anterosubmarginal band of acute scales well developed, encircling segment; small patch on dorsal disc present, sometimes arranged in "V." Posterolateral processes with scales on inner, dorsal, and ventral surfaces; processes elongate, conical, slightly curving in dorsal view, inner margin shallowly concave; sometimes lightly infuscated on base, apical ⅓ blackened; diverging 73° (55–90°, *n*=10).

Breeding habitats. *Culicoides oxystoma* breeds in a wide variety of muddy habitats and occasionally in rotting organic material. It displays a wide tolerance for organic pollution. The species has been most commonly reared from exposed mud at the margins of muddy pools (Patton 1913, Edwards 1922, Wirth & Hubert in prep., and see the collection records below), as well as from drainage and irrigation ditches, rice paddies, and swamps (Buckley 1938, Kitaoka & Morii 1963, Wirth & Hubert in prep.). Wirth & Hubert (in prep.) also report it breeding in a rotting sisal tree. Sun (1974) reported the larvae to be aquatic to semiaquatic and either swimming eellike in water or burrowing slowly through the gelatinous artificial yeast–blood agar rearing medium. In laboratory culture the life cycle takes 28–32 days at 25–28 °C (Sun 1974).

I reared this species from pupae isolated from substrate samples from 12 collection sites in Laos. All of the sites were at the margins of small to large water bodies and had only a trace of, or no, vegetation, clay, or gravel. Four sites were partly shaded, and the other 8 were sunny. No specimens of *C. oxystoma* were reared from fully shaded water margins. All but 1 of the sites had a high proportion of silt, and most had small amounts (5–20%) of organic detritus. The samples varied greatly in amounts of sand, pollution, and wetness. *Culicoides oxystoma* was often the most common species reared from the samples and was associated with 6 other species of *Culicoides,* most commonly *C. huffi* with 6 sites in common. *Culicoides similis, C. guttifer,* and *C. hegneri* were associated with *C. oxystoma* at 2 sites each, and *C. arakawae* and *C. tenuipalpis* were reared from 1 site each. At 3 sites, *C. oxystoma* was the only species reared.

Biting habits. *Culicoides oxystoma* is a serious nuisance pest of cattle and other large mammals and is potentially an important vector of filariae and arboviruses. Buckley (1938) reported *C. oxystoma* to be the most common day-biting midge on cattle near Kuala Lumpur, Malaysia. Even though he found the percentage of infection of the filarial parasite *Onchocerca gibsoni* to be less than 1% in *C. oxystoma,* he felt that, since the landing rate of *Culicoides* on cattle often exceeds 500/h, a low percent infectivity could still produce a high parasitemia in the host. *Culicoides oxystoma* was the most abundant *Culicoides* collected at cows and cow sheds near Pakse, Laos.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 22.I.1967, reared, sunny stream margin, 1♀,1♂; same loc., 12.II.1967, reared, sunny stagnant backwater margin, 1♀,1♂; same loc., 16.IV.1967, reared, sunny backwater margin, 1♀,2♂; same loc., 23.V.1967, reared, partly shaded stream margin, 1♀; same loc., 30.V.1967, reared, buffalo footprint, sunny river margin, 1♀; same loc., 28.IX.1967, at light, 1♀; same loc., 16.XI.1967, reared, partly shaded backwater margin, 4♀,4♂; same loc., 330 m, 18.XI.1967, reared, sunny stream margin, 5♀,6♂; same loc., 300 m, 25.XI.1967, at light, 2♀; same loc., 330 m, 7.I.1968, reared, sunny backwater margin, 1♀,1♂; Muong Phieng, 400 m, 20.VIII.1967, reared, partly shaded rut margin, 14♀,13♂. VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 3♀; Vientiane, 11.III.1967, reared, sunny river margin, 13♀,13♂. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 1♂; same loc., 3.IX.1967, at light in forest, 3♀, 1♂; same loc., 4.IX.1967, sweeping cow, 3♀; same loc., 5.IX.1967, sweeping cow and cow shed, 3♀,1♂; same loc., 6.IX.1967, sweeping cow, 3♀,5♂; same loc., 7.IX.1967, sweeping cow and cow shed, 2♀,1♂; same loc., 8.IX.1967, sweeping cow, 6♀,4♂; same loc., 9.IX.1967, sweeping cow, 3♀,2♂; Muong Paksong, 1270 m, 6.IX.1967, at light, 1♀.

Remarks. A single male collected by sweeping a cow in Pakse fits Causey's description and illustration of *C. housei* Causey in that the parameres are much thickened and stronger distally, with a sharp bend, and without the curvature. I agree with Wirth (pers. commun.) however, that in the absence of more material this is an aberrant *C. oxystoma* specimen.

Culicoides oxystoma is quite closely related to *C. schultzei* (Enderlein), and the 2 species have frequently been confused. The pupae of *C. schultzei* have been described 2× from African material. There are no obvious characters differentiating my Laos specimens from the *C. schultzei* description given by Carter et al. (1920). However, Nevill (1969) stated that scales are absent from both the respiratory trumpet and the disc of the caudal segment in African *C. schultzei* and gave both of these characters

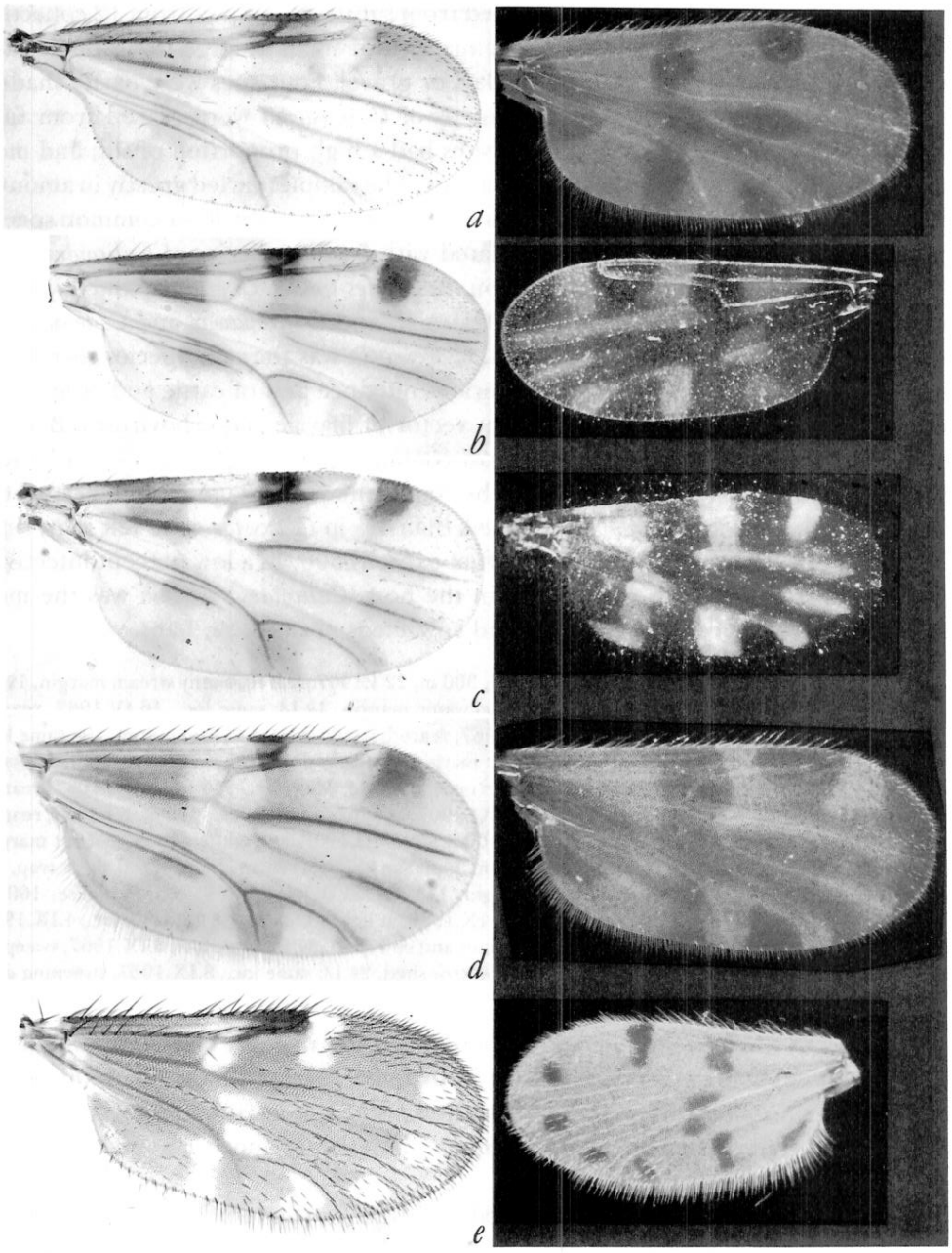

FIG. 24. *Culicoides* spp. ♀ wings, bright field left, dark field right: **a,** *C. nyungnoi*; **b,** *C. paksongi*; **c,** *C. nampui*; **d,** *C. tonmai*; **e,** *C. arenicola.*

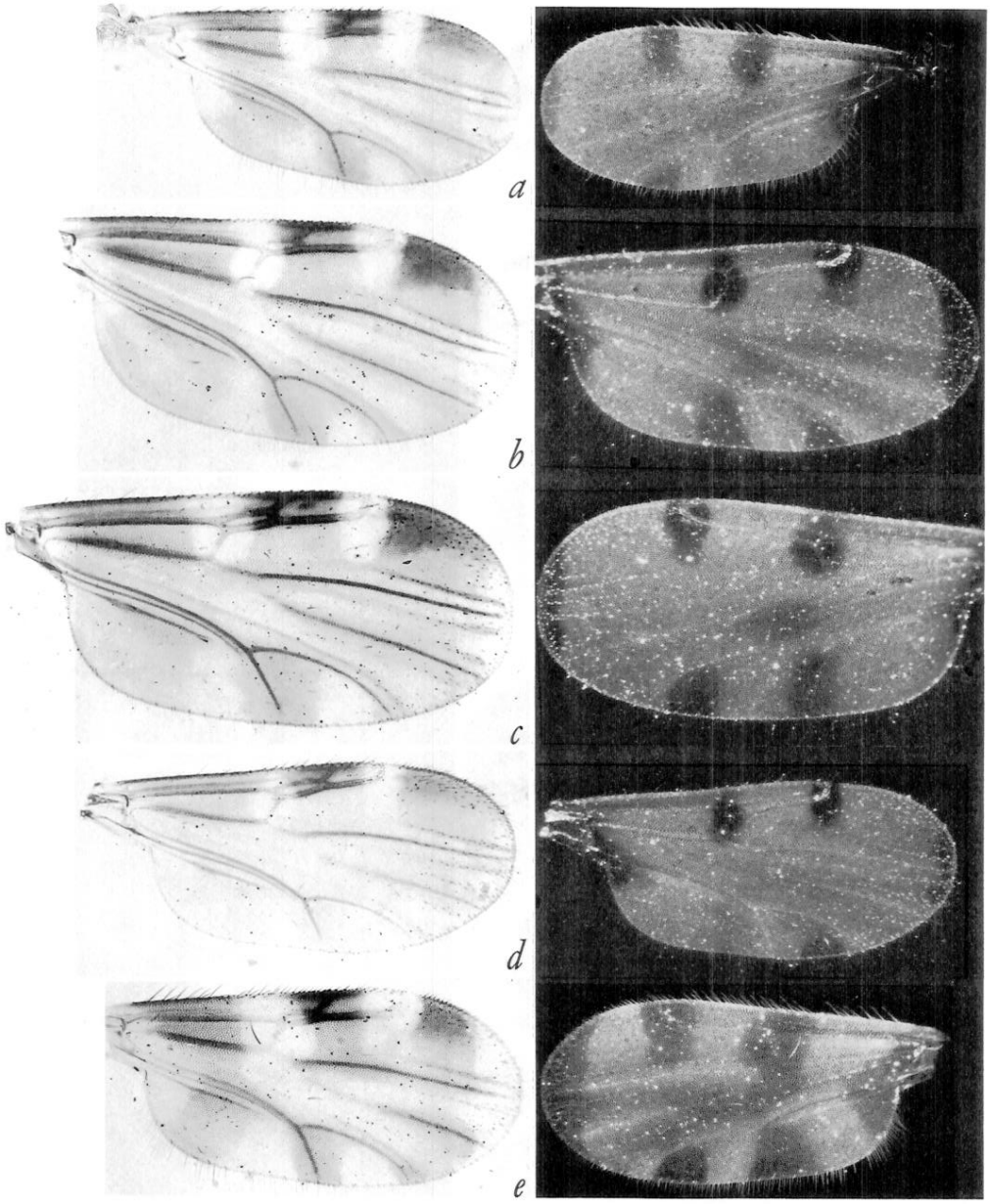

FIG. 25. *Culicoides* spp. ♀ wings, bright field left, dark field right: **a,** *C. hinnoi*; **b,** *C. huberti*; **c,** *C. laoensis*; **d,** *C. tamada*; **e,** *C. triallantionis.*

