

A revised checklist of mosquitoes Genus *Coquillettidia* Dyar, 1905 (Diptera: Culicidae) from Indonesia with key to species

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Abstract. Nugroho SS, Ayuningrum FD, Setyaningsih RS, Astutu UNW. 2020. A revised checklist of mosquitoes Genus *Coquillettidia* Dyar, 1905 (Diptera: Culicidae) from Indonesia with key to species. *Biodiversitas* 21: 5772-5777. Mosquito species from Genus *Coquillettidia* are mostly found in Afrotropic Region, with some species distributed in the Oriental and Australasian Region including Indonesia. Some species are confirmed as the vector for human pathogens. As previous research stated that up to 1981, there were eight species of *Coquillettidia* that have been on the checklist of mosquitoes in Indonesia. Nowadays, eleven *Coquillettidia* species present in Indonesia entirely included in Subgenus *Coquillettidia*. Three species were added to the checklist, namely *Cq. fuscopteron* Theobald, *Cq. novochracea* Barraud, and *Cq. xanthogaster* Edwards. Research and publication about Genus *Coquillettidia* in Indonesia are still rare, besides that, the identification key of *Coquillettidia* female mosquito in Indonesia has never been published before. This paper intended to deliver information about the species checklist and distribution of Genus *Coquillettidia* in Indonesia and provide a species identification key for female mosquitoes.

Keywords: *Coquillettidia*, distribution, identification key, mosquito, species checklist

INTRODUCTION

The first information regarding the diversity of *Coquillettidia* mosquitoes in Indonesia was published nearly 40 years ago in the Indonesian mosquito checklist. The checklist states that Indonesia has around 456 species of mosquitoes, and eight of them are in the genus *Coquillettidia* (O'Connor and Sopa 1981). About five years ago, efforts were made to update data on the diversity of mosquitoes with the National Research on Disease Vector and Reservoir (Rikhus Vektora) in 2015-2018 organized by the National Institute of Health Research and Development (NIHRD), Indonesian Ministry of Health. The study collected mosquitoes from 29 provinces in Indonesia, including those in the genus *Coquillettidia*.

In general, mosquitoes in the genus *Coquillettidia* are medium size species, yellowish in color, and have similarities with *Mansonia* Blanchard mosquitoes as well as several species of *Culex* Linnaeus mosquitoes and members of tribe Aedini Neveu-Lemaire. The differences with tribe Aedini are the simple tarsal claws and blunt abdomen tip in female mosquitoes (Harbach and Kitching 1998). The difference with *Culex* mosquitoes lies in the absence of pulvili in the tarsal claws. Moreover, members of the *Coquillettidia* subgenus are distinguished from species of the tribe Aedini and *Mansonia* in the absence of post-spiracular setae. *Coquillettidia* and *Mansonia* larvae are distinguished from other genera by spiracular apparatus and siphons that develop uniquely to attach to aquatic

plants and obtain oxygen from the air-storing tissue (Rattanarithikul et al. 2005).

Previously the status of the genus *Coquillettidia* was a subgenus in the genus *Mansonia* (Stone 1963). Belkin (1962) proposed non-formal taxa named 'tribe' in the Culicidae family below the level of the subfamily. According to Belkin (1962), the genus *Mansonia* is the sole member of the tribe *Mansoniini* Belkin with two subgenera, namely *Coquillettidia* and *Mansonioides* Theobald. Ronderos and Bachmann (1963) proposed the separation of the genus *Mansonia* into two genera, namely *Mansonia* and *Coquillettidia*. *Mansonia* with two subgenera, namely *Mansonia* and *Mansonioides*, while *Coquillettidia* with two subgenera, namely *Coquillettidia* and *Rhynchotaenia* Brèthes. Belkin (1968) added subgenus *Austromansonia* Belkin with a single member species, *Coquillettidia tenuipalpis* Edwards. Knight and Stone (1977), in the Catalogue of Mosquito in the World, also treated *Coquillettidia* and *Mansonia* as separate genera. A total of 58 species of the genus *Coquillettidia* have been identified, which belong to three subgenera, i.e., *Austromansonia* (1 species), *Coquillettidia* (44 species), and *Rhynchotaenia* (13 species).

Genus *Mansonia* and *Coquillettidia* have fundamental morphological differences. In adult mosquitoes, genus *Mansonia* has asymmetrical wing scales, while genus *Coquillettidia* has symmetrical wing scales. At the pupa stage, genus *Mansonia* has some branched cephalothorax hairs and relatively wide paddles, whereas in genus *Coquillettidia*, all cephalothorax hairs are unbranched, and

the paddles are relatively narrow. Genus *Mansonia* laid their eggs in masses and attached them to under the surface of the leaves of aquatic plants below the water surface, while genus *Coquillettidia* laid their eggs like a raft on the water surface (Belkin 1962).

