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Description of *Fredwardsius*, a new subgenus of *Aedes* (Diptera: Culicidae)

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Abstract

A new subgenus *Fredwardsius* of genus *Aedes*, is described and compared with other subgenera. Distinctive features of the female, male, female and male genitalia, pupa, and fourth-instar larva of the subgenus are listed. The subgenus has a distribution in southern Europe, southern Asia, and Africa.

Introduction

Aedes vittatus (Bigot) has long been recognized as a distinctive species of mosquito that did not fully conform to any recognized subgenus of *Aedes*, as seen from the following comments. Edwards (1925:265) set the species apart from other species of subgenus *Stegomyia* Theobald and placed it in a monotypic group, Group I (*vittatus* group). He reported the following for the group "Especially remarkable in the adult for the presence of about four well-marked lower mesepimeral bristles, all the other species of the subgenus being devoid of such bristles. This feature, together with peculiarities of the hypopygium and larva, shows clearly that the species is not a true *Stegomyia*, and it may have to be removed from the subgenus." Edwards (1932:161), in his treatment of the worldwide mosquito fauna, again placed *Ae. vittatus* in a monotypic group of subgenus *Stegomyia* (Group D) and stated "*A. vittatus* shows several peculiarities apart from the presence of lower mesepimeral bristles; in regard to its larva it shows as much resemblance to *Aedimorphus* as to the other species of *Stegomyia*." Later, Edwards (1941:125, 126, 155) reiterated the uniqueness of *Ae. vittatus* and its aberrant placement in *Stegomyia*. Barraud (1934:245) considered *Ae. vittatus* as "...a somewhat aberrant species of *Stegomyia*..." Hopkins (1936:126; 1952:114) indicated that the larva of *Ae. vittatus* differed from other *Stegomyia* in morphology and immature habitats. Mattingly (1965:53) stated "This is by no means a typical *Stegomyia*. It has many features more reminiscent of *Aedimorphus* (as indicated by its previous inclusion in *Scutomyia* and *Reedomyia*). It also possesses some features recalling *Neomelaniconion* and the curious ♂ style is most nearly matched by that of *Ae. pogonurus* Edwards..." Reinert (1973:29), while outlining characters of subgenus *Stegomyia*, indicated "*Aedes vittatus* (Bigot) currently considered as a *Stegomyia* does not belong to this subgenus..." Huang (1977:113) believed that *Ae. vittatus* showed "a close resemblance to the subgenus *Aedimorphus* Theobald of *Aedes*, particularly with some rather basic genitalic characters in common with the *vexans* group of the subgenus *Aedimorphus*." As a result she transferred this species from *Stegomyia* to *Aedimorphus*.

After a comparison of *Ae. vittatus* with all currently recognized subgenera and genera in tribe Aedini, I find that the species possesses unique and unusual features that are of subgeneric rank. Therefore, I herewith establish the new subgenus, *Fredwardsius*, with *Ae. vittatus* as the type species. A description of the primary characteristics of this new subgenus is given below. Terminology used follows Harbach & Knight (1980, 1982), except for new terms described by Reinert (1990, 1999). The recommended three letter abbreviation for *Fredwardsius* is *Fre*.

Subgenus *Fredwardsius* Reinert, new subgenus
Type species: *Culex vittatus* Bigot, 1861

Female. *Head*: Vertex with narrow curved scales on median area and broad scales laterally; vertex and occiput with numerous, narrow, long, erect, forked scales; ocular line covered with narrow, curved scales, numerous well developed setae along posterior margin; interocular space covered with broad, white scales, few setae; eyes narrowly separated dorsally; antenna with large patch of overlapping, broad scales mesally on flagellomere 1, pedicel with broad, partially overlapping,

