THE GEOGRAPHICAL DISTRIBUTION OF THE GENUS *SIMULIUM* LATREILLE IN THE ORIENTAL AND AUSTRALASIAN REGIONS

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Abstract: The geographical distributions of the genus *Simulium* Latreille s.l. in the Oriental and Australasian Regions were mapped. The patterns of distribution were examined at the subgenus and species-group levels. Among the 11 subgenera recorded in these regions, five (*Byssodon*, *Eusimulium*, *Montisimulium*, *Nevermannia* and *Simulium* s.str.) were essentially Palaearctic, apparently penetrating to varying extents from the north to the Oriental Region and two of which were further extending their eastward ranges up to the Australasian Region; while the other six subgenera (*Gomphostilbia*, *Hebridosimulium*, *Himalayum*, *Inseliellum*, *Morops* and *Wallacellum*) were nearly endemic to the Oriental or Australasian Regions or both. All the endemic subgenera, except *Himalayum*, had their own center of development and distribution on the islands. Eight of 12 species-groups of *Simulium* s.str. were mostly confined to the Oriental Region, and five of which demonstrated a definite insular pattern in their distribution. The probable dispersal routes were inferred for several species-groups of the subgenera *Nevermannia* and *Simulium* s.str. The *Simulium* faunae of the Philippines, Sulawesi and the Maluku Islands present a mixture of the Oriental and Australasian elements but the faunal break is likely to be seen on both sides of the Weber's Line.

INTRODUCTION

Black flies (Diptera: Simuliidae) are one of the most important groups among the blood-sucking insects. This family includes serious pests of man and animals in many countries. Some species transmit several pathogens, such as filarioid nematodes of the genus *Onchocerca* to man and cattle. The family is widely distributed in all zoogeographical regions, being found almost anywhere if there is running water suitable as a habitat of the immature stages.

The Simuliidae in the Oriental Region were so far classified by Crosskey (1967, 1988) and Datta (1983), and their faunal feature was briefly described by Crosskey (1990). Recently we revised the species-groups within the two subgenera, *Gomphostilbia* Enderlein and *Simulium* Latreille s.str., of the genus *Simulium* Latreille s.l. (Takaoka and Davies, 1996) and provided a checklist of the Simuliidae in the Oriental Region (Takaoka and Davies, 1995), in which all the 246 species, but one tentatively assigned to the genus *Sulci-cneiphia* Rubtsov, were placed in the 11 subgenera of the genus *Simulium* s.l. and under three major subgenera

were further classified into several species-groups.

The Oriental Region consists of two types of lands, continental (India, Indochina and south China) and insular (Philippines and Indonesia), and climatologically belongs for the most part to tropical and subtropical zones. This region is generally delimited on the north by the Himalayan mountain range and the Yangtse River in south China, on the west by the dry zone of Kashmir, and on the east by the so-called *Wallace's Line* or *Weber's Line*, both of which have been long reputed to separate it from the Australasian Region (Fig. 1). Gressitt (1956, 1961) analysing geographical distribution patterns of several insect families revealed that the Oriental elements stretched eastwardly far beyond these nominate lines, and included vast ranges of oceanic islands including New Guinea in the Oriental Region. He also discussed the faunal origins and affinities of most oceanic islands (Gressitt, 1961).

The distributional features of the genus *Austrosimulium* Smart in Australia and New Zealand, and the subgenus *Inseliellum* Rubtsov in Polynesia were already shown by Dumbleton (1963) and Craig (1983) respectively. However, no such attempts have been

Figure 1 Map of the Oriental and Australasian Regions showing several zoogeographic borderlines. Numeral below locality name indicates the number of species of the genus *Simulium* s.l. so far found. Horizontal line indicates equator.

done in the Oriental Region, mainly due to the lack of the faunistic investigations, especially in the eastern part of Indonesia including Sulawesi Island (Celebes), the Maluku Islands (Moluccas), Irian Jaya and the Lesser Sunda Islands. In this paper the geographical distributions of the genus *Simulium* s.l. in the Oriental and Australasian Regions were outlined and drawn at subgenus and species-group levels, on the basis of the published and unpublished data including one recently obtained from our faunistic surveys in Indonesia and Peninsular Malaysia. Main information sources were Takaoka and Davies (1995) for the Oriental Region, Crosskey (1967, 1989), Takaoka and Suzuki (1995), Takaoka (1995) for the Australasian Region, Crosskey (1988) for both regions, and Craig and Craig (1986), Craig (1987) and Craig *et al.* (1995) for Polynesia.