Species of the subgenus *Coquillettidia* are limited in Old World (Africa, Asia, Australia, and Europe), except for *Cq. perturbans* Walker in North America. Species of the subgenus *Coquillettidia* are generally distributed in the Afrotropic Region, but some species are spread in the Oriental and Australasian regions. Two species are found in the Palaearctic region namely *Cq. crassipes* van der Wulp and *Cq. ochracea* Theobald (Belkin 1962).

Bionomics of most mosquito species in the subgenus *Coquillettidia* are very little known. The immature stages of *Coquillettidia* are commonly found attached to the roots of aquatic plants in ponds, lakes, swamps, marshes, ditches, wells, ground pools, and flood pools in forest swamps. Female mosquitoes will readily bite humans and active during day and night time (Wharton 1962).

Some species in the subgenus *Coquillettidia* are pests for humans and livestock in Africa, Europe, and South America. For example, *Cq. perturbans* is a vector for the eastern equine encephalitis virus and the Tensaw virus in North America (Turell et al. 2005). Meanwhile, *Cq. aurites* Theobald, *Cq. metallica* Theobald, and *Cq. pseudoconopas* Theobald were important vectors for bird malaria in Africa (Njabo et al. 2009). *Coquillettidia crassipes* is the only species in the genus *Coquillettidia* that has known as a vector of human disease. Chiang et al. (1986) say that in high population density in Peninsular Malaysia these species become a secondary vector for Brugian filariasis. In West Irian, *Cq. crassipes* was incriminated as rural bancroftian filariasis (Hoedojo 1989). Population density of *Cq. crassipes* increased during periods of low rainfall and captures harbored only *Cardiofilaria* sp., an avian filarioid, in Tanah Intan, South Borneo (Atmosoedjono et al. 1993).

Information regarding genus *Coquillettidia* mosquito in Indonesia is still very limited. The purposes of this paper are to provide the updated species checklist, distribution data, and identification key for female mosquitoes in the genus *Coquillettidia* in Indonesia.

MATERIALS AND METHODS

The checklist of *Coquillettidia* species in this paper is an update for the checklist of mosquito species in Indonesia as reported by O'Connor and Sopa (1981). Species records and distribution data were summarized from related references and Rikhus Vektora 2015-2018 research reports. The distribution data of the *Coquillettidia* mosquito in this paper is limited to the territory of Indonesia alone and excludes the territories of Malaysia Borneo and Papua New Guinea. The identification keys are arranged based on the description of the species morphological characters from various references. The mosquito morphological terms follow Harbach and Knight (1980).

RESULTS AND DISCUSSION

The checklist of *Coquillettidia* species and their distribution in Indonesia is presented in Table 1. In total there are 11 species of genus *Coquillettidia* recorded from Indonesia. The most widely distributed species is *Cq. crassipes*. Papua has the greatest species diversity of *Coquillettidia* mosquito with seven species. Four species in the genus *Coquillettidia* were originally described from Indonesia, i.e., *Cq. crassipes*, *Cq. fuscopteron*, *Cq. memorans* Bonne-Wepster, and *Cq. nigrochracea* Bonne-Wepster.

The checklist of *Coquillettidia* species in this paper adds three species to the checklist compiled by O'Connor and Sopa (1981). The three species of *Coquillettidia* recorded in Indonesia are *Cq. fuscopteron*, *Cq. novochracea* and *Cq. xanthogaster*. *Coquillettidia fuscopteron* and *Cq. xanthogaster* become new record from Papua, while *Cq. novochracea* was recorded from Kalimantan. *Coquillettidia crassipes* is newly recorded from the Lesser Sunda Islands, *Cq. nigrochracea* and *Cq. nigrosignata* Edwards are newly recorded from Kalimantan and *Cq. novochracea* from Sumatra.

Coquillettidia fuscopteron was described from Digoel River, Western New Guinea (Papua). Edwards (1913) said that the name *Cq. fuscopteron* was once widely accepted as a synonym of *Cq. crassipes*, and also synonym with *Taeniorhynchus brevicellulus*. In contrast, Marks (1974) who once identified this species from Merauke, Papua stated that *Cq. fuscopteron* was distinct species. There was a possibility that the description of *Cq. crassipes* from New Guinea morphologically has been identified as *Cq. fuscopteron*.

