

History of Mosquito Systematics

Part I. Eighteenth Century

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An exposure to mosquito systematics, as in any field of human endeavor, cannot help but make one reflect upon the course of events which brought us to our present position. If investigation follows reflection, one confirms the fact that the web of history is built of people and that the point at which our science stands today is the result of their interactions. In an effort to better understand concepts prevailing today in mosquito systematics, I began some time ago to look up details in the lives of the individuals who have earlier made contributions to this field. This proved so fascinating that the effort was continued whenever time permitted. Although still very meager, these results are passed on here for the edification of anyone similarly interested.

Although a few mosquito descriptions were published earlier, the official beginning of mosquito systematics is January 1, 1758, the date established by the International Code of Zoological Nomenclature as marking the beginning of the consistent general application of binominal nomenclature in zoology. This date is arbitrarily assigned in the Code as the date of publication of the tenth edition of Linnaeus's *Systema Naturae*. Any other work published in 1758 is to be treated arbitrarily as having been published after that edition.

Two species, now attributable to *Culicidae*, were described by Linnaeus in the tenth edition: *Culex pipiens* and *Culex bifurcatus*. As one would guess, the one-line descriptions provided by Linnaeus did not adequately describe the species involved. However, Meigen (Howard, Dyar, Knab 1915, 367) appears to have been the first to associate *C. pipiens* with the cosmopolitan northern house mosquito and through the ensuing decades this identity finally has become solidly accepted by mosquito systematists (Dyar and Knab 1909, 30), although it is not as firmly settled as to which biotype the name applies. *C. bifurcatus* was considered for many years to be an *Anopheles* but finally has come (Edwards 1932, Stone et al 1959) to be regarded as *pipiens* also and falls to that species on page priority. However, Natvig (1948) presents evidence that *bifurcatus* is not equal to *pipiens* and the matter must be considered as not definitely settled.

Four other species of *Culex* were named by Linnaeus in the Tenth Edition: *pulicaris*, *reptans*, *equinus*, and *stercoreus*. According to Dyar and Knab (1909) *pulicaris* is a ceratopogonid and *reptans* and *equinus* are species of *Simulium*. *C. stercoreus* L. is now known as *Xanthempis stercorea* (L.) in the Empidae (Steyskal, personal communication).

The name Culex aegypti Linnaeus first appeared in a work by Hasselquist which had been published in 1757 under the title Iter Palaestinum. In the Iter Palaestinum, Hasselquist in a number of cases employed Latin binominal names supplied to him by Linnaeus, but, as these names were published before the starting point of zoological nomenclature they are not available for use. However, the same names appeared in a German translation by T. H. Gadebusch published in 1762 entitled Reise nach Palästina and have eventually been accepted for use as of that date. The nomenclatorial involvements of this mosquito species did not end here, but through the years included several major name changes and the subsequent discovery that it had long been incorrectly named. This story is detailed in a paper by Mattingly, Stone and Knight (1962) in which they asked the International Commission on Zoological Nomenclature to use its plenary powers to provide for the continued use of the name Culex aegypti Linnaeus, 1762, for the Yellow Fever Mosquito. This application was subsequently approved.

Linnaeus subsequently published the name Culex ciliaris, 1767 (now considered a nomen dubium in Aedes) and in 1792 Culex vulgaris (nomen dubium in Culex) and Culex alpinus (possibly a species of Simulium).

Although Linnaeus' contributions to the systematics of Culicidae were negligible, it is of interest not only that two of his names still are in use today, but that they designate perhaps the two most important mosquito species known to us today. Additionally significant is the fact that the family Culicidae is based upon the genus Culex of Linnaeus.

Linnaeus had experienced mosquitoes in Lapland and they evidently made a lasting impression upon him as he speaks of them as "most abundant" and as a terrible plague in that country. Nonetheless, it is obvious that he had no accurate concept of them phylogenetically since he also included species of Ceratopogonidae, Simuliidae and even Empidae in his genus Culex.

Other workers publishing mosquito species in the eighteenth century were De Geer, Fabricius, Forskål, Fourcroy, Müller, Olivier, Pallas, Poiret, Rossi, and Schrank. As with Linnaeus, none of these individuals were specifically interested in the systematics of mosquitoes but rather were concerned with the general cataloging of animal life forms.

De Geer (1720-1778) published the description of Culex(=Aedes) communis in 1776. Born in Sweden, Charles De Geer was the descendant of a rich merchant and manufacturer from Holland. Well educated in physics and biology at the University of Utrecht, he subsequently became the owner and successful manager of an iron foundry. Still later, he became not only one of the richest noblemen (baron) in Sweden but also highly reputed in European scientific circles.