I. DISTRIBUTIONS OF TRIBES AND GENERA (Fig. 2)

The family Simuliidae was divided into two subfamilies, i.e., Parasimuliinae and Simuliinae, of which the latter was further divided into two tribes, i.e.,

Prosimuliini and Simuliini (Crosskey, 1988). The majority of black fly species in this area were placed in the worldwide genus *Simulium* s.l. of the tribe Simuliini. This genus occurs in most areas of the Oriental and Australasian Regions and extends on the south up to Tasmania Island, on the northeast to the Micronesian Islands, and on the east as far as the Marquesas Islands. Another genus *Austrosimulium* is confined to south and east Australia and New Zealand (Dumbleton, 1963). In addition, two genera of the tribe Prosimuliini were reported: an unrevised "*Cnephia*" from Australia (9 spp.) and *Sulcicnephia* from Peninsular Malaysia. It should be remembered that the record of the latter genus was based on the tentative assignment of the unique species, i.e., *Su. unidens*, described from the pupa and larva, both of which have, though, many characters atypical for the genus *Sulcicnephia* mostly recorded from Central Asia (Takaoka and Davies, 1995). The male adult of *Su. unidens* recently obtained also differs in many morphological characters from most of the other *Sulcicnephia* species and presents more characters of tribe Simuliini than those of tribe Prosimuliini

Figure 2 The world distributions of the supraspecific taxa of Simuliidae present in the Oriental and/or Australasian Regions. P, tribe Prosimuliini; S, genus *Simulium* s.l.; A, genus *Austrosimulium*; PA, subfamily Parasimuliinae (shown only for reference).

Figure 3 The distributions of four subgenera of *Simulium* s.l. in the Oriental and Australasian Regions. B, *Byssodon*; E, *Eusimulium*; N, *Nevermannia*; S, *Simulium* s.str.

Figure 4 The distributions of seven subgenera of *Simulium* s.l. in the Oriental and Australasian Regions. HE, *Hebridosimulium*; HI, *Himalayum*; IN, *Inseliellum*; G, *Gomphostilbia*; M, *Morops*; MN, *Montisimulium*.

(unpublished data). Detailed taxonomic studies in future are certainly needed to prove that *Su. unidens* is assignable to the genus *Sulcicnephia* and also to the tribe Prosimuliini.

II. DISTRIBUTION OF GENUS *SIMULIUM* S.L.

IIa. Distributions at subgenus level (Figs. 3 & 4)

The *Simulium* fauna of these regions is represented by five main subgenera, *Gomphostilbia*, *Inseliellum*, *Morops* Enderlein, *Nevermannia* Enderlein and *Simulium* s.str. All but *Inseliellum* probably are not monophyletic, including certain heterogeneous species-groups. There are six other minor subgenera of *Simulium* s.l. Four subgenera, i.e., *Nevermannia*, *Simulium* s.str., *Eusimulium* Roubaud and *Byssodon* Enderlein, are all cosmopolitan, of which first two occur widely in the Asiatic continent and extend eastwards to cross both the Wallace's and Weber's Lines as far as Norfolk Island and the Maluku Islands, respectively, while the other two, *Eusimulium* and *Byssodon*, are poorly represented by two species, each in Taiwan and Shimokoshiki Island of the Ryukyu Islands, and by one species in Sri Lanka, respectively (Fig. 3). The remaining seven subgenera except *Montisimulium* Rubtsov (3 spp.) are almost endemic to this area, and all but *Himalayum* Lewis (2