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white scales forming large patch on mesal and lateral surfaces and not connected ventrally or dorsally; maxillary palpus relatively short, with apical portion white-scaled, palpomeres 1-3 short, 4 long, and 5 tiny and budlike; clypeus with pair of small patches of moderately broad, white scales. *Thorax*: Scutum covered with narrow, curved scales except bare median portion of prescutellar area and small antealar patch of broad, white scales anterior to base of wing; scutal setae on following areas--few anterior promontory, several to numerous acrostichal (anterior and posterior), few antedorsocentral, numerous dorsocentral (anterior and posterior), several scutal fossal, several antealar, numerous supraalar, numerous prescutellar, and 1,2 parascutellar; scutellum with patch of broad scales and numerous well developed setae on middle and lateral lobes; mesopostnotum bare; anteprononotum widely separated, with narrow curved scales dorsally and broad scales laterally, several well developed setae; postpronotum with narrow curved scales dorsally and broad scales ventrally, few well developed posterior setae; prespiracular area bare; postspiracular area with broad white scales, few setae; upper proepisternum with broad white scales, few (4-7, usually 4-6) well developed setae; subspiracular area with broad white scales; paratergite with few narrow or moderately broad white scales on lateral margin (these apparently rubbed off in some specimens); mesokatepisternum with upper and lower patches of broad white scales, setae on upper, median posterior and lower areas; prealar area with broad white scales, several (usually 10-12) well developed setae; mesepimeron with large patch of broad white scales on middle and extending onto upper area, several upper posterior setae, 2-6 well developed lower setae; mesomeron with dorsal margin well above base of hindcoxa; metameron with broad white scales. *Legs*: Postprocoxal membrane with broad white scales; femora I-III each with narrow preapical white-scaled band and with apex white-scaled; tibiae I-III each with white-scaled band at about 0.3-0.5 from base; tarsus III with tarsomeres 1-4 each with broad, white-scaled, basal band, tarsomere 5 white-scaled or nearly so; posttarsi I,II each with 2 ungues equal in size and with one tooth, III with ungues equal in size, both simple. *Wing*: Remigial setae absent; alula with row of numerous narrow scales on posterior margin; upper calypter with numerous setae on margin. *Abdomen*: Terga II-VI each with basal white-scaled band and basolateral white-scaled patches, band and patches not connected; segments VI,VII dorsoventrally flattened.

Female genitalia Segment VIII 0.9-1.0 retracted into segment VII. *Tergum VIII*: More or less trapezoid-shaped but with base concave; usually without scales (only 1-5 when present). *Sternum VIII*: Heavily pigmented but with narrow median apical lightly pigmented area; apex with moderately deep and narrow median emargination separating broadly rounded lobes that have outer portion flattened; scales absent; intersegmental membrane between segments VII and VIII long. *Tergum IX*: Moderately wide and moderately long; with 2 apical lobes separated by moderately deep median emargination; 3-6 setae apically on each lobe. *Insula*: Tonguelike; 3-9 tuberculi located on apical 0.3, each with short stout setalike spicule. *Lower vaginal lip*: Narrow; sclerite absent. *Upper vaginal lip*: Narrow; more or less stirrup-shaped; sclerite moderately large to large, heavily pigmented, posterior margin jagged. *Spermathecal eminence*: Membranous; more or less circular with basal area flattened; with numerous short simple spicules on basal 0.4-0.5. *Postgenital lobe*: Moderately long to long, narrow throughout entire length; apex flat or with median emargination; 14-17 setae forming elongate median patch on ventral surface. *Cercus*: Moderately long to long; moderately wide with basal 0.63-0.71 having uniform width; apex bluntly rounded; scales absent; index 2.42-3.10. *Spermathecal capsules*: One large- and 2 medium-sized ones, heavily pigmented, spherical.

Male Similar to female but differs in the following. *Head*: Vertex of some specimens without narrow curved scales on median area; antenna strongly plumose, setae directed mainly dorsally and ventrally; maxillary palpus noticeably longer than proboscis by about length of palpomere 5, palpomeres 2-5 each with well developed white-scaled basal band, palpomeres 4,5 thin, upturned, palpomere 3 with few short setae apically, palpomere 4 with several short setae lateroventrally along most of length, palpomere 5 with few very short setae ventrally and apically; clypeus without scales. *Thorax*: Anteprononotum with narrow curved scales reduced in number dorsally; 1-4 lower mesepimeral setae. *Legs*: Posttarsi I, II each with one large and one moderately large unguis, each with one tooth.

