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*Letter to the Editor***History of human-biting *Culex pipiens* in Sweden and Scandinavia**Anders Lindström<sup>1</sup><sup>1</sup>SVA, National Veterinary Institute, Dept of Microbiology, Sweden, 751 89 Uppsala.

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In a recent paper (Hesson et al., 2016), the authors claim to report the first human-biting *Culex pipiens* in Sweden and Scandinavia. Although this is an interesting report, the claim is rather surprising, given the information found in the literature. Here, I will briefly describe the history of human-biting *Cx. pipiens* in Scandinavian entomological literature and address the changing taxonomic status through the years.

The taxonomy of the *Cx. pipiens*-complex has changed through history. This is a very condensed overview that aims to mention only the milestones in that history. The original description of *Cx. pipiens* is from Carl Linnaeus in 1758 (Linnaeus, 1758). The type specimen in the Linnaean Collection is a damaged *Aedes (Ochlerotatus)* sp. female, but Linnaeus is believed to have based his description largely on the illustrations of a *Culex* mosquito by Réaumur (1738) (Harbach et al, 1985). Linnaeus recognised six species of *Culex*, but only two of them were actual Culicids; *Cx. pipiens* and *Cx. bifurcatus*, the others were species of *Ceratopogon*, two species of *Simulium* and one species of *Empis* (Dyar & Knab, 1909; Knight, 1972). The name *Culex bifurcatus* was used for what we know today as *Anopheles claviger* s.l. until it was synonymised with *Cx. pipiens* as well, because Linnaeus based his descriptions on Réaumur's illustrations and the illustration of *bifurcatus* is of a *pipiens* male (Harbach et al, 1985). The Italian entomologist Ficalbi noticed that there were two very similar forms of what looked like *Cx. pipiens* and they could be separated through their bloodfeeding habits. He proposed the name *Culex haematophagus* for the human-biting form (Ficalbi, 1893). In 1909 the identity of *Cx. pipiens* became more or less established through the work of Dyar and Knab who compared phallosomes of specimens from many parts of the world (Dyar and Knab, 1909). Sixteen years later, Martini described *Culex torrentium* that up until then had been nested within the *pipiens* concept, which greatly clarified the taxonomy of the *Cx. pipiens*-complex in Europe (Martini, 1925). Later, Marshall and Staley (1937) proposed the name *Culex molestus* for the autogenous form and regarded it as a different species from *Cx. pipiens* (anautogenous form). The year after, Jobling (1938) wrote a paper pointing out that the two forms can interbreed and therefore *molestus* should be regarded as a subspecies of *Cx. pipiens*. In 1959 Stone et al (1959) regarded the two forms as biotypes and since then this has been the prevailing view, even if molecular clues point to a common

ancestry of the *molestus*-form separate from the *pipiens*-form (Fonseca et al, 2004). In 1983, Harbach et al (1984) collected mosquitoes in Egypt and visited the areas that Forskål mentions as type localities for *Culex molestus*. From their collected material, they designated a neotype for *Cx. molestus* and proposed that *molestus* should be regarded as a behavioural/physiological variant or biotype of *Cx. pipiens*. Also in 1983 they collected specimens of *Cx. pipiens* near Veberöd in Scania, southern Sweden. Some of these specimens were designated as neotypes of *Cx. pipiens* to replace Linnaeus broken *Aedes* specimens as the type specimens of the species (Harbach et al, 1985).

