THE MOSQUITOES OF THE YEMEN

(DIPTERA, CULICIDAE)[1]

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This paper describes a collection of mosquitoes made by the author while a member of a medical survey team to the Yemen from U. S. Naval Medical Research Unit No. 3, Cairo, Egypt. Mount (1953) has published a general account of this survey.

Collecting was done in 1951 at Ta'izz from January 6th to the 25th, at Hodeida from January 28th to February 4th, at Ma'bar from February 5th to the 9th, and at San'a from February 11th to the 15th. A small amount of collecting was accomplished along the road between these various points. The land route of the party is shown in Fig. 1. The return from San'a to Aden was by air.

Representative sets of specimens from the collection are deposited in the U. S. National Museum and in the British Museum (Natural History).

The larval chaetotaxal nomenclature used in this paper is that of Belkin (1950).

I am deeply indebted to Mr. P. F. Mattingly, British Museum (Natural History), for making available to me the results of his critical examination of all the Yemen mosquito specimens contained in the collections of the British Museum. Dr. L. Merucci, West Aden Protectorate Medical Services, very kindly made several unpublished Yemen mosquito records available to me. Grateful acknowledgment is made to the other members of the mission, without whose assistance this part of the survey could not have been accomplished.

DESCRIPTION OF THE COUNTRY

The topography, climate, public health, and general biology of the Yemen have been described by Petrie (1939), Scott (1942), and Mount (1953) and need be reviewed only briefly here.

The Yemen lies on the Red Sea coast in the southwestern corner of the Arabian Peninsula. It is bounded on the north and east by Saudi Arabia and on the south by the Aden Protectorate. The country has an approximate area of 75,000 square miles and a population that is variously estimated to number between three and seven million people.

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[1]The opinions or assertions contained here are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval service at large.

Four main topographical features exist. First is the desert coastal plain or Tihama. No permanent surface water occurs here. Along its inland margin this area reaches an elevation

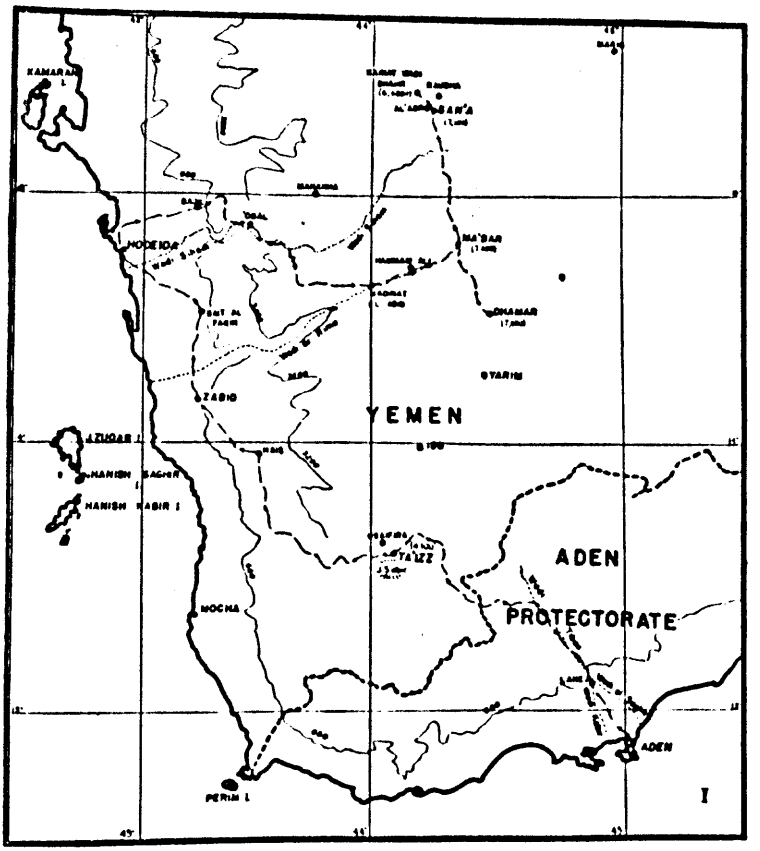

Fig. 1, Map of Yemen, adapted from Scott and Britton (1941); the land route of the Mission is indicated with dashed arrows.

of approximately 600 feet. Next occurs a broad belt of foothills and middle heights, some of which rise to elevations of more than 6,000 feet. This region is transected by innumerable stream courses or wadis, a number of which contain water throughout the year. The third area is comprised of the central highland plateaus. These occur principally between elevations of 7,000 and 8,000 feet and have mountain peaks more than 12,000 feet high. The fourth area is composed of the

arid slopes from the plateaus to the Arabian desert on the eastern border of the country. Virtually nothing is known about the aquatic biology of this last region.

The meteorological data for the Yemen consists of only a few scattered observations (Petrie, 1939; Mount, 1953). Petrie (1939: 358) indicated that the average yearly rainfall of the coastal area is about two and one-half inches and that of the central highlands about 14-15 inches. In the highland areas the rains are mostly confined to the spring and autumn seasons. Shade temperatures below 70° F. are rare in the Tihama; whereas, at San'a the mean temperature varies from 50° F. in November to 68° F. in June (Petrie, 1939: 357).

Maximum and minimum temperatures (northern exposure) were recorded during our stay in the Yemen and are presented in the table below. No rainfall occurred in the areas visited during the period of our trip.

TABLE. RECORDED MINIMUM AND MAXIMUM TEMPERATURES (NORTHERN EXPOSURE) IN THE YEMEN, JANUARY AND FEBRUARY 1951.

	Temperature F°			Temperature F°			Temperature F°	
	Min.	Max.		Min.	Max.		Min.	Max.
Date	Ta'izz		Date	Ta'izz		Date	Ma'bar	
January	(4100' el.)		January	(4100' el.)		February	(7300' el.)	
8	59.0	76.5	22	54.0	80.0	7	38.0	73.5
9	57.5	81.5	23	55.0	80.0	8	36.0	74.0
10	56.0	74.0		Hodeida		9&10	34.0	75.0
11	57.5	76.5		(Sea level)			San'a	
12	56.5	74.0	30	64.0	81.0		(7100' el.)	
13	57.0	77.5	31	65.0	82.5	12	47.0	68.5
14&15	55.0	75.0	February			13	48.0	89.0
16	54.0	73.0	1	65.0	82.0	14	47.5	80.0
17	52.5	74.5	2	63.0	81.5	15	47.5	77.5
18	52.0	74.5	3	64.0	82.0	16	49.5	79.0
19	51.0	78.0	4	64.0	82.0	17	47.0	78.0
20	51.5	80.0				18	48.0	77.5
21	54.0	80.0				19	43.0	75.0

PREVIOUS MOSQUITO RECORDS FROM THE YEMEN

Prior to the making of this collection only five species of mosquitoes had been recorded in the literature from the Yemen. Edwards (1941) published Yemen records for *Culex mattinglyi* (erroneously identified by him as *C. laticinctus*) and *C. theileri* from a series of material collected by Scott and Britton in 1937-38 and later deposited in the British Museum. From specimens sent by Dr. C. Toffolon and Dr. L.

Merucci, resident physicians in the Yemen, to the London School of Hygiene and Tropical Medicine, Buxton (1944) published Yemen records for *Anopheles adenensis*, *A. dthali*, and *A. gambiae*. The distribution records for the remainder of the material in the above two collections, and for all of the material deposited in the British Museum by Dr. Rathjens, are given here for the first time.

The collection described in this paper contains 27 species. Of these, two *Culex* species proved to be new and have been described elsewhere (Knight, 1953). A total of 29 mosquito species is now known from the Yemen. Neither *Anopheles turkhudi* nor *Culex univittatus* var. *neavei* were taken by me. A preliminary list of the species contained in this collection has been published by Mount (1953). This list is corrected and expanded here.

Biologically, the Yemen belongs to the Northeast African Province of the Ethiopian Region and contains territory of both the subdivisions of this province: the Abyssinian Highland District and the Somali Arid District (Edwards, 1941: 452).

Collection Records for the Yemen Collection

To avoid duplication in the individual species treatments, a concise account of each collection is given here.

300. El-Amra, about 7 miles north of Ta'izz, el. about 3500 feet. Marshy seepage resulting from irrigation storage tank overflow. Emergent short grass and some filamentous green algae. pH 7-8. *Anopheles gambiae*, *A. cinereus*, and *Culex theileri*.

301. Two miles west of Ta'izz on road to Hodeida, el. about 3900 feet. Roadside covered cement basin for drinking water. Aperture very small and water deeply shaded. *Anopheles rupicolus* and *Culex tigripes*.

302. Three and one-half miles west of Ta'izz on road to Hodeida, el. about 3700 feet. Roadside basin similar to 301. *Anopheles rupicolus* and *A. gambiae*.

303. About three-fourths of a mile north of Ta'izz on road to Usaifira, el. about 3900 feet. Roadside basin similar to, but much larger than, 301 and 302. *Culex tigripes* and *C. decens*.

304. Ta'izz, el. 4100 feet. Single adult taken on wall in house. *Culex nebulosus*.

308. El-Haubun, Wadi el-Malah, about 3 miles east of Ta'izz, el. about 3700 feet. Quiet marginal water of a drying wadi stream. Short emergent vegetation; a fine green floating watergrass. pH 8 ±. *Anopheles cinereus*, *A. pharoensis*, *A. sergentii* (a single specimen), *Culex theileri*, *C. simpsoni*, and *C. jenkinsi*.

309. Same locality as 308. Two female specimens taken on oiled paper placed in rodent burrows for the capture of *Phlebotomus*. Specimens in poor condition but probably *A. sergentii*.