spp.) occur for the most part on the islands (Fig. 4). *Gomphostilbia*, one of the dominant subgenera (64 spp.), occurs in vast areas of the Oriental Region and extends northward to Japan and eastward to the Solomon Islands; it is also represented in the Palau Islands (1 sp.), in Papua New Guinea (9 spp.) and in northern Australia (1 sp.). *Morops* centers on Papua New Guinea (33 spp.) and the Solomon Islands (14 spp.), and extends southwards into Australia (8 spp.) and westwards through the Maluku Islands (7 spp.) into north Sulawesi (1 sp.) and the Philippines (8 spp.); Sri Lanka has one representative. One Malaysian species was tentatively placed in the subgenus *Morops* (i.e., *S. (M.) gombakense*) by Takaoka and Davies (1995), but this was recently proved to belong to the subgenus *Gomphostilbia* on the basis of the adult morphology (unpublished data). *Inseliellum* occurs on the Polynesian Islands (23 spp.) with its western outposts in Guam Island (2 spp.) and Truk Island (1 sp.) of Micronesia. *Hebridosimulium* Grenier and Rageau, a small subgenus (3 spp.) endemic to South Pacific, has also a disjunct distribution (1 sp. each in Fiji, Vanuatu and Society Islands). *Wallacellum* Takaoka, close to *Morops*, has its main range in the Philippines (8 spp.) but extends northward up to Yonakuni Island (1 sp.) of the Ryukyus through Lan-yu Island (1 sp.), east

Figure 5 The distributions of six species-groups of the subgenus *Gomphostilbia*. A, *ambigens*-group; BI, *baisasae*-group; BT, *batoense*-group; C, *ceylonicum*-group; H, *hiroshii*-group; V, *varicorne*-group.

of Taiwan, and southward to Sulawesi Island (1 sp.); it is also represented in Seram Island (Ceram) (1 sp.) and Biak Island (1 sp.) (unpublished data).

IIb. Distributions at species-group level

IIb-1. Subgenus *Gomphostilbia* (Fig. 5)

There are five species-groups included so far in *Gomphostilbia* (Takaoka and Davies, 1996). Among these, three species-groups, i.e., *batoense*-, *ceylonicum*- and *varicorne*-groups, have a wide range in the Oriental Region, and are extending their northeast range up to Japan; while in Irian Jaya, Papua New Guinea and north Australia only *batoense*-group is represented by four, nine and one species, respectively. Seram Island of the Maluku Islands and Flores Island of the Lesser Sunda Islands each have one species of the *ceylonicum*-group, as well as one and two species of the *batoense*-group (unpublished data). The two other minor species-groups, i.e., *ambigens*-group (1 sp.) and *baisasae*-group (3 spp.), are confined to the Philippines.

In the map (Fig. 5), one more species-group, *hiroshii*-group, was added. This is provisionally proposed to accommodate *S. (G.) hiroshii* recently found in the Solomon Islands and Bougainville Island (Takaoka,

1994, 1995). The last three species-groups constitute a different element, presenting several characters which are atypical among *Gomphostilbia* (Takaoka, 1983, 1994). In particular *S. (G.) hiroshii* is an enigmatic species, of which the male genitalia are typical for *Morops*, and the female genitalia (including the spermatheca with internal setae) are very similar to those of the *ambigens*- and *baisasae*-groups.

IIb-2. Subgenus *Morops* (Fig. 6)

Of the eight species-groups of *Morops* defined by Crosskey (1967) and Colbo (1976), two species-group, i.e., *farciminis*-group (8 spp.) and *oculatum*-group (7 spp.), are confined to Irian Jaya and Papua New Guinea; another species-group, *papuense*-group (1 sp.), is also distributed in Irian Jaya and Papua New Guinea but extends eastwards into the Solomon Islands and westwards as far as Seram Island; a similar pattern is shown for the *clathrinum*-group (ca. 20 spp.) which has, though, a weak representation in north Australia (1 sp.) and extends a little further westward as far as Halmahera Island. On the other hand three small groups, i.e., *faheyi*-group (3 spp.), *lawnhillense*-group (1 sp.) and *mackerrassorum*-group (1 sp.), have their limited distri-

Figure 6 The distributions of 12 species-groups of the subgenus *Morops*. A, *alienigenum*-group (provisional name); B, *banauense*-group (provisional name); C, *clathrinum*-group; E, *faheyi*-group; F, *farciminis*-group; K, *mackerrasorum*-group; L, *lawnhillense*-group; M, *melatum*-group; O, *oculatum*-group; P, *papuense*-group; S, *sherwoodi*-group; T, *trirugosum*-group (provisional name).

bution only in Australia. The *melatum*-group (7 spp.) occurs in both Papua New Guinea (also Irian Jaya) and Australia although it is more abundant in Papua New Guinea.