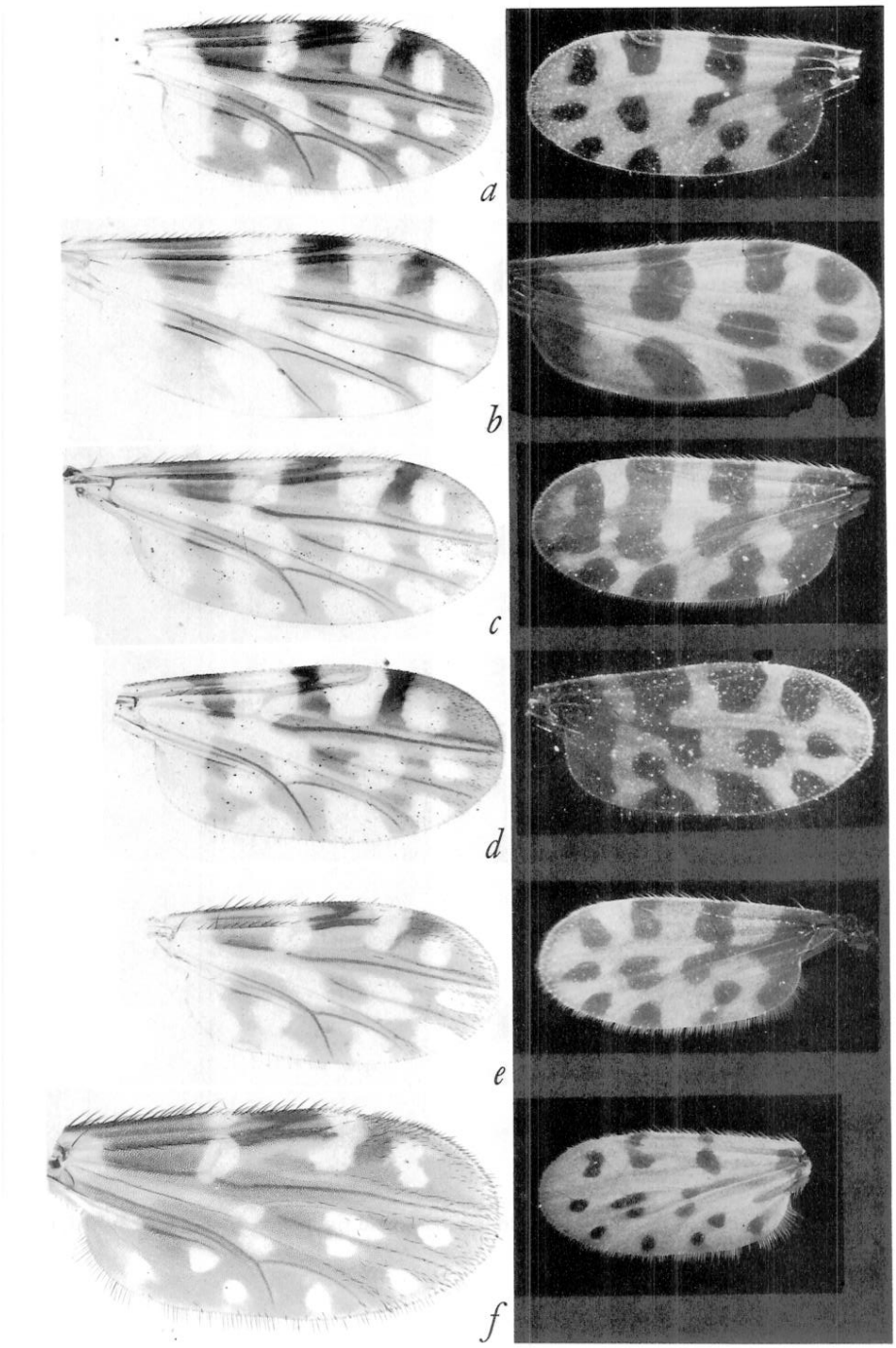

FIG. 26. *Culicoides* spp. ♀ wings, bright field left, dark field right: **a,** *C. kinari*; **b,** *C. kisangkini*; **c,** *C. nyakini*; **d,** *C. pikongkoi*; **e,** *C. spiculae*; **f,** *C. lansangensis.*

prominence in his key to species. Since the *C. oxystoma* specimens from Laos differ rather significantly in both of these characters, they provide further evidence that these 2 species are distinct.

49. **Culicoides (Oecacta) shortti** Smith & Swaminath Fig. 18b, 19e

Culicoides shortti Smith & Swaminath, 1932, Indian J. Med. Res. Mem. **25:** 183 (♀; Assam; fig. wing, palpus, spermathecae).

Immature stages. Pupa. Total length 1.60 mm (1.49–1.69, *n*=5). Cephalothorax brown, darker anteriorly; abdomen pale brown. *Respiratory trumpet* (Fig. 18b). Length 154 μm (146–158, *n*=5); 5.0–5.6× (*n*=5) longer than wide; basal ⅓ widest, infuscated, concolorous with cephalothorax; midportion narrowest, usually slightly paler; distal ⅓ to ½ very dark, slightly expanded subapically; curving, ventral surface concave; middle ⅓ with numerous conspicuous dark acute scales; a few incomplete, foldlike transverse annulations just basad of scales; 2–3 (*n*=5) lateral spiracles usually on large infuscated protuberances; tracheoles long and narrow; 3–5 (*n*=5) apical, and usually 1 subapical spiracles in same plane; pedicel ca. ¼ length of trumpet. *Operculum.* Longer than wide, 155 μm (153–158, *n*=3):141 μm (139–146, *n*=3) in ♂, and 141–151 μm (*n*=2):139 μm (*n*=2) in ♀; disc not greatly narrowed distad of lateral corners; lateral margins straight, parallel in midportion, distal ½ narrowed; operculum somewhat trapezoidal basad of lateral corners; light brown with dark, conspicuous, acute scales along lateral margin, longest 8 μm long; smaller blunt scales in irregular patch in midportion and smaller patch anteriorly on disc; ( ) marks scattered on disc and between and basad of *am*'s; distal area of disc acuductate; *am* tubercle very dark brown, weakly produced to blunt apical tooth, basal sensillum relatively large; *am* seta stout, 50 μm (45–54, *n*=5) long, length 2.5–2.9× (*n*=3) in ♂ and 1.0× (*n*=2) in ♀ distance between *am*'s. *Cephalothorax.* Setal measurements, Table 2; *dl* with 2 subapical setae and 1 in basal cleft; *vm* setae well developed, unequal, posterior one longer; *vl* tubercle present, with 2 unequal delicate setae and basal sensillum; *ad* tubercle broadly rounded, not produced, with 2 very unequal setae; *ad* sclerite with few papillae or ( ) marks; *d 1, 2,* and *3* and *d 1, 4,* and *5* in 2 straight lines as a V; *d 3* and *5* equidistant from *d 1,* distance nearly 3× length of *d 1* seta; *d 2* about 1× and *d 4* about 2× length of *d 1* seta from *d 1*; *d 1* and *2* very dark, produced, unequally bifid or trifid; *d 4* smaller than *d 3*; area between *d*'s nearly smooth; area mesad and anterior of *d*'s strongly ( ) marked. *Abdomen.* Strongly bifid *lpm*'s (Fig. 19e) with 2 large, triangular apicolateral teeth ca. ½ length of seta on *lpm 1,* seta arises between teeth; *lasm* strongly bifid, located directly anterior of *lpm 1* and on same level as *dasm*'s; *dasm 1* acutely bifid; *dasm 2* and *dpm 1* and *2* unequally bifid, teeth usually rounded, sharper on posterior segments; *dpm 3, 4,* and *5* and *vpm*'s low, broad, ridgelike, sometimes weakly produced, rounded. Intersegmental membranes minutely papillate and with broad, relatively deep median invagination dorsally and ventrally; segments 2–8 with transverse, dark, lightly infuscated anterosubmarginal band dorsally; segment 3 with anterosubmarginal band of acute scales encircling segment, band wider in midportion dorsally and ventrally, nearly interrupted laterad both dorsally and ventrally, a few scales present laterally on segments 4–7; a few larger acute scales located between *lpm 1* and *vpm 3* ventrally on segments 3–7; segment 2 with internal dorsomesal surface with numerous minute spines, 1 μm long, arranged in short rows. *Caudal segment.* With anterosubmarginal band of acute scales, well developed, encircling segment; patch of scales on disc dorsally and on ventral, mesal, and dorsal surfaces of posterolateral processes. Posterolateral processes short, wide, conical, diverging 75°; apex darkened.

Breeding habitats. I reared *C. shortti* from pupae collected from exposed mud at

the margins of 2 buffalo wallows near Sayaboury. The site of one was sunny with 50% silt, 20% vegetation (grass), 15% organic detritus, 0–10% clay, no gravel or sand, and was highly polluted and relatively wet. The site of the other was shady 50% of the time with 20% silt and clay, 15% sand, traces of organic detritus, and no vegetation or gravel, and it was polluted and relatively dry. No other *Culicoides* were reared from either of these sites, but at both sites *C. shortti* was associated with a *Stilobezzia* sp.

Biting habits. I collected this species several times biting man, including inside houses in the evening. It also appears to be an important pest of cattle in Laos. Buckley (1938) reported that *C. shortti* along with *C. oxystoma*, *C. orientalis* and *C. pungens*, were vectors of *Onchocerca gibsoni* among cattle in Kuala Lumpur, Malaysia.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 5.III.1967, in house, 1♀; same loc., 2.VI.1967, biting man, 1♀; same loc., 23.VIII.1967, reared, sunny buffalo wallow margin, 1♀; same loc., 28.IX.1967, at light, 10♀; same loc., 31.X–2.XI.1967, at light, 11♀,2♂; same loc., 29.XI.1967, at light, 1♀; same loc., 30.XI.1967, at light, 3♀; same loc., 330 m, 9.XII.1967, reared, partly shaded buffalo wallow margin, 1♀,3♂; same loc., 300 m, 2.IV.1968, at light, 3♀,2♂. VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 2♀,2♂. SEDONE PROV: Muong Pakse, 100 m, 3.IX.1967, at light in forest, 12♀,2♂; same loc., light trap in forest, 2♀; same loc., biting man in forest, 1♀; same loc., 4.IX.1967, sweeping cow, 1♀; same loc., 6.IX.1967, sweeping cow, 1♀; same loc., 7.IX.1967, sweeping cow and cow shed, 6♀; Muong Paksong, 1270 m, 6.IX.1967, at light, 1♀.

neavei group

50. **Culicoides (Oecacta) geminus** Macfie Fig. 18g

Culicoides geminus Macfie, 1937, Ann. Trop. Med. Parasitol. **31:** 472 (♀; Malaya).