Belkin (1962) stated the distribution of *Cq. xanthogaster* is in New Hebrides (Vanuatu), New Caledonia, Loyalty Islands, and Australia (Queensland). Moreover, Assem and Bonne-Wepster (1964) has been founded the male mosquitoes of *Cq. xanthogaster* in New Guinea, one of which is in Koembe, Merauke. Morphologically, *Cq. xanthogaster* is difficult to distinguish with *Cq. crassipes* (Belkin 1962), therefore both species are put in *Crassipes* grouped together with *Cq. aureosquammata* (Marks 1974).

Coquillettidia novochracea in Indonesia has been recorded in Sumatera and Kalimantan, while Rattanarithikul et al. (2006) stated that this species has been recorded from Thailand. This species was first described from Nongpoh, Assam, India by Barraud in 1927. The first discovery of *Cq. novochracea* was recorded in South Kalimantan (as *Mansonia novochracea*) written by Klokke (1961), a Dutch researcher who conducted filariasis research in Indonesia. Records in Sumatra were obtained from Lingga island, Bintan island, and Batam Island, Riau Islands Province (B2P2VRP 2018a).

Mosquito species belonging to the *Crassipes* group found in Indonesia including *Cq. crassipes*, *Cq. aureosquammata* Ludlow and *Cq. xanthogaster*. Bonne-Wepster (1954) mentioned that *Taeniorhynchus aureosquammatus* (= *Cq. aureosquammata*) exists only on the Sumatra island. Moreover, Ramalingam (1974), in his

brief survey report on Java stated that *Cq. aureosquammata* is found in Java together with *Cq. crassipes* and *Cq. ochracea*. Record of *Cq. aureosquammata* from Kalimantan derived from specimen actually present in a collection maintained by units in the compound of the CDC/P3M (O'Connor and Sopa, 1981). Species *Cq. aureosquammata* does not yellowish in color as *Coquillettidia* mosquitoes in general. This species mostly dark-colored with a metallic purple and blue sparkle (Bonne-Wepster 1954).

Coquillettidia crassipes has the most extensive distribution in Indonesia. These species distributed in Sumatra, Kalimantan, Java, Lesser Sunda Islands, Sulawesi, Maluku, and Papua. In the world, *Cq. crassipes* are known to distribute across Pakistan, India, Sri Lanka, Burma, Thailand, southern China, including Hong Kong and Macau, Malaysia, Philippines, Indonesia, Ryukyu-Retto islands, Mariana Islands, New Guinea, Australia, and Bismarck Archipelago (Ramos et al. 2000). This species was described from Soeroelangoen, Benkoelen (now Surulangun village in South Sumatra). Discovery note of *Cq. crassipes* in Lesser Sunda were obtained from Karangasem District in Bali island, and Ende District in Flores island, East Nusa Tenggara Province (B2P2VRP 2016, 2017a).

The existence of *Cq. giblini* Taylor and *Cq. nigrosignata* species had led to differences of opinion among experts. Taylor (1914) gave the name of *Pseudotaeniorhynchus conopas* var. *giblini* to the specimen from Lakekamu, Papua New Guinea. It seems that he concluded from the interpretation of Theobald (1901) of *Taeniorhynchus conopas*, however Edwards (1917) stated that Theobald had misidentified *T. conopas*, and he proposed the new name as *Taeniorhynchus nigrosignatus*. Edwards (1917) also stated that the variant described by Taylor (1914) might be different from *T. nigrosignatus*, so he decided that it was a separated species. Edwards (1922) examined female *T. giblini* specimen and found that there was no difference with *T. nigrosignatus*. He then confirmed that *T. nigrosignatus* as a synonymy for *T. giblini*.

The synonymy lasted about 40 years until Wharton (1962) compared specimens from Malaya and Kalimantan with a series of *Mansonia (Coquillettidia) giblini* specimens. Although the condition of the specimens was inadequate, Wharton could see that the *Ma. giblini* specimens have fewer dark marks, lines in the pleura are fainter, and there are no dark scales on the dorsum of the abdomen. Wharton concluded that the '*Ma. giblini*' from the Oriental region was a different species from the New Guinea form. Accordingly, Wharton restores the name *T. nigrosignatus* (as *Mansonia nigrosignata*) for species from the Oriental region by the distribution in Malaya and Kalimantan. Thus, the authors deleted the record of *Cq. giblini* distribution in Sumatra and Kalimantan as stated by O'Connor Sopa (1981). The reason is that the record of *Cq. giblini* distribution in the Oriental region is concluded as *Cq. nigrosignata*. The distribution of *Cq. giblini* is in Maluku and Papua (Australasian region). Distribution of *Cq. nigrosignata* in Sulawesi as cited by Lien et al. (1977)

from Bonne-Wepster (1954) recorded as *T. giblini*. The discovery notes of *Cq. nigrosignata* in Kalimantan were obtained from a specimen collected by CDC/P3M (O'Connor and Sopa 1981).