Male genitalia *Tergum VIII*: With median posterior margin strongly convex and bearing numerous long stout setae. *Tergum IX*: Posterior margin with pair of small lobes bearing several short thin and often 1-3 slightly thicker setae. *Gonocoxite*: Moderately long; relatively narrow; dorsal surface with scales, several long stout setae, and elongate patch of moderately long, thin setae on mesal margin; ventral surface with numerous scales and short and long setae, and small apicomesal lobe bearing several, moderately long, thin setae. *Gonostylus*: About 0.7 length of gonocoxite; proximal area

narrow; distal approximately 0.5 greatly expanded with dorsal surface bearing numerous minute spicules and several short thin setae apically; ventral surface covered with relatively long spicules in rows; gonostylar claw long, relatively narrow, strongly curved, and borne on short projection at base of expanded area. *Basal mesal lobe*: Distal portion developed as large oblong lobe that is mostly detached from mesal surface of gonocoxite, bearing very short setae on ventromesal area and row of somewhat stouter setae on mesal margin, 3-6 setae at proximal area of row slightly longer and curved. *Proctiger*: Relatively short; apex bluntly rounded; paraproct heavily pigmented and with short basoventral narrow projection; cercal sclerite large, heavily pigmented; cercal setae absent. *Phallosome*: Aedeagus relatively short, consisting of 2 lateral plates, each with several lateral and 2,3 long curved apical teeth, and proximal part covered with dorsal flap; paramere narrow and longer than aedeagus; basal piece short and wide. *Sternum IX*: Without setae or scales.

Pupa *Cephalothorax*: Lateralia with area of well developed ocular cuticular facets; setae 1-3-CT thin, usually single, relatively short, 2-CT shortest; 7-CT moderately long, branched. *Trumpet*: Relatively short; widest on distal 0.3; pinna with relatively wide opening. *Abdomen*: Seta 2-I short, single; 3-I long, normally single; 2,3-I with alveoli close together; 1-II short, with multiple fine branches; 2-II short, laterad of 1,3-II; 7-II moderately long, longer and stouter than 6-II; 1-III-VI short, with fine branches; 2-III-V mesad of 1-III-V; 3-III approximately 0.8 length of segment IV, single, often slightly anterolaterad of 1-III, but sometimes anterior or anteromesad of 1-III; 4-III, IV, 6-III-VI normally single, 4-III,IV short and fine; 5-IV,V single, nearly equal to length of following segment; 2-VI,VII anterior or slightly anterolaterad of 1-VI,VII; 6-IV-VI relatively long, dorsomesad of 9-IV-VI and inserted at approximately same level; 5-VI single, approximately 0.5 length of segment VII; 6-VII short, with few fine branches, posteromesad of 9-VII; 9-VII moderately long, with few stout aciculate branches; 4-VIII single, noticeably longer than 9-VIII; 9-VIII moderately long, with several stout aciculate branches; male genital lobe with tiny spicules on much of ventral surface, index 1.13-1.23. *Paddle*: With apical margin somewhat flattened; lateral margin with very few minute spicules; margin without fringe of long hairlike spicules; seta 1-Pa long, single.