Immature stages. Pupa. Total length 2.01 mm. Cephalothorax chocolate brown, darker anteriorly; abdomen brown. *Respiratory trumpet* (Fig. 18g). Length 230 μm; 6.6× longer than wide; basal ¼ widest, concolorous with cephalothorax; middle ⅓ distinctly pale and constricted by foldlike annulations, some scalelike; numerous strong scales distad of midportion; apical 45% very dark, slightly inflated subapically; 2 lateral spiracles on large, infuscated protuberances, 1 just basad of annulations and 1 mesally; tracheoles narrow; 6 distal spiracles approximated in line at apex, not in same plane as laterals; pedicel ¼ length of trumpet. *Operculum.* Longer than wide, 184 μm:158 μm; weakly excised distad of lateral corners, lateral margins straight, parallel in midportion; brown with numerous dark, conspicuous, acuminate scales on lateral margin and on disc, longest 19 μm long, fewer mesally; distal portion of disc with subapical longitudinal scratches, apex unmarked; area between *am*'s and basad of *am*'s ( ) marked; *am* tubercle very dark, slightly produced, apical margin rounded; *am* seta stout, 61 μm long, 5.1× as long as distance between *am*'s. *Cephalothorax.* Setal measurements, Table 2; *dl* tubercle with irregular apical margin with 3 unequal subapical delicate setae, 1 hidden in cleft; *vm* with 2 unequal setae, posterior one larger; *vl* tubercle moderately well developed, with 2 unequal setae, posterior one larger, sensillum present; *ad* tubercle large, with 2 unequal apical setae, tubercle weakly produced, margin rounded; *d 1, 2,* and *3* and *d 1, 4,* and *5* in more or less 2 straight lines as "V"; *d 2* ½ the length of *d 1* seta from *d 1*; *d 3* 2.5× length of *d 1* seta from *d 1*; *d 5* ca. 4× length of *d 1* seta from *d 1*; *d 4* closer to *d 5* than *d 1*; *d 3* and *4* subequal; *d 1* and *2* with 2–4 small, unequal, apical teeth; *d 1* seta longer than *d 2*; dorsum of cephalothorax nearly all ( ) marked, except a few patches of acute scales anteriorly; area

between *d 3, 4,* and *5* smooth. *Abdomen.* Strongly produced *lpm*'s with apical margin with wide, crownlike row of 6–9 large triangular teeth, longer teeth about ⅓ length of *lpm 1* seta; *lpm*'s with acute scales; *lasm* located ventrolaterally just posterior of segment midline, apical margin with 2–3 small triangular teeth; *dpm 1* produced, apical margin irregularly serrate; *dasm 1* and *2, dpm 2,* and *vpm 2* and *3* with broadly rounded apices; *vpm 1* and *dpm 3, 4,* and *5* with ridged apices. Intersegmental membrane weakly papillate laterally; segments darker along mesal anterior margin; segments 4–7 with wide anterosubmarginal band of small acute scales, well developed, encircling segment, more numerous mesally; anterior submarginal sensilla porelike, peg apparently absent; a large patch of acute scales dorso- and ventrolaterally near and on *lpm*'s; segment 8 with small patch of scales on dorsomedian disc, lacking patch of scales posterolaterally. *Caudal segment.* With wide, well-developed anterosubmarginal band of acute scales encircling segment and large, V-shaped patch on disc dorsally and on ventral and mesal surfaces of posterolateral processes. Posterolateral processes weakly diverging, 40°; conical, elongate, blackened on distal ½.

Breeding habitats. I reared *C. geminus* 3×, a single specimen each from 2 sunny buffalo wallow margins and a partly shaded stream margin in a rice paddy. One wallow was located at the edge of a shallow fish pond in a fallow rice field. The exposed mud at the margin consisted of ca. 70% clay and a trace of vegetation (grass), 10% silt, 5% organic detritus, and no gravel or sand. The site was highly polluted and moderately wet. The other wallow was nearby and similar except that the substrate lacked vegetation and contained more silt and less clay. The stream margin consisted of a trace of vegetation, 10% organic detritus, a high level of silt and clay, and an unknown amount of pollution. *Culicoides huffi* was reared from the same habitat at the 2nd wallow.

Biting habits. Wirth & Hubert (in prep.) list records of this species biting man and frequenting cow sheds in Malaysia. I collected a female at Sayaboury by sweeping a zebu bull and another female near Pakse by sweeping a cow and cow shed.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 13.II.1967, reared, sunny buffalo wallow margin, 1♂; same loc., 18.II.1967, swept from zebu bull, 1♀; same loc., 12.VIII.1967, sweeping, 2♀; same loc., 27.VIII.1967, at light, 1♀; same loc., 17.IX.1967, light trap, 1♀,5♂; same loc., 28.IX.1967, at light, 2♀,1♂; same loc., 6.X.1967, light trap, 1♀; same loc., 31.X–2.XI.1967, at light, 11♀,19♂; same loc., 3.XI.1967, at light, 5♀,5♂; same loc., 25.XI.1967, at light, 1♀,1♂; same loc., 27.XI.1967, at light, 1♀; same loc., 30.XI.1967, at light, 2♀; same loc., 2.IV.1968, at light, 2♀. SEDONE PROV: Muong Pakse, 100 m, 7.IX.1967, sweeping cow and cow shed, 1♀.

51. **Culicoides (Oecacta) okinawensis** Arnaud

Culicoides okinawensis Arnaud, 1956, Microentomology **21:** 118 (♀, ♂; Okinawa; fig. ♀ head, mouthparts, legs, hind tibial comb, spermathecae; ♂ genitalia; ♀,♂ antenna, palpus, wing, scutum).

Immature stages. Pupa. Total length 1.96 mm (1.83–2.04, *n*=7). Cephalothorax chocolate brown, slightly darker anteriorly; abdomen brown, darker on anterior mesal margin dorsally. *Respiratory trumpet.* Length 210 μm (198–228, *n*=8), 5.9× (5.5–6.6, *n*=8) longer than wide; widest on basal ⅓, narrowest in midportion, slightly widened subapically; dark brown, apex very dark, numerous dark scales in midportion, without annulations, a few weak incomplete transverse folds sometimes present basad of distal lateral spiracle; 2 (1–3, *n*=8) lateral spiracles on small distinct protuberances; tracheoles variable; 9 (8–11, *n*=8) distal spiracles, not in same

plane, sometimes 1 subapical spiracle; pedicel ca. ¼ length of trumpet. *Operculum.* Length: width, 1.76 μm (1.62–1.88, *n*=5):165 μm (155–172, *n*=5) in ♂; 186 μm (181–191, *n*=5):190 μm (184–198, *n*=5) in ♀; moderately narrowed distad of lateral corners, disc with lateral margin nearly straight, weakly narrowed distally, distal margin evenly convex; brown with numerous dark conspicuous scales on lateral margin and disc, larger and acuminate on lateral margin, longest ca. 12 μm long; a few scales usually present between *am*'s; disc acuductate subapically, apex unmarked; area between *am*'s and basad of *am*'s ( ) marked, a few ( ) marks on disc; *am* tubercle very dark, produced, distal margin serrate; *am* seta stout, 63 μm (50–73, *n*=10) long, 1.5× (1.1–1.8, *n*=5) in ♂ and 0.95× (0.81–1.1, *n*=5) in ♀ as long as distance between *am*'s. *Cephalothorax.* Setal measurements, Table 2; *dl* tubercle with 1 apical seta and 2 basal setae, 1 hidden in cleft; *vm* with 2 unequal setae, posterior one longer; *vl* tubercle with basal sensillum present and 2 unequal setae, posterior one larger; patch of scales anterolaterad of *vl*; *ad* tubercle large, weakly produced, bifid, with 2 unequal subapical setae; *ad* sclerite with patch of small acute scales; *d* tubercles *1, 2,* and *3* and *1, 4,* and *5* in more or less 2 straight lines as a "V"; *d 2* ca. ½ length of *d 1* seta from *d 1*; *d 3* ca. 2× length of *d 1* seta from *d 1*; *d 4* ca. 1× length of *d 1* seta from *d 1*; *d 5* ca. 2.5× length of *d 1* seta from *d 1*; *d 1* and *2* tubercles produced, each with 4–7 small triangular apical teeth; *d 3* and *4* subequal; area between *d* tubercles nearly smooth; area surrounding *d* tubercles strongly ( ) marked, a patch of acute scales anterior of *d*'s. *Abdomen.* Strongly produced *lpm*'s with 3–4 apical triangular teeth ca. ⅓ length of seta on *lpm 1,* more produced on posterior segments; *lasm* tubercle produced, usually with 2–4 apical teeth; *dasm 1* and *2* and *dpm 1* and *2* weakly produced, with 2 broadly rounded lobes, sometimes shieldlike; *dpm 3, 4,* and *5* ridgelike or weakly produced to rounded shield; *vpm 1, 2,* and *3* weakly produced, shieldlike or broadly rounded, ridgelike. Segments 3–7 with well-developed anterosubmarginal band of small acute scales, more numerous mesally both dorsally and ventrally; intersegmental membranes papillate. *Caudal segment.* With well-developed anterosubmarginal band of acute scales encircling segment and V-shaped patch of scales in midportion of dorsum. Posterolateral processes with numerous scales on dorsal, inner, and ventral surfaces; weakly diverging 40° (15–55°, *n*=4); apical ⅓ blackened.

Breeding habitats. I reared *C. okinawensis* from pupae isolated from stream margins near Sayaboury 3×. At collection sites of all 3, the substrate was loose, not compacted. The 1st site was a small (0.3 m²) patch of soft smooth mud in the sun at the water's edge of Houay La Stream. The samples contained more than 50% very fine sand, 15% silt, traces of algae and organic detritus, and no gravel or clay, and they were moderately polluted and very wet. *Culicoides okinawensis* was associated with *C. hegneri, C. huffi,* and *C. arenicola.* The 2nd site was a partly shaded small pool margin in a stream bed; it contained 20–40% sand and gravel, 5–35% silt, 5–15% leaf debris, 0–5% vegetation (roots), no clay, and was slightly polluted and relatively dry. *Culicoides huffi* and *C. arenicola* were also reared from this site. The 3rd site was 3 m from site 2 and was a partly shaded stream margin. The substrate was loosely packed fragments of up to 1 cm in diameter and was composed of more than 50% silt, 10–15% organic detritus, 10% clay, 1–5% sand, 0–5% vegetation (herb seedlings and roots), and traces of gravel; it was slightly polluted and wetter than the 2nd site. *Culicoides arenicola* was also reared from this site.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 6.X.1967, light trap, 1♀; same loc., 20 km N of Sayaboury, 400 m, 25,26.XI.1967, reared, sunny margin of Houay La Stream, 4♀,2♂; same loc., 2.XII.1967,

reared, partly shaded stream margin, 1♂; same loc., reared, partly shaded small pool margin, 2♀,3♂. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 1♀.

52. **Culicoides (Oecacta) species H**

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 30.XI.1967, at light, 1♀; 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 3♀.

Remarks. *Culicoides* sp. H will be described in Wirth & Hubert (in prep.).

similis group

53. **Culicoides (Oecacta) arenicola** Howarth, **new species** Fig. 20, 21, 24e

♀. Length of wing 0.94 mm (0.78–0.99, n=11). *Head.* Eyes very narrowly separated, bare. Antennal flagellomeres (Fig. 20a) in proportion of 18:11:11:12:13:13:13:15:28:30:29:30:40; antennae short, basal flagellomeres slightly longer than wide; sensilla coeloconica well developed on flagellomeres 3, 7–10, multiple on 3, 8–10; antennal ratio 1.46 (1.42–1.52, n=11). Palpal segments (Fig. 20b) in proportion of 7:18:25:8:11; palpal segment 3 greatly swollen in midportion, distal ⅓ excavated by large, subcircular, moderately deep sensory pit; palpal ratio 1.8 (1.7–1.9, n=11). Proboscis short, proboscis/head 0.58 (0.55–0.61, n=11). Mandible (Fig. 20d) with 10–14 small, irregular, triangular teeth; lacinia with ca. 14 well-developed, triangular teeth; cibarium with distinct oval patch of 14–17 large blunt spicules internally in midportion, and a large, distinct, subhastate internal sclerite, base of sclerite extending into pharynx. *Thorax.* Scutum, scutellum, postscutellum dark brown; scutum with distinct small pale areas (visible in slide mounts); pleuron brown. Legs (Fig. 20h) brown, all knees dark; fore and mid femora each with narrow, subapical pale band; tibiae each with distinct, narrow, subbasal pale band and dark apex; 4 spines in hind tibial comb, 1st from spur longest. *Wing* (Fig. 20c, 24e). Dark gray, small circular pale spots contrasting; 2nd radial cell entirely in dark spot; pale spot centered distad of r-m crossvein, crossvein lightly infuscated; poststigmatic pale spot not divided, transverse, sometimes dumbbell shaped, not reaching vein M_1; a subapical pale spot each in cells R_5, M_1, and M_2 not reaching wing margin; a distal transverse pale spot each in cell M_4 and anal cell; 2 round pale spots in cell M_2, 1 just anterior of mediocubital fork and 1 just posterior of M_{1+2} fork; small marginal pale spot in anal angle; base of wing dark; macrotrichia abundant in anterior ½ of cell R_5 distad of poststigmatic pale spot, near wing apex and in rows in cells R_5, M_1, and M_2 parallel to veins M_1, M_2, and M_{3+4}; 2 rows in cell M_2 nearly reaching base of wing; a few macrotrichia scattered in cells M_4 and anal cell; costa extending 0.56 (0.55–0.58, n=11) of wing length; wing 0.48 (0.47–0.49, n=11) as wide as long. Halter dark. *Abdomen.* Light brown; 2 large, slightly unequal, feebly sclerotized spermathecae (Fig. 20e) present, measuring 64 μm × 42 μm and 59 μm × 38 μm; oval, tapering to elongate, narrow, sclerotized necks, long rudimentary spermatheca present, measuring 31 μm × 5 μm; sclerotized ring present.