310. Ta'izz, el. 4100 feet. Open cement basin in courtyard of mosque. *Culex tigripes, C. laticinctus,* and *C. decens.*

311. Same general locality as 308. Marshy seepage area along the margin of a small stream. *Aedes natronius* and *Culex theileri* were in dark brown water in drying hoof prints, and *Anopheles pharoensis* was in clear water nearer to stream margin. *Culex ? jenkinsi.*

312. Ta'izz, el. 4100 feet. Closed cement basin in mosque. *Culex pipiens.*

313. Wadi Raidan, about 17 miles west of Ta'izz on road to Hodeida, el. about 3000 feet. Quiet marginal water of a drying stream. Filamentous green algae. *Anopheles dthali, A. gambiae, A. pretoriensis,* and *Culex sinaiticus.*

314, 315, 318. Hodeida, sea level. Open cement basins in mosques. *Anopheles adenensis* and *Culex sitiens.*

316. Murawah, about 35 miles east of Hodeida, el. near to sea level. Open cement basin in mosque courtyard. *Culex quinquefasciatus.*

317. Locality same as 316. Large pottery water jugs within building. *Aedes aegypti.*

319. Hodeida, sea level. Large pottery water jugs within building. *Aedes aegypti.*

320. About 13 miles north of Hodeida near shore. Small pools and seepage in meadow at edge of high tide level, water brackish. *Culex sitiens.*

321. Wadi Siham, nr. 'Obal on road from Hodeida to San'a, el. about 1000 feet. Quiet marginal water of a drying stream. Emergent short vegetation and filamentous green algae. *Anopheles dthali, A. sergentii, A. pretoriensis, Culex ethiopicus, C. sinaiticus,* and *C. tritaeniorhynchus.*

322. Hamman 'Ali, el. about 5000 feet. Very small pools along overflow ditch from the hot spring baths. Water deep brown in color. *Culex pipiens, Aedes natronius,* and *Culiseta longiareolata.*

323. Birket Ghail Masnah, about 32 miles south of Ma'bar on Hodeida-San'a road, el. 7300 feet. Small permanent pond on arid high plain. *Potamageton,* stonewart, and filamentous green algae. *Anopheles cinereus* and *Culex theileri.*

324. Wadi Grab, about 14 miles southeast of Ma'bar, el. about 7300 feet. Natural small pools along ditch course. Stonewart, rushes and filamentous green algae. *Anopheles fluviatilis, Culex salisburiensis,* and *Culex theileri.*

325. Wadi Mal el-Ghail, about 14 miles west of Ma'bar, el. about 6500 feet. Pools along small stream flowing from a mountain spring. Filamentous green algae. *Anopheles cinereus, Culex jenkinsi,* and *Culex theileri.*

327. Dhamar, el. 7400 feet. Borrow pit for mosque drainage. *Lemma,* algae, and short emergent vegetation. *Culex theileri.*

328. Wadi Dhahr, el. about 7000 feet. Small open cement tank. *Culiseta longiareolata* and *Culex mattinglyi.*

329. Birket Ma'agel-Biet Myiad, about 2 miles south of San'a el. 7100 feet. A great open cement rain-catchment tank. *Potamageton. Culex theileri.*

330. Birket Sheikh Kunnaf, San'a, el. 7100 feet. Small open cement watering tank. *Culex mattinglyi.*

331. Wadi Dhahr, el. about 7000 feet. Large open well, about 5 meters to water level. Much flotage. *Culiseta longiareolata* and *Culex mattinglyi.*

332. Al-Asr, about 3 miles west of San'a; el. about 7600 feet. Very large open cement basin. Rushes and filamentous green algae. *Dixa* sp.

333. Rouda, about 3 miles north of San'a, el. about 7100 feet. Large open cement tank. Algae. *Culiseta longiareolata* and *Culex mattinglyi.*

334. Locality same as 333. Very large open cement pool in mosque courtyard. *Culiseta longiareolata.*

335. San'a, el. 7100 feet. Three adult specimens taken in house. The *Anopheles* was biting man in the evening. *Anopheles cinereus, Culiseta longiareolata, and Culex mattinglyi.*

Summary of the Yemen Mosquito Collection Records

The general mosquito situation during the period from January 6th to February 19th, 1951, was as follows:

Elevation Sea Level (Tihama).—Collecting sites (numbers 314 to 320): Hodeida; Murawah, 21 miles inland from Hodeida; and the Red Sea shore. *Anopheles adenensis* (in small numbers) and *Culex sitiens* were present in brackish water in the open cement basins of mosques in Hodeida. *Aedes aegypti* was found breeding in numbers in the large pottery water jars of homes in both Hodeida and Murawah. *Culex quinquefasciatus* was collected from foul tepid water in the open cement ablution basin of a mosque in Murawah. The basins of approximately eight other mosques were examined without finding any mosquito breeding. *Culex sitiens* was found in abundance in small pools of brackish water in a grassy area at the edge of high tide level along the Red Sea coast about 13 miles north of Hodeida. No adult mosquitoes were collected.

Elevation 1000 to 3000 feet (lower foothills.)—Collecting sites (numbers 313 and 321): Wadi Raidan 17 miles west of Ta'izz on road to Hodeida, and Wadi Siham near 'Obal. *Anopheles dthali, A. sergentii, A. gambiae,* and *A. pretoriensis* larvae were collected along the still margins of permanent small streams flowing through the rock-strewn narrow valleys (wadis) that drain the highlands onto the Tihama. *Culex sinaiticus, C. ethiopicus,* and *C. tritaeniorhynchus* were also collected from this habitat. Small villages of agricultural people are associated with these wadis. There is extensive caravan travel near both of these locations. No nights were passed in this zone.

Elevation 3500-5000 feet (middle heights).—Collecting sites (numbers 300-312, 322): Ta'izz area and Hammam 'Ali (site of royal hot springs resort). No anopheline breeding was found within the walls of Ta'izz,

but Dr. Toffolon stated that after April small numbers of *Anopheles gambiae* may be found breeding in the open ablution pools of the mosques. *Culex laticinctus* was found breeding in these pools in sufficient numbers to constitute, potentially, a serious pest mosquito problem. *Culex decens* and *C. pipiens* were also collected from these places. Small numbers of *Anopheles rupicolus* and *A. gambiae* larvae were found in covered cement drinking water basins along the roads immediately outside of Ta'izz. *Anopheles gambiae*, *A. cinereus*, and *Culex theileri* were found breeding abundantly in a seepage area associated with an irrigation project about seven miles north of Ta'izz. *Anopheles cinereus*, *A. pharoensis*, *Culex theileri*, *C. simpsoni*, and *C. jenkinsi* were collected from the still water at the margins of a small stream three miles east of Ta'izz. One larva of *Anopheles sergentii* was collected from this same habitat. Two female anophelines, presumably *A. sergentii*, were collected on oiled paper placed in the openings of rodent burrows located near this stream. Only a few agricultural families live in this immediate area but heavy caravan traffic passes along the wadi daily, since it is beside the highland route from Ta'izz to San'a. The predatory larvae of *Culex tigripes* were found occasionally in the cement basin habitat in the Ta'izz area. At Hamman 'Ali, *Culex pipiens*, *Culiseta longiareolata*, and *Aedes natronius* were found breeding in the foul drainage water from the hot spring baths. Both here and at Ta'izz, *A. natronius* was collected from dark brown silt-ladened water. No adult mosquitoes were collected at Ta'izz during several attempted night-biting collections.

Elevation 6500-7600 feet (highland plateaus).—Collecting sites (numbers 323-335): Ma'bar, Dhamar, and San'a. *Anopheles cinereus* was abundant around the first two areas, breeding in small permanent pools surviving from the rainy season and in spring-fed stream pools. *Culex theileri*, *C. jenkinsi*, and *C. salisburiensis* were also collected from these habitats. Adults resembling *A. fluviatilis* were reared out from larvae collected here. None of these collection sites were closely associated with villages. Farmers and herders work in the areas in the daytime but nearly all return to the villages at night. No adult mosquitoes were seen.

In the San'a area not a single anopheline breeding site was found. However, one *Anopheles cinereus* female was captured in a building in San'a. Dr. Merucci, who has reported malaria present in San'a, collected *Anopheles turkhudi*, *A. cinereus*, and *A. sergentii* in the San'a area. The only water present in the San'a area at the time of our visit was that collected during the previous rainy season in huge open cement basins and that pumped from deep wells into drinking water basins and into the ablution basins of the mosques. *Culex theileri* was found in the former type of habitat, and *Culiseta longiareolata* and *Culex mattinglyi* in the latter. Unfortunately, no collecting was possible in the mountains arising from the highland plateaus.

SPECIES TREATMENTS

Anopheles (Myzomyia) adenensis Christophers

Descriptive Notes.—The only comprehensive description of the adult of this species (De Meillon, 1947:99) is based upon a single pair of specimens from Hodeida, Yemen. A series of one male and five females from this same locality are in the collection reported on in this paper. These agree satisfactorily with De Meillon's description except that the pale area on the stem of vein 5 of the female wing is more variable than he indicates. In one specimen, this area is completely lacking on one wing and represented by only two pale scales on the other; and in two other specimens it is much reduced in extent. Only one specimen has this pale area as prominent as figured by De Meillon.

De Meillon's (1947:99) larval description is based upon a larval skin from Hodeida and a whole larva from Assab, Eritrea. In this description he states that the two long mesothoracic pleural hairs are "simple or with one of the long hairs with a few branches." He does not state which specimen had the branched hair. The present collection contains a series of 14 larval skins and one whole larva, all from Hodeida. All of these specimens have both long mesothoracic pleural hairs simple. On the basis of this, it seems probable that it was the Assab specimen which possessed the branched mesothoracic hair mentioned by De Meillon, and suggests the possibility that this specimen actually represents some other species. In other details, the new Hodeida larval series agrees with De Meillon's description.

Distribution.—NEW RECORDS: 1 male, 5 females, 12 sets assoc. skins, 1 larva, Hodeida (314, 318). PREVIOUS RECORDS: Hodeida (Buxton, 1944: 211; De Meillon, 1947: 100).

Discussion.—The fact that the very closely related species, *A. culicifacies* Giles, has been reported from Bahrein Island (Afridi and Majid, 1938: 441) and the Oman and the Trucial Oman (Leeson, 1948: 254) indicates the necessity for a thorough study of the exact relationship of these two species.