Fourth-instar larva *Head*: Darkly pigmented; seta 4-C tiny, with very few (2-4) fine branches, slightly posteromesad and near 6-C, anteromesad of 5-C; 5,6-C moderately long, single, both nearly equally developed; 5-C well separated and posterior to 4,6-C; 7-C moderately long, with several branches, posterolaterad of 6-C and anterolaterad of 5-C; 8,9,13,14-C single; 11-C short, with few fine branches; labiogula short. *Antenna*: Short; with or without few tiny spicules on shaft; seta 1-A short, with few branches, lightly aciculate. *Thorax*: Seta 1-P long, stout, aciculate, single; 2-P moderately long, fine, single; 3-P short, with very few (2,3) fine branches; 5,6-P long, single, 5-P longer than 6-P; 8-P relatively long, stout, aciculate, 2,3-branched; 6-T single. *Abdomen*: Seta 1-I-VI short, with several fine branches; 5-I-VI short, inserted at same level or slightly posterior to 6-I-VI, 5-II-V single (rarely 2-branched); 6-I-III moderately long, branched, nearly equal in development and length but 6-III slightly shorter; 3-II-VI moderately long, single; 7-I,II moderately long, branched; 10-I-VII moderately long, single; 12-I absent; 13-III-V long, single; 4-VII long, single, noticeably longer than 1,3-VII; 1-VIII short, with several fine branches; 2-VIII moderately long, single; 1,2-VIII with alveoli relatively close together; comb on segment VIII composed of several (5-10) thornlike scales in an irregular row; 1-X short, fine, single, inserted on saddle near posteroventral margin; saddle small, restricted to posterodorsal area of segment X; 2-X relatively short, with several (4-7, usually 5) branches; 3-X moderately long, single; 4-X composed of 7,8 (rarely 7) 3-8-branched setae attached to grid and 3-5 (usually 4) shorter, 3-10-branched precratal setae. *Siphon*: Darkly pigmented; short and relatively broad at base; pecten with numerous (16-28) evenly spaced spines except for 1,2 more widely spaced spines distally, most spines long and narrow with few basoventral denticles; seta 1-S short, with several branches, aciculate, inserted basad of terminal pecten spine; 6-S single; 8-S branched.

Egg Scanning electron microphotographs of *Ae. vittatus* eggs were published by Hinton & Service (1969) and Hinton (1981). These articles should be examined for details of the chorion.

Distribution Kumm (1931:52-55, 102) gave a compilation of collection localities and a distribution map for *Ae. vittatus* that he derived from published literature, unpublished communications, and his collections. Edwards (1941) listed the distribution for this species in Africa and elsewhere. Mattingly (1952:255, 259, 292; 1953:48, 53; 1954:269; 1965:56) provided updated listings and/or maps of the distribution for the species. For *Ae. vittatus*, Knight & Stone (1977:166) gave

a broad distribution, Huang (1977:117, 118) listed an extensive distribution of material examined, Rodhain *et al.* (1977:317) included Djibouti, Smith (1981) included Niger, and Snow & Ramsdale (1999:16, 18) provided its distribution in Europe.

The following distribution of the subgenus is based on the above records of *Ae. vittatus*. Countries are listed in alphabetical order and spelled as in Merriam Webster's Geographical Dictionary (3rd edition, Merriam-Webster, Inc., Springfield, MA): Angola, Algeria, Benin, Botswana, Burkina Faso, Cambodia, Cameroon, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, France, Gambia, Ghana, India, Italy, Ivory Coast, Kenya, Liberia, Malawi, Malaysia, Morocco, Mozambique, Myanmar, Namibia, Niger, Nigeria, Pakistan, People's Democratic Republic of Yemen, People's Republic of China, Portugal, Republic of Sudan, Saudi Arabia, Sierra Leone, Somalia, South Africa, Spain, Sri Lanka, Tanzania, Thailand, Tunisia, Uganda, Vietnam, Zambia, and Zimbabwe.

Specimens of *Ae. vittatus* from Cambodia, Democratic Republic of the Congo, France (Corsica), India, Kenya, Malaysia, South Africa, Sri Lanka, Thailand, and Vietnam, were examined during this study.

Bionomics The usual habitat of the immature stages of *Ae. vittatus* is water in rock pools and rock holes. However, immatures occasionally have been collected from other sites (e.g., treeholes, bamboo pots, hoofprints, wells, and artificial containers). Females have been reported to feed on humans, sometimes in fair numbers. Mattingly (1965), Service (1970), and Huang (1977) provide detailed reports on the biology of *Ae. vittatus* and should be examined for additional information.