♂. With internal patch of cibarial spicules present, though reduced compared to ♀. *Genitalia* (Fig. 20g). Sternum 9 with moderately deep caudomedian excavation, membrane bare, tergum 9 trapezoidal, narrower distally, median cleft absent; apicolateral processes large, elongate, triangular, their length equal to ½ the distance between their bases. Basistyle with dorsal root spoon-shaped, elongate, heavily sclerotized; ventral roots well developed, connected mesally by hyaline rod, boat-hook shaped, caudal notch large and caudal projection angular; dististyle infuscated, swollen at base, tapering, distal ½ slender, apex slightly expanded, strongly bent to chisellike apex. Aedeagus well sclerotized, basal arms nearly straight, directed laterocephalad; distal portion triangular, with deep dorsal groove, truncate apex curving ventrad; mem-

brane caudad of aedeagus with numerous spicules. Paramere (Fig. 20f) with wide base with large notch for articulation with dorsal root; midportion rodlike, slightly swollen basally, distal thumblike process short, broader than long, distal arm bladelike, curving laterad, then ventrad, then mesad; caudal margin with comblike row of 6–8 elongate subapical teeth.

Immature stages. *Pupa* (Fig. 21a). Total length 1.50 mm (1.40–1.65, n=10). Light brown, cephalothorax darker than abdomen. *Respiratory trumpet* (Fig. 21b). Length 163 μm (153–181, n=10), 6.1× (5.8–6.5, n=10) longer than wide; widest near basal spiracle, basal ⅓ concolorous with cephalothorax; midportion pale, constricted just distad of distolateral spiracle by wide series of 6–10 distinct annulations; a few foldlike, incomplete annulations basad of distolateral spiracle; distal ⅓ not wider than annulations, tubelike, margin nearly straight, subparallel; lightly infuscated, apex narrowly dark, somewhat truncate, scales entirely absent; 3 (3–4, n=10) lateral spiracles, basal and usually mesal on small protuberances, distal one on large unpigmented protuberance; tracheoles variable, usually moderately short and wide; 5–6 (4–8, n=10) distal spiracles arranged as incomplete circle inside apical rim; plane of openings at nearly 90° from longitudinal axis, difficult to count in lateral view; pedicel ca. ⅓ length of trumpet. *Operculum.* Longer than wide, 152 μm (146–160, n=5):122 μm (111–130, n=5) in ♂, 154 μm (148–158, n=5):141 μm (136–146, n=5) in ♀; similar to *C. huffi*; lateral margin shallowly concave just distad of lateral corners and narrowed 70% (67–73, n=10), with inconspicuous convexity in midportion; light brown with numerous dark acute scales in single row along lateral margin and slightly smaller ones in transverse patch anteriorly on disc, longest ca. 14 μm long; numerous strong ( ) marks sometimes produced to blunt scales scattered on disc and extending between and basad of *am*'s and on bases of *am*'s; *am* tubercles dark, slightly produced, rounded; *am* seta stout, 55 μm (47–61, n=10) long. *Cephalothorax.* Setal measurements, Table 2; tubercles similar to *C. huffi*; *ad* tubercle weakly produced to blunt apical tooth; *ad* sclerite weakly ( ) marked; *d 2* tubercle approximad and laterad of *d 1*; *d 3* ca. 2× length of *d 1* seta from *d 1*; *d 4* ca. 1.5× length of *d 1* seta from *d 1*; *d 5* ca. 2.5× length of *d 1* seta from *d 1*; *d 4* tubercle somewhat smaller than *d 3*; *d 1* and *2* produced, shield with 2–3 acute apical teeth; dorsum between and surrounding *d*'s more strongly ( ) marked than in *C. huffi*. *Abdomen.* *Lpm*'s produced apically and laterally to form wide, curving shield, shield extending apically ⅓ length of *lpm 1* seta and laterally nearly to tubercle base; *lasm, dasm 1* and *2, dpm 1, 2, 3,* and *4,* and *vpm 2* and *3* produced, apical portion broadly rounded, shieldlike; *vpm 1* and *dpm 5* weakly produced, apex ridgelike or shieldlike, shields concolorous with abdomen; *vpm*'s larger than *dpm*'s. Intersegmental membranes papillate anteriorly and laterally; segments 2–8 darker anteromesally dorsally; segments 3–7 with anterosubmarginal band of acute scales well developed, encircling segment, more numerous mesally both dorsally and ventrally, nearly incomplete laterally, fewer on posterior segments; segment 8 with anterosubmarginal band complete, encircling segment. *Caudal segment.* Anterosubmarginal band of acute scales well developed, encircling segment; small patch of scales on disc dorsally. Posterolateral processes with scales on dorsal, inner, and ventral surfaces; diverging 86° (80–90°, n=5) in ♂ and 63° (55–70°, n=6) in ♀; blackened on distal ¼–⅓.

Breeding habitats. *Culicoides arenicola* is one of the most common species breeding along shaded sandy stream and river margins near Sayaboury. I reared this species from pupae isolated from water margins at 12 collection sites. Seven sites were along stream margins; 3 sites were along river backwater margins; and 2 sites were along river margins. Except for 1 stream margin, all sites were partly to fully shaded. The sites ranged from relatively unpolluted to heavily polluted. Eight sites contained large amounts of sand while 3 others contained lesser amounts; thus this species is psam-

mophilous. At the only site with little sand the substrate consisted of loose aerated aggregations of mud up to 1 cm in diameter. Two sites contained 50% vegetation consisting of a tangle of roots, and another 5 sites contained small amounts of vegetation. Most sites contained a moderate amount of silt and a small to moderate amount of organic detritus. Clay was present at only 3 sites and gravel was present at 4 sites. *Culicoides arenicola* was rare at the only site without shade, a small area (1.2 m^2) of very wet, soft, almost liquid mud at the water's edge; however, this site was cooled by the influence of a NW facing slope. *Culicoides arenicola* was associated with 9 other species of *Culicoides*, most commonly with *C. huffi*. Significantly, *C. arenicola* was not reared in association with *C. oxystoma*, the most common species reared from shore margins.

Distribution. Laos.

Holotype ♂, LAOS: SAYABOURY PROV: 15 km N of Sayaboury, Ban Nala, 400 m, 2.XII.1967, reared, partly shaded stream margin (F.G. Howarth) (BPBM 13,027). Allotype ♀, same data as holotype. 43♀,21♂ paratypes: SAYABOURY PROV: same data as holotype, 26♀,10♂; Sayaboury, 450 m, 19.II.1967, reared, partly shaded stream margin, 1♀; same loc., 330 m, 22.II.1967, reared, partly shaded stream margin, 1♀; same loc., 300 m, 16.IV.1967, reared, partly shaded backwater margin, 2♀, 1♂; same loc., 330 m, 18.XI.1967, reared, shaded stream margin, 1♀; same loc., 400 m, 18.XI.1967, reared, partly shaded margin of Houay La Stream, 2♀,2♂; same loc., 25.XI.1967, reared, partly shaded margin of Houay La Stream, 1♀,1♂; same loc., 25,26.XI.1967, reared, sunny margin of Houay La Stream margin, 1♀,1♂; same loc., 330 m, 6.I.1968, reared, partly shaded river margin, 3♀,2♂; same loc., 7.I.1968, reared, shaded backwater margin, 2♀,2♂; same loc., 300 m, 28.I.1968, reared, shaded river margin, 2♀,2♂; same loc., 4.III.1968, reared, partly shaded backwater margin, 1♀. (All Howarth.)

Culicoides arenicola is a typical member of the *similis* species group. It most closely resembles *C. distinctus* Sen & Das Gupta in having the undivided transverse poststigmatic pale spot and only 1 pale spot in cell M_1. Females of *C. distinctus* differ, however, in having a large, deep palpal pit opening by a small pore, an unornamented cibarium, yellowish halters, and paler leg markings. Males of *C. distinctus* have a pair of large subapical spurs on the aedeagus and an expanded, palmlike apex of the parameres.

It is worth noting that this species was not captured at either white or black lights, even when these lights were placed less than a few tens of metres from known breeding sites. Other species of the *similis* group are also rare in light trap collections.

Etymology. The species epithet is Latin and means "dweller in sand."

54. **Culicoides (Oecacta) clavipalpis** Mukerji

Culicoides clavipalpis Mukerji, 1931, Indian J. Med. Res. **18:** 1052 (♀; Calcutta; fig. wing, head, mouthparts, spermathecae).

Breeding habitats. I reared *C. clavipalpis* once from material collected from a tree wound in the fork of an unidentified tree, 1.7 m off the ground near Sayaboury. The material was collected 30.VII.1967, and a male and female emerged 18.VIII.1967. This species was associated with *C. lansangensis*, *C. innoxius*, and *C. tonmai*.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 30.VII.1967, reared, tree wound, 1♀,1♂. SEDONE PROV: Muong Pakse, 100 m, 3.IX.1967, at light in forest, 2♀.

55. **Culicoides (Oecacta) huffi** Causey Fig. 18f, 19b, f

Culicoides huffi Causey, 1938, Am. J. Hyg. **27:** 406 (♂, ♀; Thailand; fig. wing, ♂ genitalia).

Immature stages. Pupa. Total length 1.33 mm (1.31–1.35, *n*=5) in ♂, and 1.51 mm (1.45–1.63, *n*=5) in ♀. Cephalothorax light brown, darker anteriorly; abdomen palish. *Respiratory trumpet* (Fig. 18f). Length 146 μm (130–165, *n*=10), 5.7× (5.0–6.3, *n*=10) longer than wide; widest on basal ⅓, tapering to midportion, concolorous with cephalothorax; constricted in middle by narrow series of 2–7 distinct annulations (*n*=50, incomplete, foldlike in 1 specimen) just distad of distolateral spiracle, midportion palish; a series of incomplete, transverse folds just basad of distolateral spiracle, rarely ringlike; a few conspicuous acute scales always present (*n*=50) just distad of annulations and usually on lateral spiracular protuberances; distal ⅓ infuscated, darker than base, slightly expanded subapically; 3 (2–4, *n*=15) lateral spiracles, basal one and usually mesal one on small protuberances, distal one on large unpigmented protuberance; 3–7 (*n*=15) closely spaced distal spiracles, difficult to count, not in same plane; pedicel ¼ length of trumpet. *Operculum.* Longer than wide, 146 μm (141–151, *n*=5):122 μm (120–130, *n*=5) in ♂, 147 μm (141–153, *n*=5):132 μm (127–134, *n*=5) in ♀; lateral margin concave, narrowed 64% (61–70, *n*=10) just distad of lateral corners, with small convexity in midportion, nearly straight distad of convexity and narrowed distally, apex deeply convex; light brown with a row of conspicuous dark, elongate, triangular scales, largest ca. 10 μm long on lateral margin and smaller scales in transverse patch anteriorly on disc just distad of lateral corners; ( ) marks scattered on disc and basad of *am*'s; a small area mesally on disc and area between and distad of *am*'s nearly smooth; *am* tubercles dark, moderately produced, with 1–3 acute teeth; *am* seta stout, 56 μm (47–61, *n*=10) long, 1–2× longer than distance between *am* tubercles; operculum slightly narrowed just basad of lateral corners. *Cephalothorax.* Setal measurements, Table 2; *dl* with 3 setae, 1 hidden in basal cleft; *ad* produced, with 1–4 unequal large apical sharp teeth and 2 very unequal setae arising from separate apical protuberances; *ad* sclerite weakly ( ) marked; *vm* and *vl* similar to *C. notatus*; patch of acute scales laterad of *vl* tubercle; *d 1* and *2* (Fig. 19b) tubercles approximated, *d 2* laterad of *d 1*; tubercles *d 3* and *4* each ca. 2× length of *d 1* seta from *d 1*; *d 5* located nearly 3× length of *d 1* seta from *d 1*; *d 1* and *2* subequal, produced, 2–4 acute apical teeth; area between *d*'s with few ( ) marks; area surrounding *d*'s strongly ( ) marked. *Abdomen.* Strongly produced *lpm*'s (Fig. 19f) with bifid, elongate, acute apicolateral teeth, about as long as seta on *lpm 1*; *lasm, dasm 1,* and *dpm 1, 2,* and sometimes *3,* and sometimes *vpm 3* strongly bifid, with large, triangular, acute apicolateral teeth; *dasm 2, dpm 3* and *4,* and *vpm 2* and *3* usually with rounded apices or with 2 unequal rounded apicolateral lobes; *dpm 5* and *vpm 1* usually ridgelike; *vpm*'s and *dpm*'s often more strongly bifid on posterior segments. Abdominal segments 2–8 weakly infuscated anteromesally dorsally; intersegmental membranes weakly papillate; small patch of blunt scales sometimes present posteroventrolaterally between *lpm 1* and *vpm 3* on segments 3–6, weaker on posterior segments; anterosubmarginal band of acute scales present, nearly encircling segment, more numerous mesally both dorsally and ventrally, band weaker on posterior segments, narrowly incomplete laterally on segments 3–7, complete on segment 8; scales somewhat larger on venter than on dorsum; anterior submarginal sensilla peglike. *Caudal segment.* Anterosubmarginal band of acute scales well developed, encircling segment except for small gap dorsomesally; small patch of elongate acute scales on dorsal disc. Posterolateral processes with few to many scales on dorsal, mesal, and ventral surfaces; diverging 64° (50–80°, *n*=10); blackened on apical ½–¼.