Anopheles (Myzomyia) cinereus Theobald

Descriptive Notes.—The Yemen material of this species agrees satisfactorily with the description by Evans (1938:329). Females from a single larval collection show all degrees of variation in the dark area at the fork of vein 5 (on 5.2), from being entirely absent to being as long as figured by DeMeillon (1947:210, Pl. 71a). The dark area shown on vein 2 just distad of crossvein 2-3 in the wing figured by De Meillon was entirely absent in some of the Yemen specimens. This variation is not mentioned by Evans (1938:329). The apical pale spots on hind tarsal segments I-III are clearly distinct in all of these specimens, but that on IV is frequently indistinct or even absent. The upper mesopimeral hairs are dusky in color, not pale as described by Evans (1938:329).

Distribution.—NEW RECORDS: 22 males, 28 females, 27 sets assoc. skins, 14 larvae. El-Amra (300); El-Hauban, Wadi el-

Malah (308); Birket Ghail Masnah (323); Wali Mal el-Ghail (325); and San'a (335, single female taken while biting a human indoors). PREVIOUS RECORDS: None published. However, Dr. Merucci reported by personal communication (1950) the collecting of *cinereus* at San'a.

Discussion.—Leeson (1948: 254) reported one larva similar to *cinereus* in a collection of other species from Hoffuf in eastern Saudi Arabia. This larva differed from African material (Southern Rhodesia) in having prothoracic hair 13 with only three branches instead of with six to seven. All of the Yemen specimens agreed with the African larva in this respect.

Anopheles (Myzomyia) dthali Patton

Descriptive Notes.—No adults were collected. All of the larval specimens are in poor condition but they seem to show no unusual variation. In one specimen, the three dark areas immediately posterior to the frontal hairs are fused into a transverse band. In the other specimens all of the clypeal markings are rather indistinct.

Distribution.—NEW RECORDS: 4 whole larvae. Wadi Raidan (313) and Wadi Siham, nr. 'Obal (321). PREVIOUS RECORDS: Ta'izz (Buxton, 1944: 211).

Discussion.—*A. dthali* var. *wardi* Leeson and Theodor (1948: 222), which has recently been described from Socotra, differs from *dthali* only in small details of wing and palpal markings. Since no Yemen *dthali* adults were taken, it is not possible to compare Yemen and Socotra material.

Anopheles (Myzomyia) fluviatilis James

Descriptive Notes.—In the absence of larval specimens this identification is only tentative. The single female specimen resembles *cinereus*, but the pharyngeal cones (anterior view) are without roots, indicating that it must belong in either group *Myzomyia* or group *Neocellia*. This single specimen has the entire base of the costa dark, the tarsi all dark, only a single propleural bristle, and a patch of elongate scales before the wing base.

Distribution.—NEW RECORDS: 2 males, 1 female, Wadi Grab, nr. Ma'bar (324). PREVIOUS RECORDS: None.

Anopheles (Myzomyia) gambiae Giles

Descriptive Notes.—No four-banded female palpi occur in the Yemen series. The sector and accessory sector spots on vein 1 are coalesced in all of the specimens. The pale interruption in the third dark area of vein 1 is coalesced with the preceding pale area in most specimens but there are some exceptions.

Distribution.—NEW RECORDS: 5 males, 13 females, 17 sets assoc. skins, 3 larvae. El-Amra (300), Ta'izz (302), and Wadi Raidan (313). PREVIOUS RECORDS: Ta'izz (Buxton, 1944: 212). Madinat el Abid (Merucci, 1950).

Anopheles (Myzomyia) pharoensis Theobald

Descriptive Notes.—No significant differences were noted between the specimens collected and the description for this species by Evans (1938: 370).

Distribution.—NEW RECORDS: 7 males, 21 females, 7 sets assoc. skins, 2 larvae, El-Hauban, Wadi el-Malah (308, 311). PREVIOUS RECORDS: None.

Anopheles (Myzomyia) pretoriensis (Theobald)

Descriptive Notes.—The single pair of adults reared do not show any appreciable differences from the description by Evans (1938:358) except that the posterior portion of the female wing is much more darkly-scaled than figured.

Distribution.—NEW RECORD: 1 male, 1 female, 5 larvae. Wadi Raidan (313) and Wadi Siham, nr. 'Obal (321). PREVIOUS RECORDS: None.

Anopheles (Myzomyia) rupicolus Lewis

Descriptive Notes.—A small series was collected at Ta'izz. Because of the presence of 2-3 well defined pale areas in the coastal region of the wing, the females of this series go to *rhodesiensis* Theobald instead of *rupicolus* in the recent Ethiopian region keys by De Meillon (1947:21; 1949: 467). In view of the possibility that this variation may possibly represent a valid geographical form of *rupicolus*, a rather full description is given here.

Adult Female.—HEAD: Scales narrow, rod-like, unusually long, the striations extending one-half or more of the length, brownish yellow, apices generally paler, in one specimen the scales were darker posterolaterally. Frontal tuft composed of one pair of scales in the single slide-mounted head, certainly no more than two pairs in the remainder of the specimens and absent entirely in one. Vertical bristles normal, dusky. A patch of recumbent pale narrow scales extending forward between the eyes. Torus without scales. First antennal flagellar segment with small dusky scales, which can be adequately seen only on a slide mount. Palpi thin and of uniform thickness, all dark; segment V is 0.3 as long as IV (measurement from one specimen only since the division between segments IV and V is difficult to see in anything except a slide mount). Proboscis dark, labella pale. Maxilla with 12 teeth, mandible with approximately 50 (impossible to accurately determine on the single slide-mounted specimen). Pharynx (one specimen) with a single row of 10 teeth with fimbriated apices, some of the teeth expanded apically, basally each tooth has a large tubercle and a pair of short stout teeth, spiculations present on all surfaces. THORAX: Scutum with grayish tomentosity when viewed from above, shiny brown areas present in some specimens, covered with lines of dark bristles and short hairs which are not at all scale-like; anterior promotory without true scales. Anterior pronotum without scales. Pleuron without scales, integument shiny, rather pale brownish. One propleural bristle, 1 spiracular, 2-3

prealers, 3-4 upper sternopleurals, 3-5 lower sternopleurals, 7-10 upper mesepimerals. ABDOMEN: Without scales, even on cerci. LEGS: Uniformly dark. Coxae without scales. WING: Length 3.4-3.9 mm, average 3.79. Costa with 2 pale areas of rather small size, basal one-third entirely dark, the costal spots repeated on vein 1. In addition, three of the ten specimens have a sub-apical pale area on the costa, represented by only a few pale scales on vein 1. In each of these specimens, this spot is more pronounced on one wing than on the other. The anterior margin of this spot on the costa is fringed with a line of black scales. Fringe without pale spots. Outstanding scales quite narrow.

Male.—Palpi uniformly dark. Wing markings much reduced. In 3 specimens the wings are all dark except for a few pale scales present subapically on the posterior margin of costa. The other 2 specimens have, in addition to this pale scaling, a few pale scales on vein 1 in the same position, and indistinct pale scaling at one or both of the other areas of the costa which bear spots in the females, the exact combination varying even between the two wings of one specimen. TERMINALIA (1 slide): Basistyle with some scaling. Four parabasal spines, normal. Accessory spine long. Harpago with club strongly convex laterally and strongly concave mesally; apical bristle about 1.5 the length of the club and 1.7 the length of the outer accessory hair.

Larva.—HEAD: Anterior clypeus without markings, posteriorly 3 dark patches usually present. Inner clypeal hairs with sparse fine fraying, may be only 1 spicule, completely simple in 1 specimen; outer clypeal hairs simple, 0.6 to 0.7 the length of the inner; posterior simple, 0.6-0.8 the length of the inner and approximately equal to the outer; postfrontal hair (hair 8) with 2-4 branches; vertical hair (hair 9) with 2-5 branches. Antenna with a conspicuous group of spicules on internal aspect of basal one-third; longer than those on other parts of the antenna; shaft hair slightly shorter than antennal width at insertion point, inserted at approximately the basal one fourth; apical hair split before middle into 3-4 branches. Finger-shaped piece of maxillary palp slightly shorter than the paired pieces in length. THORAX: Shoulder hairs (submedian hairs) with basal tubercles of moderate size, distinctly separated, none flattened; outer hair single. Palmate hair with about 9-13 narrow lanceolate undifferentiated leaflets. Prothoracic pleural group with 1 long bristle feathered. Prothoracic hair 13 with 3-5 branches. Mesothoracic and metathoracic pleural groups each with 1 long bristle feathered, the other simple. ABDOMEN: Palmate hair on I small and more or less rudimentary, though some leaflets show differentiation into blades and filaments, with 10-13 leaflets. Palmate hair on II larger, with about 14-16 leaflets, all of which have indented shoulders and well-defined filament. On III-VII the palmate hairs are fully developed but still relatively small, with about 17-21 leaflets, these 8-10 times longer than wide, serrations generally rather few in number, variable in shape; filaments varying from being one-fifth to one-fourth of the total length of the leaflet; pigmentation of the leaflets mottled. Saddle hair simple, bifid in one specimen on one side. Tergal plate of IV and V of moderate size, being in length slightly more than

one-half of the distance between the palmate hairs of these segments; one accessory plate, this however usually constricted medially to appear as two fused plates. Integument of the ventral surface of segments III-VII with rows of sparse microtrichia. Pecten with 4-5 long teeth alternating with groups of shorter ones which total about 9-12 in number. Lateral hair of IV with 3-4 branches, of V with 2-3, of VI with 2-3.

Distribution.—NEW RECORDS: 5 males, 10 females, 5 sets assoc. skins, 3 larvae, Ta'izz (301, 302). PREVIOUS RECORDS: None.

Discussion.—As De Meillon (1947: 97) has stated, it is questionable whether *rupicolus* is specifically distinct from *rhodesiensis* Theobald. From a consideration of the type of variation that has been described for these two names, it seems highly probable that *rhodesiensis* is a polytypic species containing two or more geographically-isolated subspecies. *A. rhodesiensis* typically has well-marked wings and palpi and is widespread in Africa south of a line from Sierra Leone to Ethiopia; *rupicolus* has the wings and palpi with less distinct pale markings and is apparently confined to the arid lands lying on or near to the Red Sea.