Discussion The above description of the monotypic subgenus *Fredwardsius* is based on the type species, *Ae. vittatus*. Illustrations of the adults (female and male), female and male genitalia, pupa, and fourth-instar larva of *Ae. vittatus* were provided by Huang (1977, Figs. 1-6). In her Figure 6B, the structures on the distal portion of the insula are seta-like spicules that are on small tuberculi. Descriptions and illustrations of the four larval instars were provided by Service (1970). Most papers on *Ae. vittatus* published prior to 1952 are cited by Mattingly (1952, 1953, 1965), while several others are given in Huang (1977), therefore a list of these references is not provided here.

Unique or unusual features that distinguish subgenus *Fredwardsius* within Aedini follow: **female**--femora I-III each has a narrow, preapical, white-scaled band and the apex is white-scaled; antepronotum has narrow, curved scales dorsally and broad scales laterally; clypeus has a pair of white-scaled patches; mesepimeron has 2-6 well developed setae on the lower area; maxillary palpus is 5-segmented and has palpomeres 1-3 short, 4 long, and 5 tiny and budlike; and antennal pedicel has a large patch of broad, partially overlapping, white scales on both the mesal and the lateral surfaces and the patches are not connected ventrally or dorsally; **female genitalia**--postgenital lobe is narrow throughout its length and bears a group of setae on the median area of the ventral surface; sternum VIII is without scales and is heavily pigmented but has a narrow, median, apical, lightly pigmented area and the apex has a deep and narrow, median emargination that separates broadly rounded lobes, each with its outer portion flattened; and upper vaginal sclerite is well developed and has the posterior margin jagged; **male**--maxillary palpus is noticeably longer than the proboscis by about the length of palpomere 5, palpomeres 2-5 each has a well developed white-scaled band basally, palpomeres 4 and 5 are thin and upturned, palpomere 3 has only a few short setae apically, palpomere 4 has several short setae lateroventrally along most of its length, and palpomere 5 has a few very short setae ventrally and apically; **male genitalia**--gonostylus has the distal approximately 0.5 greatly expanded and has the dorsal surface with numerous minute spicules and several short thin setae apically, the ventral surface of the expanded area is covered with relatively long spicules in rows and bears a long, narrow, strongly curved, gonostylar claw that is situated on a short projection at the base of the expanded area; basal mesal lobe has the distal portion developed as a large, oblong lobe that is mostly detached from the mesal surface of the gonocoxite and it bears only very short setae; gonocoxite is relatively narrow and has its ventral surface with a small apicomesal lobe bearing several moderately long, thin setae; sternum IX is without setae and scales; and tergum VIII has the median posterior margin strongly convex and bearing numerous long, stout setae; **pupa**--seta 1-II is short and has multiple fine branches; seta 4-III,IV is short, fine, and single; seta 4-VIII is noticeably longer than seta 9-VIII; seta 6-IV-VI is relatively long, situated dorsomesad of seta 9-IV-VI and is inserted at approximately the same level; and paddle has the apical margin somewhat flattened, the lateral margin has only a very few minute spicules, and the margin is without a fringe of long hairlike spicules; **fourth-instar larva**--positions and development of setae 4-7-C are distinctive (see description above); seta 8-P is relatively long, stout, aciculate, and 2,3-

branched; seta 4-VII is long, single, and noticeably longer than setae 1,3-VII; seta 1-VIII is short and branched whereas seta 2-VIII is long and single; seta 5-I-VI is short and on II-V is single (rarely 2-branched); seta 1-X is short, thin, single, and is inserted on a relatively small saddle near the posteroventral margin; and ventral brush (seta 4-X) is composed usually of 8 setae each with 3-8 branches that are attached to the grid, and 3-5 precratal setae each with 3-10 branches. The combination of the above characters easily separates *Fredwardsius* from all subgenera and genera of Aedini.