Breeding habitats. Wirth & Hubert (in prep.) record the rearing of *C. huffi* near Kuala Lumpur, Malaysia, from a partially shaded stream bed and from soil at the edge of a grassy swamp where trash was dumped.

I reared *C. huffi* from pupae isolated from 21 different collecting sites in Laos, mostly stream, river, and stagnant backwater margins, and one buffalo wallow margin. *Culicoides huffi,* along with *C. oxystoma* and *C. arenicola,* is 1 of the commonest species breeding in soil and mud along water margins in Laos. Ten sites out of 21 contained greater than 30% sand and only 1 site lacked any sand. Thus, *C. huffi* appears to be psammophilous. The sites were also generally high in silt, 12 sites containing more than 30% silt, and the others containing small to moderate amounts. *Culicoides huffi* displayed a wide tolerance for high to low levels of pollution, but the limited data suggest a preference for polluted sites. The sites ranged from sunny to fully shaded. The amounts of vegetation, gravel, detritus, and clay were generally low or absent. *Culicoides huffi* was associated with 10 other species of *Culicoides,* most commonly with *C. arenicola.* The species was abundant at only 2 sites, both of which had a very loose, almost liquid, substrate.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 22.I.1967, reared, sunny stream margin, 1♀,2♂; same loc., 18.II.1967, reared, sunny buffalo wallow margin, 1♀; same loc., 21.II.1967, reared, partly shaded stream margin, 1♂; same loc., 330 m, 22.II.1967, reared, partly shaded stream margin, 6♀,8♂; same loc., 300 m, 4.III.1967, reared, partly shaded stream margin, 7♀,2♂; same loc., 16.IV.1967, reared, sunny backwater margin, 1♀,2♂; same loc., 30.VII.1967, sweeping, 1♂; same loc., 27.VIII.1967, at light, 1♀,1♂; same loc., 28.IX.1967, at light, 1♀; same loc., 6.X.1967, light trap, 2♀; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 1♂; same loc., 31.X–2.XI.1967, at light, 3♀; same loc., 24.XI.1967, at light, 1♀; same loc., 330 m, 18.XI.1967, reared, shaded stream margin, 1♀; same loc., 400 m, 25–26.XI.1967, reared, sunny margin of Houay La Stream, 4♀,6♂; same loc., 300 m, 27.XI.1967, at light, 1♀; same loc., 29.XI.1967, at light, 2♀; same loc., 400 m, 2.XII.1967, reared, partly shaded small pool margin, 1♀; same loc., 330 m, 6.I.1968, reared, partly shaded river margin, 2♂; same loc., 300 m, 7.I.1968, reared, shaded backwater margin, 2♀,2♂; same loc., reared, sunny backwater margin, 1♀; same loc., 4.III.1968, reared, partly shaded backwater margin, 2♀,2♂; 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 3♀. VIENTIANE PROV: Muong Vang Vieng, 250 m, 16.II.1968, light trap, river margin, 1♀,1♂; same loc., 13.III.1968, reared, sunny river margin, 4♀,3♂. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 3♀,1♂; same loc., 3.IX.1967, at light in forest, 5♀; same loc., light trap in forest, 5♀.

56. **Culicoides (Oecacta) notatus** Delfinado Fig. 18d, 22

Culicoides (*Oecacta*) *notatus* Delfinado, 1961, Fieldiana Zool. **33:** 648. (♀; Maco, Tagum, Davao, Philippines; fig. eye gap, palpus, wing, spermathecae).

Immature stages. Pupa. Total length 1.33 mm (1.23–1.40, *n*=3). Cephalothorax pale straw color, slightly darker anteriorly; abdomen pale. *Respiratory trumpet* (Fig. 18d). Length 136 μm (115–150, *n*=3), 5.8× (5.4–6.1, *n*=3) longer than wide; basal ⅙ widest, concolorous with cephalothorax; midportion pale, slightly narrowed distad of basal spiracle and with few incomplete transverse folds, constricted distad of distolateral spiracle by series of 1–8 annulations; distal ⅓ lightly infuscated with margins nearly straight, parallel, not or very slightly wider than annulations, scales entirely absent; 2 (*n*=3) lateral spiracles on small protuberances; tracheoles short, broad; 4 (*n*=3) distal spiracles not in same plane; pedicel 0.4× length of trumpet. *Operculum.* Longer than wide, 136 μm (132–139, *n*=3) long:118 μm (115–120, *n*=3) wide;

shape distinctive, lateral margin weakly concave and narrowed ca. 75% just distad of lateral corners; distinct narrow convexity in midportion of margin, distad of convexity margin nearly straight, narrowed distally, apex deeply convex; not or slightly narrowed basad of lateral corners; operculum pale brown with dark elongate triangular scales on lateral margin and anteriorly on disc, largest on lateral margin ca. 12 μm long; disc strongly ( ) marked, acuductate subapically; area between and basad of *am*'s weakly ( ) marked; *am* tubercle small, darker than operculum, weakly produced; *am* seta 60 μm (56–66, n=3) long, 1–2× distance between *am*'s. *Cephalothorax.* Setal measurements, Table 2; *dl* with 2 unequal delicate setae and 1 seta hidden in basal cleft; *vm* with 2 unequal setae, posterior one larger; *vl* tubercle present, with 2 unequal setae, posterior one larger; *ad* tubercle (Fig. 22c) weakly bifid apically, with 2 very unequal setae; *ad* sclerite weakly ( ) marked; *d* tubercles (Fig. 22b) *1* and *2* approximated, *d 2* just anterolaterad of *d 1* and smaller; *d 3* and *5* each less than 2× length of *d 1* seta from *d 1*; *d 4* smaller than *d 3*; *d 4* subequal distance from *d 1* and *d 5*; *d 1* and *2* strongly produced, acutely trifid; area between *d*'s weakly ( ) marked; dorsum just anterior of *d 1* strongly ( ) marked and with few scales. *Abdomen* (Fig. 22a). Strongly bifid *lpm*'s with acute apicolateral teeth ca. ¾ length of seta on *lpm 1*; *lasm, dasm 1* and *2, dpm 1* and *2,* and *vpm 3* strongly produced, acutely bifid; *dpm 3* and *4* usually unequally acutely bifid; *dpm 5* and *vpm 1* and *2* usually produced, with 2 rounded lobes; seta on *dasm 2* and *vpm 3* subuliform. Intersegmental membranes weakly papillate laterally; small patch of triangular scales sometimes present on segments 2–6 posterolaterally between *lpm 1* and *vpm 3,* patch smaller, less conspicuous on posterior segments; segments 2–7 with anterosubmarginal band of minute scales, more numerous mesally both dorsally and ventrally, interrupted laterally, band more complete on posterior segments; segment 8 with band nearly complete, scales widely spaced; abdomen unpigmented; anterosubmarginal sensilla peglike. *Caudal segment.* Narrow anterosubmarginal band of scales completely encircling segment; conspicuous patch of scales on dorsal disc. Posterolateral processes with scales; weakly diverging ca. 50° or less; apex acuminate, blackened on distal ¼.

Breeding habitats. I reared *C. notatus* from pupae isolated from 2 collecting sites at partly shaded stream margins. Both sites were relatively steep collapsed stream banks. At the 1st site, on the Houay La Stream near Sayaboury, the substrate contained a large amount of sand (5–50%), and smaller amounts of silt (1–20%), gravel (0–20%), organic detritus (0–20%), and clay (0–10%), and no vegetation. The site was relatively little-polluted and was moderately wet. *Culicoides arenicola* and *C. hegneri* were reared from the same site. At the 2nd site the substrate was very loosely packed, compact mud particles, well aerated, up to 1 cm in diameter. *Culicoides arenicola* and *C. okinawensis* were reared from the same site.

Laos records. SAYABOURY PROV: 20 km N of Sayaboury, 400 m, 25.XI.1967, reared, partly shaded margin of Houay La Stream, 1♂; same loc., 18.XI.1967, 2♀.

Remarks. Culicoides notatus, in common with most other SE Asian *similis*-group species, has a well-ornamented cibarium. In *C. notatus* the mouth (Fig. 22d) has a heavily sclerotized median sclerite produced distad into the cibarium. This sclerite is expanded and hastate distad and is ornamented with a patch of 10–13 conspicuous, well-developed, blunt spicules on the midportion internally within the cibarium, and 9–12 smaller, indistinct spicules submarginally.

57. **Culicoides (Oecacta) parviscriptus** Tokunaga

Culicoides parviscriptus Tokunaga, 1959, Pac. Insects **1:** 213 (holotype ♀; New Guinea, New Britain; ♀, ♂; fig. ♂,♀ wing, palpus, ♂ genitalia, ♀ antenna, spermathecae).

Breeding habitats. Wirth & Hubert (in prep.) report the breeding habitats of this species as treeholes and a rotting banana near Kuala Lumpur, Malaysia. It is closely related to *C. clavipalpis*, which is also a treehole breeder.

Laos records. SAYABOURY PROV: 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 1♀.

58. **Culicoides (Oecacta) similis** Carter, Ingram & Macfie Fig. 18e, 19c, g

Culicoides similis Carter, Ingram & Macfie, 1920, Ann. Trop. Med. Parasitol. **14:** 255 (♂, ♀; Gold Coast; reared, debris in canoe in river; fig. scutum, wing, ♂ genitalia).

Immature stages. Larva. The larva of presumably *C. similis* was described by Ingram & Macfie (1921) from African material.