Anopheles (Myzomyia) sergentii (Theobald)

Descriptive Notes.—The single specimen (female) taken differs in wing and leg markings from the description by Christophers (1933:193) as follows: Wing with a small basal pale spot and a few pale scales at level of crossvein 2-3 on vein 2, a basal pale area on vein 4, and vein 6 all dark except for a few pale basal scales. Fore and mid femora without apical pale scales, the hind femora with a single line of pale scales apically. All of the tibiae with pronounced apical marks, the mid and hind tibiae also each with a dorsal pale spot at the base.

The associated larval skin did not differ significantly from the description by Christophers (1933:195).

Distribution.—NEW RECORDS: 1 female and assoc. skins, El-Hanban, Wadi el-Malah (308). Three whole larvae, Wadi Siham, nr. 'Obal (321). Two female specimens trapped on oiled paper at the entrances of rodent burrows in Wadi el-Malah (309) are possibly this species. PREVIOUS RECORDS: None published. However, Dr. Merucci reported by personal communication (1950) the collecting of *sergentii* at San'a.

Anopheles (Myzomyia) turkhudi Liston

Descriptive Notes.—No material of this species was collected by us in the Yemen, although specimens were taken not far across the border, at Wadi Tiban in the Aden Protectorate.

Distribution.—NEW RECORDS: None. PREVIOUS RECORDS: None published. However, Dr. Merucci reported by personal communication (1950) the collecting of *turkhudi* at San'a.

Culiseta (Allotheobaldia) longiareolata (Macquart)

Descriptive Notes.—Nearly all degrees of the variation in tergal markings described by Edwards (1941:69) were represented in the small series of specimens collected.

Distribution.—NEW RECORDS: 8 males, 6 females, 4 sets assoc. skins, 7 larvae, Hamman-Ali (322), Wadi Dhahr (328,331), and Rouda (333, 334). PREVIOUS RECORDS: None published. However, there are specimens in the British Museum from San'a, IX-1937, Rathjens and Guest House, 26-VIII-1946 (Mattingly, 1953).

Aedes (Stegomyia) aegypti (Linnaeus)

Descriptive Notes.—Many of the specimens reared had the dorsal surface of the abdomen almost completely pale in color. However, there were all degrees of intermediates between this condition and the normal dark condition.

Distribution.—NEW RECORDS: 29 males, 17 females, 57 sets assoc. skins, 6 larvae, Murawah (317). Eleven males, 14 females, 13 sets assoc. skins, Hodeida (319). PREVIOUS RECORDS: None.

Aedes (Aedimorphus) natronius Edwards

Descriptive Notes.—The Yemen specimens differ from Edwards' description (1941:199) for this species as follows: Dististyle finely-haired over much of length. Basal lobe of basistyle with several distinct spines apically. Wings of female usually with a short continuous area of whitish scales in the area of the apices of veins 1 and 2. Tergites of female with basal dull white bands, with whitish scales along basal half of lateral margins (reduced to lateral median patches on more distal segments), and with broad complete apical bands of brassy-yellow scales.

The larva differs from that described by Hopkins (1952:205) as follows: Comb possessing 11-16 teeth. Pecten with 20-26 teeth.

Distribution.—NEW RECORDS: 27 males, 27 females, 12 sets assoc. skins, 7 larvae, El-Hauban, Wadi el-Malah, nr. Ta'izz (311). 2 males, 1 larva, Hamman 'Ali (322). PREVIOUS RECORDS: None.

Discussion.—Mr. P. F. Mattingly very kindly compared a description of the Yemen material with the series of *natronius* specimens in the collection of the British Museum (Natural History) and found them to be conspecific in every way. The discrepancies noted above between the Yemen specimens and Edwards' description of the adult of this species proved to be due to errors in the description. After studying a very large series of African larvae, Mattingly reported that the range in variation of the number of comb and pecten teeth was respectively, 12-28 and 13-31. Hopkins' statement that the larva possesses about 40 pecten teeth is thus evidently a misprint.

Culex (Lutzia) tigripes Grandpré and Charmoy

Descriptive Notes.—The single female and the three males taken resemble variant five of Edwards' (1941:249) in having pale scutal scaling, broad apical creamy bands on tergites II-V, tergites VI-VIII almost entirely yellow-scaled, and in having unbanded sternites. However, some of the sternites do possess definite apico lateral patches of dark scales. Variant five has previously been reported only from the Aden Protectorate.

The larva matches the description by Hopkins (1952:249) except that head hair 9 (hair f) is 6-7-branched instead of double.

Distribution.—NEW RECORDS: 3 males, 1 female, 2 sets assoc. skins, 1 pupal skin, Ta'izz (301, 303, 310). PREVIOUS RECORDS: None published. However, there is a single male specimen in the British Museum from Usaifira, nr. Ta'izz, XII-1937, Scott and Britton (Mattingly, 1953).

Discussion.—Mattingly (1953) reported that the male specimen from Usaifira in the British Museum, although badly rubbed and incomplete, agrees reasonably well with some of the darker specimens of Edwards' variant five. The fact that variant five has to date been reported only from the Aden Protectorate and from the Yemen seems strong support for believing this to be a geographic variety. Perhaps more complete comparison of the larvae may throw some light on this matter.

Culex (Neoculex) jenkinsi Knight

Distribution.—NEW RECORDS: 3 males, 5 females, El-Hauban, Wadi el-Malah (308). 1 male, 1 female, Wadi Mal el-Ghail (325). PREVIOUS RECORDS: None.

Discussion.—The larva of this species is not definitely known. However, following the description of *jenkinsi* as a new species (Knight, 1953), a single larval skin (pupal skin associated but adult lost) was found in the Yemen collection (Lot No. 311), which is not only different from any other *Culex* larva collected in the Yemen, but also from any *Culex* described in Hopkins (1952). Since the collection containing this specimen was made from the same general locality as the one which produced the type collection of *jenkinsi*, it seems likely that this larval skin and its associated pupal skin represent *jenkinsi*.

In Hopkins' (1952: 246) key to the larvae of Ethiopian *Culex*, this larva keys to *Culex* (*Neoculex*) *sunyaniensis* Edwards. However, it differs from that species as described by Hopkins (1952: 259) in having the infuscation of the antenna confined to the extreme base and to the portion distad of the hair tuft, head hair 5 with 3 branches, five pairs of siphonal

hair tufts of which the third and fourth are dorsally out of line, the distal margin of the anal plate finely spiculate, *isc* (hair 2) with 3 branches of which the most ventral is the longest, and the ventral brush with 6 pairs of tufts in the barred area (none proximal to this area). Additional details are: Head seta 8 with 3-4 branches, 9 with 5-6, 11 with 2, 12 with 3-4, and 13 with 3. Mentum with 7-9 teeth on either side of central tooth. Hair 6 on abdominal segments, I, II, and IV triple, on III and V double, and on VI single. Siphon index 7.8. Lateral hair of anal plate with 3 branches. Anal gills missing.

Culex (Neoculex) salisburiensis Theobald

Fig. 2

Descriptive Notes.—One male, two females, and two sets of associated larval and pupal skins were collected near Ma'bar. The adults show the following differences from the description by Edwards (1941: 257): Female palpi approximately one sixth the length of the proboscis. Torus and first flagellar segments of the female antennae with some pale scales. Scutum with pale yellowish narrow scales, the scales paler in color marginally and on the prescutellar space. The scales on *apn* narrow above and broadened below. In addition to the pleural scale patches described by Edwards, there are a few scales on the lower prealar knob, and the mesepimeral patch is divided. One female specimen possesses two mesepimeral bristles on one side. Tergites II-VII with prominent apical creamy bands, these medially widened on II-IV in male, and only on II in the female. Sternites pale-scaled, baso-lateral dark scaling present on most of them. The leaf (g) of the subapical lobe of the male genitalia with a distinctive angular and serrate margin and with a distinctive median pigmented area (fig. 2). Three accessory setae present between the two groups of rods. Dististyle narrowed apically, with an indistinct dorsal membranous structure. Additional information: Upper fork cell of male 1.5 times longer than its stem, and the cross veins separated by somewhat more than the length of the posterior one. Upper fork cell of female 2.1-2.4 times longer than its stem. Male with fore and mid tarsal claws unequal, each unidentate; hind equal, simple. Female with tarsal claws equal, simple. Dististyle of male genitalia with two setae. Lateral lobes of ninth tergite not tuberculate, broad, and each bearing 4-6 stout setae.

The larva is completely similar to the larval description of *salisburiensis* in Hopkins (1952: 254).

Distribution.—NEW RECORDS: 1 male, 2 females, with assoc. larval and pupal skins, Wadi Girab, nr. Ma'bar (324). PREVIOUS RECORDS: None.

Discussion.—Because of the many differences noted between the Yemen adults and the description by Edwards (1941: 257), a full description of this material and a drawing of the

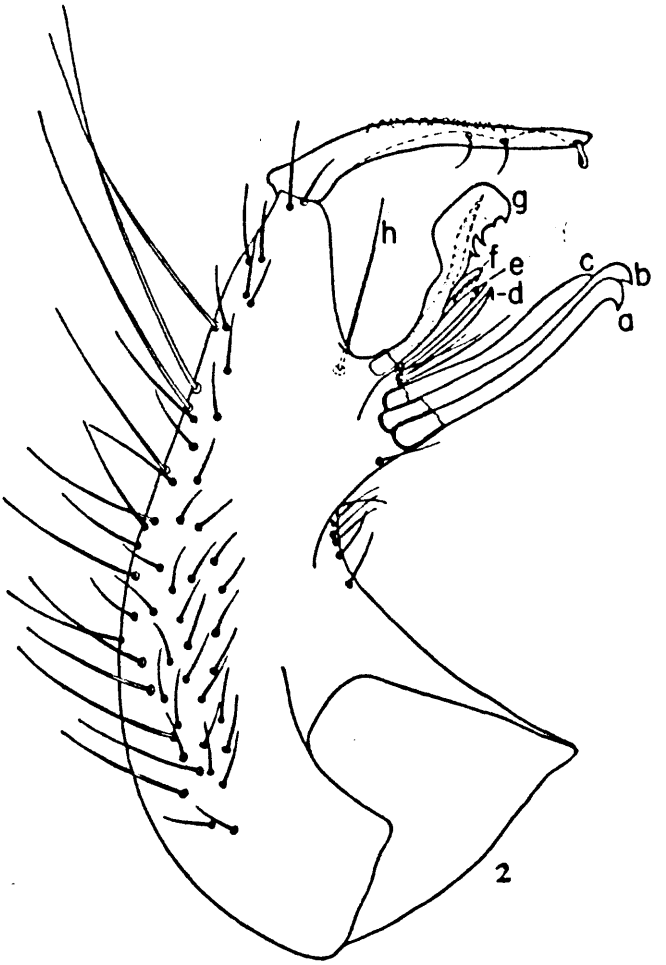

Fig. 2, *Culex (Neoculex) salisburiensis*, male genitalia; mesal aspect of basistyle.