Coquillettidia nigrosignata is distinguished from *Cq. hodgkini* Wharton by the presence of two dark lines on the dorsocentral and wider spots on the supra alar area. Bonne-Wepster (1954) might include records of *Cq. hodgkini* into *Cq. ochracea*. Wharton (1962) described *Cq. hodgkini* as a new species from Lamir (Pekan), Pahang, Malaya (Malaysia), and explained its distribution in Malaya (Pahang, Perak, Selangor) and from Indonesia. But it is not said with certainty the distribution of *Cq. hodgkini* in Indonesia. The discovery notes of *Cq. hodgkini* in Indonesia was obtained from filariasis research conducted by Bahang et al. (1984) in Southeast Sulawesi. Apart from Sulawesi, *Cq. hodgkini* was also found in Kalimantan and Java based on collected specimens by CDC/P3M (O'Connor and Sopa 1981).

Knight and Stone (1977) list the distribution of *Cq. ochracea* includes in Malaya, India, Thailand, Indochina, China, Japan, the Ryukyu-Retto islands, the Philippines, New Guinea and, Indonesia. In Indonesia *Cq. ochracea* is distributed in Sumatra, Kalimantan, Java, and Papua (Bonne-Wepster 1954). Lee et al. (1988) added the distribution of *Cq. ochracea* in Papua, specifically in Assike, Merauke and, Tanah Merah, and Bahang et al. (1984) stated that this species also had found in Sulawesi.

Coquillettidia memorans firstly was described from the upper Digoel River, Western New Guinea (Papua). This species has two forms that are distinguished from the color of the thoracic integument. The darker forms are only known to be found in the Digul River and Tanah Merah, Papua, while the lighter forms have been recorded in Papua New Guinea and the Cape York Peninsula. The record of *Cq. memorans* from Sulawesi has been stated by Brug and Bonne-Wepster (1947), however, that record did not repeated in Bonne-Wepster (1954). Steffan in 1966 stated that *Cq. memorans* has only founded from New Guinea island. Thus, the authors conclude that the distribution of *Cq. memorans* in Indonesia is only in Papua.

The type specimen of *Cq. nigrochracea* according to Bonne-Wepster (1930) No. 17.478 stored in the Medical Laboratory at Batavia, but no specimen has been seen. Lee et al. (1988) stated that Marks had been seen three specimens in KIT in 1960, in LM in 1984. One specimen from Boven Digoel, New Guinea labelled 'TYPE' and two females from Benkoelen, Sumatra labelled 'COTYPE', also one female in British Museum in 1984 with No. 15.153 from Upper Digoel River, New Guinea labelled 'Co-type' and 'Paratype'. It is decided and also stated by Lee et al. (1988) that *Cq. nigrochracea* has two type localities, i.e. Sumatra and Irian Jaya (Papua). The description of this species has been reported according to Lee et al. (1988) based on specimens from Sumatra. The new record of *Cq. nigrochracea* in Kalimantan were obtained from the Murung Raya District, Central Kalimantan Province (B2P2VRP 2017b).

Table 1. Species checklist and distribution of *Coquillettidia* mosquito species in Indonesia