Pupa. Total length 1.59 mm (1.49–1.76, n=10). Cephalothorax light brown; darker anteriorly; abdomen pale brown; a few specimens much darker. *Respiratory trumpet* (Fig. 18e). Elongate, length 172 μm (153–198, n=10), 6.1× (5.4–7.0, n=10) longer than wide; widest across basal lateral spiracle, basal portion concolorous with cephalothorax; midportion constricted by wide series of 4–9 (n=20) annulations, distinctly pale; distal ⅜ slightly swollen subapically, very dark; a few complete or incomplete annulations just basad of distolateral spiracle; a few dark scales just distad of midportion, rarely also basad; 2 (rarely 3, n=20) lateral spiracles on well-developed, infuscated protuberances; tracheoles long, slightly widened distally; 5–8 (n=11) distal spiracles, not in same plane as laterals; pedicel ¼ length of trumpet. *Operculum.* Longer than wide, 154 μm (151–158, n=5):132 μm (127–141, n=5) in ♂, 156 μm (148–162, n=5):143 μm (134–160, n=5) in ♀; narrowed 66% (61–72, n=10) distad of lateral corners; shape similar to *C. huffi*; brown with band of elongate triangular scales on lateral margin, largest ca. 12 μm long, in transverse patch anteriorly on disc and usually a transverse patch in midportion of disc; scales only slightly smaller on disc than laterally; ( ) marks as in *C. huffi*; *am* tubercles dark, weakly produced; *am* seta stout, moderately short, 49 μm (40–59, n=10) long. *Cephalothorax.* Setal measurements, Table 2; similar to *C. huffi*; *d* tubercles (Fig. 19c): *d 2* laterad and approximad to *d 1*; *d 3* 1.5–2× length of *d 1* seta from *d 1*; *d 4* nearly 2× length of *d 1* seta from *d 1*; *d 5* 2.5× length of *d 1* seta from *d 1*; *d 1* and *2* produced, 3–6 large triangular teeth along apical margin; area between and surrounding *d*'s usually more strongly ( ) marked than in *C. huffi*. *Abdomen.* Strongly produced *lpm*'s (Fig. 19g) with bifid, elongate, weakly acuminate apicolateral teeth nearly as long as seta on *lpm 1*; *lasm* strongly bifid; *dasm 1, dpm 1* and *2*, and *vpm 2* and *3* produced, with 1–2 unequal rounded apicolateral lobes, sometimes acute; *dasm 2, dpm 3, 4,* and *5*, and *vpm 1* ridgelike or weakly produced; *dpm*'s smaller than *vpm*'s. Intersegmental membrane papillate anteriorly and laterally; segments 3–7 darker anteromesally on dorsum; anterosubmarginal band of acute scales well developed on segments 3–7, encircling segment except for small gaps dorso- and ventrolaterally, more numerous dorsally, ventrally, and laterally, band weaker on posterior segments; band narrow but complete on segment 8; inconspicuous patch of blunt scales between *lpm 1* and *vpm 3* present on 1 or more abdominal segments. *Caudal segment.* Anterosubmarginal band of scales well developed, encircling segment; small patch of larger triangular scales on disc on dorsum. Posterolateral

processes with numerous scales on dorsal, mesal, and ventral surfaces; diverging 70° (55–80°, n=10); darkened on apical ⅓.

Breeding habitats. In West Africa, Carter, Ingram & Macfie (1920) reared *C. similis* from wet rotting debris taken from a canoe in the Densu River, and Ingram & Macfie (1921) reared numerous specimens collected from soft mud (sometimes semifluid) at margins of pools and puddles and a few collected from the sandy Densu River margin.

I reared *C. similis* from pupae isolated from 7 sites near Sayaboury, mostly sunny, polluted mud at water margins. Three of the sites were margins of sunny buffalo wallows, 2 were sunny stagnant backwater margins, 1 was a shaded stagnant backwater margin, and 1 was a sunny margin of a small stream on a gravel beach of the Nam Houng River. Most samples contained no vegetation, a high level of silt, little or no detritus or gravel, and none to moderate amounts of sand and clay. The samples were relatively dry. *Culicoides similis* was the most common species reared at buffalo wallow margins. It was associated with 8 other species of *Culicoides*, most commonly with *C. oxystoma* and *C. huffi*.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 9,12.I.1967, reared, sunny buffalo wallow margin, 5♀,11♂; same loc., 13.I.1967, reared, sunny buffalo wallow margin, 2♀; same loc., 17.I.1967, reared, sunny buffalo wallow margin, 1♀,1♂; same loc., 22.I.1967, reared, sunny stream margin, 4♀,3♂; same loc., 12.II.1967, reared, sunny stagnant backwater margin, 1♀,2♂; same loc., 27.VIII.1967, at light, 1♀; same loc., 17.IX.1967, light trap, 1♀; same loc., 28.IX.1967, at light, 2♀; same loc., 6.X.1967, light trap, 1♀,1♂; same loc., 31.X–2.XI.1967, at light, 5♀; same loc., 24.XI.1967, at light, 2♀; same loc., 30.XI.1967, at light, 1♀; same loc., 7.I.1968, reared, shaded backwater margin, 2♀,4♂; same loc., reared, sunny backwater margin, 1♂. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 1♂; same loc., 3.IX.1967, light trap in forest, 1♀.

59. **Culicoides (Oecacta) species I**

One female from Sedone Province, Muong Pakse, 100 m, 3.IX.1967, at light in forest (F.G. Howarth), differs from *C. clavipalpis*, collected at the same time, by the absence of the mesal pale spot in cell M_1, the finer, almost vestigial mandibular teeth, the absence of a median sclerite and spines in the mouth, and the presence of sensilla coeloconica on antennal flagellomeres 3, 7–10. No name is proposed because of the limited material.

60. **Culicoides (Oecacta) species J** Fig. 18c

Immature stages. Pupa. Total length 1.61 mm. Cephalothorax light brown, darker anteriorly; abdomen pale brown. *Respiratory trumpet* (Fig. 18c). Length 165 μm, 5.4× longer than wide; moderately curving, concave ventrally, widest near base, evenly tapering for ⅔ length, distinctly constricted just distad of distal lateral spiracle at distal ⅔, with narrow series of 6 distinct annulations, short apical portion not broader than annulations; trumpet pale brown, paler than cephalothorax, slightly infuscated at apex, scales entirely absent; with 4 lateral spiracles not on distinct tubercles; tracheoles long and slightly thickened; 4 distal spiracles, not in same plane as laterals; pedicel ca. 0.35× length of trumpet. *Operculum.* Longer than wide, 155 μm: 148 μm in ♀; narrowed 62% just distad of lateral corners, lateral margin with shallow convexity in midportion and nearly straight distally, narrowed apex deeply convex; light brown with

dark brown, elongate, curving triangular scales along lateral margin and anteriorly on disc, longest scale ca. 12 μm long; numerous strong ( ) marks on disc and between and basad of *am*'s; operculum little narrowed basad of lateral corners; *am* tubercle dark brown with small apical shield; *am* seta stout, 61 μm long, ca. 1× distance between *am*'s. *Cephalothorax.* Setal measurements, Table 2; *dl* with 2 very unequal setae and 1 curved seta hidden in basal cleft; *vm* and *vl* similar to *C. notatus*; *ad* tubercle slightly produced to rounded apical point, 2 very unequal setae on separate protuberances; *ad* sclerite ( ) marked; *d* tubercles *1* and *2* approximate, *d 2* laterad of *d 1*; *d 5* 2.5× length of *d 1* seta from *d 1*; *d 4* smaller than *d 3* and closer to *d 5* than to *d 1*; *d 1* and *2* subequal in size, produced, with short rounded, shieldlike apical margin; area between *d*'s nearly smooth; tumescent patch of strong ( ) marks just anterior of *d 1* and *2*, and a patch of acute scales anterolaterad of *d 2*. *Abdomen.* Strongly bifid *lpm*'s with apicolateral teeth as long or longer than spine on *lpm 1*; *lasm* strongly bifid; *dasm 1* and *2*, *dpm 1*, *2*, *3*, *4*, and *5*, *vpm 2* and *3*, and usually *vpm 1* with strongly produced, shieldlike apical margin; *dasm 2* and *vpm 3* setae subuliform; anterior submarginal sensilla peglike. Intersegmental membranes weakly papillate; segments 2–8 darker on anteromesal margin dorsally; anterosubmarginal band of scales present, confined to transverse patch anteromesally both dorsally and ventrally, absent laterally; without patch of scales posterolaterally on segment; segment 8 with narrow anterosubmarginal band of scales encircling segment. *Caudal segment.* Narrow anterosubmarginal band of scales encircling segment except for small gap dorsomesally; a patch of 5 larger scales on disc dorsally. Posterolateral processes with scales on dorsal, ventral, and mesal surfaces; diverging 80° but somewhat distorted by mount; apical ¼ blackened.

Breeding habitats. I reared *Culicoides* sp. J from a pupa isolated from a shaded stagnant backwater margin of the Nam Houng River. Samples of the substrate were taken from an exposed surface without vegetation from 0–3 cm above water level and consisted of 25% organic detritus, 25% silt, 15% very fine sand, and no gravel or clay. The site was moderately polluted and moderately moist. *Culicoides* sp. J was associated with *C. flavescens*, *C. huffi*, *C. arenicola*, and *C. similis*.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 7.I.1968, reared, shaded backwater margin, 1♀.

Remarks. *Culicoides* sp. J will be described in Wirth & Hubert (in prep.).

Subgenus **Meijerehelea**

61. **Culicoides (Meijerehelea) arakawae** (Arakawa) Fig. 2f, 23a, d, h

Ceratopogon arakanae [sic] [Matsumura, in litt.] Arakawa, 1910, Konchu-Sekai **14:** 411 (Japan).
Ceratopogon arakawae Arakawa: Matsumura, 1915, Konchu Bunrui Gaku Gekan, p. 56 (Japan).
Culicoides arakanae (Arakawa): Okada, 1941, J. Coll. Agric. Tokyo Imp. Univ., **15:** 14.
Culicoides arakawae: Arnaud, 1956, Microentomology **21:** 92 (♂, ♀; synonymy; fig. ♂,♀ scutum, wing, antenna, palpus; ♂ genitalia, ♀ mouthparts, legs, spermatheca, cerci).

Immature stages. The larva and pupa have been described by Tokunaga et al. (1961) from Japanese material.

Pupa. Total length 1.94–2.00 mm (*n*=2). Cephalothorax brown; abdomen light brown. *Respiratory trumpet* (Fig. 23a). Length 224 μm (*n*=2), 6.3× (*n*=2) longer than wide; brown base concolorous with cephalothorax, midportion slightly paler, distal ⅓ darker, apex blackened;

curving convex dorsad, widest on basal portion, slightly constricted in midportion, with numerous large wide scales, some forming incomplete annulations; width of scales often 0.3–0.5 width of trumpet; trumpet expanded subapically; 3 (2 on 1 side of ♂, n=2) lateral spiracles on large dark protuberances, distal one beyond midportion, and 5 distal spiracles; pedicel ¼ length of trumpet. *Operculum* (Fig. 2f). Longer than wide in ♂, 202 μm:167 μm; as long as wide in ♀, 188 μm:186 μm; not greatly narrowed distad of lateral corner; brown, disc evenly and thickly beset with small dark scales, larger along lateral margin, longest 9 μm long; scales extending basad to *am*'s and to area between *am*'s; area basad of *am*'s with numerous ( ) marks; *am* tubercle dark, slightly produced, rounded; *am* seta stout, 52–57 μm (n=2) long, 0.31 × distance between lateral corners, 0.75–1.3 × (n=2) longer than distance between *am*'s. *Cephalothorax.* Setal measurements, Table 2; *dl* with 3 setae, 1 in basal cleft; *ad* tubercle large, short, broad, with 2 setae, 1 stout, 25–34 μm long, and 1 medium, 12–13 μm long, pore absent; *ad* sclerite strongly set with blunt scales; *d* tubercles (Fig. 23d): *d 1* 2 × larger than *d 2*, 3 × larger than *d 3*, and 4 × larger than *d 4*; *d 4* reduced; *d 1* and *2* weakly produced, with 2 small rounded apical lobes; *d 1* seta 1.5 × length of *d 2* seta; *d 1, 2,* and *3* and *d 1, 4,* and *5* in 2 straight lines as a "V"; *d 2* greater than 1 × length of *d 1* seta from *d 1*; *d 3* ca. 3 × length of *d 1* seta from *d 1*; *d 4* closer to *d 5* than *d 1*; *d 5* ca. 3.5 × length of *d 1* seta from *d 1*; dorsum near *d*'s with numerous strong dark ( ) marks. *Abdomen. Lpm*'s (Fig. 23h) produced apically and laterally to base as broad, hyaline shield, produced apically ¼ length of stout seta on *lpm 1*, apical margin of shield shallowly concave; *lasm* similar to *lpm 1* but smaller and shield reduced; *vpm*'s with large shield, broader than long, length more than ½ length of seta on *vpm 1*; *dasm*'s small with broadly rounded shield; *dpm 1, 2, 3, 4,* and *5* smaller than *vpm*'s, each with large rounded shield. Intersegmental membranes anteriorly and laterally papillate; segments 2–8 with dorsal anterosubmarginal infuscated band, smaller on posterior segments; segment 4 with narrow anterosubmarginal band of small scales encircling segment, more numerous mesally both dorsally and ventrally and more numerous on posterior segments. *Caudal segment.* With strong scales in wide anterosubmarginal band encircling segment, in dorsomedian patch, and on posterolateral processes. Posterolateral processes elongate, slender, nearly straight, tapered to acute apex; slightly diverging, 20° in ♀ and 40° in ♂, infuscated on base, apical ⅔ blackened; ♂ more spinulose on caudal segment.