male genitalia (fig. 2) were prepared and sent to Mr. P. F. Mattingly to be compared with the specimens of *salisburiensis* deposited in the British Museum (Natural History). The description and drawing were compared with the following material: Sudan: Kajo Kaji, 1 female. Kenya: Nairobi, 4 males, 3 females. N. Rhodesia: Chilanga, 2 females. S. Rhodesia: Salisbury, 6 females. Transvaal: Pretoria, 1 male, 1 female. Natal: Weenen, 1 male, 1 female; Ulundi, 1 male; Estcourt, 2 males, 2 females. Cape Province: Stellenbosch, 1 male, 1 female; Cape Town, 2 males, 2 females; Mossel Bay, 1 female. His reply following this study was as follows: "I am afraid almost all of the differences you noted are due to errors in Edwards' description. The only difference of any significance is that, while the Nairobi males have terminalia identical with the Yemen form, those from further south lack the longest of three accessory bristles on the subapical lobe and one of the two small setae on the dististyle. It is clear therefore that we have a northern and a southern form but it is impossible to say which is the type form since I have no males from Salisbury. . . . It may be possible eventually to distinguish two subspecies. The southern forms are certainly much darker than yours, especially with respect to the scutal scaling but the Nairobi specimens are intermediate and, I should think, would probably intergrade in Eritrea. Also the two specimens from Chilanga suggest that there is considerable seasonal variation since one, collected in January, is very dark, while the other collected in November, is as pale as the Nairobi form. Edwards' figure for the length of the female palps seems to have been based on a single aberrant or shrunken specimen; and the tergal bands are variable, even in the same locality. The other differences are just errors in description."

∨ Culex (Culiciomyia) nebulosus Theobald

Descriptive Notes.—The single specimen (male) has a large patch of scales anteriorly on the propleuron, which would indicate that it is the East African representative of *nebulosus, n.* var. *pseudocinereus* Theobald. However, since it lacks the mesepimeral scale patch and the short hairs that are supposed to be associated with the lower mesepimeral bristle (definitive characteristics of var. *pseudocinereus* according to Edwards, 1941: 273), the identification is given here simply as the type form.

Distribution.—NEW RECORDS: 1 male, Ta'izz (304). PREVIOUS RECORDS: None.

Discussion.—The genitalia of this male and of males in the author's collection from Uganda and the A. E. Sudan differ

from that figured by Edwards (1941: fig. 89a) in that the two blunt bristles associated with the narrow leaf each have one edge spiculated.

Culex (Culex) decens Theobald

Descriptive Notes.—The Yemen material resembles that described by Edwards (1941: 336) except that some females have proboscis lighter beneath. Frequently, the scutal scaling is lighter than reddish-brown, and all of the female specimens have straight narrow white basal abdominal bands.

The larva differs slightly from that described by Hopkins (1952: 330) as follows: Head hair 5 with 2-3 branches, hair 6 with 2, hair 7 with 6-8. Mentum with 7-8 teeth on each side of the main tooth. Lateral setae of abdominal segments III, V, and VI single, very long; of segment IV shorter and slenderer and with 1-4 branches. A distinctive character, not mentioned in Hopkins, is the presence of a very long pair of subdorsal setae on both segments IV and V. Comb composed of 46-62 scales. All of the pecten teeth with 4 or more denticles. Ventral brush composed of 12 hair tufts. Dorsal anal gills 0.9-1.1 the length of the anal plate and 1.4-1.6 the length of the ventral gills. This description is based upon 10 larval skins picked at random from the collection.

Distribution.—NEW RECORDS: 75 adults, 65 sets associated skins, 8 larvae, Ta'izz (303, 310). PREVIOUS RECORDS: None.

Culex (Culex) ethiopicus Edwards

Distribution.—NEW RECORDS: 2 females, 2 sets assoc. skins, 13 larvae, Wadi Siham, nr. 'Obal (321). PREVIOUS RECORDS: None.

Culex (Culex) laticinctus Edwards

Distribution.—NEW RECORDS: 44 males, 16 females, 36 sets assoc. skins, 4 larvae, Ta'izz (310). PREVIOUS RECORDS: None. The record of San'a by Edwards (1941: 314) has been found by Mr. P. F. Mattingly to be based upon specimens of the new species, *C.* (*C.*) *mattinglyi*.

Culex (Culex) mattinglyi Knight

Distribution.—NEW RECORDS: Type series. 6 males, 21 females, 2 sets assoc. skins, numerous larvae. Wadi Dhahr (328, 331), Birket Shiekh Kunnaf (330), Rouda (333), and San'a (335). PREVIOUS RECORDS: None published. However, there are specimens in the British Museum from: San'a, II-1938 (from house at Bir-el-Azab), I-1938, III-1938, Scott and Britton (Mattingly, 1953). These were erroneously identified and published by Edwards (1941: 314) as *laticinctus*.

Discussion.—This species is most closely related to *laticinctus*.

Culex (Culex) pipiens Linnaeus

Descriptive Notes.—The DV/D ratio (Sundararaman, 1949: 307) for three male genitalia from Hamman 'Ali were -0.11, -0.13, and -0.15 (all negative); all being similar in this respect to *pipiens* from Cairo, Egypt (Knight and Abdel Malek, 1951: 178).

Ten larval specimens selected at random had the subdorsal hair of abdominal segment III double 17 times, triple twice, and missing once. The subdorsal hair of abdominal segment IV was double 16 times, triple twice, and missing twice.

Distribution.—NEW RECORDS: 1 male, 2 females, Ta'izz (312). Nine males, 6 females, 9 sets assoc. skins, 5 larvae, Hamman 'Ali (322). PREVIOUS RECORDS: None published. However, there are specimens in the British Museum from: Hada, about 4 miles west of San'a, I-1938, Scott and Britton. San'a, IX-1937, from lucerne field, Rathjens. San'a, I and II, 1938, Scott and Britton. San'a, from house at Bir-el-Azab, I-1938, Scott and Britton. (Mattingly, 1953).

Culex (Culex) quinquefasciatus Say

Descriptive Notes.—The DV/D ratio (Sundararaman, 1949: 307) for three male genitalia were 0.89, 1.00, and 1.19. In the 10 larval specimens, the subdorsal hair of abdominal segment III was single 18 times and double twice. The subdorsal hair of abdominal segment IV was single 15 times and double five times.

Distribution.—NEW RECORDS: 4 males, 4 females, 10 sets assoc. skins, Murawah (316). PREVIOUS RECORDS: None.

Culex (Culex) simpsoni Theobald

Descriptive Notes.—Both specimens show indications of a longitudinal pale line on the mid femur (see Edwards, 1941: 310). The male genitalia most resembles Edwards' figure (1941: fig. 106f) of a specimen from the Anglo Egyptian Sudan.

Distribution.—NEW RECORDS: 2 males, El-Hauban, Wadi el-Malah (308). PREVIOUS RECORDS: None.

Culex (Culex) sinaiticus Kirkpatrick

Descriptive Notes.—In general, these larvae resemble Hopkins' (1952: 295) description for this species. However, the Yemen specimens differ as follows: Comb composed of 32-40 spines and scales. Siphon index 7.3-7.9. Pecten with 10-18 spines. None of the siphonal hair tufts markedly out-of-line. Lateral hair of anal segment with 2-3 branches. Upper caudal seta with 1-4 branches. Ventral brush with 12 tufts (once with 11). Dorsal anal gills equal to anal plate in length and 1.5 length of ventral gills.

The larvae from 'Obal differ from those from Wadi Raidan in having the siphonal hair tufts 1.5 the width of the siphon at the point of attachment instead of only 1.0.

Distribution.—NEW RECORDS: 3 larvae, Wadi Raidan (313). 4 larvae, Wadi Siham, nr. 'Obal (321). PREVIOUS RECORDS: None.

Discussion.—Based upon Hopkins' (1952: 293) description of the larva of *simpsoni* Theobald, there appears to be no way by which the larva of *simpsoni* can be distinguished from that of *sinaiticus*. By combining the larval decription for *simpsoni* of MacGregor (1927) with his own, all known larval differences between these two species are eradicated. One possible remaining difference could be that the pecten teeth of *simpsoni*, according to the written description (Hopkins, 1952: 295), possess no more than two minute basal denticles. However, Hopkins' figure (1952: fig. 173) illustrates the pecten teeth with many ventral denticles and so, identical to *sinaiticus*.

✓ Culex (Culex) sitiens Wiedemann

Descriptive Notes.—ADULT: The Yemen adults resemble the variation described by Edwards (1941: 298) from the Red Sea coastal areas in that the background scaling is pale instead of dark, being brownish-yellow in the male and whitish-yellow in the female. Distinct areas of dark brown scaling occur anterior to the scutal angle (paired), before the prescutellar area, and above the wing base (paired). This dark brown scaling may become extensive enough to give the scutum an indefinite mottled appearance. Other differences are that the fore tibiae are anteriorly dark and the posterior margin of the costal vein always has a variable amount of pale scaling. The male genitalia is generally similar to that figured by Edwards (1941: fig. 102b) for the Red Sea coastal variant.