The *sherwoodi*-group (6 spp.), recently proposed by Takaoka (1995), is limited to the Solomon Islands and Bougainville Island. In the Oriental Region, eight and one *Morops* species were reported from the Philippines and Sulawesi, respectively, of which one (from Palawan Island) was placed in the *alienigenum*-group (provisional name) and the others were in the *banauense*-group (provisional name); one more species found in Sri Lanka (Davies and Györkös, 1988) was also provisionally treated to represent the different group (*trirugosum* group) by itself. The last four species-groups possess the male genitalia with parameral hooks, which are atypical among *Morops* (Takaoka, 1983, 1995; Davies and Györkös, 1988).

IIb-3. Subgenus *Nevermannia* (Fig. 7)

There are three species-groups of *Nevermannia* in these regions, which are much different morphologically from each other. The *vernum*-group, of an apparently

Holarctic origin, is widely distributed in north India, Indochina, south China, and adjacent continental islands, such as Taiwan and Java (2 spp. each) and also occurs on the oceanic islands (*S. (N.) aberrans* in north Luzon and *S. (N.) bonninense* in Hahajima Island of the Bonin Islands). The *feuerborni*-group is a small group comprising 12 species, of which 10 species are distributed in the Oriental Region, one species, *S. (N.) sasai*, is in the Palaearctic Region and one species, *S. (N.) mie*, is in both regions. In Southeast Asia, its range extends eastward to Bali Island (1 sp.), Sulawesi Island (1 sp.) and Mindanao Island (1 sp.). The *ruficorne*-group, which has a wide distribution in the Ethiopian, Palaearctic, Oriental and Australasian Regions, includes only six species in the latter two regions, of which *S. (N.) aureohirtum* and *S. (N.) ornatipes*, both autogenous in ovarian development (Hunter, 1977; Takaoka, 1989), are widely distributed in the Oriental and Australasian Regions, respectively. The ranges of both species are separated from each other by the strait between Irian Jaya and the Maluku Islands, though in the latter islands only Halmahera is inhabited by *S. (N.) aureohirtum*; this species also exists in Flores Island of the Lesser

Figure 7 The distributions of three species-groups of the subgenus *Nevermannia*. F, *feuerborni*-group; R, *ruficorne*-group; V, *vernum*-group (not confirmed from Sumatra, though included).

Sunda Islands (unpublished data). The other four species of the *ruficorne*-group have a restricted range: *S. (N.) angustitarse* in south China, *S. (N.) glatthaari* in Sumatra, *S. (N.) neornatipes* in New Caledonia, and *S. (N.) norfolkense* in Norfolk Island.

IIb-4. Subgenus *Simulium* s.str. (Figs. 8, 9 & 10)

Twelve species-groups of the subgenus *Simulium* s.str. are known in the Oriental Region but not in the Australasian Region except one species of the *melanopus*-group recorded from Seram of the Maluku Islands (unpublished data), just east of Weber's Line redrawn in 1904. The *tuberosum*- and *malyschevi*-groups are generally distributed in the Holarctic Region (Fig. 8). The *malyschevi*-group is represented by three species in south China, one of which occurs also in northeast India. The *tuberosum*-group (13 spp.) is widely distributed not only in the Asiatic mainland but also in the continental islands, such as Sumatra (2 spp.), Java (1 sp.), Borneo (2 spp.), Palawan Island (1 sp.) and the Ryukyu Islands (1 sp.). The *ornatum*- and *variegatum*-groups, which are morphologically very close to each other, are widely distributed in the Palearctic Region, of which the *ornatum*-group has only two species in the Oriental Region, one in south China and

the other in northwest India; on the other hand, the *variegatum*-group has a wide range mostly in the mainland of the Oriental Region, where it is represented by 13 species (Fig. 8).

The three species-groups, i.e., *griseifrons*-group (9 spp.), *striatum*-group (14 spp.) and *multistriatum*-group (9 spp.), which are apparently allied to one another, are widely distributed in the mainland and adjoining continental islands of the Oriental Region (Fig. 9), of which the *griseifrons*- and *striatum*-groups are spreading both northeastwards and northwestwards into the Palearctic Region. The *multistriatum*-group extends only northwestwards into Central Asia. Both the *multistriatum*- and *striatum*-groups are well represented in India by five and six species, respectively.