The unusual development of the female maxillary palpus of *Ae. vittatus* with palpomere 5 tiny and budlike is similar to species of the Edwardsi and W-albus Groups of *Stegomyia* (as defined by Huang, 1977), *Ae. meronephada* (Dyar & Shannon) (as illustrated by Huang, 1978), and apparently in some specimens of *Ae. (Stg.) aegypti* (Linnaeus) (see Huang, 1979). The antennal pedicel with a large patch of broad, partially overlapping, white scales covering the mesal and lateral surfaces is similar to species of subgenera *Stegomyia* and *Rusticoidus* Schevchenko & Prudkina. White scales on the clypeus of the female of *Ae. vittatus* are very unusual, but within Aedini this feature also is found in *Ae. (Stg.) aegypti* and *Ae. (Stg.) mascarensis* MacGregor, and in a few species (both sexes) of genus *Armigeres* Theobald. Males of these three species of *Aedes* have the clypeus bare. The development of the male maxillary palpus of *Ae. vittatus* is similar to those of subgenus *Stegomyia* except that it is noticeably longer than the proboscis. Well developed setae on the lower anterior area of the mesepimeron of females also are found in species of some other subgenera and genera (e.g., subgenera *Bothaella* Reinert, *Cancraedes* Edwards, *Christophersomyia* Barraud, *Halaedes* Belkin, *Huaedes* Huang, *Isoaedes* Reinert, *Leptosomatomyia* Theobald, *Mucidus* Theobald, *Rusticoidus*, *Skusea* Theobald, the Edwardsi Group of *Stegomyia*, some *Diceromyia* Theobald and *Ochlerotatus* Lynch Arribalzaga, many *Neomelaniconion* Newstead, and genera *Ayurakitia* Thurman, *Opifex* Hutton, *Psorophora* Robineau-Desvoidy, *Zeugnomyia* Leicester, subgenus *Heizmannia* of genus *Heizmannia* Ludlow, and some species of subgenus *Armigeres* of genus *Armigeres* Theobald). Reinert (2000) elevated *Ayurakitia* to generic rank. A white-scaled band at about 0.3-0.5 from the base of tibiae I-III also is found in *Ae. (Stg.) desmotes* (Giles).

Male genitalia with the gonostylus having the distal portion greatly expanded occurs in *Ae. (Neo.) pogonurus*, *Ae. (Zavortinkius) brygooi* Brunhes, and most species of subgenus *Aedimorphus*; however, there is only a superficial resemblance to *Ae. vittatus* in which this structure is markedly different in development (see description above). The basal mesal lobe of the male genitalia of *Ae. vittatus* also is uniquely developed in the Aedini. The male aedeagus with toothed lateral plates covered with a dorsal flap proximally is similar to species of some other subgenera and genera (e.g., subgenera *Aedimorphus*, *Albuginosus* Reinert, *Diceromyia*, *Huaedes*, and *Leptosomatomyia*, and genera *Ayurakitia* and *Udaya* Thurman).

Fourth-instar larvae of *Fredwardsius* have the distal 1,2 pecten spines more widely spaced than those proximally on the siphon. This feature is similarly developed in species of subgenera *Aedes* Meigen, *Aedimorphus*, *Edwardsaedes* Belkin, *Isoaedes*, *Neomelaniconion*, *Rusticoidus*, many *Ochlerotatus*, some *Mucidus*, the Dendrophilus Group of *Stegomyia*, and genus *Verrallina* Theobald. Larval seta 8-P is long, stout and aciculate but a similarly developed setae is found in species of genus *Aedes*, subgenera *Aedes*, *Christophersiomyia*, *Neomelaniconion*, *Paraedes* Edwards, and many *Aedimorphus* and *Ochlerotatus*, and genera *Psorophora* (subgenera *Grabhamia* Theobald and *Janthinosoma* Lynch Arribaizaga) and *Verrallina* Theobald.

Fredwardsius shares some features with subgenera *Stegomyia* and *Aedimorphus* as pointed out here and by others, but as seen from the above list of unique and unusual features it is easily separated from these two subgenera as well as all aedine genera and subgenera.