More material will be necessary to confirm the characters used to separate *C. arakawae* from *C. guttifer.* The Laos material agrees well with the description given by Tokunaga et al. (1961), except that the *am* seta is given as relatively shorter for the Japanese specimens.

Breeding habitats. Tokunaga et al. (1961) reported the breeding habitat in Japan to be submerged and exposed mud in paddy fields. Kitaoka & Morii (1963) elaborated on the breeding of *C. arakawae* in rice paddies and in irrigation ditches in Japan; larvae were most numerous in the surface mud, 1 cm deep, but also were found in fewer numbers up to 20 cm deep. They included notes on seasonal abundance. Wirth & Hubert (in prep.) report its breeding habitat near Kuala Lumpur, Malaysia, as mud at the edge of a partially shaded buffalo wallow. Sun (1974) established a breeding colony of *C. arakawae* and found that the life cycle under laboratory conditions at 25–28 °C took 24–28 d. The larvae actively swam in water with an eellike motion and also burrowed slowly through the gelatinous yeast–blood agar medium (Sun 1974). The larvae are predaceous and have been reared using the nematode *Rhabditis elongata* as prey (Kitaoka 1982).

I reared *C. arakawae* 2×, a single specimen from each of 2 sites. One female was reared from sunny exposed mud at a buffalo wallow margin in a pasture. The substrate was high in silt, clay, and level of pollution, and was relatively dry. At this site, *C. arakawae* was associated with *C. similis.* The 2nd rearing was from sunny exposed mud at the margin of a large stagnant backwater of the Melong River at Vientiane. The substrate was composed of 75% silt, 15% sand, 5% organic detritus, and no vegetation, gravel, or clay; it was relatively dry. More than 50 *C. oxystoma* were reared from the same 100 cm^3 sample.

Biting habits. *Culicoides arakawae* has a strong predilection for biting fowl and is considered an important pest of poultry in Japan (Tokunaga et al. 1961, Kitaoka 1978). The species is thought to be the most important vector of the protozoan *Leucocytozoon caulleryi,* which causes a serious disease of poultry in E Asia (Kitaoka 1978).

Laos records. SAYABOURY PROV: Muong Xieng Hon, 500 m, 25.IX.1967, at light, 1♀,3♂; Sayaboury, 300 m, 17.I.1967, reared, sunny buffalo wallow margin, 1♀; same loc., 15.V.1967, at light, 1♀; same loc., 6.X.1967, light trap, 1♂; same loc., 31.X–2.XI.1967, at light, 6♀; same loc., 27.XI.1967, at light, 1♀; same loc., 22–27.I.1968, at light, 1♀. VIENTIANE PROV: Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 3♀,2♂. VIENTIANE PROV: Vientiane, 150 m, 11.III.1967, reared, sunny river margin, 1♂. SEDONE PROV: Muong Pakse, 100 m, 1,2.IX.1967, light trap, light rain, 1♀,1♂; same loc., 3.IX.1967, at light in forest, 11♀,4♂.

62. **Culicoides (Meijerehelea) guttifer** (de Meijere) Fig. 2g, 23b, e, g

Ceratopogon (Culicoides) guttifer de Meijere, 1907, Tijdschr. Entomol. **50:** 209 (♀; Java; fig. wing).
Culicoides guttifer: Edwards, 1922, Bull. Entomol. Res. **13:** 163 (Malaya; reared, shady margin of muddy pools; fig. wing).

Immature stages. *Pupa.* Similar to *C. arakawae*; total length 1.88 mm (1.77–1.97, *n*=7). Cephalothorax brown; abdomen light brown. *Respiratory trumpet* (Fig. 23b). Length 207 μm (190–226, *n*=7), 6.1× (5.7–7.0, *n*=7) longer than wide; scales usually narrower than *C. arakawae,* usually less than 0.2 width of trumpet, usually confined to midportion; 2 (1–2, *n*=8) lateral spiracles on moderately large, dark protuberances; 5–6 (*n*=8) distal spiracles, rarely 1 subapical. *Operculum* (Fig. 2g). Length:width 179 μm (176–181, *n*=4):151 μm (141–162, *n*=4) in ♂, and 174 μm (172–179, *n*=3):179 μm (176–181, *n*=3) in ♀; scales as in *C. arakawae,* sometimes scales reduced basad of lateral corners; *am* tubercle dark, usually weakly produced apically to small blunt shield; *am* seta stout, 62 μm (52–68, *n*=6) long, length 0.39× (0.34–0.48, *n*=6) distance between lateral corners, and 1.8× (1.5–2.1, *n*=4) in ♂ and 1.3× (*n*=2) in ♀ distance between *am*'s. *Cephalothorax.* Setal measurements, Table 2; *ad,* longer seta 1.9× (1.7–2.0, *n*=4) longer than shorter seta; *d* tubercles (Fig. 23e): *d 1* and *2* produced with short broad apical shield; *d 1* seta 1.3× length of *d 2* seta; *d 1, 2,* and *3* and *d 1, 4,* and *5* as a "V"; *d 2* ca. ½ length of *d 1* seta from *d 1*; *d 3* nearly 3× length of *d 1* seta from *d 1*; *d 4* 2× length of *d 1* seta from *d 1*; *d 5* more than 3× length of *d 1* seta from *d 1*; dorsum near *d*'s usually not as strongly ( ) marked as *C. arakawae. Abdomen. Lpm*'s (Fig. 23g) with apical and lateral shield similar to *C. arakawae,* shield produced apically, usually greater than ⅓ length of *lpm 1* seta; *lasm, dasm*'s, *dpm*'s, and *vpm*'s with large broad apical shield; *vpm*'s larger than *dpm*'s. Segments 2–7 with anterosubmarginal band of acute scales more numerous mesally both dorsally and ventrally; band much reduced, nearly interrupted laterally, wide and complete on segment 8. *Caudal segment.* Anterosubmarginal band of scales stronger, scales larger than on preceding segments;

patch of conspicuous scales on middle of segment dorsally present or absent. Posterolateral processes with numerous scales; curving dorsad; diverging 80° (70–90°, *n*=3) in ♂ and 57° (40–75°, *n*=3) in ♀; infuscated on base, apical ⅔ blackened.

Breeding habitats. Edwards (1922) recorded the breeding habitat of *C. guttifer* near Kuala Lumpur, Malaysia, as "the margins of small muddy pools, well in the shade." Johannsen (1931) reported that *C. guttifer* was reared from a water pocket in an unidentified tree in southern Sumatra. His description and the anomalous rearing record suggests that the single adult specimen may have been misidentified (Wirth & Hubert, in prep.). Wirth & Hubert (in prep.) report rearing this species several times: from margin of a drainage ditch, mud among sweet potato plants, a partially shaded grassy swamp margin, and mud at the bottom of a culvert.

I reared this species 3× from sunny to shaded polluted exposed mud at pool and stream margins in and near Sayaboury, and 1× from a partly shaded stream margin 25 km N of Vang Vieng. It was a rare species relative to other *Culicoides* reared from the same sites. One site was a sunny margin of a stagnant backwater of the Nam Houng River; the substrate had a high silt content, 0–20% organic detritus and 5–15% fine sand. *Culicoides hegneri, C. oxystoma, C. similis,* and a *Stilobezzia* sp. were reared from the same site. Another was a mostly shaded wheel rut margin on a little-used jeep track in the forest; two 50 cc samples were taken from the top 1 cm of very fine wet silt which rested on a hard impervious layer of clay. *Culicoides oxystoma* and *C. tenuipalpis* were reared from the same site. Another was a shaded stream margin in a bamboo thicket and was composed of 5–10% silt, gravel, and organic detritus, and 5–30% sand and clay; it was highly polluted and relatively wet. *Culicoides flavescens, Culicoides* species D, *C. huffi,* and *C. arenicola* were reared from the same site. The partly shaded stream site north of Vang Vieng was a small stream in a forest and had 15% herbs and roots, 20–30% organic detritus and sand, 10% silt and was moderately polluted and wet. Only 1 *C. guttifer* was reared from this site.

Biting habits. Wirth & Hubert (in prep.) record a collection of this species from a poultry house in Singapore and suggest that the biting behavior of *C. guttifer* is similar to that of the related *C. arakawae.*

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 12.II.1967, reared, sunny stream margin, 1♂; same loc., 31.X–2.XI.1967, at light, 2♀,2♂; same loc., 330 m, 18.XI.1967, reared, shaded stream margin, 2♀,2♂; Muong Phieng, 400 m, 20.VIII.1967, reared, partly shaded rut margin, 1♀,1♂. VIENTIANE PROV: 25 km N of Muong Vang Vieng, 350 m, 12.III.1968, reared, partly shaded stream margin, 1♀; Muong Ban Keun, Ban Na Pheng, 180 m, 21.V.1968, light trap, 1♀,3♂. SEDONE PROV: Muong Pakse, 100 m, 3.IX.1967, at light in forest, 4♂.

63. **Culicoides (Meijerehelea) hegneri** Causey Fig. 2h, 23c, f

Culicoides hegneri Causey, 1938, Am. J. Hyg. **27:** 402 (♂, ♀; Thailand; fig. wing, spermatheca, ♂ genitalia).

Immature stages. Pupa. Total length 1.60 mm (1.50–1.73, *n*=10). Cephalothorax light brown; abdomen pale. *Respiratory trumpet* (Fig. 23c). Length 151 μm (136–170, *n*=10), 4.8× (4.2–5.4,

n=10) longer than wide; concolorous with cephalothorax except midportion slightly paler and apex and spiracular protuberances infuscated; trumpet weakly curving, outer margin concave; widest on basal portion, narrowed in midportion with few incomplete transverse annulations, scales absent, expanded subapically; 3 (2–4, n=10) lateral spiracles usually on prominent protuberances, 5 (4–6, n=10) distal spiracles (basal one in distal series often well separated from others); both lateral and distal spiracles arranged in 1 plane; pedicel ⅕ length of trumpet. *Operculum* (Fig. 2h). Slightly longer than wide in ♂, 141 μm (136–148, n=4):127 μm (127–130, n=4); as long as wide in ♀, 140 μm (134–148, n=6):142 μm (134–153, n=6); pale brown with large, dark, sharp scales, longest 7 μm long, in row on lateral margin and scattered on disc; numerous smaller scales on disc and extending basad to area between *am*'s; area basad of *am*'s with numerous strong ( ) marks, sometimes scalelike; *am* tubercle dark, medium-sized, weakly produced apically to rounded tooth; *am* seta short, stout, 26 μm (21–31, n=10) long; length 0.8–1.0 (n=4) (♂) and 0.7 (0.6–0.8, n=6) (♀) as long as distance between *am*'s. *Cephalothorax.* Setal measurements, Table 2; *ad* rounded, apex produced, bifid, apical teeth nearly as long as smaller apical seta; 2 apical setae, without basal sensillum; *d* tubercles (Fig. 23f): *d 1* and *2* subequal, apices produced, *d 1* with 2–3 unequal sharp apical teeth, *d 2* with sharp apical tooth or unequally bifid; *d 3* and *4* small, tubercles subequal; *d 1, 2,* and *3* in straight line, *d 2* about as far from *d 1* as length of *d 1* seta, *d 1, 4,* and *5* in straight line, *d 3* and *d 5* each about 6× length of *d 1* seta from *d 1, d 4* close to *d 5*; area between *d*'s with numerous strong ( ) marks; dorsum anterior of *d 1* with transverse patch of sharp scales. *Abdomen. Lpm*'s, *lasm, dasm*'s, *dpm 1* and *2* and *vpm 2* and *3* tubercles each strongly bifid with 2 large triangular apicolateral teeth and a seta arising between teeth; apical teeth on *lpm 1* and *3, dpm 2,* and *lasm* nearly as long as respective stout setae; *vpm 1, dpm 3, 4,* and *5* tubercles each a low broad ridge. Intersegmental membranes with minute papillae laterally; shallow dorsomedian invagination barely discernible; segments 2–8 with transverse, weakly infuscated band on anteromedian margin dorsally; segments 3–8 with relatively large patch of small sharp scales on anteromedian margin both dorsally and ventrally, and narrow scattered anterior band of sharp scales encircling segment; scales fewer and smaller laterally. *Caudal segment.* With wide anterosubmarginal band of strong small sharp scales encircling segment; without scales on disc and few or none on posterolateral processes. Posterolateral processes slender, conical, with longitudinal dorsal ridge, tapered to subacute apex; widely diverging, 115° (105–130°, n=10); pale on base, apical ½ or less blackened.