At an early age De Geer became interested in entomology. In this field he continued the investigations began by Réaumur, and published under the same title a sequel to the latter's great work, which it in every way equals in value. It comprised seven volumes, containing observations upon the systematic classification of insects, their life habits and evolutionary history. Although contemporary with Linnaeus, De Geer did not adopt his nomenclature, but retained the old method of

characterizing the species by means of diagnoses. (Nordenskiöld 1935, 232). However, in his later works De Geer did adopt the binomial system by putting what he considered the species name in parenthesis after the generic name, which made available the names so treated.

Johan Christian Fabricius (1745-1808) described a total of 10 new mosquito species (5 of which were published in the eighteenth century) in four separate publications. These included the following presently valid species: Toxorhynchites haemorrhoidalis, Trichoprosopon longipes, Psorophora ciliata, P. cingulata, P. cilipes, and Sabethes cyaneus. Fabricius, sometimes called the "Linnaeus of insects," was the first insect systematist in the true sense. A student and lifelong friend of Linnaeus, this great Danish entomologist used the Linnaean system of nomenclature but contributed greatly to that system by his concept that systematics was not an end in itself but a tool for gaining a better understanding of natural science. Fabricius collected very little himself, relying instead principally upon the collections of others. This is evidenced by the fact that none of the mosquito species listed above occur in the Old World. Although a frequent traveler between many important European areas, he never traveled outside the continent. (Tuxen 1967).

Linnaeus' influence was rapidly and broadly disseminated, even early in his career, by the many fine students which he trained. As his influence grew, many exciting opportunities came to him for exploration in the far reaches of the world, all of which he turned down. This was perhaps wise since a number of his disciples met early tragic deaths because of their explorations (Peattie 1936). One of these was Pehr (Peter) Forskal (also Forsskal, 1732-1763) who died, presumably of malaria, while on a Danish expedition led by Carsten Niebuhr to the Yemen. He first studied natural science at Uppsala, then philosophy at Göttingen; owing to an essay he wrote attacking the Wolffian philosophy, which was predominant at that time, he was able to obtain an appointment in Sweden. This resulted in his receiving the opportunity to go into Danish service as a natural scientist on Niebuhr's expedition (1761-1767). As an outcome of earlier phases of this work he named one mosquito species, Culex molestus, which was published posthumously by Niebuhr in 1775 (Descrip. Anim.:85). The material for this species was collected by Forskal at Rosetta, Kahira (=Cairo), and Alexandria, Egypt. Today, this species is recognized as the predominant autogenous, stenogamous biotype of Culex pipiens. For a detailed account of this expedition, see Hansen (1964).

Of the six members of Niebuhr's party, only the leader survived to return to Denmark and to publish an account of the expedition. The party arrived in the Yemen at the end of December 1762. Forskal died at Yarim in July 1763 on the journey from Mocha to Sana (Scott 1947,15). I had the interesting experience of visiting these areas with an expedition in 1951 but due to modern medical and entomological knowledge our entire party was able to remain healthy throughout.

Antoine Francois de Fourcroy (1755-1809) participated in a rather unique mosquito naming situation. Fourcroy (1785), Fabricius (1787) and Schrank (1776) not only all independently proposed the name Culex annulatus, but apparently for the same species, Culiseta annulata (Schrank).

Fourcroy's diagnosis is totally inadequate, but he gives the habitat as Parisian gardens, so that he more probably had this species than an Aedes. Neither type nor author-identified specimens exist (Edwards 1921, 288). Fourcroy was a French chemist who first studied medicine. He was a zealous supporter of the Revolution, was a member of the famous committee on public safety, and eventually became director-general of instruction. (Nordenskiöld 1935,370).

Otto Frederik Muller (1730-1784) was another 18th century scientist who contributed, equally briefly, to the mosquito literature. Born in Copenhagen, he studied theology and law but through tutoring for the aristocracy became exposed to nature and began a study of insects. These he collected and described in a series of small treatises. In one of these he described Culex (=Aedes) flavescens and C. fasciatus (=Culex pipiens) in 1764. His subsequent work was with the Infusoria.

Culex (=Aedes) geniculatus was described by Guillaume Antoine Olivier (1756-1814) in 1791 from Paris. This is the principal tree hole breeding species of England and Europe. An eminent French naturalist and entomologist, Olivier studied medicine and in the process became interested in natural history. Subsequently finding medicine unattractive and unprofitable, he took employment with a wealthy amateur entomologist to collect insects, which in turn enabled him to procure the information which he later published.

The important mosquito species, Anopheles (Anopheles) hyrcanus and Aedes (Ochlerotatus) caspius, were contributed by the eminent eighteenth century zoologist, Peter Simon Pallas (1741-1811). Born in Berlin, the son of a doctor, Pallas studied medicine at Göttingen and Leyden and later worked in Holland on zoological collections from the tropics. In 1768 he was employed by the Russian government to accompany an expedition to Siberia. From this trip, he brought back an immense quantity of scientific material which he worked on in St. Petersburg for a number of years. Later, he spent additional years in explorations of the Crimea and the Caspian Sea area. Although his contributions to invertebrate zoology were many, he is particularly known for his vertebrate studies.