All the other five species-groups have their ranges only on the islands except the *nobile*-group, which, in addition to its probable distribution center on the Philippines (6 spp.), is also represented by two species in the Asiatic mainland (1 sp. in northeast India and 1 sp. from northeast India to south China through Thailand), and also by one species in Taiwan (Fig. 10). The *melanopus*-group is mostly distributed in the Philippines (14 spp.); it is also represented in Sulawesi (4 spp.), Borneo (3 spp.), Peninsular Malaysia (1 sp.), and the

Figure 8 The distributions of four species-groups of the subgenus *Simulium* s.str. M, *malyschevi*-group; O, *ornatum*-group; T, *tuberosum*-group; V, *variegatum*-group.

Sunda Islands from Sumatra to Flores (3 spp.). The one undescribed species of this species-group was found on Seram Island of the Maluku Islands, representing the easternmost distribution of the subgenus *Simulium* s. str., as already noted. In the Sunda Islands (Sumatra, Java and Flores) there are two small species-groups, i.e., *eximium*-group (3 spp.) and *celsum*-group (provisional name, 2 spp.). The most striking finding is the new species-group (yet unnamed) found only on Sulawesi Island, which consists of 11 new species (unpublished data).

III. SUMMARIZED DISTRIBUTION PATTERNS AND POSSIBLE DISPERSAL ROUTES OF SOME SUBGENERA AND SPECIES-GROUPS

As shown in Figs. 2-4, the genus *Simulium* s.l. as a whole showed a rather simple pattern of distribution, with more subgenera in the Asiatic mainland, progressively diminishing its faunal variety toward the east to the South Pacific, reflecting the geographical situations. The similar tendency was already reported in many other groups of insects (Gressitt, 1961).

The more definite patterns of distribution were demonstrated at the subgenus and species-group levels. The 11 subgenera of the genus *Simulium* s.l. recorded in

these regions are divided into five groups on the basis of their distribution patterns: the first group is an essentially Holarctic or Palaearctic, apparently is penetrating to varying extents from the north to the Oriental Region (eg., *Eusimulium*, *Byssodon* and *Montisimulium*, all confined to the mainland or nearby continental islands), and further extending their eastward ranges up to the Australasian Region (*Simulium* s.str. and *Nevermannia*); the second is confined to the Asiatic mainland (*Himalayum*); the third has its distribution center on the continental islands (eg., the Sunda Islands) and is widely extending northwards into the Asiatic mainland and eastwards beyond the Weber's Line (*Gomphostilbia*); the fourth is almost the same as the third except its distribution center on New Guinea and its westward and southward dispersals (*Morops*); the fifth is characterized by an exclusively insular distribution (*Wallacellum*, *Inseliellum* and *Hebridosisimulium*). The last five subgenera are morphologically similar to one another, and certainly must have derived from a common ancestor, but their phylogenetic relationship has not been elucidated yet. None of the subgenera has been attempted to reconstruct its phylogeny, except *Inseliellum* which is presently under study by Dr. D. A. Craig (pers. commun.).

Figure 9 The distributions of three species-groups of the subgenus *Simulium* s.str. G, *griseifrons*-group; M, *multistriatum*-group; S, *striatum*-group.

The subgenus *Simulium* s.str., though generally regarded as a cosmopolitan, is heterogenous in element, including eight species-groups whose ranges are mostly in the Oriental mainland and/or islands. They also exhibit two different distribution patterns, i.e., center of distribution being on the continent and/or continental islands in one group (eg., *griseifrons*, *multistriatum*, *striatum*, *eximium*, and *celsum*), and on the oceanic islands in the other (*nobile*, *melanopus*, and the unnamed group on Sulawesi). All these species-groups apparently had developed in tropical Asia. The first group may be inferred to have been inferior to the second group in over-sea dispersal abilities or in adaptabilities to insular environments. In the second group, supposedly the local speciation of the *nobile*-group had taken place on each island of the Philippine Archipelago and a few of its descendants had then undergone their westward and northward movements to reach northeast India, south China and Taiwan. This hypothesis on dispersal may be supported by the morphological characters, such as the variation in number and shape of the pupal gill filaments in the *nobile*-group, assuming that the pupal gill filaments tend to decrease in number and to become inflat-

ed in the process of the specialization. The similar dispersal from the Philippines might have been done also by the *melanopus*-group, according to the morphological changes in the female genitalia, particularly, in the paraprocts (Takaoka, 1983). The unnamed species-group found in Sulawesi is different from the former two species-groups by presenting a remarkable intra-island speciation.