Some variation in *Ae. vittatus* was noted in specimens from some geographical areas, e.g., vertex of females had more extensive pale-scaled areas and the numbers of pleural setae varied; and female genitalia showed variation in the length of the cercus, width of tergum IX, presence or absence of the basal lateral setae on sternum VIII and tergum VIII, depth of the median apical emargination of sternum VIII, and shape of the apex of the postgenital lobe. Variation of the trumpet index, male genital lobe index, and the location of setae 1,3-III was noted in pupae from different areas.

Freyvogel & McClelland (1969) examined the isozymes of European and African strains of *Ae. vittatus* and reported: "Zymograms of esterase and alkaline phosphatase, separated by disc-electrophoresis, showed that in females of Italian and Rhodesian strains of *Aedes (Stegomyia) vittatus* (Bigot) and their reciprocal hybrids: (1) the two strains exhibited a real difference in their esterase isozymes and a quantitative difference in their alkaline phosphatases; (2) in the esterase pattern of the hybrids some of these differences assumed an intermediate character and some seemed to follow a new pattern; (3) the alkaline phosphatase pattern of the hybrids tended to show a greater resemblance to their respective maternal parents."

Because of the morphological and isozyme variations noted in *Ae. vittatus*, it seems advisable that material from throughout its wide geographical range should be evaluated by modern molecular and morphological techniques.

I take pleasure in naming the new subgenus, *Fredwardsius*, for Frederick W. Edwards, who during his approximately 30 years of work at the British Museum (Natural History) (now The Natural History Museum) published numerous outstanding articles on the systematics of the Culicidae. Many of his latter papers provided an insight that established the generic and subgeneric framework of the family that remains little changed today.

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References

Barraud, P.J. (1934) *The fauna of British India, including Ceylon and Burma.* Diptera, Vol. V. Family Culicidae. Tribes Megarhinini and Culicini. Taylor and Francis. London, United Kingdom. 463 pp. + plates I-VIII.

Edwards, F.W. (1925) Mosquito notes.--V. *Bulletin of Entomological Research* **15**, 257-270.

Edwards, F.W. (1932) Diptera, Fam. Culicidae. In: P. Wytsman, *Genera Insectorum*. Desmet-Verteneui, Brussels, Fasc. 194. 258 pp.

Edwards, F.W. (1941) Mosquitoes of the Ethiopian Region III.--Culicine adults and pupae. *The British Museum (Natural History)*. London. United Kingdom. 499 pp.

Freyvogel, T.A. &. McClelland, G.A.H (1969) Differences in hydrolase isozymes of Italian and Rhodesian strains of *Aedes vittatus* (Bigot) (Diptera: Culicidae) and their hybrids. *Proceeding of the Royal Entomological Society of London (A)* **44**(4-6), 80-84 + plates I & II.

Harbach, R.E. & Knight, K.L. (1980) *Taxonomists' glossary of mosquito anatomy.* Plexus Publishing, Inc. Marlton. NJ. 415 pp.

Harbach, R.E. & Knight, K.L. (1982) Corrections and additions to *Taxonomists' Glossary of Mosquito Anatomy. Mosquito Systematics* (1981) **13**, 201-217.

Hinton, H.E. (1981) *Biology of insect eggs,* Volume III. Pergamon Press. Oxford. United Kingdom.

Hinton, H.E. & Service, M.W. (1969) The surface structure of aedine eggs as seen with the scanning electron microscope. *Annals of Tropical Medicine and Parasitology* **63**, 409-411.

Hopkins, G.H.E. (1936) *Mosquitoes of the Ethiopian Region I.--Larval bionomics of mosquitoes and taxonomy of culicine larvae.* The British Museum (Natural History). London. United Kingdom. 250 pp.

Hopkins, G.H.E. (1952) *Mosquitoes of the Ethiopian Region I.--Larval bionomics of mosquitoes and taxonomy of culicine larvae.* Second edition. The British Museum (Natural History). London. United Kingdom. 355 pp.

Huang, Y-M. (1977) Medical entomology studies - VIII. Notes on the taxonomic status of *Aedes vittatus* (Diptera: Culicidae). *Contributions of the American Entomological Institute (Ann Arbor)* **14**(1), 113-132.