Valid species	Synonymy	Geographical distribution	Taxonomic remarks
<i>Cq. aureosquammata</i> (Ludlow 1909)	<i>Cq. pagei</i> Ludlow	Sumatra, Kalimantan, Java	
<i>Cq. crassipes</i> (van der Wulp 1881)	<i>Cq. brevicellulus</i> Theobald, <i>Cq. diaeretus</i> Dyar, <i>Cq. pygmaeus</i> Theobald	Sumatra ⁺ , Kalimantan, Java, the Lesser Sunda Islands ^R , Sulawesi, Moluccas, Papua	Marks (1974) restored <i>Cq. crassipes</i> from synonymy with <i>Cq. fuscopteron</i> (see <i>Cq. fuscopteron</i>).
<i>Cq. fuscopteron</i> (Theobald 1911)*		Papua ⁺	<i>Cq. fuscopteron</i> once accepted as a synonymy of <i>Cq. crassipes</i> until Marks (1974) stated that <i>Cq. fuscopteron</i> is a distinct species.
<i>Cq. giblini</i> (Taylor 1914)		Moluccas, Papua	Wharton (1962) restored <i>Cq. giblini</i> as a synonymy with <i>Cq. nigrosignata</i> and limited its distribution in Australasian region (see <i>Cq. nigrosignata</i>).
<i>Cq. hodgkini</i> (Wharton 1962)		Kalimantan, Java, Sulawesi	
<i>Cq. memorans</i> (Bonne-Wepster 1930)		Papua ⁺	
<i>Cq. nigrochracea</i> (Bonne-Wepster 1930)		Sumatra ⁺ , Kalimantan ^R , Papua ⁺	The original type specimen of <i>Cq. nigrochracea</i> has not been seen. Marks choose two co-type (syntype) from Benkoelen, Sumatra and Upper Digoel River, Papua.
<i>Cq. nigrosignata</i> (Edwards 1917)		Sumatra, Kalimantan, Sulawesi	Edwards (1922) sunk <i>Cq. nigrosignata</i> as a synonymy of <i>Cq. giblini</i> . Wharton (1962) restored 'oriental <i>Cq. giblini</i> ' as <i>Cq. nigrosignata</i> .
<i>Cq. novochracea</i> (Barraud 1927)*		Sumatra ^R , Kalimantan	
<i>Cq. ochracea</i> (Theobald 1903)	<i>Cq. chrysogona</i> Knab, <i>Cq. shakujiiensis</i> Ogasawara	Sumatra, Kalimantan, Java, Sulawesi, Papua	
<i>Cq. xanthogaster</i> (Edwards 1924)*		Papua	

Note: ^R: data from Rikhus Vektora; ⁺: type locality; *: newly added species to checklist

Identification key for female mosquito of Genus *Coquillettidia* in Indonesia

Modified from Rattanaarithikul et al. (2006)

- | | | |
|-----|---|--------------------------|
| 1. | Plume (wing scales) purple or dark brown | 2 |
| - | Plume yellow or golden | 5 |
| 2. | Pleural integument yellow to brownish orange | 3 |
| - | Pleural integument dark brown | 4 |
| 3. | Scutellum bright yellow, without scales;
Terga abdomen segment 2-3 bluish purple | <i>Cq. crassipes</i> |
| - | Scutellum with golden yellow scales;
Terga abdomen segment 2-3 golden yellow | <i>Cq. fuscopteron</i> |
| 4. | Scutal integument dark, covered with creamy yellow scales;
Terga abdomen segment 3-8 metallic blue with silvery white scales in laterobasal | <i>Cq. aureosquamata</i> |
| - | Scutal integument brown, covered with golden yellow scales;
Terga abdomen segment 3-4 metallic purplish blue, segment 5-8 copper colored | <i>Cq. memorans</i> |
| 5. | Scutellum yellow or dull brown on all lobes | 6 |
| - | Scutellum middle lobe yellow or brown, lateral lobes dark | 8 |
| 6. | Scutal and pleural integument dark | <i>Cq. nigrochracea</i> |
| - | Scutal and pleural integument yellow | 7 |
| 7. | Lateral scutum with brown short line in front of wing root;
Pleura with dark line from posterior margin of post-pronotum to posterior margin of mesepimeron
..... | <i>Cq. novochracea</i> |
| - | Lateral scutum without brown short line in front of wing root;
Pleura without dark line from posterior margin of post-pronotum to posterior margin of mesepimeron
..... | <i>Cq. ochracea</i> |
| 8. | Pleura with distinct three longitudinal lines | 9 |
| - | Pleura without distinct three longitudinal lines | 10 |
| 9. | Terga abdomen with apical dark band on some segments;
Hind tibia with broad purplish brown basal band | <i>Cq. nigrosignata</i> |
| - | Terga abdomen without dark bands;
Hind tibia with few dark scales on basal | <i>Cq. giblini</i> |
| 10. | Scutum with two pairs of dark spots above wing root;
Terga abdomen with small posterolateral dark spots on segment 3-4, sometimes on segment 2-5 | <i>Cq. hodgkini</i> |
| - | Scutum without two pairs of dark spots above wing root;
Terga abdomen with golden and dark purple scales in indistinct pattern | <i>Cq. xanthogaster</i> |

In conclusion, Indonesia has 11 mosquito species in the genus *Coquillettidia* that included in one subgenus (*Coquillettidia*). This paper adds three species newly recorded namely, *Cq. fuscopteron*, *Cq. novochracea* and *Cq. xanthogaster*. The distribution data updated for following species: *Cq. crassipes* (Lesser Sunda Islands), *Cq. nigrochracea* and *Cq. nigrosignata* (Kalimantan), and *Cq. novochracea* (Sumatra). The identification key for female *Coquillettidia* mosquito is provided at the end of paper.

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