The difference in colonization of oceanic islands by these species-groups (also by the three insular subgenera) may have been caused not only by the difference in the over-sea dispersal abilities of the adults and the adaptabilities of the immature stages to the various insular environments but also by the difference in the time of their ancestor's arrival(s) and various geological events on each island in the past.

Among the species-groups widely distributed in and outside the Oriental Region, the *ruficornis*-group of *Nevermannia* seems to have well conformed to warm climate conditions and also to very slow-flowing waters since it was often found to inhabit lowland ditches with the water temperature of 30 °C or more in paddy fields where no other black fly species usually could live

Figure 10 The distributions of five species-groups of the subgenus *Simulium* s.str. C, *celsum*-group (provisional name); E, *eximium*-group; M, *melanopus*-group; N, *nobile*-group; X, unnamed group.

(unpublished data). Interestingly *S. (N.) glatthaari* and *S. (N.) aureohirtum* in the Oriental Region have eight and six pupal gill filaments per side respectively, while all the other species in the Palearctic, Ethiopian and Australasian Regions have four gill filaments. As inferred for the *nobile*-group, it may be speculated that the *ruficorne*-group had originated in Southeast Asia (probably in or near Sumatra) and had migrated both eastwards and westwards. On the other hand, the *vernum*-group of *Nevermannia* inhabits only high mountains over 1000 m in altitude with cool climate conditions in Peninsular Malaysia, Java, Taiwan and Philippines (Takaoka and Davies, 1995, 1996; Takaoka, 1979, 1983). The relic distribution of this species-group may be explained by their influx into Southeast Asia from the north at the Pleistocene glaciations and their subsequent retreat northwards, leaving several species only at the high elevations where the climate was cool enough to support their breeding. This species-group would be predicted to be found also at the Mt. Kinabaru (alt., ca. 4100 m) in north Borneo and at the Mt. Kerinci and others (alt., over 3000 m) in Sumatra if explored.

The *tuberosum*-group of *Simulium* s.str., which seems to be less susceptible to the high temperature conditions, is distributed not only on the mainland but also on the continental islands, such as Sumatra, Java,

Borneo and Palawan, all of which are situated on the Sunda continental shelf delimited by the contour of 180 m below sea surface. The colonization of these islands in tropical Asia by this species-group might have occurred also during the Pleistocene glacial periods when these islands had been connected. The relatively poor representation on each continental island by these two species-groups, only one or two endemic species (Takaoka and Davies, 1995), might have been due to the shortage of time to allow subsequent local speciation.

IV. THE *SIMULIUM* FAUNA AND THE WALLACE'S AND WEBER'S LINES

The Wallace's and Weber's Lines are the zoogeographical boundaries separating the Oriental from the Australasian Region. The significance of these lines differs by the different groups of animals (Mayr, 1944). The modified Wallace's Line (Huxley's Line) united by the Kano's Line coincides well with the western edge of the range of the insular subgenus *Wallacellum* (Figs. 1 & 4), and the Wallace's Line 1910 corresponds to the eastern edge of the *feuerborni*-group range (Figs. 1 & 7). However the more drastic change of the *Simulium* fauna is likely to be seen on both sides of the Weber's Line. In the Philippines the Oriental elements (72% or 41 of 57 total spp., i.e., *Nevermannia* 4 spp., *Gomphostil-*

bia 13 spp., and *Simulium* s.str. 24 spp.) outnumber the Australasian element (14%, *Morops* 8 spp.) (Takaoka, 1983). The Sulawesi fauna of *Simulium* s. l. is also characterized by the predominance of the Oriental elements (92.8% or 26 of 28 total spp., i.e., *Nevermannia* 2 spp., *Gomphostilbia* 9 spp. and *Simulium* s. str. 15 spp.) and the impoverishment of the Australasian element (3.5%, *Morops* 1 sp.) (Takaoka and Roberts 1988; unpublished data). The fauna of Flores Island of the Lesser Sunda Islands is all represented by the Oriental elements (*Nevermannia* 1 sp., *Gomphostilbia* 4 spp. and *Simulium* s.str. 3 spp.) (unpublished data). On the other hand, in the Maluku Islands, just east of the Weber's Line, the Australasian element (50% or 7 *Morops* spp. of 14 total spp.) somewhat predominates the Oriental elements (43%, i.e., *Nevermannia* 1 sp., *Gomphostilbia* 4 spp., and *Simulium* s.str. 1 sp.) (unpublished data).

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