Larva (described from 8 adult-associated skins and 2 whole larvae, representing 4 collections).—ANTENNA: Shaft pigmented at extreme base and along portion beyond hair tuft, spiculate from base to level of hair tuft, slenderer and nearly smooth from there to apex. Antennal hair tuft (hair 1) inserted shortly beyond middle (0.6 from base), with numerous elongate frayed branches, hairs 2 and 3 slightly subapical and extending anteriorly slightly further than hair 4. HEAD: Clypeal spines stout, pigmented, usually swollen medially, obtuse, sometimes spiculate medially; hair 4 single; 5 with 5-8 branches; 6 with 4-5 (once with 8); 7 with 7-11; 8 with 2-5; 9 with 2-4, 10 with 1-2; 11 with 2-3; 12 with 2 (once single); 13 with 2-3; 14 single; 15 with 2-3. Mentum with 7 teeth on each side of the median tooth. ABDOMEN, I-VII: Hair 6 of I with 3 branches, hair 7 single. Hair 6 of II with 3 (occasionally with 4), of III-VI double. ABDOMEN, VIII: Hair 1 with 6-9 branches, hairs 2 and 4 single, hair 3 with 8-10, hair 5 with 4. Comb consisting of a patch of 41-58 scales, each scale with an evenly-expanding lateral and apical fringe. SIPHON: Pale; index 3.6-4.8; acus present; 5 or 6 more or less paired multiply-branched elongate ventral hair tufts present,

one pair of 2 or 3-branched subdorsal tufts beyond middle, the most basal pair of ventral tufts beginning either before or after the last pecten tooth; pecten composed of a line of 12-18 teeth, each tooth with numerous denticles ventrally along entire length. ANAL SEGMENT: Anal plate narrow, complete, with minute denticles along the dorso posterior margin; hair 1 (*lh*) single, slightly longer than anal plate; hair 2 (*isc*) with 2-5 branches, each more ventral branch longer than the preceding; hair 3 (*osc*) single; hair 4 (ventral brush) with 12 tufts (twice with 11), each tuft arising from the barred area. Anal gills broadly tapered, the dorsal pair 0.5-0.6 the length of the anal plate and 1.0-1.4 the length of the ventral pair.

Distribution.—NEW RECORDS: 58 males, 60 females, 62 sets assoc. skins, 20 larvae, Hodeida (314, 315, 318, 320). PREVIOUS RECORDS: None published. However, there are specimens in the British Museum from near Hodeida, III-1938, Scott and Britton (Mattingly, 1953).

Discussion.—Hopkins (1952: 284) states that he has seen no definitely-identified Ethiopian material of this species. Because of this, a full description of the larva of Yemen *sitiens* is given here. It differs from the Red Sea variant as keyed by Hopkins (1952: 248) as follows: Very frequently the most proximal siphonal hair tufts begin before the last pecten tooth, the comb scales are 41-58 in number instead of "about 35," *lh* is only slightly longer than the anal plate, and the dorsal gils are 0.5-0.6 the length of the anal plate instead of less than one-half.

Culex (Culex) theileri Theobald

Distribution.—NEW RECORDS: A very large series of all stages, El-Amra (300): El-Hauban, Wadi el-Malah (308, 311); Birket Ghail Masnah (323); Wadi Grab (324); Wadi Mal el-Ghail (325); Dhamar (327); and Birket Ma'agel-Biet Myiad (329). Additionally, there are specimens in the British Museum from the following localities: Hada, about 4 miles west of San'a, I-1938, Scott and Britton. San'a, X-1937, Rathjens. San'a, I-1938, from lucerne field, Scott and Britton. (Mattingly, 1953). PREVIOUS RECORDS: San'a (Edwards, 1941-306). This record duplicates in part the one given just above.

Culex (Culex) tritaeniorhynchus Giles

Descriptive Notes.—The Yemen specimens key satisfactorily in Hopkins (1952: 249).

Distribution.—NEW RECORDS: 3 larvae, Wadi Siham, nr. 'Obal (321). PREVIOUS RECORDS: None.

Culex (Culex) univittatus var. neavei Theobald

Distribution.—NEW RECORDS: Not taken. However, there is

one male and one female in the British Museum from Usaifira, nr. Ta'izz, XII-1937, Scott and Britton (Mattingly, 1953). PREVIOUS RECORDS: None.

SUMMARY

A collection of mosquitoes made early in 1951 in the Yemen is the basis for this paper. Taxonomic, biological, and distributional notes are given for the 27 included species. This collection raises the total of mosquito species known to occur in the Yemen to 29. Prior to the making of this collection, only five species of mosquitoes had been recorded in the literature from the Yemen.

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A REVIEW OF THE *CULEX PIPIENS* COMPLEX IN THE MEDITERRANEAN SUBREGION (DIPTERA, CULICIDAE).

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INTRODUCTION.

IT is now well established that two major biological forms of *pipiens* Linnaeus occur widely distributed in the Palaearctic region. These forms, variously considered species or subspecies, are treated under the names of *pipiens* L. and *molestus* Forskål by most present-day workers. In addition, other less well-known forms have been recognized, three of which have received the names of *berbericus* Roubaud, *sterno-pallidus* Roubaud and *sterno-punctatus* Roubaud.

Although much has been published on various phases of the *pipiens* complex, our knowledge of the taxonomy and biology of the included forms is still far from complete. This is due, in part to the meager morphological data available for the various forms, and in part to the absence of the necessary biological data from many portions of the geographical range. A further complicating factor is the incompleteness of our knowledge of the relationship of *pipiens* to its sister species, *fatigans* Wiedemann.

It is the purpose of this paper to review all of the diagnostic-type information available on the *pipiens* complex in the Mediterranean subregion of the Palaearctic region (as defined by Smart, 1948). For the sake of coherency it has been necessary to include information from the following European subregion countries: the British Isles, northern France, Germany, the Netherlands and Hungary.

Culex (*Culex*) *molestus* Forskål.

ADULT.—Summarized from Marshall and Staley (1937) and Jobling (1938).

Male.—First four segments of the palpi not exceeding the labium, including the labella (according to Marshall and Staley, 1935, equalling 86–100 per cent. of the length of the labium); segment III usually curved when seen from a lateral view. Scutum yellowish-brown (Ficalbi, 1893, described the scutum as being light reddish, almost rust-coloured). The dark scaling of the distal portion of the labium, the apical portion of the tergites and the dorsal surfaces of the femora and the tibiae lacking metallic blue reflections. Yellowish-white scaling at apices of femora and tibiae not visible as white dots to the naked eye. Abdominal sternites without postero-lateral patches of dark scales; median patches either absent, or else consisting of only a very few darkish scales. Ninth tergite lobes each bearing 7–15 setae (Jobling, 1938). However, in connection with these setae Marshall and Staley (1937) found averages as low as 6·8 and 7·2 for an English strain (Westminster). Their other strains (British: Hayling and Hull. France; Greece; Hungary; Malta) had averages of 9·5 to 14·7.

Female.—As in male but differing as follows: Apex of palpi sometimes having a vestige of a fourth segment (found by Jobling, 1938, in a Grecian strain and in a very few specimens of a German strain). The pale tergal bands of the female are described by Marshall and Staley (1937) as being not constricted, i.e., the basal and apical margins being straight and

parallel. However, Jobling (1938) states that the shape of the dark bands of the tergites is too variable for diagnostic use.

EGG.—Floor of micropylar apparatus with reticulations poorly defined, particularly towards the center (Roubaud, 1935). Index of greatest breadth to overall length with an average value of 0·24 (Marshall and Staley, 1935; Hayling strain). The shape of the raft and the arrangement of the included eggs are not as regular as in *pipiens* (Jobling, 1938). Often the eggs do not form rows at all. In almost every raft a number of eggs are arranged, obliquely. The shape of the raft may be rounded, square, triangular, oblong, ribbon-like or indefinite. The oblong and triangular rafts are generally laid by fed females. According to Jobling (1938), 120 rafts from unfed females contained 7–111 eggs with an average of 43, and 52 rafts from fed females contained 67–176 eggs with an average of 91. Christophers (1945) reports that the autogenous raft rarely exceeds 2 mm. in length, whereas the blood-meal raft may reach 3 mm. The total number of eggs contained in the autogenous raft and the first blood-meal raft of any single female is about equal to the total number of eggs contained in a single *pipiens* raft (Tate and Vincent, 1936).

LARVA.—Summarized from Jobling (1938). Anal papillae lengths are for larvae bred in rain-or tap-water.

First instar.—Distal portion of siphon dilated; the proximal edge of the pigmentation not sharply indicated. Siphon index 2·5–3·0, mean 2·7; length 209·1–299·3 microns, mean 265·5.

Second instar.—Siphon stout and almost straight, ventral surface straight except the most distal portion which bends inwards, dorsal surface slightly wavy. Siphon index 2·7–3·3, mean 3·0; length 426·4–508·4 microns, mean 457·2. Anal (ventral) brush with 9–19 branches, mean 13·0. Anal papillae about equal to the anal plate in length.

Third instar.—Ventral margin of siphon with a more regular curvature. Siphonal valves more or less triangular and broadly pointed from lateral view; ventral edge of valve lever with a rounded projection in middle, its dorsal edge more narrowly incurved. Siphon index 2·9–3·7, mean 3·2; length 610·5–925·0 microns, mean 746·0. Anal brush with 28–47 branches, mean 35·6. Anal papillae much shorter than anal segment.

Fourth instar.—Mentum with 18–24 teeth, mean 21 (median tooth not counted). Siphon is shorter and broader than in *pipiens*, and lacks the distinct sigmoid curve of *pipiens* because of the nearly straight dorsal surface. The valves are more or less triangular in lateral view, with a rounded apex; the valve lever narrows abruptly in two places and its narrow distal part is straight. Siphon index 3·5–4·8, means (4) of 3·9–4·4; length 1110·0–1554·0 microns, mean 1329·0. Extensive use has been made of the number of branches in the siphon hair tufts (Marshall and Staley, 1937, and Callot, 1947), but this character seems to be more indicative of local population differences than of anything else (Jobling, 1938). Anal brush with 59–90 branches, mean 70·5. Anal papillae shorter than anal segment.

VARIATIONS.—Although a number of morphological variations of the *pipiens* complex have been described, the absence of the necessary biological data in most of these cases makes it impossible at present to evaluate them. The following is the principal exception.