Huang, Y-M. (1978) Redescription and subgeneric position of *Aedes meronephada* (Dyar and Shannon) with notes on the subgenus *Diceromyia* (Diptera: Culicidae). *Mosquito Systematics* **10**, 334-350.

Huang, Y-M. (1979) Medical entomology studies - XI. The subgenus *Stegomyia* of *Aedes* in the Oriental Region with keys to the species (Diptera: Culicidae). *Contributions of the American Entomological Institute (Ann Arbor)* **15**(6), 1-79.

Knight , K. L. & Stone, A.(1977) *A catalog of the mosquitoes of the world (Diptera: Culicidae).* Volume VI. Second edition. The Thomas Say Foundation. Entomological Society of America. College Park. MD. 611 pp.

Kumm, H.W. (1931) Yellow fever vectors, a compilation of material recorded in the literature, unpublished communications, and certain collections made by the author in Nigeria, west Africa. *The American Journal of Hygiene, Monographic Series No. 12.* 110 pp.

Mattingly, P.F. (1952) The sub-genus *Stegomyia* (Diptera: Culicidae) in the Ethiopian Region I. A preliminary study of the distribution of species occurring in the West African Sub-region with notes on taxonomy and bionomics. *Bulletin of The British Museum (Natural History), Entomology* **2**(5), 233-304.

Mattingly, P.F. (1953) The sub-genus *Stegomyia* (Diptera: Culicidae) in the Ethiopian Region II. Distribution of species confined to the East and South African Sub-region. *Bulletin of The British Museum (Natural History), Entomology* **3**(1), 1-65.

Mattingly, P.F. (1954) Notes on the subgenus *Stegomyia* (Diptera, Culicidae), with a description of a new species. *Annals of Tropical Medicine and Parasitology* **48**, 259-270.

Mattingly, P.F. (1965) *The culicine mosquitoes of the Indomalayan area Part VI. Genus Aedes Meigen, subgenus Stegomyia Theobald (Groups A, B and D).* The British Museum (Natural History). London. United Kingdom. 67 pp.

Reinert, J.F. (1973) *Aedes wainwrighti* Baisas, a synonym of *Aedes (Stegomyia) meronephada* (Dyar and Shannon), with notes on the subgenus *Stegomyia* Theobald (Diptera: Culicidae). *Mosquito Systematics* **5**, 27-30.

Reinert, J.F. (1990) Medical entomology studies - XVII. Biosystematics of *Kenknightia*, a new subgenus of the mosquito genus *Aedes* Meigen from the Oriental Region (Diptera: Culicidae). *Contributions of the American Entomological Institute (Gainesville)* **26**(2), 1-119.

Reinert, J.F. (1999) Descriptions of *Zavortinkius*, a new subgenus of *Aedes*, and the eleven included species from the Afrotropical Region (Diptera: Culicidae). *Contributions of the American Entomological Institute (Gainesville)* **31**(2), 1-105.

Reinert, J.F. (2000) Restoration of *Ayurakitia* to generic rank in tribe Aedini and a revised definition of the genus. *Journal of the American Mosquito Control Association* (in press).

Rodhain, F., Boutonnier, A., Carteron, B. & Morvan, D. (1977) Les culicides du territoire Francais des Afars et des Issas 3. Les genres *Aedes, Culiseta, Uranotaenia* et *Mimomyia. Bulletin de la Societé de Pathologie Exotique* **70**, 316-319.

Service, M.W. (1970) Studies on the biology and taxonomy of *Aedes (Stegomyia) vittatus* (Bigot) (Diptera: Culicidae) in northern Nigeria. *Transactions of the Royal Entomological Society of London* **122**(4), 101-143 + plates I & II.

Smith, D.M.S. (1981) Mosquito records from the Rupublic (sic) of Niger, with reference to the construction of the new 'Trans-Sahara Highway'. *Journal of Tropical Medicine and Hygiene* **84**, 95-100.

Snow, K. & Ramsdale, C. D. (1999) Distribution chart for European mosquitoes. *European Mosquito Bulletin* **3**, 14-31.