One of Linnaeus disciples, Peter Forskål, joined a Danish expedition to Egypt, The Holy Land and Arabia. He died in Jemen 1763, but his travel notes were published posthumously in 1775 by the only surviving member of the expedition, Carsten Niebuhr (Forskål, 1775). In those notes he describes *Culex molestus* from Egypt. He mentions that they bother sleeping people at night and that they are difficult to avoid unless you have well-closed curtains (Forskål, 1775). In 1837 the Swedish entomologist Dahlbom writes about *pipiens*, referring that it is common all over Europe and that it bites both animals and humans (Dahlbom, 1837). The taxonomic confusion stemming from Linnaeus very broad concept of *Cx. pipiens* was still prevailing though, as he also states that it is common in the mountains in the far north of Sweden, which it is not. Therefore, this record should probably not be regarded as a report of *molestus*. Johan Wilhelm Zetterstedt was a famous Swedish entomologist in his day. In 1822 he published a book on his travels in the far north of Sweden and Norway, in which he states that there are only three kinds of mosquitoes and that the "real mosquito" is *Cx. pipiens* (Zetterstedt, 1822). In 1840 he published his *Insecta Lapponica*, claiming that *Cx. pipiens* causes "inflammatory bites" and that it is common in Lappland (Zetterstedt, 1840). In 1850 he states the same and adds that it can be found indoors (Zetterstedt, 1850). Zetterstedt also uses a broader Linnaean concept of *Cx. pipiens*, much broader than we do today and none of his publications should probably be regarded as actual reports of human-biting *Cx. pipiens*. In 1862, Thomson writes in his handbook of entomology that *Cx. pipiens* attacks humans and animals guided by their "evaporations" (Thomson, 1862), but he also refers to

the mosquitoes in Lapland as *pipiens* so it should be discarded as a report of *molestus*.

The first credible report of *molestus* in Scandinavia is from Wesenberg-Lund, (1920) who writes about human-biting *Cx. pipiens* in Denmark, describing how they live in the basement and attack people indoors in winter. Both the zoophilic and the homodynamic behaviour is regarded as traits of the biotype *molestus* rather than *pipiens*. In 1933 the biologist Olof Ryberg on a side note in a paper on malaria and *Anopheles*, writes that in the month of September he has been bitten by *Cx. pipiens* in his apartment in Lund in southern Sweden (Ryberg, 1933). Forsslund (1941) writes that in late fall 1934 a very troublesome mosquito appeared in residential areas in central Stockholm and that many people were bitten and got infected bites. He tentatively identifies the mosquitoes as *Cx. pipiens*, but sends some specimens to Natvig in Oslo, who replies that they are *Culex molestus*, as it is still regarded as a valid species. A few years later Natvig (1948) comments on the report and confirms that he regards them as the human-biting form of *Cx. pipiens*, but then regards them as a subspecies, *Cx. p. molestus*. He also writes that *Cx. p. molestus* is established in Norway since at least 1933 (Natvig, 1948).

In her overview of the Swedish Culicid fauna, Dahl (1977) also mentions *molestus* and refers to Natvig (1948). In the distribution table, it is clearly indicated to have been reported from the province of Uppland (Stockholm) as well as in both Denmark and Norway (Dahl, 1977). In 1987, Jaenson writes that there are no recent reports of *molestus* in Sweden but mentions the records from 1934, referring to Forsslund (1941) (Jaenson, 1987). An overview of the mosquito fauna in northern Europe, reported *Cx. pipiens* as a species from all Scandinavian countries, but with no mention of subspecies or biotypes (Dahl, 1997). The same is true for the European distribution chart by Snow & Ramsdale (1999). In a popular scientific account on the biology of mosquitoes, with a checklist of Swedish mosquitoes at the end, *molestus* is stated as present in central Sweden, and possibly in the southern parts as well (Dahl, 2002).

In a recent paper about Culicid fauna of forested wetlands in Sweden, the previous reports of *molestus* from the Scandinavian countries are referred to (e.g. Natvig, 1948, in Schäfer & Lundström, 2001). Finally, Vogels et al (2016) who report both *molestus* and *molestus x pipiens* hybrids from southern Sweden, refer to Schäfer & Lundström (2001) as a reference to earlier reports of *molestus* in Sweden while Hesson et al (2016), as mentioned in the introduction, claim to have found it for the first time in Scandinavia.

In summary, this short review of the history of *pipiens* and *molestus* in Scandinavian entomological literature shows, contrary to the claim of Hesson et al. (2016), that *Cx. pipiens* biotype *molestus* has been found prior to their study in Sweden and in all Scandinavian countries, which is well established in the literature.

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