Breeding habitats. I reared *C. hegneri* from 6 sites near Sayaboury, Laos. The sites were all sunny or partly shaded exposed mud at the margins of large streams and rivers. Most samples had a high sand content (5–50%) and contained quite variable amounts of silt and organic detritus, had variable pollution levels, and had no or small amounts of vegetation, gravel, and clay. *Culicoides hegneri* was rare relative to other *Culicoides* species from all except 2 sites. It was the most common species from a partly shaded backwater margin of the Nam Thien River. The site contained no vegetation or gravel, small amounts of organic detritus and clay, 20–30% silt, and 40% sand; it was highly polluted and relatively dry. *Culicoides oxystoma* was also reared from this site. *Culicoides hegneri* was the only species of *Culicoides* reared from a site at a sunny exposed margin of the Nam Houng River. The site contained more than 50% sand and small amounts of vegetation (seedlings and small roots), silt, organic detritus and pollution, and no gravel or clay. It was also relatively dry. A *Stilobezzia*

sp. and another unidentified ceratopogonid were reared from the same site. At the other 4 sites *C. hegneri* was associated with *C. huffi*, and *C. arenicola*. *Culicoides okinawensis, C. notatus, C. oxystoma, C. guttifer, C. similis*, a *Dasyhelea* sp., and a *Stilobezzia* sp. were associated with *C. hegneri* at single sites.

Biting habits. Unknown; however, I collected 4 females by sweeping a cow with a net at Pakse, Laos.

Laos records. SAYABOURY PROV: Sayaboury, 300 m, 12.II.1967, reared, sunny backwater margin, 2♀,1♂; same loc., 6.X.1967, light trap, 1♀; same loc., 7.X.1967, light trap, secondary woods, margin of Nam Houng Riv, 9♀,15♂; same loc., 16.XI.1967, reared, partly shaded backwater margin, 9♀,6♂; same loc., 400 m, 18.XI.1967, reared, partly shaded big stream margin, 1♀; same loc., 26.XI.1967, reared, sunny big stream margin, 1♀; same loc., 300 m, 17.XII.1967, reared, sunny river margin, 6♀,3♂; same loc., sweeping river margin, 2♀; same loc., 4.III.1968, reared, partly shaded backwater margin, 2♂; 22 km S of Muong Phieng, 325 m, 29.II.1968, light trap, margin of Nam Poui Riv, 1♀. VIENTIANE PROV: Muong Vang Vieng, 250 m, 16.II.1968, light trap, river margin, 2♀,2♂. SEDONE PROV: Muong Pakse, 100 m, 6.IX.1967, sweeping cow, 4♀.

Subgenus **Beltranmyia**

64. **Culicoides (Beltranmyia) circumscriptus** Kieffer

Culicoides circumscriptus Kieffer, 1918, Ann. Hist.-Nat. Mus. Natl. Hung. **16:** 49 (Tunis).

Immature stages. Tokunaga (1937) described the larva and pupa of *C. circumscriptus* from Japan. Kettle & Lawson (1952) described the 4th-instar larva and the pupa from England; however, they were unable to separate the pupa of this species from *C. salinarius* Kieffer. *Culicoides circumscriptus* has been added to the key to pupae on the basis of the literature.

Breeding habitats. Tokunaga (1937) reared this species in Japan from small salt water pools on rocky seashore above the high tide. Kettle & Lawson (1952) record the larval habitat in Britain as mud devoid of vascular vegetation near brackish water, and an atypical series of adults reared from exposed mud in a farmyard. Becker (1958) found larvae common in salt marshes in Britain and gave an interesting account of their feeding behavior and response to light. Braverman et al. (1974) reared large numbers of this species from a wide variety of wet muddy habitats in Israel. They found it dominant at sites high in organic matter and low in dissolved oxygen.

Parasites. I collected 1 female from Sayaboury with a phoretic water mite larva (superfamily Hydryphantoidea) on the abdomen.

Laos records. SAYABOURY PROV: Muong Sayaboury, 300 m, 2.IV.1968, at light, 5♀.

Remarks. The adult female mouth has a median pharyngeal sclerite with about 7 large distal triangular spines and 10–12 smaller spines basad. The cibarium has a sclerotized internal hastate sclerite, the basal lobe of which meets the median pharyngeal sclerite. The cibarial-pharyngeal armature is similar to that found in *C. arakawae* and *C. guttifer* and corroborates the close relationship of these species.

Subgenus **Pontoculicoides**

65. **Culicoides (Pontoculicoides) kamrupi** Sen & Das Gupta

Culicoides albipennis Smith & Swaminath, 1932, Indian Med. Res. Mem. **25:** 184 (♂, ♀; Assam; fig. wing, palpus, spermathecae, ♂ genitalia). Preoccupied by *albipennis* Kieffer, 1919.

Culicoides kamrupi Sen & Das Gupta, 1959, Ann. Entomol. Soc. Am. **52:** 617. New name for *albipennis* Smith & Swaminath, not Kieffer.

Immature stages. Pupa. Total length 1.59 mm (1.44–1.74, n=10). Cephalothorax brown on anterior ½, paler posteriorly; abdomen unpigmented. *Respiratory trumpet.* Length 139 μm (130–148, n=9), 4.6× (4.2–5.2, n=9) longer than wide; basal ⅓ concolorous with anterior cephalothorax, midportion distinctly paler, distal ¼ strongly infuscated; trumpet weakly curving, outer margin concave, widest on basal ½, constricted distad of lateral series of spiracles by narrow band of transverse annulations encircling trumpet, a few incomplete transverse folds on basal portion; distal portion expanded, scales entirely absent; 3 (rarely 2, n=20) lateral spiracles on small, dark protuberances; tracheoles greatly expanded, 3 (3–5, n=10) approximated distal spiracles; plane of distal row of spiracles rotated slightly (ca. 20°) on longitudinal axis from plane of lateral series; pedicel less than ¼ length of trumpet. *Operculum.* Length ♂ 154 μm (144–158, n=8) and ♀ 153 μm (144–160, n=5); width ♂ 126 μm (118–130, n=8) and ♀ 141 μm (134–148, n=5), slightly narrowed distad of lateral corner, less so in ♀; brown, with numerous dark scales, longest 10 μm long, on disc, located on lateral margin, in longitudinal row mesally, and in transverse row just distad of lateral corners; a few weak ( ) marks basad of *am*'s; *am* tubercle small, dark, not or slightly produced apically; *am* seta short, stout, 21 μm (16–26, n=13) long, 0.82 (0.6–0.9, n=8) in ♂ and 0.54 (0.4–0.6, n=5) in ♀ as long as distance between *am*'s. *Cephalothorax.* Setal measurements, Table 2; *dl* with only 1 subapical delicate seta 23 μm long and medium seta in basal cleft 10 μm long; *vm* with 2 delicate setae, 7 μm and 17 μm long; *vl* setae widely spaced; *ad* tubercle rounded, with 2 setae, 1 stout, 19 μm long and 1 medium, 11 μm long, basal sensillum absent; *d* tubercles relatively small and widely spaced, *d 1* somewhat larger than *d 2*, each usually produced, unequally bifid or trifid; *d 3* and *4* rounded, reduced (in some specimens each represented only by seta); *d 1, 2,* and *3* and *d 1, 4,* and *5* in 2 straight lines as a "V"; *d 2* as far from *d 1* as 1.5× length of *d 1* seta; distance from *d 1* to *d 4* 3× length of *d 1* seta; *d 3* and *d 5* equidistant from *d 1*, distance ca. 4× length of *d 1* seta; area between *d*'s nearly smooth. *Abdomen.* Strongly bifid *lpm*'s produced apicolaterally into pair of large triangular spines ½ or more length of *lpm 1* seta; *lasm* weakly bifid; *dasm*'s and *dpm*'s not produced, rounded; *vpm 1* absent, only 2 *vpm*'s present, not produced. Intersegmental membranes with minute papillae laterally; segments 3–7 with few small scales scattered in dorsal anterosubmarginal band, more numerous mesally, absent on lateral margin; larger patch confined to mesal anterosubmarginal band ventrally; scales more numerous on segment 8. *Caudal segment.* Anterosubmarginal band of small scales present, encircling segment, scales relatively widely and irregularly spaced, no scales on disc. Posterolateral processes without scales; elongate, conical, strongly diverging, 131° (115–150°, n=8); blackened on distal ⅓, apex acute.

Breeding habitats. I reared a large series of *C. kamrupi* from pupae collected from exposed mud at the margin of the Mekong River near Vientiane. Three 100 cc samples of mud from the water's edge to 5 cm above water level yielded more than 80 pupae and a few larvae of this species (larvae lost). The site was exposed, sunny, moderately wet, with low pollution. The samples of mud contained more than 50%

very fine silt, no vascular vegetation, gravel or clay, and small amounts of detritus (1–10%) and very fine sand (1–20%). The larvae, almost surely of this species, were common in the shallow water, all swimming towards or parallel to the shore. They appeared mature and in search of a pupation site. The collection site was approximately 400 m from the edge of the wet season channel. The Mekong River at this season of the year is approaching its lowest level, which usually occurs by the beginning of May, when the monsoon rains start. The change in volume of the Mekong River at Vientiane is extreme. It increases 12 m in depth and as much as 1 km in width in the wet season. It is quite likely that *C. kamrupi* is a river bottom species and that the larvae migrate from the river bottom to pupate along the shoreline of the subsiding river. Further collecting would be necessary to determine whether this species is tied closely to the river dynamics. However, it is unlikely that pupae could successfully establish along the river margin during the several months that the river is increasing in depth. Any pupae would be quickly washed away from such sites.

Laos records. VIENTIANE PROV: Vientiane, 150 m, 12.III.1967, reared, sunny river margin, 13♀,13♂.

Remarks. Fredeen (1969) describes *C.* (*Selfia*) *denningi* Foote & Pratt from Canada as a unique river-breeding species. The biology discussed for *C. denningi* in North America is very similar to my limited observations of *C. kamrupi. Culicoides denningi* is placed in a different subgenus, but the 2 subgenera are similar morphologically and now the similarity in biology perhaps indicates a closer relationship. Atchley (1970) reared 6 species of *Selfia,* including *C. denningi,* from the margins of a wide variety of streams and rivers. He believed that the larvae were aquatic, migrating to the shore to pupate. Both *Selfia* and *Pontoculicoides* species have entirely unmarked wings with distal macrotrichia, slitlike 1st radial cell, and short, broad 2nd radial cell. *Selfia* has 3 unsclerotized spermathecae; those of *C. kamrupi* are poorly sclerotized.

The pupal characters of *C. kamrupi* confirm its close relationship to the New World subgenus *Selfia.* It is significant that the 3 characters found by Jones (1961) to separate *Selfia* from *Oecacta* s.l., namely *dl* with only 2 setae, *am* seta very short, and the shape of the respiratory trumpet, are also shared by *C. kamrupi.* Of these the *dl* character seems of primary importance, as all other known *Culicoides* have 3 setae. More recently the pupal stages of all 7 species of *Selfia* have been described by Atchley (1970). All share the presence of 2 *dl* setae and only 1, *C. brookmani* Wirth, differs in the length of the *am* setae and the shape of the respiratory trumpet. *Culicoides kamrupi* is quite distinct from the species of *Selfia,* however, in having only 2 *vpm* tubercles.

66. **Culicoides (?) species K**

A single female collected in Sayaboury Province, 15 km SW of Sayaboury, 300 m, 7.I.1967, sweeping near stream (F.G. Howarth), resembles *C. kusaiensis* Tokunaga in having unmarked wings. It differs in having antennal sensilla coeloconica on flagellomeres 3, 5, 7–10, and the eyes with numerous interfacetal hairs. No name is proposed because only a single specimen is known.

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