Lewis (1945) described the *pipiens* form occurring in the Anglo-Egyptian Sudan from Khartoum to Wadi Halfa on the Egyptian frontier as *molestus* on the basis of its man-biting habits and its breeding places (bilge-water of barges, pit latrines and in pools). No data are given concerning autogeny or stenogamy.

Adult: General colour dark brown. First four segments of male palpi are together about equal in length to the labium, sometimes slightly shorter or longer; segment III is

somewhat curved. Number of setae on each lobe of the 9th tergite 5–16, mean 8·9. *Larva*: Siphon index 3·5–5·3, mean 4·3. Some larvae had a slight sigmoid curvature of the siphon. The ventral valves and the valve lever vary in shape and some specimens were of the *pipiens* type.

Biology.—*Autogeny*: Perhaps the most interesting biological diagnostic character of *molestus* is its ability to lay eggs without a previous blood meal (autogeny). The historical aspects of our knowledge of autogeny in the *pipiens* complex have been extensively reviewed by Marshall and Staley (1937) and Jobling (1938), as have the problems relating to the selection of the name *molestus* for the autogenous form of *pipiens* and the restriction of the name *pipiens* to the anautogenous form (also Natvig, 1948).

By now it seems to be well established that autogeny in *molestus* is an inherited character (Roubaud, 1930; Vincent, 1933; De Buck, 1935; Tate and Vincent, 1936; Weyer, 1935; and Callot, 1947), rather than solely the result of the larval diet as believed by De Boissezon (1933, 1934). In nature the percentage of *molestus* females that can lay autogenously is quite small, but the ability to do so markedly increases in succeeding autogenous-selected generations (Mathis, 1940). Hybridization experiments between *molestus* and *pipiens* have shown that autogeny always appears in at least some of the offspring, but that its appearance may be delayed until the F_2 generation (Tate and Vincent, 1936). Since it is generally conceded that hybridization between these two forms occurs in nature, the above fact would make it possible to find autogeny present in some of the offspring of anautogenous wild-caught adults (as was done by Vincent, 1933).

The exact mechanism of autogeny has not been definitely demonstrated. One widely-held opinion is that the larvae of autogenous mosquitoes store up exceptional quantities of fat body, which is carried through into the adult stage and permits the maturation and oviposition of the eggs without further nourishment (Huff, 1929; Roubaud, 1931, 1933, 1934; Roubaud and Toumanoff, 1930; Roubaud and Mezger, 1934*a*; Hecht, 1932; Weyer, 1934; and Mathis, 1940).

Very little information is available upon the exact larval dietary requirements for autogeny, but it seems logical to believe that the larval food must be sufficiently rich in proteins and minerals to compensate for the amounts of these compounds that are normally obtained via the adult blood meal. Whatever the needed compounds are, they are apparently present in the ordinary laboratory larval diets of hay or dog-biscuit infusions, since these media prove quite satisfactory for maintaining autogenous cultures.

The maintenance of an autogenous colony by Tate and Vincent (1936) through 49 generations adequately demonstrates that the continuous use of autogenous powers does not devitalize the stock (spanogyny). Roubaud (1933) found that spanogyny did occur, but it seems likely that his cultural conditions in some way became unfavourable.

Since autogeny is not obligatory to *molestus*, it is an interesting problem as to what use *molestus* females make of a blood meal when it is taken before the initial egg laying, as they will readily do whenever it is offered. Jobling (1938) states that it not only permits the laying of a greater number of eggs but also of a greater number of viable eggs. Also, a blood meal is apparently necessary for a second (or later) egg-laying. And, of course, as with feedings

with sugar water, honey solution, sliced apple or other similar adult foods, a blood meal greatly prolongs adult life. Tate and Vincent (1936) report that autogenous females usually appear reluctant to take a blood meal before they have laid their autogenous rafts.

Copulation seems to be a prerequisite for autogenous egg-laying, as Vincent (1933) has reported that females fed on blood would lay unfertilized rafts, whereas autogenous rafts were almost invariably fertile.

Stenogamy : The ability to copulate in small spaces (stenogamy) is a second important diagnostic character for *molestus*, mating in this form having been reported in spaces as small as three cubic inches (16·39 c.c.) by Callot (1937). This is in marked contrast to *pipiens*, which requires a much larger space (eurygamy). More practical space volumes for stenogamic rearing of *molestus* range from 30 cubic inches (500 c.c.) (Marshall, 1938) to 663 cubic inches (10,867 c.c.) (MacGregor, 1932).

No definite maximum space volume has apparently been established for the diagnosis of the presence of stenogamy. However, Weyer (1935) reported that the anautogenous form would not mate in a space of 2400 cubic inches (39,336 c.c.) ; and Callot (1947) obtained fertilization in a eurygamous, anautogenous strain in a space of 3904 cubic inches (64,000 c.c.). Therefore, according to the results of these two investigators the minimum space requirement of *pipiens* should be somewhere between a cube of 13·5 inches and one of 15·5 inches.

Stenogamy is an inherited character. In crosses between eurygamous and stenogamous forms, stenogamy always appears in the F_1 generation (Vincent, 1933 ; Tate and Vincent, 1936).

In *molestus* the males copulate with resting females (Tate and Vincent, 1936) ; whereas in *pipiens* male swarms occur and the mating act begins in the air (Marshall, 1938).

Homodynamy : A third biological characteristic that is diagnostic for *molestus* is its ability to maintain reproductive activity throughout the year (homodynamy), as opposed to the intervention in the life cycle of a period of reproductive inactivity (heterodynamy) such as is the case with *pipiens*.

The mechanism of hibernation in mosquitoes is still inadequately known. However, according to Roubaud (1929, 1930, 1933) cyclical hibernation is obligatory in *pipiens* to allow recovery from a normally occurring specific debility. On the other hand, Bates (1949) believes it more likely that fat production (gonotrophic dissociation), and the following inactive period, is due to any combination of factors that tend to restrict the activity of the mosquito, rather than to the presence of some inner physiological rhythm. He would include here such factors as temperature and the length of the light period. As de Boissezon (1930) has pointed out, such restriction of activity probably results in a cessation of ovarian function due to the slowing down of the general metabolism, thus permitting the reserves normally used for egg maturation to be preserved and used for the survival of the hibernating female. The immediate cause of this cessation of ovarian function according to Wigglesworth (1949) is probably the failure of the corpus allatum to secrete the hormone necessary for egg production.

In view of the fact that Tate and Vincent (1936) were able to maintain a colony of *pipiens* (English strain) with the aid of artificial light and at labora-

tory temperatures through 11 generations without the occurrence of cyclical hibernation, it seems likely that the theory advanced by Bates is the more sound for this species at least.

If this theory is accepted, then it would appear that *molestus* (since it is homodynamic) should lack the ability to meet low temperatures by the production of fat body, and therefore would be less resistant to low temperatures than is *pipiens*, and that its activity should not be dependent upon the length of the daily light period. The former condition has been shown to be true in part by Jobling (1938), who found that *pipiens* is more active below 15° C. than is *molestus*. Further, it is now known that *pipiens* is probably the only subspecies in the most northern parts of Europe and that *molestus* is more common in the Mediterranean parts of the Palaearctic region (Jobling, 1938). The maintenance of *molestus* throughout the year in central Europe and in England is probably only possible because of its invasion of heated places during the winter. The second condition listed above is borne out by the fact that Jobling (1937) has shown that *molestus* can carry out complete development in total darkness.

Type of blood: A fourth biological character that has been commonly used for the separation of *molestus* from *pipiens* is host preference. Man and other mammalian animals are readily fed upon by *molestus*, whereas *pipiens* does so only rarely. This difference in feeding habits was one of the first clues to the discovery that more than one biotype of mosquito was being treated under the name *pipiens* (see Marshall and Staley, 1937, and Jobling, 1938, for the historical aspects of this problem).

In addition to mammals, *molestus* also feeds readily upon avian hosts. In connection with this it is of interest to note that bird blood results in the production of more eggs by *molestus* than does human blood (Roubaud and Mezger, 1934).

Miscellaneous: For some years *molestus* was believed to be strictly an urban species, in contrast to *pipiens*, which was regarded to be a rural species. That this distinction is no longer tenable is shown by Marshall (1938), who states, "The assumption that it is exclusively (or even chiefly) an 'urban' mosquito can no longer be supported. On the contrary, sufficient evidence has already been obtained to indicate that *C. molestus* and *C. pipiens* often co-exist in rural areas."

Another biological characteristic of *molestus* which apparently is of use in distinguishing it from *pipiens* is its ability to breed in water very rich in decaying organic material. Roubaud and Gaschen (1932) experimented with this capacity and found *molestus* more resistant than *pipiens* to solutions of human urine, ammonia, and ammonium carbonate.

DISTRIBUTION.—Using autogeny and stenogamy as the basic diagnostic characters for *molestus*, it has been definitely recorded from only the following localities in the Mediterranean subregion: France, Italy, Malta, Greece, Palestine and Egypt.

Culex (*Culex*) *molestus* var. *sterno-pallidus* Roubaud.

MORPHOLOGY.—This name was applied to the morphological variety of *molestus* in France which has the abdominal sternites without dark scaling.

Roubaud (1945) described two strains of this form, one from Aigues-Mortes and the other from the Pyrenees, which he stated differed slightly from one another biologically and morphologically.

BIOLOGY.—This variety is described as being stenogamic, homodynamic and autogenic.

Culex (*Culex*) *molestus* var. *sterno-punctatus* Roubaud.

MORPHOLOGY.—This name was applied to the morphological variety of *molestus* in France which has black spots medially on the abdominal sternites. As with *sterno-pallidus*, two strains are described. One, from Arles, showed the black spots consistently; but the other, from Paris, had these spots altogether lacking in about one-fifth of the examples. Roubaud (1945) believed this latter variation to be the result of hybridization between *sterno-pallidus* and *sterno-punctatus*.

BIOLOGY.—As with *sterno-pallidus*, this form is autogenic, stenogamic and homodynamic.

Culex (*Culex*) *pipiens* Linnaeus.

ADULT.—Summarized from Marshall and Staley (1937) and Jobling (1938).