Culex argenteus (=Aedes aegypti) was described by Poiret in 1787 from female specimens collected in Barbary. The Abbé Jean Louis Marie Poiret was born in St. Quentin, France in 1755 and died in 1834. He was a prolific writer on botanical subjects now chiefly remembered as the continuer and completer of the botanical section of the Encyclopédie Méthodique begun by Lamarck. In the years 1785-6 he travelled and collected in North Africa and in 1787 he published an account of some insects from that region, among them his Culex argenteus. This is identifiable with fair certainty as the first published description of the yellow fever mosquito to which, as noted above, the name Aedes aegypti continues to be attached merely for convenience. In his description he notes that the whole body is covered with silvery scales, a clear indication that he was dealing with an extreme form of var. queenslandensis. He adds that this insect was so beautiful that he often forgave its bites for the pleasure of admiring it. One wonders whether he would have felt differently had he known as much about it as we do.

Culex (=Aedes) rusticus was described by Rossi in 1790 from adult specimens from Pisa, Italy. Pietro Rossi was a professor in the University of Pisa. He is best known for his Fauna Etrusca Sistens Insecta published in two volumes in 1790 and later republished with additions in 1795, a work of major historical importance in the development of entomology in Italy.

Culiseta (Culiseta) annulatus was described by Schrank in 1776 from adult specimens from Austria. He also named Culex variegatus in 1781 from Austria. This is presently regarded as a synonym of A. (Ochl.) flavescens (Müller). Franz von Paula von Schrank was born in 1747 at Warnbach in Bavaria and died in Munich in 1835. He became a subdeacon in Bamberg and deacon in Vienna, Professor of Physics and Mathematics in Bamberg, Professor of Rhetoric in Burghausen, Professor of Theology and later of Botany in Ingolstadt and finally the first superintendent of the Botanical Gardens in Munich. His spare time was devoted to the production of numerous entomological, zoological and other works including a 548 page Insects of Austria and a 2150 page Fauna of Bavaria. (They were giants in those days even if pages had a bit less on them than they do now).

In summary, for the portion of the eighteenth century occurring after January 1, 1758, 11 individuals are known to have published a total of 22 new species, eight of which are presently regarded as synonyms. As would be expected of this early period, these species were named somewhat incidentally. Of the authors of these species, only De Geer, Fabricius and possibly Olivier can be considered as being entomologists, and certainly none of them had any special interest in mosquitoes. Fabricius was the only one of this group who could be considered as possessing a truly adequate comprehension of systematics. Also, he is the only one of the eleven whose work with mosquitoes extended into the nineteenth century. It is of special interest to note that all of the eighteenth century mosquito species were named in one genus, Culex, no other generic names having been proposed during that time.

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Literature Cited

- Dyar, H. G. and F. Knab. 1909 On the identity of Culex pipiens Linnaeus. [Diptera, Culicidae] Ent. Soc. Washington, Proceedings 11: 30-39.
- Edwards, F. W. 1921. A revision of the mosquitos of the Palaearctic Region. Bulletin Ent. Res. 12: 263-351.
- Edwards, F. W. 1932. General Insectorum. Diptera Fam. Culicidae. Fascicle 194, 258 p. Belgium.
- Hansen, T. 1964. Arabia Felix. The Danish Expedition of 1761-1767. Harper and Row, New York and Evanston. (English translation). 381 p. (1st Ed. 1962).
- Howard, L. O., H. G. Dyar and F. Knab. 1915. The mosquitoes of North and Central America and the West Indies. Vol. 3 (in 2 parts). Carnegie Inst. of Washington, Washington, D. C. 523 p.
- Linnaeus, C. 1758. Systema Naturae. Regnum animale, ed. 10.
- Mattingly, P. F., A. Stone and K. L. Knight. 1962. Culex aegypti Linnaeus, 1762 (Insecta, Diptera); Proposed validation and interpretation under the plenary powers of the species so named. Z. N. (S.) 1216. Bulletin Zool. Nomenclature 19(4): 208-219. 1 plate.
- Natvig, L. R. 1948. Contributions to the knowledge of the Danish and Fennoscandian mosquitoes - Culicini. Suppl. Norsk ent Tidsskr. 1. 567 p.
- Nordenskiöld, Erik. 1935. The history of biology, a survey. New York, Tudor Publ. Co. 629 p.
- Peattie, D. C. 1936. Green Laurels. Simon and Schuster, New York 368 p.
- Scott, H. 1947. In the high Yemen. London: John Murray. 260 p. 2nd Ed. (1st Ed. 1942).
- Stone, A., K. L. Knight and H. Starcke. 1959. A synoptic catalog of the mosquitoes of the world (Diptera, Culicidae). Thomas Say Foundation Vol. 6, 358 p. Entomological Society of America, Washington, D. C.
- Tuxen, S. L. 1967. The entomologist, J. C. Fabricius. Annual Review of Entomol. 12: 1-14.