Male.—First four segments of the palpi longer than the labium (according to Marshall and Staley, 1935, equalling 101–109 per cent. of the length of the labium in two English strains); segment III almost straight when seen from a lateral view. Scutum dark brown, in some specimens almost sepia. Distal portion of the labium, dark bands of the tergites and dorsal surface of the femora and tibiae bear very dark scales which have distinct metallic-blue reflections. White scales on apices of femora and tibiae visible as white dots to the naked eye. Sternites with median and postero-lateral patches of dark scales; the postero-lateral patches may be indistinct or absent. Ninth tergite lobes each bearing 6–11 setae, mean 8.

Female.—Apex of palpi is pointed and ends in a cup-shaped sensillum.

EGG.—Floor of micropylar apparatus with a well-defined reticulated area (Roubaud, 1935). Slenderer than the egg of *molestus*, the average value of the ratio of greatest breadth to overall length being 0·22 for an English strain (Marshall and Staley, 1935). The egg raft is symmetrical and boat-shaped, being formed of numerous eggs arranged in straight rows. One or two median rows are the longest and extend from one narrow end of the raft to the other. The majority of rafts contain from 150–300 eggs but extremes of 77 and 505 were observed (Jobling, 1938). Rafts may measure as much as 1·8 × 6·0 mm. in size (Christophers, 1945).

LARVA.—Summarized from Jobling (1938). Anal papillae lengths are for larvae bred in rain-or tap-water.

First instar.—The portion of the siphon beyond the constriction is funnel-shaped, and the portion before is convex ventrally and slightly concave dorsally in the middle; the proximal edge of the pigmentation is ragged and dark (more sharply indicated than in *molestus*). Siphon index 3·0–4·1, mean 3·6; length 266·5–348·5 microns, mean 310·8.

Second instar.—Siphon is slender, gradually narrowing distally and has a very slight sigmoid curvature; the ventral side is slightly concave along the basal part, whereas the dorsal side is convex on the basal half and concave distally. Siphon index 3·5–3·9, mean 3·7; length 434·8–572·5 microns, mean 473·8. Anal (ventral) brush with 8–13 branches, mean 10·2. Anal papillae are about as long as the anal segment.

Third instar.—Siphonal valves are double-pointed from lateral view. Ventral edge of valve lever is almost straight and the dorsal edge is broadly incurved. Siphon index

3·4–4·4, mean 3·9; length 703·0–925·0 microns, mean 810·3. Anal brush with 16–36 branches, mean 24·5. Anal papillae very much longer than the anal segment.

Fourth instar.—Mentum with 14–24 teeth, mean 18 (median tooth not counted). Siphon slender, gradually narrowing distally and has a slight sigmoid curvature which is much more distinct basally, where the ventral surface is concave and the dorsal one is convex. Each ventral valve is roughly rectangular with a blunt apex from lateral view. Valve lever narrows more or less uniformly towards the distal end, which is curved. Siphon index 4·5–6·1, mean 5·3; length 1184·0–1850·0 microns, mean 1573·8. Callot (1947) gave the siphon index of a French strain as 3·45–5·55 with three means of 3·8–4·15. Anal brush with 41–79 branches, mean 60. Anal papillae more than twice as long as anal segment.

Variations.—Lewis (1945) reported on 3 adults and 2 larvae from the Anglo-Egyptian Sudan (south of Khartoum) collected at 6000 to 10,000 feet elevation in the mountains. The adults were not appreciably darker than the material he felt to be *molestus*. In one male the first four segments of the palpi only just exceeded the proboscis in length. Sternites had distinct median and postero-lateral dark patches. One female had the abdominal tergite banding reduced. The number of setae on each lobe of the 9th tergite were 11–14. Siphonal indices of the two larvae were 5·8 and 6·1.

Biology.—The biological features that have thus far been found to be of diagnostic value in distinguishing between the members of the *pipiens* complex are discussed in some detail under the biological treatment for *molestus*.

Culex pipiens is anautogenous, eurygamous, heterodynamic, and ornithophilous. It is largely a rural species, and does not have the tolerance of *molestus* for larval breeding waters rich in decaying organic materials.

Although not adequately studied it is now known that more than one biotype of the anautogenous *pipiens* occurs (see the discussion of *Culex pipiens* var. *berbericus*).

Distribution.—Anautogenous, eurygamous *pipiens* has definitely been reported in the Mediterranean subregion from France and Italy.

Culex (*Culex*) *pipiens* var. *berbericus* Roubaud.

Morphology.—This name was applied by Roubaud (1933) to a form of the *pipiens* complex from Algeria on the basis of biological differences. No morphological data was given except that Roubaud pointed out it may correspond with the short siphon *pipiens* form recognized by Barraud (1921) in Palestine.

Biology.—This form was originally described as being anautogenous, stenogamous, homodynamous, and mammal-biting. Later, Roubaud (1939) found that it may sometimes exhibit autogeny, but attempted to explain this (1945) by saying that the involved material was probably hybrid.

Callot and Dao Van Ty (1943) found *berbericus* at Nice in southern France, differing from the Algerian material only in that it never exhibited autogeny. They also found two other strains of anautogenous, stenogamic *pipiens* in France (one at Richelieu and the other at Paris). However, these differed from *berbericus* in that they did not demonstrate any zoophilism. Roubaud (1945) suggested that the Richelieu strain must be a hybrid between *molestus* and *pipiens*, but later Callot (1947) found that its biological characters remained true through several generations. That there is a form in the United States

similar to *berbericus* is evidenced by the studies of Roth (1948) and Farid (1949), who worked with *pipiens* strains from Ohio and from Michigan and Maryland respectively and found them to be anautogenous and stenogamous (copulation occurred in spaces of 1815 and 107·5 cubic inches). In addition, pairing began in flight. No mention was made of host preferences.

A further biotype of *pipiens* was described by Roubaud (1944) from south France which combines the qualities of anautogeny, eurygamy, and anthrophilism (predilection for feeding on man).

Unnamed Morphological Varieties of the *pipiens* Complex.

(1) Theobald (1905) applied the name *quasimodestus* to a single female from Sfax, Tunis (Biro). Later Edwards (1921) described this as being a variant form of *pipiens* characterized by having the scutal scales more or less ochreous (some of the dark parts of the abdomen also tend to this colour).

(2) According to Edwards (1913) females of *pipiens* from British East Africa have extremely variable abdominal banding, being reduced in some specimens to inconspicuous pale lateral spots and with every gradation in between. Later, he (1921) stated that this variant occurred in the Mediterranean area, and Kirkpatrick (1925) specifically mentioned it as occurring in Egypt. Edwards (1921) believed it possibly to be associated with the Barraud larval variety. Still later Edwards (1926, 1941) repeated his 1913 remarks, and said that in Africa there is hardly any trace of a pale spot on the outer side of the hind tibial apex, and that the male palpi are longer than the proboscis by about one-half the length of the penultimate segment.

(3) A third variant has been described by Edwards (1921) from the Levant and Asia Minor in which the upper fork cell is shorter than usual, thus resembling *fatigans*. However, he did not find this variant in material from Mesopotamia, where both *pipiens* and *fatigans* occur.

(4) Barraud (1921) stated that *pipiens* larvae in Palestine differed from material from Western Europe and Mesopotamia (Iraq) in having a shorter siphon, a slightly smaller average number of pecten teeth, and the antennae light in colour. The abdominal bands were incomplete in some of the adults from these larvae. Edwards (1921) in speaking of this form described it as having 9–17 pecten teeth (average 12) and a siphon index of about 4·5.

Hybridization in *pipiens* Complex.

A number of investigators have performed crossing experiments between *molestus* and *pipiens* and between various strains of both forms (Vincent, 1933; Roubaud, 1933, 1945; De Buck, 1935; Tate and Vincent, 1936; Weyer, 1936; and Callot, 1947). In most cases fertile offspring have resulted from crosses of either sex, and it has been possible to show something of the genetic nature of autogeny and stenogamy, and also to hypothesize the fairly frequent occurrence of hybridization in nature. However, puzzling results have occurred in some cases, and it is clear that much more carefully-controlled experimentation is needed on this subject. Callot (1947) is practically the only investigator to have concerned himself about the results of hybridization on morphological characters, and even his work is not very conclusive, due to the fact that no very complete agreement has yet been reached on what the salient morphological characters are of *molestus* and *pipiens*.

Relationship of *pipiens* Complex to *fatigans*.

A further complicating factor in the *pipiens* complex is the close relationship of *fatigans*, which comes in contact with members of the *pipiens* complex in many portions of the world and has even been shown to produce intermediates with this complex in some of these places (Farid, 1949, and Sundararaman, 1949). Successful laboratory interbreeding between members of the *pipiens* complex and *fatigans* and the production of fertile hybrid offspring is also readily obtained (Weyer, 1936; Roubaud, 1941; Farid, 1949, Sundararaman, 1949).

In the Mediterranean sub-region the only real point of contact between the *pipiens* complex and *fatigans* known to occur at present is in lower Iraq (Mesopotamia) and in eastern Persia (Edwards, 1921); and no intermediates have yet been reported from this zone of contact (it is probable that the distribution of these two overlap in Eritrea and the Anglo-Egyptian Sudan, but these areas are on the northern edge of the Ethiopian region). However fortunate this condition is for students of the *pipiens* complex in the European and Mediterranean areas, it leaves unsettled the broader problem of terminology. Farid (1949) has suggested treating *fatigans* and *molestus* as subspecies of *pipiens* because of their proven interfertility in the laboratory, and Sundararaman (1949) has given evidence to show the presence of interbreeding in nature between *fatigans* and *pipiens*. Therefore, that the differences between these three (and the other *pipiens* biotypes that have been described) are infraspecific in character now seems to be indisputable. However, that they are all subspecies and thus fully equal in degree of evolution is impossible when the nature of the supposed differences between them are qualitatively examined.

Relationship of *Culex scotti* Theobald to the *pipiens* Complex.

This species, which is known only from the Seychelles Islands, is described by Edwards (1941) as closely resembling *pipiens* in terminalic structure. However, in ornamentation it resembles *C. musarum* Edwards or *C. ornatothoracis* Theobald. Because of the possibility that *scotti* might be a true member of the *pipiens* complex, a more detailed study of its morphology and biology certainly seems to be indicated.

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